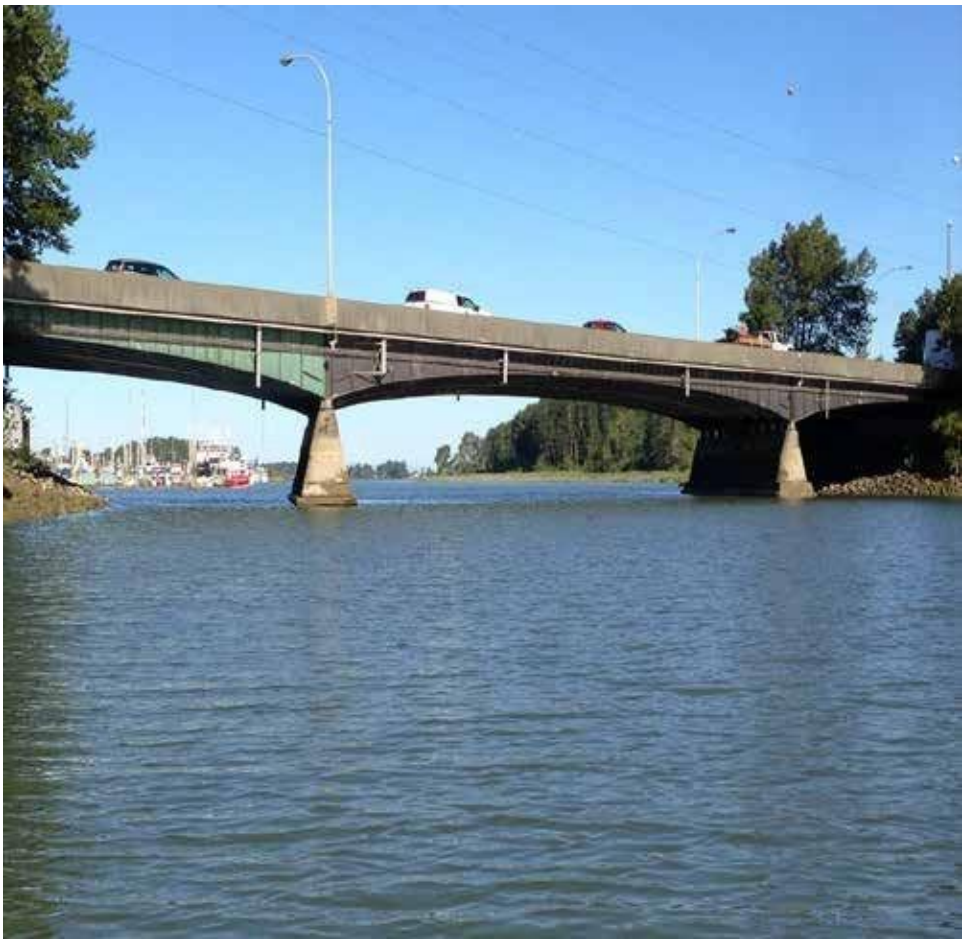
Environmental Input to GMC Multiple Accounts Evaluation



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Ministry of Transportation and Infrastructure
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EXECUTIVE SUMMARY

Hemmera conducted an evaluation of the potential environmental effects of six George Massey Crossing options, in support of the development of a Multiple Accounts Evaluation analysis, based on the high level design concepts provided by the Ministry of Transportation and Infrastructure's technical consultant team. Three technologies each with six-and eight-lane configurations are being considered as candidate options to address the problem of congestion at the existing George Massey Tunnel; deep bored tunnel (DBT), immersed tube tunnel (ITT) and bridge. All six options include two lanes of transit and multiuse pathways for pedestrians and cyclists. For the six-lane options and both DBT options the multiuse pathways would be in the existing George Massey Tunnel, which would require seismic retrofit.

The evaluation was completed using performance measures framework developed during Phase 1 of the Project. Performance measures relevant to the environment were evaluated, with the following outcomes:

	Agriculture	Industry	Fish & Wildlife	Noise & Light	Air Quality / GHG	Regulatory
DBT	🔴	🟡	🟡	🟡	🔴	🔴
ITT	🟢	🟢	🟡	🟢	🟡	🟡
Bridge	🟡	🟢	🟡	🔴	🟢	🟢

Consistency with project objectives: 🟢 = aligned, 🟡 = somewhat aligned, 🔴 = not aligned

Agriculture: ITT and bridge options have the least agricultural land impacts. The bridge options include one additional agricultural crossing of Highway 99 in Delta near River Road. Nighttime agricultural access across the Fraser River will be possible for all options.

Industry: No industrial lands are directly affected by any options. Access to Highway 99 from industrial areas will be longer for the DBT option.

Fish / Wildlife: All options except the 8-lane bridge affect fish and fish habitat; due to in-river activities. Tunnel options have high temporary habitat effects, much of which can be offset by habitat creation opportunities. DBT options have least effects on Deas Island Regional Park but have the greatest potential risk associated with effects of a sink hole.

Noise / Light: Tunnel options have the lowest long-term noise and light impacts. Construction noise (pile driving) is higher for DBT and bridge options.

Air Quality: Overall outcomes will be better than experienced currently (fewer emissions). Emissions from the bridge option will be more dispersed, whereas tunnel emissions will concentrate at the portals. The DBT has the least favourable outcomes.

The regulatory process can be expected to be about two years for the bridge options; reflecting an EAC amendment path. The ITT and DBT options would require a new three to four year-long provincial Environmental Assessment review.

Agricultural Land Uses

Crossing options that include a DBT were found to have the greatest effect on agricultural land use, during construction and operations, due to their land requirements for tunnel portals. Crossing options involving the DBT are anticipated to require in the range of 54 ha of agriculturally-designated land (Agricultural Land Reserve). During construction an additional 12 ha of agriculturally designated land would be required for ground improvement activities above the DBT. Agricultural land that is temporarily required for construction would need substantial post-construction improvements to avoid the effects of soil compaction and lost fertility. ITT and bridge crossing options were determined to have lesser effects on agricultural land use at approximately 2-3 ha and 7 ha respectively, which is less than that of the previously approved George Massey Tunnel Replacement Project.

Compensation for effects to individual land users, and for overall impact to agricultural productivity can be assumed necessary, but particularly so for the DBT options. In addition, given the magnitude of potential effects associated with the DBT crossing options, it is assumed that permitting for non-agricultural use of agricultural lands under the Agricultural Land Commission process would require schedule considerations.

Agricultural Access (Highway 99 crossings)

All options would maintain the same agricultural equipment passage across Highway 99 as is currently available, i.e., at Steveston Highway and Highway 17A. The 8-lane DBT option gives more crossing opportunities, but both the ITT and bridge options can accommodate additional agricultural crossings at the current location of River Road. Continued use of the existing tunnel for transit and multiuse pathways may prevent more agricultural crossing locations, especially for 6-lane options.

Currently there is no agricultural equipment passage across the Fraser River on Highway 99, as regulations prohibit such use. All options enable nighttime passage of farming equipment such as tractors and self-propelled harvesters; though changes to current highway use regulations would be required.

Agricultural Parcel Effects

The DBT crossing options have the greatest potential effect on agricultural parcels, both during construction and operations, with up to 19 parcels fully or partially affected. Potential effects on agricultural parcels include those from parcel isolation (fragmentation) and loss of productivity.

The ITT and bridge crossing options are anticipated to have small effects on one to four parcels with the bridge options resulting in fragmentation of three agricultural parcels.

Industrial Land Uses

There are few direct effects to industrially-designated lands in Richmond as a result of the crossing options. The ITT option may temporarily (during construction) affect industrial lands. No industrially-designated lands in Delta are affected by the crossing options.

Crossing improvements across the Fraser River would improve travel times for industrial traffic, and all options would be designed for transportation of dangerous goods. However, during construction for all options, access to Highway 99 from industrially-designated areas would likely alter industrial traffic (along with other traffic) connections and travel duration. The DBT option would have greater travel distances for access between industrial areas and Highway 99 than today or would be the case for the bridge and ITT crossing options.

Habitat Losses

All crossing options that include continued use of the existing tunnel for transit and or multiuse pathways would affect between two and three hectares of fish habitat. This would require offsetting and mitigation for fish including underwater noise and turbidity effects on fish and marine mammals.

The ITT option would affect 8 to 10 hectares of fish habitat due to installation of new tunnel tubes in the riverbed and riparian areas, ground densification and the dry dock. This option has the greatest potential for temporary effects on fish habitat, much of which can be offset by habitat creation generated within this option.

The DBT option has the least effect on habitat for terrestrial wildlife, whereas the ITT and bridge options would directly or indirectly affect between one and two hectares of wildlife habitat close to Deas Island Regional Park and Deas Slough. The bridge options would have effects that are similar to or slightly greater than those of the previously approved George Massey Tunnel Replacement Project.

Habitat Creation and Connectivity Opportunities

The 8-lane ITT and bridge options have the greatest potential for habitat creation for fish and wildlife because the existing tunnel infrastructure would not be maintained, allowing for on-site wetland offsetting on Ministry right-of-way at the south portal of the existing tunnel. The ITT option also has the potential for post-project rehabilitation of the construction dry dock which, if strategically chosen in an area of low fish and wildlife values, could provide for increased post-project habitat values.

Total consolidation of habitat in the two portions of Deas Island Regional Park currently separated by the Highway 99 right-of-way is only achieved by the 8-lane bridge option, which itself introduces shading effects. However, all options provide some opportunities to enhance the park on the west side of the current tunnel portal.

Improvements to Habitat or Water Quality

Seismic upgrade of the existing tunnel may provide an opportunity to upgrade its current water treatment, which is direct discharge to the Fraser River. Although all options can include water quality management (e.g., diversion and treatment), only the 8-lane bridge and ITT options that abandon the existing tunnel directly address effects to water quality associated with the current operation of the tunnel.

Notwithstanding operational phase water quality considerations, substantial water quality management would be required, to address sediment and turbidity associated with the DBT (potential effects on groundwater) and ITT (in-river potential effects) options.

Noise and Light Pollution

Noise levels for the two tunnel technologies, particularly around the Fraser River crossing area would be lower than levels predicted in the studies for the previous George Massey Tunnel Replacement Project. The DBT portals are farther north and south (and larger) than the ITT options, thus there would be a larger area around the Fraser River crossing with lower noise. Operational noise effects from the bridge options would be very similar to those predicted by the studies for the previous project. Deas Island Regional Park would experience noise levels similar to those predicted in previous project studies. During construction noise from ground densification and pile driving associated with the DBT and bridge options would be of greater intensity and duration, over a wider area and closer to residential properties than for the ITT option.

Lighting impacts for the tunnel options would be similar, though in different locations for the DBT option, to those of the existing situation, and less than the bridge impacts predicted in previous project studies. The effects of the bridge option would be similar to those predicted in the previous project studies. No adverse effects from the bridge option to receptors including fish and fish habitat as a result of changes to ambient light conditions are anticipated, though lighting on Deas Island for the bridge options is a possible effect on nocturnal wildlife (bats and birds).

Greenhouse Gas Emissions and Air Contaminants

All options would have improvements in air quality and GHG as compared to the existing condition, in large part due to improvements in vehicle emission standards. The bridge option, being an elevated structure, would provide for better air dispersion of vehicle emissions and reduce potential effects on air quality associated with localized emissions concentrations as compared to the tunnel options. The DBT option with more complex and longer lane configurations at interchanges is expected to have higher emissions affecting air quality and GHG than the other options.

Regulatory Path

Provincial environmental assessment requirements based on current *BC Environmental Assessment Act* (BCEAA) triggers under the *Reviewable Projects Regulation* are exceeded for all crossing options, except the 8-lane bridge. The tunnel crossing options and the 6-lane bridge option exceed the two hectare regulatory trigger for sub-surface riparian disturbance due to Fraser River densification activities associated with seismic upgrades to the existing tunnel or the new ITT installation and dry dock. The 8-lane bridge option has no clear BCEAA trigger, however, an amendment to EAC #T17-01 (George Massey Tunnel Replacement Project, 2017) is assumed necessary due to design and operation changes associated with the proposed bridge options.

The potential for an amendment to the existing EAC for the bridge options is possible given that the extent and nature of potential effects of bridge options are similar to those considered during the assessment of the George Massey Tunnel Replacement Project. An EAC amendment process (“complex path”) is likely a two year-long undertaking, as compared to a three to four year regulatory schedule for a new environmental assessment under the new BCEAA.

New BCEAA regulations triggering environmental assessment review are understood to include primary project thresholds such as that noted above for in-water effects, secondary effect thresholds for GHG emissions (382,000 tonnes) and notification trigger thresholds for workforce size (>250). All crossing options would exceed the notification trigger for workforce.

For all crossing options, notwithstanding changes to federal environmental assessment legislation under the *Impact Assessment Act*, no review would be required because the bridge, tunnel and highway thresholds in the *Physical Activities Regulations* are not exceeded. The relevant thresholds from the *Physical Activities Regulations* are (i) an interprovincial or international bridge or tunnel s.48(a), and (ii) a 75km all-season highway on a new right-of-way s.51. No federal land is involved, and the provision of federal funding and or the requirement for federal permits does not trigger an environmental assessment.

Regardless of the regulatory triggers associated with federal and provincial environmental assessment legislation, provincial and federal ministers reserve the right to require environmental assessment if, in their opinion, such a review is in the public interest. The DBT option may elicit consideration for designation as a physical activity by the federal minister given the prevailing seismic conditions of the area, the propensity for deep bored tunnels to develop sink holes, and the importance of the Fraser River.

Requirements for permitting under the federal *Fisheries Act* would likely have substantial option to option variations in schedule, approvability or offsetting requirements, with the ITT having the more complex requirements.

Provincial *Water Sustainability Act* and *Agricultural Land Commission Act* (ALC) permitting would be required for all options. ALC permitting for the DBT option would need to be factored into schedule considerations.

For all project options, regardless of whether a new regulatory process or an EAC Amendment might be pursued, the key factor influencing the regulatory schedule will be securing a broad base of support for the preferred option amongst Indigenous groups, the public and stakeholders. Consensus on a preferred solution likely would help shorten the timeframe for the provincial review.

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1.0 INTRODUCTION

This document provides environmental input for the George Massey Crossing (GMC) project team to consider in respect of the development of a multiple-accounts evaluation (MAE) analysis of crossing options being considered to replace the George Massey Tunnel (existing tunnel).

The six options under consideration for the GMC project are as follows:

1. New 8-lane deep bored tunnel, and a multiuse pathway in the existing tunnel
2. New 6-lane deep bored tunnel, and a multiuse pathway and two lanes of transit in the existing tunnel
3. New 8-lane immersed tube tunnel with two lanes of transit and a multiuse pathway (existing tunnel remains in place, for utilities only)
4. New 6-lane immersed tube tunnel, and a multiuse pathway and two lanes of transit in existing tunnel
5. New 8-lane bridge with a multiuse pathway (existing tunnel remains in place, for utilities only)
6. New 6-lane bridge with a multiuse pathway, and two lanes of transit in the existing tunnel

Each of the six options were evaluated for the crossing study area along Highway 99 from north of the Steveston Highway crossing of Highway 99 to just south of the Highway 17A crossing (approximately the City of Delta Works Yard). Evaluations were conducted in the following discipline areas:

- Aquatics and aquatic habitat – Jim Roberts, R.P.Bio.
- Agriculture and land use (industrial land zoning) – Ruth Hardy, P.Ag.
- Air Quality/Noise – Mark Milner, P.Eng.
- Terrestrial ecology – Charlie Palmer, P.Biol., R.P.Bio.
- Environmental Permitting – Malcolm Smith R.P.Bio., Charlie Palmer and Ruth Hardy

This environmental information for the MAE focuses identifying substantial environmental constraints including potentially significant environmental effects, regulatory approval risk, significant offsetting, and public and stakeholder concerns. The framework and layout of the environmental analysis conducted by Hemmera reflects the pre-established principles and goals for the GMC project, which are available on the project website.

In performing this analysis, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This analysis was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered be valid at the time this report was produced. The conclusions and recommendations contained herein are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

2.0 METHODS

This environmental evaluation reflects the already established principles and goals for the GMC project.

The overall principles for the GMC project have been determined as:

a. alignment with regional objectives and respect for Aboriginal interests
b. safety
c. reliability
d. connectivity

Within these principles there are four goals, each with specific performance indicators:

1. Support the sustainability of Fraser River Communities
2. Facilitate an increased share of sustainable modes of transport
3. Enhance regional goods movement and commerce
4. Support a healthy environment

Qualitative evaluations were conducted based on the available design information for the six options, as provided in plans and descriptions provided by the Ministry of Transportation and Infrastructure and interviews. The evaluations were conducted qualitatively to describe the extent and magnitude of environmental effects associated with each option. Effects conclusions are estimates based on high-level expert-led assessments of the information available for each option. The methods were applied consistently across options.

In addition, high level input into the mitigation (including offsetting) requirements to address the potential effects from each option, and the additional studies that would be required to replace or augment the results of studies conducted for earlier work on the George Massey Tunnel Replacement Project in and around 2015-16 were described. These were based on expert-led evaluations of each of the options. The intersection with known environmental values including considerations for the mitigation associated with the provincial approval of the George Massey Tunnel Replacement Project was used to inform the mitigation descriptions.

The implications of specific environmental effects on the potential regulatory path for the GMC project were described based on review of regulatory triggers under the revised 2018 *BC Environmental Assessment Act* due to come into force in late 2019, the federal *Impact Assessment Act* and related provincial and federal permit requirements.

The specific methods used for the evaluations of each environmental discipline will be described in the sub-sections within **Sections 4.0**, **5.0** and **6.0**.

2.1 Study Area

The study area for this evaluation is the Highway 99 corridor and adjacent lands intersecting with or influenced by each of the options, which is approximately 100 m west of and 200 m east of the existing Highway 99 alignment. The study area runs from 500 m north of the Steveston Highway crossing of Highway 99 to 500 m south of the Highway 17A crossing (approximately the City of Delta Works Yard). For consistency, the delineation of the evaluation area is the same for all options regardless of the option footprint.

For some disciplines a wider assessment area to provide context has been described, this is the case for agriculture and industry land and land uses (i.e., the boundaries of the City of Richmond, and the Corporation of Delta) and air quality (i.e., the boundaries of Metro Vancouver).

2.2 Assumptions

Agriculture / Industry

- Land requirements for construction activities such as for traffic diversions and laydown areas outside the footprint have not been included. Offsite ITT dry dock requirements are included.
- Due to preliminary layout information for each option the amount of affected land was estimated.
- There are no industrial tenures (Crown land) in the Fraser River within the existing highway right-of-way. Construction activity impacts outside the right-of-way, if necessary, are not considered because construction phase details are not yet known.
- Agricultural Land Use Inventory 2016 information has not substantially changed and remains applicable for this assessment.
- Industrial land includes that zoned for light and heavy industry and commercial uses.
- Excavations for the DBT portals and the tunnels are approximately 80 m wide, and that the excavated length for the tunnel portals is approximately 400 m, and for the densification approximately 600 m for each portal.

Fish and Wildlife

- Fish habitat values within upland ditches that flow into the Fraser River and/or sloughs through flood control infrastructure (dikes with flood gates and pumps) are considered to be low, such that replacement with similar ditch features during project delivery can occur without *Fisheries Act* Authorization (FAA) or offsetting. This assumption considers recent revisions to the federal *Fisheries Act*, which have reinstated protections for all fish and fish habitat[1].
- Riparian habitat values are considered to apply within a maximum 30 m setback from any higher value features (e.g., Fraser River, and Deas or Green sloughs) where native vegetation is present.
- Ground densification (stone column) and pile driving on Deas Island and other locations within 30 m of high value water features (e.g., Fraser River, Deas Slough, or Green Slough) is required for all options. The extent of noise impacts on fish are difficult to predict at this time, though the bridge and ITT will likely have the greatest such effects.
- The 8-lane ITT and bridge options would require replacement of the existing Deas Island Bridge on a new alignment. The existing Deas Island Bridge would be replaced with a pedestrian / cycle bridge allowing repatriation of the artificial peninsulas in Deas Slough as fish habitat.
- For all 6-lane options, seismic upgrades to the existing Deas Island Bridge to allow bus and or bicycle / pedestrian use, and both DBT options will include in-water or sub-surface activities and would therefore have aquatic or riparian habitat impacts. Pedestrian and bicycle only use could be accommodated (DBT 6-lane option) by decommissioning the existing Deas Island bridge and replacing it with a footbridge.

[1] The federal Fisheries Act has been modernized (effective August 28, 2019) and reinstates protection for all fish and fish habitat (i.e., replacing focus on fish that support commercial, Aboriginal or recreational fisheries as previously applied).

- The temporary dry dock required for ITT options could be located at a riparian site currently characterized by low (or even degraded) value fish and wildlife habitats to limit environmental impacts. This would also facilitate habitat creation during dry dock decommissioning.
- For the 6-lane ITT option, the in-river disturbance from densification (stone column work) is approximately 5 ha; it is also understood that there may be some overlap between this impact area and seismic upgrade work required for the existing tunnel. As a result, this is a conservative calculation.
- For the bridge options, each pile cap would have dimensions of 45 m x 15 m (675 m^2). Furthermore, it is assumed that bridge piers would be located directly adjacent to the edges of both the Fraser River and Deas Slough with resultant impacts on riparian (but not aquatic) fish habitats.
- For bridge option densification (stone columns) would be required around each pier. It is assumed that densification would extend 10-15 m from each pier and these areas would be unavailable for post-construction fish habitat creation and/or restoration.
- For the bridge options, areas greater than 15 m from any piers and located underneath the bridge would be available for aquatic or riparian habitat creation. Additionally, the bridge deck would be high enough that potential shading or drought effects that might impair the function of potential created habitat (e.g., impacts on riparian plants) could be partially avoided, or minimized including the beneficial re-use of runoff water.

Air quality, Noise and Light

- Projected traffic numbers for the crossing are assumed to be less than those used for predictions in the George Massey Tunnel Replacement Project EA, but with congestion in peak hours. Traffic number projections are assumed to be broadly similar between each option, but greater congestion and therefore longer travel times associated with the DBT suggests emissions might be higher.
- The assessment of air and noise primarily focuses on the operation phase. While there are likely to be option-to-option differences in the duration and type of construction activities required, the effects from this phase are more difficult to predict at this stage of design; however, they will have a much shorter duration and hence a lower effect on air and noise than the operations phase.
- Air dispersion and noise modelling will be conducted as part of a future EA.

3.0 EXISTING CONDITIONS AND PERFORMANCE MEASURES

3.1 Agriculture

3.1.1 Existing Conditions

Most agriculturally used land in the study area is included in the Agricultural Land Reserve (ALR), a provincially protected land use designation pursuant to the *Agricultural Land Commission Act*. All agricultural uses within and adjacent to the proposed crossing options are within the ALR (See **Figure 3.1**). Information on agricultural use and agricultural parcels is drawn from an Agricultural Land Use Inventory ALUI (Metro Vancouver 2016[2]), based on field surveys. Substantial changes to the ALUI since 2016 are not anticipated as the lands are protected for agricultural use by the ALR and are assumed to still be in production although individual crop types may have altered.

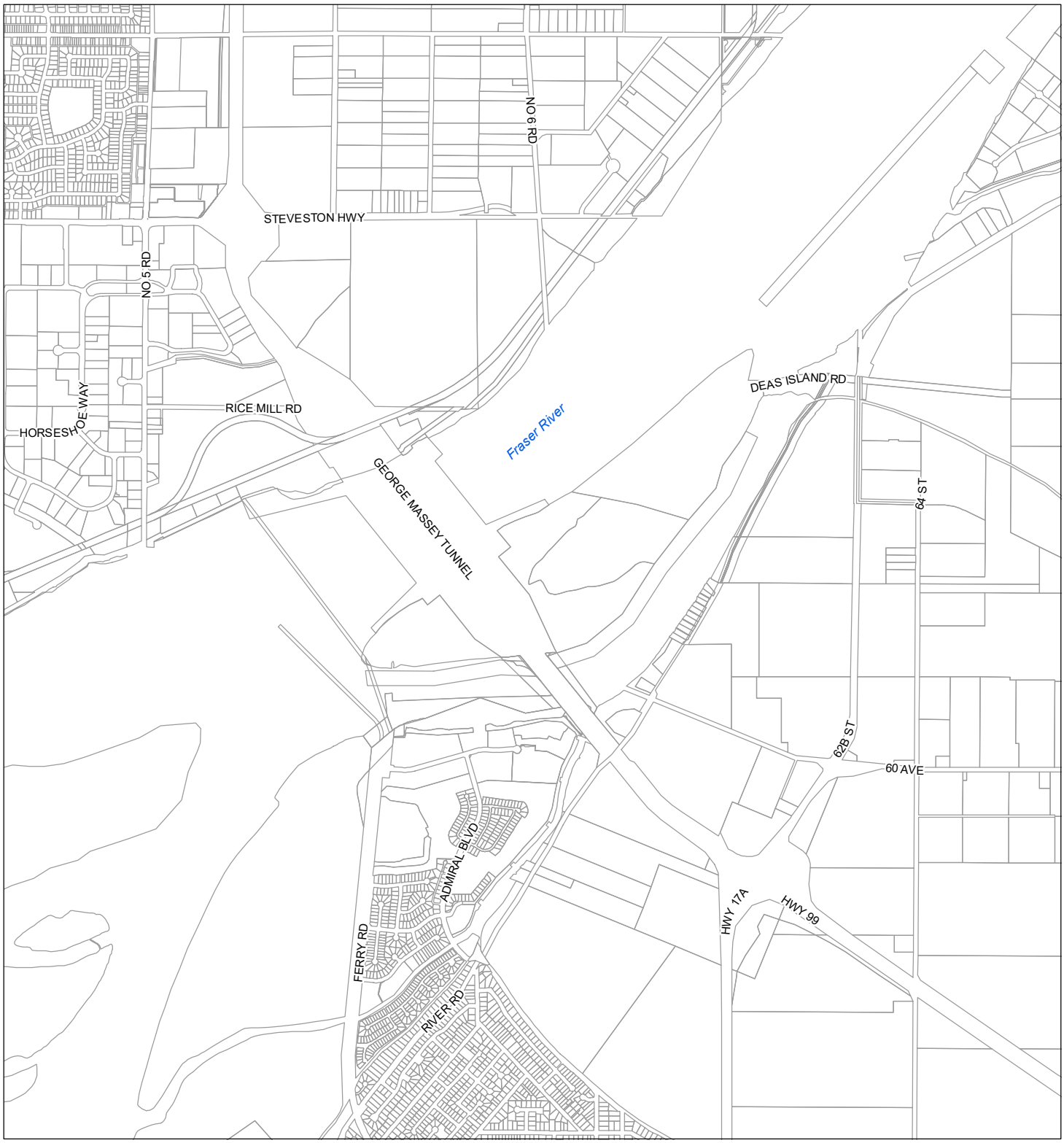
The study area for the assessment includes agricultural uses and land in the ALR from the maximum extents of the north and south connections for each of the options to the existing Highway 99 alignment. ALR boundaries and agricultural parcels are shown in **Figure 3.1**.

Agricultural uses are summarized for the Corporation of Delta (Delta) and the City of Richmond (Richmond) in the ALUI. In Delta, of the 6,517 ha in crops, the main crops are vegetables (41%), followed by forage (28%) and berries (21%). In Richmond, of the 2,645 ha in crops, more than half are berry crops (52%), followed by vegetables (24%) and forage (16%). Areas adjacent to the existing alignment are actively and inactively farmed, with drainage and irrigation infrastructure common.

Of the 123 activities where livestock were identified in Delta, the majority were equine, followed by conventional livestock (e.g. dairy) and poultry. Activities were mainly small-scale, with 2 to 25 animal units. In Richmond, there were 68 livestock activities, also predominantly equine and small-scale. The closest livestock activities to the option footprints are located in Delta are located on the south side between River Road and Highway 17A (one parcel). In Richmond there is a mixed poultry operation identified in the parcel southeast of the Steveston intersection.

Existing access for farm equipment across Highway 99 is provided at the Steveston and the Highway 17A intersections. There is presently no connection from the west side of River Road across Highway 99. Existing access is also available across Highway 99 just south of the South Fraser Perimeter Road (Highway 17) interchange. Section 19.07 of *Motor Vehicle Act Regulations* prevent use of Highway 99 from 1st Avenue in Surrey to the south approach of the Oak Street Bridge by farm implements and farm machinery, whether self-propelled or towed.

[2] Metro Vancouver ALUI 2016 Available here.



Legend

Property Line

Regional Growth Strategy Land Designation

- Agricultural
- Conservation and Recreation
- Industrial
- Mixed Employment
- Urban

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence - British Columbia, GVRD
- Basemap: ESRI World Topographic Base

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George Massey Crossing Multiple-Accounts Evaluation

Regional Growth Strategy Land Use Designation

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3.1.2 Performance Measures

The performance measures established under each of the four goals for the project (**Section 2.0**) are the basis for the assessment of the potential effects on agriculture and industry (**Table 3.1**).

Table 3.1 Performance measures for agriculture

Direction Indicator/Trajectory	Performance Measure	Comment
Agriculture		
Improve movement of farm goods, produce and equipment across the river and across Hwy 99 in Richmond and Delta. *Increase in land use productivity.*	*BC Fresh Spoilage Counts* *Access to crossing [of Highway 99 and the Fraser River] for farm equipment* *Land use inventory (Agriculture Use)*	*See **Sections 4.1.1, 5.1.1** and **6.1.1**.* *Consider the number of existing crossings affected and the number of proposed new crossings* *Consider the area of agricultural land (either in use or in the ALR) that may be affected*
Minimum no net loss. *Opportunities for improved drainage and/or irrigation.*	*# of parcels connected / isolated*	*Consider the number of agriculturally designated parcels within the footprint, and the number in which a portion of the parcel may be isolated from the remainder*

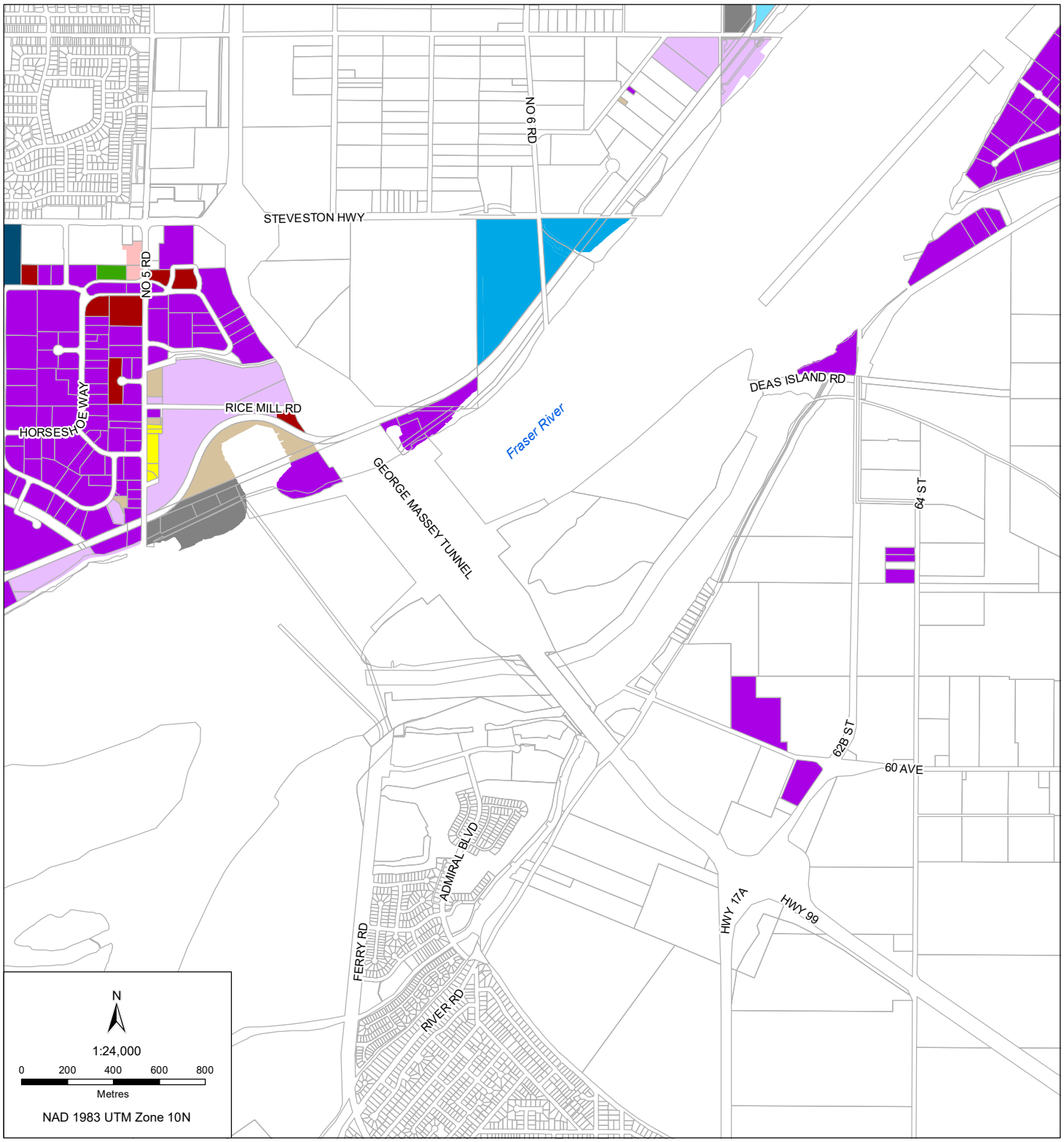
3.2 Industry

3.2.1 Existing Conditions

This assessment of potential effects to industry considers designated industrial and commercial land use parcels, and effects related to the isolation of portions of parcels from the remainder of the parcel, and access to industrial areas. Industrial land use designations have been taken from the *Metro Vancouver 2040 Regional Growth Strategy*[3]. Additional land use designations in the Richmond and Delta Official Community Plans provide greater disaggregation of industrial uses however they are in alignment with the Regional Growth Strategy and are not likely to substantially change the assessments.

Designated Industrial areas are intended for heavy and light industrial activities and appropriate accessory uses. Mixed Employment areas are intended for industrial commercial and other employment-related uses that complement Urban Centres and Frequent Transit Development Areas. The Regional Growth Strategy designates industrial lands in Richmond to the east and west of Highway 99. On the west side industrial land abuts the Highway 99 right-of-way from the Fraser River north to Jacobson Way and west to No. 5 Road, north of Jacobson Way is Mixed Employment. On the east side of Highway 99, lands are designated Industrial adjacent to the Highway from the Fraser River to just north of the railway (**Figure 3.1** and **Figure 3.2**).

[3] Metro 2040 Shaping Our Future Regional Growth Strategy. Available here.



Legend

- Property Line

Industrial Lands Inventory (Metro Vancouver 2015) Detailed Type of Land Use

- Industrial - General
- Industrial - Outdoor Storage
- Industrial - Resource Extraction
- Non-Industrial - Commercial (small or medium-scale)
- Non-Industrial - Office
- Non-Industrial - Recreation
- Non-Industrial - Residential
- Transportation Infrastructure - Developed Port Terminal
- Transportation Infrastructure - Vacant Port Lands
- Transportation Infrastructure - Other
- Vacant Land

Sources

- Contains information licensed under the Open Government Licence - British Columbia, GVRD
- Basemap: ESRI World Topographic Base

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George Massey Crossing
Multiple-Accounts Evaluation

Industrial Land Use

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Land uses in Richmond to the west of the Highway 99 right-of-way are classified as General Industrial from Jacobson Way to near Steveston Highway, and as predominantly Vacant south of Jacobson Way. There is Gravel Extraction and General Industrial adjacent to the Fraser River. The parcels to the east of Highway 99 right-of-way are General Industrial[4]. In Delta, there are General Industrial uses in Delta south west side of the Highway 17A and 60th Avenue intersection, and on 60th Avenue[5]. Neither are adjacent to Highway 99.

There are no designated industrial lands adjacent to the Highway 99 right-of-way in the Delta study area. Nearby industrially-designated lands near the Vancouver landfill, the Boundary Bay airport, and parts of the Tilbury area may use Highway 99 access points in the study area. There is commercial land at the Highway 99 and 17A interchange, and on Deas Slough (access from Highway 17A).

Industrial land use data were obtained from the Industrial Lands Inventory[6] and the Regional Growth Strategy interactive mapping[7].

3.2.2 Performance Measures

The performance measures established under each of the four goals for the project (**Section 2.0**) are the basis for the assessment of the potential effects on industry (**Table 3.2**).

Table 3.2 Performance measures for industry

Direction Indicator/Trajectory	Performance Measure	Comment
Improve movement of goods across the river. *Reduced travel time and delay. No net loss of industrial land.*	*Average travel time between key nodes* *# of parcels connected / isolated*	*See **Sections 4.2, 5.2** and **6.2*** *Number of industrially designated parcels in the footprint, and where a portion of the parcel may be isolated from the remainder*

3.3 Fisheries and Wildlife

3.3.1 Existing Conditions

The lower Fraser River and estuary provides habitat for fish species of high ecological, social, cultural, and commercial value; salmonids (family Salmonidae), eulachon (*Thaleichthys pacificus*), and sturgeon (*Acipenser* spp.). Salmonids use the lower Fraser River during adult spawning, migration, and juvenile outmigration to marine environments. Juvenile salmonids and sturgeon rear and overwinter in brackish habitats. Eulachon migrate upstream for spawning in the Fraser River and the mouths of large tributaries.

Studies completed for the George Massey Tunnel Replacement Project identified salmon (five species), sturgeon (two species), eulachon, trout and char, and the habitats that support these species, as key values. Common marine mammals, harbour seal (*Phoca vitulina*) are present, with others less frequently noted, i.e., Steller sea lion (*Eumetopias jubatus*) and California sea lion (*Zalophus californianus*).

4 Richmond sub-region land use (2015). Available here.
5 Delta sub-region land use (2015). Available here.
6 Industrial Lands Inventory, Available here.
7 Strategic Plan interactive mapping. Available here.

The GMC crossing options intersect aquatic and riparian areas of value to fish and fish habitat, including in the Fraser River South Arm and Deas and Green sloughs. Although aquatic habitat values are very high, shoreline and riparian areas on the Fraser River in proximity to the potential crossing options are characterized by extensive historical development and are classified as of low (green-coded) or moderate (yellow-coded) productivity by the Fraser River Estuary Management Program (FREMP). Deas Slough, a backwater feature of the Fraser River, has productive (red-coded) shoreline habitats with the exception of the riprap-armoured shoreline in the vicinity of the Deas Island Bridge which is characterized as low (green-coded) to moderate (yellow-coded) productivity habitat. Green Slough, which is tidally- influenced and drains into the lower reaches of Deas Slough is classified as an environmentally sensitive area under Delta's Official Community Plan and is classified as high productivity (red-coded) by FREMP. Upland ditches located landward of dikes and associated flood control infrastructure (e.g., flood gates and pump stations) generally have low fish habitat values and are not further considered in this MAE.

The crossing area has modest wildlife values, a reflection of the current use of this area as a busy highway corridor. Adjacent to the corridor in Richmond and Delta are low-value intensively farmed agricultural fields or highway verges with blackberry-dominated hedgerow and grass habitats utilized by common raptor and songbird species. The riparian areas of the Fraser River are heavily covered in riprap providing habitat for river otter (*Lontra canadensis*) and less frequently great blue heron (*Ardea herodias)*. Second-growth riparian forest and shrublands in Deas Island Regional Park, Green Slough and Captains Cove harbour common songbird and bat species, as well as less common species that utilize anthropogenic structures in and around the park; little brown myotis (*Myotis lucifagus*) in a nearby building roost and barn swallow (*Hirundo rustica*) nesting under the Deas Island Bridge.

3.3.2 Performance Measures

The performance measures established under each of the four goals for the project (**Section 2.0**) are the basis for the assessment of the potential effects on fisheries and wildlife resources (**Table 3.3**).

A range of fish and aquatic resource impact types were considered during the George Massey Tunnel Replacement Project, these were (i) the likelihood of injury or mortality of fish, (ii) changes in suspended sediment (induced turbidity), (iii) changes in underwater sound levels, and (iv) loss of habitat area. Of these four key potential effects, this MAE focuses only on habitat loss by evaluating each option based on anticipated extent of affected fish habitats requiring *Fisheries Act* Authorizations and associated offsetting in order to achieve no net loss. Furthermore, it includes an assessment of the opportunities that might be provided by each option for improvements to fish habitat connectivity, fish habitat quality, and water quality.

With respect to the potential for injury or mortality of fish, changes in suspended sediment, or changes in underwater sound levels, none of these potential effects are directly evaluated by this MAE. It is assumed that these other potential effects which are largely similar to other river construction and maintenance practices which take place regularly in the Fraser River, and are currently managed through standard best management practices, and specialized mitigation when required.

Table 3.3 Performance measures for fisheries and wildlife

Direction Indicator/Trajectory	Performance Measure	Comments
Avoid loss of habitat for fish, wildlife, birds and marine mammals	*No net loss*	*Consider the quantity and quality of fish and wildlife habitats (incl. aquatic and riparian) that will be affected, and anticipated extent of offsetting to achieve no net loss*
	Facilitate opportunities for new habitat	*Consider fish and wildlife habitat creation opportunities for potential use as project-related offsetting*
Improve habitat quality and protect water quality	*Facilitate opportunities for improved habitat connectivity*	*Consider fish and wildlife habitat connectivity improvement opportunities for potential use as project-related offsetting*
	Facilitate opportunities for other improvements to habitat or improvements to water quality	*Consider how many fish habitat quality or water quality improvement opportunities will be provided, for potential implementation by the project*

This MAE primarily focuses on project footprint effects, including the extent of impact and required offsetting and how each option provides opportunities for improvements that would benefit fish and wildlife (e.g., habitat connectivity, habitat quality, and water quality). Reference to other potential effects is included only in cases where substantial challenges are expected as a result of anticipated effects to fish and wildlife.

3.4 Air Quality

3.4.1 Existing Conditions

Air Quality Monitoring and Ambient Objectives

Metro Vancouver (MV) operates a network of 29 air quality monitoring stations, six near the GMC crossing options, to help characterize air quality in the Lower Fraser Valley. The stations in the network primarily measure common air contaminants (CAC), including ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter PM_{10} (particles less than 10 microns in diameter) and $PM_{2.5}$ (particles less than 2.5 microns in diameter). Other air quality parameters monitored in the network although with less geographic extent include ammonia (NH_3), and volatile organic compounds (VOC). Toxic air contaminants (TAC) are also monitored.

Although there are periods of degraded air quality in the Lower Fraser Valley due to the formation of summertime smog during hot weather or smoke from forest fires, the long-term trends generally indicate improvements. Concentrations of SO_2, CO, NO_2, and $PM_{2.5}$ have all improved since the mid-nineties. Reduction in air emissions from stricter vehicle emissions are responsible for decreased levels of CO and NO_2. Recent requirements to reduce sulphur content in fuel used in marine vessels and vehicles, as well as reduced emissions from petroleum refining, and cement plants have made significant gains to decrease SO_2. $PM_{2.5}$ levels have dropped due to reductions in vehicle, wood products and petroleum refining emissions. A slight increase in long-term O_3 has been measured due to an increase in global background concentrations. Region-wide monitoring, and project specific monitoring to inform project approval decisions compares the results against provincial, federal or regional ambient air quality criteria.

Ambient Air Quality

Results of the George Massey Tunnel Replacement Project dispersion modelling (using CALINE and based on the 2011 vehicle fleet) for the existing condition scenario (**Table 3.4**) show that most parameters measured are within the most- stringent relevant Ambient Air Quality Objective (AAQO). The maximum concentrations of CO, NO_2, benzene, and benzo(a)pyrene exceed the most stringent of the AAQO (shaded cells).

The George Massey Tunnel Replacement Project modelling predicted improvement in air quality by 2031 without the project due to improvements in vehicle technologies:

- A 14 % reduction in emissions without the project.
- A 40 % reduction in volatile organic compound (VOC) emissions without the project.
- Two exceedances of the current most stringent air quality objectives for specific air contaminants without the Project.

Greenhouse Gases

Metro Vancouver region greenhouse gas (GHG) emissions have slowly declined (improved) since 1995. In 2015 the GHG emissions for transportation vehicles was 4.7 million tonnes. Based on Metro Vancouver's forecast, vehicle GHG emissions are anticipated to reduce by 35%. Vehicle emission standards and fuel efficiency standards as well as lower carbon fuel vehicles are the primary reasons for the reductions. Heating of homes and buildings as well as industrial GHG emissions are expected to rise 11% and 13%, respectively and thus overall emissions are only expected to reduce by 1% from 2015 to 2035.

In 2007, the Province of British Columbia committed to a legally-binding 80% reduction in GHG emissions by 2050. In 2018, with consideration of the recent progress to reduce emissions, B.C. refined the emission targets to reach a 40% reduction by 2030, 60% by 2040 and 80% by 2050. Current initiatives including building retrofits and renovations, new building planning for net-zero energy, zero-emission vehicles and industry incentives are predicted to have B.C. 75% of the way to the 2030 target by 2030.

Greenhouse gas emissions from traffic along the Highway 99 corridor were expected to decrease, with or without expanded capacity at the George Massey Crossing, as newer engine technologies provide substantial reductions in overall CO_2 equivalent emission levels.

Table 3.4 Estimated maximum and 98th percentile concentrations (µg/m^3) of pollutants of concern – existing conditions

Pollutant	Averaging Period	Maximum Existing Concentration (µg/m^3)	98th Percentile Existing Concentration (µg/m^3)	Ambient Air Quality Objective (µg/m^3)
VOC	1-hour	2,796.7	1,167.9	n/a
	24-hour	256.3	162.2	n/a
	Annual	73.4	n/a	n/a
Carbon monoxide	1-hour	20,325.1	8,616.0	14,300
	8-hour	4,980.6	2,491.8	5,500
Nitrogen dioxide (100% conversion)	1-hour	2,574.1	1,086.0	188
	Annual	92.8	n/a	40
Sulphur dioxide	1-hour	27.6	11.6	196
	24-hour	2.7	1.7	125
	Annual	0.8	n/a	25
Ammonia	24-hour	11.0	6.9	100
PM_{10} (Vehicles)	24-hour	19.5	12.4	50
	Annual	5.6	n/a	20
$PM_{2.5}$ (Vehicles)	24-hour	12.1	7.6	25
	Annual	3.5	n/a	8
PM_{10} (Road Dust)	24-hour	37.1	23.1	50
	Annual	11.7	n/a	20
$PM_{2.5}$ (Road Dust)	24-hour	9.0	5.6	25
	Annual	2.8	n/a	8
Benzene	1-hour	58.0	24.4	30
	24-hour	6.9	4.3	2.3
	Annual	2.0	n/a	0.45
Naphthalene	24-hour	0.5	0.3	22.5
1,3-Butadiene	24-hour	0.7	0.4	10
	Annual	0.2	n/a	2
Formaldehyde	1-hour	26.3	11.0	60
Acetaldehyde	1-hour	18.1	7.6	90
	24-hour	2.1	1.3	500
Acrolein	1-hour	1.7	0.7	4.5
	24-hour	0.2	0.1	0.4
Benzo(a)pyrene	24-hour	8.9E-04	5.7E-04	5.00E-05
	Annual	2.6E-04	n/a	1.00E-05

Notes: n/a = Objective not applicable. Shaded cells indicate an exceedance of the relevant, most stringent AAQO.

3.4.2 Performance Measures

The performance measures comparing outcomes to the existing condition and the other options (**Section 2.0**) are the basis for the assessment of the potential effects on air quality, (**Table 3.5**).

Table 3.5 Performance measures for air quality

Direction Indicator/Trajectory	Performance Measure	Option-specific Comments
Reduce concentrations of criteria air contaminants (CAC)	*Reduce emission rates and achieve reduced concentrations of CAC*	*Comparison of outcomes for each option against the existing conditions and the GMC options*
Reduce concentrations of toxic air contaminants (TAC)	*Reduce emission rates and achieve reduced concentrations of CAC*	*Comparison of outcomes for each option against the existing conditions and the GMC options*
Reduce emissions of greenhouse gases (GHG)	*Reduce emissions of GHG*	*Comparison of outcomes for each option against the existing conditions and the GMC options*

3.5 Noise

3.5.1 Existing Conditions

Existing noise levels in the vicinity of the Project are primarily created from traffic on Highway 99 and the connecting roadways such as Steveston Highway, River Road and Highway 17A.

Criteria and Assessment Approach

Noise criteria and the assessment approach for highway projects follows the *Policy for Assessing and Mitigating Noise Impacts from Highways*[8], and are guided by criteria developed to address potential health effects in Health Canada's *Guidance for Evaluating Human Health Impacts in EA: Noise*[9]. Consideration is given to excessive absolute noise that may affect sleep, speech and enjoyment of property as well as excessive project-related increases in noise that may heighten annoyance and environmental degradation. Effects are assessed at noise sensitive receptors such as residences, hospitals, educational facilities, places of worship, libraries, and parks. Rather than specifying absolute noise criteria levels, the policy classifies Project-related changes to noise levels as minor, moderate, or severe. Communities affected by moderate and severe increases in noise levels warrant a review of potential mitigation measures.

Health Canada (2017)[9] does not enforce noise thresholds or standards but provides information on potential health effects. The most relevant health effect for residences is the potential for noise-induced sleep disturbance. Health Canada refers to a variety of internationally recognized standards for acoustics, such as those from the United States Environmental Protection Agency[10] and the World Health Organization.

Existing 2013 Noise and Operation Levels

Existing noise levels at the select sensitive receptors were monitored in 2013 in association with the George Massey Tunnel Replacement Project studies. Existing noise levels ranged between 51.5 dBA and 75 dBA L_{dn} at residential receptors, and between 61.7 dBA and 71.8 dBA L_d at places of worship and schools in the

8 Ministry of Transportation and Infrastructure 2014
9 Health Canada 2017
10 U.S. EPA. 1974. Levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety

vicinity of the Project. Existing noise levels in passive parks ranged from approximately 46 dBA L_d in Deas Island Regional Park to 58.0 dBA L_d near the south end of Richmond Nature Park.

The ranges and average values of operation residual changes (i.e. change from existing noise levels) for each of these types of land uses are as follows:

- Residences: 0 to -7 dBA; average of -4 dBA.
- School and places of worship: range of -2 to -1, average -1.5 dBA.
- Parks: range 11 to 4 dBA.

Study results predicted that, with mitigation, post-Project noise levels would be lower than existing levels.

3.5.2 Performance Measures

The performance measures established under each of the four goals for the project (**Section 2.0**) are the basis for the assessment of the potential effects on noise (**Table 3.7**).

Table 3.6 Performance measures for noise

Direction Indicator/Trajectory	Performance Measure	Option-specific Comments
Minimize noise levels in the project area	*Adherence to commitments and obligations made in the Provincial EAC for the George Massey Tunnel Replacement Project and any EA commitments for the new project*	*Compare outcomes for the options against the George Massey Tunnel Replacement Project criteria and operation results*

3.6 Light

3.6.1 Existing Conditions

The GMC crossing corridor on both sides of the Fraser River is well-lit consistent with a busy highway. Lighting is provided by street / highway lights and light spill from commercial and residential premises. Lighting is required in this corridor for safety and convenience purposes. The Fraser River portion of the crossing is not lit, and nighttime conditions are characterized by darkness in the immediate area, but noticeable skyglow from nearby ambient lighting in the Highway 99 corridor.

3.6.2 Performance Measures

The performance measures established under each of the four goals for the project (**Section 2.0**) are the basis for the assessment of the potential effects on light (**Table 3.7**).

Table 3.7 Performance measures for light

Direction Indicator/Trajectory	Performance Measure	Option-specific Comments
Minimize light levels in the project area	*Adherence to commitments and obligations made in the George Massey Tunnel Replacement Project Provincial EAC and any EA commitments for the new project*	*Compare outcomes for the options against probable outcomes – noting that no light assessment was completed*

4.0 DEEP BORED TUNNEL (DBT) OPTIONS

4.1 Agriculture

4.1.1 Agricultural Use

The agricultural area that may be affected by the DBT options includes lands that will be needed for tunnel portal excavation, ground densification above the tunnels and the on- and off-ramps from the north and south portals that connect to Steveston Highway and Highway 17A. Land requirements for other construction activities such as for traffic diversions and laydown areas have not been included.

With the assumptions for the required land area, DBT options will intersect with approximately 66 ha of agricultural land during construction (**Table 4.1**), with an estimated permanent footprint on ALR land of approximately 54 ha. Temporarily used ALR lands (12 ha required for ground densification above the future tunnel) will be returned to agricultural uses after construction is complete. The estimated ALR impact is substantially higher than for other crossing options due to the need for new ramps and roadway to connect with the Steveston and Highway 17A interchanges.

In Richmond, the majority of the affected ALR area is actively farmed for berries, mixed fruit, and other cultivated crops including grapes. A small portion of the affected area is not actively farmed but is associated with farming operations. In Delta, the affected ALR land is actively farmed for vegetables, forage, corn, and potatoes. There may be effects to agricultural operations and infrastructure such as access, irrigation and drainage due to interchange construction, and it is possible that the extent of the effects would be beyond the directly affected areas.

Table 4.1 Estimated area of affected agricultural land – DBT options

Area	Project Footprint*	ALR Footprint*
Richmond (north of Fraser River)	21 ha	19 ha
Delta (south of Fraser River)	49 ha	47 ha
Total	**70 ha**	**66 ha**

* estimates are based on the 8-lane DBT footprint and exclude existing Highway 99 right-of-way.

4.1.2 Access to Crossings

The DBT options are likely to cause disruption to agricultural equipment passage at the existing crossings at the Steveston and the Highway 17A intersections during construction. During operation, the future design of the intersections is expected to allow for agricultural equipment crossing, and farmers north of the Richmond portal and south of the Delta portals are likely to have to travel further to cross Highway 99 resulting in an adverse effect on their mobility. Those farmers between the portals on both sides of the Fraser River would likely have more freedom of movement across the currently Highway 99 alignment as the tunnel will be under the current at-grade alignment.

4.1.3 Parcels

The analysis of the parcels affected by the DBT options considered all parcels in the ALR, although some are not currently used for agriculture and two smaller parcels are not available for agriculture. Within the alignment, 10 parcels would be affected, and an additional nine parcels are considered likely to be affected by the interchanges, in total around 19 parcels. One identified parcel is part of Highway 99 and not considered further. Five of these parcels would be affected during construction only, and, with mitigation can be returned to their current productivity after construction is complete. The smallest of these parcels are likely to be completely within the project footprint and will not be able to maintain their current uses. The larger parcels are likely to maintain their current agricultural uses, albeit over a smaller area.

The DBT options may also alienate or fragment portions of individual parcels. Approximately eight parcels would be fragmented, and an additional eight are considered likely to be affected by the interchanges. In total 16 parcels would be affected, five of which are likely affected during construction only.

4.2 Industry

The alignment of the DBT options does not intersect industrial land uses or industrial / commercial designated land in Richmond or Delta and is not anticipated to directly affect industrial uses during operation. Soil densification activities on the north side of the crossing do not extend to industrial lands on and close to the Fraser River up- and down-stream of the crossing, as the alignment mostly remains within the Highway 99 right-of-way. The railway line also is not affected.

The alignment on the east side of the Steveston Highway intersection and an anticipated new interchange north of Steveston Highway would change the access to and from Highway 99 for industrial land. These new connections would create more complex and circuitous traffic routing, thus increasing access time to industrial properties and potentially adversely affecting the viability of some industrial lands or viability for some industrial uses.

In Delta access to Highway 99 from industrially designated lands at the Vancouver landfill, Boundary Bay Airport and Tilbury are likely to be similar or improved to the current condition with the DBT options because the Highway 17 interchange is unchanged. Alterations to the interchange at Highway 17A may affect industrial land users in the Tilbury area and commercial property users in the Highway 17A area that use this access point, by adding to trip times.

4.3 Fisheries and Wildlife

The DBT options include several project components (deep bored tunnels; seismic upgrades to the existing tunnel; and seismic upgrades to Deas Island Bridge) that interface with water features that support fish and fish habitat values, and that are afforded protection under the federal *Fisheries Act.* The Fraser River and Deas and Green sloughs all have high value water features supporting a wide range of valued fish and fish habitat resources. Low value wildlife habitats are intersected.

The evaluation of performance measures included in **Table 3.3** is discussed for each project component. Any key differences between the 8-lane and 6-lane DBT options have been described, if applicable. For any potential footprint effects from the DBT options (i.e., no net loss performance measure), the spatial extent and quality of any affected habitats is described. Potential requirements for offsetting are based on

a preliminary assumption that habitat loss would require offsetting at a ratio of 2:1 (offsetting:impact) consisting of equal or higher value habitat and alteration or disruption would require offsetting of similar value habitat at a ratio of 0.1:1. Final offsetting requirements would require more detailed consideration of affected fish habitats, quantity and quality offsetting habitats, temporal delays, and other considerations and would be subject to review and acceptance by Fisheries and Oceans Canada (DFO).

4.3.1 Deep Bore Tunnels

Objective: No net loss

Tunnel portals would be set back from the Fraser River, Deas Slough, or Green Slough and would overlap with upland ditches characterized by low fish habitat values. The DBT would be located between -35 and -80 m below the river and sloughs and any ground densification work would be sufficiently set back from these features (i.e., > 30 m, where existing riparian habitat values apply). No aquatic or riparian fish habitat impacts would therefore be expected. The only exception would be for an accident or malfunction resulting from a sinkhole under the Fraser River or Green Slough.

Few terrestrial wildlife values are affected by this option. Farmed areas in the footprint have some wintering bird habitat, but largely only for common species and usually only in unused farm fields.

Objective: Opportunities for new habitat

The DBT would be located under the existing Highway 99 right-of-way. Both DBT options might provide opportunities for new fish and wildlife habitat to be created within unused portions of the right-of-way and that are associated with areas of current riparian habitat on the Fraser River and Deas Slough. For the 8-lane option there is potential for riparian and off-channel and/or tidal slough creation, including the establishment of brackish tidal marsh benches, around the old roadways on Deas Island that would be used exclusively by bicyclists and pedestrians. The 6-lane option has lower potential as bus lanes as well as bicycle and pedestrians would use the existing tunnel and roadways. There may also be some opportunities on the north side of the Fraser River. The total available area for new fish and wildlife habitat creation in these areas may range between one and two hectares.

Objective: Opportunities for improved habitat connectivity

Opportunities for creation of new fish and wildlife habitat above the DBT could also be used to provide some fish habitat connectivity benefits (e.g., new connections for fish between Deas Slough and the Fraser River).

Objective: Opportunities for other improvements to habitat or improvements to water quality

DBT options do not appear to have any additional, unique opportunities for other fish habitat improvements.

Other comments

The requirement for expansive open excavations for the portals would result in substantial water quality management for site discharge water. This is considered mitigable and unlikely to result in impacts to low fish habitat values associated with upland ditches, and more-valuable downstream fish habitat approximately 600 m away. There is availability of land for water storage/settlement and treatment.

4.3.2 Seismic Upgrade of Existing Tunnel

Objective: No net loss

Seismic upgrading of the existing tunnel to support its re-use as a multiuse pathway (8-lane option) or combined multiuse pathway/transit route (6-lane option) requires ground densification adjacent to the tunnel. This involves drilled (stone column) bores filled with gravel vibrated into place to a depth of -30 m adjacent to the length of the existing tunnel in the river and upland. The anticipated disturbance is between two and three hectares, and includes fish habitat in the Fraser River, and a relatively narrow, but valuable, nearshore band of riparian habitat. Less than 0.5 ha is unproductive upland within the Highway 99 right-of-way. *Fisheries Act*[11] requirements suggest these aquatic habitat impacts are characterized as alteration, as the river bottom is expected to naturalize within one freshet. Preliminary offsetting requirements based on an offsetting ratio of 0.1:1 suggest that approximately 0.25 ha of similar value habitat may be required.

Objective: Opportunities for new habitat

Seismic upgrading of the existing tunnel does not present any opportunities for restoration of existing right-of-way areas or other habitat creation options that are unique to these options, however it is noted that some riparian planting could be undertaken within the right-of-way following stone column work.

Opportunities for improved habitat connectivity

No identified opportunities for improvements to habitat connectivity are considered to apply.

Objective: Opportunities for other improvements to habitat or improvements to water quality

No unique opportunities for other fish habitat improvements are obvious because both DBT options also require use of the existing tunnel and roadways. Retrofit of the existing tunnel with updated water management features concurrent with the seismic upgrades would benefit fish. The existing right-of-way is sufficiently large to accommodate retention pond features.

Other comments

Although considered in this MAE as mitigable during construction, approximately 2.2 ha of in-river seismic upgrading with stone columns would result in a substantial amount of sediment mobilization and underwater noise within the Fraser River over an extended period of time. This would warrant specific and focused attention from the perspective of mitigative measures for fish and marine mammals.

4.3.3 Seismic Upgrade of Deas Island Bridge

Objective: No net loss

Seismic upgrading of the existing Deas Island Bridge for the 6-lane option only would likely necessitate upland and in-water ground densification around the abutments and piers of the existing three-span, two pier bridge. Stone column densification is necessary within 20 m of each abutment and pier. About half a hectare of fish habitat would be affected, including alteration of riparian and aquatic habitat associated with Deas Slough. Preliminary offsetting requirements based on a ratio of 0.1:1 for alteration suggests that under 0.25 ha of similar value habitat would be required.

[11] The federal *Fisheries Act* was amended on 28 August 2019 to provide protection for all fish and fish habitat, while also restoring the previous prohibition against the harmful alteration, disruption or destruction of fish habitat.

Objective: Opportunities for new habitat

Seismic upgrading of the existing bridge does not present any unique opportunities for restoration of existing right-of-way areas or other habitat creation options that are unique to these options.

Objective: Opportunities for improved habitat connectivity

No identified opportunities for improvements to habitat connectivity are considered to apply.

Objective: Opportunities for other improvements to habitat or improvements to water quality

No unique opportunities for other fish habitat improvements or improvements to water quality are considered to apply.

4.3.4 Summary

The deep bored tunnels, seismic upgrades to the existing tunnel and to Deas Island Bridge would result in fish habitat impacts that require a *Fisheries Act* Authorization and associated offsetting for approximately two to three hectares of aquatic habitat (Fraser River bottom) and smaller areas of riparian habitat. A preliminary offsetting assessment based on a ratio of 0.1:1 for alteration indicates that approximately half a hectare of similar value habitat may be required. One to two hectares may be available for onsite fish habitat creation within the existing right-of-way, primarily on Deas Island, which exceeds the anticipated offsetting needs. These offsetting opportunities could also support improvements to fish habitat connectivity, and additional water quality improvements could be implemented to both the new and existing tunnels. DBT options have the greatest potential risk for sink holes to develop in the Fraser River, the result of which would require additional and in-river ground improvement activity around the sink area.

No impacts to terrestrial wildlife habitats requiring more than standard best management practice mitigation are considered to be affected by this option.

4.4 Air Quality

Project-related construction activities contribute to the emissions that include fugitive dust associated with soil stockpiles and ground disturbance, and CAC and TAC (see **Section 3.4** for definitions) from fuel combustion in construction equipment. Previous air quality monitoring results and analysis on construction projects in the Lower Mainland, including the South Fraser Perimeter Road project, show that overall construction-related emissions, even with the additional excavation activities required for the DBT option, are expected to be immaterial in relation to the existing emissions occurring along the corridor. As such the construction-related emissions will not be addressed further in this evaluation, and such emissions can be considered similar across all GMC options.

For the George Massey Tunnel Replacement Project EA, the operations-period emissions and predicted concentrations of potential air contaminants were assessed for a future scenario in 2031 with the proposed bridge project and without the project in 2031 assuming that no road improvements had been made (i.e., future with status quo infrastructure). In general, vehicle emissions of most pollutants were predicted to be lower in 2031 than those that are currently observed, with or without the project. Although traffic volumes are projected to increase in 2031, emission factors from the vehicles in use by 2031 would have decreased sufficiently to offset the increase in traffic volume. Improvements to vehicle emissions through more

stringent regulations, better emissions control technology in vehicles, and vehicle fleet turnover will drive this reduction. Projected traffic numbers for all crossing options are lower than those used for predictions in the George Massey Tunnel Replacement Project EA, but there is expected to be greater traffic congestion, consistent with regional and provincial commitments (and the Independent Technical Review recommendation) to manage but not eliminate congestion.

Air quality outcomes for the DBT option, as well as the ITT and bridge options, are expected to show similar future improvements due to improved vehicle technology. The six-lane DBT option uses the existing tunnel for transit and as such there are air emissions concentrated at two locations each about 1 km apart on both sides of the river. Air quality at the portals for the DBT option would have higher concentrations, and because the south portal would be further away from population-dense areas on the Delta side there is a marginal benefit. On the north side the portal is closer to residences and there may be higher concentrations, with correspondingly greater impacts. Overall the differences between the 6- lane and 8-lane options are expected to be minor, and the differences compared to the ITT and bridge options are minimal. Of the three technologies, the DBT represents a slightly worse air quality outcome because complex and longer interchanges with greater congestion drive higher emissions.

With regards to the performance measures for CAC, TAC and GHG the DBT option would be an improvement over the scenario without the Project. This option would have similar improvements in air quality as compared to the ITT and bridge options; however it would result in more concentrated localized accumulation of pollutants as compared to the bridge option which being an elevated structure, provide for better air dispersion of vehicle emissions and reduced potential effects.

4.5 Noise

Construction activity is anticipated to result in an increase in overall noise exposures of 1 dBA to 3 dBA at setback distances of 100 m to 200 m, and up to 4 dBA at distances of more than 400 m.

Predicted future (2030) noise conditions without mitigation, would be similar to those presented below from George Massey Tunnel Replacement studies.

Residential Receptors

Predicted future (2030) noise levels:

- L_{dn} – 52.5 to 77.3 dBA, with an average of 68.3 dBA
- L_n - 42.9 to 70.1 dBA, with an average of 60.2.2 dBA

Existing (measured) noise levels:

- L_{dn} - 51.5 to 75 dBA, with an average of 66.3 dBA
- L_n - 41.3 to 67.8 dBA, with an average of 59.2 dBA

Schools and Places of Worship

Predicted future (2030) noise levels:

- L_d – 65.3 to 75.2 dBA, with an average of 71.7 dBA

Existing noise levels:

- L_d - 61.7 to 71.8 dBA, with an average of 68.2 dBA

During construction the DBT option, particularly the ground densification activities required for approximately 600m on the Fraser River side of the portals and pile driving for the tunnel portal construction would be louder than the noise generated by the ITT options, but similar to that of a bridge due to combined ground densification and pile driving activities required for that option. On the south, Delta, side there are fewer residences close to the ground densification activities, on the north side in Richmond there are residences that are close to the densification and pile driving activities. During operation, noise levels in the area around the Fraser River would be reduced over that of the other options, and lower than that predicted in the George Massey Tunnel Replacement Project EA studies. This includes few to no noise effects on Deas Island Regional Park.

4.6 Light

Lighting effects are likely to be positive, since the DBT would not surface as close to the Fraser River as other options do, lighting effects from this option are farther from populated residential areas.

5.0 IMMERSED TUBE TUNNEL (ITT) OPTIONS

5.1 Agriculture

5.1.1 Agricultural Use

In Richmond, the alignment of the ITT options are generally within the existing Highway 99 right-of-way. The proximity of the proposed alignment to the property boundaries of the agricultural land on the east side suggests that temporary areas would be required for construction and in operation the right-of-way may need to be widened, affecting two parcels. The area affected is likely between two and three hectares (**Table 4.2**). Interactions with access, drainage and irrigation infrastructure are likely, as are opportunities for enhancements to this infrastructure both for addressing effects and offsetting.

In Delta the ITT alignment is also largely within the existing Highway 99 right-of-way, with effects to one parcel. The the agricultural use is identified as vegetable production. The direct effects to agricultural land are not expected to adversely affect farm viability, though interactions with drainage and irrigation infrastructure, and opportunities for enhancements to address effects and offset are possible.

Table 5.1 Estimated area of affected agricultural land – ITT options

Area	Project Footprint*	ALR Footprint*
Richmond (north of Fraser River)	1 ha	1 ha
Delta (south of Fraser River)	2 ha	2 ha
Total	**3 ha**	**2-3 ha**

* estimates are based on the 8-lane ITT footprint and exclude existing Highway 99 right-of-way

5.1.2 Access to Crossings

Existing agricultural equipment crossings over Highway 99 are not changed from the existing conditions, and one additional crossing at River Road is proposed. Disruption to use during construction is possible.

5.1.3 Parcels

No parcels are directly affected by the operation alignment of the ITT options; however, three parcels may be affected in the event of right-of-way expansion. No parcels experience isolation effects.

The direct effects to agricultural parcels are not expected to adversely affect farm viability. The extent of the effects is likely limited to the directly affected properties; noting that access, drainage and irrigation infrastructure effects cannot be evaluated at this time.

5.2 Industry

The ITT options are within the existing Highway 99 right-of-way and do not intersect industrial and commercial land uses or industrially designated land in Richmond. There are no effects due to loss of parcel area or isolation of parcels, but altered access to the industrial parcels from Highway 99 may alter travel times, specifically during construction. The construction of the railway crossing across the north portal is expected to accommodate unimpeded rail operations during operations.

There are no industrial uses within or adjacent to the alignment of the ITT option in Delta, aside from commercial uses at the Highway 17A interchange which are not directly affected. For industrially designated lands in Delta at the Vancouver landfill, Boundary Bay airport and Tilbury access is likely to be similar to the current condition because interchanges at and east of Highway 17A are largely unchanged. Access to and from commercial properties near Highway 17A will be re-arranged but similar to the current situation.

Installation of the ITT segments might require industrially-designated land outside of the existing Highway 99 right-of-way for a dry dock, but the precise location of this component has not been identified.

The ITT options are not anticipated to significantly affect the viability of industrial land uses, but there are potential adverse effects due to access changes during construction.

5.3 Fisheries and Wildlife

The ITT options intersect aquatic and riparian areas with fish and fish habitat values. This includes the Fraser River South Arm and Deas and Green sloughs. Wildlife habitat in the riparian areas on both sides of Deas Slough would be directly and or indirectly affected by the new Deas Slough bridge (8-lane option), and potentially by upgrades to the existing Deas Slough bridge (6-lane option).

Both ITT options include a temporary dry dock for tunnel segment construction and installation. Seismic upgrade works on the existing tunnel and Deas Island Bridge are only required for the multiuse pathways and transit lanes associated with the 6-lane ITT option. The 8-lane option would maintain the existing tunnel, as a utility corridor, and replace the Deas Island Bridge with a multi-use pathway bridge.

Potential offsetting requirements (as described in **Section 4.3**) are based on equivalent offsetting ratio assumptions with the understanding that actual requirements would be based on final design, detailed consideration of affected fish habitats, quantity and quality offsetting, temporal delays, and other considerations such as regulatory and Indigenous group inputs.

5.3.1 Temporary Dry Dock

Objective: No net loss

A temporary dry dock would be required to construct the tunnel segments for both options. The dry dock would be 10 to 15 hectares in size to simultaneously accommodate half the tunnel segments, and adjacent to the Fraser River or other deep-water. Although a site has not been identified, the location would likely lack high value fish or wildlife habitats to minimize environmental effects while also facilitating opportunities for habitat creation after decommissioning. The effects to fish habitat are likely two to five hectares.

Objective: Opportunities for new habitat

Depending on location and design for the decommissioned dry dock there may be an opportunity to create new fish habitat of between two and three hectares that could be used to offset project-related effects.

Objective: Opportunities for improved habitat connectivity

If the site selected for the temporary dry dock is carefully selected, there may be an opportunity to develop a design for the dry dock at decommissioning that also provides some improved fish habitat connectivity (e.g., connection of tidal channel features and/or backwaters, potentially affected by historic development).

Objective: Opportunities for other improvements to habitat or improvements to water quality

With careful site selection, there may be an opportunity to decommission the dry dock for fish habitat improvement benefits and/or improvements to water quality.

5.3.2 Installation

Objective: No net loss

Installation of the ITT would involve upland excavations within 100 to 120 m of the Fraser River, stone column densification on either side of the river (approximately two hectares), in-river densification under the tunnel (approximately five hectares), trenching and subsequent installation of the tunnel segments, and installation of cover materials (i.e., aggregate fill and rip rap). After fabrication, installation for each segment would take approximately one to two months, with tunnel installation occurring over two years to adhere to least risk periods for fish protection. Of the anticipated seven hectares upland and in-river footprint associated with trenching and stone column work, there is approximately five hectares of fish habitat, including alteration of mostly Fraser River bottom habitat and smaller losses of Fraser River riparian habitat. Preliminary offsetting requirements based on an offsetting ratio of 2:1 for riparian and 0.1:1 for aquatic habitat suggest that approximately 0.5 ha of similar value habitat may be required for offsetting.

Objective: Opportunities for new habitat

The ITT would intersect existing right of way areas, including riparian habitats. As the land-based approaches are at or near the ground surface, neither option provides any notable opportunities for the establishment of new fish habitat. See 5.3.3 for habitat offsets at existing GMT infrastructure.

Objective: Opportunities for improved habitat connectivity

As with the lack of any specific opportunities for creation of new fish habitat, no obvious opportunities for improvements to fish habitat connectivity have been identified.

Objective: Opportunities for other improvements to habitat or improvements to water quality

As with the DBT options, both ITT options provide an opportunity to incorporate design features which provide for improved water management over the status quo associated with the existing tunnel (i.e., pumping to engineered retention ponds for water management and spill contingency).

Other comments

Upland excavations required for either option are approximately 86 m wide and 100-120 long and directly adjacent to the Fraser River. These excavations would be plugged and dewatered using appropriate methods including settling ponds. Although considered mitigable given available space within the right of way, careful attention will be required to avoid potential impacts on water quality and fish.

5.3.3 Seismic Upgrade or Decommissioning of Existing Tunnel

Objective: No net loss

As noted in **Section 4.3.2**, seismic upgrading of the existing tunnel to support its re-use as a combined multiuse pathway/transit route (6-lane option) would necessitate ground densification in the area around the tunnel. Alteration of between two and three hectares of productive fish habitat, mostly aquatic habitat (Fraser River bottom). Preliminary offsetting requirements based on an offsetting ratio of 0.1:1 indicate that approximately 0.25 ha of similar value habitat may be required. For the 8-lane option which would involve decommissioning of the existing tunnel without densification, no impacts on fish habitat requiring offsetting are anticipated.

Objective: Opportunities for new habitat

Seismic upgrading of the existing tunnel (6-lane option) does not present any opportunities for the creation of new fish habitat.

The 8-lane option does not require the existing tunnel and Deas Island Bridge, which appears to provide new fish habitat creation opportunities in the unused areas of the existing right-of-way on Deas Island. These areas could be connected to tidal waters because there are no dikes or flood control infrastructure which provides opportunities for off-channel and/or tidal slough creation and brackish tidal marsh benches; high value habitat features in the lower Fraser River. Riparian habitat values could also be established, providing broad benefits to fish and wildlife, aesthetics, and parkland values. The available area for new fish habitat creation appears to range between one and three hectares. could be used as offsetting for the project and may provide substantial benefits. Combined with potential offsetting with decommissioning of the temporary dry dock, the 8-lane option is expected to provide ample offsetting alternatives.

Opportunities for improved habitat connectivity

The 6-lane option does not provide any notable opportunities for fish habitat connectivity improvements, but opportunities for new fish habitat facilitated by the 8-lane option are substantial, see the section above.

Objective: Opportunities for other improvements to habitat or improvements to water quality

The 6-lane option also provides an opportunity to retrofit the existing tunnel with updated water management features and the existing right-of-way is sufficiently large to accommodate retention pond features. For the 8-lane option, the estimated availability of between one and three hectares for the creation of new habitat in upland areas currently used for the existing tunnel would also provide ample areas that could be used for establishment of retention ponds with biofiltration channels located “upstream” of created fish habitats to facilitate management of any water pumped from the new immersed tunnel.

5.3.4 Seismic Upgrade of Deas Island Bridge and new Deas Island Bridge

See **Section 4.3.3** for a discussion of Deas Island Bridge (i) no net loss, (ii) opportunities for new habitat and (iii) opportunities for improved habitat connectivity in relation to fish habitat, and (iv) opportunities for other improvements to habitat or improvements to water quality.

Deas Island Bridge has a barn swallow colony, which during the nesting period in early to late summer is federally protected under the *Migratory Birds Convention Act* and *Species at Risk Act*, and provincially under the *Wildlife Act*. Disturbance-related effects to nesting barn swallow are likely.

Construction of the new Deas Island Bridge to connect the ITT portal and Highway 99 in Delta would affect around one hectare of habitat in and around Deas Slough, most of which is in the Highway 99 right-of-way. As noted above, compensation associated with this option, particularly the 8-lane option appears possible.

5.3.5 Summary

The project components associated with the ITT options (i.e., temporary dry dock, installation of immersed tube tunnel, and for the 6-lane option only, seismic upgrades to the existing tunnel and Deas Island Bridge) are expected to result in fish habitat impacts requiring a *Fisheries Act* Authorization and associated offsetting. Seven to ten hectares of fish habitat would be altered or lost. Approximately one hectare of similar value habitat (primarily aquatic) may be required for offsetting.

Terrestrial habitat effects are between one and two hectares.

5.4 Air Quality

See **Section 4.1** for general / background air quality effects assessment discussions.

The ITT options would create emission concentrations in localized areas at the north and south portals (including the nearby existing tunnel portals for the 6-lane ITT tunnel option).The differences between the 6-lane and 8-lane options are expected to be minor, and the differences compared to the DBT and bridge options are overall minimal.

5.5 Noise

In addition to the predicted post-project noise levels at receptors (as discussed in **Section 4.5**), the following noise level predictions at Deas Island Park are relevant to the ITT and bridge options, but not the DBT options.

Passive Parks

Predicted future (2030) noise levels:

- L_d – 49.5 to 61.7 dBA, with an average of 55 dBA

Existing noise levels:

- L_d - 45.9 to 58 dBA, with an average of 49 dBA

The noise effects from the ITT option in areas north and south of the portals would be similar to those predicted by the George Massey Tunnel Replacement Project EA studies. Deas Island Regional Park would experience noise levels similar to those currently experienced.

5.6 Light

The ITT would have similar, maybe lower light effects as the current situation. Light levels at the new portals may be lower as this option would employ cut-and-cover tunnelling technology, where the current George Massey Tunnel is an open cut. Regardless, the effects would be less than those predicted in the George Massey Tunnel Replacement Project EA studies.

6.0 BRIDGE OPTIONS

6.1 Agriculture

6.1.1 Agricultural Use

The footprint of the bridge options overlaps with agricultural land and the ALR at the Steveston Highway intersection in Richmond and near River Road in Delta.

In Richmond, the bridge options at the Steveston interchange would overlap with actively farmed land in the ALR and ALR land that currently has non-farm uses.

In Delta, the new River Road crossing would affect agricultural land either side of Highway 99 between River Road and the Highway 17A intersection. The new alignment on the east side will traverse a portion of a 19-ha agricultural parcel actively farmed with field crops (potatoes, vegetables). On the south side, the new alignment will traverse a parcel with residential and active agricultural uses (beans, vegetables, sweet corn, potatoes). Both parcels are in the ALR.

An estimate of the area of agricultural land intersected by the bridge options has assumed the 8-lane bridge, with a width of 80 m. In Richmond, the bridge options partially overlap with approximately three hectares of ALR land. In Delta approximately four hectares is affected by the bridge piers and approaches and the River Road crossing, on both sides of the existing Highway 99 alignment.

Table 6.1 Estimated area of affected agricultural land – bridge options

Area	Project Footprint*	ALR Footprint*
Richmond (north of Fraser River)	3 ha	3 ha
Delta (south of Fraser River)	5 ha	4 ha
Total	**8 ha**	**7 ha**

* estimates are based on the 8-lane bridge footprint and exclude existing Highway 99 right-of-way

The direct effects to agricultural land are not expected to adversely affect farm viability, although the direct effect and the isolation of a portion by the River Road crossing would require further consideration for mitigation. The extent of the effects is likely limited to the directly affected properties.

6.1.2 Access to Crossings

The ability for farm equipment to access agricultural lands either side of Highway 99 is anticipated to be improved by the River Road crossing included in the Bridge options. The Steveston intersection will remain available to cross Highway 99, and the Highway 17A intersection will not be changed, although there may be some disruption to use during construction.

6.1.3 Parcels

The bridge options would affect five to six parcels of agricultural land, and four parcels would experience isolation of portion of the parcel. The direct effects to agricultural parcels are not expected to adversely affect farm viability, although the parcel with both the direct effect and the isolation of a portion by the River Road crossing would be most affected and would require further consideration for mitigation. The extent of

the effects is likely limited to the directly affected properties, though interactions with drainage and irrigation infrastructure are likely. Enhancements to drainage and irrigation infrastructure both for addressing effects and offsetting may be available.

6.2 Industry

The bridge options do not intersect industrial land uses or industrial - commercial designated land in Richmond or Delta and are not anticipated to directly or indirectly (i.e., isolation) affect industrial uses during operation. The railway line crossing would be accommodated under the new bridge. Changing traffic patterns that alter access between Richmond and Delta industrial parcels and Highway 99 may alter travel times, specifically during construction. The bridge options are not anticipated to significantly affect the viability of industrial land uses, especially in Delta where industrially designated lands at the Vancouver landfill, Boundary Bay airport, Highway 17A and Tilbury are unlikely to have access changes because interchanges at and east of Highway 17A are largely unchanged.

6.3 Fisheries and Wildlife

Both bridge options (6-lane and 8-lane) include similar project components (i.e., new bridge, seismic upgrades to existing tunnel, and seismic upgrades to Deas Island Bridge) that overlap with Fraser River and Deas and Green slough fish and fish habitat values afforded protection under the federal *Fisheries Act*. Terrestrial wildlife habitat values, while modest, would also be affected, largely indirectly through shading and light and noise effects.

Evaluation of performance measures described in **Table 3.3** is provided below, for each separate project component and associated potential effects. For any potential footprint effects from bridge options (e.g., no net loss performance measure), the anticipated spatial extent and quality of any affected fish habitats are described. Potential offsetting requirements are based on the previously used offsetting assumptions with the understanding that requirements will be based on final design, detailed consideration of affected fish habitats, quantity and quality offsetting habitats, temporal delays, and other considerations including DFO acceptance.

6.3.1 Bridge

Objective: No net loss

Bridge construction includes a clear-span design without any encroachment on aquatic habitats, however it is anticipated that primary piers would likely be located within close proximity to river/slough edges and therefore result in some riparian impacts. Further to the pier footprints, densification (stone column technique) would need to be implemented within upland areas within proximity to each pier. With consideration towards potential pier locations and additional impact zones from densification extending 15 m from each pier there might be very small effects to fish habitat; riparian habitat adjacent to the Fraser River and Deas Slough. Preliminary offsetting requirements based on an offsetting ratio of 2:1 for loss of riparian habitat indicate that around half a hectare of similar value habitat may be required.

Terrestrial wildlife values adjacent to and below the bridge on Deas Island and near Deas Slough would be indirectly affected by shading, and light and noise. The areas that are most-affected are within the Highway 99 right-of-way, but adjacent wildlife habitat in Deas Island Regional Park would be affected to a lesser degree. These effects were examined, and mitigation developed during the George Massey Tunnel

Replacement Project EA, though the design under consideration here is off-centre from the current Highway 99 route and therefore has greater levels of such effects than the earlier design directly above Highway 99. Shading to about one hectare and direct effects to about half a hectare is considered likely. Noise effects and, less-so light effects on a little brown myotis (bat) maternity roost are likely.

Objective: Opportunities for new habitat

The new bridge would primarily intersect existing right-of-way areas which were historically modified, along with some riparian habitat areas adjacent to the Fraser River and Deas Slough. Both bridge options would establish an elevated structure beneath which new fish and wildlife habitat could be created. There may also be opportunities for fish habitat creation between the new bridge and the existing tunnel. With the exception of densification areas within 30 m of each individual pier, these areas provide opportunities for off-channel and/or tidal slough creation and riparian plantings for fish and terrestrial wildlife. Primary opportunities are on Deas Island, however there may also be opportunities on the northern side of the Fraser River. Although the total available area for new fish habitat creation in these areas would be dependent upon final bridge design (i.e., pier spacing/locations), it appears to range between 1.0 and 1.5 ha in size. This opportunity for creation of new, high value fish habitats could be used as offsetting for the project and may therefore be of substantial benefit.

Objective: Opportunities for improved habitat connectivity

Opportunities for creation of new fish habitat underneath the bridge is unlikely to provide substantial fish habitat connectivity benefits (e.g., new connections for fish between Deas Slough and the Fraser River) given the anticipated requirement for piers with associated densification next to these water features. Opportunities for expanding Deas Island Regional Park into the current portal area and reducing the fragmentation of the park are available but would be limited if the existing tunnel is used for transit and multiuse pathway infrastructure such as for the 6-lane bridge option.

Objective: Opportunities for other improvements to habitat or improvements to water quality

The bridge provides an opportunity to be designed with water management features that provide for gravity flow and diversion into constructed retention pond features. This is consistent with best practices applied to design of other new bridges within the Lower Mainland (e.g., Golden Ears and Port Mann Bridges), which avoids scuppers and direct drainage to fish-bearing water features. The existing right-of-way is sufficiently large enough to accommodate installation of retention pond features.

6.3.2 Seismic Upgrade of Existing Tunnel

Objective: No net loss

As noted for the other options which involve seismic upgrading of the existing tunnel, ground densification around the tunnel would result in alteration of around two hectares of fish habitat, mostly aquatic habitat (Fraser River bottom) and small areas of riparian habitat, Preliminary offsetting requirements suggest that around half a hectare of similar value habitat may be required.

Objective: Opportunities for new habitat

Seismic upgrading of the existing tunnel does not present any opportunities for the creation of new fish habitat.

Objective: Opportunities for improved habitat connectivity

Seismic upgrading of the existing tunnel does not present any opportunities for the establishment of improved fish habitat connectivity.

Objective: Opportunities for other improvements to habitat or improvements to water quality

As with other options involving seismic upgrades and re-use of the existing tunnel, there exists an opportunity to retrofit the tunnel with updated water management features.

6.3.3 Seismic Upgrade of Deas Island Bridge

See **Section 4.3.3** for a discussion of (i) no net loss, (ii) opportunities for new habitat and (iii) opportunities for improved habitat connectivity for fish, and (iv) opportunities for other improvements to habitat or improvements to water quality.

Deas island Bridge has a barn swallow colony, which during the nesting period in early to late summer is federally protected under the *Migratory Birds Convention Act* and *Species at Risk Act*, and provincially under the *Wildlife Act*. Disturbance-related effects to nesting barn swallow are possible if seismic upgrade activities occur during the breeding season (April to September).

6.3.4 Summary

The project components associated with the bridge options (i.e., bridge construction; seismic upgrades to the existing tunnel; and seismic upgrades to Deas Island Bridge) would result in one to three hectares of fish habitat effects (depending on the option), including:

- riparian habitat loss and alteration (Fraser River and Deas Slough)
- aquatic habitat alteration (Fraser River)

A Preliminary assessment based on offsetting ratios of 2:1 for loss and 0.1:1 for alteration indicate that approximately 1.0 ha of similar value habitat (primarily aquatic) may be required for offsetting, some of which could be available on-site.

Terrestrial habitat effects of this option are about one hectare and are focussed on the forest west of the alignment on the south side of Deas Slough.

6.4 Air Quality

See **Section 4.4** for general / background air quality effects assessment discussions.

Air quality outcomes for the bridge option, as well as the DBT and ITT options, are expected to show future improvements due to improvements in vehicle emission standards. The bridge options would, however, have more dispersed emissions that those of the tunnels which have emissions concentrations in localized

areas at the portals. Overall the differences between the 6-lane and 8-lane bridge options are expected to be minor, and in general the bridge options would provide improved air quality over that of the tunnels as a result of the greater dispersion.

With regards to the performance measures for CAC, TAC and GHG all options would be an improvement over the existing condition due to improvements in vehicle emission standards. The bridge option, being an elevated structure, would provide for better air dispersion of vehicle emissions and reduce potential GHG effects associated with localized accumulation of pollutants at the tunnel portals. The decrease in GHG emissions as compared to the tunnel options is due to a combination of better dispersion and less complex lane configurations associated with the bridge as compared to the DBT.

6.5 Noise

See **Section 4.5** for a discussion on general and background noise conditions. In addition to the predicted post-project noise levels at receptors the following noise level at Deas Island Park is relevant to this and the ITT options, but not the DBT options.

Passive Parks

Predicted future (2030) noise levels:

- L_d – 49.5 to 61.7 dBA, with an average of 55 dBA

Existing noise levels:

- L_d - 45.9 to 58 dBA, with an average of 49 dBA

The noise effects from the bridge options would be very similar to those predicted by the George Massey Tunnel Replacement Project EA studies. Deas Island Regional Park would experience noise levels similar to those predicted in that EA.

During construction of the bridge options pile driving would be louder than the noise generated by the ITT options. DBT construction would be similarly loud, due to combined ground densification and pile driving activities.

6.6 Light

Light impacts on fish and fish habitat, would be minimal due to the high clearance of the proposed bridge deck where it is over fish-bearing watercourses. The George Massey Tunnel Replacement Project EA noted that no light-related adverse effects to fish and fish habitat have been documented for similar structures in the lower Fraser River, such as the Alex Fraser Bridge, the Port Mann Bridge, or the existing Deas Slough Bridge. No adverse effects to receptors including to fish and fish habitat as a result of changes to ambient light conditions were anticipated. The similar design of the bridge options suggest that the effects of this option would be similar to those predicted in the previous EA studies.

7.0 REGULATORY PATH

An analysis of the assumed provincial regulatory requirements has been conducted on the basis of *BC Environmental Assessment Act* (BCEAA) triggers under the *Reviewable Projects Regulation* (as amended 29 November 2019). The primary project threshold triggering environmental assessment associated with the GMC crossing options is the shoreline modification threshold of:

- >2 ha of sub-surface or 1,000 m of linear riparian disturbance to a watercourse.

All the crossing options except the 8-lane bridge exceed this threshold either through the densification activities associated with seismic upgrades to the existing tunnel, or the new ITT installation and dry dock. The DBT and ITT options would be considered reviewable projects under BCEAA and requiring environmental assessment because these options have interactions in the sub-surface area of the Fraser River; about two and a half hectares in the case of the DBT options and between five and fifteen hectares in the case of the ITT options. It is, however, assumed that the 6-lane bridge crossing option may have an Environmental Assessment Certificate (EAC) Amendment path open, as existing EAC #T17-01 has given approval in principle for existing tunnel decommissioning and bridge construction that has effects that are similar to those of the proposed bridge options. An EAC amendment process is likely a two year-long undertaking, as compared to a three to four year undertaking for a new environmental assessment under the new BCEAA. The 8-lane bridge option has no clear BCEAA trigger, though an amendment to EAC #T17-01 is assumed necessary due to similarities with the purpose for the George Massey Tunnel Replacement Project, but differences in the design and operations for the currently proposed bridge option.

New BCEAA regulations triggering environmental assessment review include primary project thresholds as noted above for shoreline modification effects, and secondary effects thresholds for greenhouse gas emissions (380,000 tonnes), impacts to prescribed protected areas, and lineal (60km) or spatial (600ha) disturbances; none of which apply to the crossing options. Notification to the EAO is required for projects that meet specified thresholds, one of which applies to the crossing options. All crossing options would exceed the notification trigger for having a workforce greater than 250 persons.

For all crossing options, notwithstanding changes to federal environmental assessment legislation under the *Impact Assessment Act* (IAA), no federal impact assessment review would be required. Thresholds for federal impact assessment as contained in the recently released *Physical Activities Regulations* (formerly known as the project list) are not exceeded or triggered for any of the crossing options:

- A new inter-provincial or international bridge or tunnel, s.48(a) of the *Physical Activities Regulations*
- 75 km or more of new all-season highway right-of-way, s.51 of the *Physical Activities Regulations*

There is no federal land requiring impact assessment under s.82 of the *Impact Assessment Act*, and there is no federal funding trigger if federal financial contributions are leveraged by the proponent.

Regardless of the triggers, provincial and federal ministers reserve the option to require an assessment / review if, in their opinion, there are significant effects, or such a review is in the public interest. The DBT option, being a novel technology for British Columbia and the largest such project that would have been completed in substrates such as those in Richmond / Delta, may elicit consideration for designation as a physical activity (IAA s.9) or a reviewable project (BCEAA s.7/s.11) by federal or provincial ministers regardless of the regulatory thresholds relative to the project.

Permit requirements are likely to include *Fisheries Act* and *Canadian Navigable Waters Act* authorizations for all options, the assumed extent of fisheries permitting is described in the fisheries and aquatic resources sections (**Sections 4.3**, **5.3** and **6.3**). Provincial *Water Sustainability Act* permitting would also be required. *Heritage Act* (archaeology) and possibly *Wildlife Act* permitting for investigative work may be required.

The *Agricultural Land Commission Act* sets the legislative framework for the establishment, administration and preservation of agricultural land through designation of land in the Agricultural Land Reserve (ALR). The ALR is administered by the Agricultural Land Commission (ALC). The *Agricultural Land Commission Act*, and amendments, and Regulation 171/2002 (up to February 22, 2019 amendments) specify the regulatory requirements. Authorization from the ALC must be obtained for widening an existing road right of way and construction of a road within a new right of way in the ALR, as well as for other utility or recreational works within the ALR. The timeframe for review of an application and a decision would vary depending on the chosen option. Because the DBT option has the greatest effects to the ALR, and is tied to agreement on a mutually-acceptable offsetting plan that may need to be completed prior to approval by the ALC, the review of an application and a decision would likely require the longest time of all the options. The timeframe for the immersed tunnel and the bridge is likely less than a year.