4.10 Atmospheric Noise Assessment Highlights:

- Ambient noise levels in the Project area are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Trains, aircraft, marine, and agricultural activities also contribute to ambient noise in and around the Project area.
- Construction-related noise can be addressed by applying mitigation and best practices, including the following, that have proven to be effective on other recent transportation infrastructure projects in the Lower Mainland:
  - Equipment and activity restrictions to minimize noise emissions
  - Noise monitoring program
  - Processes for community communication, engagement, and adaptive management.
- Appropriate mitigation measures will be implemented at select locations to address Project-related change in noise levels during operation.
- With the application of mitigation, ambient noise levels during operation are expected to be lower than current levels–on average by 4 dBA at residences and 1.5 dBA at schools and places of worship.
- Noise levels at parks adjacent to the Project, including Deas Island Regional Park, are expected to increase by varying degrees dependent on the distance from the highway, but will generally remain below levels that warrant mitigation consideration for residential and institutional use.
- No significant Project-related residual or cumulative effects on atmospheric noise are predicted post construction.

4.10 Atmospheric Noise

This section describes the existing conditions related to atmospheric noise and anticipated changes resulting from Project components and activities. Atmospheric noise is studied as an intermediate component (IC), and the information presented on predicted changes in atmospheric noise is used to support the assessment of potential effects of the Project on human health, terrestrial wildlife, and land use (**Section 4.8 Terrestrial Wildlife, Section 5.3 Land Use,** and **Section 7.1 Human Health**).

A technical volume, **Atmospheric Noise Study**, containing technical details on the methodology used to evaluate existing conditions and predict Project-related changes is included under **Section 16.6**.

4.10.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on atmospheric noise in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.10.1.1 Assessment Context

Construction activities associated with the Project, including highway upgrades, reconfiguration of interchange ramps, construction of the new bridge, and decommissioning of the Tunnel, have the potential to temporarily alter atmospheric noise conditions in and around the Project alignment. Post construction, changes in traffic volumes, vehicle types, and travelling speeds resulting from the upgraded traffic corridor, and alignment changes of some highway components, specifically the introduction of the new bridge, may result in an alteration of the noise environment in the vicinity of the Project. Predicting the anticipated nature and magnitude of such changes is important for assessing Project-related effects on human health, wildlife, and land use, which have all been defined as valued components (VCs) in this environmental assessment. The decision to undertake an assessment of Project-related effects on atmospheric noise was also informed by feedback received through pre-Application consultation on the Project with government agencies, Aboriginal Groups, and the general public. Potential influence of the Project on atmospheric noise and consequent effects on human health, terrestrial wildlife, and land use was identified as an area of specific interest by Vancouver Coastal Health, Fraser Health, Metro Vancouver, local communities (City of Richmond, Corporation of Delta), and Aboriginal Groups. Metro Vancouver expressed an interest in potential Project-related effects on noise within Deas Island Regional Park, and Aboriginal Groups expressed an interest in potential effects of Project-related changes in atmospheric noise on wildlife. Potential influence of change in noise conditions on quality of experience in the context of traditional uses was also identified as an area of interest by Aboriginal Groups.

Additional information on the selection of VCs, and the link between atmospheric noise and the above VCs, is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**. The assessment of atmospheric noise follows the general methodology described in **Section 3.0 Assessment Methodology**.

In late 2013, the Ministry initiated field and desktop studies and modelling to support the environmental assessment of the Project. The studies had the following key objectives, and were designed to build on existing information and address known data gaps:

- Describe, through monitoring, existing noise environments at locations representative of noise-sensitive land uses that may be affected by the Project
- Assess potential effects of Project-related construction noise and ground-borne vibration (associated with pile-driving only) on noise-sensitive receptors
- Predict Project-related changes in operational (traffic) noise exposures at noise-sensitive receptors

- Identify appropriate mitigation measures and best practices to eliminate or minimize atmospheric noise increases at noise-sensitive receptors
- Estimate residual Project-related changes in noise conditions that may remain after application of appropriate mitigation
- Identify cumulative changes that may result from the interaction of Project-related residual changes and changes in noise conditions attributable to other certain or reasonably foreseeable projects or activities

The objectives identified above were addressed through the completion of studies outlined in **Table 4.10-1**. Technical details of these studies are provided in the technical volume**, Atmospheric Noise Study**, **Section 16.6**.

Table 4.10-1 Atmospheric Noise Studies

Study Name	Study Description
Pre-Project Noise Monitoring	Continuous noise monitoring was conducted (for 24-hour, 48-hour, and shorter periods) at noise-sensitive receptor sites in the vicinity of the Project to establish existing ambient noise conditions.
Post-Project (2030) Traffic Noise Modelling	Post-Project (i.e., operation phase) traffic noise levels were predicted to 2030 using numerical modelling along the new bridge and approaches, and baseline adjustment method for the remainder of the highway alignment.
Project Construction Noise Forecasts	A generic approach was taken to estimate noise levels typically experienced during standard highway construction activities at various setback distances. Pile driving noise was estimated using numerical modelling.

4.10.1.2 Methodology

The following methods and procedures have been used to assess the baseline and future (post-Project) operational atmospheric noise conditions as well as construction noise levels within the extent of the Project:

- Baseline (pre-Project) noise monitoring was conducted at noise sensitive locations as shown on **Figure 4.10-1**.
- CadnaA outdoor sound propagation software was used to model post-Project noise exposures at noise-sensitive locations in the vicinity of the new bridge and its approaches, where proposed changes in the vertical alignment of Highway 99 are substantial.
- The baseline adjustment method (BAM) was used to predict post-Project noise exposures at noise-sensitive locations along Project segments where proposed changes to the horizontal and vertical alignments of Highway 99 are negligible or minor.

- Locations (residential and others) at which mitigation consideration is warranted under the Ministry's 2014 noise policy were identified based on measured pre-Project (baseline) and post-Project (predicted) noise levels.
- The CadnaA model developed to predict post-Project noise exposures was used to assess potential effectiveness of mitigation measures in the vicinity of the new bridge. Effectiveness of mitigation measures at the remaining locations were assessed using basic acoustic principles.
- Construction noise exposures at noise sensitive locations have been estimated through a generic construction noise procedure[1] appropriate for use in the assessment stages of projects when detailed construction equipment lists and schedules are not available

An overview of the methodology used, metrics obtained in noise monitoring, and relevant thresholds considered in assessing noise conditions is provided below. Methodology used to assess potential Project-related changes is discussed briefly in **Section 4.10.3.1**. Technical details on noise monitoring and assessment methodology are included in the technical volume, **Atmospheric Noise Study, Section 16.6.**

Monitoring to Establish Existing Conditions

To document and characterize the existing (pre-Project) noise environments in the study area, monitoring was conducted at representative residential and non-residential noise-sensitive locations shown on **Figure 4.10-1**. Selected receptors were discussed with relevant stakeholders during the pre-Application consultation on the Project to confirm their suitability.

Continuous monitoring at all sites was conducted between October 2 and November 22, 2013, and between April 7 and 9, 2014. Monitoring data collected in September 2013 from an adjacent project was used for two sites.

Monitoring was conducted using logging sound level meters compliant with ANSI S1.4 standards for type 1 precision sound level meters. Technical details on methods, including equipment, noise level histories obtained at monitoring sites, site photos and descriptions, and dominant sources of existing noise are presented in the technical volume, **Atmospheric Noise Study**, **Section 16.6**.

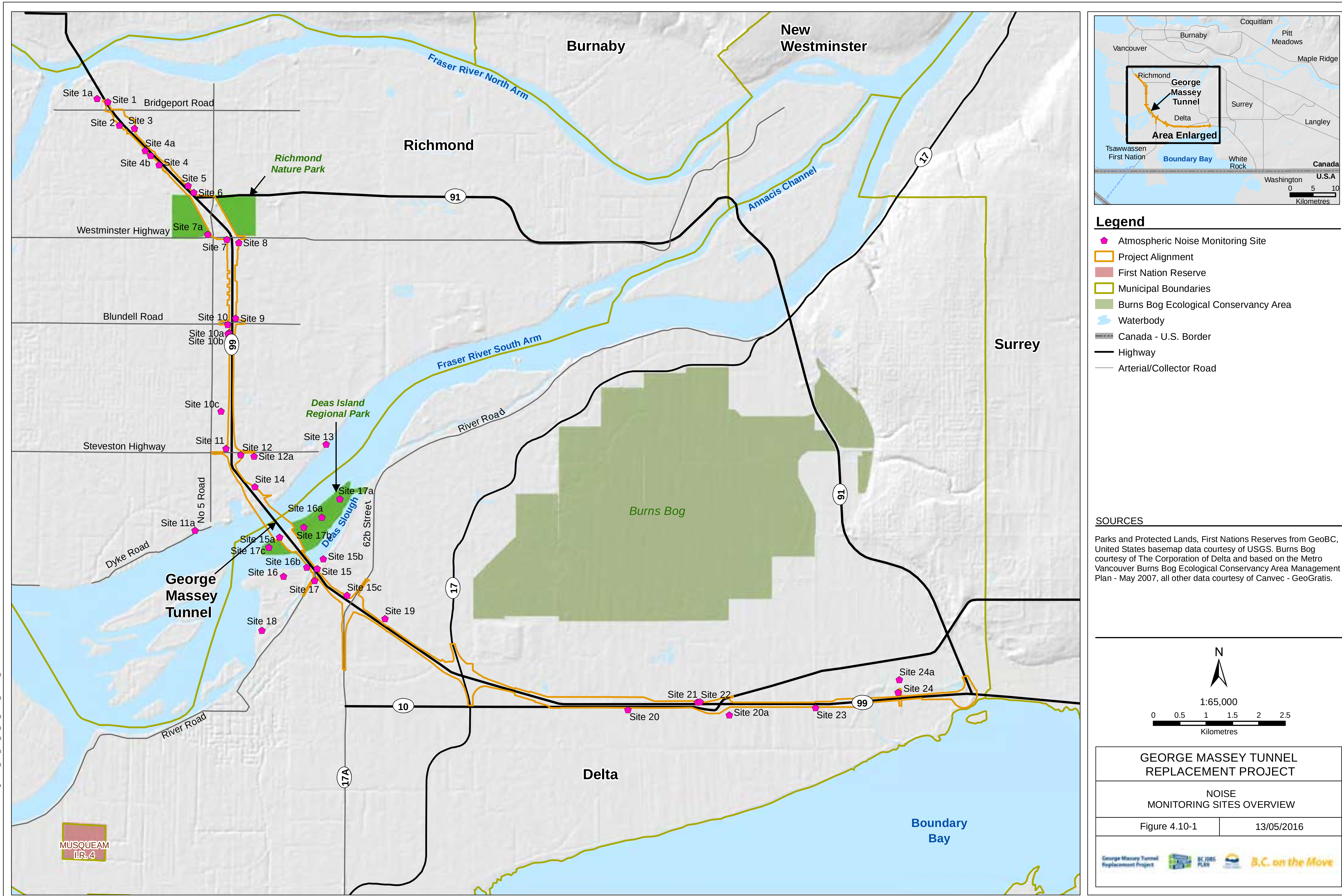
1 This procedure has been used in previous applications for the Sea to Sky Highway Improvement, South Fraser Perimeter Road and Port Mann/Highway 1 projects.

Noise Metrics

The principal noise metric obtained for the Project, through monitoring, is the day-night average noise level (L_{dn}), which is the primary noise metric used in the Ministry's *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (Wakefield Acoustics Ltd. 2014), hereafter referred to as the Ministry's 2014 noise policy. Noise monitoring also provided the daytime average sound level (L_d), which is the equivalent sound level (L_{eq}) between 7 a.m. and 10 p.m., and the nighttime average sound level (L_n), which is the L_{eq} between 10 p.m. and 7 a.m. While these latter two noise metrics are not used directly in the Ministry's 2014 noise policy, they provide important information relevant to the human health effects assessment (**Section 7.1 Human Health**).

Relevant Community Noise Thresholds

The threshold beyond which noise has the potential to interfere with sleep is identified as L_n of 30 dBA indoors, which can be reached when outdoor noise levels are in the L_n 45 to 70 dBA range (WHO 1999). Thresholds beyond which noise has the potential to interfere with conversation are identified as L_d 55 dBA for conversations indoors, and L_d 45 dBA in classrooms. Depending on the nature and condition of the school façade, indoor levels of 45 dBA can be reached when outdoor noise levels are in the L_d 60 dBA to 75 dBA range.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

NOISE MONITORING SITES OVERVIEW

Figure 4.10-1 13/05/2016

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4.10.1.3 Assessment Boundaries

The assessment boundaries for atmospheric noise are defined below.

Spatial Boundaries

The assessment area for atmospheric noise includes those areas in the vicinity of the Project where noise impacts are likely to occur. Boundaries of the assessment area were established based on the lateral distance beyond which daily-average noise levels from traffic related to the Project would not be expected to exceed what is considered acceptable for residential land uses. The metrics used to determine acceptability are based on those identified by the U.S. EPA (1974) and the Canada Mortgage and Housing Corporation (CMHC) (1981).

The lateral distance within which Project-related traffic could affect atmospheric noise will depend on the volume, average speed, and heavy truck component of the future traffic streams on Highway 99. This distance will also depend on the elevation of the traffic above the ground and the nature of the ground surface between the highway and the noise-sensitive receptors. Where sound travels close to the surface of the earth and, in particular, where the intervening surface is acoustically absorptive, or soft (i.e., grass, farmland, or wooded areas), the rate at which sound levels are attenuated with distance is relatively high. Where the sound source is elevated well above the ground and, in particular, where the intervening surface is acoustically reflective, or hard (i.e., water, pavement, or hard-packed earth/gravel), the rate of attenuation of sound levels with distance is generally lower.

For these reasons, for the majority of the study area within which Highway 99 is close to natural ground level and largely bordered by agricultural or undeveloped lands, the study area width extends 500 m from either side of the Project footprint. This width is sufficient to capture the following:

- Residences north of the Fraser River on both sides of No. 5 Road, which parallels Highway 99 to the west, and Sidaway Road, which parallels Highway 99 to the east.
- Residences south of the Fraser River along 64th, 72nd, 80th 88th, 96th Streets, Burns Drive, and Ladner Trunk Road.

In the vicinity of the new bridge, where Highway 99 traffic will be elevated well above natural ground level, and where much of the surrounding surfaces are water, the study area extends approximately 1,600 m from either side of the Project footprint, since the rate of decrease in sound levels over these acoustically reflective surfaces is lower. This distance is sufficient to capture the following:

- Condominium buildings located along Riverport Way in Richmond on the north bank of the Fraser River to the east of Highway 99 and the new bridge.
- Townhouses along Regatta Way, Delta, to the west of Highway 99.
- Residences and parks along Dyke Road and residences along Rice Mill Road in Richmond.
- Residences along River Road and Admiral Way in Delta.

Based on the above considerations, select noise-sensitive locations along the Project alignment as shown on **Figure 4.10-1** were selected as ambient noise monitoring stations to support the assessment of Project-related changes in atmospheric noise levels.

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects were established based on the potential for each phase of the Project to interact with and have an effect on atmospheric noise. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect atmospheric noise conditions along the Project alignment; therefore, the following temporal boundaries were defined for atmospheric noise assessment:

- Existing conditions
- Project construction, which includes Tunnel decommissioning
- Project operation, including maintenance

Temporal characteristics (timing) of the Project construction phase (including decommissioning of temporary construction-related facilities and the Tunnel), and operational phases are defined in **Section 1.1.3 Project Phases and Schedule**.

Temporal boundaries for the atmospheric noise study were defined as extending from initiation of Project construction to 10 years after completion of the Project construction, in accordance with the Ministry's 2014 noise policy. The anticipated Project completion date of 2022 puts the 10-year post-completion horizon year at 2032; however, 2030, the year for which future traffic volume projections were available, was used as the horizon year for this assessment [2]. This temporal period encompasses existing conditions, and the Project construction and operations phases.

Administrative Boundaries

No administrative boundaries, (i.e. political, economic, or social constraints on the collection or analysis of data), relevant to the assessment of atmospheric noise, were identified.

Technical Boundaries

The level of accuracy and precision of the baseline noise measurements is ±0.5 dBA for the instrumentation itself. Day-to-day variations in traffic volumes on major highways are generally not large enough to cause variations in daily average noise levels of more than ±0.5 dBA.

Traffic volume modelling, which forms the basis of future traffic noise-level predictions, has a certain margin of error; however, given the relatively weak relationship between traffic volumes and average noise levels (3 dBA per doubling of volume), the influence of this margin on predicted noise levels is considered negligible.

Prediction of future (2030) traffic noise levels using the BAM method in situations where the highway alignment is not changing substantially is typically accurate to within approximately ±0.5 dBA while predictions made using a TNM/CadnaA model are typically accurate to within ± 1.0 to 2.0 dBA when geometries are not overly complex and setback distances are not too large. However, it has to be noted that the TNM/CadnaA modelling approach considers meteorological conditions favourable for sound propagation (i.e. noise receiver downwind of noise source), which results in a somewhat conservative estimation of noise levels in situations involving sound propagation over soft ground.

4.10.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of the noise environment within the assessment areas. An overview of the regulatory context as relevant to the Project is also provided.

[2] The difference in noise levels due to traffic growth from one year to the next is negligible. Should Project completion occur within a few years of 2022, the difference in forecasted noise levels in between is considered to be minor and within the acceptable margin of uncertainty for the operational noise impact assessment.

4.10.2.1 Regulatory Context

Community noise impacts associated with provincial highway projects are addressed in the Ministry's 2014 noise policy. Under this policy, noise effects are assessed at noise sensitive receptors such as residences, hospitals, educational facilities, places of worship, libraries, museums, and passive recreational facilities (parks). Mitigation measures, including Project design considerations, aim to promote public health and welfare and avoid situations where noise levels are inconsistent with a healthy residential environment, are intrusive and disruptive to the communities, and compromise the intended functioning of public facilities and noise-sensitive outdoor spaces. Typically, mitigation consideration is warranted when certain noise thresholds are exceeded.

There are currently no published Canadian guidelines, noise thresholds, or standards appropriate for the assessment of noise effects. Construction contractors are typically required to meet construction noise requirements of the jurisdictions where construction is taking place. Health Canada refers to a variety of internationally recognized standards for acoustics, such as the United States Environmental Protection Agency's (U.S. EPA) Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (U.S. EPA 1974, Health Canada 2010).

4.10.2.2 Factors Influencing the Existing Noise Environment

The existing noise environment along Highway 99 between Bridgeport Road and the Highway 91 interchange in Delta is controlled primarily by traffic on the highway and connecting roadways (i.e., Bridgeport Road, Westminster Highway, Steveston Highway, River Road, and Highways 17A, 17, 10, and 91). Other sources contributing to the noise environment, but to a lesser degree, include local traffic and activities, trains, aircraft, marine, and agriculture-related activities.

Changes in the noise environment in the vicinity of the Project in recent decades have largely been due to traffic volume growth on Highway 99 and, to a lesser degree, on connecting roadways.

Opening of the South Fraser Parameter Road (Highway 17) and associated interchange with Highway 99 in December 2013 resulted in some reduction in traffic (including heavy trucks) along Highway 17A south of Highway 99, and River Road north of Highway 99 (B.C. MOTI 2014). A comparison of Ministry traffic data collected near the south Tunnel portal before and after the opening of Highway 17 (i.e. October 2013 versus February and April 2014) shows that, after a brief period of adjustment following the opening of the new highway, traffic on Highway

99 through the Tunnel returned to volumes comparable to pre-Highway 17 numbers. This suggests that traffic volume changes associated with the opening of Highway 17 are not likely to have measurably altered the noise environment for most noise-sensitive receptors along the Project alignment. An exception is the Riverport Way condominium development on the Fraser River north shore, approximately 1,600 m east of Highway 99. Before Highway 17 was in operation, the noise environment was dominated by River Road traffic, south of the river. Ministry data show that total daily average traffic volumes on River Road decreased by about 30% with the opening of Highway 17, which suggests a consequent decrease in noise levels at Riverport Way condominium development.

4.10.2.3 Range of Existing Noise Levels along the Project Alignment

Existing noise levels at the select sensitive receptors are presented in **Table 4.10-5**. Existing noise levels range 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 vicinity of the Project. Existing noise levels in passive parks range 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.

4.10.2.4 Highway 99 Traffic Noise in the Study Area

Based on the results of monitoring, existing noise levels in the study area are generally controlled by Highway 99 traffic, with the following exceptions:

- Near Highway 99 and Westminster Highway in Richmond, there are secondary noise contributions from Westminster Highway traffic.
- The eastern end of the parking lot and trail system in Richmond Nature Park is 300 m from Highway 99, but only 60 m from Westminster Highway and 100 m from No. 5 Road. As such noise exposures are controlled by traffic on these two routes rather than by Highway 99 traffic.
- At Site 13 (Figure 4.10-1), situated at Riverport Condominiums on the Fraser River north bank, noise exposures were measured in autumn 2013 (i.e., prior to opening of Highway 17), and were found to be dominated by River Road traffic.
- Residence on Rice Mill Road in Richmond receives noise contributions from industrial and marine sources, particularly at night.
- Noise levels at residence on Ferry Road in Delta are controlled by local traffic and activities.
- At the municipal park along Dyke Road in Richmond, daytime noise levels are slightly influenced by Highway 99 traffic.

- Noise levels at Richmond Country Farms are influenced by traffic on the northbound off-ramp from Highway 99 to Steveston Highway.
- At the eastern end of Deas Island Regional Park, daytime noise levels were measured in November 2013 (i.e., prior to opening of Highway 17) and were found to be dominated by River Road traffic.
- Noise levels at two residences on 112th Street in Surrey near the southern limit of the project are dominated by railway activities rather than Highway 99 traffic.

Residences along No. 5 Road and Sidaway Road, between Westminster and Steveston Highway, are located approximately 400 m from Highway 99 over acoustically soft ground. Consequently, existing noise levels due to Highway 99 traffic at these residences are estimated to be below the threshold for noise concerns in residential areas. Residences on No. 5 Road are typically exposed to higher noise levels from local No. 5 Road traffic (estimated to be approximately 63 dBA based on 2006 traffic information; City of Richmond 2014) than from Highway 99. Highway 99 traffic noise levels at residences on Sidaway Road are anticipated to be similar to those expected at No. 5 Road residences. Influence of local traffic on noise levels at Sidaway Road residences are expected to be relatively low.

4.10.2.5 Future Conditions without the Project

To provide context for understanding potential Project-related changes, future (2030) noise conditions without the Project were estimated based on monitoring results and supporting information. Year 2030 was used as the reference year in predicting future noise conditions to make effective use of the vehicle fleet forecasts set out by Metro Vancouver and the Regional Transportation Model. Future noise levels are generally expected to be somewhat higher than existing levels due to gradual growth in traffic volumes.

As discussed in **Section 5.1 Traffic**, by 2030, growth in Highway 99 traffic volumes without the Project, expressed as annual average daily traffic (AADT), is expected to be in the range of 20% over the northern portion of the Project alignment (north of Highway 17A interchange) to 30% over the southern portion of the Project alignment (south of Highway 17A interchange). Without the Project, heavy truck mixes on Highway 99 are be expected to increase from approximately 3.5% to 5% in 2013 to 5% to 11% in 2030.

Influence of this projected growth in total traffic volumes and truck mixes between 2013 and 2030 on noise levels (L_{dn}) are expected to be increases of approximately 2 dBA over the northern portion of the Project alignment, and between 2.2 and 3.2 dBA over the southern portion.

4.10.3 Potential Effects

4.10.3.1 Assessment Methods

Project-related changes in atmospheric noise were assessed using the following methods and procedures:

- The baseline adjustment method (BAM) was used to predict post-Project noise exposures at noise-sensitive locations where proposed alignment changes are minor (e.g., lane additions, on- or off-ramp alignment adjustments, and traffic volume and posted speed changes)
- Traffic noise model (TNM) within the outdoor sound propagation software, CadnaA, was used to predict post-Project (i.e., operation phase) noise exposures at noise-sensitive locations where proposed alignment changes are substantial (e.g., construction of new bridge and approaches)
- Comparison of baseline and predicted post-Project noise levels to identify locations where mitigation consideration is warranted
- Assessment of mitigation effectiveness in the vicinity of the new bridge using the TNM/CadnaA model, and at locations with proposed minor alignment changes using fundamental acoustic principles.

As discussed in **Section 5.1.2.4**, average annual daily traffic volumes (AADT) for 2030 were assessed using TransLink's RTM for two scenarios– with the new bridge in place and no tolls being applied (TL-RTM Untolled), and with a new tolled bridge in place (TL-RTM Tolled). Given the variability in the forecasting, and to ensure a conservative assessment for EA purposes, the upper range of forecast values (TL-RTM untolled, 2030 With the Project) were used as it represents the highest potential volume of traffic.

Further detail on the TNM/CadnaA noise model, and how the BAM was used in predicting Project-related changes in noise conditions is provided in **Section 16.6 Atmospheric Noise Study Technical Volume**.

A generic highway construction noise model was used to estimate anticipated construction-related noise levels.

4.10.3.2 Project Interactions

An overview of potential interactions between Project activities and atmospheric noise during the construction and operation of the Project is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on atmospheric noise, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Temporary noise generated during Project construction, and change in traffic conditions along the Project corridor post-construction, are expected to result in changes in ambient noise conditions within the study area. Less frequent, temporary changes in noise may be experienced during maintenance activities after the Project is operational, depending on the activity required.

As discussed in **Section 4.10.1.1**, potential influence of the Project on atmospheric noise and consequent effects on human health, terrestrial wildlife, and land use was identified as an area of specific interest by Aboriginal Groups, the public, government agencies (in particular Vancouver Coastal Health, Fraser Health, and Metro Vancouver), and local communities (City of Richmond, Corporation of Delta). Project-related changes in atmospheric noise are discussed in this section and mitigation measures proposed for addressing adverse effects are discussed in **Section 4.10.4** below. The potential health effects of change in exposure to atmospheric noise are discussed in **Section 7.1 Human Health**. Changes in land use activities that may be influenced by change in atmospheric noise are discussed in **Section 5.3 Land Use**. Quality of Experience in Exercising Aboriginal Interests in the context of direct sensory disturbance to traditional users through Project-related changes noise is discussed in **Section 10 Aboriginal Consultation**. Potential influence of Project-related change in noise conditions on terrestrial wildlife (i.e., sensory disturbance) is discussed in **Section 4.8 Terrestrial Wildlife.**

4.10.3.3 Construction-Related Effects

Noise from Construction Activities other than Pile Driving

A generic analysis, originally developed for the Sea to Sky Highway Improvement Project and subsequently employed for the assessment of the Port Mann/Highway 1 Improvement Project and South Fraser Perimeter Road (Highway 17) Project, was adapted to fit Project conditions and used to estimate anticipated construction-related noise emissions. Factors considered during generic construction noise modelling, such as distance from the noise source, duration of construction activities, and setbacks from the highway, are listed in the technical volume, **Atmospheric Noise Study** included as **Section 16.6.**

Average construction noise levels predicted to be generated at various setback distances from a 200-m long, active construction zone due to cumulative noise output of all active heavy construction equipment are shown in **Table 4.10-2**. The levels presented are those that would be expected if the intervening ground was acoustically soft (i.e., grass, farms, or undeveloped land).

Table 4.10-2 Average Construction Noise Levels (L_{eq}) Expected Outdoors at Various Setback Distances from a 200 m-long, Active Construction Zone, Over Acoustically Soft Ground

Major Construction Activity	Levels at Distances from a Typical 200-m Construction Zone (dBA)						
	15 m	30 m	50 m	100 m	200 m	400 m	800 m
Clearing and grubbing	82.5	78.0	74.5	69.0	60.5	51.0	39.5
Excavation	84.0	79.5	76.0	70.5	62.0	52.5	41.0
Retaining walls and structures	80.0	75.5	72.0	66.5	58.0	48.5	37.0
Grading	82.0	77.5	74.0	68.5	60.0	50.5	39.0
Asphalt paving	79.0	74.5	71.0	65.5	57.0	47.5	36.0

Construction noise exposures presented in **Table 4.10-2** are considered conservative since they assume construction activities are continuous throughout working hours. Typically, slowdowns and stoppages in construction activities occur.

More than one major construction activity may occur concurrently, which would have an additive effect on noise exposure. Such additive effects are small at locations close to the Project alignment, where construction noise levels are highest. Concurrent 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.

Noise from Pile Driving

Pile driving will occur during construction of the two bridge towers and the north and south bridge approach support piers. Due to the proximity of the new bridge and approaches to residential areas and Deas Island Regional Park, a more rigorous noise prediction method, CadnaA (described in more detail in **Section 16.6 Atmospheric Noise Study Technical Volume**) was applied for pile driving noise. Sound emission data (Environmental Protection Department 1997; expressed in L_{eq}) for a diesel impact hammer driving steel pipe piles was input to the CadnaA model to estimate pile driving noise levels at all noise-sensitive locations in the vicinity of the new bridge and approaches.

Ground-borne Vibration from Pile Driving

Pile driving will generate ground-borne vibration that may, at times, be perceptible at residences closest to the alignment. In such situations, ongoing vibration monitoring will be undertaken and pre-condition surveys of residences located closest to the piling areas conducted as appropriate.

Overall Estimated Construction-related Noise Effects

Project-related changes in noise levels at noise-sensitive receptors expected during construction are summarized below.

Maximum temporary construction noise levels at residential receptors are anticipated to range between 52 and 86 dBA L_d, with an average of 75 dBA $L_{d,}$ for construction involving pile driving, and between 39 and 84 dBA L_{dn}, with an average of 75 dBA, for other activities.

At non-residential receptors (school, Places of Worship) along the Project alignment, temporary construction noise levels are estimated to range from 61 to 77 dBA $L_{dn,}$ with an average of 71 dBA.

Maximum temporary daytime construction noise levels in various parks are anticipated to range between 52 and 65 dBA L_d, with an average of 58 dBA, during construction activities involving pile driving, and between 32 dBA and 57 dBA L_d, with an average of 46 dBA, during other construction activities.

4.10.3.4 Operational Effects

Predicted Project-related effects and estimated post-Project (2030) noise levels at the noise-sensitive receptors assessed as part of the noise studies are presented in **Table 4.10-5**. A brief overview of predicted future noise conditions with the Project at noise-sensitive receptors along the Project corridor, without mitigation, is presented below.

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

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

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

Deas Island Regional Park is the only park in the vicinity of the Project where readily perceptible Project-related changes to the noise environment could occur. Predicted effects of the Project within Deas Island Regional Park range from a 4 dBA increase in Ld at its eastern end (approximately 1,200 m from Highway 99), to an approximate 10 dBA increase at locations around 350 m to the east and west of the highway centreline. While noise mitigation for passive parks is considered on a case-by-case basis, post-construction noise levels within the park generally remain below levels that warrant mitigation consideration for residential and institutional use.

4.10.4 Mitigation Measures

This section outlines measures that will be implemented during Project construction and operation to avoid or minimize potential increase in noise levels at sensitive receptors. These measures will be informed by the Ministry's 2014 Noise Policy, and prior experience with comparable transportation infrastructure projects in the Lower Mainland.

4.10.4.1 Construction

Measures that will be implemented during Project construction to prevent or minimize potential effects on atmospheric noise will be outlined in a Construction Environmental Management Plan (CEMP), as described in **Section 12.0 Management Plans**. The CEMP will include a Noise Management Plan that describes standard best practices and Project-specific mitigation measures to prevent or minimize community impacts due to temporary, unavoidable construction-related noise. These measures may include, but not be limited to, the following:

- Control of noise at the source– Measures may be taken to reduce construction noise emissions at the source through the selection, appropriate operation, modification/enhancement and/or maintenance of equipment or processes. These measures include:
    - Turning off idling equipment such as diesel engines when not in use for more than 30 minutes.
    - Fitting all gas or diesel-powered equipment on site with intake (if appropriate) and exhaust silencers (i.e., mufflers) that meet manufacturer's recommendations for optimal attenuation and maintain these silencers in effective working condition.
    - Using hydraulic-powered equipment where appropriate/feasible.
    - Supplying and operating all equipment with appropriate covers, hoods, shields etc., in place and latched shut.
    - Carrying out regular maintenance on all equipment, including lubrication and replacement of worn parts, especially exhaust systems.
    - Operating all equipment at minimum engine speeds consistent with effective operation.
- Noise control along the source-receiver path–Community noise exposures may be reduced by blocking the dominant sound path (usually the line of sight) between the noise source zone and noise-sensitive receivers. For effectively shielded individual noise sources, noise reductions of 5 to 10 dBA may be achieved in this manner. Reductions in overall construction site noise emissions will generally be less and will depend on the degree to which all prominent noise sources can be effectively shielded. The following approaches to path noise control may be considered:
    - Where possible, locating and/or orienting noisy stationary equipment (e.g., compressors, generators) so as to take advantage of any inherent noise shielding available from the natural terrain, roadway fill or shoulder or other large objects (equipment, buildings, material piles) and to direct as little noise as possible towards nearby noise sensitive areas.

- ▫ When working in close proximity to noise sensitive areas and where no inherent shielding elements are available, locating temporary, perhaps portable, noise barriers close to fixed sources of noise such as compressors and generators. Use plywood, strand-board or other convenient, solid materials. If practical, the barrier will be made wider and higher than the noise source and line the source-facing surface with sound absorptive material such as 25 to 50 mm semi-rigid fiberglass insulation.
- ▫ Where permanent noise barriers are warranted to shield residents from operation (traffic) noise, installing them early in the construction phase, if possible, so as to shield construction noise as well.

- Selection of quieter equipment and processes–In some cases, construction processes can be selected that, by nature or design, produce less noise while doing similar work. Similarly, standard equipment or processes can be selected that have had additional noise control features added, such as better mufflers and enclosures on diesel or gas-powered equipment, exhaust silencers on air tools, etc. Equipment involved in any necessary night construction work near residential areas should be fitted with better-than-standard (i.e., "residential-rated") mufflers/silencers.
- Community engagement–Early engagement with communities on the scheduling of particularly noisy activities will help to reduce negative reaction to construction-related noise. As such, the following approaches are recommended for consideration:
  - ▫ Hold information meetings with community representatives throughout the Project corridor to identify site-specific construction activities and the timing of these activities. If there are any activities that must be done outside of regular work hours, the measures to be taken by the contractor to minimize the noise produced and/or received in the community should be discussed in advance.
  - ▫ Communicate with affected communities on a regular basis to advise them well in advance of the types of activities that will be taking place in the future (especially for pile driving, riveting and other operations involving noise impacts) and to notify them of any changes in the estimated start and/or completion dates for the various phases of construction. This can be achieved in a number of ways, including, but not limited to an information telephone line; and updates on the Project website (e.g. construction schedule with scheduled detours & traffic delays, electronic postcard updates with photos, construction bulletins, etc.).
  - ▫ Carry out monitoring of construction noise as appropriate to ensure mitigation measures are effective.

The above mitigation measures and best practices have been successfully implemented by the Ministry on comparable projects in the Lower Mainland, and are expected to effectively address construction-related noise.

4.10.4.2 Operation

The Ministry's 2014 noise policy provides a procedure to determine whether noise environments that will exist within adjacent communities ten years after completion of a highway project warrant mitigation consideration. Mitigation may be considered when the absolute post-project noise levels exceed certain fixed upper limits, and may also be considered when project-related changes in noise levels relative to pre-project conditions are predicted to be of certain magnitudes. The principal noise metric for residential areas is the L_{dn}, with fixed upper noise limits of 65 dBA for moderate impacts and 75 dBA for severe impacts. Details on mitigation thresholds under the Ministry's 2014 noise policy are provided in **Section 16.6 Atmospheric Noise Study Technical Volume**.

Noise impacts at residential receptors are classified as Severe under the noise policy if post-project total noise levels exceed a fixed threshold of L_{dn} 75 dBA, and Moderate if post-project total noise levels exceed a fixed threshold of L_{dn} 65 dBA. Classification of noise impacts under the policy also takes into account pre-Project noise levels and project-related change in noise levels. In cases where pre-Project noise levels are high, noise impacts due to a relatively small increase in noise level could be classified as Moderate or Severe, whereas in cases where pre-Project noise levels are low, noise impacts associated with a larger increase in noise levels may be classified as Minor (additional detail on noise impact classification under the Ministry's noise policy can be found in **Section 16.6 Atmospheric Noise Study Technical Volume)**.

Predicted total noise levels and changes from existing noise levels at noise-sensitive receptors were compared against the mitigation thresholds under the Ministry's 2014 noise policy (see **Section 16.6 Atmospheric Noise Study Technical Volume**) to identify locations where Project-related noise mitigation may be required.

Table 4.10-5 identifies existing (2013) and predicted post-Project (2030) noise levels at noise-sensitive receptors (i.e., residences, schools, places of worship, and parks) along the Project alignment, and indicates whether the resultant noise impact warrants mitigation consideration under the Ministry's 2014 noise policy. The table also provides an overview of locations where Project-related mitigation considerations are warranted and the approximate spatial extent of such mitigation works. Mitigation measures will be implemented at these locations as warranted to meet the objectives of the Ministry's noise policy and achieve a minimum target noise reduction of 5 dBA. These measures identified in the Ministry's 2014 Noise Policy involve methodologies (e.g. noise barriers) that have been proven to be effective in mitigating traffic-related noise impacts associated with comparable projects. Noise mitigation measures will be integrated into Project design and construction to ensure that mitigation is effective when the Project becomes operational.

4.10.5 Residual Effects

Potential residual effects of the Project on atmospheric noise conditions are characterized with respect to the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated residual effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to atmospheric noise are presented in **Table 4.10-3**.
A summary of criteria ratings for the potential residual effect is provided in **Table 4.10-5** and **Table 4.10-7** for operational phase noise and construction phase noise respectively. The context of the residual effects assessment (i.e., sensitivity and resilience to change, based on existing conditions) is also taken into account in characterizing potential residual effects of the Project.

Context: Existing (pre-project) traffic noise environments at several residential and other noise sensitive land uses (schools, places of worship) along the Project alignment are generally high. Such land uses would be sensitive to any increases in traffic noise that might be associated with the Project. With mitigation, however, residual effects of the Project on ongoing operational (traffic) noise exposures are generally expected to be positive, particularly at those locations which are closest to the alignment and therefore have the highest levels of existing noise. Temporary residual effects due to construction noise cannot be avoided, but will be minimized through the development and implementation of a construction noise control plan, which would include the employment of best practices. Notwithstanding, temporary construction noise levels will, at some residential locations (particularly near the bridge approaches where pile driving is required) and over some limited time periods, exceed the existing noise levels.

Table 4.10-3 Criteria Used to Characterize Residual Effects on Atmospheric Noise

Criteria	Description	Definition of Rating	
Direction	Overall nature of the residual effect	Adverse	Negative effect as a result of the Project.
		Positive	Beneficial effect as a result of the Project.
		Neutral	Neutral effect as a result of the Project.
Magnitude	Intensity of the effect relative to natural or baseline conditions	Negligible	No change in day-night average operational noise levels (L_{dn}).
		Low	An increase in day-night average operational noise levels (L_{dn}) of 1 to 4 dBA.
		Moderate	An increase in day-night average operational noise levels (L_{dn}) of 5 to 10 dBA.
		High	An increase in day-night average operational noise levels (L_{dn}) of more than 10 dBA.
Extent	Geographic extent / distribution of the residual effect	Site	Effect is restricted to the immediate Project alignment.
		Local	Effect is restricted to the LAA
		Regional	Effect extends beyond the LAA
Duration	Length of time over which the residual effect is expected to persist	Short term	Effect occurs for a period of less than 3 months
		Moderate term	Effect persists for up to 12 months
		Long term	Effect persists beyond 12 months

Criteria	**Description**	**Definition of Rating**	
Frequency	Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC)	Occasional	Less than 5 days a week, up to 8 hours/day
		Frequent	Five or more days a week, up to 12 hours/day
		Continuous	7 days a week, up to 16 hours/day
		Permanent	Permanent change
Reversibility	Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased)	Reversible	Baseline conditions will be naturally restored after disturbance has ceased.
		Irreversible	Baseline conditions will not be naturally restored after disturbance has ceased.
		Change	Effect may fluctuate between positive and adverse for the duration of the disturbance.
Likelihood	Likelihood that the residual effect may occur	Low	Likelihood of residual effect is less than 25%.
		Moderate	Likelihood of residual effect is between 25% and 75%.
		High	Likelihood of residual effect is greater than 75%.

4.10.5.1 Construction-related Residual Effects

During construction, mitigation measures and best practices as discussed in **Section 4.10.4.1**, including equipment and activity restrictions, appropriate scheduling of construction activities, noise monitoring, and community communication, will be implemented to minimize potential Project-related effects on ambient noise conditions. However, frequent construction noise will be experienced in areas near active construction sites. **Table 4.10-4** presents a summary of the criteria ratings for potential change in atmospheric noise conditions during construction activities.

Magnitude of residual construction noise effects will vary from low to high, depending on receptor location relative to construction site, and nature of construction activity. Effects will be short-term during construction of interchanges etc., and of moderate term during pile installation for the new bridge. During other construction activities, effects of lower magnitude will be experienced occasionally to frequently at receptor sites along the corridor for short durations. All construction-related effects on atmospheric noise will be temporary and fully reversible. Project-related changes in atmospheric noise levels are not expected to overlap temporally or spatially with similar effects of other project or activities and result in cumulative effects.

Table 4.10-4 Criteria Ratings for Residual Effect: Construction Noise

Criteria	Criteria Rating	Rationale for Criteria Rating
Direction	Adverse	Construction noise will create adverse residual effects resulting in increases in total noise exposures relative to baseline traffic levels.
Magnitude	Low to High	Residual construction noise effects will vary substantially with receiver location and construction phase. Generally the magnitude of such residual construction noise effects will be low to Moderate. However, at some locations (within roughly 350 m of active pile driving at bridge approaches) and for some limited time periods, increases of more than 10 dBA may be experienced.
Extent	Local	Spatial extent will be restricted to within the LAA.
Duration	Short to Moderate term	Individual construction phases, including pile driving, within specific segments of the project corridor will have durations of one year or less.

Criteria	Criteria Rating	Rationale for Criteria Rating
Frequency	Occasional to Frequent	Within the various segments of the project, and during the various stages of construction, construction noise is expected to be present from less than 5 days per week and 8 hours per day, to seven days per week and up to16 hours per day.
Reversibility	Reversible	Construction noise will cease upon completion of the project.
Likelihood	High	Construction noise residual effects will occur, but their magnitudes and durations will vary depending on nature and schedule of specific construction activities.

4.10.5.2 Operation

Table 4.10-5 provides an overview of the predicted residual effects of the Project on community noise levels at all relevant noise receptors (residence, schools and places of worship, and parks), after implementation of mitigation measures in accordance with the Ministry's 2014 noise policy. The ranges and average values of 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

Note that a negative residual effect indicates that, with mitigation, post-Project noise levels will be lower than existing levels.

Table 4.10-5 Anticipated Project-related Changes, Mitigation Considerations and Residual Changes at Noise-Sensitive Receptors[1]

Site #	Location	Land Use	2013 Baseline Noise Levels (dBA)		Total Unmitigated Post-Project (2030) Noise Levels (dBA)		Total Change from Baseline (before mitigation)	Mitigation Consideration Warranted under Noise Policy?	Location (extent) of Anticipated Mitigation Works	Total Post-Project (2030) Noise Levels after Mitigation[3] (dBA)		Total Change from Baseline (after mitigation)
			L_{dn}	L_d	L_{dn}	L_d	Δ (dBA)			L_{dn}	L_d	Δ (dBA)
2	9700 block, Capella Drive, Richmond	Residential	72	-	74	-	2	Yes	Southbound on-ramp from Sea Island Way and along Hwy 99 (approximately 600 m).	69	-	-3
3	10100 block, Caithcart Road, Richmond	Residential	70	-	72	-	2	Yes	St. Edwards Drive between Bird Road and access road to Sandman Signature Hotel (approximately 150 m).	67	-	-3
4	10400 block, Hall Avenue, Richmond	Residential	72	-	73	-	1	Yes	Southbound Hwy 99 starting approximately 100m north of Kilby Drive to within 100 metres of Shell Road trail (approximately 750 m).	68	-	-4
4a	10500 block, Kilby Drive, Richmond	Residential	70	-	71	-	1	Yes	Included in Site #4, see comment above.	66	-	-4
4b	10300 block Bryson Drive, Richmond	Residential	69	-	70	-	1	Yes	Included in Site #4, see comment above.	65	-	-4
5	4500 block Dallyn Road, Richmond	Residential	68.7	-	70.3	-	1.6	Yes	North bound Hwy 99, starting approximately 170 m south of Shell Road trail and ending on shoulder of northbound Highway 91 on-ramp (approximately 450 m).	65	-	-3
6	11600 block Dewsbury Drive, Richmond	Residential	74	-	76	-	2	Yes	Included in Site #5, see comment above.	71	-	-3
7	12200 block Old Westminster Highway	Residential	67	-	71	-	4	Yes	Southbound on-ramp to Highway 99, extending to the west along Westminster Hwy.	66	-	-1
7a	Richmond Nature Park, 11800 block Westminster Highway, Richmond	Municipal - Park	-	58	-	62	4[2]	No	N/A	-	62	4
8	12200 block Old Westminster Highway, Richmond	Residential	64.2	-	67.6	-	3.4	Yes	Northbound off-ramp from Highway 99, extending to the east along Westminster Hwy (200 m to 300 m).	63	-	-2
9	12400 block Blundell Road, Richmond	Daycare/ residential	73	-	77	-	4	Yes	Northbound along Highway 99, extending 150 - 200 m to north and south of Blundell Road (300 m to 400 m).	72	-	-1

Site #	Location	Land Use	2013 Baseline Noise Levels (dBA)		Total Unmitigated Post-Project (2030) Noise Levels (dBA)		Total Change from Baseline (before mitigation)	Mitigation Consideration Warranted under Noise Policy?	Location (extent) of Anticipated Mitigation Works	Total Post-Project (2030) Noise Levels after Mitigation[3] (dBA)		Total Change from Baseline (after mitigation)
			L_{dn}	L_d	L_{dn}	L_d	Δ (dBA)			L_{dn}	L_d	Δ (dBA)
10	12200 block, Blundell Road, Richmond	Daycare/ residential	67	-	70	-	3	Yes	Southbound along Highway 99, south of Blundell overpass (250 m to 300 m).	65	-	-2
10a	Mosque, 12300 block, Blundell Road Richmond	Worship	-	72	-	75	3	Potentially[4]	Southbound along Highway 99, possibly merged with treatment at Site 10 (approximately an additional 200 m).	-	70	-2
10b	School, 12300 block, Blundell Road Richmond	School	-	71	-	74.5	3.5	Potentially	Southbound along Highway 99, possibly merged with treatment at Site 10 (approximately an additional 200 m).	-	70	-2
10c	Ling Yen Mountain Temple, No. 5 Road, Richmond	Worship	-	61.7	-	65.3	3.6	Potentially[5]	Mitigation to be determined by interior noise level measurements.	-	60	-1
11	10600 block, No. 5 Road, Richmond	Residential	66	-	71	-	5	Yes	Southbound along Highway 99 extending along Steveston Hwy to west (approximately 650 m); mitigation may not be warranted if the nearby residential towers have fixed windows).	66	-	0
11a	11500 block, Dyke Road, Richmond	Municipal - Park	-	46.4	-	49.5	2.9[6]	No	None	-	50	3
12	12900 block, Steveston Highway, Richmond	Commercial	70	-	69	-	-1	No	None	69	-	-1
12a	13000 block, Steveston Highway, Richmond	Residential	59.3	-	61.5	-	2.2	No	None	62	-	2
13	14100 block Riverport Way, Richmond	Multi-family	62	-	62	-	0	No	None	62	-	0
14	12900 block, Rice Mill Road, Richmond	Residential	63	-	65	-	2	Yes	Northbound along Highway 99 near Rice Mill Road.	60	-	-3
15	River Woods, 6100 block, River Road, Delta	Multi-family	68.4	-	67.5	-	-0.9	Yes	East side of the southern bridge approach at River Road (approximately 800m).	63	-	-6
15a	Deas Island Regional Park, Delta	Regional Park	-	54	-	57	-	-	This location is very close to the future southern bridge approach	-	57	3
15b	River Watch, 6200 block, River Road, Delta	Multi-family	60	-	62	-	2	No	N/A[7]	62	-	2

Site #	Location	Land Use	2013 Baseline Noise Levels (dBA)		Total Unmitigated Post-Project (2030) Noise Levels (dBA)		Total Change from Baseline (before mitigation)	Mitigation Consideration Warranted under Noise Policy?	Location (extent) of Anticipated Mitigation Works	Total Post-Project (2030) Noise Levels after Mitigation[3] (dBA)		Total Change from Baseline (after mitigation)
			L_{dn}	L_d	L_{dn}	L_d	Δ (dBA)			L_{dn}	L_d	Δ (dBA)
15c	Town & Country Inn, Highway 17A, Delta	Hotel	70	-	69	-	-1	No	N/A	69	-	-1
16	Woodwards Landing, 5300 block, Admiral Way, Delta	Multi-family	57.6	-	57.4	-	-0.2	No	N/A[8]	57	-	0
16a	East of Parking, Deas Island Regional Park, Delta	Regional Park	-	46	-	53	7	No	N/A	-	53	7
16b	Captain's Cove Marina, Ferry Road, Ladner	Multi-family	67	-	68	-	1	Yes	West side of the southern bridge approach at Captain's Cove (approximately 800m).	63	-	-4
17	5954 River Road, Ladner	Residential	68	-	66	-	-2	Yes	West side of the southern bridge approach at River Road (part of the treatment for Captain's Cove).	61	-	-7
17a	Burr House, Deas Island Regional Park, Delta	Regional Park	-	47	-	51	4	No	N/A	-	51	4
17b	First Fork, Deas Island Regional Park Delta,	Regional Park	-	46	-	57	11	No	N/A	-	57	11
17c	Second Fork, Deas Island Regional Park, Delta	Regional Park	-	46	-	56	10	No	N/A	-	56	10
18	5400 block, Ferry Road, Ladner	Residential	52	-	53	-	1	No	None	53	-	1
19	5600 block, 64th Street, Delta	Residential	61	-	64	-	3	Yes	Northbound along Highway 99, just north of 64th Street, centred on receptors	59	-	-2
20	8600 block, Ladner Trunk Road, Delta	Residential	68	-	70	-	2	Yes	Southbound along Highway 99, centred on receptors.	65	-	-3
20a	4700 block, 96th Street, Delta	Residential	53.6	-	56.1	-	2.5	No	None	56	-	3
21	Delta View Life Enrichment Centre, Delta	Multi-family	75	-	77	-	2	Yes	Northbound along Highway 99, just north of 96th Street (400-500m).	72	-	-3
22	Delta View Life Enrichment Centre, Delta	Multi-family	74.5	-	77.2	-	2.7	Yes	See comments for Site 21.	72	-	-3

Site #	Location	Land Use	2013 Baseline Noise Levels (dBA)		Total Unmitigated Post-Project (2030) Noise Levels (dBA)		Total Change from Baseline (before mitigation)	Mitigation Consideration Warranted under Noise Policy?	Location (extent) of Anticipated Mitigation Works	Total Post-Project (2030) Noise Levels after Mitigation[3] (dBA)		Total Change from Baseline (after mitigation)
			L_{dn}	L_d	L_{dn}	L_d	Δ (dBA)			L_{dn}	L_d	Δ (dBA)
23	4700 block, 104th Street, Delta	Residential	69	-	71	-	2	Yes	Highway 99 at 104th Street.	66	-	-3
24	4900 block, 112th Street, Delta	Residential	74[9]	-	-	-	-	No	N/A	-	-	-
24a	5000 block, 112th Street, Delta	Residential	76[10]	-	-	-	-	No	N/A	-	-	-

Notes:
1. Numbers shown in the table have been rounded off to nearest whole decibels except in cases where such rounding off would result in an erroneous representation of post-Project conditions in the three rightmost columns. In such cases, the tenth decibel has been retained
2. Where warranted under the Ministry's 2014 Noise Policy, a minimum mitigation objective of 5 dBA noise level reduction at the receptor sites will be applied.
3. This is the projected change in Highway 99 traffic noise; however, overall noise levels at this site are not dominated by Highway 99 noise, and the actual Project-related noise increase will be lower than indicated here.
4. The Ministry's 2014 noise policy specifies that for educational institutions, the potential need for mitigation must be investigated where post-project noise levels at a school facade are predicted to be Leq(max-hr) 60 dBA or higher. This will often involve measurement of (post-project) noise levels inside unoccupied classrooms. The target minimum noise level reduction objective of 5 dBA will be applied to these receptors.
5. Under the Ministry's 2014 noise policy, the same impact thresholds as specified above for educational institutions apply to places of worship. Given the setback distance of the temple from the highway, which influences mitigation effectiveness, the need for mitigation and appropriate mitigation approach at this location will be determined by post-construction interior noise level monitoring. The target minimum noise level reduction objective of 5 dBA will be applied to this receptor as well.
6. This is the projected change in Highway 99 traffic noise; however, overall noise levels at this site are not dominated by Highway 99 noise, and the actual Project-related noise increase will be lower than indicated here.
7. This receptor would benefit from mitigation treatment at River Woods; however, this reduction in noise levels is not considered in the post-Project noise levels presented.
8. This receptor would benefit from mitigation treatment at for Captain's Cove; however, this reduction in noise levels is not considered in the post-Project noise levels presented.
9. Overall noise exposures at this site are controlled by railway activities; no Project-related influence on noise is anticipated, and therefore future noise predictions were not made.
10. Overall noise exposures at this site are controlled by railway activities no Project-related influence on noise is anticipated, and therefore future noise predictions were not made.

As can be seen in **Table 4.10-5**, with the application of mitigation measures (e.g. noise barriers) in accordance with the Ministry's Noise Policy, post-construction ambient noise levels at most residential and institutional receptors along the Project alignment are predicted to be lower than current levels. This long-term operational residual effect of the Project on noise conditions at residential and institutional receptors are considered to be positive, and of negligible to low magnitude.

Once the new bridge becomes operational, noise levels within Deas Island Regional Park, specifically in proximity to the bridge approach, will increase, but will generally remain below levels that warrant mitigation consideration for residential and institutional use.

Table 4.10-6 presents a summary of the criteria ratings for Post-construction residual effects.

Table 4.10-6 Criteria Ratings for Residual Effect: Operational Noise

Criteria	Criteria Rating	Rationale for Criteria Rating
Direction	Positive	Overall, residual (with mitigation) effects will be positive
Magnitude	Negligible to Low	Typical residual effects in residential areas will be between -1 and -7 dBA (i.e., approx. perceived loudness reductions of from 7 to 38%)
Extent	Local	Spatial extent will be restricted to the LAA – 500 to 1500 m..
Duration	Long term	Effects will persist into future; 10 years or more.
Frequency	Permanent	Effects will exist on a daily basis well into the future.
Reversibility	Irreversible	Operational noise levels will persist at or near predicted levels as long as traffic conditions are relatively free flowing.
Likelihood	High	Changes in operational noise levels are quite certain to occur. Likelihood greater the 75%.

4.10.6 Cumulative Effects and their Significance

The combination of Project-related changes and changes from other present and certain and reasonably foreseeable future projects and activities, listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes to atmospheric noise. This section provides an assessment of these cumulative changes.

Short-term noise exposures are unavoidable especially during Project-related construction activities. However, implementation of standard industry and best practices, informed by the Ministry's experience with prior projects of similar scale and nature, will minimize residual changes in atmospheric noise to the extent practically possible.

Changes in overall traffic noise levels associated with any other certain or reasonably foreseeable projects within the Project alignment are anticipated to be small during Project construction. It has therefore been assumed that cumulative changes due to the interaction of any such increase in non-Project-related traffic noise with Project-related construction noise would be negligible.

A list of other certain and reasonably foreseeable projects and activities that could interact with a Project-related change to atmospheric noise (operation phase) and result in a cumulative change is presented in **Table 4.10-7**. A map showing the locations of these projects and activities in relation to the Project is included as **Figure 3.10-2** in **Section 3.10**. The types of potential cumulative change resulting from these interactions are described below.

Road traffic growth associated with major projects (e.g., Roberts Bank Terminal 2, Fraser Surrey Docks) planned within or near the Project alignment has been considered in the Ministry's EMME 2 traffic modelling, and therefore was included in the 2030 Highway 99 traffic volumes used in the atmospheric noise assessment.

The increase in daily average noise exposures with traffic volume is very gradual, about 3 dBA per doubling of total traffic volume, all else being equal. For example, if, conservatively, over a 10-year period all foreseeable projects in or near the Project alignment collectively resulted in a 15% increase in total daily traffic on Highway 99, the increase in daily average traffic noise exposures from Highway 99 traffic (expressed in terms of L_{dn}) would be 0.6 dBA and would be imperceptible.

Projects that could increase the volumes of other types of transportation movements in the Project alignment are provided in **Table 4.10-7**. These include rail movements along the Canadian National Railway line paralleling Highway 99 to the south between 72 and 96 streets as a result of Roberts Bank Terminal 2, and increased vessel traffic on the Fraser River South Arm beneath the new bridge, as a result of the Vancouver Airport Fuel Delivery project, Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal), and WesPac LNG Marine Jetty Project. While these transportation-related noise events are expected to be audible, they will be transient, not present for long enough to interact with Project-related noise effects, and are not expected to contribute in a measurable or readily perceptible way to the daily average noise levels. At locations where noise from Project operations will be audible, the average daily noise levels are expected to be dominated by the continuous noise created by new bridge traffic.

Table 4.10-7 Potential Cumulative Changes Due to the Interaction of Other Certain and Reasonably Foreseeable Projects on Atmospheric Noise

Other Certain and Reasonably Foreseeable Project	Relevant Source of Change	Anticipated Change	Anticipated Cumulative Change
Roberts Bank Terminal 2	Increase in rail traffic volumes on rail line parallel to Highway 99 between 72 and 96 streets	Increase in numbers of relatively low level rail noise events experienced at rural residences along west side of Ladner Trunk Road approximately 700 m east of rail line	Cumulative change in overall daily noise exposure will be very minor
Vancouver Airport Fuel Delivery Project	Increase in vessels transiting the Fraser River South Arm beneath the new bridge	Increase in noise levels in Fraser River South Arm beneath new bridge	No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels
Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal)	Increase in vessels transiting the Fraser River South Arm beneath the new bridge	Increase in noise levels in Fraser River South Arm beneath new bridge	No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels
WesPac LNG Marine Jetty Project	Increase in vessels transiting the Fraser River South Arm beneath the new bridge	Increase in noise levels in Fraser River South Arm beneath new bridge	No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels

In summary, no cumulative changes of readily measurable or perceptible magnitude are predicted within the Project alignment. A small cumulative change is identified as the combined effect of projects on traffic volumes on Highway 99 and other components of the roadway system. However, such traffic growth is expected to have been included in the EMME 2 traffic modelling for the Project and hence in the 2030 noise predictions made herein.

4.10.7 Follow-up Strategy

During Project construction, monitoring of construction noise will be undertaken as appropriate to ensure mitigation measures are effective.

Once the new bridge and upgraded highway become operational, and traffic patterns have stabilized (no more than a year after completion), post-project, 24-hour noise monitoring will be carried out at selected, representative noise receiver locations. Such monitoring will serve to both confirm noise predictions and to assess the effectiveness of mitigation measures.

4.10.8 References

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APPENDIX A

Project Interaction Table

Table 1 Overview of Potential Project Interactions with Atmospheric Noise

Project Phase/ Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Pre-Construction / Site Preparation			
Pre-Construction / Site Preparation	No interaction	• Surveying • Acquiring property for the Project	N/A
	No effect	• N/A	N/A
	Potential Effect	• Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction	**Potential Project-related effects include:** • An increase in atmospheric noise levels near the Project alignment.

Project Phase/ Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Construction			
New bridge including approaches and ramp connections	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls	**Potential Project-related effects include:** • An increase in atmospheric noise levels near the Project alignment.

Project Phase/ Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Highway 99 improvements, including interchange upgrades	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving	**Potential Project-related effects include:** • An increase in atmospheric noise levels near the Project alignment.

Project Phase/ Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Tunnel decommissioning	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity	**Potential Project-related effects include:** • An increase in atmospheric noise levels near the Project alignment.
Decommissioning of Deas Slough Bridge	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Removal of Deas Slough Bridge including substructures	**Potential Project-related effects include:** • An increase in atmospheric noise levels near the Project alignment.

Project Phase/ Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Operation and Maintenance			
Highway 99 and interchanges	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.)	**Potential Project-related effects include:** • An increase in atmospheric noise levels along the Project alignment.
New bridge	No interaction	• N/A	N/A
	No effect	• N/A	N/A
	Potential Effect	• Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.)	**Potential Project-related effects include:** • An increase in atmospheric noise levels along the Project alignment.

"N/A" indicates that no Project works and/or activities are applicable to the category