

1 **10 EFFECTS OF THE ENVIRONMENT ON THE PROJECT**

2 Environmental conditions such as extreme weather, climate change and seismic events could have
3 adverse effects on the infrastructure or operation of the Ksi Lisims LNG - Natural Gas Liquefaction and
4 Marine Terminal Project (the **Project**). The assessment of potential effects caused by the environment on
5 the Project is required under section 22(1)(j) of the *Impact Assessment Act*, section 25(2)(j) of the
6 *Environmental Assessment Act* and is therefore included in the Application Information Requirements
7 issued for the Project.

8 This assessment looks at potential effects of external environmental factors on construction, operation,
9 and decommissioning of the Project, it considers mitigation measures to avoid or reduce these potential
10 effects of the environment and assesses the potential resultant effects on valued components (**VCs**).
11 Mitigation measures focus on engineering design measures that allow the proposed Project infrastructure
12 to adapt to or withstand current and predicted future environmental conditions or events.
13 Hazard identification studies were prepared for the floating liquefaction, storage and off-loading barges
14 (**FLNGs**) and onshore facilities (PSRG 2022a, 2022b). The resulting reports were used in the preparation of
15 this assessment. Workers while at work for the Project are part of the Project and effects on these
16 individuals is included in the scope of the assessment. Those who are not working but are residing in
17 on-Site (e.g., while off-shift or during days off) are not considered part of the Project and therefore not
18 considered in this assessment.

19 **10.1 Project Setting and Hazard Overview**

20 The Project is located on Pearse Island and adjacent to Portland Canal. It is near the mouth of the
21 Nass River and in an area with strong tides (ranging up to seven metres above chart datum). The Site is
22 within the Coast and Mountains Ecoprovince in the Central Very Wet Hypermaritime Coastal Western
23 Hemlock biogeoclimatic zone. This zone occurs on coastal islands from Portland Canal in the north to the
24 Vancouver Forest Region in the south (Banner et al. 1993). The Central Very Wet Hypermaritime Coastal
25 Western Hemlock biogeoclimatic zone occurs within 25 kilometres (**km**) of the ocean with an elevational
26 range of 0 to 600 metres (**m**) (Banner et al. 1993). The climate is cool and mild with little snow; fog and
27 rain are common throughout the year. The Coastal Western Hemlock zone has a mean annual
28 temperature of 8 degrees Celsius (**°C**) with cool summers and mild winters (Meidinger and Pojar 1991).
29 The north end of Pearse Island has 18 streams, of which 10 flow directly into the marine environment;
30 the remaining 8 are tributaries that flow into these streams. Watercourses on the west and north sides of
31 the Site (at Wil Milit including both District Lots 5431 and 7235) are generally lower gradient while
32 watercourses on the southeast side of the Site are generally steeper. Pearse Island, like much of the
33 north coast, has many wetlands, including bogs, swamps, shallow open water, and estuarine marshes and
34 meadows (Appendix 7.08A).

35 Pearse Island is located in the southern most extent of the Boundary Ranges, which comprise the
36 north-western area of the Coast Mountain physiographic region of British Columbia (**BC**).
37 The Boundary Ranges extend along the Alaskan Pan Handle from the mouth of the Portland Canal to the

1 Yukon/BC boundary (Holland 1976). Elevations in the Boundary Range extend from sea level to greater
2 than 2000 m above sea level (**ASL**); however, elevations at the Site do not exceed 100 m ASL, or 1000 m
3 ASL in the adjacent upslope areas on Pearce Island.

4 The Site is located within the Early Tertiary: granodioritic tectonic assemblage, and comprises
5 post-accretionary, batholithic granodiorites of the Cenozoic. As per the Provincial bedrock mapping,
6 no faults are mapped within the area (McIntyre et al. 1994).

7 Surficial materials in the nearby region are largely mapped as bedrock dominant slopes in the upper alpine
8 regions of the mountains, with pockets of organics along ridge top depressions. Mid-slopes are generally
9 dominated by moderate to steep colluvial deposits, with intercepting gently sloped benches often hosting
10 sub-alpine organic deposits. Lower slopes in the region largely comprise marine deposits, glaciofluvial,
11 fluvial, morainal deposits and bedrock ridges with intersecting organic deposits in the lower depressions.
12 The Site is largely mapped as organics atop bedrock, with north/south oriented exposed bedrock ridges;
13 lesser active marine and alluvial deposits are mapped in, or near, the inter-tidal zone of Pearce Island
14 (Vold and Kowall 1977).

15 The environment in the Project vicinity has the potential to interact with Project infrastructure through
16 oceanographic, seismic, and climactic interactions. Natural Resources Canada classifies the north coast as
17 having a ‘medium-high’ seismic hazard (NRCAN 2015). Moreover, the Coast Mountains have risen with an
18 average of 0.5 mm/year over the past 4,000 years – this being largely attested to isostatic compensation
19 for erosion and thermal expansion of the crust and upper mantle associated with offshore subduction
20 (Mathews 1991). Seismic hazards are further discussed in Section 10.6. Subsidence is unlikely in this area
21 due to shallow bedrock depths. Geotechnical studies are expected to be completed prior to Site
22 preparation; the results of the investigations will be considered in final Project design and front-end
23 engineering and design (**FEED**).

24 Stantec reviewed publicly available bathymetry and derivative hillshades, from National Resource
25 Canada’s TopoBathy digital elevation layers accessible from ESRI’s ArcGIS Online Portal. Evidence of
26 submarine channel and gully erosion, and possible submarine landslides, were observed in the imagery at
27 the mouth of the nearby Nass Bay, where the Nass River alluvial fan meets the Portland Canal
28 (approximately 27 km west-south-west of the Site). No other clearly distinguishable submarine landslides
29 were visible within a 30-kilometer proximity to the Site. However, submarine rilling and channel formation
30 was observed in localized areas where submarine fans (shelves) transition to the deeper canal waters.
31 Some submarine landslides, rilling and gully erosion were observed at the mouth of the Portland Canal.

32 The Site is located within the Northern Cordilleran Volcanic Belt (NRCAN 2020). This volcanic belt is
33 approximately 400 km wide and 1,200 km long and extends into Alaska and Yukon (Edwards and
34 Russell 1999). The volcanoes in this belt are a result of the movement of the North American and
35 Pacific Plates (Le Moigne et al. 2020). Crow Lagoon is a volcano located approximately 36 km directly
36 south of the Project. This volcano has had some seismic activity since 1985 (Stasiuk et al. 2003). The most
37 recent eruption in this region was the Tseax volcano in the 1700s, which destroyed Nisga'a villages and
38 killed approximately 2,000 people (Williams-Jones et al. 2020). This volcano is at the southern end of the

1 Northern Cordilleran Volcanic Belt and is approximately 83 km east of the Project. The main hazards
2 associated with volcanoes that may affect the Project are rock projectiles, seismic activity associated with
3 an eruption, ash fallout, landslides from an eruption which may cause a tsunami, and volcanic gases and
4 acid rain (Stasiuk et al. 2003). The annual probability of a volcanic eruption in the Northern Cordilleran
5 Volcanic Belt is approximately 1:200; a lava eruption is 1:220; and the probability of a significant eruption
6 is approximately 1:3,333 (Stasiuk et al. 2003). This is considered a low probability hazard to the Project
7 and therefore is not carried forward for further assessment.

8 The Green Island meteorological station, (located approximately 60 km southwest of the northern portion
9 of Pearse Island) receives an annual average of 44.0 centimetres (**cm**) of snowfall (Government of Canada
10 2022a). Pearse Island does not contain any alpine areas and is not considered to have avalanche potential
11 by Avalanche Canada (Backcountry BC 2022).

12 Stantec completed a site assessment in September 2022, to identify potential geohazards. The
13 field assessment included a 4-hour helicopter reconnaissance flight of the Site and adjacent
14 Portland Canal (approximately 30 km in either direction), and a one-day field traverse of the Site,
15 completed both on foot and by boat along coastal areas.

16 From the field assessment, provincial bedrock and terrain mapping was observed to generally match field
17 observations. No evidence of major or minor faults were identified during the field visit. Localized cliffs
18 on the flanks of ridges within the Site area, were identified as potential rockfall sources. These areas are
19 localized to low relief cliff bands, generally oriented north-south, aligning with bedrock lineaments visible
20 in the LiDAR DEM surface and satellite imagery. Fractured rock and potential rock fall sources are
21 anticipated to be encountered during construction but are anticipated to be managed by practical rockfall
22 mitigation methods during construction (i.e., scaling, blasting etc.). The results of subsequent
23 investigations will be considered in Project design and FEED.

24 Portland Canal, which encompasses Pearse Island, is lined by steep, granodioritic mountain ranges,
25 upwards of 1000 m ASL. During Stantec's field assessment, shallow translational landslides and rock
26 avalanches were observed along the mountain ranges of the Portland Canal. Several of the observed
27 landslides deposited in the canal; however, no evidence associated with landslide-generated wave runoff
28 along adjacent coastlines was observed by Stantec during this flight. Landslide tsunamis have occurred in
29 fjords along the Pacific Coast, and landslides are associated with steep slopes, local seismic activity, and
30 heavy precipitation (Leonard et al. 2012). Based on observations of the Site and surrounding terrain, there
31 is a possibility that tsunamis, generated by terrestrial landslides, may affect the Site. The results of ongoing
32 investigations will be considered in Project design and FEED.

33 Some gullies, with evidence of debris flows, were identified upslope of the Project area. Based on
34 observations of gully confinement, slope steepness, and general slope aspect - all of which would affect
35 the fall line and depositional characteristics of a landslide - no evidence was observed during Stantec's
36 field assessment to support landslide runoff from these gullies that would affect the Site. Additionally,
37 during the field assessment, no observations of landslides were observed within the Site. At this time, the
38 potential for landslide runoff affecting the Site is not considered a hazard.

10.2 Prevention and Response

The Project will integrate layers of prevention and response measures to comply with the robust regulatory regime applicable to LNG projects in BC, reduce the likelihood that effects of the environment will affect the Project, and manage potential consequences in the unlikely event that they do. These include design standards and regulations the Project will follow, planning steps related to safety and prevention of effects on the Project from the environment, robust communication protocols, response protocols (including spill response), and on-site personnel health and safety requirements.

10.2.1 Design

The Project will be designed to comply with the following standards, codes, and regulations:

- Liquefied Natural Gas Facility Regulation under the *Energy Resource Activities Act*
- Canadian Standards Association (CSA) Z276 (Liquefied natural gas [LNG] – Production, storage and handling)
- CSA EXP276.2 (Design requirements for near-shore FLNG facilities)
- CSA SPE-276.1:20 (Design requirements for marine structures associated with LNG facilities (DRMS))
- CSA Z246.2 (Emergency preparedness and response for petroleum and natural gas industry systems)
- National Building Code of Canada
- BC Building Code

These standards and codes provide guidance, minimum requirements to maintain compliance with codes and regulations, and industry best practices. These codes and standards are updated periodically to reflect advancements in the global LNG engineering design practice. The Proponents will follow current standards and codes for the design of buildings, stormwater systems, and marine terminal infrastructure. Best practices will be incorporated into the design, including building structures above flood elevation (i.e., for the 1:100-year rainfall) and predicted sea level rise. Project infrastructure will be designed to account for the maximum predicted wave heights (PSRG 2022b). Seismic design for the onshore buildings and for the marine infrastructure will be based on the National Building Code of Canada and the BC Building Code. The performance levels and seismic hazard levels will be:

- Life Safety Protection: for a seismic event with a 2,475-year return period
- Controlled and Repairable Damage: for a seismic event with a 475-year return period

The mooring lines on the FLNGs will be designed to account for potential effects of high waves, wind and tsunamis. The Project will be equipped with automatic safety systems to facilitate safe shutdown during extreme weather conditions, should the need arise.

1 **10.2.2 Response**

2 In the event of an emergency, the Project will activate emergency response procedures with the
3 objectives of protecting and saving people, followed by protecting the environment, and finally
4 maintaining the operability of the facility. Determining emergency procedures is a requirement of
5 CSA Z276 (Liquefied natural gas [LNG] - Production, storage, and handling) and 8(1) of the
6 Liquefied Natural Gas Facility Regulation under the OGAA.

7 Section 9.1.2 of Malfunctions and Accidents describes the plans and policies relating to safety, including
8 a Health, Safety, Security and Environment policy, emergency response program, emergency
9 preparedness and response plan, communication plan, and spill response management plan that will
10 apply in the event that the environment affects the Project.

11 If the environment causes a change to the Project that might affect VCs, the Project may implement
12 response measures (e.g., repairing marine infrastructure) that could have an incremental effect on VCs.

13 In the event of a moderate or high consequence (see Table 10.3–2) effect on a VC within the Proponents’
14 control for response, the Proponents will provide notice to Indigenous Nations, stakeholders, and
15 regulators, if requested.

16 **10.3 Methods**

17 The following section identifies the potential effects of the environment on the Project that are considered
18 in this assessment, the boundaries of the assessment, and the methods used for assessment.

19 **10.3.1 Inclusion and Scope of the Assessment**

20 The Application Information Requirements (Section 10.0) identifies the following environmental factors
21 that may have consequences for the Project:

- 22 • Climate change, including long-term changes in:
 - 23 • Temperature
 - 24 • Precipitation
 - 25 • Sea level
- 26 • Extreme weather, including:
 - 27 • Temperature
 - 28 • Precipitation
 - 29 • Flooding
 - 30 • Wind
 - 31 • Waves
- 32 • Tsunamis
- 33 • Seismic events
- 34 • Forest fires

1 A review of baseline conditions and predicted events associated with each environmental factor is
2 included in this assessment. The temporal limits of the assessment extend to 2057, when Project
3 decommissioning, abandonment, and reclamation is anticipated to occur. The geographic extent of this
4 assessment is limited to the Project footprint (both on land and water), the shipping routes [Figure 1.1-2
5 and 1.1-3 in Section 1.0] and the transmission line assessment area, described in Section 6.3.1.

6 **10.3.2 Assessment Components**

7 For each environmental factor, the assessment of potential impacts of the environment on the Project
8 includes the following:

- 9 • A description of the environmental event and/or scenario(s)
- 10 • Identification of Project mitigation measures, including design strategies and risk management
11 that will support resiliency of the Project
- 12 • A description of reasonably likely impacts on the Project as a result of the event and/or scenario
13 including any applicable response measures
- 14 • Identification of valued components with potential consequential effects resulting from the
15 impacts to the Project and/or response measures, based on the results of the hazard identification
16 studies for the Project (PSRG 2022a, 2022b)
- 17 • A description of the risk to potentially affected valued components based on the likelihood and
18 consequence of an environmental factor, taking mitigation measures into account
- 19 • Conclusions

20 **10.3.3 Risk Scoring System**

21 A risk assessment system is used to evaluate potential impacts to the Project from a perspective of
22 infrastructure resiliency. This system assigns risk based on a semi-quantitative approach that considers
23 the likelihood of an environmental factor on the vertical axis and consequence on the horizontal axis. The
24 intersection of these two provides a final risk score, which considers the mitigation measures in place for
25 each potential effect. Likelihood and consequence definitions are generic and can be applied to each
26 scenario described in this section. Likelihood and consequence ratings and their definitions can be found
27 in Table 10.3–1 and Table 10.3–2, respectively.

1 **Table 10.3–1 – Likelihood Ratings for Environmental Event and/or Scenario**

Rank	Title	Definition
1	Rare	Has not yet occurred in the global LNG industry Occurs less than once in 1,000,000 years
2	Very Unlikely	Similar event has occurred in the global LNG industry but is very unlikely Occurs less than once in every 100,000 years
3	Unlikely	Not expected to happen but it is possible and has occurred somewhere in the global LNG industry Occurs once in 10,000 years
4	Possible	Might happen during life of the Project and has occurred somewhere on a similar project Occurs once in 1,000 years
5	Likely	Likely to occur during life of the Project Occurs once or twice during the lifetime of the Project
6	Frequent	Will happen and recur several times within Project lifetime Occurs once per year or less

2

Table 10.3–2 – Consequence Ratings for Valued Components

Rank	Title	Safety and Health Definition	Environmental Definition
1	Insignificant	First aid only, no medical treatment. This typically represents no measurable change in magnitude.	Slight environmental damage contained within the Site such as a small spill (below regulatory or permit level that requires agency notification) in the LNG production area or at the FLNGs that is readily cleaned-up or evaporates with no residual contamination. This typically represents no measurable change in magnitude.
2	Minor	Recordable injury or illness. Lost workday or restricted work up to 5 days. Illness with reversible effects. This typically represents a low magnitude change.	Minor environmental damage such as could be expected from a small on-Site spill with no off-Site impacts. Single exceedance of a regulatory or permit limit requiring agency notification. This typically represents a low magnitude change.
3	Moderate	Lost workday or restricted work more than 5 days. Illness or injury with irreversible health effects. Offsite injury or health effect that does not require hospitalization. This typically represents a moderate magnitude change.	Limited environmental damage that will persist or require active remediation. Repeated exceedance of regulatory or permit limits. This typically represents a moderate magnitude change.

Table 10.3–2 – Consequence Ratings for Valued Components

Rank	Title	Safety and Health Definition	Environmental Definition
4	Major	Single fatality, significant irreversible disability, impairment, or health effect to one or more person; offsite injury or health effect that results in hospitalization. This typically represents a high magnitude change that is reversible or short-term in duration.	Major environmental damage that requires extensive measures to restore beneficial uses. Extended exceedances of regulatory or permit limits. This typically represents a high magnitude change that is reversible or short-term in duration.
5	Severe	Multiple fatalities (2-10), permanent total disabilities. This typically represents a high magnitude change of extended duration.	Severe environmental damage that is contained within the Site. Extended exceedances of regulatory or permit limits. This typically represents a high magnitude change of extended duration.
6	Catastrophic	Multiple fatalities (>10), permanent total disabilities. This typically represents a high magnitude change that is irreversible or has long-term duration.	Persistent severe environmental damage that leads to loss of natural resources over a wide area. Persistent off-Site habitat and/or ecological effects or damage with long-term effects. This typically represents a high magnitude change that is irreversible or has long-term duration.

1

2 The likelihood and consequence ratings described in Table 10.3–1 and Table 10.3–2 are combined to
3 create an overall risk score (Table 10.3–3). A description of the risk scores is provided as:

4

- Low – No additional preventative or mitigation action required.

5

- Moderate – Risk is within the “as low as reasonably practicable” principle, the concept that efforts to reduce risk should be continued until the incremental sacrifice (in terms of cost, time, effort, or other expenditure of resources) is grossly disproportionate to the incremental risk reduction achieved.

6

7

- High – Implement controls as soon as practical to reduce to the lowest feasible value. Initiate permanent risk mitigation as necessary.

8

9

- Severe – Implement temporary controls immediately to reduce risk level or lowest feasible value. Initiate permanent risk mitigation immediately.

10

11

12

1 **Table 10.3–3 – Risk Matrix**

		Consequence					
		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Likelihood	Frequent	Moderate	High	Extreme	Extreme	Extreme	Extreme
	Likely	Moderate	Moderate	High	Extreme	Extreme	Extreme
	Possible	Low	Moderate	Moderate	High	Extreme	Extreme
	Unlikely	Low	Low	Moderate	Moderate	High	Extreme
	Very Unlikely	Low	Low	Low	Moderate	Moderate	High
	Rare	Low	Low	Low	Low	Moderate	Moderate

2

3 **10.4 Climate Change**

4 Climate change is defined as the change in climate which can be attributed to human activity, either
 5 directly or indirectly (IPCC 2018). Climate change primarily occurs because of burning fossil fuels
 6 (UN 2022). The current levels of greenhouse gases in the atmosphere will continue to increase surface
 7 temperature, even if the levels of greenhouse gases in the atmosphere stops increasing (IPCC 2021).

8 **10.4.1 Description**

9 Warming due to climate change has changed global weather patterns; northern latitudes have
 10 experienced more warming during winter than other areas (Cui et al. 2021). In addition to increased
 11 temperatures, climate change is predicted to cause:

- 12 • Increased ocean temperatures
- 13 • Increased sea level
- 14 • Shifting of the range of plant and animal species
- 15 • An increase in minimum temperatures
- 16 • Increase in extreme temperatures
- 17 • Increase in severe storms
- 18 • Increased wind events
- 19 • Increase in the intensity of droughts and forest fires
- 20 • Increase in the frequency of pest outbreaks (IPCC 2014)

21 The potential for storms (i.e., extreme weather) and forest fires, including potential effects related to
 22 climate change, are described in Sections 10.5 and 10.7, respectively. Due to the nature and location of
 23 the Project, potential effects related to drought and pests, both of which are unlikely to affect Project
 24 processes, are not carried further for analysis. The climate change scenarios most likely to interact with
 25 the Project are changes in temperature, changes in precipitation, and rising sea level. The baseline
 26 conditions and projected changes for each of these is described below.

10.4.1.1 *Change in Temperature and Precipitation*

2 The average temperature in the coast and mountains ecoprovince has increased by 1.1°C per century
3 since 1900, which is higher than the global average of 0.8°C per century (MOE 2016). Temperatures in the
4 coast and mountains ecoprovince increased most during winter (1.7°C per century) and least during fall
5 (0.6°C per century). The temperature is predicted to increase by 1.7°C to 4.5°C by 2080 (MOE 2016).
6 Minimum temperatures in the coast and mountains ecoprovince have increased by 1.5°C per century
7 since 1900 and are predicted to continue increasing (MOE 2016).

8 Heating and cooling requirements are measured in heating degree days and cooling degree days,
9 respectively. These are a measure of the difference between a comfortable indoor temperature of 18°C
10 and the average outdoor temperature. For example, a day with an average outdoor temperature of 8°C
11 contributes 10 heating degree days, while a day with an average outdoor temperature of 28°C contributes
12 10 cooling degree days. The annual heating requirement for the coast and mountains ecoprovince has
13 decreased by 460 heating degree days per century since 1900 while the annual cooling requirement has
14 increased by 13 cooling degree days per century (MOE 2016).

15 The potential effects on the Project from extreme temperature are discussed in Section 10.5.

16 Climate change has increased the annual precipitation in the coast and mountains ecoregion by 10% per
17 century since 1900. There are no statistically significant trends for which seasons received more
18 precipitation in the last century in this ecoprovince. Projections for precipitation show an increase of 4%
19 to 17% by 2080, compared to the historical average (MOE 2016). Winter precipitation is expected to
20 increase more than other seasons, with more precipitation falling as rain than snow as temperatures
21 warm.

22 Climate change is predicted to result in more extreme precipitation events: more warm, wet years with
23 more variability between years (MOE 2016). Further discussion on climate change is provided in
24 Section 8.0 (Climate Change) and Appendix 8B (Strategic Assessment of Climate Change technical data
25 report).

26 The potential effects on the Project from extreme precipitation are discussed in Section 10.5.

27 10.4.1.2 *Change in Sea Level*

28 Sea level has risen at a rate of 13.3 cm per century since 1900 at Prince Rupert and is expected to rise by
29 more than 50 cm by 2100 (Gifford et al. 2022). Prince Rupert is at higher risk of sea level changes because
30 it already receives high water events more often than other coastal areas (MOE 2016). Prince Rupert
31 experiences larger sea level fluctuations because of the El Niño southern oscillation in the winter, and the
32 Pacific decadal oscillation in the summer (Abeyirigunawardena and Walker 2008).

33 Increased sea level could result in more localized flooding or inundation of low-lying areas, particularly
34 when combined with high tides or storm surges. The potential effects on the Project from precipitation
35 and flooding, and wind and waves are discussed in Section 10.5.

1 *10.4.1.3 Summary of Potential Impacts of Climate Change on the Project*

2 The HAZID reports (PSRG 2022a, b) have identified extreme weather scenarios that are expected to be
3 similar to those of climate change that may lead to the following potential impacts on the Project:

- 4 • Icing on equipment, decking and piping, leading to personnel hazards (e.g., slips, trips and falls,
5 hypothermia); icing on roads and paths leading to difficulty accessing areas
- 6 • Potential flooding of WC-04, leading to loss of egress from the southern FLNG; broken pipes
7 leading to loss of containment of natural gas and cooling water and possible jet fire; or, possible
8 safety impacts to workers
- 9 • Impacted carrier and crew loading, resulting from high wind and waves, leading to failure of
10 mooring lines and a collision between the FLNG and marine trestles, which could result in a loss
11 of containment of LNG and cooling water and a possible fire
- 12 • Undermining of marine and onshore infrastructure foundations resulting from high surface runoff
13 and flooding

14 Section 8.0 noted the following risks to the Project, based on climate changes described above:

- 15 • High wind gusts (90 km per hour or more) which may cause structural damage as described above,
16 affect the ability of helicopters to land and take off, or cause power failures.
- 17 • Long duration rainfall may cause gutters on buildings to overflow, causing localized flooding.
- 18 • Lightning could cause structural damage to the facility.
- 19 • Climate changes could result in an increased need for maintenance around the facility.

20 **10.4.2 Project Mitigation and Response**

21 In addition to the design-based codes, standards, and regulations that the Project will adhere to
22 (Section 1.3), the following mitigation measures will help the Project adapt to a changing climate:

- 23 • Mitigation 10-1: FLNGs will be built in a manner that allows adjustment to changing water levels,
24 whether due to sea level rise or storms.
 - 25 • This design consideration accounts for the approximately 7 m tidal range at the Site.
- 26 • Mitigation 10-2: Ensure onshore infrastructure that is potentially vulnerable to damage or critical
27 to operation is located at elevations above that expected for high water levels, severe weather,
28 and storm surge to limit the potential for inundation.
- 29 • Mitigation 10-3: Develop and implement inclement weather response measures including ice
30 melt or gravel to provide traction.

31 Mitigation measures in Section 10.5.2 also apply to climate change. Using these mitigation measures, the
32 potential impacts of climate change will be managed.

1 To address potential impacts on the environment, response measures could include:

- 2 • Spill response and clean up (see Section 9.3)
- 3 • Emergency repairs to marine or onshore infrastructure
- 4 • Fire response measures (see Section 9.4)

5 **10.4.3 Residual Impacts of Climate Change on the Project**

6 Climate change is predicted to continue throughout the life of the Project. Climate change is predicted to
7 increase sea level and affect the severity and frequency of storms on the north coast. Design-based
8 measures have been included in Project planning and will be included in FEED and detailed designs for
9 infrastructure. With the mitigation measures described above, and requirements for considering climate
10 change when designing infrastructure, it is **unlikely** that changes in precipitation or temperature would
11 affect the operation of the Project; the consequence of any damage to infrastructure would be **minor**.
12 Predicted sea level rises in the Project area will be included in the design of the FLNGs and marine
13 infrastructure; the consequence of sea level rise affecting the Project is considered **insignificant**. Overall,
14 the risk to the Project from climate change is therefore considered **low**. Change in temperature,
15 precipitation, and sea level are not predicted to have any effects on on-site personnel.

16 **10.4.4 Effects to VCs from Project Effects Related to Climate Change**

17 The potential interactions with VCs from response measures related to spills and fires from climate change
18 would be consistent with those described in Sections 9.3 and 9.4. Potential effects to VCs from loss of
19 containment of LNG related to climate change would be consistent with those described in Section 9.5.
20 Other impacts from the Project and response measures related to climate change include:

- 21 • Short-term damage to marine or terrestrial areas during repair works for damaged infrastructure
- 22 • Salt and brine in run-off related to deicing of roads and infrastructure for safety

23 In the unlikely event of impacts to the Project from climate change, the following VCs have potential to
24 be affected:

- 25 • Air Quality
- 26 • Surface Water
- 27 • Vegetation and Wetlands
- 28 • Wildlife and Wildlife Habitat
- 29 • Freshwater Fish and Fish Habitat
- 30 • Marine Resources
- 31 • Human Health

32 Given that the risk to the Project is considered low, the likelihood of an impact to the Project that
33 adversely affects VCs is considered **very unlikely**.

1 **10.4.4.1 Air Quality**

2 Potential effects to air quality from onshore spills and fires are in described in Section 9.3 and 9.4, and
3 potential effects from loss of containment of LNG are considered in Section 9.5. There are no potential
4 effects to air quality from repair works to the marine or terrestrial environment, or from salt or brining in
5 run-off. Overall, the consequence of climate change on air quality is **insignificant**.

6 **10.4.4.2 Surface Water**

7 The effect to surface water from a spill associated with climate change would depend on the type and
8 volume of material spilled, the location of the spill, and the time it takes to respond and control the spill.
9 Onshore spills and fires are described in Sections 9.3 and 9.4. Loss of containment of LNG is not anticipated
10 to affect surface water (see Section 9.3.3). Potential effects on surface water from brining or salting work
11 areas to reduce slips, trips, and falls during extreme weather associated with climate change will be
12 managed through the site water management system. The consequence of climate change on surface
13 water is **minor**.

14 **10.4.4.3 Vegetation and Wetlands**

15 The potential effects of a spill or fire on vegetation and wetlands are described in Section 9.3 and
16 Section 9.4. Loss of containment of LNG is not anticipated to affect vegetation and wetlands
17 (see Section 9.3.3). Potential effects to vegetation and wetlands from repair work to terrestrial or marine
18 infrastructure would be of low consequence, because the footprints would already be cleared, and
19 additional works outside of the Project footprint are anticipated to be small in area. Potential effects on
20 surface water from brining or salting work areas to reduce slips, trips, and falls during extreme weather
21 associated with climate change will be managed through the site water management system and are not
22 expected to interact with vegetation and wetlands. Overall, the consequence of climate change on
23 vegetation and wetlands is **minor**.

24 **10.4.4.4 Wildlife and Wildlife Habitat**

25 The potential effects of a spill or fire on wildlife and wildlife habitat are described in Section 9.3 and
26 Section 9.4. The potential effects and consequence of loss of containment of LNG is described in
27 Section 9.5. Wildlife habitat may be affected by repair work in the terrestrial or marine footprint;
28 however, the areas will have already been cleared so potential effects are anticipated to be minor. Wildlife
29 could be deterred from the area around where the repair work is taking place. The consequence of
30 potential effects to wildlife and wildlife habitat is **minor**.

1 **10.4.4.5 Freshwater Fish and Fish Habitat**

2 The potential effects of a spill or fire on freshwater fish and fish habitat is described in Section 9.3 and
3 Section 9.4. Loss of containment of LNG is not anticipated to affect freshwater fish and fish habitat
4 (see Section 9.3.3). Potential effects to freshwater fish and fish habitat from repair works are expected to
5 be minor, given that the areas around watercourses in the footprint will already be cleared. Potential
6 effects on freshwater fish and fish habitat from brining or salting work areas to reduce slips, trips, and
7 falls during extreme weather associated with climate change will be managed through the site water
8 management system. The consequence of potential effects to freshwater fish and fish habitat are
9 considered **minor** to **moderate**, depending on whether riparian habitat is affected and whether fish are
10 killed.

11 **10.4.4.6 Marine Resources**

12 Potential effects of a spill or fire on marine resources is described in Section 9.3 and Section 9.4. Loss of
13 containment of LNG is described in Section 9.5. Potential effects to marine resources from repair work in
14 the marine environment are expected to be minor, given that areas around the Project footprint will
15 already be disturbed. Potential effects to marine resources from brining or salting work areas to reduce
16 slips, trips and falls during extreme weather associated with climate change is not expected to affect the
17 marine environment. The consequence of potential effects to marine resources is **minor** to **moderate**.

18 **10.4.4.7 Human Health**

19 Potential effects of a spill on human health are described in Section 9.3. A fire is not anticipated to have
20 an effect on human health because no long-term exposure is anticipated, and no potential effects from
21 loss of containment of LNG are expected. No human health concerns are anticipated from repair work on
22 land or in the marine environment. The consequence of potential effects to human health is **insignificant**.

23 **10.4.5 Risk**

24 Table 10.4–1 provides a summary of the likelihood, consequence, and overall risk to the Project from
25 climate change, and the associated likelihood, consequence, and overall risk to VCs from potential effects
26 of the Project from climate change.

1 **Table 10.4–1 – Summary of Risk to the Project and Valued Components from Climate Change Effects**

		Consequence					
		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Likelihood	Frequent						
	Likely						
	Possible						
	Unlikely		Project				
	Very Unlikely	AQ HH	SW VW WWH	FFFH MR			
	Rare						
Risk-Level	Low	Moderate	High	Extreme	Note: where a range of consequences are predicted, the more conservative consequence is reported in the table.		
Colour-coding:							
Notes:		AQ – Air Quality AE – Acoustic Environment SW – Surface Water GW – Groundwater VW – Vegetation and Wetlands			WWH – Wildlife and Wildlife Habitat FFFH – Freshwater Fish and Fish Habitat MR – Marine Resources EE – Employment and Economy MU – Marine Use INS – Infrastructure and Services		CHW – Community Health and Wellness HH – Human Health AHR - Archaeology and Heritage Resources GHG – Greenhouse Gases

2

3 **10.4.6 Conclusion**

4 There is uncertainty around the scale and outcomes of climate change on the North Coast. Project
 5 infrastructure will be designed following the standards and codes in effect at the time of design. Design
 6 and resilience planning will occur during the engineering process. These design considerations are
 7 expected to reduce the probability of damage to the marine terminal and onshore infrastructure from an
 8 increased severity or frequency of storm events or higher sea levels that result from climate change. Any
 9 adverse effects on the Project from climate change are expected to be insignificant and any damage
 10 sustained can be repaired without overall interruption to the Project operation; the overall risk to the
 11 Project from climate change is low.

1 **10.5 Extreme Weather**

2 Extreme weather events include extreme (high and low) temperatures, precipitation, and wind and wave
3 events. Extreme weather events may be exacerbated by climate change, as discussed in Section 10.4.

4 **10.5.1 Description**

5 The following sections describe historical extreme weather near the Site and the hazards posed by
6 extreme weather.

7 *10.5.1.1 Extreme Temperature*

8 The average daily temperature at the Green Island meteorological station is 8.5°C, with an average daily
9 maximum of 10.7°C and average daily minimum of 6.4°C (Government of Canada 2022a). The extreme
10 maximum temperature recorded by the weather station was 29.0°C in June 2004 and the extreme
11 minimum temperature recorded was -18.5°C in November 1985 (Government of Canada 2022a). As
12 discussed in Section 10.4.1.1, daily temperatures are predicted to rise by 1.7°C to 4.5°C by 2080
13 (MOE 2016).

14 The average and extreme temperatures on the north coast of BC are temperate and well within the range
15 of temperatures experienced at other global LNG facilities, and therefore extreme temperatures are not
16 predicted to have an effect on infrastructure.

17 For workers, extreme heat can cause illness such as heat exhaustion and heat stroke (CCOHS 2017).
18 In addition, extreme cold can increase the risk of hypothermia, which may result in confusion, an inability
19 to pay attention, and loss of coordination (WorkSafe BC 2022). Both extreme heat and extreme cold can
20 make it harder for people to work and may increase the risk of accidents or temperature-related illness.

21 Extreme temperatures could result in decreased productivity if workers need to take breaks to avoid heat
22 stress or hypothermia. Extreme temperatures can result in an increased energy cost either to heat or cool
23 buildings. Cold temperatures could affect the Project by increasing ice loads on marine infrastructure or
24 by increasing the risk of travel to the Site.

25 *10.5.1.2 Precipitation and Flooding*

26 The Green Island meteorological station recorded an annual average of 2,429.4 millimetres (**mm**) of rain
27 and 44.0 cm of snowfall between 1981 and 2010. On September 22, 2001 an extreme rainfall of 137.6 mm
28 was recorded and on December 5, 1978, an extreme snowfall of 22.2 cm was recorded (Government of
29 Canada 2022a).

30 The Green Island meteorological station recorded an annual average of 256 days with greater than or
31 equal to 0.2 mm of rain and 22.6 days with greater than or equal to 25 mm of rain. An average of 12.9 days
32 with greater than or equal to 0.2 cm of snow were recorded; zero days with greater than or equal to 25 cm
33 of snow were recorded over the time period (Government of Canada 2022a). As noted in Section 10.4.1.1,
34 precipitation levels are predicted to change with climate change.

1 10.5.1.3 *Wind and Waves*

2 The Green Island meteorological station recorded a maximum hourly wind speed of 157 km per hour
3 (**km/h**) in June 1987 (Government of Canada 2022a). The station does not record data on average hourly
4 windspeed, so data from the Prince Rupert Airport meteorological station was used.

5 Data from the Prince Rupert Airport provides average hourly windspeed, which was lowest in July
6 (8.9 km/hr) and highest in January and December (18.8 km/h). Wind direction is primarily south or
7 southeast, but changes to west in July and August (Government of Canada 2022a). The average annual
8 windspeed is 12.0 km/h. Maximum hourly windspeed ranged from a low of 55 km/h in June 1967 and a
9 high of 93 km/h in October 1964. A maximum gust of 137 km/h was recorded in November 1968
10 (Government of Canada 2022a).

11 Portland Inlet, on the east side of Pearse Island, connects to the open ocean south of Pearse Island, and
12 is the largest, deepest fjord in BC (Ricker and McDonald 1992). It is approximately 60 m deep at the
13 northern end and 715 m deep at its southern end, with an average width of 5.3 km (Ricker and
14 McDonald 1992). Spring tides in Portland Inlet can reach speeds of 1 metre per second (Stacey 1984).
15 Portland Canal, which is approximately 114 km long and runs along the west side of Pearse Island from
16 the ocean to Stewart, is influenced by the Nass River, which drains north into the Canal. The head of
17 Portland Canal has the highest tides in BC (Lucas et al. 2007).

18 10.5.1.4 *Summary of Potential Impacts of Extreme Weather on the Project*

19 The HAZID reports prepared for the Project describe potential impacts to the Project as a result of extreme
20 weather. These are described in Section 10.4.1.3. In addition, the following potential impacts to the
21 Project could occur:

- 22 • Icing on equipment, decking and piping, leading to personnel hazards (e.g., slips, trips and falls,
23 hypothermia); and, icing on roads and paths leading to difficulty accessing areas.
- 24 • Potential flooding of WC-04, leading to loss of egress from the southern FLNG; broken pipes
25 leading to loss of containment of natural gas and cooling water and possible jet fire; or, possible
26 safety impacts to workers.
- 27 • Impacted carrier and crew loading, resulting from high wind and waves, leading to failure of
28 mooring lines and a collision between the FLNG and marine trestles, which could result in a loss
29 of containment of LNG and cooling water and a possible fire.
- 30 • Undermining of marine and onshore infrastructure foundations resulting from high surface runoff
31 and flooding.
- 32 • An extreme rainfall event could cause local flooding and erosion, overwhelm stormwater
33 management systems, or damage onshore and marine equipment and infrastructure.

- 1 • An extreme snowfall event could cause local flooding if it melts rapidly, which may overwhelm
2 stormwater management systems. Extreme rain or snowfall could result in unsafe working
3 conditions onshore or on the FLNGs. Snow may make working more difficult and cause unsafe
4 conditions for workers on-site.
- 5 • Wind and waves will interact with operational activities throughout the life of the Project.
6 Extreme waves, driven by wind and tides, could damage marine infrastructure (e.g., mooring
7 systems), or prevent LNG carriers or natural gas liquids (NGL) product vessels from arriving or
8 departing, or cause erosion to the shoreline.
- 9 • Project vessels (LNG carriers, NGL product vessels, or other vessels) could be affected by wind and
10 waves while in the shipping route.
- 11 • A severe storm could affect emergency response (e.g., a helicopter may be unable to fly in
12 extreme wind) or cause unsafe working conditions on the FLNGs. As mentioned in Section 10.4,
13 climate change could increase the frequency or severity of storm events.

14 **10.5.2 Project Mitigation and Response**

15 The design-based mitigation measures in Section 1.3, and mitigation measures in Section 10.4.2 will
16 mitigate some of the effects of extreme weather on the Project. In addition, the following mitigation
17 measures are expected to manage the effects of extreme weather on the Project:

- 18 • Mitigation 10-1: The FLNGs will be built in a manner that allows adjustment to changing water
19 levels, whether due to sea level rise or storms.
- 20 • Mitigation 10-2: Ensure onshore infrastructure that is vulnerable to damage or critical to
21 operation is located at elevations above that expected for high water levels, severe weather, and
22 storm surge to limit the potential for inundation.
- 23 • Mitigation 10-3: Develop and implement inclement weather response measures including ice
24 melt or gravel to provide traction.
- 25 • Mitigation 10-4: A marine operations vessel will be available at the facility during operations to
26 provide security and emergency response, if necessary.
- 27 • Mitigation 9-5: BC Coast Pilots aboard LNG carriers and NGL vessels will assess potential issues
28 (e.g., inclement weather) and adjust speed to change arrival time at the Site, if required.

29 Using these mitigation measures, the potential impacts of extreme weather on the Project will be
30 managed.

31 Response measures to address potential impacts on the Project from extreme weather could include:

- 32 • Spill response and clean up (see Section 9.3)
- 33 • Emergency repairs to marine or onshore infrastructure
- 34 • Fire response measures (see Section 9.4)

1 The Proponents will prepare an emergency management program for operation that will be prepared in
2 accordance with the Emergency Management Regulation under the *Energy Resources Activities Act* and
3 CSA Z246.2 (emergency preparedness and response for petroleum and natural gas industry systems). The
4 emergency management program will cover on-site personnel and personnel on LNG carriers and NGL
5 product vessels while moored at the facility. This program will also include reference to procedures for
6 emergency shutdown if required (details on shutdown will be covered in the operating manuals).

7 The Proponents will require that onsite personnel follow health and safety policies consistent with
8 WorkSafeBC requirements for working in extreme temperatures.

9 A Terminal Operations Manual will be developed by the Proponents as required by Transport Canada. This
10 Manual will include the use of tugboats around the FLNGs and methods to establish safety zones around
11 the FLNGs during operation. A berth procedures and provisions summary, completed as part of the
12 Navigation Safety Assessment for the Project, is included as Appendix E.5 and provides the environmental
13 conditions under which LNG carriers and NGL product vessels are able to complete docking maneuvers.

14 **10.5.3 Residual Impacts of Extreme Weather on the Project**

15 Recorded extreme temperatures at weather stations in the region are moderate compared to other
16 locations where LNG facilities are located (e.g., Malaysia, Qatar, Australia, Russia). The FLNGs will be
17 designed to withstand higher and lower temperatures than have been recorded near the Site. Extreme
18 temperatures are **unlikely** to affect Project operations and would have **minor** consequences if they do.
19 The risk of extreme temperature on the Project is **low**.

20 The Project will be designed to withstand changes in sea level rise predicted due to climate change, which
21 will also account for storm surges due to extreme precipitation events. A watercourse (WC-04) enters
22 Portland Canal between the two FLNG cooling systems. The watershed associated with this watercourse
23 has an area of 0.98 square kilometres, and a mean annual discharge of 0.075 cubic metres per second
24 (Appendix 7.08A). Given the wetlands upstream in the watershed, it is unlikely that this watercourse will
25 flood the Site. There is a floodplain adjacent to this watercourse; a small portion (0.2 ha) will be affected
26 by the Project (Appendix 7.06A), but the remaining floodplain will attenuate some of the flooding during
27 a high rainfall event.

28 The shoreline around the Site is primarily bedrock, with some gravel, cobble, and boulders. Erosion is not
29 expected to damage marine infrastructure. Erosion that results from clearing the Site of vegetation will
30 be managed through the Project's erosion and sediment control plan. On-site stormwater management
31 systems (i.e., berms and swales) will help manage water around the facility.

32 With the design of the Project and mitigation measures in place, extreme precipitation and flooding
33 events are **unlikely** to affect Project operations and would have **minor** consequences if they do. The risk
34 of extreme precipitation and flooding on the Project is **low**.

1 **10.5.4 Effects to VCs from Project Effects Related to Extreme Weather**

2 The potential interactions with VCs from response measures related to spills and fires from extreme
3 weather would be consistent with those described in Sections 9.3 and 9.4, and potential effects from loss
4 of containment of LNG related to extreme weather would be consistent with those described in
5 Section 9.5. Other impacts from the project and response measures related to extreme weather include:

- 6 • Short-term damage to marine or terrestrial areas during repair works for damaged infrastructure
- 7 • Salt and brine in run-off related to deicing of roads and infrastructure for safety
- 8 • Sedimentation associated with flooding events that overwhelm the stormwater management
9 system

10 In consideration of the unlikely changes to the Project from extreme weather, the following VCs may
11 experience minor effects:

- 12 • Air Quality
- 13 • Surface Water
- 14 • Vegetation and Wetlands
- 15 • Wildlife and Wildlife Habitat
- 16 • Freshwater Fish and Fish Habitat
- 17 • Marine Resources
- 18 • Human Health

19 Given that the risk to the Project is considered low, the likelihood of an impact to the Project that
20 adversely affects VCs is considered **very unlikely**.

21 **10.5.4.1 Air Quality**

22 The potential effects to air quality from extreme weather is anticipated to be the same as that for climate
23 change, described in Section 10.4.4.1 The consequence of extreme weather on air quality is **insignificant**.

24 **10.5.4.2 Surface Water**

25 The potential effects to surface water related to onshore spills, fires or loss of containment of LNG are
26 described in Section 10.4.4.2. Extreme weather could result in flooding that overwhelms the stormwater
27 management system; this could result in short-term changes in surface water quality. The consequence
28 of extreme weather on surface water is **minor**.

1 **10.5.4.3 Vegetation and Wetlands**

2 The potential effects to vegetation and wetlands related to onshore spills, fires or loss of containment of
3 LNG from extreme weather are described in Section 10.4.4.3. An extreme flooding event could result in
4 sedimentation to adjacent ecological communities. Depending on the depth of sediment and length of
5 time it takes to be washed away, consequences on vegetation and wetlands could be **insignificant** to
6 **minor**.

7 **10.5.4.4 Wildlife and Wildlife Habitat**

8 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
9 of LNG from extreme weather are described in Section 10.4.4.4. Wildlife habitat may be affected by
10 sedimentation; this is anticipated to be temporary and would affect a small portion of the overall wildlife
11 habitat. Consequences on wildlife and wildlife habitat are considered **insignificant to minor**.

12 **10.5.4.5 Freshwater Fish and Fish Habitat**

13 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
14 of LNG from extreme weather are described in Section 10.4.4.5. During a flood event, fish may be harmed
15 or killed by changes in water quality. Consequences on freshwater fish and fish habitat from extreme
16 weather are considered **minor to moderate**.

17 **10.5.4.6 Marine Resources**

18 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
19 of LNG from extreme weather are described in Section 10.4.4.6. The marine environment may experience
20 sedimentation associated with a flood event; this is anticipated to be short-term. Potential effects to
21 marine resources from repair work in the marine environment are expected to be minor, given that areas
22 around the Project footprint will already be disturbed. Overall, consequences on marine resources from
23 extreme weather are considered **minor to moderate**.

24 **10.5.4.7 Human Health**

25 The potential effects to human health from extreme weather are anticipated to be the same as those for
26 climate change, described in Section 10.4.4.7. The consequence of extreme weather on human health is
27 **insignificant**.

28 **10.5.5 Risk**

29 Table 10.5–1 provides a summary of the likelihood, consequence and overall risk to the Project from
30 extreme weather, and the associated likelihood, consequence and overall risk to VCs from potential
31 effects of the Project from extreme weather.

1 **Table 10.5–1 – Summary of Risk to the Project and Valued Components from Extreme Weather**

		Consequence					
		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Likelihood	Frequent						
	Likely						
	Possible						
	Unlikely		Project				
	Very Unlikely	AQ HH	SW VW WWH	FFFH MR			
	Rare						
Risk-Level	Low	Moderate	High	Extreme	Note: where a range of consequences are predicted, the more conservative consequence is reported in the table.		
Colour-coding:							
Note:		AQ – Air Quality AE – Acoustic Environment SW – Surface Water GW – Groundwater VW – Vegetation and Wetlands WWH – Wildlife and Wildlife Habitat FFFH – Freshwater Fish and Fish Habitat MR – Marine Resources EE – Employment and Economy MU – Marine Use INS – Infrastructure and Services			CHW – Community Health and Wellness HH – Human Health AHR - Archaeology and Heritage Resources GHG – Greenhouse Gases		

2

3 **10.5.6 Conclusion**

4 The Project will be designed following the codes, standards, and regulations current at the time of design.
 5 The Canadian standards that the Project will be designed to are based on industry best practices from
 6 around the world. There are LNG facilities located elsewhere with normal temperatures that are more
 7 extreme than the north coast of BC, where the weather is typically mild, temperate, and wet.
 8 Portland Canal experiences high tides, which will be considered during Project design and FEED. The risk
 9 of extreme temperatures that are predicted for the Project area are within normal operating limits for
 10 LNG facilities based on current design standards. The potential for extreme weather-related events to
 11 have an adverse effect on the Project is unlikely. Any effects on the Project that do occur are expected to
 12 be managed through maintenance during operations. The risk of extreme weather on the Project is
 13 predicted to be low.

10.6 Tsunamis and Seismic Events

The north coast of BC is located near one of the most seismically active faults in Canada (Government of Canada 2021). This results in a medium-high seismic hazard in the vicinity of the Project (NRCan 2015).

10.6.1 Description

The Prince Rupert region is located along the Queen Charlotte – Fairweather fault system, along the boundary of the North American and Pacific tectonic plates (Barrie et al. 2013). This fault extends from northern Vancouver Island to the Gulf of Alaska, a length of approximately 1,200 km (NOAA 2018). This fault is moving at a rate of >5 cm per year and may be the fastest moving strike-slip fault in the world (NOAA 2018). The area along this fault is one of the most seismically active in Canada (Government of Canada 2021).

10.6.1.1 Tsunamis

Tsunamis are waves caused by a sudden displacement of water or release of energy and can be caused by landslides, human-made explosions, or earthquakes (Clague et al. 2003). The waves have shorter amplitudes in deep water but can reach 30 m or more in shallow water (Clague et al. 2003). The waves may occur within minutes of each other or be separated by hours. Tsunamis in the Project area are likely to be caused by earthquakes.

The tide gauge at Prince Rupert has recorded eight tsunamis since 1909 (Rabinovich et al. 2018). A tsunami in 2012 occurred as a result of the earthquake on Haida Gwaii; the remainder of the tsunamis originated in Alaska, Russia, Chile, and Japan (Rabinovich et al. 2018). Six of these tsunamis were generated by earthquakes with a magnitude of 8.6 or greater. When the tsunamis were recorded at Prince Rupert, the amplitude ranged from 7 cm to 132 cm, with a maximum wave height of 15 cm to 271 cm (Rabinovich et al. 2018). Tsunami modelling for another project on Portland Canal found that the maximum expected wave level from a tsunami was 3 m above mean sea level at a velocity of 0.35 metres / second. This was based on a 1964 Alaska earthquake (Hatch et al. 2006). The Coastal Flood Hazard Assessment (NHC 2022) indicated that a tsunami at the site would have wave heights of less than 0.4 m based on a seismic tsunami from the Alaska or Cascadia Subduction Zone.

A tsunami in the Project area could cause wave runup, local flooding and shoreline erosion. It has potential to affect workers on Site if they are struck by the wave. A sudden, large wave could cause damage to the marine infrastructure, LNG carriers, NGL product vessels, or other Project vessels. Collisions between LNG carriers and NGL product vessels could occur; the potential effects of an accident such as this is discussed in Section 9.0 Malfunctions and Accidents.

10.6.1.2 Seismic Events

There are two smaller faults to the northeast of Pearse Island: the Portland Canal Fault and the Big Dam Fault, which both run close to north-south (Evenchick et al. 1999).

Between January 1, 1985 and May 31, 2022, there have been 634 earthquakes magnitude 2 or greater recorded within 200 km of the Site, including 557 (88%) magnitude 2, 64 (10%) magnitude 3, 12 (2%)

1 magnitude 4, and 1 (<1%) magnitude 5. No earthquakes of magnitude 6 or greater have been recorded
2 within 200 km of the Site (Government of Canada 2022b). The closest earthquake to the Site was a
3 magnitude 2.5 quake on August 23, 2011. It occurred on the mainland, approximately 59 km north of
4 Prince Rupert, and approximately 30 km south of the Project location. The largest earthquake within a
5 200 km radius of the Site was a magnitude 5.3 earthquake at latitude 53.870° longitude -131.316° on
6 January 12, 1990 at 2217, at a depth of 19 km. This earthquake was approximately 85 km southwest of
7 Prince Rupert and 148 km southwest of the Site, between Porcher Island and Haida Gwaii.

8 Given the Project's location near the Queen Charlotte – Fairweather Fault and the number of earthquakes
9 that have occurred in the area, it is likely that additional earthquakes within 200 km of the Site will occur
10 during the lifetime of the Project. Most (88%) earthquakes within 200 km of the Project since 1985 were
11 magnitude 2. A low magnitude (i.e., less than 3.5) earthquake may not be felt, while earthquakes with a
12 magnitude of 3.5-5.4 may be felt but do not cause damage often. A well-designed building may have minor
13 damage from an earthquake under magnitude 6.0 and major damage from an earthquake over magnitude
14 6.0, depending on the location and proximity to the Project (NRCan 2021).

15 Earthquakes have potential to cause mass wasting (i.e., landslides) from the steep slopes of the islands
16 and peninsulas near the Site, which could lead to large waves similar to those from a tsunami. A landslide
17 at the head of a bay that resulted from an earthquake in Lituya Bay, Alaska, in 1958 caused damage up to
18 200 m upslope on the shores of the bay (Miller 1960).

19 The majority of earthquakes near the Site would likely cause shaking and vibration. The effects of a seismic
20 event would depend on the magnitude and the distance from the Project. A seismic event has potential
21 to affect infrastructure (e.g., the transmission line, which could lead to a power outage) and worker safety
22 in the Site and surrounding area. The results of subsequent investigations and seismic design will be
23 considered in Project design and FEED.

24 *10.6.1.3 Summary of Potential Impacts of Tsunamis and Seismic Events on the Project*

25 The HAZID reports (PSRG 2022a, b) have identified that earthquakes and flooding (from a tsunami) may
26 lead to the following impacts on the Project:

- 27 • Impacts to carrier and crew loading, leading to a ship mooring line breaking resulting in a
28 navigational hazard; mooring failure leading to a collision of the FLNG with the marine trestle,
29 resulting in loss of containment of LNG and cooling water, with a possible fire; possible effects to
30 personnel.
- 31 • Impacts to marine or onshore infrastructure leading to a possible safety hazard and
32 environmental damage.
- 33 • Impacts from water overtopping areas, knocking over pipe racks and storage tanks, resulting in
34 loss of containment of LNG and possible fire.

10.6.2 Project Mitigation and Response

The standard design requirements in Section 1.3 will mitigate some of the effects of tsunamis and seismic events on the Project. In addition, the following mitigation measures are expected to manage the effects of tsunamis and seismic events on the Project:

- Mitigation 10-1: FLNGs will be built in a manner that allows adjustment to changing water levels, whether due to sea level rise or storms.
- Mitigation 10-2: Ensure onshore infrastructure that is vulnerable to damage or critical to operation is located at elevations above that expected for high water levels, severe weather, and storm surge to limit the potential for inundation.
- Mitigation 10-5: Establish muster points on high ground to ensure the safety of personnel during a storm surge, seismic event and/or tsunami

The Project will include backup emergency generators in case there is an interruption to power from the BC Hydro power grid. These generators will provide electrical power to essential systems and are not intended to support normal operation. The safety systems also have uninterruptible power systems (battery backup) to allow for continued operation and/or safe shut-down in case the power grid becomes unavailable.

The results of the Project-specific geotechnical and tsunami studies will provide further information that will be used during Project FEED and detailed design.

To address these potential impacts on the environment, response measures could include:

- Spill response and clean up (see Section 9.3)
- Emergency repairs to marine or onshore infrastructure
- Fire response measures (see Section 9.4)

10.6.3 Residual Impacts of Tsunamis and Seismic Events on the Project

Tsunamis recorded at Prince Rupert have been relatively small (e.g., less than 3 m high waves). Onshore infrastructure will be designed to withstand extreme wave and wind events, which will also account for the size of historical tsunami waves. A Project-specific tsunami study has been completed, and any recommendations from the study will be incorporated into the design. Consideration of tsunamis will be incorporated into the design with the objective of mitigating or avoiding an effect on Project operations. The intent of this design would be to have **minor** consequences if impacts cannot be fully avoided. The risk of tsunamis on the Project is **low**.

Seismic events have occurred near the Project area in the past and will likely continue to occur; however, none of these events has been of a magnitude that is likely to cause major damage (i.e., events with a magnitude greater than 6). Project infrastructure including the FLNGs will be designed to withstand the most likely seismic events (i.e., low magnitude). A seismic event is **unlikely** to affect Project operations and would have **minor** consequences if it does. The risk of seismic events on the Project is **low**.

1 **10.6.4 Effects to VCs from Project Effects Related to Tsunamis and Seismic Events**

2 The interactions with VCs from a tsunami or seismic event are expected to be similar to that of extreme
3 weather (i.e., high water and flooding).

4 The potential interactions with VCs from response measures related to spills and fires would be consistent
5 with those described in Sections 9.3 and 9.4. Potential effects to VCs from loss of containment of LNG
6 would be consistent with the effects described in Section 9.5.

7 In the unlikely event of impacts to the Project from tsunamis and seismic events, the following VCs have
8 potential to be affected:

- 9 • Air Quality
- 10 • Surface Water
- 11 • Vegetation and Wetlands
- 12 • Wildlife and Wildlife Habitat
- 13 • Freshwater Fish and Fish Habitat
- 14 • Marine Resources
- 15 • Human Health

16 **10.6.4.1 Air Quality**

17 The potential effects to air quality from tsunamis and seismic events is anticipated to be the same as that
18 for climate change, described in Section 10.4.4.1. The consequence of tsunamis and seismic events on air
19 quality is **insignificant**.

20 **10.6.4.2 Surface Water**

21 The potential effects to surface water related to onshore spills, fires or loss of containment of LNG are
22 described in Section 10.4.4.2. A tsunami could result in flooding that overwhelms the stormwater
23 management system; this could result in short-term changes in surface water quality. The consequence
24 of tsunamis and seismic events on surface water is **minor**.

25 **10.6.4.3 Vegetation and Wetlands**

26 The potential effects to vegetation and wetlands related to onshore spills, fires or loss of containment of
27 LNG from extreme weather are described in Section 10.4.4.3. A tsunami would cause similar effects to
28 extreme flooding and could result in sedimentation to ecological communities adjacent to the Project
29 footprint if the stormwater management system is overwhelmed. A tsunami or seismic event could lead
30 to damage to Project infrastructure, which could require repairs. The Project footprint will be cleared, and
31 no additional effects are anticipated. Depending on the depth of sediment and length of time it takes to
32 be washed away, consequences on vegetation and wetlands could be **insignificant to minor**.

1 **10.6.4.4 Wildlife and Wildlife Habitat**

2 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
3 of LNG from extreme weather are described in Section 10.4.4.4. A tsunami could overwhelm the
4 stormwater management system, leading to sedimentation in wildlife habitat. Consequences of a tsunami
5 and seismic event on wildlife and wildlife habitat are considered **minor**.

6 **10.6.4.5 Freshwater Fish and Fish Habitat**

7 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
8 of LNG from extreme weather are described in Section 10.4.4.5. During a tsunami, stormwater
9 management systems may be overwhelmed, leading to a decrease in water quality in nearby
10 watercourses. This could result in fish being harmed or killed. Overall, consequences on freshwater fish
11 and fish habitat from tsunamis and seismic events are considered **minor to moderate**.

12 **10.6.4.6 Marine Resources**

13 The potential effects to wildlife and wildlife habitat related to onshore spills, fires or loss of containment
14 of LNG from extreme weather are described in Section 10.4.4.6. A tsunami may overwhelm the
15 stormwater management system, resulting in a decrease in marine water quality with potential to harm
16 or kill fish. A tsunami or seismic event may damage Project infrastructure requiring in-water works in the
17 marine environment; this is expected to be short-term and within areas previously disturbed. Overall,
18 consequences on marine resources from tsunamis and seismic events are considered **minor to moderate**.

19 **10.6.4.7 Human Health**

20 The potential effects to human health from tsunamis and seismic events are anticipated to be the same
21 as that for climate change, described in Section 10.4.4.7. The consequence of tsunamis and seismic events
22 on human health is **insignificant**.

23 **10.6.5 Risk**

24 Table 10.6–1 provides a summary of the likelihood, consequence and overall risk for the Project from
25 extreme weather, and the associated likelihood, consequence and overall risk to VCs from potential
26 effects of the Project from tsunamis and seismic events.

1 **Table 10.6–1 – Summary of Risk to the Project and Valued Components from Tsunamis and Seismic**
 2 **Events**

		Consequence					
		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Likelihood	Frequent						
	Likely						
	Possible						
	Unlikely		Project				
	Very Unlikely	AQ HH	SW VW WWH	FFFH MR			
	Rare						
Risk-Level	Low	Moderate	High	Extreme	Note: where a range of consequences are predicted, the more conservative consequence is reported in the table.		
Colour-coding:							
Note:		WWH – Wildlife and Wildlife Habitat		CHW – Community Health and Wellness			
AQ – Air Quality		FFFH – Freshwater Fish and Fish Habitat		HH – Human Health			
AE – Acoustic Environment		MR – Marine Resources		AHR – Archaeology and Heritage Resources			
SW – Surface Water		EE – Employment and Economy		GHG – Greenhouse Gases			
GW – Groundwater		MU – Marine Use					
VW – Vegetation and Wetlands		INS – Infrastructure and Services					

3

4 **10.6.6 Conclusion**

5 The timing and magnitude of tsunamis and seismic events are difficult to predict, and the magnitude of
 6 effects could vary widely with different events. However, given the historical tsunamis and seismic events
 7 in the Project area, the most likely event would be a low magnitude earthquake that may cause some
 8 shaking or vibration of Project buildings and infrastructure. The Project will be designed to withstand
 9 seismic events in accordance with engineering design standards. The risk of a tsunami or seismic event is
 10 based on historical events. There is uncertainty in the risk since tsunamis and seismic events cannot be
 11 predicted.

12 **10.7 Forest Fires**

13 An average of 1,352 wildfires have occurred each year over a 10-year period (2010 to 2020) throughout
 14 BC. Forest fires can be started by lightning or people and affect an average of 348,917 hectares per year
 15 (BCWS 2022a). In the Northwest Fire Centre, an average of 90 wildfires have occurred each year over a
 16 10-year period (2012 to 2022), with an average of 99,532 ha burned. This represents 7% of annual fires
 17 across the province in an area covering 25% of the province) and 29% of annual area burned across the
 18 province (C. Thomas pers. comm).

1 **10.7.1 Description**

2 The Canadian Forest Fire Weather Index System is a general index of fire danger, which uses temperature,
3 relative humidity, wind speed, and 24-hour precipitation to determine fuel moisture, buildup index, and
4 initial spread index (NRCan 2022). The timing of precipitation has an influence on the wildfire season.
5 When rain falls throughout the spring and into June, larger fuels take longer to dry out and fires are less
6 likely to ignite (BCWS 2022b).

7 Data from Green Island (approximately 60 km southwest of the Site) shows that the Project area receives
8 rainfall 256 days of the year (70% of days), on average. Green Island received an average of 2,429.4 mm
9 of rain per year (Government of Canada 2022). The months with the most rainfall are October through
10 January, while June and July are the driest; every month received over 100 mm of rain, on average
11 (Government of Canada 2022).

12 Natural Disturbance Types categorize the province into zones based on the frequency and severity of
13 disturbance events. The central very wet hypermaritime coastal western hemlock biogeoclimatic zone is
14 within Natural Disturbance Type 1, where ecosystems have rare stand-initiating events such as windfall,
15 fire, floods, and landslides which occur every 250 years or greater (BC FLNRORD 2022). Recent evidence
16 shows that historical fire returns in wet, coastal forests is between 350 and thousands of years; fire is
17 limited because of low fuel flammability and rare ignition opportunities (Daniels and Gray 2006).

18 According to the BC Wildfire Service, no wildfires of note (either highly visible or a threat to public safety)
19 have been recorded in coastal areas of northern BC between 2012 and 2021 (BCWS 2022c).

20 A forest fire has the potential to disrupt construction, operation, or decommissioning of the land-based
21 components of the Project if it occurs on Pearse Island or cause a disruption in power resulting in an
22 emergency shutdown if a fire affects the transmission line.

23 Because of climate change, forest fires are predicted to become more frequent because increased
24 temperatures will result in drier vegetation and increased lightning activity. Warmer temperatures may
25 increase the length of the fire season (Flannigan et al. 2013). However, climate change in the Prince Rupert
26 region will likely result in more rain throughout the year (see Section 10.4.1.1), which may counteract any
27 vegetation drying due to warmer temperatures.

28 *10.7.1.1 Summary of Potential Impacts of Forest Fires on the Project*

29 No potential impacts to the Project were identified by the HAZID. However, if a forest fire were to break
30 out on Pearse Island, the Project may implement mitigation measures to protect infrastructure, which
31 could have adverse effects on VCs.

10.7.2 Project Mitigation and Response

- Mitigation 9-1: Develop and implement an emergency response program in accordance with the requirements of the Emergency Management Regulation and section 8 of the Pipeline and Liquefied Natural Gas Facility Regulation under the *Oil and Gas Activities Act* and CSA Z246.2 (Emergency preparedness and response for petroleum and natural gas industry systems).
- Mitigation 7.12-4: Develop and implement emergency management and response including fire prevention and protection measures. Appropriate fire response equipment and personnel trained to use it will be maintained at Site.

To address potential impacts on the environment, response measures could include cutting a firebreak into the forest surrounding the Project footprint.

10.7.3 Residual Impacts of Forest Fires on the Project

The climate at the Site and the lack of recent wildfires in the area suggests that the likelihood of a forest fire interacting with the Project is **possible**. A forest fire on Pearse Island is unlikely to affect the Project since the area within the fenceline as well as a 10 m buffer will be cleared of vegetation. Smoke from a large fire may affect operations if the air quality decreases below a level suitable for outdoor work, or if the smoke hampers the ability for ships to navigate. The consequence of a forest fire would be **insignificant** with an overall **low** risk.

10.7.4 Effects to VCS from Project Effects Related to Forest Fires

The potential interactions with VCs from response measures related to onshore fires at the facility are described in Section 9.4. Impacts from response measures related to forest fires include damage to ecological communities from cutting a firebreak. In the unlikely event of impacts to the Project from a forest fire, the following VCs have the potential to be affected:

- Vegetation and Wetlands
- Wildlife and Wildlife Habitat
- Freshwater Fish and Fish Habitat

Given that the risk to the Project is considered low, the likelihood of an impact to the Project that adversely affects VCs is considered **very unlikely**.

10.7.4.1 Vegetation and Wetlands

The potential effects of a fire on vegetation and wetlands are described in Section 9.4. Clearing of vegetation to create a fire break may result in a loss of old forest, ecological communities at risk or wetlands. The overall area cut for a firebreak is anticipated to be small, and reversible in the long-term. Overall, the consequence of a forest fire on vegetation and wetlands is **minor**.

1 **10.7.4.2 Wildlife and Wildlife Habitat**

2 The potential effects of a fire on wildlife and wildlife habitat are described in Section 9.4. A firebreak would
 3 result in a loss of habitat for wildlife species using the communities disturbed. Cutting a firebreak may
 4 also destroy nests of certain species (assuming that a fire would happen during the breeding season). The
 5 consequence of potential effects to wildlife and wildlife habitat is **minor to moderate**.

6 **10.7.4.3 Freshwater Fish and Fish Habitat**

7 The potential effects of a fire on freshwater fish and fish habitat are described in Section 9.4. Cutting a
 8 firebreak may result in a loss of riparian habitat adjacent to watercourses; this would recover over the
 9 medium-term. The consequence of potential effects to freshwater fish and fish habitat are considered
 10 **minor to moderate**, depending on whether riparian habitat is affected and whether fish are killed.

11 **10.7.5 Risk**

12 Table 10.7–1 provides a summary of the likelihood, consequence and overall risk for the Project from
 13 forest fires, and the associated likelihood, consequence and overall risk to VCs from potential effects of
 14 the Project from forest fires.

15 **Table 10.7–1 – Summary of Risk to the Project and Valued Components from Forest Fires**

		Consequence					
		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Likelihood	Frequent						
	Likely						
	Possible	Project					
	Unlikely						
	Very Unlikely		VW FFH	WWH			
	Rare						
Risk-Level	Low	Moderate	High	Extreme	Note: where a range of consequences are predicted, the more conservative consequence is reported in the table.		
Colour-coding:							
Note:		AQ – Air Quality AE – Acoustic Environment SW – Surface Water GW – Groundwater VW – Vegetation and Wetlands			WWH – Wildlife and Wildlife Habitat FFFH – Freshwater Fish and Fish Habitat MR – Marine Resources EE – Employment and Economy MU – Marine Use INS – Infrastructure and Services		CHW – Community Health and Wellness HH – Human Health AHR – Archaeology and Heritage Resources GHG – Greenhouse Gases

1 **10.7.6 Conclusion**

2 The assessment of the potential effects of wildfires to the Project indicates that there is a low risk of a
 3 forest fire affecting the Project. A forest fire on Pearse Island or along the transmission line route could
 4 result in an emergency shutdown, which is discussed in Section 9.0. If a firebreak is needed on
 5 Pearse Island, this response measures would lead to minor potential effects on Vegetation and Wetlands
 6 and Freshwater Fish and Fish Habitat, and moderate potential effects on Wildlife and Wildlife Habitat.
 7 Smoke from a local wildfire could hamper operations (e.g., shipping).

8 **10.8 Summary of Mitigation**

9 Mitigation and enhancement measures were selected based on provincial and federal regulations and
 10 policies, on management practices and guidelines, and relevant peer-reviewed literature. Mitigation was
 11 selected to address Project interactions with the environment during all Project phases. Table 10.8–1
 12 provides a summary of the mitigation and enhancement measures to avoid or reduce effects of the
 13 environment on the Project. In conjunction with these measures, the Proponents will develop and
 14 implement a Project-specific construction environmental monitoring plan that collects the mitigation and
 15 enhancement measures tied to Project-related activities and physical works associated with construction.
 16 The construction environmental monitoring plan will be incorporated into appropriate construction-
 17 related contracts.

Table 10.8–1 – Mitigation and Enhancement Measures Proposed to Avoid or Reduce Effects of the Environment on the Project

Mitigation/Mitigation Mechanism	Rationale for Selection	Expected Success/Risks and Uncertainty	Timing	Management and/or Compensation Plans
<p>Mitigation 10-1: FLNGs will be built in a manner that allows adjustment to changing water levels, whether due to sea level rise or storms Mitigation Mechanism: This mitigation measure allows the FLNGs to adjust to different water levels, which makes the infrastructure more resilient to flooding or high tides.</p>	<p>This mitigation measure is a design component that allows for safe operation in consideration of tsunamis and climate change (i.e., sea level rise)</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure. Risk and Uncertainty: There is little uncertainty or risk associated with this mitigation measure.</p>	<p>Project Phase: Operations Effectiveness: Long-term</p>	<p>N/A</p>

Table 10.8–1 – Mitigation and Enhancement Measures Proposed to Avoid or Reduce Effects of the Environment on the Project

Mitigation/Mitigation Mechanism	Rationale for Selection	Expected Success/Risks and Uncertainty	Timing	Management and/or Compensation Plans
<p>Mitigation 10-2: Ensure onshore infrastructure that is vulnerable to damage or critical to operation is located at elevations above that expected for high water levels, severe weather, and storm surge to limit the potential for inundation.</p> <p>Mitigation Mechanism: This mitigation measure will avoid or limit the potential for infrastructure damage due to water inundation.</p>	<p>This design measure will reduce the potential for effects related to tsunami and storm surges as well as effects related to potential climate change (i.e., sea level rise)</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure.</p> <p>Risk and Uncertainty: There is little uncertainty or risk associated with this mitigation measure.</p>	<p>Project Phase: All phases</p> <p>Effectiveness: Long-term</p>	<p>N/A</p>
<p>Mitigation 10-3: Develop and implement inclement weather response measures including ice melt or gravel to provide traction.</p> <p>Mitigation Mechanism: This mitigation measure will identify proactive and reactive response measures that will avoid or limit effects on the Project from inclement weather.</p>	<p>This mitigation measure was selected to reduce the potential for injury because of weather events (e.g., freezing rain or snow)</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure.</p> <p>Risk and Uncertainty: There is little uncertainty or risk associated with this mitigation measure.</p>	<p>Project Phase: Operations</p> <p>Effectiveness: Long-term</p> <p>Project Phase: All phases</p> <p>Effectiveness: Short-term</p>	<p>Construction Environmental Management Plan (CEMP)</p>

Table 10.8–1 – Mitigation and Enhancement Measures Proposed to Avoid or Reduce Effects of the Environment on the Project

Mitigation/Mitigation Mechanism	Rationale for Selection	Expected Success/Risks and Uncertainty	Timing	Management and/or Compensation Plans
<p>Mitigation 9-5: BC Coast Pilots aboard LNG carriers and NGL vessels will assess potential issues (e.g., inclement weather) and adjust speed to change arrival time at the Site, if required.</p> <p>Mitigation Mechanism: This mitigation measure uses the experience from BC Coast Pilots to assess where potential issues may be and how to address them.</p>	<p>This measure recognizes that BC Coast Pilots are a requirement under the <i>Pilotage Act</i>. Having a BC Coast Pilot onboard will support the safe operation of the LNG carriers and NGL product vessels.</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure.</p> <p>Risk and Uncertainty: There is no risk or uncertainty associated with this mitigation measure.</p>	<p>Project Phase: Operation</p> <p>Effectiveness: Short-term</p>	<p>N/A</p>
<p>Mitigation 10-4: A marine operations vessel will be available at the facility during operations to provide security and emergency response, if necessary.</p> <p>Mitigation Mechanism: This mitigation measure provides an alternate means of leaving the Site for workers on the FLNGs.</p>	<p>Having a marine operations vessel will provide workers on the FLNG an alternate method of evacuating the site, if the infrastructure is compromised.</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure.</p> <p>Risk and Uncertainty: There is little uncertainty or risk associated with this mitigation measure.</p>	<p>Project Phase: Operations</p> <p>Effectiveness: Short-term</p>	<p>N/A</p>
<p>Mitigation 10-5: Establish muster points on high ground to ensure the safety of personnel during a storm surge, seismic event and/or tsunami.</p> <p>Mitigation Mechanism: This mitigation measure works by removing site personnel from danger and away from the areas at most risk of flooding.</p>	<p>Having a safe muster point on higher ground will reduce potential for injuries due to flooding and/or from the facility being affected by a storm surge, seismic event and/or tsunami.</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure.</p> <p>Risk and Uncertainty: There is little uncertainty or risk associated with this mitigation measure.</p>	<p>Project Phase: All phases</p> <p>Effectiveness: Short-term</p>	<p>CEMP</p>

Table 10.8–1 – Mitigation and Enhancement Measures Proposed to Avoid or Reduce Effects of the Environment on the Project

Mitigation/Mitigation Mechanism	Rationale for Selection	Expected Success/Risks and Uncertainty	Timing	Management and/or Compensation Plans
<p>Mitigation 9-1: Develop and implement an emergency response program in accordance with the requirements of the Emergency Management Regulation and section 8 of the Pipeline and Liquefied Natural Gas Facility Regulation under the <i>Energy Resource Activities Act</i> and CSA Z246.2 (Emergency preparedness and response for petroleum and natural gas industry systems).</p> <p>Mitigation Mechanism: This mitigation measure helps prepare Project personnel for a potential emergency by describing the emergency response steps and procedures.</p>	<p>This mitigation measure is required under the <i>Energy Resource Activities Act</i>.</p>	<p>Expected Success: There is a high likelihood of success associated with this mitigation measure because the CSA standards are based on worldwide design information.</p> <p>Risk and Uncertainty: There is no risk or uncertainty associated with this mitigation measure.</p>	<p>Project Phase: All phases</p> <p>Effectiveness: Long-term</p>	<p>CEMP</p>

Table 10.8–1 – Mitigation and Enhancement Measures Proposed to Avoid or Reduce Effects of the Environment on the Project

Mitigation/Mitigation Mechanism	Rationale for Selection	Expected Success/Risks and Uncertainty	Timing	Management and/or Compensation Plans
<p>Mitigation 7.12-4: Develop and implement emergency management and response including fire prevention and protection measures. Appropriate fire response equipment and personnel trained to use it will be maintained at Site.</p> <p>Mitigation Mechanism: The mitigation is expected to assist in the avoidance of and management of emergencies at the Site, limiting the demand on emergency services in the LAA (Infrastructure and Services local assessment area).</p>	<p>This mitigation was selected because it is an established strategy for managing demand on infrastructure and services and keeping personnel safe.</p>	<p>Expected Success: Environmental Management Plans are standard best practice for the LNG industry and the mitigation has a high likelihood for successfully mitigating effects posed to the health and safety of the construction and operation workforce.</p> <p>Risk and Uncertainty: Risk and uncertainty are low due to the availability of well-established safety procedures.</p>	<p>Project Phase: All phases</p> <p>Effectiveness: Short to long-term</p>	<p>CEMP</p>

1
2