4 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS

4.12 Summary of Potential Environmental Effects

A summary of the predicted residual environmental effects of the Project, cumulative effects, and their significance is provided below.

4.12.1 Air Quality

4.12.1.1 Summary of Project Residual Effects on Air Quality

Project land-based and marine-based air emissions will affect air quality by increasing ambient CAC concentrations in the RAA. Project-alone contributions will be most notable in the immediate vicinity of the Project and decrease in contribution with distance.

Table 4.12-1 summarizes Project residual effects on air quality.

Table 4.12-1 Summary of Project Residual Effects on Air Quality

Valued Component (Stage of Project)	Potential Effects	Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Air Quality (Construction, Operation, Decommissioning)	Change in ambient CAC concentrations	4.2.1 to 4.2.13	Not Significant. A residual effect on ambient CAC concentrations is considered significant when ambient concentrations of air contaminants exceed relevant applicable objectives and are of concern relative to the geographical extent of predicted exceedances, their frequency of occurrence, and the presence of potentially susceptible receptors that are exposed to ambient air. All predicted CAC concentration maxima during operations are below the most stringent applicable objectives. The magnitude of CAC emissions during construction is lower than during operations, so the same characterizations, but to a lesser degree, apply to the construction phase. Decommissioning activities, and corresponding emissions, are anticipated to be of even lower intensity. With mitigation, the residual effect of change in ambient CAC concentrations is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.1.2 Summary of Cumulative Effects on Air Quality

Residual Project effects will interact cumulatively with residual effects of existing or future projects and physical activities and will change ambient CAC concentrations in the RAA. Cumulative dispersion modelling results are generally less than applicable objectives for criteria air contaminants. Predicted ground-level concentrations that are greater than the applicable objectives occur infrequently and are of limited geographic extent.

The cumulative air quality effects are characterized as low to moderate in magnitude as predicted concentrations are generally less than the applicable objectives, regional in geographic extent, continuous over the operations phase, and medium-term in duration. Potential effects of Project CAC emissions occur continuously; predicted concentrations are greater than applicable objectives only sporadically as a function of meteorological and terrain constraints. The cumulative effects occur in a disturbed environment; however they are reversible upon Project closure.

The residual cumulative effects for air quality do not meet the significance definition described in Table 4.12-1 and are, therefore, considered to be not significant.

4.12.2 Greenhouse Gases

4.12.2.1 Summary of Project Residual Effects on Greenhouse Gases

The Project residual effect on greenhouse gases include emissions during construction, operations, and decommissioning of the LNG facility and the operation of marine vessels. Table 4.12-2 summarizes Project residual effects on GHGs.

Table 4.12-2 Summary of Project Residual Effects on Greenhouse Gases

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
GHGs (Construction, Operation, Decommissioning)	Emissions of greenhouse gases	4.2.1, 4.2.3 to 4.2.6, 4.2.11 to 4.2.13, 4.3.1 to 4.3.6	Significant. Significance related to the release of GHG emissions is considered in terms of the effect Project emissions will have on the provincial and national inventory report totals. In the absence of provincial and federal policy and legislation related to a quantitative significance threshold, this Project uses CEA Agency guidance (2003), professional judgment (i.e., interpretation of the precedent set by the BC EAO on like projects), and an industry profile to arrive at a significance determination. The precedent set by regulators for similar projects within the industry profile, in combination with the high magnitude evaluation based on CEA Agency guidance (2003) and professional judgement, leads to the conclusion that the Project-alone case is significant for GHG emissions.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.2.2 Summary of Cumulative Effects on Greenhouse Gases

The consensus of the IPCC and the scientific community is that anthropogenic sources of GHG emissions are impacting and subsequently changing the global climate. Therefore, a significant cumulative effect of global GHGs levels on climate change already exists with or without the implementation of this Project. It is not possible to clearly identify the effect that the GHG emissions from individual projects would have on the global climate and the effects that may or may not ensue (CEA Agency 2003). It can, however, be said that annual GHG emissions released from the Project would contribute to the high GHG concentrations already present in the atmosphere, and therefore the Project's GHG emissions are considered significant in the cumulative case.

At a global cumulative level, there is a possibility that the use of LNG would displace higher carbon intensity fuels (such as oil and coal). Globe Advisors (2014) pointed out that if the LNG exported from BC manages to reach a lower life cycle intensity than other fuel sources around the world, then exporting BC LNG could have an overall positive effect on global GHG levels. The most recent IPCC report on mitigation of climate change also states that GHG emissions from the energy sector could be substantially reduced if coal-fired power plants are replaced with natural gas power plants. The report also states that natural gas power plants could act as a bridge technology and that natural gas could play an important role as a transition fuel (IPCC 2014). Many socio-economic factors impact the potential displacement or replacement of higher carbon fuels in the global market with LNG produced from BC. However, regulators in BC have implemented legislation that will require that BC LNG be one of the cleanest sources of LNG in the world (BC Ministry of Energy and Mines 2012).

4.12.3 Acoustic Environment

4.12.3.1 Summary of Project Residual Effects on Acoustic Environment

The Project residual effects on the acoustic environment are a change in noise levels and a change in vibration levels during LNG facility construction and operation. Table 4.12-3 summarizes Project residual effects on the acoustic environment.

Table 4.12-3 Summary of Project Residual Effects on Acoustic Environment

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Acoustic Environment (Construction, Operation)	Change in noise level	4.4.1 to 4.4.9	Not Significant. A residual effect on noise level is considered significant if the effect does not meet the provincial and federal noise guidance. Noise effects from construction and operations of the Project will comply with provincial noise guidelines and federal noise guidance. With mitigation, the residual effect for change in noise level is predicted to be not significant.
Acoustic Environment (Construction)	Change in vibration level	4.4.10 to 4.4.12	Not Significant. A residual effect on vibration level is considered significant if the effect does not meet the municipal and federal vibration guidance. Vibration effects from construction of the Project will comply with municipal and federal vibration guidance. With mitigation, the residual effect for change in vibration level is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.3.2 Summary of Cumulative Effects on Acoustic Environment

The existing acoustic environment is characterized by a combination of residential, industrial, and commercial activities, and the natural environment. Residual effects of the Project, in combination with those of future projects regulated by the BC OGC and existing activities in the RAA, are expected to comply with provincial and federal thresholds for noise and with guidance related to vibration. Therefore, the residual cumulative effects on the acoustic environment are predicted to be not significant.

4.12.4 Water Quality

4.12.4.1 Summary of Project Residual Effects on Water Quality

The Project residual effects on water quality are a change in chemical and physical composition of surface water (freshwater) and marine water (saltwater). Table 4.12-4 summarizes Project residual effects on water quality.

Table 4.12-4 Summary of Project Residual Effects on Water Quality

Valued Component (Stage of Project[1])	Potential Effects	Key Mitigation Measures[2]	Significance Analysis of Residual Effects (Summary Statement)
Water Quality (Construction, Operation, Decommissioning)	Change in chemical and physical composition of surface water (freshwater)	4.2.1 to 4.2.13	Not Significant. A residual effect on freshwater ecosystems from atmospheric emissions that can result in acidification or eutrophication is considered significant if it is predicted to result in impaired conditions in waterbodies extending through the LAA and RAA. No waterbodies represented in the dataset were predicted to have a biologically significant change in pH with critical load exceedances due to acidic input. Under the Application emissions scenario, one lake (dystrophic) of the 30 lakes analyzed (3.3%), showed a nutrient-N critical load exceedance, which is below the threshold of critical risk and of significance. As such, the significance thresholds were not exceeded for acidification or eutrophication. With mitigation, the residual effect of change in chemical and physical composition of surface water is predicted to be not significant.
Water Quality (Construction, Operation, Decommissioning)	Change in physical and chemical composition of marine waters	4.5.1 to 4.5.10	Not Significant. A residual effect on marine waters is considered significant if it is predicted to result in a change in sediment or water quality that would result in a health risk to aquatic life (toxicity for contaminants, habitat and physical damage to fish for suspended sediments), considering the water and sediment quality guidelines and the conservatism built into those guidelines. During construction there is potential for an increase in TSS above the relevant guideline; however, this will be limited to a small section of the LAA in shallow water, and the increase is anticipated to be of short-term duration (returning to background when dredging stops each day). Contaminant mobilization and dispersal during dredging is assessed as minor (small area, short-term duration) and not of a magnitude to cause toxicity in aquatic life. As such, the significance threshold (risk to the health of marine organisms) will not be exceeded. With mitigation, the residual effect of change in physical and chemical composition of marine waters is predicted to be not significant.

NOTES:

[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.4.2 Summary of Cumulative Effects on Water Quality

The Project cumulative effects on freshwater quality are considered to be not significant. No change in pH above the significance threshold for acidification (ΔpH > 0.3 units) are predicted for any lakes with a critical load exceedance. Although three streams were modeled to have exceedances of the significance threshold for acidification, site-specific conditions indicate the predicted changes in pH due to cumulative air emissions in the three streams will not be significant. The significance threshold for eutrophication was not exceeded for the Cumulative Effects Assessment case.

Project cumulative effects on marine waters from dredging, other construction activities, and effluent discharges are predicted to be not significant, as no spatial overlap of the Project residual effects with those of other projects is expected to occur.

4.12.5 Vegetation and Wetland Resources

4.12.5.1 Summary of Project Residual Effects on Vegetation and Wetland Resources

The Project residual effects on vegetation and wetland resources are change in abundance of plant species of interest, change in abundance or condition of ecological communities of interest, and change in wetland functions. Table 4.12-5 summarizes Project residual effects on vegetation and wetland resources.

Table 4.12-5 Summary of Project Residual Effects on Vegetation and Wetland Resources

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Vegetation and Wetland Resources (Construction)	Change in abundance of plant species of interest	4.5.1, 4.6.1 to 4.6.6, 4.8.5	Not Significant. A residual effect on plant species of interest is considered significant if the viability of these plant species is impaired within the RAA. With implementation of mitigation measures, including translocation, the viability of plant species of interest will not be impaired within the RAA. As such, the residual effect of change in abundance of plant species of interest is predicted to be not significant.
Vegetation and Wetland Resources (Construction, Operation)	Change in abundance or condition of ecological communities of interest	4.6.7, 4.6.8, 4.6.9, 4.6.10, 4.2.1 4.2.3 to 4.2.13	Not Significant. A residual effect on ecological communities of interest is considered significant if it interferes with the sustainable persistence of these communities within the RAA. The residual effect to ecological communities of interest will not interfere with the sustainable persistence of these communities within the RAA, as they all occur in other areas of the RAA. With mitigation, the residual effect of change in abundance or condition of ecological communities of interest is predicted to be not significant.

Table 4.12-5 Summary of Project Residual Effects on Vegetation and Wetland Resources

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Vegetation and Wetland Resources (Construction)	Change in wetland functions	4.6.11, 4.6.12 to 4.6.15, 4.7.3, 4.7.4, 4.7.18, 4.7.19	Not Significant. A residual effect on wetland functions is considered significant if it results in an uncompensated net loss of wetland functions of ecologically important wetlands as defined by guidance from Environment and Climate Change Canada (Environment Canada 2014). No uncompensated net-loss of wetland functions will occur to ecologically important wetlands. As such, the residual effect of change in wetland functions is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.5.2 Summary of Cumulative Effects on Vegetation and Wetland Resources

The total area of disturbance, including past, present, and reasonably foreseeable future projects in combination with the Project will result in a loss of approximately 9,187 ha (10%) of the vegetated area of the RAA. The viability of plant species of interest will not be impaired within the RAA due to the mitigations in place (e.g., translocations of listed plants, reclamation of the Project using traditional use plants) and because traditional use plants occur commonly throughout the RAA. The effects to ecological communities of interest will not interfere with the sustainable persistence of these communities within the RAA due to Project mitigations and known mitigations from other projects that will manage the effects to sustainable persisting levels for each measureable parameter. No uncompensated net-loss of wetland functions will occur to ecologically important wetlands.

With the implementation of Project specific mitigation measures, and the mitigation measures expected to be in place for other projects within the RAA, the residual cumulative effects on vegetation and wetland resources are predicted to be not significant.

4.12.6 Wildlife Resources

4.12.6.1 Summary of Project Residual Effects on Wildlife Resources

The Project residual effects on wildlife resources are a change in habitat, change in mortality risk, and change in movement. Table 4.12-6 summarizes Project residual effects on wildlife resources.

Table 4.12-6 Summary of Project Residual Effects on Wildlife Resources

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Wildlife Resources (Construction, Operation, Decommissioning)	Change in habitat	4.5.1, 4.6.2, 4.6.5, 4.6.12, 4.-7.1 to 4.7.8	Not Significant. A residual effect on wildlife habitat is considered significant if the extent (hectares) of habitat change or sensory disturbance and displacement is expected to change the long-term viability of local or regional wildlife populations. With the implementation of mitigation measures, including adherence to the vegetated riparian buffer, the partial loss of terrestrial habitat communities, and species they support, will be reduced or offset for the Project, and will not affect the viability of local or regional wildlife populations. As such, the residual effect of change in habitat is predicted to be not significant.
Wildlife Resources (Construction, Operation, Decommissioning)	Change in mortality risk	4.5.1, 4.6.2, 4.7-4 to 4.7.22	Not Significant. A residual effect on wildlife mortality risk is considered significant if Project infrastructure or activities are expected to decrease the long-term viability of local or regional wildlife populations through increased mortality. With the implementation of mitigation measures, the residual effect will not affect the viability of local or regional wildlife populations. As such, the residual effect of change in mortality risk is predicted to be not significant.
Wildlife Resources (Construction, Operation, Decommissioning)	Change in movement	4.6.2, 4.6.5, 4.7.2 to 4.7.6, 4.7.12, 4.7.23	Not Significant. A residual effect on wildlife movement is considered significant if Project infrastructure or activities are predicted to cause changes in wildlife movement, primarily due to the introduction of physical or perceived barriers that could limit wildlife movement to the extent that there is an adverse effect on the long-term viability of local or regional wildlife populations. With adherence to applicable legislation and regulations, and implementation of mitigation measures, changes in use of known movement corridors or preferred habitats are not anticipated to affect the viability of local or regional wildlife populations. As such, the residual effect of change in movement is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.6.2 Summary of Cumulative Effects on Wildlife Resources

Residual Project effects will interact cumulatively with residual effects of other past, present, or reasonably foreseeable future projects and physical activities regarding the removal or alteration of terrestrial wildlife habitats used for foraging, breeding, denning, overwintering, or roosting. Within the RAA, direct change in terrestrial habitat has occurred primarily through clearing, construction, or modification of vegetated areas for forestry, roads, residential areas, transmission lines, and railways. Cumulative changes in habitat have primarily affected the availability of herb/shrub/sapling forests, which are widely distributed throughout the RAA as a result of forestry regeneration from past projects or activities. Project mitigation will be applied in combination with those for other present and reasonably future projects and physical activities in the region, regional adherence to industry standards, and regional planning initiatives in order to mitigate for habitat-based cumulative effects overall.

Cumulative change in mortality risk for terrestrial wildlife may result from residual Project effects acting in combination with past, present, and potential future incidental destruction of nests, dens, cavities, and roosts, human-wildlife interactions, collisions with vehicles, high-disturbance activities (e.g., blasting and drilling), routine flaring events, and attraction to anthropogenic light and associated collisions with lit structures (including the flare stack). Residual mortality effects will be greatest for wildlife species that require specialized habitat features such as nests, dens, cavities, and roosts during the breeding, roosting, denning, or overwintering periods, as well as for species that demonstrate strong site fidelity or have limited dispersal capability (e.g., nesting birds, small mammals including bats, amphibians). Cumulative effects on change in mortality risk would be reduced by regional planning initiatives that emphasize decreasing the extent of cleared areas to the extent feasible (for reasonably foreseeable future projects and physical activities), regional implementation of adherence to sensitive wildlife timing windows for vegetation clearing, limiting the extent of road construction and the volume of vehicle traffic through group transportation options, and decreasing the use and distribution of anthropogenic light throughout the RAA.

Cumulative change in movement to wildlife resources (terrestrial) may be attributed to placement of infrastructure relative to important wildlife habitats as well as increased light and noise disturbance within the RAA, both of which may cause a change in wildlife movement patterns or use of preferred habitats. Existing projects and physical activities currently contribute to disturbance and displacement of wildlife with small ranges; although the potential for spatial overlap in effects for those species is low, the combined contribution has potential to affect the viability of regional populations. Likewise, wildlife with larger ranges throughout the RAA are primarily affected by linear developments. Increased road density will result in adverse cumulative effects on movement of ungulates and large and mesocarnivores attracted to roadside vegetation, or are using roads as movement corridors. Mitigation measures proposed for the Project applied in combination with those for other past and reasonably foreseeable future projects and physical activities, regional adherence to industry standards, and regional planning initiatives are expected to effectively avoid or reduce combined changes to terrestrial wildlife movement.

With the implementation of Project specific mitigation and environmental protection measures, and the mitigation measures of other projects within the RAA, the residual cumulative effects on change in habitat, change in mortality risk, and change in movement for wildlife resources (terrestrial) are predicted to be not significant; the Project is not anticipated to affect the long-term viability of local or regional wildlife populations.

4.12.7 Freshwater Fish and Fish Habitat

4.12.7.1 Summary of Project Residual Effects on Freshwater Fish and Fish Habitat

The Project residual effects on freshwater fish and fish habitat are change in fish habitat, change in fish mortality or health, and change in fish abundance or relative abundance. Table 4.12-7 summarizes Project residual effects on freshwater fish and fish habitat.

Table 4.12-7 Summary of Project Residual Effects on Freshwater Fish and Fish Habitat

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Freshwater Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in fish habitat	4.8.2, 4.8.3, 4.8.5 to 4.8.6, 4.8.8	Not Significant. A residual effect on fish habitat is considered significant if the effects on productive capacity of fish habitat of importance to key life stages of CRA fishes will exist after mitigation and offsetting measures. With implementation of fish habitat offsetting, as part of a *Fisheries Act* Authorization, there is no expected decrease in the amount of available fish habitat in the RAA. As such, the residual effect of change in fish habitat from the Project is predicted to be not significant.
Freshwater Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in fish mortality or health	4.8.1, 4.8.4, 4.8.7, 4.8.8, 4.8.9 to 4.8.11	Not Significant. A residual effect on fish mortality or health is considered significant if the effect would exist after application of mitigation measures and is at a level that would cause interference with the natural ability of the fish populations to recover from the effects of the project or disturbance. Fish will be relocated to retained habitat within the PDA, where possible, prior to infilling or construction activities. Adherence to mitigation measures, best management practices, and guidance documents for fish salvage activities is expected to result in low fish mortality. As such, the residual effect of change in fish mortality or health is predicted to be not significant.
Freshwater Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in fish abundance or relative abundance	4.8.1, 4.8.4, 4.8.7, 4.8.8, 4.8.9 to 4.8.11	Not Significant. The residual effect on fish abundance or relative abundance is considered significant if a reduction in the population of resident fish would reduce the ability of that population to be self-sustaining in the LAA, or would reduce overall numbers in the LAA, after application of mitigation and offsetting measures. The effect is also considered significant if there will be a reduction in the availability of food and nutrient sources or of habitat critical for carrying out one or more life-cycle processes of the populations in the LAA.

Table 4.12-7 Summary of Project Residual Effects on Freshwater Fish and Fish Habitat

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Freshwater Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in fish abundance or relative abundance (cont'd)		Within the LAA, the majority of fish habitat that contains CRA fish species will be retained, and offsetting will occur to maintain the amount of available fish habitat and productive capacity in the RAA. As such, the residual effect of change in fish abundance or relative abundance is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.7.2 Summary of Cumulative Effects on Freshwater Fish and Fish Habitat

A small number of the freshwater watercourses in the RAA have been disturbed by past or present activities and projects. The Project is anticipated to contribute a loss of 10,857 m^2 of instream fish habitat within the RAA, through construction-related watercourse removal in the PDA prior to offsetting. Outside of the PDA, no further loss of freshwater fish habitat in the RAA is expected from Project activities or from acidification and eutrophication of watercourses.

With the implementation of Project specific mitigation (including offsetting) and best management practices, and the mitigation measures of other projects within the RAA, the residual cumulative effects on change in fish habitat, change in fish mortality or health, and change in fish abundance or relative abundance, for freshwater fish and fish habitat, are predicted to be not significant.

4.12.8 Marine Fish and Fish Habitat

4.12.8.1 Summary of Project Residual Effects on Marine Fish and Fish Habitat

The Project residual effects on marine fish and fish habitat are change in fish habitat, change in behaviour, change in mortality risk, and change in health. Table 4.12-8 summarizes Project residual effects on marine fish and fish habitat.

Table 4.12-8 Summary of Project Residual Effects on Marine Fish and Fish Habitat

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Marine Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in habitat	4.5.1 to 4.5.5, 4.9.1 to 4.9.7	Not Significant. A residual effect on marine fish habitat is considered significant if it threatens the long-term persistence of a marine fish population. Project construction will result in the permanent alteration or destruction of up to 264,976 m^2 of marine fish habitat (including up to 6,180 m^2 of eelgrass). Some of these changes are expected to constitute *serious harm to fish*, and will be offset through the implementation of a Fish Habitat Offsetting Plan. With the implementation of avoidance and mitigation measures, residual adverse effects for change in habitat during all Project phases are not expected to threaten the long-term persistence of a marine fish population and are therefore predicted to be not significant.
Marine Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in behaviour	4.9.3, 4.9.4, 4.9.8 to 4.9.13	Not Significant. A residual effect on marine fish behaviour is considered significant if it threatens the long-term persistence of a marine fish population. Underwater noise generated by in-water construction activities and Project-related vessels is expected to result in localized changes in fish behaviour. Temporary avoidance behaviour, altered swimming direction or startle response exhibited by fish in waters surrounding underwater sound sources are expected to be localized and not jeopardize the ability of a fish to complete one or more of their life processes. With the implementation of avoidance and mitigation measures, residual adverse effects for change in behaviour during all Project phases are not expected to threaten the long-term persistence of a marine fish population and are therefore predicted to be not significant.
Marine Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in mortality risk	4.9.1, 4.9.3 to 4.9.12, 4.9.14 to 4.9.15	Not Significant. A residual effect on marine fish mortality risk is considered significant if it threatens the long-term persistence of a marine fish population. Some marine organisms, primarily sessile or slow-moving benthic invertebrates and infauna, are expected to be killed through burial or crushing during in-water construction activities (e.g., dredging, disposal at sea, infilling, pile installation). In addition, some fish may be injured or killed during impact pile driving and underwater blasting due to exposure to loud underwater noise. During operations, some mortality is expected due to larval impingement or entrainment in the seawater intake pipe. These effects are considered reversible, as habitats remaining after construction will be colonized via dispersal and immigration from nearby areas, and individuals killed by Project activities are expected to be replaced within one to two generations of the affected species.

Table 4.12-8 Summary of Project Residual Effects on Marine Fish and Fish Habitat

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Marine Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in mortality risk (cont'd)		While avoidance and mitigation measures cannot eliminate the risk of mortality for marine fish, the loss of a limited number of individuals is not expected to threaten the long term persistence of a marine fish population. Therefore, residual effects for change in mortality risk are predicted to be not significant.
Marine Fish and Fish Habitat (Construction, Operation, Decommissioning)	Change in health	4.5.1 to 4.5.5, 4.5.8, 4.5.10, 4.9.5, 4.9.8	Not Significant. A residual effect for marine fish health is considered significant if it threatens the long-term persistence of a marine fish population. During construction, some marine organisms, especially those with limited mobility (e.g., sessile or slow moving fish or invertebrates), are expected to be exposed to TSS levels above the 5 mg/L guideline for the protection of marine life, and as a result, may experience health effects. Dredging and disposal at sea are considered the two construction activities that have the greatest potential to alter TSS levels in the water column. Dredging may also re-suspend historical contaminants into the water column (e.g., PCDD/Fs); however, this is expected to occur over a small area for a short-term duration and any change in surface sediment contaminant levels in the surrounding area will be minor and not of a magnitude to cause toxicity to aquatic life. During operations, discharges from the Project may alter the physical and chemical composition of marine waters (e.g., temperature or salinity) and may affect the health of marine fish located in close proximity to the discharge pipe(s). With the implementation of avoidance and mitigation measures, residual adverse effects for change in health during all Project phases are not expected to threaten the long-term persistence of a marine fish population. Therefore, residual effects for change in health are predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.8.2 Summary of Cumulative Effects on Marine Fish and Fish Habitat

The likelihood of residual cumulative effects on marine fish habitat is considered low due to the application of standard industry mitigation measures and regulated requirements to offset *serious harm to fish* (formerly HADD) resulting from project activities. Marine habitats affected by the Project and other reasonably foreseeable marine development projects comprise a relatively small area of fish habitat in the RAA. Although some temporary reduction of productivity may be attributed to the permanent alteration or destruction of these habitats, habitat offsetting is expected to achieve an overall net gain of fisheries productivity. With the implementation of mitigation measures, including habitat offsetting, residual cumulative effects for change in habitat are not expected to affect the long-term persistence of any marine fish population and therefore are predicted to be not significant.

Following the implementation of Project mitigation measures and assuming the practicable mitigation of activities for other future marine development projects that contribute to underwater noise, residual cumulative effects for change in behaviour are predicted to be low in magnitude and reversible. During the Project's operations phase, in waters surrounding overlapping vessel paths, fish frequently exposed to underwater noise from vessels are expected to exhibit some habituation. This habituation is expected reduce the tendency of resident fish to exhibit behavioural avoidance, altered swimming direction, or startle response when exposed to a sound source. Residual cumulative effects for change in behaviour are not expected to affect the long-term persistence of any marine fish population and therefore are predicted to be not significant.

The cumulative mortality of marine fish resulting from the Project acting in combination with past, present, and reasonably foreseeable projects and activities is not expected to affect the long-term persistence of any marine fish population. While fishery-induced mortality is widespread within the RAA, mortality associated with the Project and other marine development projects will be localized, occurring primarily within the development footprint of each project. Most species affected by marine construction activities (and CRA fisheries) have high intrinsic population growth rates, and their populations can sustain the removal of some individuals. Through management of CRA fisheries by DFO, and the implementation of avoidance and mitigation measures for marine development projects, the cumulative mortality of marine fish within the RAA is not expected to affect the long-term persistence of any marine fish population. Therefore, residual cumulative effects for change in mortality risk are predicted to be not significant.

The cumulative effects to marine fish health resulting from the Project acting in combination with past, present, and reasonably foreseeable projects and activities is not expected to affect the long-term persistence of any marine fish population. Areas affected by elevated levels of TSS are expected to be limited to the immediate area affected (e.g., dredge and disposal area), and sediment plumes generated from the Project, and other projects, are not expected to overlap spatially, but may overlap temporally (construction schedules for other projects are currently unknown). With the implementation of mitigation measures, residual cumulative effects for change in health are predicted to be not significant.

With the implementation of Project specific mitigation and environmental protection measures, and the mitigation measures of other projects within the RAA, the combined residual cumulative effects on marine fish and fish habitat are predicted to be not significant.

4.12.9 Marine Mammals

4.12.9.1 Summary of Project Residual Effects on Marine Mammals

The Project residual effects on marine mammals are a change in marine mammal health, behaviour, and mortality risk. Table 4.12-9 summarizes Project residual effects on marine mammals.

Table 4.12-9 Summary of Project Residual Effects on Marine Mammals

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Marine Mammals (Construction, Decommissioning)	Change in health	4.10.1, 4.10.2	Not Significant. A residual effect on marine mammal health is considered significant if it threatens the long-term persistence of a marine mammal species or local population in the RAA. Project construction and decommissioning, particularly in-water blasting and impact pile driving, will result in the introduction of underwater noise at sound levels that may cause a change in health for marine mammals in the immediate vicinity (i.e., <300 m). With mitigation, most notably monitoring of an appropriately-sized marine mammal exclusion zone, the residual effect of change in health is predicted to be not significant.
Marine Mammals (Construction, Operations, Decommissioning)	Change in behaviour	4.10.1, 4.10.2	Significant for harbour porpoises. Not significant for all other species of marine mammal. A residual effect on marine mammal behaviour is considered significant if it threatens the long-term persistence of a marine mammal species or local population in the RAA. With mitigation, the Project is predicted to result in underwater noise above the US NOAA behavioural disruption thresholds over distances of up to 6 km at the material offloading facility (MOF) and 3 km at the LNG jetty during the marine construction phase. During operations, Project-related underwater noise capable of causing behavioural change in marine mammals will extend up to 10 km from the LNG jetty (during berthing events), and 15 km from the LNG carriers transiting through the RAA. Based on the distribution and habitat use of marine mammals in the RAA and demonstrated avoidance responses by harbour porpoise during previous pile driving studies, the residual adverse effect of change in behaviour is predicted to be significant for the local population of harbour porpoises since it may threaten their long-term persistence in this area. This residual effect is not anticipated to threaten the long-term persistence of other marine mammal species or local populations in the assessment area.
Marine Mammals (Construction, Operations, Decommissioning)	Change in mortality risk	4.10.3	Not Significant. A residual effect on marine mammal mortality risk is considered significant if it threatens the long-term persistence of a marine mammal species or local population in the RAA. The Project will result in an increase in vessel traffic of up to 640 LNG carrier transits annually for 25 years. This will increase the relative risk of a marine mammal-vessel strike in the LAA; however, as this is not anticipated to threaten the long-term persistence of a marine mammal species or population in the RAA, the adverse effect of change in mortality risk is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.9.2 Summary of Cumulative Effects on Marine Mammals

It is assumed that DFO will apply similar mitigation measures and exclusion zone requirements for all future projects and activities in the RAA that are likely to produce intense levels of underwater noise. With the implementation of industry standard mitigation measures, residual cumulative effects for change in health are expected to be not significant.

From a regional ecological perspective, temporal and spatial overlap of underwater noise from past, present and reasonably foreseeable future projects and activities in the RAA may result in an overall reduction in availability of marine habitat that is not exposed to sound levels capable of causing a change in behaviour for marine mammals. This effect is considered to be of somewhat lesser relative concern for local populations that demonstrate a broad-scale distribution of habitat use (e.g., where there is suitable alternative habitat in the vicinity). With the implementation of mitigation measures, residual cumulative effects of change in behaviour are expected to be significant for harbour porpoise, and not significant for other species of marine mammal.

Increases in cumulative shipping traffic levels in the RAA will result in a corresponding increase in mortality risk from vessel strikes. A significant adverse residual effect is defined as one that threatens the long-term persistence of a marine mammal species or local population in the RAA. Since strike risk increases in higher density traffic areas, the likelihood of residual cumulative effects for change in mortality risk to marine mammals is considered high. In the event of an accidental vessel strike, effects on the marine mammal involved are assumed to be permanent and irreversible, and would be of heightened concern for SARA-listed species. Based on current marine mammal population sizes and trends for species known to occur in the RAA, changes in mortality risk are considered unlikely to affect population viability, and therefore, residual cumulative effects for change in mortality risk are expected to be not significant.

With the implementation of Project specific mitigation and environmental protection measures, and the mitigation measures of other projects within the RAA, the overall residual cumulative effects on marine mammals are predicted to be significant for harbour porpoise, and not significant for other species of marine mammal.

4.12.10 Marine Birds

4.12.10.1 Summary of Project Residual Effects on Marine Birds

The Project residual effects on marine birds are change in habitat, change in mortality risk, and change in behaviour. Table 4.12-10 summarizes Project residual effects on marine birds.

Table 4.12-10 Summary of Project Residual Effects on Marine Birds

Valued Component (Stage of Project)	Potential Effects	Key Mitigation Measures[1]	Significance Analysis of Residual Effects (Summary Statement)
Marine Birds (Construction, Operation, Decommissioning)	Change in habitat	4.9.2, 4.11.1 to 4.11.3	Not significant. A residual effect on marine bird habitat is considered significant if the extent (m^2) of habitat change or sensory disturbance is expected to adversely affect the long-term viability of local or regional marine bird populations. With the implementation of Project specific mitigation and environmental protection measures, the residual Project effect will not adversely affect the long-term viability of local or regional marine bird populations. As such, the residual effect of change in habitat is predicted to be not significant.
Marine Birds (Construction, Decommissioning)	Change in mortality risk	4.7.9, 4.7.13, 4.7.14, 4.7.15, 4.7.16, 4.7.20, 4.7.21, 4.11.4, 4.11.5, 4.11.6	Not significant. A residual effect on marine bird mortality risk is considered significant if Project infrastructure or activities are expected to adversely affect the long-term viability of local or regional marine bird populations. With the implementation of Project specific mitigation and environmental protection measures, the residual Project effect will not adversely affect the long-term viability of local or regional marine bird populations. As such, the residual effect of change in mortality risk is predicted to be not significant.
Marine Birds (Construction, Operation, Decommissioning)	Change in behaviour	4.9.3, 4.11.1 to 4.11.3, 4.11.7	Not significant. A residual effect on marine bird behaviour is considered significant if Project infrastructure or activities are predicted to cause changes in behaviour, primarily through changes in movement, due to the introduction of physical or perceived barriers that could adversely affect the long-term viability of local or regional marine bird populations. With the implementation of Project specific mitigation and environmental protection measures, the residual Project effect will not adversely affect the long-term viability of local or regional marine bird populations. As such, the residual effect of change in behaviour is predicted to be not significant.

NOTES:
[1] See Section 16 (Table 16-1 Proposed Mitigation Measures) for a full list of mitigation measures

4.12.10.2 Summary of Cumulative Effects on Marine Birds

Past, present and reasonably foreseeable future projects and physical activities have contributed to the removal or alteration of marine bird habitats used for foraging, breeding, staging, or roosting. Change in marine mortality risk for marine birds may result from a combination of existing and future attraction to anthropogenic light and associated collisions causing mortality, fisheries by-catch of marine birds, and lethal or sub-lethal effects of contaminants. However, the combined effect of these activities is not considered a primary source of mortality. Behavioural changes in marine bird populations may be attributed to increased vessel activity in the RAA causing displacement from preferred habitats; however marine birds occupying habitats in the RAA are expected to exhibit varying degrees of habituation to vessel traffic and have access to similar habitats throughout the RAA for foraging, breeding, staging, or roosting.

With the implementation of Project specific mitigation measures, and the mitigation measures of other projects within the RAA, the residual cumulative effects on marine birds are predicted to be not significant, and are not anticipated to affect the viability of local or regional marine bird populations.