

PACIFIC NORTHWEST LNG - ADDENDUM TO THE ENVIRONMENTAL IMPACT STATEMENT

Human and Ecological Health
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19.0 HUMAN AND ECOLOGICAL HEALTH

The assessment of potential effects of the Project to human and ecological health was provided in Chapter 19 of the EIS. This section of the EIS Addendum provides:

- An update to the potential project and cumulative effects on the Human and Ecological Health VC as a result of the project changes
- Responses to requests for additional information from the federal government (August 14, 2014)
- An updated list of mitigation measures for the Human and Ecological Health VC
- Updated conclusions on the assessment of effects on the Human and Ecological Health VC, taking into account project changes and the requested additional information.

Table 19-1 lists the documents applicable to human and ecological health submitted by PNW LNG as part of the environmental assessment process to date and identifies whether information is either *updated by EIS Addendum*, *superseded*, *not relevant*, or *not affected* by information in the EIS Addendum. The following sections of the EIS Addendum contain information that updates the documents classified as *updated by EIS Addendum* in Table 19-1. Figures 19-1 to 19-3 have been updated from those provided in the EIS to reflect Project changes and any other applicable updates.

Table 19-1 Status of Previously Submitted Documents

Document Name	Status
Chapter 19 and Appendix C of the EIS (February 2014)	Updated by EIS Addendum
Technical Memorandum: Human Health Risk Assessment Report (June 2014)	Not affected
Responses to the Working Group (June 2014)	Not affected

19.1 PROJECT EFFECTS ASSESSMENT UPDATE

The project effects assessment update for human and ecological health considers recent project changes. The marine terminal design mitigation results in the relocation of the marine terminal berth by about 510 m from the location described in the EIS. The relocation of the marine terminal into deeper waters eliminates the need to dredge over 7,000,000 m³ of sediment from Chatham Sound associated with the terminal construction over 1.5 years during the construction phase of the Project. It also eliminates the need for maintenance dredging at the marine terminal during the operations phase. Dredging will still be required at the materials off-loading facility (MOF), located off the north shore of Lelu Island. Additional geotechnical work after the submission of the EIS has determined that deeper areas of the MOF are composed predominantly of cobble and boulders rather than fine sediment. Therefore, the 690,000 m³ of dredged sediment originally projected in the MOF has been revised to less than 200,000 m³. The dredge duration will be reduced from 1.5 years to 6 months. The removal of cobble and boulders is expected to account for more than half of the 6 months of dredge work in the MOF. Table 19-2

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compares the dredging requirements associated with original marine terminal design submitted in the EIS with the marine terminal design mitigation assessed in this EIS Addendum.

Table 19-2 Comparison of Project Design Mitigations Associated with Dredging

Dredging Parameters	Combined Marine Terminal and MOF (EIS Scenario)	MOF Only (New Design Scenario)
Dredge Volume	7,915,000 m ³	< 200,000 m ³
Dredge Area	900,000 m ²	54,000 m ²
Dredging Duration	1.5 years	6 months
Radius of Sediment Plume	3 km	500 m
Maintenance Dredging	Every 3-5 years	Not required

19.1.1 Baseline Conditions

The baseline environmental conditions regarding human and ecological health are described in Chapter 19 of the EIS and the Technical Memorandum: *Human Health Risk Assessment* submitted in June 2014. Baseline data includes laboratory results for concentrations of chemicals in the environment (i.e., drinking water, soil, marine sediment, and marine country foods), air quality and levels of light and noise.

The project changes do not affect the baseline environmental data, which quantifies the quality of air, soil, drinking water, and marine country foods and also levels of noise and light. Elimination of dredging at the marine terminal results in the exclusion of all sediment samples collected within the original marine terminal dredge area (see Section 13 for detailed information). Sediment quality was independently described for the MOF and marine terminal in Section 2.3.4 of the Technical Memorandum: *Human Health Risk Assessment* submitted in June 2014, and this information remains valid.

19.1.2 Effects Assessment

This section describes how the marine terminal design mitigation will affect the subcomponents of human health (i.e., air quality, drinking water quality, soil quality, sediment quality, quality of marine country foods, noise levels, light levels and electromagnetic fields) and ecological health (i.e., air quality, water quality, soil quality, sediment quality, noise levels, light levels, chemical uptake and trophic transfer to ecological receptors).

19.1.2.1 Changes to Human Health

19.1.2.1.1 Potential Effects

The assessment of change in human health recognizes that human receptors are primarily located in populated areas of Port Edward and Prince Rupert and the marine terminal design mitigation will not affect the subcomponents of human health in the terrestrial environment (i.e., municipal drinking water quality, soil quality and levels of electromagnetic fields) and are not discussed further here.

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19.1.2.1.1 Air Quality Health Risks

For air quality during the operations phase, human health risks from the inhalation of criteria air contaminants were predicted to be not significant in the EIS (see Section 19.5.4) because the concentration ratio defining inhalation health risk was below the significance threshold. The operations phase has the greatest potential for health risks because emission rates of criteria air contaminants and the duration of emissions is greater than construction and decommissioning phases.

There will be a considerable reduction in marine-based criteria air contaminant emissions during construction due to the substantially reduced dredging activities. These design mitigations, while reducing the adverse effects, do not change the characterization of residual effects on human health (i.e., context, magnitude, extent, duration, frequency, reversibility) or predicted significance of those effects (i.e., remains not significant) (Table 19-3). Changes to the information presented in Table 19-3 (compared to Table 19-10 of the EIS) are identified with underlined text.

19.1.2.1.2 Marine Country Food Health Risks

Human health risks from consuming marine country foods harvested from the dredge zones and subsequent sediment distribution area were identified as public health concerns. Chapter 19 (Human and Ecological Health) of the EIS indicated that there are no increases in the concentration of chemicals of potential concern (COPC) in the marine environment from project activities. Public concern regarding the potential for human health risk comes from COPCs in the marine environment; specifically polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F) that were introduced into Porpoise Harbour from a decommissioned kraft pulp and paper mill.

The US Environmental Protection Agency provides guidance on modelling PCDD/Fs in aquatic biota (US EPA 1993). This guidance outlines that PCDD/Fs concentrations in aquatic life are directly dependent on concentrations of PCDD/F in the sediment, defined as the biota-sediment accumulation factor. The baseline sediment quality conditions indicate that there are no buried or capped reservoirs of sediment containing higher concentrations of PCDD/Fs in the dredge area; therefore, dredging at the MOF in Porpoise Channel cannot increase the concentration of PCDD/Fs in the marine environment or in the food chain. The hazard quotient defining health risk to people consuming locally harvested seafood would not change between the baseline and project phases (i.e., construction, operations, decommissioning).

Porpoise Channel resides in Fisheries and Oceans Canada's Management Area 4-11. This area is under a permanent, year-round crab and shellfish ban due to the area's proximity to Porpoise Harbour and the potential for red tide toxins affecting shellfish. It is illegal and unsafe to commercially or recreationally harvest crab and shellfish from Management Area 4-11 at any time (DFO 2014). However, First Nations marine food harvesting for food, social and ceremonial purposes is open coast-wide throughout the year. The potential for First Nations to harvest marine country foods from the area is low due to perceived contamination and the availability of harvesting locations throughout Chatham Sound. People who continue to harvest crab and shellfish from Management Area 4-11 are unlikely to harvest the majority of their seafood from this area due to marine traffic, project construction activities and the presence of better food harvesting locations in Chatham Sound.

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Substantially lowering the amount of dredged sediments containing PCDD/Fs will reduce the geographical range of any suspended sediments. These design mitigations, while reducing the adverse effects, do not change the characterization of residual effects on the quality of marine country foods (i.e., context, magnitude, extent, duration, frequency, reversibility) or predicted significance of those effects (i.e., remains not significant) (Table 19-3). The confidence ranking will, however, change to high because suspended sediments would only be present for a short period within 500 m radius of the MOF. Changes to the information presented in Table 19-3 (compared to Table 19-10 of the EIS) are identified with underlined text.

19.1.2.1.1.3 Noise and Light Effects to Annoyance and Nuisance Rates

For levels of noise and light, annoyance and nuisance rates during the operations phase (i.e., worst case) of the Project were predicted to be not significant in the EIS. The percent of “highly annoyed” residents predicted during the operations phase was 1.7%, which is below the significance threshold of 6.5% recommended by Health Canada (2010) and the Alberta Energy and Utilities Board Noise Control Directive 038 (AEUB 2007).

The marine terminal design mitigation will not affect levels of noise and light generated from project facilities and infrastructure on Lelu Island during operations. Noise and light generated from LNG carriers operating at the marine terminal will be farther from shore, and therefore lower in magnitude to local residents.

For the construction phase, project changes will substantially reduce the overall need for underwater blasting with the removal of dredging at the marine terminal. However, the revised estimates of cobble and boulder removal at the MOF will require additional underwater blasting. The duration of blasting in the MOF will increase to a maximum of 6 months. The magnitude and frequency of noise per blast blasting will not change.

The percent of highly annoyed residents would be lower under the project changes. While reducing the adverse effects, the reduction of noise levels does not change the characterization of residual effects on human health (i.e., context, magnitude, extent, duration, frequency, reversibility) or predicted significance of those effects (i.e., remains not significant) (Table 19-3). Changes to the information presented in Table 19-3 (compared to Table 19-10 of the EIS) are identified with underlined text.

19.1.2.1.2 Characterization of Residual Effects

The assessment of changes to human health is based on the concentration ratio and hazard quotient when considering the marine terminal design mitigation. The characterization of residual effects for changes to human health was included with the EIS in Table 19-10 of Chapter 19. The following characterization of residual effects supersedes the characterization table in the EIS.

The context considers the presence of sensitive human receptors within the assessment area and change to human health is characterized as having a low resilience. The magnitude of change is characterized as low because the concentration ratio and hazard quotient associated with air quality and marine country foods is below the significance threshold where health risks could potentially occur. The geographic extent for potential changes to human health is within the local assessment area. The duration of potential effects is characterized as long-term based on air emissions over the life of the Project. Any potential changes to human health are reversible because, after cessation of project activities, the changes to air quality and marine country foods would return to baseline conditions. The frequency of potential effects is characterized as continuous, based on air emissions of criteria air

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contaminants over the life of the Project. Overall, the project changes increase the confidence rating for the residual effects assessment.

The likelihood of residual effects to change human health in the EIS was characterized as low. This is the lowest characterization possible for likelihood. The likelihood of residual effects to change in human health from the project changes remains unchanged (i.e., low). The project changes will reduce the likelihood of effects to human health by disturbing substantially lower volumes of sediments containing PCDD/Fs and positioning the LNG carrier berth farther from Port Edward.

Changes to human health were ranked as not significant in the EIS. The project changes will marginally reduce changes to human health from air quality, noise and light. Substantially lowering the amount of dredged sediments containing PCDD/Fs will reduce the geographical range of any suspended sediments but will not change the quality of marine country foods. Therefore, the significance ranking for this exposure pathway will continue to be not significant under the project changes.

The characterization of confidence for the assessment of changes to human health in the EIS was moderate during the construction phase. This ranking is based on the availability of baseline data and quantitative modelling of air quality, sediment plumes, and levels of noise and light. Based on the reduced amount of sediment disturbance associated with the marine terminal design mitigation, the confidence ranking will change to high because suspended sediments would only be present for a short period within 500 m radius of the MOF. This small area is not capable of sustaining the food requirements of Port Edward and Prince Rupert and is also under a permanent crab and shellfish harvesting ban. Therefore, there is a higher degree of confidence in the assessment conclusion for the project changes and the confidence ranking increases from moderate to high.

A marine country food follow-up and monitoring plan will be required due to continuing public concern regarding the potential human health risk associated with any dredging activities. The follow-up and monitoring plan for marine country foods also aims to confirm the predictions of the EIS that there will be no change to the quality of marine country foods harvested from Porpoise Channel during dredging in the construction phase and 1 year post-completion of dredging (to determine whether there is a latent period between dredging and detectable changes in the quality of marine country foods). Details of the follow-up and monitoring plan for marine country foods are in Section 30.4.8 of the EIS Addendum.

The follow-up and monitoring plan will be limited to a 500 m radius of the MOF encompassing Porpoise Channel, which is the modelled area that suspended sediments would be present during dredging (Figure 19-4). Sampling will include the collection of Dungeness crab (meat and hepatopancreas tissue) for PCDD/F analysis because crabs are present in Porpoise Channel and they are an important food source for local Aboriginal groups and to residents of Port Edward and Prince Rupert. Arsenic and copper will also be measured in crab meat. Although there is no potential for these metals to increase in the environment, the uptake of arsenic and copper into sediment dwelling organisms such as crabs will be monitored as requested by Health Canada. Other marine species such as small groundfish (i.e., flounders) may be collected in Porpoise Channel; however, due to difference in habitat and lifecycles, these species of marine country food may not be available in Porpoise Channel throughout the year for monitoring.

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19.1.2.2 Change in Ecological Health

19.1.2.2.1 Potential Effects

The marine terminal design mitigation will not affect the subcomponents of ecological health including: air quality, water quality, soil quality, and levels of noise and light. The assessment of ecological health assumes that ecological receptors are present throughout the entire local and regional assessment area. The positioning of the marine terminal without tangible increases in chemical emissions to the environment will not affect the overall assessment conclusions of ecological health for these subcomponents.

19.1.2.2.1.1 Sediment Quality and Trophic Uptake of COPCs

For sediment quality, the ecological health risks associated from dredging were not significant as presented in the EIS because the Project does not release any COPCs into the marine environment. There are no buried or capped reservoirs of COPCs in the sediment, so concentrations of COPCs cannot increase beyond levels currently found in the environment.

The marine terminal design mitigation reduces the volume of dredged material from 7,915,000 m³ to <200,000 m³, or a reduction of 97.5%. Dredging will continue to be required in the MOF, although at lower volumes than described in the EIS. Sediment disturbance will therefore remain a pathway that exposes marine life to suspended sediments; however the magnitude of suspended sediments, duration and geographical extent is substantially reduced compared with the original project design submitted in the EIS. The reduced marine disturbance will also be perceived to have lower effects to ecological health by the public.

19.1.2.2.2 Characterization of Residual Effects

The characterization of residual effects for changes to ecological health was included with the EIS in Chapter 19 (Table 19-10). The following characterization does not change from the rankings presented in Table 19-10 in the EIS.

The context is characterized as moderate and considers that the assessment area is a stable ecosystem and that baseline conditions are not likely to contribute to changes in ecological health. The magnitude of change is characterized as low because the concentration of PCDD/Fs cannot increase beyond baseline levels; therefore, there is no increase in exposure and risk to marine ecological receptors. The geographical extent of potential changes to ecological health is within the local assessment area. The duration of effects is characterized as long-term based on the sediment disturbance and potential latent effects exceeding one year. Any changes to ecological health are reversible because, after cessation of project activities, environmental conditions would return to baseline conditions. The frequency of potential effects is characterized as continuous because noise and lighting effects would occur throughout the life of the Project.

The likelihood of residual effects to change ecological health in the EIS was characterized as low and remains unchanged (i.e., low) considering project changes. The project changes will require dredging only in the MOF which was already evaluated in the EIS. It is highly unlikely that such a small disturbance area – which does not increase in PCDD/F concentrations – could have the potential to influence ecological health.

The significance ranking for changes to ecological health in the EIS was not significant. Based on the project changes, the significance ranking for ecological health remains unchanged and is characterized as not significant.

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Dredging of sediments containing PCDD/Fs was one of the primary concerns of the public due to the perceived effect it could have to marine life. The project changes will substantially reduce the amount of dredged sediments in the marine environment and the range of suspended sediments.

The characterization of confidence for the assessment of changes to ecological health in the EIS was high and remains high considering the marine terminal design mitigations. This ranking is based on the availability of baseline data and quantitative modelling of levels of noise and light. US EPA guidance on modelling PCDD/Fs in aquatic life indicates that PCDD/Fs do not increase in the food chain without an increase in PCDD/F concentrations in the sediment. Therefore, modelling would result in no change to ecological health risks relative to the baseline risk.

Follow-up and monitoring for marine country foods associated with human health will also be used to evaluate ecological health with respect to concentrations of PCDD/Fs, arsenic and copper in the tissues of crab. Details of the follow-up and monitoring program are in Section 30.4.8 of the EIS Addendum.

There will be a considerable reduction in the magnitude, duration and geographical extent of suspended sediments due to substantially reduced dredging activities. These design mitigations, while reducing the adverse effects, do not change the characterization of residual effects on ecological health (i.e., context, magnitude, extent, duration, frequency, reversibility) or predicted significance of those effects (i.e., remains not significant) (Table 19-3). Changes to the information presented in Table 19-3 (compared to Table 19-10 of the EIS) are identified with underlined text.

19.1.2.3 Summary of Change to Human and Ecological Health

The project changes will not change the effects assessment conclusions described in Chapter 19 (Human and Ecological Health) of the EIS. The residual environmental effects characteristics for human and ecological health for the marine terminal design mitigations are in Table 19-3. Changes in human health and ecological health were not significant in the EIS, and will remain not significant under the marine terminal design mitigation. The general public will perceive the project changes as having substantially lower human and ecological health risks due to the reduced dredging; although the perceived health risk is not supported by the available science.

19.2 CUMULATIVE EFFECTS ASSESSMENT UPDATE

The cumulative effects assessment provided in the EIS identified three potential cumulative effects:

1. Cumulative effects to human health from emissions of criteria air contaminants from other projects within the regional assessment area
2. Cumulative effects to human health from spatially and temporally overlapping dredge areas and areas of increased suspended sediments that could affect the quality of locally harvested marine country foods
3. Cumulative effects to ecological health from spatially and temporally overlapping dredge areas and areas of increased suspended sediments that could affect ecological health from exposures to PCDD/Fs.

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Local forestry and commercial fishing activities were considered for their potential to cumulatively affect human health. No cumulative effects pathway was identified that could affect human health from these activities.

Cumulative effects to human health from air emissions include the accommodation camp for the Project, which will be relocated from Lelu Island to the mainland. The change in location of the accommodation camp will require transportation of workers from the camp to the Lelu Island worksite. Based on the maximum peak number of construction workers in the camp (4,500 workers per day for a period of 6 months), assuming two shift changes per day, and an average of 45 passengers per shuttle, traffic on Skeena Drive associated with camp relocation could amount to 200 additional vehicle movements (or 100 shuttle round trips) per day. The 2012 annual average daily traffic on Skeen Drive was approximately 1,498 vehicles per day, down from an average of 3,305 vehicles per day in 1995. With the expected traffic increase due to the Project, the annual average daily traffic on Skeena Drive will likely be less than the 1995 historic traffic volumes. Overall, health effects of air emissions from busses during construction will be negligible.

The accommodation camp location change is not expected to result in a material change to the assessment of residual cumulative effects for the construction, operations, and decommissioning phases of the Project. The potential change in effects to air quality does not change the characterization of cumulative effects to human and ecological health.

The cumulative effects assessment provided in the EIS concluded that there would be no exceedances of any health based ambient air quality objectives. The EIS also concluded that spatially and temporally overlapping dredging disturbance areas would not affect human and ecological health because PCDD/Fs are not released from project activities and there are no buried or capped reservoirs of sediments containing higher than baseline concentrations of PCDD/Fs.

The marine terminal design mitigation effectively reduces the magnitude, geographical range and duration of sediment disturbance. Dredging from other projects in Porpoise Channel during the same period of time is not anticipated by any other project. Therefore the potential for cumulative effects to human and ecological health in the marine environment is no longer considered a viable pathway and will remain not significant.

Summary characterizations of cumulative residual effects are in Table 19-4.

19.3 RESPONSES TO THE OUTSTANDING INFORMATION REQUESTS

Information requests regarding human and ecological health are presented in Appendix H.1 and H.2 of the EIS Addendum. The information requests from the Canadian Environmental Assessment Agency and Health Canada focused on the assessment of human health from the consumption of marine traditional country foods. The responses in Appendix H.1 and H.2 of the EIS Addendum are based upon the original project design, which includes dredging in the marine terminal area. Although the marine terminal design mitigation eliminates the need to dredge in this area, the responses to the information requests are still valid for the MOF area. While the physical effect of suspended sediments will occur during dredging at the MOF, the magnitude and duration will be substantially lower given that total dredge volume decreased by 97.5% as a result of the project changes.

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19.4 MITIGATION

19.4.1 Changes to Mitigation Measures Presented in the EIS

Updates to mitigation measures as a result of project changes and feedback received during the environmental assessment process are described in Section 6 (Air Quality), Section 8 (Acoustic Environment), Section 9 (Ambient Light), and Section 13 (Marine Resources) of the EIS Addendum. There are no additional updates to mitigation measures relating to human and ecological health.

19.4.2 Complete List of Current Mitigation Measures

Mitigation measures will reduce the potential for the Project to affect human and ecological health. These mitigation measures include those that reduce air emissions of criteria air contaminants and suspended sediments in the water column during dredging activities. Mitigation measures will also reduce the levels of noise and light that could reach residential areas in Port Edward. These technically and economically-feasible mitigation measures presented by PNW LNG to address potential effects to human and ecological health were described previously in the EIS, and where relevant have been updated in the EIS Addendum, for Air Quality (Section 6), Acoustic Environment (Section 8), Ambient Light (Section 9), and Marine Resources (Section 13). By implementing this full set of mitigation measures, PNW LNG is confident that the Project will not result in significant adverse effects to human and ecological health.

19.5 CONCLUSION

Project changes were assessed for potential effects, including cumulative effects, on human and ecological health. Based on this assessment the potential adverse effects, the characterization of residual effects (i.e., context, magnitude, extent, duration, frequency, reversibility) and the cumulative effects on human and ecological health that were identified in the EIS remain valid and no changes are warranted (see Table 19-3 and Table 19-4).

The project effects to human and ecological health will remain not significant with the project changes. There are no additional mitigation measures to protect human and ecological health beyond what is presented in the amendments for air quality, acoustic environment, ambient light, and marine resources.

The outstanding information provided in response to the information requests does not change the results of the assessment.

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Table 19-3 Characterization of Residual Effects for Human and Ecological Health

Potential Residual Environmental Effects	Mitigation/Compensation Measures	Residual Environmental Effects Characteristics						Likelihood	Significance	Confidence	Follow-up and Monitoring
		Context	Magnitude	Extent	Duration	Reversibility	Frequency				
Change in Human Health											
Construction	Mitigation measures described in the amendments for Air Quality, Acoustic Environment, Ambient Light and Marine Resources.	L	L	LAA	LT	R	C	L	N	H	Follow-up: <ul style="list-style-type: none"> Marine Country Foods
Operations		L	L	LAA	LT	R	C	L	N	H	
Decommissioning		L	L	LAA	LT	R	MR	L	N	H	
Residual effects for all Phases		L	L	LAA	LT	R	C	L	N	H	
Changes in Ecological Health											
Construction	Mitigation measures described in the amendments for Air Quality, Acoustic Environment, Ambient Light and Marine Resources.	M	L	LAA	LT	R	C	L	N	H	Follow-up: Marine Country Foods
Operations		M	L	LAA	LT	R	C	L	N	H	
Decommissioning		M	L	LAA	LT	R	MR	L	N	H	
Residual effects for all Phases		M	L	LAA	LT	R	C	L	N	H	

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<p>KEY</p> <p>CONTEXT:</p> <p>L = Low resilience - occurs in a fragile ecosystem with sensitive receptors and/or the level of baseline disturbance can be a contributing factor to changes in human and ecological health.</p> <p>M = Moderate resilience - occurs in a stable ecosystem and/or level of baseline disturbance not likely to contribute to change in human and ecological health.</p> <p>H = High resilience - occurs in a viable ecosystem and/or the level of baseline disturbance does not contribute to changes in human and ecological health.</p>	<p>MAGNITUDE:</p> <p>L = Low - Complete exposure pathway to affect health risk, with exposures near or slightly above health-based guidelines. Residual effects offset by mitigation and management options.</p> <p>M = Med - Complete exposure pathway to affect health risk with exposures slightly above health-based guidelines. Residual effect will still persist with mitigation and management.</p> <p>H = High - Complete exposure pathway to affect health risk with exposures above health-based guidelines.</p>	<p>EXTENT:</p> <p>PDA = project development area - Residual effects are restricted to the project development area.</p> <p>LAA = local assessment area - Residual effects are restricted within the LAA.</p> <p>RAA = regional assessment area – residual effects are restricted within the RAA.</p> <p>DURATION:</p> <p>ST = Short term - Short-term residual effect lasting up to one month.</p> <p>MT = Medium term - Medium-term residual effect lasting up to one year.</p>	<p>LT = Long term - Long-term residual effect lasting more than one year.</p> <p>P = Permanent - Permanent residual effect.</p> <p>REVERSIBILITY:</p> <p>R = Reversible - Changes to human or ecological health are reversible if the exposure ceases (i.e., temporary illness).</p> <p>I = Irreversible – Changes to human or ecological health are irreversible and will persist if exposure ceases (i.e., cancer effects).</p>	<p>FREQUENCY:</p> <p>O = Effect occurs once.</p> <p>MI = Multiple irregular events - residual effect occurs more than once but at an unpredictable interval of time.</p> <p>MR = Multiple regular events - residual effect occurs more than once at a regular interval of time.</p> <p>C = Residual effect occurs continuously.</p> <p>LIKELIHOOD OF RESIDUAL EFFECTS:</p> <p>L = Low likelihood of residual effects to health.</p> <p>M = Medium likelihood of residual effects to health.</p> <p>H = High likelihood of residual effects to health.</p>
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Table 19-4 Cumulative Residual Environmental Effects to Human and Ecological Health

Cumulative Environmental Effect and Project Contribution	Other Projects, Activities and Actions	Mitigation and Compensation Measures	Residual Environmental Effects Characteristics						Likelihood	Significance	Confidence	Follow-up and Monitoring
			Context	Magnitude	Extent	Duration	Reversibility	Frequency				
Change to human health from exposure to air emissions	<ul style="list-style-type: none"> • Canpotex Potash Export Terminal • CN Rail Line • Fairview Container Terminal Phase I • Fairview Container Terminal Phase II • Northland Cruise Terminal • Prince Rupert LNG Facility • Prince Rupert Ferry Terminal • Prince Rupert Grain Limited • Ridley Terminals Inc. • <u>Transportation of workers between the accommodation camp and Lelu Island.</u> 	None	L	L	RAA	LT	R	C	L	N	H	None
Change to ecological health from exposure to disturbed sediments containing PCDD/Fs	<ul style="list-style-type: none"> • Canpotex Potash • Fairview Container Terminal Phase I • Fairview Container Terminal Phase II 	None	L	L	RAA	ST	R	C	L	N	H	None

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<p>KEY</p> <p>CONTEXT:</p> <p>L = Low resilience - occurs in a fragile ecosystem with sensitive receptors and/or the level of baseline disturbance can be a contributing factor to changes in human and ecological health.</p> <p>M = Moderate resilience - occurs in a stable ecosystem and/or level of baseline disturbance not likely to contribute to change in human and ecological health.</p> <p>H = High resilience - occurs in a viable ecosystem and/or the level of baseline disturbance does not contribute to changes in human and ecological health.</p>	<p>MAGNITUDE:</p> <p>L = Low - Complete exposure pathway to affect health risk, with exposures near or slightly above health-based guidelines. Residual effects offset by mitigation and management options.</p> <p>M = Med - Complete exposure pathway to affect health risk with exposures slightly above health-based guidelines. Residual effect will still persist with mitigation and management.</p> <p>H = High - Complete exposure pathway to affect health risk with exposures above health-based guidelines.</p>	<p>EXTENT:</p> <p>PDA = project development area - Residual effects are restricted to the project development area.</p> <p>LAA = local assessment area - Residual effects are restricted within the LAA.</p> <p>RAA = regional assessment area – residual effects are restricted within the RAA.</p> <p>DURATION:</p> <p>ST = Short term - Short-term residual effect lasting up to one month.</p> <p>MT = Medium term - Medium-term residual effect lasting up to one year.</p>	<p>LT = Long term - Long-term residual effect lasting more than one year.</p> <p>P = Permanent - Permanent residual effect.</p> <p>REVERSIBILITY:</p> <p>R = Reversible - Changes to human or ecological health are reversible if the exposure ceases (i.e., temporary illness).</p> <p>I = Irreversible – Changes to human or ecological health are irreversible and will persist if exposure ceases (i.e., cancer effects).</p>	<p>FREQUENCY:</p> <p>O = Effect occurs once.</p> <p>MI = Multiple irregular events - residual effect occurs more than once but at an unpredictable interval of time.</p> <p>MR = Multiple regular events - residual effect occurs more than once at a regular interval of time.</p> <p>C = Residual effect occurs continuously.</p> <p>LIKELIHOOD OF RESIDUAL EFFECTS:</p> <p>L = Low likelihood of residual effects to health.</p> <p>M = Medium likelihood of residual effects to health.</p> <p>H = High likelihood of residual effects to health.</p>
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PACIFIC NORTHWEST LNG - ADDENDUM TO THE ENVIRONMENTAL IMPACT STATEMENT

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19.6 REFERENCES

Alberta Energy and Utilities Board (AEUB). 2007. *Energy Resources Conservation Board – Directive 038: Noise Control*. Revised edition.

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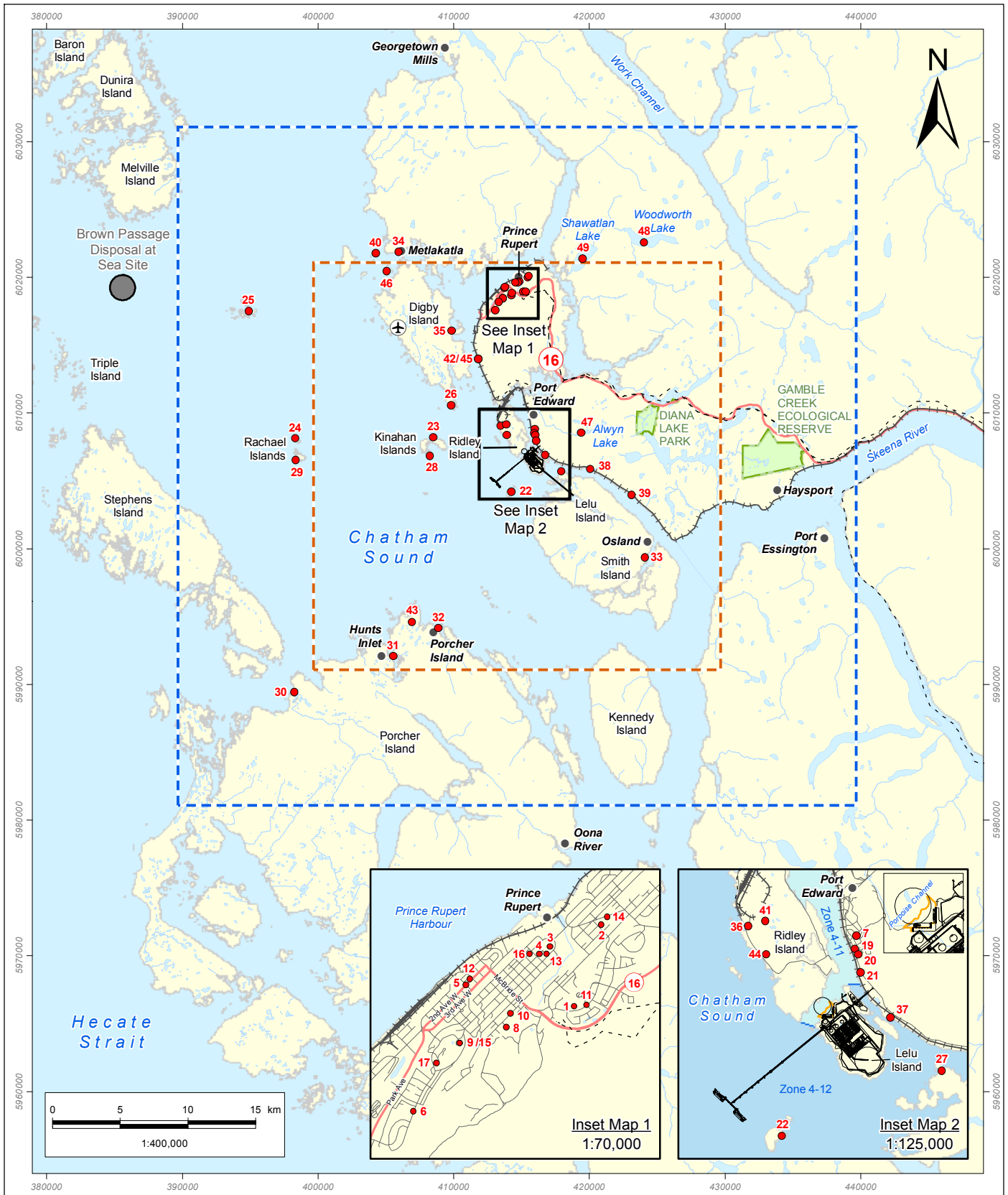
US EPA (United States Environmental Protection Agency). 1993. Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife. EPA/600/R-93/055.

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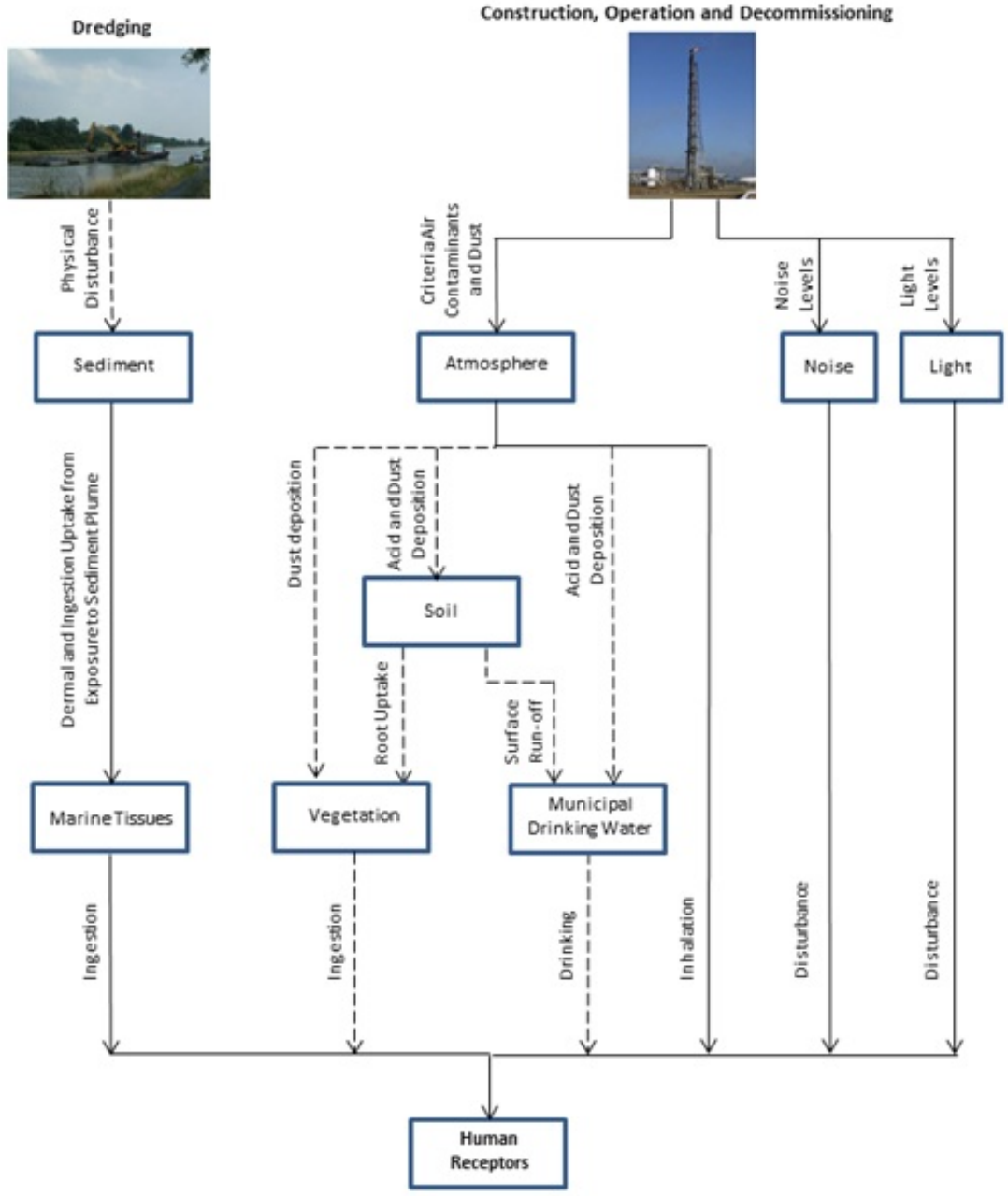
19.7 FIGURES

Please see the following pages.



<ul style="list-style-type: none"> ● Human Receptor Location Disposal at Sea Location Local Assessment Area for HHERA Regional Assessment Area for HHERA Project Component Airport City or Town Electrical Power Transmission Line Highway Railway Watercourse Protected Area Waterbody 	<p>Pacific NorthWest LNG</p> <p>Assessment Areas and Human Receptor Locations for the HHERA</p> <p><i>EIS ADDENDUM</i></p> <p><small>Sources: Government of British Columbia; Prince Rupert Port Authority; Government of Canada; Natural Resources Canada; Centre for Topographic Information; Progress Energy Canada Ltd; WorldView-2 Imagery. Imagery date: 2011.</small></p> <p><small>Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.</small></p>	<p>PREPARED BY:</p> <p> Stantec</p> <p>PREPARED FOR:</p> <p> Pacific NorthWest LNG</p> <p>FIGURE NO:</p> <p>19-1</p>
<p>Fisheries and Oceans Fishing Area</p> <ul style="list-style-type: none"> Zone 4-11 Zone 4-12 	<p>DATE: 10-DEC-14</p> <p>FIGURE ID: 123110537-301</p> <p>DRAWN BY: K. POLL</p>	<p>PROJECTION: UTM - ZONE 9</p> <p>DATUM: NAD 83</p> <p>CHECKED BY: R. LEE</p>

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----- Interaction Ranking "1" = Incomplete exposure pathway.
This interaction is not assessed further.

————— Interaction Ranking "2" = Complete exposure pathway.
This interaction is assessed in the Effects Assessment

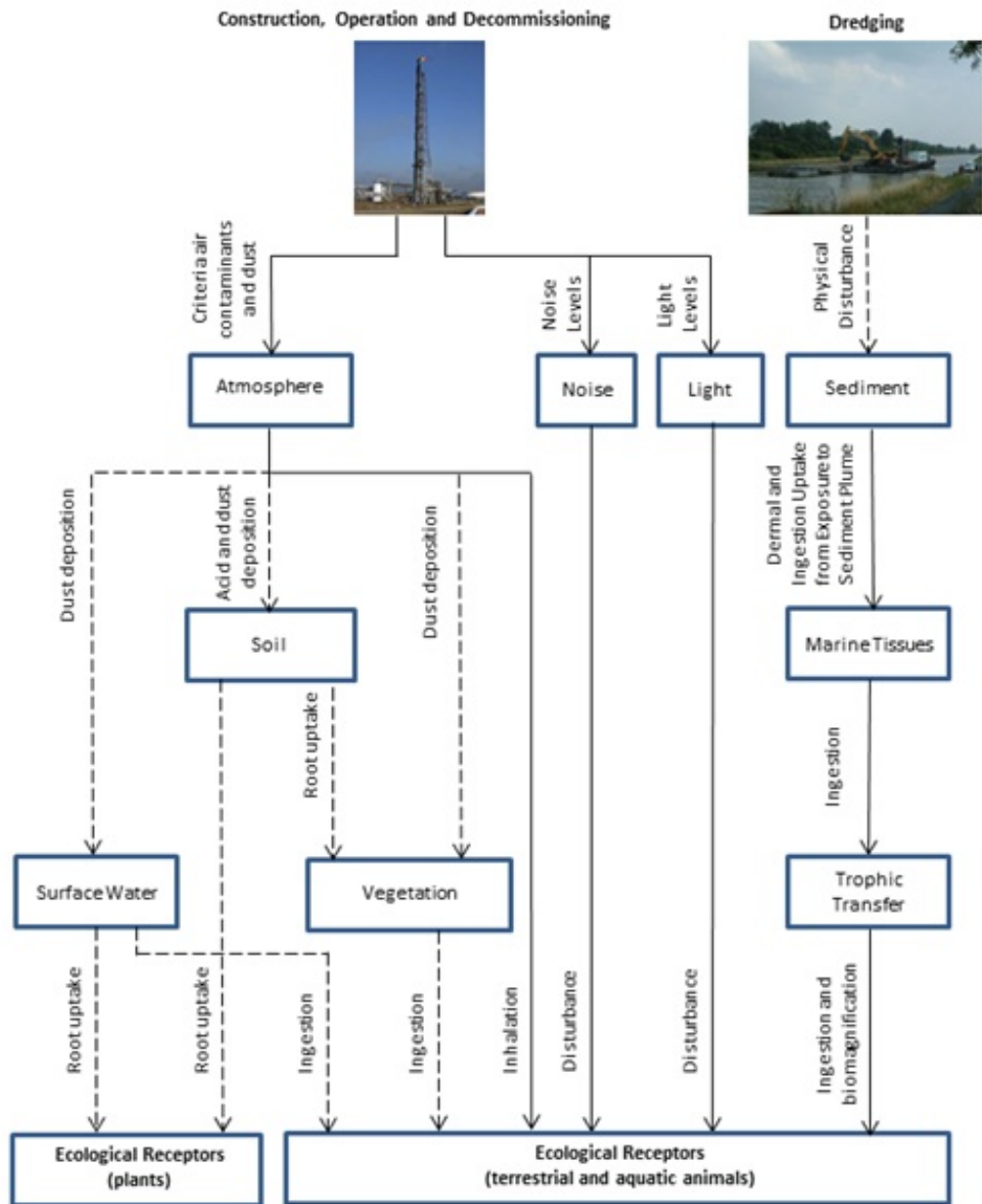
Pacific NorthWest LNG

Human Health Conceptual Model

PREPARED BY:

 PREPARED FOR:

 FIGURE NO:
19-2



----- Interaction Ranking "1" = Incomplete exposure pathway.
This interaction is not assessed further.

————— Interaction Ranking "2" = Complete exposure pathway.
This interaction is assessed in the Effects Assessment

Pacific NorthWest LNG

Ecological Health Conceptual Model

EIS ADDENDUM

PREPARED BY:

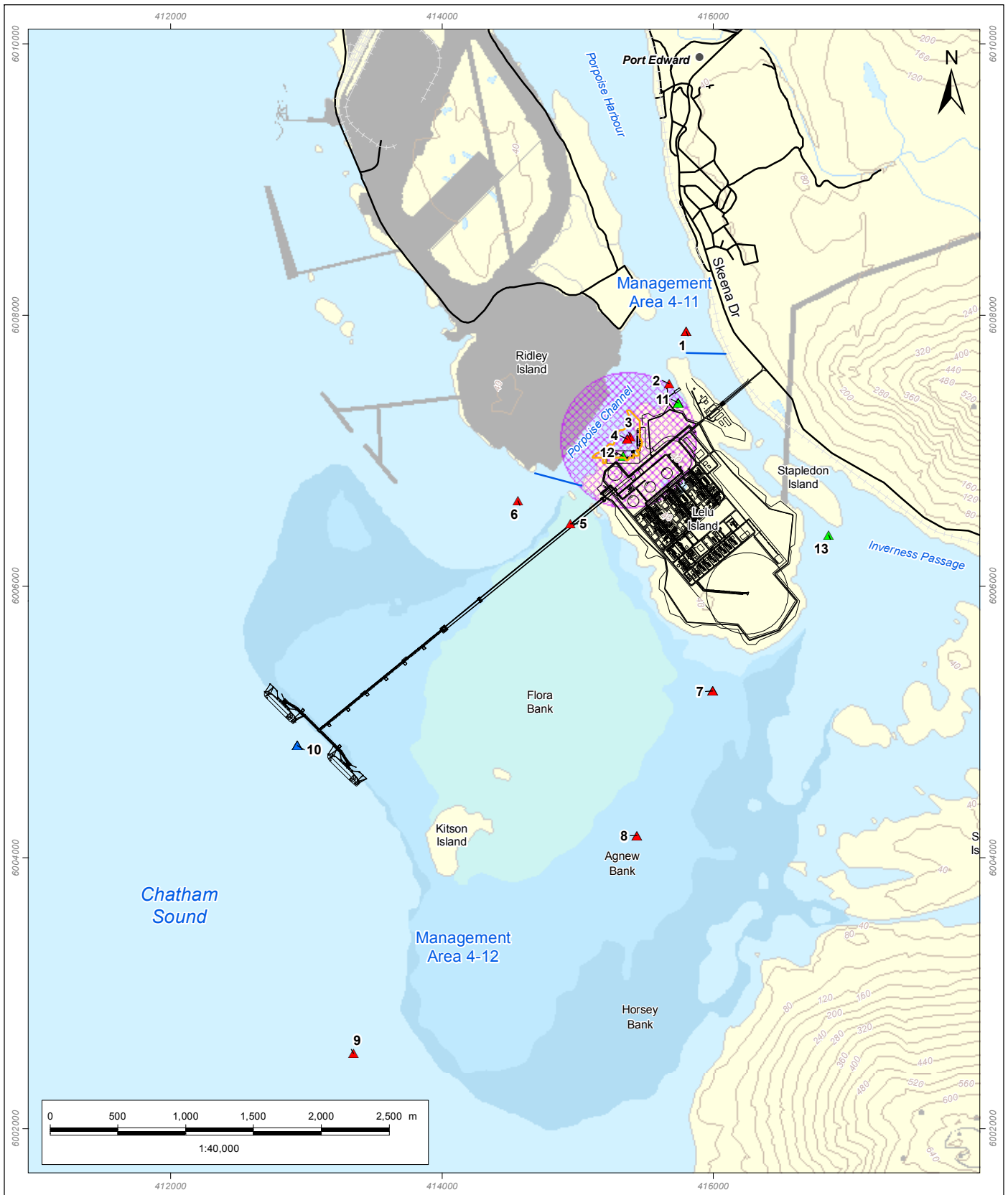


PREPARED FOR:



FIGURE NO:

19-3



<ul style="list-style-type: none"> ▲ Clam Collection Area ▲ Crab Collection Area ▲ Prawn Collection Area — Project Component — Fisheries and Oceans Management Area Boundary ▭ Dredge Area 	<ul style="list-style-type: none"> Marine Country Food Follow-Up Program Study Area Proposed or Existing Industrial Development ● City or Town — Contour (m) —+— Railway — Road — Watercourse 	<p style="text-align: center;">Pacific NorthWest LNG Baseline Tissue Sampling Locations and Study Area for the Follow-Up Program EIS ADDENDUM</p> <p><small>Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.; WorldView-2 Imagery. Imagery date: 2011.</small></p> <p><small>Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.</small></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">DATE: 10-DEC-14</td> <td style="width: 50%;">PROJECTION: UTM - ZONE 9</td> </tr> <tr> <td>FIGURE ID: 123110537-792</td> <td>DATUM: NAD 83</td> </tr> <tr> <td>DRAWN BY: D. COOK</td> <td>CHECKED BY: G. MATHEWS</td> </tr> </table>	DATE: 10-DEC-14	PROJECTION: UTM - ZONE 9	FIGURE ID: 123110537-792	DATUM: NAD 83	DRAWN BY: D. COOK	CHECKED BY: G. MATHEWS	<p>PREPARED BY: </p> <p>PREPARED FOR: </p> <p>FIGURE NO: 19-4</p>
DATE: 10-DEC-14	PROJECTION: UTM - ZONE 9								
FIGURE ID: 123110537-792	DATUM: NAD 83								
DRAWN BY: D. COOK	CHECKED BY: G. MATHEWS								

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