SECTION 10.0

ENVIRONMENTAL EFFECTS ASSESSMENT

GOLDBORO LNG

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10.0 ENVIRONMENTAL EFFECTS ASSESSMENT

10.1 Geology, Soil/Sediments

The geophysical environment was identified as a VEC for a number of reasons: the potential for disturbance of acid generating rocks; the previously identified abandoned mine workings in the northeastern and southwestern sections of the Project site; and the previously identified tailings deposits (Figure 9.1-5).

10.1.1 Threshold for Determination of Significance

The NSE and EC jointly prepared *Guidelines for Development on Slates in Nova Scotia* (NSE and EC, 1991) and the provincial Sulphide Bearing Materials Disposal Regulations (April 1995) regulate the management of materials with potential for acid rock drainage. To determine if a particular rock can be considered acid producing the total sulphide content must exceed 0.4% with insufficient minerals such as calcium to neutralize or consume the acid. These guidelines specifically target Meguma, Halifax Formation. Geological mapping of the area indicates the main Project area is underlain by rocks of the Meguma, Goldenville Formation (Section 9.1). A significant effect would be an unmanaged release of acid rock drainage (meeting conditions specified in the above guidelines) into surfacewater or groundwater.

With respect to contaminated soil, a significant effect is any unmanaged remobilization or disturbance of old mine tailings, with mercury and/or arsenic concentrations exceeding regulatory guidelines.

10.1.2 Effects on Geophysical Environment

A total of 28 abandoned mine workings have been identified in the Project area with many more in the surrounding areas (Figure 9.1-5). Some of the abandoned workings are known to be quite extensive with depths up to 70 m. These workings date back to the early part of the 1900's, are poorly mapped, and poorly documented. Overgrowth in the area makes it difficult to locate the mines.

Four tailings disposal areas have been identified in the Project area. All of the tailings samples exceeded the CCME guideline values for mercury for freshwater and marine sediments (CCME, 2001). All of the tailings samples collected exceed the CCME guideline values for arsenic for sediments in both fresh water and marine environments as well as for soil under all land uses (Table 9.1-1).

10.1.2.1 Effects of Construction

Acid Generating Rock

Geological mapping and preliminary geotechnical investigations indicates that it is unlikely that acid generating material will be encountered during construction within the LNG facility footprint. The geotechnical investigation of the LNG facility area revealed sulphur measurements ranging from 0.008% to 0.085%, well below the 0.4% sulphur limit established by NSE with respect to mineralized rock (MapleLNG, 2008).

There are two narrow bands of Halifax formation crossing the proposed water supply pipeline along the route to Meadow Lake (Figure 9.1-3). Should acid generating rock be disturbed, the acid generated may enter the surface water flow regime and be transported to the nearest down gradient waterbody or it may enter the groundwater flow regime and be transported more slowly.

The potential exists for the contamination of ground water wells through acidified groundwater or the contamination of the aquatic ecosystem through contaminated surface water. Recent geotechnical investigations indicate a low likelihood of encountering acid generating rock in the main site area where the heavy construction will occur.

It is likely that excavation and/or blasting will be avoided during pipeline installation. The pipe trench will be relatively shallow (probably not more than 1.5 m deep) and relatively narrow (less than one metre wide); therefore, it is anticipated that the volume of acid generating material disturbed (if any) would be insignificant. It is likely that acid runoff created from such small volumes of acid generating rock would be entirely buffered by any receiving waterbody.

Since there remains a possibility that small areas of acid generating rock will be encountered during construction, standard mitigation is recommended below. However, the potential for significant impacts in any event is considered low.

Abandoned Mines

The abundance of abandoned mines throughout the Project area raise health and safety concerns during site preparation and construction. Exact locations are difficult to pinpoint and identify as a result of the overgrowth. Workings close to the surface pose a risk to both workers and equipment.

Available mapping of abandoned mine locations as well as information from the NS AMO Database (NSDNR, 2013d) will be used to assist with site clearing and a detailed geotechnical investigation of relevant areas will be conducted before any construction activity proceeds.

Tailings

The tailings areas could become disturbed during plant site preparation or plant construction. Disturbing the tailings increases the potential for arsenic- and mercury-bearing dust and sediment to be released by wind or via the watercourses that originate from or run through them. The airborne particles can be inhaled directly or migrate downwind to be deposited elsewhere. The mercury may also volatilize, to be introduced in downwind environments as mercury vapour. The tailings areas will be mapped and construction activities in the vicinity of the sites will be guided by protocols outlined in the NS Guidelines for the Management of Contaminated Sites to be detailed in the RMP and EPP.

There is a possibility of acid drainage generation from tailings sites. The tailings sites will be mapped and further defined prior to construction following protocols outlined in the NS Guidelines for the Management of Contaminated Sites to be detailed in the RMP and EPP.

The tailings present at Dung Cove may become disturbed should there be a need to work in this body of water. The installation of the access road for the marginal wharf along the gravel and cobble barrier beach will help to stabilize the exposed end of Dung Cove Pond, thus protecting the beach from erosion during severe storm events for the foreseeable future. A detailed design of the access road will be completed during FEED; which will consider the hydrological implications on Dung Cove Pond and if necessary provide drainage/connectivity to the bay.

10.1.2.2 Effects of Operation

Acid Generating Rock

No disturbance of acid generating rock will occur during operation.

Abandoned Mines

During the operation of the facility, abandoned mine workings could serve as rapid pathways, or "highways," for accidental spills or other groundwater contaminants from the Project toward neighbouring residential wells, watercourses, and Isaac's Harbour. Since all fixed storage areas will be thoroughly contained, this potential only applies to vehicles; therefore, the volume would be relatively small. Underground cavities will be identified during preconstruction geotechnical surveys. Areas of high risk will be identified and avoided to the extent possible during FEED. Mitigation for accidental spills is described in Section 10.17.

Tailings

Potential effects during operation are similar to that for construction, above. In addition, runoff directed to Dung Cove will have to meet pre-development conditions to prevent the potential for disturbance and remobilization of contaminated sediments in the pond. This may require engineering controls to regulate flow rates. As stated above, the marginal wharf access road will permanently stabilize the barrier beach at Dung Cove Pond, protecting the waterbody from storm surges and the possible release of arsenic and mercury to the ocean.

10.1.2.3 Effects of Decommissioning

The potential effects related to tailings during decommissioning are anticipated to be similar to those described during construction, and operation. No potential effects related to acid generating rock or abandoned mine workings are anticipated.

10.1.3 Mitigation

Acid Generating Rock

Existing geological mapping of the area will be used to pinpoint areas where the pipeline crosses the bands of Halifax Formation. Construction activities in the vicinity of the sites will be guided by protocols outlined in the NS Guidelines for the Management of Contaminated Sites to be detailed in the SBMMP and EPP. Standard mitigation measures for acid generating rock include:

- more clearly define areas which might become a concern for acid drainage based on preliminary grading design;

- test bedrock in those areas where there might be acid drainage potential and where excavation for grading is deemed necessary, or where new sources of borrow material are likely to be obtained on-site; and
- where acid drainage potential is confirmed based on the testing, change the grading design so as to minimize or avoid excavation of potentially acid generating rock.

With proper mitigation measures in place, the significance of residual effects of acid drainage is expected to be minimal.

Abandoned Mines

Some mapping of the old mine workings in the Project area has been completed, but additional surveys will be required to identify all former mine sites in areas of concern and to make the proposed LNG facility safe to workers and/or structures. Additional surface mapping (Global Positioning System (GPS) delineations and location surveys) will be completed prior to site development and during site preparation and grading operations. Those workings believed to be shallow will be pumped out for direct observation to confirm depth, and subsequently filled with stone from the site.

Former mine workings which are deep and/or extensive will be mapped using electric sounding techniques and/or shallow seismic methods so as to properly delineate them for structural reasons and for evaluation regarding potential influences on groundwater flow. Those which are deemed to pose a risk to the groundwater regime (quantity, quality, flow) will be sealed with the use of low-permeability grout where possible. Survey information will also be used to assist in the development of groundwater/spill contingency planning (i.e., high risk areas).

Tailings

Since the location of tailings and contaminated soils is poorly defined, a comprehensive RMP will be developed and implemented. Tailings areas will be avoided where feasible and marked with signage or temporary fencing during construction. Where tailings cannot be avoided, sites will be managed to prevent the emanation of dust, sediment, surface water, or groundwater. Construction activities in the vicinity of the sites will be guided by protocols outlined in the NS Guidelines for the Management of Contaminated Sites to be detailed in the RMP and EPP.

Table 10.1-1 summarizes the potential effects and proposed mitigation measures for geological impacts.

Table 10.1-1 Mitigation Measures for Geological Impacts

Potential Effect	Mitigation Measures	Project Application
Acid rock drainage.	• Testing for acid drainage potential. • Avoid where possible. • Develop SBMMP if avoidance is not feasible.	Plant site construction.
Structural/safety risks associated with former mine workings.	• Detailed surveys and mapping of Project site. • Filling and stabilization as appropriate. • Grouting where appropriate. • Develop and implement RMP and EPP.	Foundation of LNG facility during construction.
Former mine workings provide conduit to surface water/ground water resources.		
Disturbance of tailings disposal sites.	• Avoidance where possible. • Develop RMP if avoidance is not feasible.	Project construction, operation and decommissioning.

10.1.4 Summary and Residual Effects

With proper mitigation measures in place, the significance of residual effects of acid drainage is expected to be minimal. The abandoned mines and tailings areas will be mapped and avoided, where possible. If avoidance is not possible, construction and operation activities in these areas will be guided by protocols outlined in the NS Guidelines for the Management of Contaminated Sites to be detailed in the SBMMP (if applicable), RMP, and EPP.

Table 10.1-2 summarizes the residual environmental effects for the geophysical environment.

Table 10.1-2 Residual Environmental Effects Summary for Geology, Soil/Sediments

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Contamination of surface/groundwater from acidic drainage due to the exposure of acid generating rock.	A	• Perform pre- construction survey and inspect excavations regularly. • Sampling from rock excavation areas will be done to determine sulphide mineralization. • Implementation of SBMP and EPP policies.	Low	Localized to two areas along water supply pipeline.	Construction Phase	NR	• Pipeline route will follow existing route in forested area, 1500 m from nearest residential receptor. • Water courses with little or no significance for local fisheries and water supply.	Minimal
Mine workings could pose a risk for worker's health and safety.	A	• Detailed geotechnical investigation and inventory of underground workings and mine openings.	Low	LNG facility area and vicinity.	Construction Phase	NR	• Known historic mining activities.	Minor
Disturbance of tailings could release arsenic- and mercury-bearing dust and sediment.	A	• Map tailings areas. • Implement RMP. • Stabilize barrier beach at Dung Cove. • Implement EPP policies.	Low	Localized to main LNG facility area.	Construction Phase	NR	• Known historic mining activities and tailings.	Minimal
Operation								
Mine workings are conduits for spilled contaminants to surface water / groundwater.	A	• Design self contained storage for all areas. • Implement EPP (with standard spill prevention and response).	Low	LNG facility area.	Operation Phase	NR	• Known historic mining activities.	Minor
Disturbance of tailings could release arsenic- and mercury-bearing dust and sediment.	A	• Map tailings areas. • Implement RMP. • Stabilize barrier beach at Dung Cove. • Implement EPP policies.	Low	Localized to main LNG facility area.	Construction Phase	NR	• Known historic mining activities and tailings.	Minor

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.2 Groundwater Resources

Groundwater resources was identified as a VEC based on the effects construction, operation and decommissioning may have on water supply wells, and the effects that changes to the groundwater regime may have on surface water bodies, streams, and wetlands adjacent to the Project.

It is of note that changes to the groundwater regime can also cause significant effects on ecological receptors. For example, the change in groundwater levels and flow can lead to the alteration of wetlands and/or baseflow conditions and thus fish habitat in watercourses. The significance of these effects is established in the respective sections of this report (Section 10.8 and 10.10).

Unlike surface water, where sun, exposure to air, wind, and wave action may help to break down or disperse deleterious substances, the dark and cold conditions present in the subsurface are generally conducive to the long-term preservation of many substances. Thus, deleterious materials introduced into groundwater may remain there for long periods of time, and once adsorbed to soil and rock, may serve as a long-term source of dissolved material. These dissolved materials may in turn be introduced to surface waters via base flow and discharge to wetlands, thus possibly affecting those environments as well.

10.2.1 Threshold for Determination of Significance

The significance of the effects on groundwater resources is based on the evaluation of the anticipated effects of Project-related activities on:

- the change of well water yields; and
- change of well water quality.

A change in water well yields that result in a long-term reduction in water supply at a receiver location is considered a significant effect. Further, a Project-related change in well water quality beyond the drinking water quality guidelines for NS/Canada is considered a significant effect. NS has adopted the Guidelines for Canadian Drinking Water Quality from Health Canada (Health Canada, 2012).

10.2.2 Effects on Groundwater

Field reconnaissance by AMEC (2006) indicated that there were approximately 40 wells located within 1 km of the main Project area. As identified in Section 9.2, there is one stream within the site boundaries (the unnamed tributary to Dung Cove) which may have groundwater supplies interrupted by excavation associated with site preparation and construction.

Based on the projected gravitational groundwater flow lines (Figure 9.2-1), possible surface water receptors could include Gold Brook, Betty's Cove Brook, Crusher Brook, associated wetlands, the unnamed tributary to Dung Cove, Dung Cove, and Isaac’s Harbour. Possible receptor wells, depending upon the final site configuration, are likely to include wells west of the site within a zone that extends along Highway 316 for a distance of approximately 1 km north of the gas plant road; the degree and significance of which would depend on the exact locations

and nature of the source, well type, nature of the surficial and bedrock geology present between the source and the well, and distance to the well. Depending upon facilities locations, other wells north of this zone could, to a lesser degree, also become receptors.

10.2.2.1 Effects of Construction

The main considerations with respect to impacts on water supply wells from the Project during construction include:

- blasting and vibration damages, with consequent temporary siltation (for dug and drilled wells) and possible permanent reduction in well yield (for drilled wells) during construction;
- trenching, site drainage and large cuts or changes in surface topography, could result in water level reductions during and after construction (dug well effects); and
- accidental release of fuel, oil, or lubricants due to equipment failure during site preparation and construction.

The severity of the water supply well impacts are expected to be a function of well type (spring, dug well, drilled well), age of the well, well construction method, distance from the site boundaries, overburden thickness and the hydraulic properties of the soil and bedrock. The effect of deep trenches to nearby wells and streams may also be reduced by placing low-permeability plugs within the trenches to prevent large-scale groundwater flow and drainage within the gravel backfill placed in trenches.

With respect to groundwater quantity, the main concerns related to plant site construction are:

- potential loss of well yield or lowered water level in dug wells (this is not expected to be significant due to the relative distance and small number of wells involved);
- possible damage to, or loss of drilled wells during blasting operations; and
- possible reduction in base flow at on-site streams and reduced (or increased) discharge at wetlands.

With respect to groundwater quality, the main concerns related to plant site construction are:

- chemistry changes in down-gradient wells due to uncontrolled runoff;
- temporary siltation of dug wells during heavy equipment operations; and
- accidental release of hazardous materials up-gradient of wells or streams.

There are locations within the proposed plant site, which are known to have sulphide mineralization. Initial geotechnical studies performed by Maple LNG in 2008 indicate that the main Project area is underlain by rocks of the Goldenville Formation and that all of the 11 samples tested were well below the sulphide sulphur limit established by NSE with respect to mineralized rock. Contamination of wells and/or on-site streams from acidic drainage due to the exposure of acid generating rock is unlikely in these areas; however, a more comprehensive assessment of the bedrock will be performed as part of a site geotechnical investigation to be completed prior to construction.

The effects of groundwater on surface water bodies and streams adjacent to the Project include stream dewatering which may be caused by deep and/or large-scale site drainage.

10.2.2.2 Effects of Operation

The main considerations with respect to impacts on water supply wells from the Project during operation include:

- accidental (acute) and chronic spills and release of chemicals, and possible releases due to fires, during plant operation.

As with the construction phase, the severity of the water supply well impacts will be a function of well type, age of the well, well construction method, distance from the plant site boundaries, overburden thickness and the hydraulic properties of the soil and bedrock. With regard to groundwater quantity, the main concern is potential loss of well yield or lowered water level in dug wells. With respect to groundwater quality, the main concerns related to the operation of the plant include:

- chemistry changes in down-gradient wells due to uncontrolled on-site road runoff; and
- acute accidental release of hazardous materials up-gradient of wells or streams.

The potential for well contamination from acidic drainage should be considered low so long as the rock, if present, is managed to prevent exposure to water or oxygen.

The effects of groundwater on surface water bodies and streams adjacent to and within the site boundaries, which include stream dewatering (caused by deep and/or large-scale site drainage during construction) are not expected to change from conditions possibly arising from the construction phase.

10.2.2.3 Effects of Decommissioning

The effects of decommissioning are anticipated to be similar to those described during construction.

10.2.3 Mitigation

Proper precautions such as secondary containment, leak detection systems, and monitoring alarms will be incorporated into the Project design and processes as appropriate. The potential effects of chronic and accidental spills of deleterious materials on groundwater will be reduced through vigilant monitoring and rapid cleanup response.

Table 10.2-1 summarizes the potential effect and proposed mitigation measures for groundwater quality and quantity impacts.

Table 10.2-1 Mitigation Measures for Groundwater Quality and Quantity Effects

Potential Effect	Mitigation Measures	Project Application
Loss of well yield and temporary siltation of wells.	• Avoid blasting to the extent possible within 500 m of residential wells. • Use ripping techniques as an alternative to blasting where possible. • Pre-blast survey. • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	Blasting during LNG facility preparation.
Water-level lowering in shallow, dug or drilled wells.	• Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	Excavation during LNG facility preparation.
Groundwater quality degradation from spills.	• Proper fuel management. • Application of EPP.	LNG facility construction.
Stream flow decreases and dry streams.	• Assess specific site hydrogeologic characteristics, design to minimize depth of cuts near streams.	Excavation during LNG facility preparation.
Groundwater and surface base flow quality degradation due to chronic spills.	• Apply impermeable aprons, secondary containment where necessary. • Double-wall vessels and piping subject to leakage. • Proper management, regular equipment inspections. • Develop/adhere to EPP. • Monitoring and local remedial action as necessary to restore damaged soil and groundwater.	LNG facility operation.
Degradation of groundwater, surface base flow and well-water quality due to accidental spills.	• Contingency planning (spill containment, recovery, etc.). • Remedial action as necessary to restore damaged groundwater. • Remedial action as necessary to restore damaged wells and/or provide other sources of potable water as needed.	LNG facility operation.
Contamination of wells and/or on-site streams from acidic drainage in areas of known sulphide mineralization on-site.	• Conduct geotechnical investigations to determine area of mine tailings. • Avoidance or stabilization of mine tailings within the Project site.	Construction.
Groundwater quality degradation and siltation.	• Drainage and vibration controls. • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	Road construction and repairs.

10.2.4 Summary and Residual Effects

The effects on groundwater quality, groundwater flow, and base flow conditions in the area caused by the construction, operation and decommissioning of the Project are not expected to be significant. Effects on well water supply and quality depend on the type, age, and construction method of the wells as well as the distance from the plant, the overburden thickness, and the hydraulic properties of the associated soil and bedrock.

Table 10.2-2 (below) summarizes the residual environmental effects for the groundwater.

Table 10.2-2 Residual Environmental Effects Summary for Groundwater Resources

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Siltation of dug and drilled wells and possible permanent change in water quality or well yield of drilled wells from blasting and vibrations.	A	• Avoid blasting to the extent possible within 500 m of residential wells. • Pre-blast well survey. • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	Low	1 km around and including Project area.	Temporary (dug and drilled wells) Possibly permanent (drilled)	R/NR	• Vacant Project site; sparsely populated area; 40 wells within 1 km of site.	Minor
Water level reductions in dug wells as a result of trenching, site drainage, and large cuts or changes in surface topography.	A	• Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	Low	1 km around and including Project area.	Construction Phase	NR	• Vacant Project site; sparsely populated area; 40 wells within 1 km of site.	Minor
Contamination of wells and/or on-site streams from remobilized mine tailings/contaminated soils.	A	• Avoidance, where possible, of mine tailings within the Project site. Implement RMP.	Low	1 km around and including Project area.	Construction Phase	R	• 40 wells within 1 km of site; three on-site water course. Site is zoned as “heavy industrial”; historical mining contamination in the surrounding region (including terrestrial, freshwater and marine environment); sparsely populated area.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.3 Surface Water Resources

Surface water was identified as a VEC based on the effects construction, operation and decommissioning may have on surface water bodies, streams, and wetlands within and adjacent to the Project area.

10.3.1 Threshold for Determination of Significance

Guidelines for water quality published by the CCME (1999) recommended the following for the protection of aquatic life:

10.3.1.1 Clear Flow

The total suspended sediments (TSS) concentration in surface waters should not increase by more than 25 mg/L for any short-term exposure (i.e., 24-hour period) with a maximum average increase of 25 mg/L from background levels for longer term exposures (i.e., inputs lasting between 24 hours and 30 days).

10.3.1.2 High Flow

The TSS concentration in surface waters should not increase by more than 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. When background levels are greater than or equal to 250 mg/L, TSS concentration should not increase more than 10% of background levels. Surface water quality will be monitored throughout both the construction and operation phases (Section 10.3.3).

An adverse effect that does not meet the above criteria may be considered significant depending on the frequency and duration of exceedance.

A significant impact on surface water quantity, relative to Project activities, is any daily withdrawal greater than 10% of baseflow, or any withdrawal rate that reduces lake water levels enough to affect the associated wetland habitat. A 10% withdrawal limit of baseflow is generally considered to be protective of aquatic habitat. Potential effects on wetlands are discussed further in Section 10.8.

10.3.2 Effects on Surface Water

The principal interactions between the Project activities and surface waters are associated with:

- land disturbance during and after construction and commissioning of the LNG facilities; and
- wastewater and stormwater discharges during the construction, operation and decommissioning phases of the Project.

The greatest potential for impact to surface waters is expected to be during construction. The largest discharge component by volume is expected to be stormwater both during and after construction.

10.3.2.1 Effects of Construction

LNG-site construction, access to work areas, and the preparation of sites for the placement of buildings and other facilities will require:

- the clearing of vegetation and earthworks including grubbing and stripping topsoil and overburden;
- the placement of excess material in temporary stockpiles which may be susceptible to erosion and result in sedimentation of watercourses adjacent to the site; and
- blasting and the potential exposure of acid generating rock.

Table 10.3-1 summarizes the three principal types of water discharge expected during construction.

Table 10.3-1 Principal Types of Water Discharge Expected at the Site (Construction Phase)

Project Phase	Type of Water Discharge
Construction	Clean and possibly sediment-laden stormwater.
	Construction wastewater (hydrostatic test waters, concrete wash water, stormwater that has been in contact with uncured concrete).
	Sanitary wastewater (worker sites and field offices).

The potential for adverse effects on and off-site watercourses during construction are discussed below.

On-site Watercourses and Waterbodies

The possible effects of runoff during construction have the highest potential to impact surface water, as construction will result in exposing soil to potential erosion. If unmanaged, erosion of site soils can lead to sedimentation of watercourses. Erosion control measures will be implemented as work progresses following the EPP and site grading plans.

During construction, TSS concentrations in stormwater, residual hydrocarbons, and/or metals in hydrostatic test waters, or the concentration of lime in concrete production wastewaters, could exceed the water quality guidelines for the protection of aquatic life published by the CCME (1999).

Mitigative measures (see Section 10.3.3) will be initiated to address these concerns. Sediment settling ponds will be put in place early during Project construction, silt fences and berms will be used as required. Removed vegetation will be replaced, or more likely, process areas will be gravelled or paved and curbed, as soon as practical to minimize erosion and to direct runoff to a stormwater collection system and sediment control ponds. Monitoring during storm events will be undertaken to confirm that the mitigative measures are functioning properly and to identify areas that need to be addressed (see Section 12.0).

To prevent the migration of construction chemicals into the aquatic environment, guidelines for the storage and disposal of chemicals, fuel and lubricants storage and concrete wash containment will be addressed in the EPP.

There is one tributary within the LNG site; unnamed tributary to Dung Cove (Figure 3.1-2). This is a small first-order tributary located on the southwestern corner of the Project area, approximately 75 m east of the SOEI gas plant road at the closest point. It appears to be spring fed and originates within a former mining and tailings disposal area, flows generally southward to where it crosses Highway 316 and discharges into Dung Cove. In summer, the tributary has been observed to be dry (AMEC, 2006).

This tributary will need to be diverted around the perimeter of the site. Due to its former mining legacy and the possibility of mobilizing contaminated sediments (tailings), this activity will need to be carefully monitored and addressed in both the RMP and EPP. The in-stream footprint to be realigned is less than 0.1 ha. The tributary is approximately 1000 m long but less than 1 m wide.

In addition, Pond 4 and Pond 5 will be infilled. Pond 4 and Pond 5 are a small brackish ponds located to the south of Dung Cove Pond, situated very near the shoreline. Area to be infilled is approximately 0.2 ha for Pond 4 and 0.4 ha for Pond 5 for a total of approximately 0.6 ha.

Off-site Watercourses and Waterbodies

Depending on final site grading plans and construction staging, there may be periodic stormwater discharges to Betty's Cove Brook from one or more temporary sediment ponds during LNG site construction. The stormwater ponds will be sized to accommodate flows from the exposed areas upstream of the ponds and allow for sufficient settling time for sediments. If necessary, flocculent may be added to the pond to enhance settlement prior to discharge. Effects on water quality in Betty's Cove Brook are expected to be minor with proper implementation of mitigation measures described in Section 10.3.3.

Watercourses near the Project area include the Gold Brook Lake, Gold Brook, and Seal Harbour Lake system (Figure 9.2-4, coastal sub-watershed 1EQ-SD31). The headwaters of the Gold Brook watershed originate at Oak Hill Lake. Gold Brook Lake discharges to Gold Brook at Gold Brook Road, near the remains of a former gold mine. Gold Brook flows generally southeasterly to Seal Harbour Lake.

Gold Brook has been the historical receiving water for significant amounts of tailings discharges from the Boston Richardson gold mine. As a result, the sediments in the watercourse are highly contaminated, with levels of arsenic as high as 221,000 mg/kg, and mercury as high as 120,000 µg/kg, with some elevated levels of lead, chromium, and nickel (Parsons *et al*., 2012). High concentrations of both arsenic and mercury are present in sediments all along Gold Brook and it is thought that the bottom sediment of Seal Harbour Lake (located over 1 km east of the closest Project) is also contaminated (Parsons *et al*., 2012).

In light of the area's past mining history and the possibility of mobilizing contaminated sediments during periods of high flow, other than the current levels of natural overland flow, Pieridae intends to avoid discharging stormwater into Gold Brook Lake, Gold Brook, and Seal Harbour Lake. Measures will be put in place to avoid stormwater (controlled drainage) flow toward these features both during and after construction.

The Project does not encroach on Gold Brook Lake, Gold Brook, or Seal Harbour Lake and there will be no Project discharges of any kind to these features. Pieridae will protect them both during construction and operation by a comprehensive set of mitigation measures (Section 10.3.3). As such, there are no anticipated effects of the Project on Gold Brook Lake, Gold Brook River, or Seal Harbour Lake.

Meadow Lake Water Intake

Meadow Lake has been identified as a source for water for the Project. Comprehensive mitigation measures will be used to ensure the protection of Meadow Lake and Isaac's Harbour River from contaminated site runoff during the construction of the water intake structure (See Section 10.3.3). These include measures to control siltation and erosion, appropriate storage of fuel, appropriate operation of construction machinery, among others. The intake will be situated near the deepest portion of the lake. The construction footprint of the intake structure within the lake is to be approximately 0.054 ha. This area based on a 140 m pipe to be located within the lake bed with a maximum construction width of 3.8 m. A fish screen has been incorporated into the design of the intake structure. With the effective implementation of these measures, there are no expected adverse effects on the water quality of Isaac's Harbour River or Meadow Lake during the construction phase of the water-intake structures.

The water withdrawal associated with the water supply pipeline has the potential to alter lake water levels (and potentially downstream baseflow in Isaac's Harbour River). A significant reduction in either could result in loss of aquatic or wetland habitat. For the purpose of this EA report, an average water withdrawal of 600 m^3/d has been selected as a slightly conservative amount that probably exceeds actual withdrawals that will occur. As stated in Section 9.2, the lowest monthly baseflow in June is 1,570,000 m^3. Since the average water withdrawal would be about 18,600 m^3, the anticipated water requirement represents less than 1.2% of total baseflow during the driest month; far less than the allowable withdrawal of 10% of baseflow. In other months, the baseflow is four to ten times higher, so this water withdrawal represents only 0.23% of annual baseflow. Another factor to consider is that up to 25% of base flow is derived from groundwater (AMEC, 2006), so the water volume in the Meadow Lake and Isaac's River is somewhat less sensitive to short term fluctuations in weather. Therefore, the potential effects on aquatic habitat in Meadow Lake and downstream are negligible.

Meadow Lake contains approximately 1.9 million m^3, and the monthly baseflow ranges from a high of over 16 million m^3 in March to a low of 1.6 million m^3 in June. The lowest average monthly baseflow is about equal to one lake volume, so in theory the maximum lake draw down would be 2.4 cm (1.2% of average depth – 2 m). In reality, this will be much smaller, since the rate at which the lake continues to fill up will likely increase slightly in response to the draw down. In other months, the lake will recharge far faster than the intake system can withdraw

water, and will have a negligible effect on lake water levels annually. Overall, the effect on water level in the lake will not be large enough or long enough to cause changes in shoreline habitat (i.e., the change in water level will be much smaller than natural fluctuations).

A provincial water withdrawal permit will be required, as the Project demand (600 m^3/d) is well over the 23 m^3/d specified in the *Activities Designation Regulations* (Division I). Since no other water users were identified at Meadow Lake or downstream, water allocation is not an issue. The water withdrawal permit application will require calculation of sustainable yield using flow-duration curves, in order to demonstrate that the proposed Project withdrawal is acceptable. Fisheries maintenance flow requirements would then be coordinated with DFO, when precise FEED level water demands are known. It is likely that the limit of 10% of baseflow used in this EA will be more conservative than the total withdrawal allowance based on the sustainability curve.

Water withdrawn from Meadow Lake (Figure 9.2-4, watershed 1EP-1) will be piped straight to the plant site and, following its on-site use, disposed of within the treated wastewater stream directly to the ocean. This is where the water from Meadow Lake would typically arrive if it were allowed to flow naturally via the Isaac's Harbour River so it does not constitute an inter-watershed transfer. Currently, the proposed site partially overlies two separate watersheds (Figure 9.2-4, 1EP-SD1 to the southwest, and 1EQ-SD32 to the northeast). However, LNG site grading may alter the surface runoff direction and the watershed boundaries. It is not anticipated that these changes will constitute an inter-watershed transfer.

Water Supply Pipeline

The water supply pipeline will be buried and is anticipated to cross two watercourses; Branch Gold Brook and Betty's Cove Brook, at existing pipeline ROWs. These watercourses are to be crossed using open trenching. No culvert will be needed as existing access exists.

10.3.2.2 Effects of Operation

Discharge Waters

During operation, there are three principal types of water discharge expected at the Project site (See Table 10.3-2).

Table 10.3-2 Principal Types of Water Discharge Expected at the Project Site (Operation Phase)

Project Phase	Type of Water Discharge
Operation	Potentially oily stormwater from some process complexes (paved or hard surfaces), process water, and cooling water blow down.
	Clean stormwater from some process complexes and general areas, either paved (hard surface) or unpaved (soft surface).
	Domestic-type or sanitary wastewater (some from process complexes and some from common-user utilities).

The largest discharge component by volume will be stormwater since much of the site will have gravel or impervious surfaces.

Process areas will be paved and curbed to direct runoff to one or more collectors equipped with a sump and oil and water separator to remove oil and grease from stormwater flows. A Stormwater Management Plan envisages the use of large fire ponds as the primary means to control and treat sediment-laden runoff from the facility prior to being discharged. Based on the preliminary layout of the facilities it is expected that much of the stormwater will be directed to Isaac's Harbour although this will be confirmed during the FEED.

Controlled drainage from a large land development such as this Project may periodically generate large amounts of stormwater discharge to Betty's Cove Brook. Flushing of the watercourse may occur as a result of the more severe flows experienced during and immediately after storms although the wetland associated with Betty's Cove Brook would likely have an ameliorating effect on the flows. Reduced groundwater recharge in paved areas (thus, reduced stream base flow) may cause drier conditions and longer dry periods between flow events in streams. Although this impact is considered minor in relation to the overall watershed that includes Betty's Cove Brook (AMEC, 2006).

The Project will include a wastewater treatment facility used to treat and discharge process water into the sea at the south eastern corner of the plot. The final location of the discharge point will be selected in FEED subject to dispersion analysis and to meeting any environmental requirements.

The water management systems will comprise a number of streams including; potentially contaminated, oily water, and domestic water.

Stormwater will be treated as either clean when it originates in clean plant areas, or potentially contaminated when from process areas. Water from process areas may be further segregated into first flush that will be monitored for contamination before either treatment or discharge to sea. Runoff from uncontaminated areas will not be treated prior to discharge although monitoring may be required.

Normal domestic sanitary waste will be partially treated on site prior to removal by vacuum truck for local treatment off-site. Further study is required in FEED to confirm this philosophy.

Receiving Waters

Following treatment, process and sanitary wastewater will be discharged to Isaac's Harbour using conventional gravity and, if required, forced main systems.

Should the proposed plan to direct the majority of the volume of stormwater to Isaac's Harbour require that storm drains be installed in deep trenches to accommodate site topography, the potential impact of the trenches (which can redirect groundwater flow) on base flows to Betty's Cove Brook will be further investigated. Groundwater and surface water investigations indicated

that the groundwater flow is an important contributor to the flows and water quality of the watercourse.

The protection of Betty's Cove Brook was a component of the SOEI development plan for the gas plant indicating the importance the regulatory agencies placed on the watercourse. Therefore, Pieridae will take steps to design the facilities to maintain the watercourse's existing water balance such as employing soft-surface practices where practical and proactive management of stormwater ponds to help attenuate storm surges.

Meadow Lake Water Withdrawal

During operation, the water withdrawal rate will likely be slightly less than peak construction demands (closer to 500 m^3/d). Potential impacts on water quality and quantity would be similar to construction.

10.3.2.3 Effects of Decommissioning

The effects of decommissioning are anticipated to be similar to those described during construction. It is possible that the water supply system may continue to operate, depending on the next use of the site and/or the municipality. If there is no after-use for the pipeline, then it would be decommissioned at the same time as the other Project components.

10.3.3 Mitigation

The main potential effect on surface water during construction is the possibility of silt-laden runoff into various surface waters. Mitigation measures during construction will include the use of existing vegetated surfaces, silt fences, granular stabilization materials, ditch checks, etc. for sedimentation and erosion control. Settling/detention ponds will also be used, as appropriate, to achieve acceptable stormwater-quality objectives.

Construction equipment fuelling stations and fuelling operations will also be kept away from any surface water body so as to minimize the risk of spillage into surface waters. As part of the EPP, spill kits will be on hand for possible use by all construction teams. Construction personnel will be trained in the use of these kits. With respect to water supply pipeline watercourse crossings mitigation measures, refer to Table 10.10-1 in Section 10.10.4.

During operations, the main mitigation measure will be the development of a stormwater management system. This system will include collection, detention, and discharge facilities designed to meet or exceed regulatory requirements. All stormwater will be intercepted before discharge into any watercourses. Stormwater ditches will be lined with granular material and will contain ditch checks to prevent and control erosion. Flow from the stormwater ditches will be directed to settling/detention ponds intended to capture the first 25 mm of each rainfall event. These stormwater ponds may also be used to augment on-site fire-fighting storage volumes.

The guiding document regarding the mitigation of potential effects on surface water will be "*Erosion and Sedimentation Control Handbook for Construction Sites*" (NSE, 1988) or equivalent. Following is a discussion of mitigation measures proposed for potential stormwater-related effects of the Project, with relevant information summarized in Table 10.3-3.

The locations of the LNG facilities were selected, in part, to minimize interactions with watercourses.

Table 10.3-3 Mitigation Measures for Surface Water Effects

Potential Effect	Mitigation Measures	Project Application
Siltation of surface waters.	• Location of plant-site facilities to minimize interactions with watercourses. • Erosion control measures. • Provision for spill control. • Restrict the removal of riparian vegetation from margins of surface waters i.e., 20 m setback. • Use of surface water settling/detention ponds. • Stabilization of disturbed soils.	Construction and decommissioning.
Contamination of surrounding surface waters via runoff, spills, and leaks.	• All on-site fuels, oils and chemicals should also be stored at a designated fuelling and material storage site at least 150 m from any surface waters. • Re-vegetation of disturbed soils. • Management of stormwater quantity and quality to relevant provincial standards. • Treatment of wastewater to comply with regulatory requirements prior to discharge. • Use of surface water settling/detention ponds. • Discharge of collected wastewater within respective watershed. • All rock excavation will be tested for acidic conditions. If any is found it will be disposed of in a provincially approved manner. • Stormwater runoff from uncontaminated areas will be segregated from potentially contaminated areas.	Excavation, construction, and operation.
Effects on Meadow Lake and Isaac's Harbour River.	• Construction of cofferdam. • In-water works to take place outside of spawning/fish migration season and will be conducted between June 1st and September 30th. • Use of siltation curtains. • Rehabilitation of shoreline upon completion.	Construction and operation.

Potential Effect	Mitigation Measures	Project Application
Erosion of watercourses.	• Line ditches with granular materials. • Flow checks used in drainage ditches. • Use of surface water settling/detention ponds. • Develop an erosion and sediment control plan. • Retain as much vegetated and porous surface as possible to aid in groundwater recharge.	Operation.

Environmental management features for the Project include monitoring and maintenance programs such as EEM and Environmental Compliance Monitoring (ECM). These environmental management features will be refined and expanded on throughout the Project design. The EMP includes EEM for surface water quality, fish and fish habitat including the habitat compensation plan, and monitoring of the new diversion channel for stability and functioning. ECM for effluent quality and quantity will be undertaken; the Project surface water management systems and water treatment facilities will be designed to include controlled outlet structures with monitoring points.

Monitoring programs outlined above will be designed to verify the effectiveness of the mitigative measures. The details of the monitoring programs will be determined in consultation with regulatory agencies and documented in the EMP.

Upon final siting of the road, piping, and onshore facilities, a follow up survey may be required to permit the refinement of site-specific mitigative measures and to allow for final adjustments to rights-of way, if necessary (e.g., for stream crossings). The erosion and sedimentation control structures will be inspected regularly and quarterly surface water sampling protocols will be in place prior to the facility starting operations.

10.3.4 Summary and Residual Effects

During construction, operation and decommissioning, impacts on surface water (freshwater) resources on and off-site are expected to be not significant as effective mitigation measures are available to minimize construction impacts that are related to erosion, sediment loading, and contamination resulting from accidental spills, fuel storage and handling.

Operation-related effects will be minimized through an on-site wastewater treatment system. This system will ensure that discharges from any components of the development will be treated to applicable federal and provincial standards, guidelines, and objectives prior to discharge. Monitoring of effluent quality will be implemented to ensure effectiveness of the treatment process.

Table 10.3-4 summarizes the residual environmental effects for surface water.

Table 10.3-4 Residual Environmental Effects Summary for Surface Water Resources

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Effects on all on-site watercourses (erosion, sediment loading, stormwater discharges, spills).	A	• Diversion of Unnamed Tributary to Dung Cove. • Implement EPP (includes: Erosion and Sediment Control Plan, Buffer Zone, Stormwater Management Plan, and Spill Prevention and Response Plan). • Designated fuelling and material storage site. • Implement RMP.	Low with management measures.	All on-site water courses .	Construction Phase	NR	• Small, local drainage system.	Minimal
Effects on all off-site watercourses (erosion, sediment loading, stormwater discharges, spills).	A	• Wastewater management system will discharge water directly into Harbour from south east portion of the Project footprint. • Implement EPP (includes: Erosion and Sediment Control Plan, Buffer Zone, Stormwater Management Plan, and Spill Prevention and Response Plan). • Designated fuelling and material storage site.	Low with management measures.	Local drainage system.	Construction Phase	R	• Part of small, local drainage systems.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Effects on Meadow Lake through in-water works and onshore works for water intake structure (erosion, sediment loading, stormwater discharges, and spills).	A	• Implement EPP (includes: Erosion and Sediment Control Plan, Buffer Zone, Stormwater Management Plan, and Spill Prevention and Response Plan). • Designated fuelling and material storage site. • Conduct in-water works outside of spawning / fish migration season (June 1st to September 30th). • Use of silt curtains. • Rehabilitation of shoreline upon completion.	Low with management measures.	Limited to river and Meadow Lake.	Construction Phase	R	• Small, local drainage systems.	Minimal
Operation								
Effects on - and off-site surface water quality as a result of discharges of stormwater, process water, and sanitary wastewater.	A	• Implement EPP (includes: Stormwater Management Plan). • On-site wastewater treatment facility to collect and treat all wastewater streams. • Controlled discharge point(s). • Monitoring of discharge quality (ECM). • RMP.	Low with management measures.	All on-site watercourses and local drainage system.	Operation Phase	R	• Some sediments contaminated due to historic mining activities.	Minor
Effects on Meadow Lake hydrology (water levels, fluctuations, flow) as a result of water withdrawal from Meadow Lake.	A	• Maintain minimal flow conditions in Isaac's Harbour River.	Low with management measures.	Meadow Lake	Operation Phase	R	• No sensitive uses at Lake or along Isaac's Harbour River.	Minor

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Inter-watershed water transfer (resulting potentially in changes in hydrology and water quality).	A	• Discharge of collected stormwater within respective watershed. • Water withdrawn from Meadow Lake to be discharged to Isaac's Harbour / ocean (= ultimate receiver under baseline conditions).	Low with management measures.	Project area and Isaac's Harbour.	Operation Phase	R	• Not identified as a concern in the area.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.4 Air Quality and Climate Change (GHG)

10.4.1 Threshold for Determination of Significance

A significant adverse air quality effect has been determined to represent a condition where regulatory objectives are regularly exceeded.

NSE has established maximum permissible ground level concentrations (GLCs) for ambient air quality in NS. All approvals issued by the Minister of Environment contain provisions to ensure that the maximum permissible GLCs are not exceeded.

The CCME has developed a CWS for $PM_{2.5}$ which is 30 µg/m^3, based on a 24-hour average over three consecutive years.

Health Canada provides a reference value of inhalation of 3 µg/m^3 for an annual period; Quebec has an objective of 10 µg/m^3 for a 24 hour period; and Alberta has an objective of 30 µg/m^3 for a one hour period.

For GHG emissions a significant effect is defined as one that has the potential to adversely affect the Province's GHG reduction targets.

10.4.2 Effects of Construction

The use of equipment to construct the site will result in temporary, short-term emissions of air pollutants that will be restricted to the construction period for the natural gas liquefaction plant and marine terminal, and will terminate once construction has been completed. These emissions will likely not result in significant adverse impacts to the air quality within the vicinity of the Project site. Fugitive dust control measures will be implemented, if required.

Natural gas liquefaction plant and marine terminal construction activities can generally be categorized into site preparation, natural gas liquefaction plant process construction, and marine pier construction activities. During construction, activities associated with the natural gas liquefaction plant will include the use of internal combustion engines in various cranes, backhoes, dozers, loaders, pavers, trucks, welders, generators, air compressors, pumps, pile drivers, miscellaneous heavy construction equipment, and worker commuting vehicles will result in emissions of NO_X, SO_2, CO, PM_{10}, $PM_{2.5}$, and VOCs.

Fugitive dust emissions from activities such as site preparation, grading and vehicle traffic will occur during construction periods. Prior to paving or revegetation of disturbed soil areas within the Project footprint, wind erosion of displaced soil may also generate fugitive dust emissions. Pieridae will use mitigation measures to minimize the fugitive dust emissions associated with construction of the natural gas liquefaction plant. These measures may include the application of water or dust suppressants, covering of haul trucks, use of paved roads to the extent possible, limiting vehicle speed, and stabilizing disturbed areas.

It is expected that construction activities may last as long as 54 months (4.5 years).

As the site is fairly isolated from residents, schools and businesses of the area, the impact to the public are expected to be insignificant, approaching background concentrations at off-site locations.

10.4.3 Effects of Operation

In general, emissions from the operation of the natural gas liquefaction plant and marine terminal will be managed in a manner to meet ambient air quality objectives that fall under the NSEA (section 112 of the *Environment Act* S.N.S 1994-95, c. 1).

The Project will consist of the construction and operation of the following major elements:

- Natural Gas Liquefaction Plant: A facility for converting natural gas from the Maritimes and Northeast Pipeline into liquefied natural gas for export to overseas markets, with a capacity of 10 Mtpa of LNG.
- LNG Loading Terminal: A marine jetty for berthing and loading of LNG tankers; a marginal wharf will be built for supply of building components during construction and berthing of tugs during operation.
- 180 MW Power Plant: On-site power generating station to support the LNG facility and support services.
- Storage Tanks: Three on-site LNG storage tanks. Each tank will store up to a net capacity of 210,000 m^3 of LNG.
- LNG transport: The marine terminal will be designed to accommodate LNG carriers ranging in size from 145,000 m^3 to 263,000 m^3.

The assessment of air emissions from the operation of the natural gas liquefaction plant and marine terminal was conducted in two steps:

1. An inventory of all combustion emissions and GHGs was developed and compared to the emissions inventory for the Province of NS.
2. An air dispersion modeling study was performed to predict the impacts on air quality at the three residential properties, a hospital and a senior citizens home located closest to the natural gas liquefaction plant property.

10.4.3.1 Approach to Inventory of Air Emissions

The following sections provide an assessment of air emissions projected to be generated from the operation of the proposed natural gas liquefaction plant and marine terminal. The approach developed to inventory air emissions and assess their impacts is based on the following documents:

- CB&I London Goldboro LNG Emissions List Document No. 185352-000-SE-LS-00001, February 13, 2013 (CB&I, 2013f);
- CB&I London Goldboro LN Gas Dispersion Analysis Report Document No. 18532-000-SE-RP-00002, February 14, 2013 (CB&I, 2013e);

- AMEC, Keltic Petrochemicals Inc. Petrochemicals and Liquefied Natural Gas Facility Environmental Assessment, July 2006 (AMEC, 2006); and
- Dillon, Maple LNG Air Quality Assessment, November 2007 (Dillon, 2007).

Air emissions for the Project were predicted on the basis of the following activities and components:

- LNG facility including incinerator for acid gas removal, refrigerant compressor gas turbines, power generation gas turbines, pilot/purge gas flares, and emergency diesel generator sets;
- LNG carriers; and
- fugitive gas emissions from the LNG processing.

Two scenarios were assessed, the facility operating under normal conditions and emergency or upset conditions. In addition to all of the sources for normal conditions, emergency conditions also include flaring activities.

10.4.3.2 Inventory of Project Emissions

Table 10.4-1 provides a summary of the annual air emissions estimated to be produced by the operation at full production of the proposed Goldboro LNG plant.

Table 10.4-1 Estimated Annual Emissions – Proposed Natural Gas Liquefaction Plant and Marine Terminal (Tonnes/Year)

Activity	CO	NO_X	PM	SO_2	VOC
Incinerator For AGRS	36.02	43.2	-	662	-
Refrigerant Compressor Gas Turbines	8.5	1,093	43	-	150
Power Generation Gas Turbine	7	902	199	-	124
Pilot/Purge Gas For Flares	3	68	99	-	620
Emergency Diesel Generator Set	0.1	1.4	0.3	-	0.1
LNG Carrier Ship	92.7	971	60	359.5	33.4
Total	**147.3**	**3,078.6**	**401.3**	**1,021.5**	**927.5**

It is estimated that the operation of the proposed natural gas liquefaction plant and marine terminal will produce 147.3 t of CO, 3,078.6 t for NO_x, 401.3 t of PM, 1,021.5 t of SO_2, and 927.5 t of hydrocarbon emissions.

In addition to the priority contaminant emissions, the processing of natural gas will result in the leakage of gas from fugitive equipment leaks, process venting, evaporation losses and accidents and equipment failures. A background paper, "*Fugitive Emissions from Oil and Natural Gas Activities"* (Pickard, not dated), that addresses good practice guidance for Canadian national GHG inventories estimates the percent leakage for LNG plants ranges from a low of 0.005 to a high of 0.1% of throughput. The estimated amount of gas to be processed at

the Pieridae facility is approximately 44.6 million m^3 per day. The percent of CH_4 in the feed gas is expected to be 91.24%. Since the facility will be new and will be constructed of state of the art equipment, the low percent leakage number of 0.005% was applied to estimate the total amount of CH_4 that is estimated to leak from the facility per year to be 742,593 m^3.

Since the feed gas to the proposed natural gas liquefaction plant will be supplied from a national transmission line, it is possible that some gas sources may contain components, such as benzene, that are normally removed during natural gas processing. The typical amount of benzene in the feed gas is 50 ppmv.

10.4.3.3 Greenhouse Gas (GHG) Emissions

Many GHGs take approximately 100 years to naturally dissipate. The primary concern related to emissions of GHGs is climate change.

NS is committed to playing a constructive role in addressing GHG emissions and climate change and moving forward in a manner that ensures the province will be a model of economic and environmental sustainability. In 2011, the Province developed two documents that address climate change:

- Guide to Considering Climate Change in Environmental Assessments in NS, February, 2011 (NSE, 2011a).
- Guide to Considering Climate Change in Project Development in NS, February, 2011 (NSE, 2011b).

Following these guidelines, an EA serves to promote sustainable development by identifying measures to protect and conserve the environment for future generations. A key element of environmental sustainability will be how project proponents incorporate climate change considerations – efforts related to overall GHG emissions reductions and climate change adaptation – into their respective projects.

Table 10.4-2 provides a summary of GHG emissions predicted for the proposed Project.

In 2010 the estimated GHG emissions generated in NS was 20,400 kt CO_2e and 692,000 kt CO_2e for all of Canada. The Project is expected to generate an estimated 3,778 kt of CO_2, which would result in an increase in CO_2 emissions of approximately 15% to the Provincial levels and 0.5% to the Canadian levels. Within the Provincial context, this is considered a significant adverse effect. For efforts and commitments related to reducing and/or off-setting the Project's GHG emissions refer to Section 10.4.5.4.

Table 10.4-2 Estimated Annual Greenhouse Gas (GHG) Emissions - Liquefaction Plant and Marine Terminal (Tonnes/Year)

Activity	Methane as CO_2e	CO_2
Incinerator For AGRSs	-	566,386
Refrigerant Compressor Gas Turbines	-	1,812,564
Power Generation Gas Turbine	-	1,196,291
Pilot/Purge Gas For Flares	26,040	34,745
Emergency Diesel Generator Set (assumed to run intermittently two hours per week)	-	13,950
LNG Carriers(1)		47,694
Leakage from Natural Gas Processing Plant	11,130	69,490
Subtotal	**37,170**	**3,741,120**
Total		**3,778,290**

Note:
1. Represents two LNG Carriers idling at the berth for entire year.

It is possible that there may be an option to obtain power off the NSPI grid and this would eliminate the need for the power generation gas turbines. Use of the gas turbines would result an estimated 1,196,211 t (or 40% of the facility's total GHG release) of CO_2 to be released to the atmosphere. Currently, this is a conceptual option, pending a better understanding of the timeline and feasibility; which will be further examined during FEED.

10.4.3.4 Comparison of Project Inventory with Provincial Inventory

This section provides a summary of CAC emissions for all sources in NS compared to the total estimated CAC emissions for the proposed natural gas liquefaction plant and marine terminal. Table 10.4-3 compares Project emissions with the NS CAC emissions guidelines (NSE, 2011a).

Table 10.4-3 Comparison of Project Emissions with NS Emissions (Tonnes/Year)

Category	TPM[1]	SO_2	NOx	VOC	CO
Total Project Emissions for Pieridae[2]	401.3	1,021.5	3,078.6	927.5	147.3
NS Total CAC Emissions (2011)	375,982	92,736	65,332	269,784	214,861

Note:
1. TPM - total particulate matter.
2. Value represents estimated hydrocarbon emissions from the proposed Project.

A comparison of total CAC emissions in the Province with estimated emissions from the proposed natural gas liquefaction +t and marine terminal determined that the operation of the Terminal will increase provincial emissions of PM by 0.1%, SO_2 by 1.1%, NO_x by 4.7%, VOCs by 0.3% and CO by 0.07%.

10.4.3.5 Air Dispersion Modeling Methodology

Air quality impacts to both environment and human health are assessed by comparing GLCs of priority pollutants to NS ambient air quality objectives. NS provides objectives for NO_2, SO_2, total suspended particulate and CO for different averaging periods including one hour, 24 hour and annual. The emission rates developed in the previous sections were used in an air dispersion model computer simulation program to predict GLCs at the three closest residential receptors: east of Betty's Cove Brook, Red Head and Webb's Cove. In addition, impacts were predicted at other sensitive receptors farther from the site such as the Isaac's Harbour Villa Seniors Apartments and District Medical Centre.

The specific sources of continuous and intermittent air contaminant emissions during routine operation and upset conditions include the following:

- simple cycle combustion turbines for power supply (continuous);
- compressors (continuous);
- flares (at start up and at emergencies);
- LNG Carrier Ship (continuous); and
- LNG liquefaction plant fugitive emissions (continuous).

The specific air pollutants emitted from some or all of these units that have been evaluated for their impacts consist of the following:

- NO_x, generated when fuel is burned at high temperatures as in a combustion process;
- TSP, PM_{10} and $PM_{2.5}$ are particles found in air including dust, dirt, soot, smoke and liquid droplets;
- SO_2 formed when fuel containing sulphur is burned;
- CO formed from the incomplete combustion of carbon containing fuel; and
- VOCs from process leakage.

Model Description

The AERMOD dispersion model was selected for use in this study. AERMOD was designed to replace the United States Environmental Protection Agency (USEPA) regulatory model ISCST3. In 2005, AERMOD was adopted by USEPA and promulgated as their preferred regulatory model. It is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including, point, area and volume sources).

The specific model inputs for the dispersion model include meteorological data, terrain inputs and the various source emissions data.

The model was configured to assess the operation of the facility at normal operations and during upset conditions.

Five years of sequential hourly meteorological data were used in the AERMOD modelling. A five-year dataset of meteorology statistically covers all wind speed and stability conditions that

are anticipated to occur in the modelled area. The dataset used for the modelling is from the Shearwater and Halifax Airport weather stations for the years from 2007 to 2012.

Meteorological Data

AERMOD requires hourly surface meteorological data for calculating downwind concentrations. The data required for each simulation are:

- wind speed;
- wind direction;
- dry-bulb temperature;
- cloud cover;
- ceiling height;
- station pressure; and
- vertical profiles of temperature, pressure and relative humidity.

The proposed site does not have an on-site station. Therefore, meteorological data used in the analysis consists of 4.5 years (June 2008-2012) of hourly surface observations taken at Halifax and Shearwater weather stations. The Shearwater station is located approximately 160 km southwest of the Pieridae site. The distance from the site supports its spatial representativeness since it places it in the same general synoptic flow regime as well as most mesoscale systems. The Shearwater station is also located in a similar geographic setting as the Pieridae site being situated on the northeastern portion of an inlet and about 5 km north of the southeastern NS coastline. This is the station located closest to the Pieridae site that monitors most of the meteorological parameters required for the AERMOD model. The Shearwater station collects the following information: wind direction, wind speed, dry bulb temperature, relative humidity and station pressure. The meteorological file was supplemented with ceiling height and cloud opacity data from the Halifax Airport weather station which is located 20 km to the north of the Shearwater station.

The aforementioned meteorological data are processed using the AERMET pre-processor program along with the definition of the surface characteristics within the modeling domain. These surface characteristics of albedo (i.e., ratio of reflected to incident solar radiation), Bowen ratio (i.e., ratio of sensible latent heat fluxes from the earth's surface) and surface roughness length (i.e., height above ground at which the mean wind speed becomes zero) are specified by season as a function of distance and direction from the Pieridae site based on land use information and the AERMOD User's Guide recommended values of these parameters.

Upper air sounding data was developed by the Preprocessor AERMET. The specific parameters obtained from the station are provided in Table 10.4-4.

Table 10.4-4 Meteorological Stations

Type of Station	Surface Station	Surface Station
Station Name:	Shearwater	Halifax Airport
Location:	Shearwater, NS	Halifax, NS
Years:	June 2008 – 2012	2008 – 2012
Parameters:	• Wind Speed. • Wind Direction. • Temperature. • Pressure. • Relative Humidity.	• Ceiling Height. • Cloud Cover.

Source: EC, 2013c

Meteorological data for AERMOD was processed with the most recent release of the AERMET meteorological pre-processor AERMET. The major purpose of AERMET is to calculate boundary layer parameters for use by AERMOD. A meteorological interface module, internal to AERMOD, uses these parameters to generate profiles of the needed meteorological variables.

Emissions Source Data

The source data required to run the model include the following parameters for each source: the physical location of the emission point, physical stack height, stack inside diameter, stack gas exit velocity, stack gas temperature and the mass emission rates of each pollutant.

The parameters for the source exhaust stacks used in the modelling study are presented in Table 10.4-5.

Table 10.4-5 Source Parameters for Natural Gas Liquefaction Plant and Marine Terminal Site

Location	Source UTM X Coordinate (m)	Source UTM Y Coordinate (m)	Stack Base Elevation (m)	Stack Diameter (m)	Stack Height (m)	Gas Velocity (m/s)	Gas Temperature (K)
Incinerator for Acid Gas #1	607930	5002341	21.6	4.75	40	40	530
Incinerator for Acid Gas #2	607915	5002341	21.6	4.75	40	40	530
Compressor #1	607925	5002341	21.6	4.75	50	17.4	530
Compressor #2	607935	5002341	20.6	4.75	50	17.4	530
Compressor #3	607945	5002341	21.6	4.75	50	17.4	530
Compressor #4	607955	5002341	21.5	4.75	50	17.4	530
Gas Turbine #1	608198	5002139	15.6	3.4	40	40	530
Gas Turbine #2	608205	5002341	20	3.4	40	40	530
Gas Turbine #3	608210	5002341	20	3.4	40	40	530

Location	Source UTM X Coordinate (m)	Source UTM Y Coordinate (m)	Stack Base Elevation (m)	Stack Diameter (m)	Stack Height (m)	Gas Velocity (m/s)	Gas Temperature (K)
Gas Turbine #4	608215	5002139	15.6	3.4	40	40	530
Gas Turbine #5	608220	5002139	15.6	3.4	40	40	530
Gas Turbine #6	608225	5002139	20	3.4	40	40	530
BOG Flare #1	607650	5002564	28	0.05	120	40.7	820
BOG Flare #2	607787	5001350	1	0.05	120	40.7	820
Wet Flare #1	607900	5001273	1	0.05	120	40.7	820
Wet Flare #2	607905	5001273	1	0.05	120	40.7	820
Dry Flare #1	607557	5002509	26.3	0.05	120	40.7	820
Dry Flare #2	607662	5002509	26.2	0.05	120	40.7	820
HP Flare #1	607650	5002564	28	0.05	120	40.7	820
HP Flare #2	607655	5002564	28	0.05	120	40.7	820
Emergency Diesel Generator	608190	5002139	15.6	0.4	40	55	440
LNG Carrier Ship #1	606315	5000621	0	0.8[(2)]	30[(2)]	20.7[(3)]	423[(3)]
LNG Carrier Ship #2	606215	5000621	0	0.8[(2)]	30[(2)]	20.7[(3)]	423[(3)]

Notes:
1. K - Kelvin.
2. Dillon, 2008b
3. Dillon 2007a

Source data for the Incinerator for Acid Gas Removal, Refrigerant Compressor Gas Turbine, Power Generation Gas Turbine, Pilot/Purge Gas Flares and Emergency Diesel Generator Set sources was obtained from the 2013 document 185352-000-SE-LS-00001 Emissions List developed by CB&I for the Project (CB&I, 2013f). Source data for the LNG carrier ship auxiliary diesel generators used for hoteling was obtained from the Wartsila manufacturer website. Table 10.4-6 provides a list of particulate emission rates for each source.

Table 10.4-6 Emission Rates for Natural Gas Liquefaction Plant and Marine Terminal Site[(1)]

Location	PM	NO_2	CO	SO_2	VOCs	$PM_{2.5}$
Incinerator for Acid Gas #1	na	1.37	1.14	21	na	na
Incinerator for Acid Gas #2	na	1.37	1.14	21	na	na
Compressor #1	0.34[(2)]	17.4	4.25	na	1.2	0.0027[(2)]
Compressor #2	0.34[(2)]	17.4	4.25	na	1.2	0.0027[(2)]
Compressor #3	0.34[(2)]	17.4	4.25	na	1.2	0.0027[(2)]
Compressor #4	0.34[(2)]	17.4	4.25	na	1.2	0.0027[(2)]
Gas Turbine #1	1.19[(3)]	9.7	1.75	na	0.5	0.84[(3)]
Gas Turbine #2	1.19[(3)]	9.7	1.75	na	0.5	0.84[(3)]
Gas Turbine #3	1.19[(3)]	9.7	1.75	na	0.5	0.84[(3)]
Gas Turbine #4	1.19[(3)]	9.7	1.75	na	0.5	0.84[(3)]
Gas Turbine #5	1.19[(3)]	9.7	1.75	na	0.5	0.84[(3)]
Gas Turbine #6	0.36[(3)]	2.9	0.53	na	0.2	0.25[(3)]
BOG Flare #1	0.391[(4)]	0.102	3	na	20	0.391[(3)]
BOG Flare #2	0.391[(4)]	0.102	3	na	20	0.391[(3)]
Wet Flare #1	0.391[(4)]	0.102	3	na	20	0.391[(3)]
Wet Flare #2	0.391[(4)]	0.102	3	na	20	0.391[(3)]
Dry Flare #1	0.391[(4)]	0.102	3	na	20	0.391[(3)]
Dry Flare #2	0.391[(4)]	0.102	3	na	20	0.391[(3)]
HP Flare #1	0.391[(4)]	0.102	3	na	20	0.391[(3)]
HP Flare #2	0.391[(4)]	0.102	3	na	20	0.391[(3)]
Emergency Diesel Generator	0.24[(5)]	4.01	0.3	na	0.16	0.24[(4)]
LNG Carrier Ship #1	0.95	15.4[(6)]	1.47[(4)]	5.7[(6)]	0.53[(4)]	0.31[(4)]
LNG Carrier Ship #2	0.95	15.4[(6)]	1.47[(4)]	5.7[(6)]	0.53[(4)]	0.31[(4)]

Notes:

1. All values in grams per second (g/sec)
2. Emission rate calculated using USEPA AP-42 emission factors for natural gas fired reciprocating engines (USEPA, 2004 and 2006).
3. Emission rate calculated using USEPA AP-42 emission factors for natural gas combustion engines.
4. Emission rate are sourced from Dillon (2007a).
5. Emission rate calculated using USEPA AP-42 emission factors for large stationary diesel and all stationary dual fuel engines (USEPA 2004 and 2006).
6. Calculated based on IMO Tier 1 and Wartsila 32 Engine Product Guide. SO_2 emission rate based on a sulphur limit of 1% in weight in fuel.

Terrain Data

The area surrounding the site can be characterized as rural in nature with very little industrial activity with the exception of the metering station. The Pieridae site terrain elevations vary from sea level to 75 m above sea level. Nearby hills are most prominent to the northwest and north of the site while areas to the east, southeast, south, and southwest are generally flat to gently

rolling that do not exceed 60 m above sea level. The terrain elevations reach 100 m at a distance of about 5,000 m from the site to the north, 120 m at a distance of approximately 8,000 m to the northwest, and 150 m at a distance of approximately 12,000 m to the northwest and north. The highest elevation within 20 km of the site is 200 m at a distance of approximately 20 km to the northwest.

The modelling domain in terms of receptor grid development is selected such that the impacts of both the low level and elevated facility emissions are correctly estimated and are relevant for the analysis. The topography of the Project site and modelling domain are obtained using digital topographic data for the site region.

The UTM coordinate system is used to generate a Cartesian receptor grid starting at the centre of the LNG facility and extending out to a distance as needed such that the maximum air impacts are captured by the modelling runs. A grid spacing of 1000 m was used from the Pieridae property boundary out a distance of 12 km each direction so that a 25 km Cartesian grid was developed. Sensitive receptors were placed at the three closest residences: east of Betty's Cove Brook, and to the west of the proposed facility at Red Head and Webb's Cove. In addition, impacts were predicted at other sensitive receptors farther from the site such as the Isaac's Harbour Villa Seniors Apartments and District Medical Centre.

The topographic elevations for the receptors in the modelling domain are developed using the AERMAP pre-processor along with Digital Elevation Model equivalent terrain files covering the modelling domain.

Building Downwash

The model was configured to evaluate the effects of aerodynamic wakes and eddies that can be formed by a building on exhaust plume dispersion. The building downwash program was used to calculate direction-specific building wake effect concentrations on plumes exiting the stacks on-site. The program determined dominant downwind structures and maximum expected widths for each dominant structure for a 10-degree radial wind direction increment. All buildings with stacks were included in the model. Table 10.4-7 provides a summary of building dimensions for each source.

Table 10.4-7 Building Characteristics

PM	Quantity	Dimensions[1]
Power generation	6	28 m (L) x 21 m (W) x 13 m (H)
Refrigerant Compressor	4	28 m (L) x 20 m (W) x 13 m (H)
Tanks	3	82.5 m (Diameter) x 45 m (H)
Ship	2	290 m (L) x 43 (W) x 26 m (H)
Control Building	1	37 m (L) x 27 m (W) x 8 m (H)

Note:
1. L = length, W = width, H = height.

Air Dispersion Modelling Results

Table 10.4-8 provides a summary of predicted air dispersion modelling results compared to the NS ambient air quality objectives. The aerial distribution of modelled GLCs is presented for all parameters in Appendix N. The two parameters that come closest to regulatory guidelines NO_2 and SO_2) are depicted in Figures 10.4-1 through 10.4-8.

Table 10.4-8 Dispersion Modeling Results – Maximum Ground Level Concentrations (GLCs)

Pollutant	Averaging Time Period	Normal Conditions Location with the Highest Predicted GLC	Upset Conditions Location with the Highest Predicted GLC	NS Objectives
NO_2 (µg/m^3)	1 hour	318.7 (606425,5000841)	318.7 (606425,5000841)	400
	Annual	30.8 (606425,5000841)	-	100
SO_2 (µg/m^3)	1 hour	679 (606425,5000841)	679 (606425,5000841)	900
	24 hour	182.2 (606425,5000841)	182.2 (606425,5000841)	300
	Annual	27.3 (606425,5000841)	-	60
TSP (µg/m^3)	24 hour	30.4 (606425,5000841)	30.4 (606425,5000841)	120
	Annual	4.6 (606425,5000841)	-	70
$PM_{2.5}$ (µg/m^3)	24 hour	9.9 (606425,5000841)	9.9 (606425,5000841)	30[1]
CO (µg/m^3)	1 hour	175.1 (606425,5000841)	175.1 (606425,5000841)	34, 600
	8 hour	86.9 (606425,5000841)	86.9 (606425,5000841)	12,700

Note:
1. CCME, 2000

A comparison of maximum GLCs results with NS objectives indicates that all results are well within the objectives for NO_2, SO_2, CO and TSP and the CWS for $PM_{2.5}$.

Table 10.4-9 provides a summary of predicted air dispersion modelling results for the sensitive receptors located around the site. These results are compared to the NS ambient air quality objectives.

A comparison of highest results for the east of Betty's Cove sensitive receptor indicates that all results are well within the NS objectives for NO_2, SO_2, CO and TSP and the CWS for $PM_{2.5}$.

Table 10.4-9 Dispersion Modeling Results

Pollutant	Averaging Time Period	Sensitive Receptor Location (Betty's Cove) with the Highest Predicted GLC	NS Objectives
NO_2 (µg/m^3)	1 hour	175.6 (608666,5000934)	400
	Annual	4.9 (608666,5000934)	100
SO_2 (µg/m^3)	1 hour	150.3 (608666,5000934)	900
	24 hour	25.2 (608666,5000934)	300
	Annual	1.6 (608666,5000934)	60
CO (µg/m^3)	1 hour	70.6 (608666, 5000934)	34,600
	8 hour	21.4 (608666, 500934)	12,700
TSP (µg/m^3)	24 hour	23 (608666,5000934)	120
	Annual	3.6 (608666,5000934)	70
$PM_{2.5}$ (µg/m^3)	24 hour	2.1 (608666,5000934)	30[(1)]

Note:
1. CCME, 2000

Modelling was also performed for gas leakage from valves, fittings, storage tanks, vents, etc. that occurs during natural gas liquefaction processing. Since benzene is present in the feedgas and it has the lowest criterion compared to all other possible feed gas VOCs, it was the chosen parameter to model. Using a concentration of 50 ppmv in the feed gas, an emission rate of 0.0041 g/s of benzene was developed. AERMOD was run with the same configuration as for the priority pollutants and the site was treated as area source for benzene. The predicted concentration of benzene at the site boundary is 0.8 µg/m^3 for a one hour period, 0.3 µg/m^3 for a 24 hour period, and 0.008 µg/m^3 for an annual period. A literature search for available regulatory values for benzene in Canada determined that Health Canada provides a reference value of inhalation of 3 µg/m^3 for an annual period; Quebec has an objective of 10 µg/m^3 for a 24 hour period; and Alberta has an objective of 30 µg/m^3 for a one hour period. All benzene results are below their respective guidelines.

GLCs Combined with Background Levels

Continuous monitoring for NO_2, SO_2 and TSP was conducted in Seal Harbour from June 10, 2004, through August 10, 2004. There are no other longer term background air quality data available that are representative of this area.

The highest monitored 24-hour NO_2 concentration during this two month period was approximately 2.0 parts per billion (ppb) and the highest SO_2 value was 4.0 ppb.

An assessment of combined impacts on local air quality was performed by adding the predicated dispersion modelling results from the location with the highest predicted annual average ground level concentration to the air monitoring data obtained at the in 2004 for the NO_2, SO_2, and TSP parameters, and then comparing the calculated values to the NS ambient air quality objectives. Refer to Table 10.4-10 for a summary of estimated cumulative impacts for locations with the highest average annual GLCs.

Table 10.4-10 Assessment of Cumulative Effects

Pollutant	Averaging Time Period	Goldboro Monitoring Results (A)	Highest Annual GLCs (B)	Cumulative Impacts (A) + (B)	NS Annual Objectives
NO_2 (µg/m^3)	Annual	3.8(1)	30.8	44.6	100
SO_2 (µg/m^3)	Annual	10.5(1)	25.6	33	60
TSP (µg/m^3)	Annual	19.8(2)	4.6	24.4	70
CO (mg/m^3)	1 hour	na	-	na	na

Notes :
1. The values are an average for a two month period and were measured in 2004.
2. TSP value is representative of the highest 24 hour result obtained over a two month period in 2004 at a location near the SOEI gas plant.

A comparison of the calculated combined impact numbers indicates that all values are lower than the NS annual objectives. A review of the air monitoring results determined that for the NO_2 and SO_2 parameters, the source that is contributing the most to the highest GLCs is emissions from the LNG Carrier while it is hoteling in port. It should be noted that these predicted results are conservative since by the time the facility is complete and in operation that new international regulations for marine engines will require an 80% reduction in NO_x emissions compared to the emission rates used in this dispersion modelling study.

10.4.4 Effects of Decommissioning

Air impacts during decommissioning would be expected to be comparable to construction-related air impacts.

10.4.5 Mitigation

Mitigation will be required for a number of potential effects described above, including:

- fugitive dust emissions from activities such as site preparation, grading and vehicle traffic during construction periods and the decommissioning phase, which will also include demolition activities;
- impacts to the air shed from exhaust emissions from LNG Carrier ships, compressors, gas turbines and flares, during operation of the natural gas liquefaction plant and marine terminal; and
- contribution of GHG to the atmosphere, particularly a significant volume of CO_2.

The proposed mitigation for fugitive dust and exhaust emissions in the local air shed are described below for construction and operation. Mitigation for GHG emissions are discussed separately (Section 10.4.5.4) and are relevant to all Project phases. The proposed mitigation for potentially global impacts of climate change is discussed further in Section 10.18 and Section 10.19.

10.4.5.1 Mitigation during Construction Phase

In conducting site construction operations, Pieridae will:

- require contractors meet all provincial air quality regulations and emission standards applicable to their equipment. All construction equipment should be properly maintained to ensure exhaust emissions are typical for each piece of equipment; and Apply water or dust suppressants to disturbed areas, as necessary, to reduce vehicle traffic dust;
- cover open hauling trucks with tarps, as necessary;
- use paved roads for construction vehicle traffic, wherever practical;
- use best practices to limit track out onto paved sections;
- limit vehicle speeds as required to reduce dust generation;
- respond promptly to any significant particulate emission concerns that occur during construction by evaluating the source of emissions and ensuring all practicable mitigation measures are being implemented; and
- upon completion of construction activity, stabilize disturbed areas.

10.4.5.2 Mitigation during Operation Phase

During operation of the facility, Pieridae will implement the following measures to minimize air quality effects:

- All equipment used on-site is to be properly maintained to ensure exhaust emissions are typical for each piece of equipment.
- Conform to current and future regulated emissions standards for state of the art natural gas combustion engines.
- Conform to normal industry practices that are known to reduce emissions such as the use of auxiliary engines for LNG tanker hoteling. It is noted that the International Marine

Organization has developed limits for NO_x, SO_x and VOCs. In 2016, marine diesel engines are required to reduce NO_x levels by 80% compared to the levels that marine engines emit prior to 2010.

- On-going CAC monitoring during operation to confirm effects predictions of the dispersion modeling and to document compliance.

10.4.5.3 Mitigation during Decommissioning Phase

Air impacts during decommissioning would be expected to be comparable to construction-related air impacts. Mitigation measures proposed for the construction phase therefore generally also apply to the decommissioning phase.

10.4.5.4 Mitigation/Off-Sets for Greenhouse Gas (GHG) Emissions during All Phases

The provincial guidance describes two types of responses to climate change: mitigation and adaptation (NSE, 2009a). Adaptation relates to potential impacts of climate change on the Project, and is discussed in detail in Section 10.18, below. Mitigation aims to avoid, reduce or at least limit climate change by reducing GHG emissions through: energy efficiency, the use of renewable energy, capturing/storing GHG emissions, and the development of "carbon 'sinks" (e.g., forests and wetlands).

The Province of NS has capped GHG emissions under the *Greenhouse Gas Emission Regulations* (NS Reg, 260/2009) and this provincial cap will be 26.32 million metric tonnes (MMt) CO_2e in 2014 reducing to 7.5 MMt CO_2e in 2020 and potentially to 4.5 MMt CO_2e by 2030 (EC, 2013d).

With the exception of the LNG Carriers' diesel engines and the emergency diesel generator set for the site, all other Project components involving combustion processes are fuelled by natural gas. The use of natural gas will result in approximately a 37% reduction in GHG emissions when compared to the use of Bunker C fuel for the Project.

Assessment and quantification of opportunities both to maximize energy efficiencies and reduce GHG emissions will be a key objective during FEED. Pieridae is committed to continue efforts to reduce GHG emissions during operation. Further, for such GHG emissions that cannot not be further mitigated, Pieridae commits to developing and implementing strategies to offset the emissions by investing in designated GHG offset projects within the province. This would be done in close consultation with the NSE Climate Change Directorate and in support of identified Provincial initiatives. The MODG would also be consulted in order to investigate future opportunities for energy synergies and potentials for sharing of utilities among industrial park users. Overall, Pieridae's efforts to GHG management will involve:

GHG Management Plan

During FEED, a GHG Management Plan will be developed. This plan will:

- detail the inventory of the Project's GHG sources as a baseline for further action and reduction assessment;
- detail the control equipment and measures for air emissions and ensure that all reasonable measures are taken to minimize air emissions (and with it GHG emissions);
- evaluate the technical feasibility and marginal cost structure of potential process and energy efficiency technologies and investigate opportunities for maximizing energy efficiencies through selection of high efficiency equipment and operating procedures minimizing energy usage);
- evaluate alternative power supply options;
- identify opportunities for cooperation with potential future industries in the Goldboro Industrial Park (e.g., sharing of utilities, utilization of waste heat by other businesses);
- develop GHG offset strategies (see separate discussion below);
- establish operating procedures and protocols for relevant land based and marine operations that minimize GHG emissions (e.g., minimize the use of flaring; hoteling LNG Tankers to run low emissions auxiliary diesel engines during time at jetty);
- design a monitoring plan for an evaluation of the effectiveness of GHG related mitigative measures including specific operating procedures and protocols; and
- establish an internal auditing, reporting and adaptive management mechanism that ensures the plan's implementation and that corrective action is taken if required.

It is envisaged that Pieridae will review and update its GHG Management Plan annually in order to ensure that as new technologies are developed, these are considered for application in the Project's operation. Technical solutions are not expected to become available over the short term but will need to be phased in for the various components and operations as they become available and as regulatory requirements change. Further, the Plan will facilitate close contact with the NSE and the NSE Climate Change Directorate for routine reviews of and updates to Pieridae's commitments to GHG reduction and off-set measures (see below).

As part of the GHG Management Plan, Pieridae will define the GHG emissions estimation techniques to be employed for the duration of the Project. All Project related GHG emissions will be reported annually to NSE.

GHG Emission Off-sets

Pieridae anticipates that despite all efforts to maximize efficiencies and minimize energy fuel consumption, the Project, within the context of the NS emissions cap, will remain a significant source for GHG emissions. By exporting natural gas to markets in Europe and Asia, other oil and coal based energy uses are likely going to be replaced by natural gas. While this has the potential to reduce GHG emissions in the context of those markets and could be seen as a global off-set this will not affect absolute emissions within the province of NS. As such, Pieridae is committed to undertake or contribute to additional provincial programs aimed at off-setting the anticipated GHG emissions of the Project.

Governments on both the provincial and federal level are working closely together to develop technical and policy approaches to manage GHG emissions from the oil and gas sector and to identify and facilitate mitigation and approaches to off-sets. Currently most of the present provincial legislative drivers related to offset projects have been linked to projects in Alberta or Quebec; the exception being some landfill gas and energy efficiency projects. At this point the only provincial government guidance that could govern Pieridae's efforts to off-set Project GHG impacts is Bill 38, the *Voluntary Carbon Emissions Offset Fund Act* which received Royal Assent in 2010 but has not yet come into force. This Act establishes both the Nova Scotia Voluntary Carbon Emissions Offset Fund and defines "emissions offset" as an emissions credit used by an individual, business, organization or government to offset an equivalent GHG emission originating in a reportable inventory that is not the inventory in which the credited emissions reduction is realized.

As a consequence, Pieridae commits to develop, in close consultation with NSE, the Climate Directorate, and, if appropriate, the Municipality, off-set strategies. This will be conducted as part of the above described GHG Management Plan. Pieridae has been in consultation with NSE and the Climate Change Directorate and will continue to engage regulators during both FEED and during Project operation as GHG emissions are expected to remain an ongoing concern. No particular preferences have been identified and all options for off-sets that are currently discussed for the oil and gas industry will be considered. Pieridae's ultimate off-set scheme may focus on one of these or a combination of several and may also evolve over time as opportunities arise and policies are being developed. Potential off-set schemes involve:

- partnership in provincial alternative or clean energy projects;
- assistance to Efficiency Nova Scotia;
- contribution to a technology research fund;
- assessment of opportunities for technological innovation including carbon capture and storage;
- contribution to carbon "sinks" (e.g., tree plantings at the site / region);
- trading in off-sets as allowed either under the current voluntary market or established trading markets;
- contributions to carbon reductions elsewhere in the province;
- support for Project under the Climate Change Adaptation Fund; and
- support for policy development for oil and gas sector.

10.4.6 Summary and Residual Effects

Overall effects on air quality in the local air shed during the Project's construction and operation phase are not expected to be significant. In order to assess potential impacts to the air shed, ambient air monitoring for NO_2 is recommended for one month during the operation of the facility at full capacity. Over the last 20 years regulations on internal combustion engines have become increasingly stricter, resulting in a significant lowering of priority pollutants in engine exhaust. This trend is expected to continue. The Project will use state of the art equipment that will conform to industry emissions standards, as these standards are developed in the future

with the intention to further reduce emissions as new emissions reducing technologies become available. In addition the primary fuel source for combustion in the power plant and LNG compressors is natural gas; which is a much cleaner burning fuel than other potential options. Production of GHGs by the Project, particularly CO_2, has been minimized to the extent possible through specific design and planning. Pieridae is committed to develop and implement measures to contribute to the off-setting of GHG emissions in NS.

Table 10.4-11 summarizes the residual environmental effects for air quality.

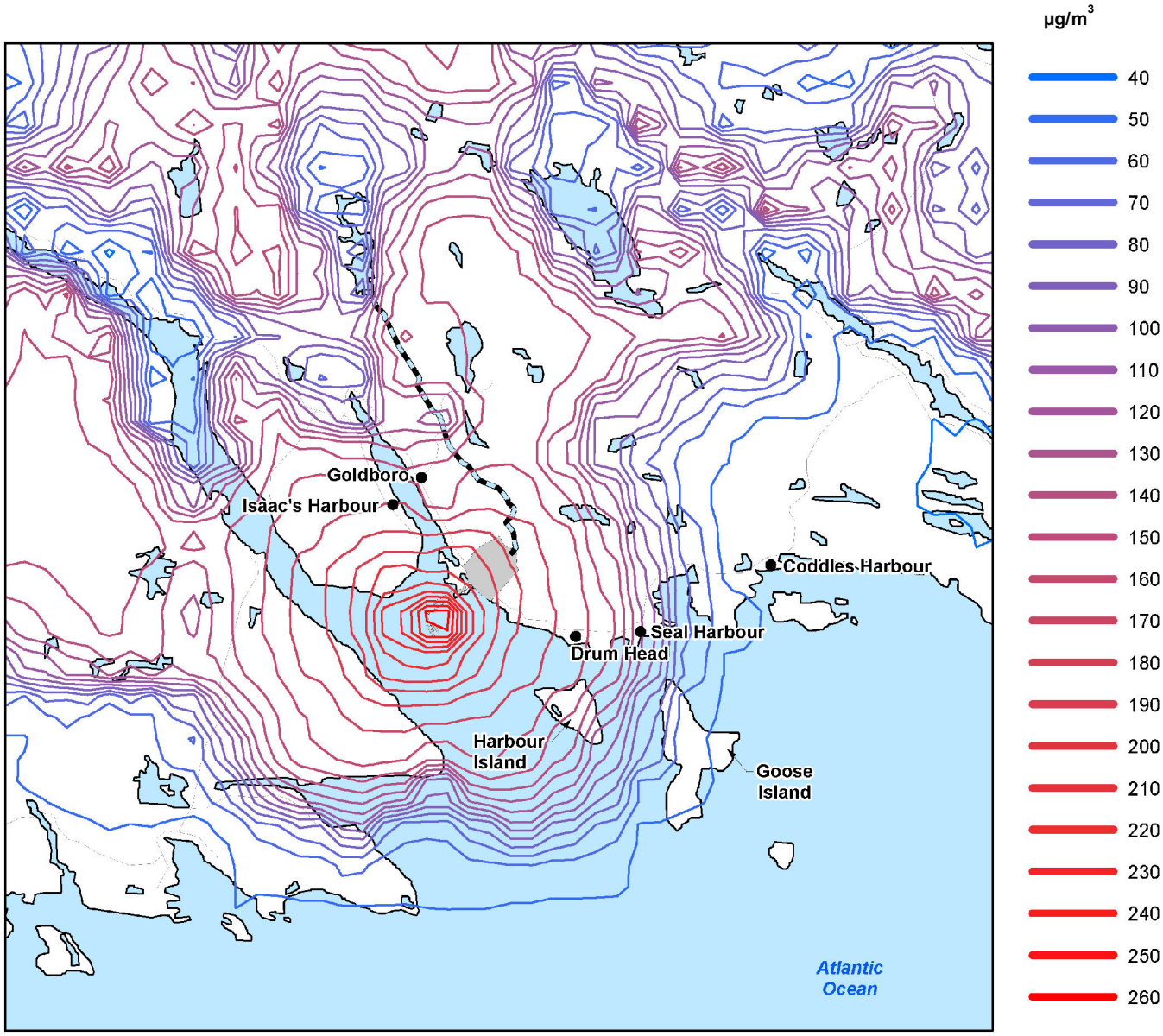
Table 10.4-11 Residual Environmental Effects Summary for Air Quality and Climate Change (GHG)

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Emissions of gaseous pollutants from the use of internal combustion engines in various equipment and worker commuting vehicles.	A	• Maintaining vehicles and equipment in good working condition. • Maintaining speed restrictions on roads. • Promote car pooling.	Low	Construction envelope plus adjacent lands and transport routes.	Construction Phase	R	• Rural setting; sparsely populated; nearest residential receptors at 300 to 800 m off-site.	Minimal
Fugitive dust emissions from activities such as demolition, site preparation, grading and vehicle traffic. Wind erosion of displaced soil may also generate fugitive dust emissions prior to paving or revegetation.	A	• Application of water or dust suppressants. • Covering of haul trucks. • Use of paved roads to the extent possible. • Limiting vehicle speed. • Stabilizing disturbed areas.	Low	Construction envelope plus adjacent lands.	Construction Phase	R	• Rural setting; sparsely populated; nearest residential receptors at 300 to 800 m off-site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Operation								
Emissions to air from hoteling of LNG Carrier ships, natural gas compressors, natural gas power turbines, flares, process leakage.	A	• All equipment used on-site is to be properly maintained to ensure exhaust emissions are typical for each piece of equipment. • Equipment will conform to current and future regulated emissions standards for state of the art natural gas combustion engines. • Conform to normal industry practices that are known to reduce emissions such as the use of auxiliary engines for container vessel hoteling. • On-going CAC monitoring during operation to confirm effects predictions of the dispersion modelling and to document compliance.	Low (all within applicable regulatory standards).	Nearest receptor	Operation phase Infrequent occurrences short duration	R	• Rural setting; sparsely populated; nearest residential receptors 300 to 800 m off site; designated and approved industrial reserve.	Minimal
Combined emissions within local air shed	A	• Mitigation measures are the same as those listed for other potential air quality impacts during operations.	Low (levels all within applicable regulatory standards).	Regional	Operation phase	R	• Rural setting; sparsely populated; nearest residential receptors 300 to 800 m off site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Project contribution to GHG emissions (CO_2).	A	• GHG management plan (long-term reduction commitment). • Use high efficiency equipment and "low carbon" natural gas fuel. • LNG Tankers run low emissions auxiliary diesel engines at jetty. • On-going air quality monitoring. • Mitigation measures for other emissions above also apply to GHGs. • Restore carbon sink capacity by wetland compensation and planting trees. • Development of/ contribution to GHG emission offsets.	High; (Represents increase of provincial emissions by 15%). Low: (Represents increase of Canadian emmissions by 0.5%)	Global	All phases	R	• GHGs already represent a significant impact due to large contributions by industrialized countries, and particularly the US and China.	Major (Provincially) Minor (Globally; potentially no impact at all).

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0



Nova Scotia Objectives for NO_2 : 1hr-100 µ/m ^{3}/ Annual -400 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG — ENVIRONMENTAL ASSESSMENT	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: **NO_2 ANNUAL NORMAL (µg/m^3)**	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
	PROJECT NO: TV121039		FIGURE NO: 10.4-1

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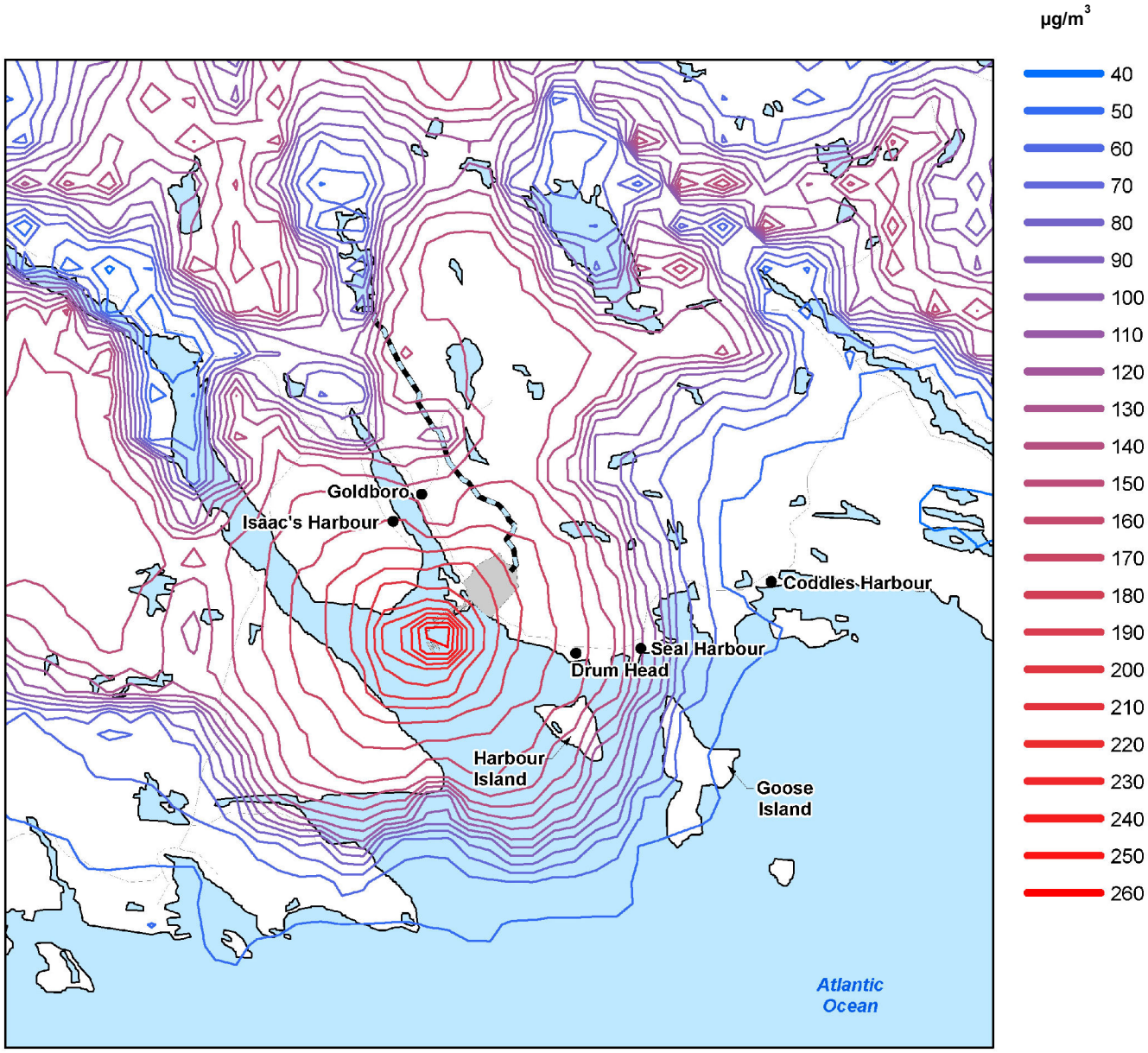

Nova Scotia Objectives for NO_2 : 1hr-100 µ/m ^{3}/ Annual -400 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG **ENVIRONMENTAL ASSESSMENT**	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: **NO_2 1 HOUR NORMAL (µg/m^3)**	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
	PROJECT NO: TV121039		FIGURE NO: 10.4-2

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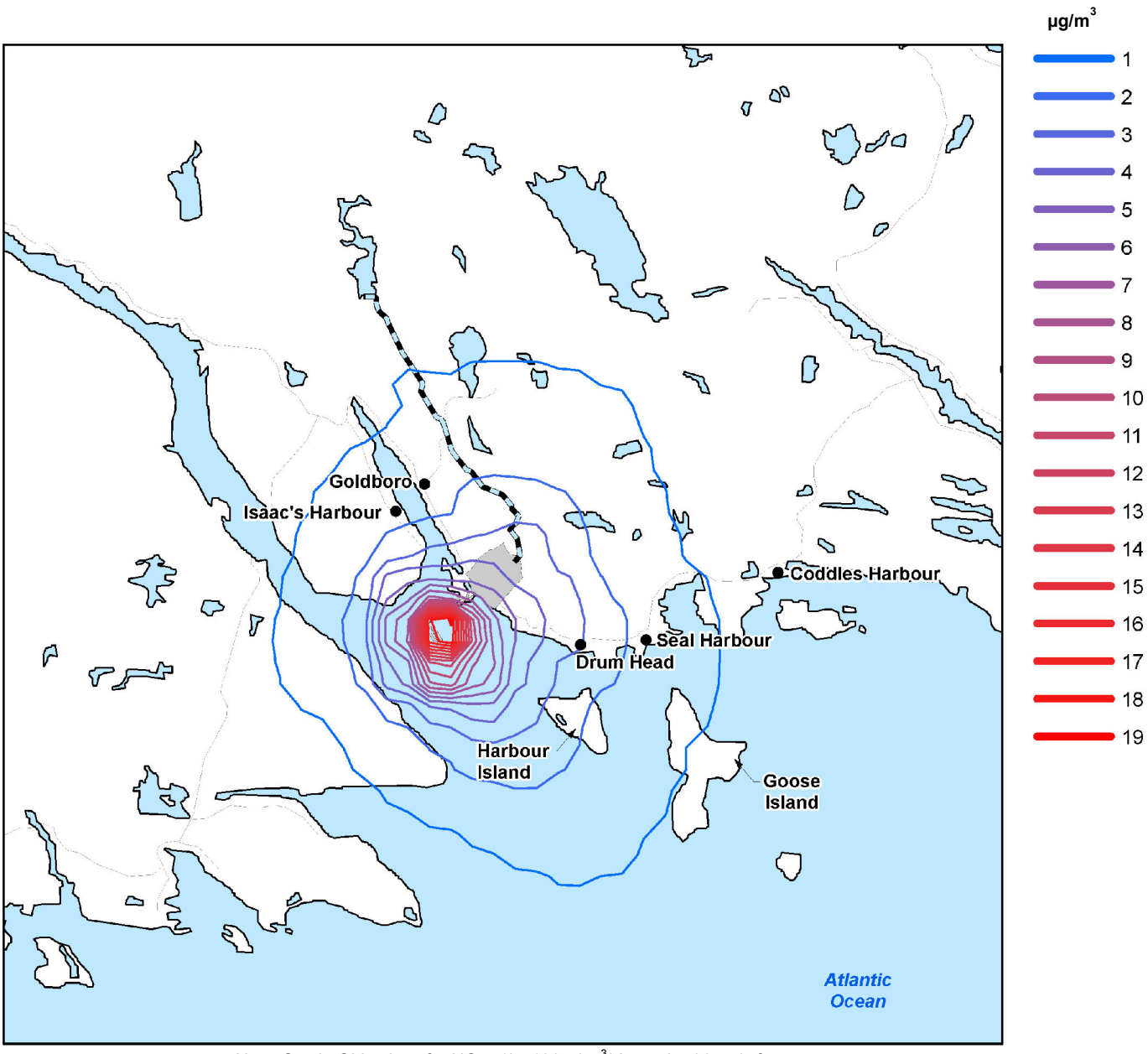

Nova Scotia Objectives for NO_2 : 1hr-100 µ/m ^{3}/ Annual -400 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG **ENVIRONMENTAL ASSESSMENT**	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: **NO_2 1 HOUR UPSET (µg/m^3)**	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
	PROJECT NO: TV121039		FIGURE NO: 10.4-3

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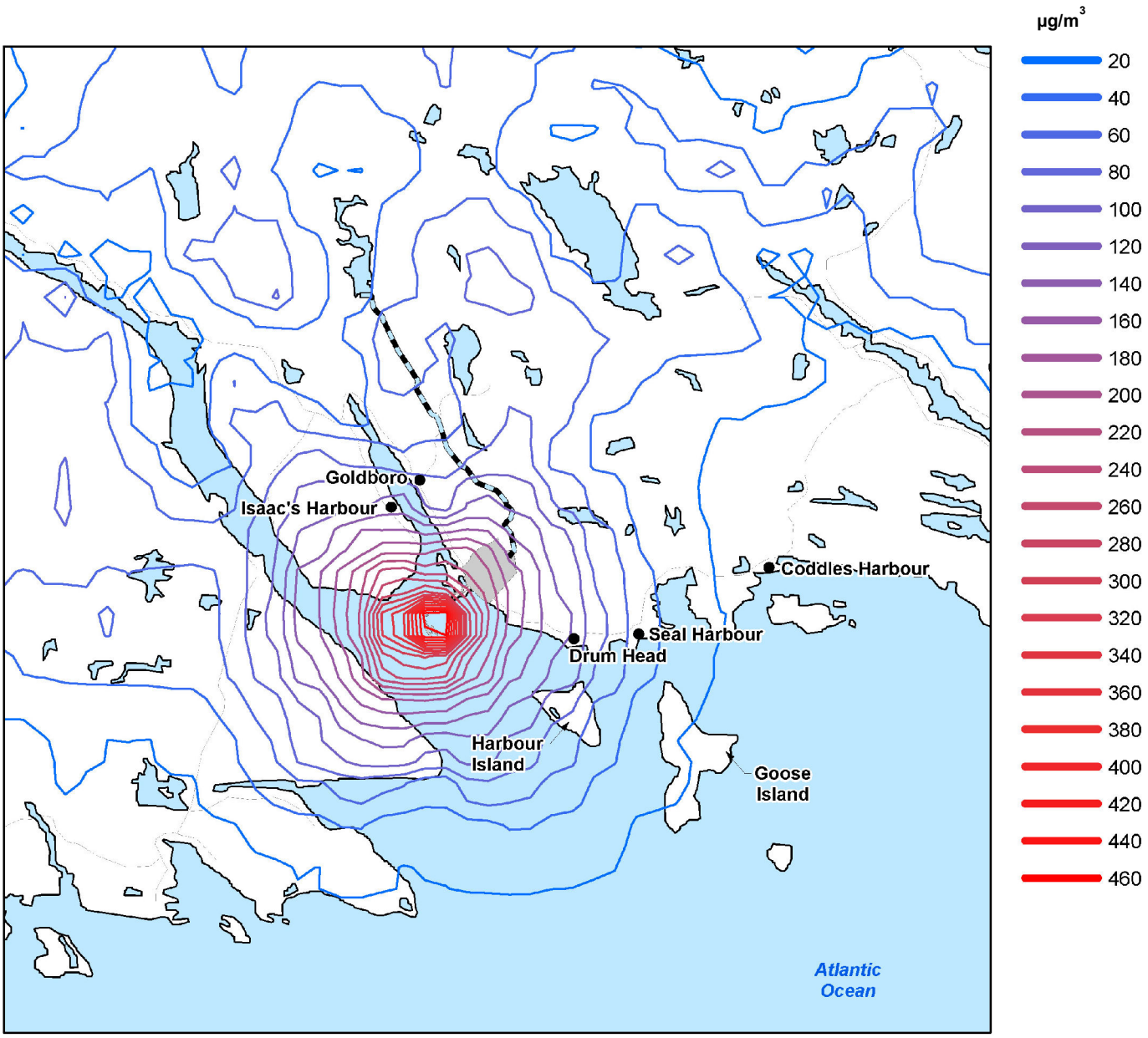

Nova Scotia Objectives for SO_2 : 1hr-900 µ/m ^{3}/ 24hr-300 µg/m³/ Annual -60 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG ENVIRONMENTAL ASSESSMENT	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20 PROJECTION: NAD83 PROJECT NO: TV121039	TITLE: **SO_2 1 HOUR NORMAL (µg/m^3)**	DATE: Aug 2013 REV. NO: FIGURE NO: 10.4-4

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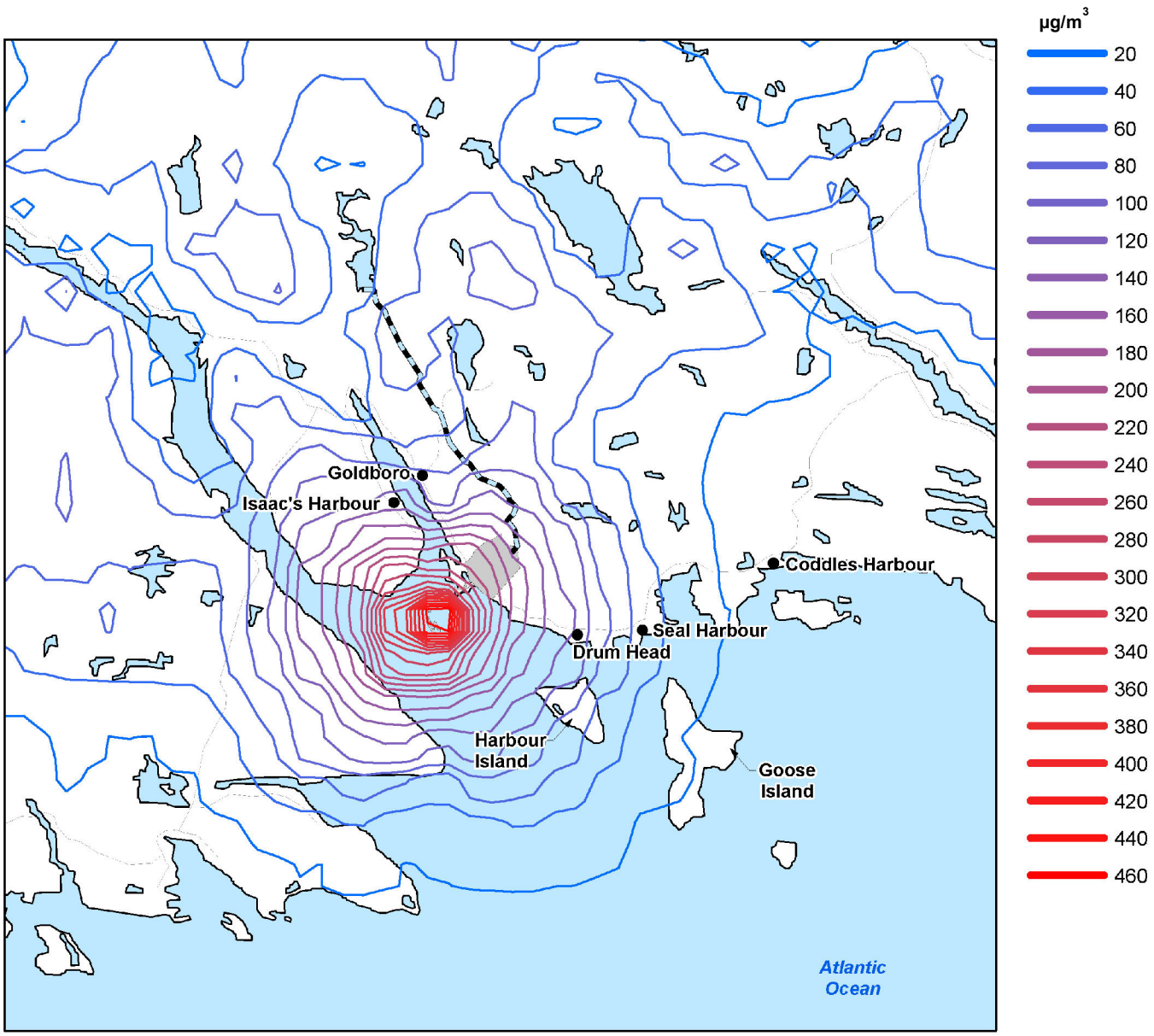

Nova Scotia Objectives for SO_2 : 1hr-900 µ/m ^{3}/ 24hr-300 µg/m³/ Annual -60 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG **ENVIRONMENTAL ASSESSMENT**	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: **SO_2 1 HOUR UPSET (µg/m^3)**	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
	PROJECT NO: TV121039		FIGURE NO: 10.4-5

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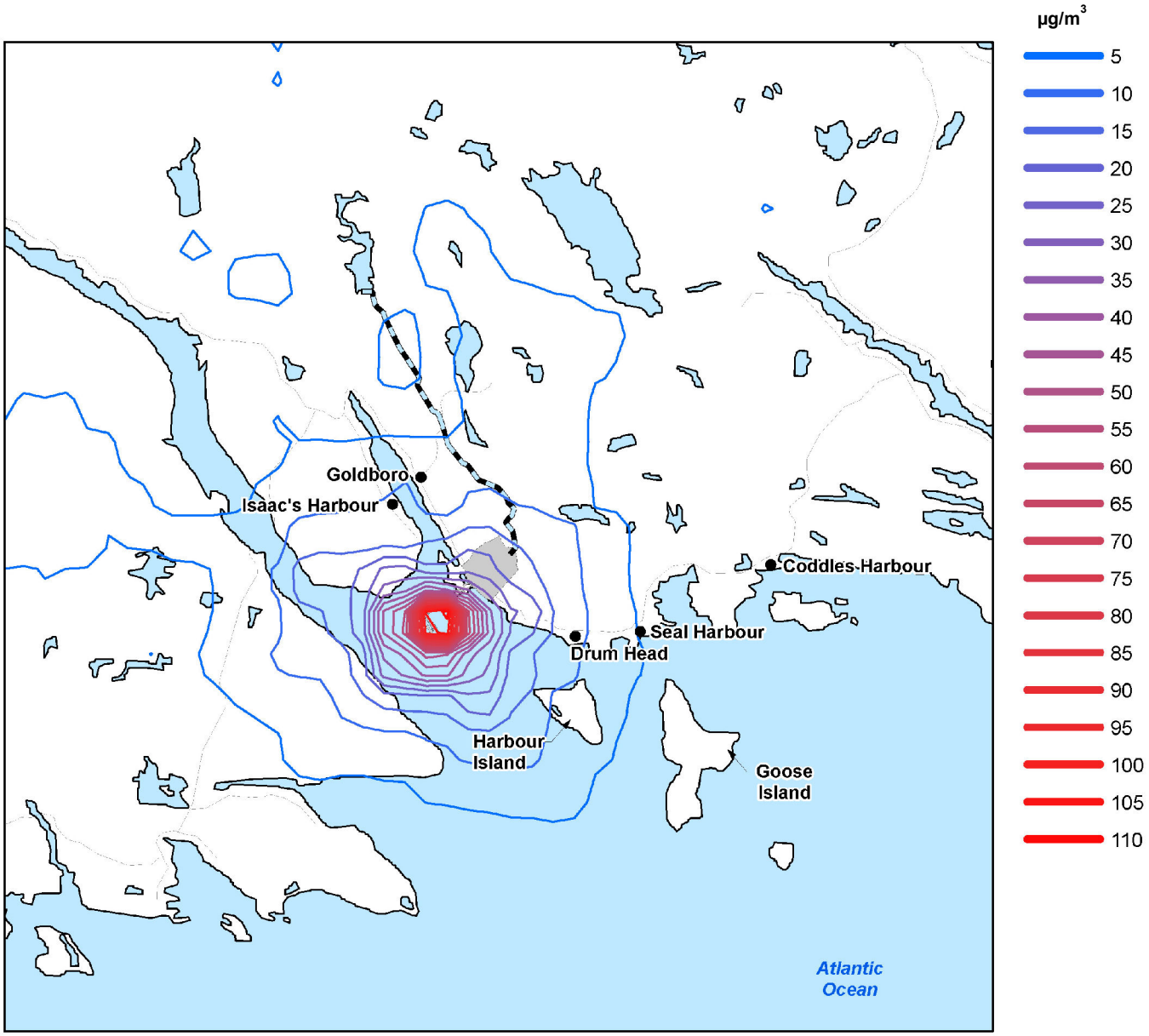

Nova Scotia Objectives for SO_2 : 1hr-900 µ/m ^{3}/ 24hr-300 µg/m³/ Annual -60 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG ENVIRONMENTAL ASSESSMENT	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: SO_2 24 HOUR NORMAL (µg/m^3)	DATE: Aug 2013
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	PROJECT NO: TV121039		FIGURE NO: 10.4-6

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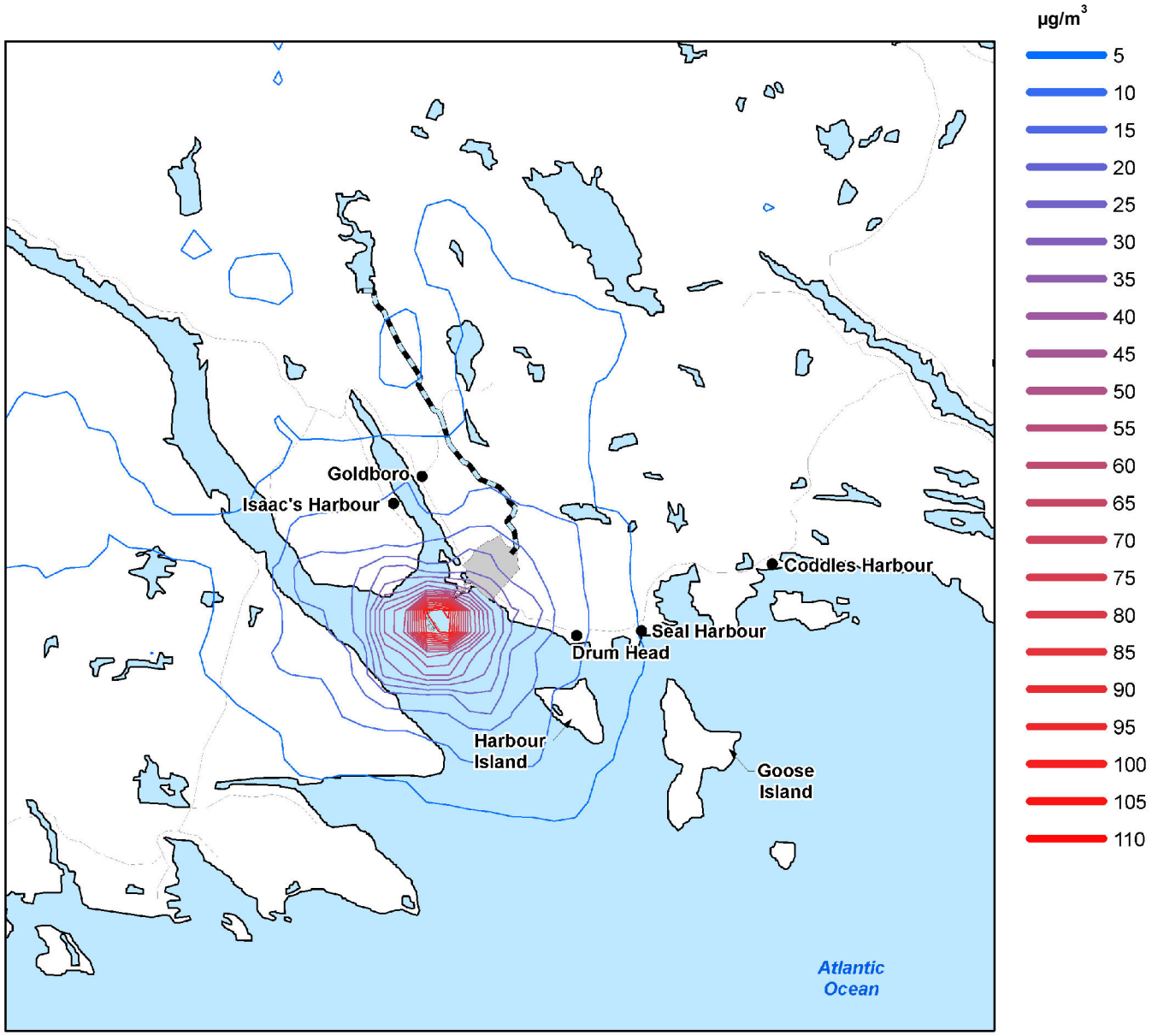

Nova Scotia Objectives for SO_2 : 1hr-900 µ/m ^{3}/ 24hr-300 µg/m³/ Annual -60 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG ENVIRONMENTAL ASSESSMENT	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: SO_2 24 HOUR UPSET (µg/m^3)	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
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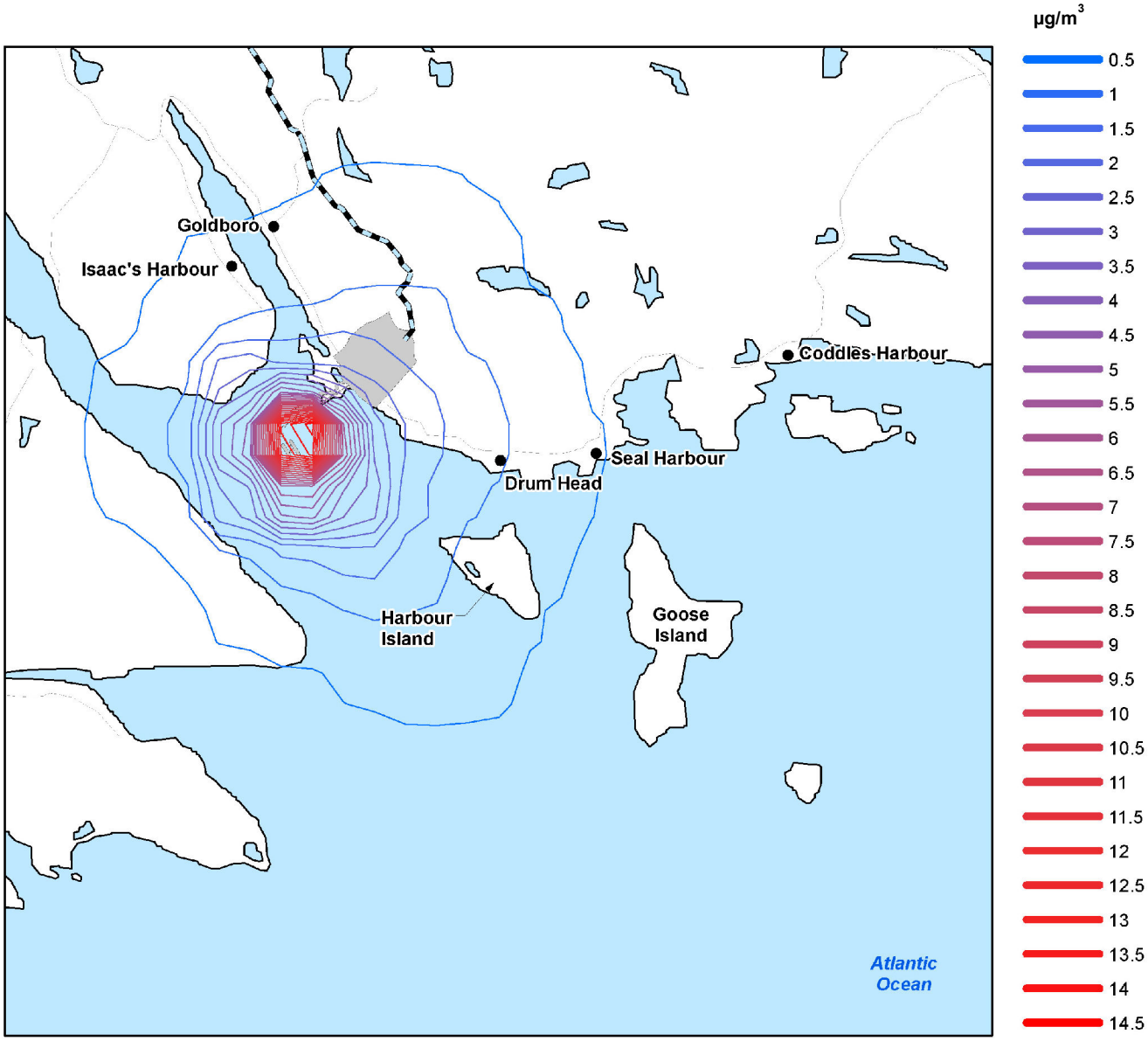

Nova Scotia Objectives for SO_2 : 1hr-900 µ/m ^{3}/ 24hr-300 µg/m³/ Annual -60 µg/m³

CLIENT: Pieridae Energy (Canada) Limited	SCALE:	PROJECT: GOLDBORO LNG ENVIRONMENTAL ASSESSMENT	DWN BY: JT
			CHK'D BY: GB
AMEC Environment and Infrastructure A Division of AMEC Americas Ltd. 50 Troop Avenue, Unit 300 Dartmouth, N.S., B3B 1Z1 (P) 902-468-2848 (F) 902-468-1314	DATUM: UTM Zone 20	TITLE: SO_2 ANNUAL NORMAL (µg/m^3)	DATE: Aug 2013
	PROJECTION: NAD83		REV. NO:
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SOURCE: AMEC 2013

10.5 Acoustic Environment (Noise)

10.5.1 Threshold for Determination of Significance

A significant adverse noise effect has been determined to represent a condition where the recommended guidelines are regularly exceeded. The NS guidelines are 65 dB(A) for daytime, 60 dB(A) evening, and 55 dB(A) for night-time. The WHO guideline level of 45 dB(A) is commonly considered a standard for residential receptors at night to ensure minimal sleep disturbance.

10.5.2 Effects on Acoustic Environment (Noise)

10.5.2.1 Effects of Construction

Construction equipment includes a large number of types of machines and devices, varying widely in physical size, horsepower rating and principle of operation. Despite the variety in type and size of construction equipment, the similarities in dominant noise source and in patterns of operation are sufficient to define three categories:

- equipment powered by internal combustion engines;
- impact equipment; and
- other equipment.

Equipment Powered by Internal Combustion Engines

The internal combustion engine is used to provide movement to the wheels or tracks and/or operating power for working mechanisms such as buckets, dozers, etc. Exhaust noise is usually the most important component of engine noise in internal combustion engines; however, noise from the intake, cooling fans and mechanical/hydraulic transmission and control systems also can be significant contributors. The tracks of earthmoving equipment, and the interaction of materials handling equipment and earthmoving equipment with the material on which it acts, often produce significant noise output (Harris, 1979). Typical noise sources and associated noise levels are listed in Table 10.5-1.

Impact Equipment

Impact equipment includes pile drivers, pavement breakers, tampers, rock drills and small hand-held pneumatically, hydraulically or electrically powered tools. With the use of pile drivers, the primary noise source is the impact of a hammer striking the pile; engine related sources are secondary. The dominant sources of noise in pneumatic tools are the high-pressure exhaust and the impact of the tool bit against the material on which it acts (Harris, 1979).

Other Equipment

Generally, the above-mentioned categories contain the bulk of equipment used in remedial activities. There are, however, many pieces of equipment that do not fit either of these categories. Examples are the high-pitched whine from a power saw or the noise a concrete vibrator produces when it shakes concrete forms (Harris, 1979).

For comparison, a chainsaw at 1 m is approximately 110 dB, a busy highway at roadside is 80 dB, and conversational speech at 1 m is 60 dB. Noise levels in a library can be expected to be at about 40 dB. Table10.5-1indicates some typical noise levels for construction equipment.

Table 10.5-1 Typical Construction Equipment Noise Levels at 15 m

Equipment	Typical Noise Range (dB(A)) at 15 m	Calculated Noise Level at 300 m
Loader	74-84	48-58
Bulldozer	82-95	56-68.8
Trucks	82-92	56-65.8
Pumps	68-72	42-46
Generators	72-80	46-54
Compressors	74-83	48-57

Source: Harris, 1979

It is noted that the nearest occupied properties are some 300 m from the site boundary lines, and, accordingly, sound pressure levels (noise) will decrease from the point of origin and degrade further from the site boundary. The inverse square law states that the sound pressure level will decrease by six decibels for every doubling in distance from the source of noise. The following formula is used to determine the change in sound pressure levels over a distance:

$$\Delta D = 10 \log (d_1/d_2)^2$$

Where d_1 and d_2 are the two distances and ΔD is the change in sound pressure level in decibels (dB).

Given the above formula, in general, most of the construction equipment working on the site will produce noise levels at receptors located 300 m away at a level that is below the lowest recommended noise level of 65 dB(A) for the hours from 0700 to 1900 as per the NSEL Guidelines presented in section 6.4.1.3 (NSEL, 2005). However, the approximate sound pressure levels for a bulldozer at 300 m from the property boundary would be 52-68.8 dB(A). A level of 68.8 dB(A) exceeds the lowest recommended noise level of 65 dB(A) for the hours from 0700 to 1900 as per the NSEL Guideline. Since the predicted value assumes the bulldozer is at the eastern edge of the site and most of the bulldozing work will take place at distances farther than 300 m, it is expected that noise levels will be exceeded at the closest receptor for only short durations of time. The attenuation formula does not take into account the effect of vegetation, topography, or climatic conditions, which would also affect the noise levels.

It is noted that when several pieces of equipment are operating in proximity to each other, sound levels (in dB(A)) are not additive. For example, two bulldozers, each with an operating sound level of 82 dB(A) would be the equivalent of a level of 85 dB(A), since 3 dB(A) represents a doubling of the noise level, a difference that is considered to be barely perceivable to the human ear.

10.5.2.2 Effects of Operation

In general, normal operational noise sources for all activities will be required to be attenuated so that resultant noise levels at the site boundary (otherwise referred to as the site perimeter or fence-line) are in the range of 55-65 dB(A), in accordance with section 6.4.1.3 of the NSEL "Guidelines for Environmental Noise Measurement and Assessment" (May 2005).

The proposed natural gas liquefaction plant and marine terminal is located in a rural area with the closest residences located approximately 300 m from the property boundary on Red Head and along Webb's Cove and 800 m on the east side of Betty's Cove Brook. The main anthropogenic noise source in the area is the ExxonMobil Sable (SOEI) natural gas plant that is located approximately 800 m to the northeast of the proposed Project boundary. AMEC field staff noted that operation of the flare at the SOEI gas plant generated noise that was noticeably above background. Within the last two years, a small wind farm consisting of three wind turbines was also constructed within one kilometre of the proposed Project boundary. Other noise sources are those found typically in nature and consisted of wind, birds, and ocean. There is also periodic noise from vehicles travelling along Route 316.

Noise monitoring performed on previous proposed LNG projects for this area, along with the SOEI gas plant consistently produced results well within NS guidelines. It is unknown whether monitoring was performed during the operation of the SOEI plant gas flare.

During operation of the natural gas liquefaction plant and marine terminal, noise will be generated from the following activities:

- LNG facility including incinerator for acid gas removal, refrigerant compressor gas turbines, power generation gas turbines, pilot/purge gas flares, and emergency diesel generator sets; and
- LNG carriers.

Typical LNG liquefaction plants contain items of equipment that will cause high noise levels, either due to the equipment being noisy or due to the sheer number of units producing noise. Typically, the noise sources that emit high levels of noise include the large refrigeration compressor trains, the boil off gas compressors, the power generation gas turbine exhaust stacks and some utility equipment such as cryogenic nitrogen generation plants and instrument air compressors. Most of these sources are continuous. Fin fan air cooled heat exchangers tend to not be excessively noisy; however, there will be a large number of these types of units installed adjacent to each other which will combine to produce high noise levels on site (CB&I, 2013b).

Intermittent sources tend to be noisier in nature but operate infrequently and for short durations. Emergency flaring and operation of pressure relief valves are examples of noise sources that will emit high noise levels (CB&I, 2013b).

Generally, the design of the gas liquefaction plant can meet on-site noise levels of 85 dB(A). There are some areas, such as compression areas and some utilities where noise levels of 85 dB(A) cannot be met and noise levels will be controlled for this equipment by housing them in buildings with sound proofing materials.

Operational upsets will cause on-site noise levels up to 115 dB(A).

As part of the noise assessment, CB&I performed a dispersion modeling study to predict off-site noise impacts. The model SoundPLAN v.7.1 was used to predict noise levels at the closest sensitive residential receptors located to the east and west of the site boundary. The noise model was based on previous CB&I gas liquefaction experience that considers the main equipment (compressors, power generation and utilities) are contained within basic steel structures. A noise level of 60 dB(A) is predicted at the three residential receptors that are located closest to the site. This level is a continuous and will be present throughout an entire 24 hour day. The level is lower than the NS guideline for daytime and is at the guideline for evening. It is higher than the NS night-time guideline of 55 dB(A). It is also higher than the WHO noise level of 45 dB(A) for residential receptors at night to ensure minimal sleep disturbance.

10.5.2.3 Effects of Decommissioning

Noise impacts during decommissioning would be expected to be comparable to construction-related noise impacts.

10.5.3 Mitigation

Noise factors will be considered in the design and selection of equipment in order to meet the levels of the NS noise and WHO guidelines at near-by receptors. The following noise mitigation measures will be considered:

- All equipment will be assessed at the source to determine the equipment's feasibility for low noise designs;
- Acoustic mitigation will include the use of enclosures, piping insulation and silencers;
- Due to the climate of NS, most of the equipment will be enclosed or partially enclosed for winterization purposes; and
- Key noise emitters that are external to any winterization are the fin fan cooled heat exchangers. The feasibility of using low noise designs on-site will be explored.

10.5.3.1 Construction Phase

In conducting site construction operations, Pieridae will:

- Ensure that all equipment has appropriate noise-muffling equipment installed and in good working order.
- Conduct routine noise monitoring at both the site boundaries and nearby occupied properties as appropriate.
- Restrict intensive construction activities to the hours of 0700-1900 where practical.

- Ensure that the public has contact numbers for appropriate construction and government personnel in the case of noise issues.
- Ensure that the public is given adequate prior notice of any blasting activities scheduled to take place.
- Maintain, where practical, treed buffers between the working site and the public.

The above measures address the issues of noise and/or vibration as they may affect nearby residents. There are also concerns as to the impacts from construction activities that generate noise emissions transmitted through the underwater environment.

Although there is not an extensive use of the nearshore waters by cetaceans and seals, these species may be susceptible to damage from the underwater noises generated using conventional pile-driving techniques.

Possible mitigation, if required, includes working during low tide, working outside of sensitive periods, the use of ramped warning signals and masking the noise with bubble curtains (David, 2006). The need for the implementation of these measures will be established in consultation with the regulators.

Alternative construction techniques such as vibratory pile-driving may also be used. Additionally, Pieridae will confer with representatives of both the recreational fishery and the commercial fishery in order to identify and consider seasonal and daily activity schedules which will be the least likely to disrupt these activities, at least to the extent that proposed measures are consistent with the orderly and timely construction of the facility.

10.5.3.2 Operation Phase

During operation of the facility, Pieridae will implement the following measures to minimize noise effects:

- appropriate and properly operating noise-mufflers on all noise emitting equipment;
- in addition to the noise generating equipment, other potential noise transmission sources such as piping, fittings, valves and feed systems will undergo frequent examination and maintenance. Operational plans will include adequate inspection procedures and maintenance logs;
- noise monitoring (site boundaries and nearby occupied properties) as appropriate;
- establish mechanism to address complaints response procedures; and
- maintenance, where practical, of treed buffers.

10.5.3.3 Decommissioning Phase

Noise levels during decommissioning would be expected to be comparable to construction-related noise levels. Mitigation measures proposed for the construction phase therefore generally also apply to the decommissioning phase.

10.5.4 Summary and Residual Effects

Overall effects of noise during the Project's construction phase are not expected to be significant (Table 10.5-2). With proper noise mitigation design, noise levels should be reduced to below guideline values. The nearest occupied residences are about 300 m away from the Project site. Any Project-related noise that reaches these properties will decrease relative to the point of origin. If required, off-site noise abatement measures (e.g., buffer plantings, berms) will be employed to reduce operation related noise effects at the nearest residential receptors.

Table 10.5-2 Residual Environmental Effects Summary for Acoustic Environment (Noise)

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Disruption of residences around property by site preparation (blasting, earth moving) and construction of marine and on-shore components.	A	• Ensure machinery has working noise muffling equipment. • Conduct routine noise monitoring. • Restrict intensive activity to hours between 700 and 1900. • Supply public with contact numbers in case of noise issues. • Give public prior notice of blasting. • Maintain treed buffer between worksite and public.	Low to Medium	Construction envelope at Project site.	Construction Phase	R	Rural setting; sparsely populated; nearest residential receptors at 300 m off-site.	Minimal
Operation								
Disturbance of nearby residents by noise from Pieridae operations (e.g., vessel engines, compressors, turbines).	A	• Maintenance of equipment and noise mufflers. • Piping, fittings, valves and feed systems will undergo frequent examination and maintenance. Operational plans will include adequate inspection procedures and maintenance logs. • Establish mechanism to address complaints response procedures. • Noise monitoring program to confirm noise levels at nearest occupied properties.	Low during daytime hours; potentially Moderate at night.	Pieridae site	Operation Phase; 24/7	R	Rural setting; sparsely populated; nearest residential receptors at 300 m off-site.	Minimal during daytime hours; possibly Medium during night-time hours.

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.6 Ambient Lighting

Lighting requirements for the facility and associated infrastructure in the Project area will be designed with the following criteria in mind:

- safety of operating personnel;
- safety of the general public;
- adherence to government regulations;
- minimization of the impact of the lighting on the environment; and
- maximization of efficiency of the lighting system.

10.6.1 Threshold for Determination of Significance

A significant impact on ambient light conditions would be any unmitigated "light trespass" (i.e., unintentional direction of lighting off-site) or interference with migrating bird populations, causing bird fatalities. The minimum requirement for preventing light trespass is determined by the best available technology. A typical definition of shielding required would be – a luminaire light distribution where zero light occurs above 90 degrees above nadir and less than 10% of light above 80 degrees above nadir (Strum Engineering Associates Ltd. (SEA), 2007).

10.6.2 Effects on Ambient Lighting

Light pollution can disrupt ecosystems and have adverse health effects. For this Project, light pollution would include light trespass, effects on night sky access, glare, and impacts to migratory birds during migration as well as nocturnal activities of wildlife.

10.6.2.1 Construction

During construction lighting shall be provided to ensure a safe working environment for all personnel throughout all seasons and at all times of day. As the Project is being built in a semi-rural area, night time lighting will be visible, especially from the communities of Isaac's Harbour, Goldboro, and Drum Head.

10.6.2.2 Operation

During operation there will be permanent light at the LNG facility. This includes lights along the perimeter fence, lighting of the marginal wharf, the marine terminal, the LNG facilities and storage tanks, and the cogeneration power plant.

10.6.2.3 Decommissioning

The effects of decommissioning are anticipated to be similar to those described during construction.

10.6.3 Mitigation

A lighting plan was developed by Jacques Whitford (2008) for the Keltic Project to satisfy EA Condition 1.6. The lighting plan addressed:

- light pollution during and after site preparation, construction, commissioning and operation of the plant facilities;

- effective lighting for all aspects of operational activities; and
- quality luminaire evaluation.

The lighting plan (Jacques Whitford, 2008) included lighting requirements, recommendations based on LEED Buildings Guide (Canadian Green Building Council, 2006) and a bird mortality monitoring plan.

Similar lighting needs will be required for this Project, consequently it is recommended that a lighting plan be developed post FEED.

During construction lighting shall be provided to ensure a safe working environment for all personnel throughout all seasons and at all times of day. A temporary lighting system shall be used with additional tower lighting used to illuminate specific areas; all construction crews shall have access to portable lighting for working in confined areas. At a minimum, Pieridae will ensure adherence to occupational lighting requirements set out in the Canada Occupational Safety and Health Regulations, Part VI under the Canada Labour Code.

In addition, to minimize impacts of light on the surrounding community and wildlife:

- no unnecessary lighting will be used;
- lighting to be shielded where possible; and
- lighting to be angled or directed close to work area.

During operation the LNG facility permanent lighting shall be used, this shall light all accesses, walkways, roads, car parks and building areas. The types and positions of lighting will be selected in later design phases taking the following criteria into account:

- safety;
- no sodium type lamps in hazardous areas;
- if colour recognition is required the lamp type will be adapted to this requirement;
- optimization of lamp type regarding power consumption;
- optimization of number and position of light poles;
- light trespass;
- proximity to the ocean;
- luminaire light distribution;
- glare;
- bird fatalities; and
- obstruction lights.

A bird mortality monitoring program will also be required.

10.6.4 Summary and Residual Effects

By developing a lighting plan that incorporates the aforementioned measures, Pieridae will ensure that surrounding communities are protected from harmful glare and will be able to maintain night sky access. Impacts to wildlife (particularly migratory birds) are anticipated to be minimal.

Table 10.6-1 summarizes the residual environmental effects for ambient lighting.

Table 10.6-1 Residual Environmental Effects Summary for Ambient Lighting

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Effects of lighting on the local visual landscape character.	A	• Implement lighting plan. • Temporary lighting system shall be used with additional tower lighting used to illuminate specific areas. • Lighting to be focussed on intended work area. • Shielded lighting to minimize diffusion.	Medium	Project site and area within approximately 3 to 5 km.	Construction Phase	R	• Coherent, rural landscape, minimal lighting to rural undeveloped nature of the area; existing SOEI gas plant.	Medium
Effects of lighting on safety could pose a risk.		• Implement lighting plan. • Adherence to Canada Occupational Health and Safety Regulations IV for occupational lighting requirements. • Construction crews shall have access to portable lighting for working in confined areas.	Low	Project site	Construction Phase	R	• Coherent, rural landscape, minimal lighting to rural undeveloped nature of the area; existing SOEI gas plant.	Minimal
Operation								
Effects of lighting on the local visual landscape character.	A	• Implement lighting plan. • No sodium type lamps in hazardous areas. • If colour recognition is required the lamp type will be adapted to this requirement. • Optimization of lamp type regarding power consumption. • Optimization of number and position of light poles. • Minimum night lighting.	Medium	Approximately 3 to 5 km around Project site.	Operation Phase	R	• Rural, fairly undeveloped coastal environment.	Medium

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Effects of lighting on birds.		• Implement lighting plan. • Conduct Bird Mortality Monitoring Program. • Full cutoff light fixtures for street, roadway, wharves and piers. • Minimum light levels for wharves/piers when not in operation with both manual and automatic controls. • Minimum obstruction lighting with maximum flash. • No additional lighting other than that required for safe operation of facility. • Use low intensity fluorescent or high pressure sodium lamps with flat bottomed lenses and place as close to area required to be lit as possible. • Minimum night lighting while still adhering to TC standards.	Low	Project site	Operation Phase	R	• Coastal environment.	Minimal
Effects of lighting on transportation.		• Implement lighting plan. • Establish obstruction lighting in accordance with TC Standard 621.19 and a TC Aeronautical Evaluation.	Low	Project site	Operation Phase	R	• Coastal environment.	Minor

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.7 Terrestrial Habitat and Vegetation

This section discusses the potential impacts of the proposed Project on terrestrial habitat, as well as vascular plants and non-vascular vegetation. Freshwater aquatic vascular plants are also included here because of expected similarity of effects and mitigation to those for terrestrial vegetation. Marine vegetation is discussed in Section 10.11 and flora SAR is discussed in Section 10.12. Effects on terrestrial flora are a pathway to other VECs including wetlands, SAR, wildlife, hunting or gathering activities, and land-use. These are discussed respectively in Sections 10.8, 10.9, 10.12, 10.13 and 10.14.

10.7.1 Threshold for Determination of Significance

A significant adverse effect on terrestrial habitat and vegetation would be a decline in abundance and/ or a change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its pre-project level within several (3-5) generations. A significant adverse effect on sensitive/ critical habitat would be a permanent net loss of habitat function.

10.7.2 Effects on Terrestrial Habitat and Vegetation

A discussion of potential impacts of activities in each Project phase is presented below. Recommended mitigation is described in Section 10.7.3 and proposed monitoring programs are outlined in Section 12.0.

10.7.2.1 Construction

Construction activities associated with the Project may result in temporary or permanent adverse effects on terrestrial and freshwater/brackish aquatic flora. Potential detrimental effects to terrestrial flora can result from site preparation (clearing/grubbing/grading/blasting), road, pipeline and building construction, associated dust, erosion/sedimentation, and possible introduction of invasive species. Potential effects on terrestrial and aquatic flora, habitat, communities, and individuals during construction may also occur as a result of accidental events. Effects can be limited to the footprint of the Project, or extend to adjacent lands as indicated below.

During construction, potential adverse effects on vegetation and habitat include:

- direct and indirect mortality of plants;
- temporary or permanent loss or alteration of habitat and habitat availability;
- impairment from changes to wind exposure and microclimatic conditions;
- impairment or displacement from introduction of invasive species; and
- mortality or impaired growth due to accidental events.

Mortality of Plants and Loss or Alteration of Habitat

Since the effects and the significance of the effects may vary for the different Project components, direct mortality of plants and loss or alteration of habitat will be discussed separately for the various Project components.

LNG Facility and Marginal Wharf

Site clearing/grubbing/grading will result in loss of availability of vegetation habitat, as well as direct mortality of the vascular and non-vascular plants in the area affected. For the purpose of this EA, it is assumed that all the vegetation in the entire footprint of the Goldboro LNG facility will be permanently lost for the lifetime of the Project, though the final development may integrate some small amounts of habitat, such as amenity green space (ornamental plantings and turf). Habitat loss within the footprint of the LNG facility and marginal wharf will amount to 119 ha. Lay-down areas will be located within the footprint of the LNG facility and therefore will not require additional space. While the affected habitats are not pristine and show evidence of previous disturbance from mining and logging activities, they will be replaced with paved surfaces and buildings.

Clearing may also change wind- exposure and microclimatic conditions in adjacent forests, resulting in some die-off and reduced growth of forest species until edge vegetation matures. However the land in and surrounding the LNG facility area is already highly altered. The SOEI pipeline, gas plant and helipad are actively maintained to prevent the growth of trees. Vegetation is dominated by shrubs with mainly tall alders surrounding the SOEI helipad. At the LNG facility location there is evidence of regenerating clear cuts. Consequently, there is little potential for effects on forest edges.

These effects are not considered to be significant for common flora populations, and no mitigation beyond standard environmental protection measures is recommended.

Temporary Work Camp

The vegetation in the work camp area consists of alder thickets or tall shrub habitat. The vegetation will be cleared to make room for the temporary camp, which has a footprint of 16.5 ha. However, the loss of vegetation and associated habitat for the work camp may not be permanent, since this area is anticipated to be re-vegetated when a work camp is no longer required, likely at the end of the construction phase. It should be noted that the temporary work camp is located adjacent to the LNG facility in the vicinity of an existing windfarm in an industrial park. The owners of the property, or the MODG as the interim owners of the land in the industrial park, may prefer that the site is not re-vegetated because it may be used for another development.

These effects are not considered to be significant for common flora populations, and no mitigation beyond standard environmental protection measures is recommended.

Water Supply Pipeline ROW

The water supply pipeline ROW is anticipated to run parallel and adjacent to the M&NP pipeline corridor for most of its length. Vegetation on about 10 ha will be cleared to allow placement of

the pipeline and the access and maintenance road, resulting in direct mortality of vascular and non-vascular plants. The loss of habitat in the pipeline Row will not be permanent, because the disturbed areas will be re-vegetated. However, to protect the pipeline, the growth of trees and tall shrubs will be prevented. The clearing therefore will effectively result in habitat alteration in most of the ROW.

Clearing may also change wind- exposure and microclimatic conditions in adjacent forests, resulting in some die-off and reduced growth of forest species until edge vegetation matures. However, since the water pipeline is located adjacent to the M&NP pipeline ROW, which does not support forest habitat, the effects on forest habitat will be limited to one side of the water supply pipeline ROW for most of the length of the pipeline.

These effects are not considered to be significant for common flora populations, and no mitigation beyond standard environmental protection measures is recommended.

Meadow Lake Water Intake Structure

The construction of the Meadow Lake water intake structure and associated access road has a comparatively small footprint. Changes in water levels, especially inundation, are not anticipated. Therefore, there will be no loss or alteration of habitat along the lake shore. Impacts therefore are limited to the footprint of the intake structure, work areas and access road.

The construction of the water intake structure will require the removal of terrestrial habitat, and likely also some freshwater aquatic habitat. In addition, vegetation will have to be cleared from a limited surface area near the intake structure to accommodate lay-down areas and access road. Vegetation clearing results in direct mortality of vascular and non-vascular plant species in the Project component footprint. Temporary workspace/lay-down areas will be re-vegetated upon finalization of the construction. Permanent habitat loss would be limited to the footprint of the water intake structure (less than 0.15 ha) and the 500 m access road.

Potential effects in adjacent forests due to clearing (i.e., changes to wind-exposure and microclimatic conditions) are expected to be minimal, since most of the habitat adjacent to the intake structure consists of “brush and barrens” or “marsh and fen” (see Figure 9.4-3); thus greatly reducing the amount of forest habitat that may potentially be affected.

These effects are not considered to be significant for common flora populations, and no mitigation beyond standard environmental protection measures is recommended.

Erosion/ Sedimentation

Clearing and grubbing required for all Project components, results in disturbed soil surfaces without cover of vegetation. Exposed soil is vulnerable to erosion, and the resulting sedimentation may smother vegetation or impair plant growth in adjacent terrestrial and aquatic habitats. With the implementation of standard sediment and erosion control measures, as outlined in Section 10.3, effects on common terrestrial and aquatic vegetation are not considered significant, and no further specific mitigation is recommended.

Fugitive Dust

Earthwork, movement of construction and transportation machinery, and storage of soil and construction materials may result in development of fugitive dust. The deposition of dust on the leaf surfaces of near-by vegetation may have temporary inhibiting effects on photosynthesis and transpiration in the affected plants, potentially resulting in slower growth rates (Farmer, 1993). Noticeable dust deposition is expected to not exceed a few metres. Standard dust-abatement measures and measures for the protection of air quality as outlined in Section 10.4 will reduce the effects of dust on vegetation in all habitats. These effects are not considered to be significant for common vegetation, and plants will recover. No special mitigation is recommended.

Introduction of Alien and Invasive Species

Clearing, grading and construction activities will result in disturbed areas without cover of natural vegetation. Open soil surfaces encourage the establishment of non-native and potentially invasive species of plants. As the plant inventory indicates, several alien plant species have already been detected in the foot print of the Goldboro LNG plant, which may be the result of previous disturbance from forest harvesting or mining activities (Section 9.4). Seeds, roots or "rootable" fragments of invasive species may be stuck to construction equipment, transportation vehicles or shoes of workers. Non-native or invasive species may lead to alteration of near-by habitat and may have an adverse effect on the abundance and diversity of native flora.

Due to the limited size of the affected areas, the potential effects would not be significant for the local flora. Further, measures for the re-establishment of appropriate native vegetation in re-vegetated areas may result in enhanced habitat for both flora and fauna.

Spills, Malfunctions and Accidents

The potential effects of spills, malfunctions and accidents and recommended mitigation measures are discussed in more detail in Section 10.17. Spills could directly kill vegetation and also create soil conditions unsuitable for vegetation growth.

10.7.2.2 Operation

No significant direct effects (mortality, loss of habitat) on vegetation communities are expected during operation. Some minor disturbances may occur, related to maintenance activities or equipment upgrades. Impacts would be similar to construction but on a very much smaller scale.

Dust generated by Project related vehicle traffic on roads in the Project area is not likely to result in adverse effects on adjacent vegetation, because traffic on the access road to Meadow Lake and in the water supply pipeline ROW is anticipated to be infrequent. Most traffic within the LNG facility is expected to be distant from the property boundaries and thus too far removed from vegetation.

While lichen species are known to be sensitive to air pollution and the LNG facility will include several sources of air emissions, significant adverse effects on common lichen species in the

vicinity of the LNG facility are not expected with the application of standard mitigation measures (see Section 10.4). Current lichen species composition is likely largely reflective of the air quality associated with the neighbouring SOEI plant. Potential effects on lichen SAR are discussed in detail in Section 10.12.

Possible adverse effects on terrestrial and aquatic flora of a minor nature may, however, occur due to road maintenance, traffic, and possibly introduction of invasive species. There is also potential for adverse effects on flora during operation from spills and accidental events, which are further discussed in Section 10.17.

During operation, potential adverse effects on flora habitat, communities and individuals include:

- impairment from chemicals;
- impairment or displacement from introduction of invasive species; and
- mortality or impaired growth due to accidental events.

Increased Levels of Toxic and Deleterious Substances (Herbicides and Salt)

Road salt used on roads within the LNG facility and herbicides potentially used for ROW maintenance may adversely affect immediately adjacent terrestrial vegetation and soil conditions. Herbicides, if they enter streams, may also be carried downstream and could potentially affect aquatic vegetation, unless and until herbicide concentration is diluted sufficiently by the water in the stream. Since herbicides would be applied according to regulations and manufacturer's instructions, the likelihood of un-intended effects to vegetation outside of the application area is minimal. With the application of mitigation measures, significant adverse effects on vegetation from herbicides and road salt are not expected.

Introduction of Alien and Invasive Species

The potential for effects from the introduction of alien or invasive species during the operational phase is small to non-existent, since most if not all of the open surface areas created during the construction phase will have been re-vegetated or sealed. However, since non-native or invasive species may lead to alteration of near-by habitat and may have an adverse effect on the abundance and diversity of native flora, remaining open areas should be re-vegetated as soon as possible (see Section 10.7.3, below). Due to the limited size of the affected areas and low potential, the effects are not expected to be significant for the local flora.

Spills, Malfunctions and Accidents

The potential effects would be similar to construction, above. Recommended mitigation measures are outlined in Section 10.17.

10.7.2.3 Decommissioning

During the decommissioning phase, Project infrastructure will be removed, temporarily resulting in open, unprotected soil surfaces. It is likely that the marginal wharf will be re-used for new purposes, and that the LNG facility property is sold to new owners who may want to keep all or part of the LNG facility footprint non-vegetated for other industrial uses, thus reducing the size of the potentially disturbed areas.

Potential effects of Project activities during the decommissioning phase are somewhat similar to the potential effects during the construction phase (see Section 10.7.2.1). Temporary adverse effects on terrestrial and freshwater/brackish aquatic flora, habitat, communities and individuals could occur from infrastructure removal and associated soil disturbance, associated dust, erosion/sedimentation, and possible introduction of invasive species. Potential adverse effects on flora could also arise from spills and accidental events, further discussed in Section 10.17.

10.7.3 Mitigation

Mitigation measures for construction related impacts (such as clearing, grubbing and blasting) will be established as part of the EPP. The following mitigation measures are recommended to minimize or eliminate impacts on terrestrial habitat and vegetation:

During Construction:

- reduce area of Project footprint and temporary lay-down areas to that which is absolutely necessary;
- mark Project boundaries to prevent accidental impacts outside the work area;
- store topsoil (i.e., approximately upper 30 cm) separately and reuse for site restoration where possible;
- control erosion and sedimentation as outlined in Section 10.3;
- dust-prevention measures and dust abatement measures outlined in Section 10.4, will also protect local flora and habitats;
- immediately stabilize and rehabilitate areas of temporary disturbance (work camps, lay-down areas, water pipeline);
- use local native vegetation in restoration;
- seed mixes used should contain native flora and will not contain invasive species;
- restoration should include native forest habitat, if feasible; and
- efficacy of the erosion and sediment control measures, as well the establishment of native flora should be monitored through an EEM program (see Section 12.0).

To prevent introduction of invasive plant species**:**

- construction and transportation equipment should be cleaned from vegetation and soil residues and inspected before entering the Project site;
- clean equipment that has been used in a wetland/wet area before transportation to another site;
- areas of exposed soil should be re-vegetated as soon as possible, following completion of work activities; and
- a program of monitoring and removal of invasive species will be incorporated.

During Operation:

- vegetation management will be conducted by mechanical cutting;
- only when mechanical means are not effective, use approved herbicides according to applicable regulations and manufacturer's instructions;
- mitigation measures for the protection of watercourses (see Section 10.3 and 10.10 will help to protect terrestrial and freshwater aquatic vegetation and habitats; and
- mitigation measures pertaining to air emissions pollution control as outlined in Section 10.4 will also protect common lichen species.

Mitigation measures for potential impacts during decommissioning are similar to those for construction. Decommissioning activities will be conducted in accordance with all applicable regulatory requirements at the time and a decommissioning plan would be developed.

10.7.4 Summary and Residual Effects

Table 10.7-1 provides a summary of recommended mitigation measures and residual environmental effects after successful implementation of the mitigation measures described above.

With the implementation of the recommended mitigation measures, Project activities are not likely to result in significant adverse residual effects on terrestrial and freshwater aquatic vegetation and habitat.

Table 10.7-1 Residual Environmental Effects Summary for Terrestrial Habitat and Vegetation

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Direct plant mortality, habitat removal or alteration due to site preparation, clearing and grubbing (LNG facility, temporary work camp, Meadow Lake water intake structure and access road, water supply pipeline ROW).	A	• Minimize Project footprint. • Minimize lay-down areas. • Implement EMP provisions for clearing, grubbing and blasting.	Low	Limited to Project footprint (about 150 ha).	• Short- term loss: temporary work camp (16.5 ha; construction phase). • Long-term alteration: water supply pipeline ROW (about 10 ha). • Permanent loss: LNG facility Meadow Lake water intake structure (about 120 ha).	R; LNG facility: NR during lifetime of Project.	Similar habitat in the region. Area is affected by past and present human activity; pristine areas not known. Designated Industrial Park.	Minor
Indirect plant mortality as a result of potential erosion, sediment loading, stormwater discharges, and spills.	A/P	• Temporarily disturbed surfaces to be re-habilitated as soon as possible. • Rehabilitation to be based on site-specific landscape plans; plans to favour forest habitat and native plant species typical for the area (same applies for site rehabilitation during decommissioning phase). • Save and store organic soil layer and apply in rehabilitation. • Where applicable, use high quality seed with low probability of containing invasive species.	Low	Project lifetime/ Infrequent	• Construction phase.	R	Similar habitat in the region. Area is affected by past and present human activity; pristine areas not known. Designated Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
		• Implement erosion and sediment control plans. Monitoring of EPP/EMP implementation, success of rehabilitation and erosion control measures (EEM/ECM).						
Displacement or loss of suitable habitat due to the introduction of invasive species.	A	• Re-vegetate or seal disturbed surfaces as soon as possible. • Construction and transportation equipment to be cleaned from vegetation and soil residues before entering the Project site. • Discourage workers from entering off-site areas. • Implement a program of identification, monitoring (EEM) and removal of noxious weeds.	Low	Local; depends on size of affected area.	• Project lifetime Infrequent.	R	Similar habitat in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minimal
Indirect plant mortality and impairment as a result of fugitive dust emissions during construction.	A	• Implement dust- abatement measures and sediment control measures as outlined in Section 10.4 and EPP/EMP.	Low	Local	• Construction and decommissioning phase.	R	Similar habitat in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Increase in levels of toxic and deleterious substances due to infrastructure maintenance (herbicides and salt).	A	• Vegetation growth should generally be regulated by physical cutting. • Approved herbicides may be used for maintenance only if necessary. • Herbicides will be applied according to legal regulations (NSE). • Implement measures outlined in an EPP/ EMP.	Low	Local; depends on size of affected area.	• Operation phase Short term/ infrequent.	R	Similar habitat in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minimal
Direct plant mortality, habitat loss or alteration due to removal of water supply pipeline.	A	• Minimize Project footprint. • Minimize lay-down areas. • EPP/ EMP provisions for clearing, grubbing.	Low	Limited to water pipeline ROW footprint, about 10 ha.	• Short term loss in Pipeline ROW (Decommissioning phase).	R	Similar habitat in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.8 Wetlands

10.8.1 Threshold for Determination of Significance

A significant adverse effect from the Project on wetlands is defined as an effect that is likely to cause a permanent net loss of wetland function as established during the wetland evaluation.

An adverse effect that does not cause a permanent net loss in wetland function is considered to be not significant.

10.8.2 Effects on Wetlands

As described in Section 9.4.2, field surveys have identified 13 wetlands within or near the LNG facility (Figure 9.4-2) and numerous others along the preliminary water supply pipeline route (Figure 9.4-4). All of the wetlands identified are smaller than 1 ha in total area and most are under 0.5 ha. Twelve of the wetlands within the Project footprint will be partially or completely infilled, totalling approximately 3 ha. Several more will be temporarily disturbed by pipeline crossing. These are summarized in Table 10.8-1. A wetland field survey, delineation and functional assessment report is provided in Appendix E.

Table 10.8-1 Summary of Predicted Impacts on Wetlands

Wetland #	Type	Size (ha)	Predicted Impact
WL1	Bog/Fen/Swamp/Marsh	0.17	Infilled during construction.
WL2	Herb Fen	0.20	Infilled during construction.
WL3	Fen/Bog/Marsh	0.19	Infilled during construction.
WL4	Fen	0.15	Infilled during construction.
WL5	Fen	0.32	Infilled during construction.
WL6	Shrub/Treed Fen	0.10	Infilled during construction.
WL7	Shrub Bog	0.1	Currently avoided but near the Project boundary.
WL8	Shrub Swamp/Fen	0.62	Infilled during construction.
WL9	Coastal Saline Pond	0.61	Partially infilled (0.36 ha) during construction.
WL10	Shrub Swamp	0.05	Currently avoided but near the Project boundary.
WL11	Treed Bog	0.44	Partially infilled (0.31 ha) during construction.
WL12	Treed Swamp / Fen	0.17	Infilled during construction.
WL13	Treed Bog	0.19	Infilled during construction.
Numerous small wetlands occur along the preliminary water supply pipeline route. These are composed of several wetland types; commonly present in the surrounding landscape.			Short pipeline crossing with temporary disturbance. Allowed to revegetate naturally, with management of trees and tall shrubs.

Wetlands can be adversely affected by direct removal, fragmentation, disturbance, erosion/ sedimentation, and changes to hydrology, introduction of invasive species and release of hazardous materials. These impacts can interfere with wetland function, including species diversity. The effects can result from short term activities during the construction phase and decommissioning phases, as well as long-term activities during the Project operation. Runoff from acid generating slates exposed due to construction activities is a potential and may negatively impact wetland habitat should runoff from this material enter this habitat type.

10.8.2.1 Construction

Directly Impacted Wetlands

Wetlands 1, 2, 3, 4 and 13 (WL1 – WL4 and WL13) are associated with the unnamed tributary that flows along the western side of the LNG facility (Figure 9.4-2). This stream was determined to contain a number of fish species including American Eel and Brook Trout and as such, these wetlands were determined to provide critical wetland functions or important hydrological benefits. Plant SOCC were found in WL2 and WL3 however none of the wetlands were identified as providing critical habitat for SAR. All of these wetlands are small and of common types in the region. All of these wetlands will be completely infilled; therefore approximately 0.9 ha of wetland habitat providing "critical wetland function" will be lost.

Wetland 5, 6, 8, 11, and 12 (WL5, WL6, WL8, WL11 and WL12) are not of high value in terms of wetland function, and belong to a wetland class that is common both in the vicinity of the wetland and in NS. All of these wetlands do not support rare plant species, and are not considered to provide important wildlife habitat. Wetland 5, 6, 8 and 12 will be completely infilled and wetland 11 will be partly infilled (0.31 ha) therefore approximately 1.52 ha of relatively common "low value" wetland habitat will be lost.

Wetland 9 (WL9) is characterized as a coastal saline pond wetland type with low vegetative diversity but providing moderate habitat for birds. It is located within the proposed footprint of the marginal wharf and will be partially infilled (0.36 ha) resulting in the partial loss of wetland habitat and associated functions. This wetland type is somewhat limited in the overall landscape, but does not provide critical habitat or support SAR.

A wetland alteration approval will be obtained from NSE prior to construction in any of these wetlands. In conjunction with this approval, compensation will be developed for the loss of these wetlands, as NS aims to prevent net loss of wetland function. The compensation plan will be subject to approval by NSE.

Potentially Impacted Wetlands

A number of wetlands have been identified in close proximity to the Project footprint both at the LNG facility (Figure 9.4-2; WL7 and WL10) and along the water supply pipeline route (Figure 9.4-4). Since the Project is in the pre-FEED design stage, it is possible that they may be directly impacted, indirectly impacted, or avoided, pending further design development. These wetlands are considered to be potentially impacted by Project activities such as increased sedimentation, alterations to hydrology, impacts resulting from accidental spills or dust / runoff from roads.

Wetland 10 (WL10) (0.05 ha) is located just outside of the proposed Project footprint, downstream of WL4 along the unnamed stream (refer to Section 9.4.2, Figure 9.4-3). WL10 has been classified as a riparian shrub swamp. This wetland may be impacted indirectly by Project activities that cause sedimentation in the wetland burying vegetation and altering habitat characteristics. The unnamed stream on which this wetland is located will be significantly altered by construction; which could alter hydrology within WL10.

Wetland 7 is located just outside the Project footprint at the southeast boundary (Figure 9.4-3). It is a small (0.1 ha) shrubby bog with relatively low value in terms of wetland function, and belongs to a wetland class that is common both in the watershed and in NS. It does not support rare plant species, and is not considered to provide important wildlife habitat. It could be indirectly impacted by uncontrolled site runoff leading to sedimentation, changes in hydrology, dust deposition, or accidental spills.

Numerous small wetlands are located along the water supply pipeline route (Figure 9.4-4) that may be directly or indirectly impacted by construction. Since the pipeline routing is subject to further design modifications and property related issues, it may change slightly at any location. Therefore, no attempt has been made to quantify the amount of wetland area impacted by the pipeline construction. It is estimated that the pipeline may be located in or near 10 to 15 small wetlands that will be subject to construction related effects. Such impacts would be temporary and the wetlands would be allowed to revegetate naturally following construction, with the exception that trees and tall shrubs would not be allowed over the pipeline.

The following discussion of potential impacts applies to all wetland areas in close proximity to the Project footprint.

Wetlands depend on a certain level of soil humidity. If the water regime is changed, so will the vegetation, character and functionality of the wetland. In addition to the direct impacts due to localized infilling, wetlands surrounding the Project footprint could potentially be adversely affected by changes to the hydrology, due to impeded drainage caused by the construction of the LNG facility or water supply pipeline. Wetlands located upgradient of the proposed construction may be flooded if drainage is impeded. In wetlands located down-gradient could be adversely affected if surface water flow, including streams, decreases. If stormwater from the roads which is collected in roadside ditches is allowed to enter these wetlands in amounts exceeding natural pre-construction flow, similar adverse effects are likely.

All of the above wetlands could also be adversely affected by sediment runoff during construction activities. Exposed soil associated with earth movement, site clearing, grubbing, grading, stripping and storing of topsoil or construction materials and reclamation of the Project site during decommissioning, may result in erosion and subsequent sedimentation. Sediments carried into wetlands could smother existing vegetation, but may also contribute nutrients to the wetlands. Changes in nutrient levels will change water quality and potentially plant communities in the wetlands. Effects would be greatest in low nutrient systems such as treed bogs and shrub bogs, and would likely result in adverse effects on wetland function.

Dust and minerals from road runoff may have similar effects. Most fugitive dust will be formed during the construction phase or decommissioning phase from soil movement, soil and material storage, and the movement of construction equipment and transportation vehicles. The dust may cover native vegetation and smother it, but dust also deposits minerals and nutrients into the wetlands.

Wetlands in close proximity to the Project footprint may be adversely affected if accidental spills of deleterious substances such as fuels, lubricants or engine oil occur during the operation of construction and transportation equipment.

Where construction activities occur in wetlands, there is potential for introduction of invasive species. Seeds, roots or "rootable" fragments of invasive species may be stuck to construction equipment, transportation vehicles or shoes of workers. These propagules may be introduced into wetlands directly when equipment or people access the wetlands, or indirectly via runoff or dust from the roads. Invasive species such as Purple Loosestrife (*Lythrum salicaria*), are known to severely degrade wetland habitat and thus one or more of wetland functions. The potential for introduction of invasive species is highest in wetlands in or near the construction zone, including lay-down areas, followed by wetlands downstream or downgradient of those areas. Since the amount of traffic during construction will be increased over current levels, especially long distance traffic, the likelihood of introduction of invasive species is elevated. However, during the field surveys carried out in 2012 and 2013, no Purple Loosestrife was noted in the Project area.

Wildlife using the wetlands near the construction zone as habitats may be disturbed by noise or lights, or impacted by accidental spill of hazardous materials such as fuel or lubricants from construction and transportation equipment during the construction and decommissioning phases. These effects are discussed in Section 10.9 and Section 10.17.

10.8.2.2 Operation

During the operation phase, wetlands located in close proximity to the Project footprint can be adversely affected by release of hazardous materials during maintenance activities or accidents and malfunctions, dust/ sedimentation, introduction of invasive species, as well as disturbance.

The unmanaged use of road salt for winter safety may adversely affect vegetation and water quality in wetlands. Road salt is a toxic substance, controlled under CEPA that can harm wildlife. Road salt runoff can influence vegetation species composition in wetlands, though the area would be very small.

Maintenance of roadsides, water supply pipeline ROW and the LNG facility grounds will involve vegetation management. If herbicides are used indiscriminately, wetland vegetation and wildlife could be adversely affected. These effects would be limited to wetlands immediately adjacent to the Project.

Fugitive dust and sediment runoff from roads during operation are not likely to adversely affect wetlands, since the amounts of material are expected to be very small.

The potential for introduction of invasive species carried on vehicles operated on roads is much lower during operation, since traffic volumes will be relatively low and disturbed wetland soils will be revegetated. During maintenance of the water supply pipeline, the potential for introducing invasive species would be similar to construction.

During the operation phase, wildlife in wetlands may be disturbed by noise and lights from the LNG facility. Potential impacts on terrestrial fauna are described in Section 10.9, below.

10.8.2.3 Decommissioning

The effects of Project activities during the construction and the decommissioning phase are similar, as are proposed mitigation measures.

10.8.3 Mitigation

Mitigation measures are outlined for each potential adverse effect. Mitigation measures developed for the protection of surface water quality and fresh water fish and fish habitat (Sections 10.3 and 10.10, respectively) will also protect wetlands. The potential effects of spills, malfunctions and accidents and recommended mitigation measures are discussed in Section 10.17. A wetland specific EEM program shall be implemented immediately post-construction to confirm the predictions of the EA and to identify any unforeseen wetland impacts.

To reduce disturbance and eliminate loss of wetland function in directly impacted wetlands:

- Wetland areas will be avoided to the extent feasible during Project design and planning.
- Where wetlands cannot be completely avoided, the Project footprint in the wetland area will be minimised to the extent possible.
- A wetland alteration permit will be obtained from NSE, prior to construction.
- Wetland functions will be assessed for all potentially disturbed wetlands and the amount and type of functions lost (if any) will be determined.
- Where a permanent loss of wetland function is identified, a compensation plan will be developed, subject to approval by NSE.

To prevent impacts on wetland hydrology:

- Where infrastructure cuts across diffuse natural drainage paths, drainage structures of sufficient size shall be installed to maintain water flow to and from wetlands at pre-construction levels.
- Drainage structures should be designed to dissipate the hydraulic energy and maintain flows at velocities sufficiently low to prevent erosion of wetland soils.
- If road crossings are proposed in wetlands (if any), the design will allow for regular diffuse surface runoff to seep through. This would be enhanced by using permeable road fill (clean shotrock) near the soil surface for additional cross drainage in areas where increased surface flow is expected. Geotextile may be used to maintain the pore space in the permeable road fill.
- To the extent feasible, clean site runoff will be managed so that the amount of water entering adjacent wetlands is similar to pre-construction levels.
- Runoff collected along the roads should not be allowed to enter directly into wetlands, but shall be directed into vegetation buffers around wetlands.
- Integration of existing/remnant wetlands will be considered in the Stormwater Management Plan and in the EMP.

- The EEM program will identify any vegetation changes or new formation of wet areas adjacent to Project components that would be a sign of a disrupted hydrologic regime.

To prevent impacts on wetlands from erosion/sedimentation or dust:

- General erosion and sediment control measures will be established in the Project EMP and implemented on site to prevent or minimize erosion and subsequent site runoff into nearby wetlands and surface waters while soils are exposed and de-stabilized.
- Uncontaminated drainage shall be directed away from the area of construction into a wooded area, at least 30 m from any wetland or watercourse.
- Prior to construction, develop a site-specific erosion and sediment control plan including installation of silt fences or cofferdams.
- Keep ground disturbance to a minimum and stabilize disturbed areas immediately following completion of construction activities.
- Dust control will be established in the Project EMP, such as covering of stored construction materials and dust abatement measures in dry weather.
- Efficacy of the erosion and sediment control measures should be monitored regularly and when high precipitation events are forecast.

To prevent the introduction of invasive plant species into wetland areas:

- Prior to entering to the Project site, construction and transportation equipment will be cleaned to remove vegetation and soil residues.
- Equipment will also be cleaned prior to leaving a site where it has been used in other wet or wetland areas.
- Site rehabilitation in and near wetlands will utilize natural vegetation species. Hydro-seeding with commercially available seed mixes may be acceptable, depending on the composition. Experience has shown that, in general, native wetland species gradually replace the ‘alien’ species in the seed mixes while the wetlands recover.
- The EEM program will detect the presence of any noxious weeds in wetland areas. Where Project related activities have resulted in the introduction of noxious weeds, a program of removal and monitoring should be established until the introduced plants have been eradicated. Since the biggest threat to wetlands is from Purple Loosestrife, the monitoring should be carried out in late summer, likely August, when it is in bloom. Any invasive plants found should be dug up and properly destroyed in order to avoid further distribution.

To prevent impacts on wetland habitat from contaminated runoff:

- Vegetation management in or near wetlands will be conducted by hand cutting.
- Approved herbicides may be used for the ROW maintenance only if mechanical means are not effective.
- Herbicides will be applied according to regulations and manufacturer instructions.
- Potentially contaminated site runoff will be directed to the on-site wastewater treatment system.

10.8.4 Summary and Residual Effects

Project related activities are not likely to result in significant residual adverse impacts on wetland habitats after the successful implementation of recommended mitigation measures, including compensation.

Table 10.8-2 provides a summary of recommended mitigation measures and residual environmental effects after successful implementation of these mitigation measures.

Table 10.8-2 Residual Environmental Effects Summary for Wetlands

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non-reversible)	Ecological/ Social-cultural and Economic Context	
Construction								
Wetland removal or loss of wetland functions as a result of infilling and development activities.	A	• Avoid wetlands during Project design and layout where practical. • Minimize Project footprint. • Lay-down areas and construction camps not to be located in or near wetlands. • Workers will be instructed not to enter wetlands. • Wetlands which will be subjected to partial or total infilling to be formally evaluated in terms of wetland function. • Develop a wetland compensation plan in conjunction with the wetland alteration approval.	Low	3 ha	Permanent	NR	• Similar habitat exists in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minor
Alteration of wetland hydrology.	A	• Stream crossings to be constructed with culverts of sufficient size (also see Section 10.3 and Section 10.10). • Drainage structures of sufficient size to be constructed where infrastructure cuts across diffuse natural drainage paths, drainage channels and wetland habitat. • Drainage structures to dissipate hydraulic energy and maintain flow velocities sufficiently low to prevent erosion of native soil material. • Crushed rock used for road construction to allow for regular diffuse surface runoff to seep through.	Low	Local; depends on size of affected wetland.	Construction and Decommissioning Phase; once per wetland.	R	• See above.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non-reversible)	Ecological/ Social-cultural and Economic Context	
		• Stormwater Management Plan to maintain pre-construction flow conditions off-site. • Runoff collected along the roads not to enter directly into wetlands. • Runoff from the LNG facility to be collected and treated in a stormwater facility before discharge into the surrounding environment (see EMP-Stormwater Management Plan). • Maintain a vegetated buffer zone of 20 m minimum around wetland. • Implement EEM program to identify any signs of changed hydrologic regime.						
Alteration of water quality from sediments and dust.	A	• Maintain a vegetated buffer zone of 20 m minimum around wetlands. • Implement Stormwater Management Plan • Implement erosion and sediment control plans specifically for the wetland crossings (see EMP). • Implement dust control plan (see EMP). • Monitor efficacy of the erosion and sediment control measures.	Low	Local; depends on size of affected wetland.	Construction and Decommissioning Phase/ Infrequent.	R	• See above.	Minimal
Reduction in wetland functionality due to the introduction of invasive species.	A	• Construction and transportation equipment to be cleaned of vegetation and soil residues before entering the Project site. • Monitor and remove noxious weeds.	Low	Local; depends on size of affected wetland.	Construction and Decommissioning Phase/ Infrequent.	R	• See above.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non-reversible)	Ecological/ Social-cultural and Economic Context	
Operation								
Impacts from contaminated site runoff and vegetation management.	A	• Vegetation growth generally to be managed by physical cutting. • Approved herbicides may be used for the maintenance only if necessary. • Herbicides to be applied according to legal regulations (NSE). • Implementation of mitigation measures for the protection of watercourses (see Section 10.3 and Section 10.10) • Implement all measures of EMP.	Low	Local; depends on size of affected wetland.	Short term/ infrequent	R	• See above activity.	Minimal
Reduction in wetland functionality due to the introduction of Alien invasive species.	A	• Monitor and remove noxious weeds.	High	Local; depends on size of affected wetland.	Permanent/ Infrequent	R	• See above.	Medium (unlikely)

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.9 Terrestrial Fauna

A discussion of potential impacts of the construction, operation and decommissioning phases of the Project on common terrestrial fauna is presented below.

10.9.1 Threshold for Determination of Significance

A significant adverse effect of Project components or activities on terrestrial fauna is defined as an effect that causes a decline in abundance and/ or a change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its pre-project level within several (three to five) generations. An adverse effect that does not cause such declines or changes is not considered to be significant.

10.9.2 Effects on Terrestrial Fauna Other Than Birds

10.9.2.1 Effects of Construction

Habitat removal and fragmentation will result in displacement of wildlife within the Project footprint. Species that can move easily will likely move to similar habitats elsewhere, if such habitat is available; however, ultimately, there will be a detrimental effect on terrestrial wildlife populations within the Project area. These effects will be non-reversible for the duration of the Project lifetime. During construction activities, temporary and reversible effects from noise and dust generation may also affect terrestrial wildlife in and around the Project area. Potential effects on terrestrial fauna SAR and SOCC are described in Section 10.12.

Invertebrates (Odonates and Lepidopterans)

Some loss of Odonate breeding and feeding habitat is expected from the loss of wetlands, ponds and riparian areas within the Project area. Dust from construction activities may contribute to sediment loading in watercourses, somewhat altering aquatic habitats. Lepidopterans will be most affected by the loss of larval foodplants, which varies from species to species; adults are highly mobile and therefore able to avoid areas impacted by Project activities.

Herpetiles

The loss of ponds, wetlands and riparian areas in the Project area will result in habitat loss for local amphibians and for turtles, and increased sedimentation from dust generated by construction may further impact aquatic habitats. Snakes may utilize much of the Project area, and will be impacted by habitat loss as well as increased fragmentation which may inhibit movement between areas of suitable habitat.

Mammals

A number of furbearers have potential to occur in the Project area. Habitat removal and disturbance due to human activities may result in some or all of these species being extirpated from the area. Impacts on other mammals are also expected to be mainly related to loss and fragmentation of habitat.

The Project area supports a large number of deer throughout the year, and is a known deer wintering area. Clearing and construction activities are expected to slightly reduce the available area used by deer and interrupt local movement to and from adjacent areas of suitable habitat.

Project related noise may cause deer in immediately adjacent areas to flee temporarily. The furbearers and wintering deer populations in the local area may temporarily move elsewhere along the coast toward Drum Head and Seal Harbour, during the construction period. Local populations are likely to return to normal after construction is complete.

Mammal species with special status, such as Moose, and bats (*Myotis lucifugus and M. septentrionalis*) occur in the Project area, and possibly also fisher. Potential for impacts on such species are presented in Section 10.12.

10.9.2.2 Effects of Operation

Potential effects of the operation phase of the Project are anticipated from increased noise and disturbance from traffic and other human activities at the LNG facility. Local nocturnal species may be attracted to and/or disoriented by changes in ambient lighting.

Invertebrates (Odonates and Lepidopterans)

No additional impacts on odonates and butterflies are expected during the operation phase. Moths may be attracted to new artificial lighting on the Project site, increasing the risk of predation.

Herpetiles

No additional impacts on snakes are expected during the operation phase; additional impacts on turtles and amphibians may occur if water levels or surface water drainage patterns were to change, and/or if there is a change in water quality from operational procedures.

Mammals

Project operation may cause changes in the diversity and relative abundance of local mammal populations, such as potential increase in red fox, raccoon and striped skunk that are well adapted to human presence. This effect could be exacerbated if good housekeeping practices are not maintained on-site.

10.9.2.3 Effects of Decommissioning

Impacts during decommissioning are expected to be similar to construction but of much shorter duration. The condition of the site after decommissioning will depend on the future use by the next owner or the municipality, but it is likely that the site will not be rehabilitated to wildlife habitat since the property is within an industrial park zone. Therefore, reduction in available habitat for local populations and increased fragmentation will probably be permanent.

10.9.3 Effects on Birds

A discussion of potential impacts of the construction, operation and decommissioning phases of the Project on birds is presented below. Since the potential effects and mitigation for avian SAR and SOCC is identical to non-SAR birds, they have been included in this discussion.

10.9.3.1 Effects of Construction

Landbirds (including Raptors and Passerines)

The main impact on landbirds will be the loss of nesting and foraging habitat. Further, vegetation clearing and grubbing activities may cause destruction of nests and nestlings or eggs if conducted

during the breeding season (May 1st to August 31st). Breeding evidence has been observed for several species within the Project footprint, including eight landbird SAR and SOCC (Short-eared Owl, Common Nighthawk, Olive-sided Flycatcher, Common Loon, Barn Swallow, Boreal Chickadee, Grey Jay and Canada Warbler). Up to 150 ha of terrestrial bird habitat may be removed. Habitat within the Project area consists mostly of coniferous forest of varying ages due to repeated cutting; although some mature forest has been identified in the Project area (Figure 9.4-1), it is unlikely to be sufficiently large to provide habitat for forest interior species.

In addition to habitat loss, construction noise may have deleterious effects on animals in and near the Project area. Flushing of nesting birds may result in decreased productivity due to increased nest predation and stress to adult birds affecting foraging behaviour (Beale, 2007); as well, birds may leave the Project area and be forced to move to less favourable nesting sites (Larkin 1996). The data regarding effective distance due to noise disturbance are relatively few and conflicting, with various field studies showing effects from edge of area of disturbance to 200 m. Construction noise can interfere with normal bird behaviour, such as feeding, migrating, and breeding. The distance of effect is of course related to noise volume and quality. Negative effects from noise vary from species to species because of interspecies differences in both hearing abilities and in behavioural and physiological responses to stimuli. In addition to interspecies differences, there is considerable intraspecies variation in vulnerability to effects of noise, for example in different times of year (i.e., different stages of the breeding cycle) and different life stages (Blumstein *et al.,* 2005). The effects of noise on the site due to construction are expected to be temporary and short-term.

Shorebirds

Pipeline construction is planned to occur on the beach and dike at Betty's Cove; this area provides potential feeding habitat for wintering Purple Sandpipers, and Greater Yellowlegs are known to breed here (AMEC, 2006). Disturbance due to construction noise is expected to have minor impacts on breeding and/or wintering shorebirds, depending on when the activities take place. As well, Greater Yellowlegs have been reported to be nesting at Meadow Lake. Changes to hydrology of the lake could potentially result in habitat alteration or habitat loss for Greater Yellowlegs.

Seabirds and Waterfowl

Waterfowl along the marine shoreline and inland ponds and lakes may be disturbed by noise from blasting and other construction activities, but these effects are likely to be temporary and minor. Waterfowl and loons potentially nesting at Meadow Lake may be negatively affected by habitat loss or alteration, if water use is such that it impacts the water level of the lake; however, this is unlikely under the current water use anticipated.

Seabirds nest on a number of offshore islands and other inaccessible coastal areas, notably Goose, Harbour, and Country Islands. A large tern colony supporting a significant number of breeding Roseate Terns exists on Country Island; at a distance of over 9.0 km, this colony is sufficiently far from the Project area that no disturbance at the colony is anticipated. Minor disturbance of foraging terns from blasting and other construction noise may occur; however, the results of foraging studies indicate that Roseate Terns only rarely use the waters near the Project

area for foraging (Section 9.7). Gulls, cormorants, and Common Eiders nest on Goose and Harbour Islands; of these, eiders represent some concern, but they are believed to be sufficiently distant from the Project area that no impacts at the colony are anticipated.

10.9.3.2 Effects of Operation

Landbirds (including Raptors and Passerines)

Increased human activity associated with the operation phase is expected to result in an increase in populations of species that are adapted to human environments, including European Starlings, American Robins, Common Grackles and Rock Pigeons; these species may compete with native woodland and forest edge birds.

The LNG facility (particularly flare stacks, LNG jetty and the Marginal Wharf) will of necessity be well-lit with high intensity lighting at night, and although the lighting will be directed as narrowly as possible by shielding, these lights may have disorienting effects upon migrating landbirds, causing collisions leading to death. In addition to collisions, there is potential for mortality resulting from birds flying too close to flares; this is particularly a concern at nighttime during migration season. Little information exists on bird mortalities involving flare towers. Incidents have been been reported but seem to be extremely rare.

Shorebirds

Increased human activity around the Marginal Wharf will result in increased disturbance to fauna in the surrounding coastal environment, including shorebirds that may be feeding in the area. Accidental spills and releases from marine traffic could result in the direct physical exposure of birds to oil within the affected area; effects of accidents and malfunctions are discussed in Section 10.17.

Waterfowl and Seabirds

Increased shipping activity associated with the Project will cause disturbance to seabirds and waterfowl in the waters off the Project site. The possible effects of marine vessel traffic on birds in the offshore environment include behavioural changes (e.g., avoidance, stress response) that may have energetic consequences (Schummer and Eddleman, 2003), and loss of suitable feeding habitat as vessel traffic can reduce bird use of vessel disturbed areas (Bramford *et al.*, 1990). Increased vessel traffic is not anticipated to cause disturbance at the Roseate Tern colony on Country Island; however, adults may encounter disturbance at feeding sites. Accidental spills and releases from marine traffic could result in the direct physical exposure of birds to oil within the affected area, with possible lethal and sublethal effects; effects of accidents and malfunctions are discussed in Section 10.17.

10.9.3.3 Effects of Decommissioning

During decommissioning, increased human activity, noise and dust are expected to have temporary negative effects on local terrestrial wildlife populations (including birds). Local populations are expected to return to normal following decommissioning activities.

10.9.4 Mitigation

Generic mitigation measures related to fauna are listed below. For specifics on mitigation related to Moose and bats refer to Section 10.12.5.2. Mitigation for potential impacts on marine shorebirds, waterfowl and marine birds from shipping are identical to other marine fauna, as described in Section 10.11.

Mitigation measures for potential impacts during decommissioning are similar to those outlined for the construction phase. Decommissioning activities will be carried out in accordance with all applicable regulatory requirements at the time and a decommissioning plan will be developed.

During Construction:

- Reduce Project footprint and temporary work areas to the extent possible.
- Clearing and grubbing should be restricted to areas absolutely necessary to carry out the Project.
- Dust-prevention measures and dust abatement measures shall be implemented.
- Workers will be instructed to maintain good housekeeping practices and not leave any food items and garbage at the Project site in order to avoid attracting omnivorous predators which may disturb or cause direct mortality or injury to wildlife (including birds).

To minimize impacts on nesting landbirds:

- Vegetation clearing should be avoided during the nesting season (May 1 to August 31). Particular care will be taken that trees with a width of 15 cm or more are not cut down unnecessarily. With implementation of these mitigation measures, significant adverse residual effects on birds are not likely.
- If an Osprey, Bald Eagle or Northern Goshawk nest is found within the forested areas to be cleared, even outside of the breeding season, a buffer zone must be placed around the nest and clearing can only occur outside of the buffer zone.
- Mitigation measures are particularly important during the breeding season when nest failure could result if incubating adults are repeatedly flushed from active nests.
- All construction equipment should have appropriate noise-muffling equipment installed and in good working order in order to minimize noise disturbance. The duration of noise disturbance should be minimized. Lighting should be restricted to areas where it is necessary.
- To minimize interference of nesting activities from noise and human presence, workers will be encouraged to refrain from entering surrounding undisturbed habitat areas where no work is done, as those areas likely hold the largest number of birds.
- In the event that impacts on migratory birds are detected during construction, further mitigation will be developed in consultation with NSDNR and EC.

During Operation:

- Lighting should only be used where required by TC regulations.

- Where possible, obstruction lighting marking tall stacks will use lights with short flash durations and the ability to emit no light during the “off phase” of the flash (i.e., LED lights), with the minimum number of flashes per minute and the briefest flash duration allowable, as recommended by EC’s CWS (2007b).
- White lights will be preferred for use on towers or high structures at night, as recommended by the US Fish and Wildlife Service (2003);
- Solid red or flashing red lights will be avoided as they appear to attract nocturnal migrants more than white flashing lights (US Fish and Wildlife Service, 2003);
- High intensity lights, including floodlights, will be turned off at night when the terminal is not in use if possible, especially during the spring and fall migration period;
- Frequency and intensity of flaring will be minimized to the extent possible;
- Where feasible, tinted or frosted glass windows will be used in buildings to reduce bird mortality from collisions, as recommended by Erickson *et al.,* 2005.

10.9.5 Summary and Residual Effects

Table 10.9-1 provides a summary of recommended mitigation measures and residual environmental effects after successful implementation of the above mitigation measures.

With the successful implementation of these mitigation measures, Project activities related to construction, operation and decommissioning of Project components are not likely to result in significant adverse residual adverse effects on terrestrial fauna, excluding SAR (which are discussed in Section 10.12).

Table 10.9-1 Residual Environmental Effects Summary for Terrestrial Fauna

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Loss of habitat for terrestrial wildlife, including landbirds.	A	• Minimize Project footprint.	Low	Limited to Project footprint (about 150 ha).	• Short- term loss: temporary work camp (16.5 ha; construction phase). • Long-term alteration: water supply pipeline ROW (about 10 ha). • Permanent loss: LNG facility, Meadow Lake water intake structure (about 120 ha).	R; LNG facility: NR during lifetime of Project.	Similar habitat exists in the region. Area is affected by past and human activity; pristine areas not known. Designated Industrial Park.	Minor
Fragmentation of terrestrial habitat in and around the Project area.	A	• Minimize Project footprint; maintaining connectivity between areas of similar habitat where possible.	Low	Project footprint and adjacent areas of similar habitat.	• Construction and Operation Phase.	NR	Habitats in the Project footprint are not unique; fragmentation already exists from the presence of the highway, pipeline, and SOEI plant.	Minor
Disturbance of terrestrial fauna due to construction activities (noise, dust generation).	A	• Implementation of EPP.	Low	Limited to Project footprint and a 200 m buffer (noise).	• Construction phase; Decommissioning phase.	R	Nearby areas are already subject to disturbance by human activities (SOEI plant, highway).	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Destruction of active migratory bird nests during vegetation clearing.	A	• Avoidance of the breeding bird season.	Low	Limited to Project footprint.	• Construction phase.	NR		Minor
Operation								
Disturbance of terrestrial fauna due to increased human presence.	A	• Implementation of EPP.	Low	Limited to Project footprint.	• Operations phase.	R	Nearby areas are already subject to disturbance by human activities (SOEI plant, highway).	Minimal
Loss or degradation of habitat for aquatic herpetiles and aquatic-nesting bird species (loons, waterfowl).	A	• Ensuring that water draw from Meadow Lake does not result in a change in hydrology. • Implementation of EPP. • Treatment of water to government standards prior to discharge. • Monitoring of discharge quality.	Low	Meadow Lake and on-site watercourses.	• Operations phase.	R	Not considered ideal habitat for aquatic herpetiles of special status.	Minimal
Increased lighting attracting and/or disorienting nocturnal wildlife, including migrating birds.	A	• Minimizing use of lighting and flaring to the greatest extent possible.	Low	Project footprint.	• Operations phase.	R	Project site is not considered part of a major avian migration corridor. No protected moth species expected in Project area.	Minor
Increased shipping activity causing disturbance to seabirds and waterfowl.	A	• Implementation of EPP. • Refer to marine fauna VEC.	Low	Shipping routes offshore near the Project area.	• Operations phase.	R		Minor

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Increased numbers of human-adapted bird species competing with native species.	A	• Implementation of EPP; proper housekeeping practices and avoiding activities that may entice bird species.	Low	Project footprint and adjacent habitat.	• Operations phase.	R		Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.10 Freshwater Aquatic Species and Habitat

The following section describes potential effects from the Project on the freshwater aquatic environment described in Section 9.5.

10.10.1 Threshold for Determination of Significance

A significant adverse effect on aquatic habitat and species would be a net loss of habitat, a decline in abundance and/ or a change in distribution of species beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its pre-project level within several (3-5) generations. A significant adverse effect on sensitive/ critical habitat would be a permanent net loss of habitat or habitat function.

In addition, refer to Section 10.3.1 regarding CCME guidelines (CCME, 2002) for the protection of freshwater aquatic life (FWAL).

An adverse effect that does not meet the above criteria is evaluated as not significant.

A positive effect is one that may enhance the quality of habitat, increase species diversity, and increase the area of valued habitat.

With respect to proposed water withdrawal at Meadow Lake, a provincial permit will be required. As part of the application, the sustainable yield will be calculated using flow-duration curves, in order to demonstrate that the proposed Project withdrawal is acceptable. Fisheries maintenance flow requirements would then be coordinated with DFO, when precise FEED level water demands are known. For the purpose of this EA, a withdrawal limit of 10% of baseflow has been chosen as the threshold of significance; which likely will be more conservative than the total withdrawal allowance based on the sustainability curve. The effects on surface water quality and quantity have been described in Section 10.3, above.

Effects to freshwater SAR and SOCC are discussed in Section 10.12.2.

10.10.2 Effects on Fish and Fish Habitat

As stated in Section 9.5.2, the diversity of fish species within the Project site is limited, but fish are present in the unnamed watercourse, Dung Cove pond and the brackish ponds at the coast. Of particular note is the presence of American Eel and Brook Trout, two species which have significance in relation to commercial, recreational, and Aboriginal fisheries. Both are also Priority species (COSEWIC Threatened or NSDNR Yellow, respectively) (see Section 9.7).

10.10.2.1 Effects of Construction

The construction phase will involve a wide range of activities which can potentially impact watercourses and waterbodies and the associated fish and fish habitats (where present) on the Project site. These include site preparation (clearing, grubbing, leveling, blasting), excavation, foundation construction, construction of buildings, utilities, equipment, and transportation of construction material. The construction phase will cover all aspects related to the construction of the LNG facility, the development of the temporary work camp, the Meadow Lake water intake

structure, and the Meadow Lake water supply pipeline. Effects on surface watercourses as discussed in detail in Section 10.3 also affect freshwater fish and fish habitat.

The Goldboro LNG facility was sited to avoid larger streams and, as much as possible, freshwater lakes or ponds. Nevertheless, one small unnamed watercourse running near the western edge of the Project site into Dung Cove Pond will need to be removed and drainage will be directed through a new open channel along the western site perimeter. Though it is quite close to the proposed causeway to the marginal wharf, Dung Cove Pond will remain in place and receive all waters from the newly aligned drainage channel. In addition, two brackish ponds contained within Wetland 9, will also be partially removed during the construction phase. This is discussed in Section 10.8. Fish are currently present in all of these waterbodies (see Section 9.5.2)

The removal of the unnamed watercourse and redirection of its waters to a drainage channel along the western site perimeter could result in displacement and/or loss of aquatic biota, in particular Brook Trout and American Eel, although some recolonization of the rerouted watercourse may take place over time.

The detonation of explosives in the vicinity of fish habitat may cause fish mortality, and may potentially affect the physical characteristics of fish habitat. The use of explosives may also result in the introduction of NH_3 and other detonation by-products into the aquatic environment. These contaminants can be lethal to fish and other aquatic biota (Wright and Hopky, 1998).

Site clearing and grading will take place within the spatial Project boundaries. These activities can lead to problems with sedimentation and siltation downstream, as well as changes to surface water hydrology and changes in stream flow volumes.

The changes in topography on the Project site, unless compensated, will result in permanent losses of freshwater aquatic habitat in the unnamed creek, as well as permanent changes to drainage, and diversion of runoff on and from the site. As well, the relative amounts of infiltration and runoff on the Project site footprint will change.

During the construction period, equipment and materials will be delivered by road and ship. Materials and equipment will be transported to the Project site by truck via Highway 316. Day-to-day transportation operations during construction activities are not anticipated to have an adverse effect on freshwater aquatic habitat. A discussion of potential accident and malfunction scenarios and associated effects on the environment is provided in Section 10.17.

There is potential for deleterious effects on freshwater aquatic habitat resulting from improper disposal of waste material. A variety of liquid wastes will be generated during construction, including oils and lubricants from equipment, and wastewater (i.e., sewage). Untreated discharge of these waste liquids into watercourses could have a deleterious effect on freshwater aquatic habitats and fauna.

The remains of three former gold mills and three tailings disposal areas have been identified within the Project area (see Section 9.1 for more detail). Soil samples collected from the three

tailings areas in 2008 exceeded the CCME guideline values for arsenic for sediments in both freshwater and marine environments, as well as for soil under all land uses. Disturbance of these areas could lead to deleterious effects on the unnamed watercourse, Dung Cove Pond, and potentially the marine environment and the associated fish and fish habitats. Impacts to Betty's Cove Brook are unlikely, given the locations of the known tailings deposit areas and the site topography.

Additionally, there is a potential for erosion as a result of construction activity that could affect the quality of the redirected drainage (formerly unnamed watercourse) and Dung Cove Pond. Increased siltation and turbidity would decrease freshwater quality, and could lead to losses of biota from suffocation. Runoff and erosion can also impact the freshwater environment through possible acid rock drainage from exposed acid-generating bedrock rock.

Meadow Lake Water Intake and Water Supply Pipeline

At Meadow Lake, a water intake structure is proposed consisting of a pump station and an in-take pipe (see Section 3.1). Construction related potentials for adverse effects are principally the same as those discussed above but would occur on a much smaller scale given the small geographic area affected. Refer to Section 10.3.2.1 for additional information.

During the installation of the water supply pipeline, two watercourses, Branch Gold Brook and Betty's Cove Brook, will be crossed. With the current layout, these water course crossings are located at the current M&NP pipeline crossings. The water pipeline will be buried and the watercourses will be crossed using an open trench method.

For a discussion of accidental events (e.g., spills) and associated potential effects on the environment including fish and fish habitat refer to Section 10.17.

10.10.2.2 Effects of Operation

Drainage from the unnamed watercourse will be redirected to a new drainage channel along the western site perimeter. There is potential for the operations phase to affect the water quality in this drainage channel and Dung Cove Pond and therefore affect fish and fish habitat located there.

A Stormwater Management Plan for the Project site will be developed during FEED. It is anticipated that much of the site will drain to the new channel on the western site perimeter and will continue to drain into Dung Cove Pond. Discharge of insufficiently treated water and surface runoff could potentially have a deleterious effect on freshwater and aquatic habitat quality in Dung Cove Pond. This could include contamination, erosion, increased turbidity, siltation, and possible acid rock drainage.

Meadow Lake Water Withdrawal

Meadow Lake has been identified as a source for water for the Project. It is expected that the Project will require 300 to 500 m^3 of freshwater per day. Refer to Section 10.3.2.2 for additional information.

For a discussion of accidental events (e.g., spills) and associated potential effects on the environment refer to Section 10.17.

10.10.2.3 Effects of Decommissioning

Effects associated with the decommissioning phase in all Project component footprints are expected to involve generally similar issues as those identified for the construction phase; however they are predicted to be of lesser magnitude. Demolition or renovation of buildings has the similar potential for contamination of runoff, but in general soil disturbance is expected to be much less than during the construction phase. No stream removal or relocation would be required during the decommissioning phase.

The specific effects on the freshwater aquatic environment will depend on the extent of the decommissioning. Of key importance would be the question of whether or not the Project site would be rehabilitated to pre-development or similar near- natural conditions. It is more likely that the key elements of the infrastructure (roads, water supply, and stormwater management) will remain in place to serve subsequent land uses in the industrial park. However, should the site be completely rehabilitated, it would provide an opportunity for beneficial effects through re-construction of watercourses and associated aquatic habitat. Any in-water works and works near existing watercourses would need to be conducted with the necessary mitigation measures to avoid and reduce temporary effects related to sediment loadings and potential accidental contamination (e.g., fuel spills). The decommissioning objectives and approach would be discussed first and foremost with DFO, NSE, and MODG and all other relevant stakeholders and would need to be implemented in compliance with the regulatory standards applicable at that time.

Potential effects of accidental events (e.g., spills) are discussed in Section 10.17.

The detonation of explosives in the vicinity of fish habitat may cause fish mortality, and may potentially affect the physical characteristics of fish habitat. The use of explosives may also result in the introduction of NH_3 and other detonation by-products into the aquatic environment. These contaminants can be lethal to fish and other aquatic biota (Wright and Hopky, 1998).

The removal of the unnamed watercourse and redirection of its waters to a drainage channel along the western site perimeter could result in displacement and/or loss of aquatic biota, in particular Brook Trout and American Eel, although some recolonization of the rerouted watercourse may take place over time.

10.10.3 Mitigation

Mitigation for potential impacts to the freshwater environment will take a variety of forms. Key components include minimization footprint during Project design phase, a Habitat Compensation Plan , a Tailings Management Plan and potentially a SBMMP. These are outlined in the following subsections. A list of all mitigation measures proposed to avoid, minimize and compensate impacts to the freshwater environment is provided in Table 10.10-1 below in Section 10.10.4.4.

10.10.3.1 Habitat Compensation Plan

The construction of the Project site and related works will result in the permanent loss of freshwater habitat. Construction of the LNG facility and associated marine terminal will result in the loss of one watercourse, along with its associated habitats and fish communities. Betty's Cove Brook may be affected by the levelling of the Project site, which may impact runoff volumes reaching the Brook, leading to decreased flows downstream. The *Fisheries Act* and relevant policies of the DFO require that Pieridae compensate for these losses/alterations to the satisfaction of DFO, with the objectives of achieving "no net loss" of fish habitat, and maintaining productivity and CRA fisheries. The loss of freshwater habitat, while not considered critical or limiting habitat for any of the species identified as being in the area, is not considered to be potentially significant. The implementation of measures outlined in the Habitat Compensation Plan will offset any such losses.

The location of the Project footprint will require a *Fisheries Act* Authorization for freshwater habitats (Marine Habitat impacts and mitigation are discussed in Section 10.11). DFO has determined that an Authorization under the *Fisheries Act* is required, triggering the requirement for offsets. A Fish Compensation Plan will be developed and implemented to mitigate losses of freshwater fish habitat resulting from the Project, in order to avoid serious harm to fish. Given the small size, poor habitat, and low population densities of fish within the unnamed water course, a productivity survey was deemed to be unwarranted. As part of the Plan, Pieridae will detail the habitat description provided in Section 9.5 and will determine, in consultation with DFO, the requirements for offsetting the loss in habitat/production. Further development of the plan and compensation options will occur following additional discussions with DFO.

The total quantity of habitat directly within the Project area will be quantified as per DFO guidelines and direction. Total habitat equivalent units will be calculated (1 unit = 100 m^2) of stream habitat (i.e., lost due to site development and Project infrastructure). The overall habitat equivalent unit's value is being used in determining the quantity and types of habitat that will be required for compensation.

Fish Habitat Compensation Options

Habitat compensation activities aim to achieve no net loss of productive aquatic habitat/production. The most preferred option would be rehabilitation occurring occur within the same watercourse. However, given the limited space along the western site perimeter and rather steep slope, potential for fish habitat compensation measures within the newly created drainage channel are considered limited. As such the recommended strategy is to for compensation to take place within the same or adjacent (sub-) watershed.

The three most promising options to mitigate the removal of the unnamed watercourse at this point in time are considered:

- enhancement of aquatic habitat in Crusher Brook (same watershed);
- enhancement of aquatic habitat in Betty's Cove Brook (adjacent watershed); and
- support for local First Nations fisheries organization.

While all options outlined below are considered candidates to improve habitat/production, all feasible options will be further assessed as part of the final Compensation Plan design and submission in order to determine the best overall net gain in productive capacity. It should be kept in mind that any undertaking will need to be conducted in concert with all activities within the area so that long-term benefits are realized and integrated. Consultation with the MODG regarding future development plans for the Goldboro Industrial Park are of particular importance, to ensure the long-term feasibility and sustainability of the selected compensation options.

Enhancement of Aquatic Habitat in Crusher Brook (Same Watershed)

Crusher Brook is a small watercourse located to the west of the Goldboro LNG property, and is located within the same watershed as the unnamed watercourse. This brook flows near old mine workings and appears to have been impacted by either mine dump material or subsurface mineralization. No data on fish species present within this watercourse are available, though it is likely that, at a minimum, Brook Trout and American Eel are present. Rehabilitation and/or enhancement of this stream could benefit fish populations, particularly salmonids, in the general area. Fish from the unnamed watercourse to be removed will also be captured and may be released into this watercourse if water quality will allow their survival.

Enhancement of Aquatic Habitat in Betty's Cove Brook (Adjacent Watershed)

Betty's Cove Brook is a watercourse located to the east of the Goldboro LNG property, in a different watershed than the unnamed watercourse. Assessment of the fish habitat/production within Betty's Cove Brook during 2008 identified approximately equal amounts of cobble, gravel, and sand, with smaller amounts of rock, cobble, sands and fines. Brook Trout and American Eel occur in this watercourse, as do several minnow species. Enhancement of spawning and rearing habitat within stream could benefit fish populations, particularly salmonids, in the general area. Fish from the unnamed watercourse to be removed will also be captured and released into this watercourse.

Support for local First Nations Fisheries Organization

Pieridae will consider available options for supporting a local fisheries and/or habitat enhancement organization. American Eels are known to occur in the unnamed watercourse and are of particular importance to First Nations as a fisheries resource. Brook Trout are a popular recreational fishery species in the area.

Options will be discussed with DFO, the MODG, local fisheries and First Nations organizations to determine the preferred solution.

10.10.3.2 Acid Rock Drainage

Bedrock geology at the Project site has been described as uniformly Goldenville Formation, containing alternating layers of sandstone and finer grained beds; however, smaller bands of Halifax Formation material (known for its acid generating potential) or similar material may be present which have not been previously mapped, particularly in small areas where highly mineralized zones are present (AMEC, 2006). As a precaution, prior to construction, samples from rock excavation areas will be tested for acid generating potential. If acid generating rock is determined to exceed the 500 m^3 regulatory volume, a management plan for the rock will be

developed for approval by NSE. The plan will consider the suitability of isolating the area through in-fill or construction of berms; stabilization; and/or excavation and disposal at a facility approved to accept such material. Options for use of the material to fill AMOs may also be investigated and implemented if feasible and acceptable to regulators.

10.10.3.3 Management of Contaminated Soils

As outlined in Section 10.1.3, known tailings disposal areas will be fenced and avoided where feasible. In the event that this is not possible, a comprehensive RMP will be developed and implemented. Tailings sites may also be encapsulated to prevent the emanation of dust, sediment, surface water, or groundwater. Options for use of the material to fill AMOs may also be investigated as part of the risk assessment and implemented if feasible, safe, and acceptable to regulators.

10.10.3.4 Mitigation Summary

Table 10.10-1 provides a summary for recommended mitigation for potential effects on the Freshwater Environment and Fauna. Mitigation measures as outlined in Section 10.3 will also protect freshwater fish and fish habitat.

Table 10.10-1 Mitigation Measures for Freshwater Aquatic Species and Habitat

Potential Effect	Mitigation Measures
Construction /Decommissioning Phase	
Permanent alteration/damage/destruction to aquatic habitat (HADD).	Habitat Compensation Plan (refer to Section 10.10.4.1).
Displacement or loss of aquatic biota.	Restore substrates.
	Complete works during periods of least biological activity/sensitivity. In water works to take place outside of spawning/fish migration season and will be conducted between June1st and September 30th.
	Prior removal (fish rescue) or exclusion of fish from work area.
Impacts from runoff and erosion. Siltation and turbidity of surface waters and potential loss of biota.	Use of suitable backfill materials.
	Restrictions on the removal of riparian vegetation.
	Establish a buffer zone of 20 m around freshwater habitat.
	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
	Erosion and sediment control measures will be implemented as described in an EMP. Measures will be specified in site-specific erosion and sediment control plans (temporary stormwater detention, sedimentation ponds, and open swale systems for drainage).
	Employ erosion and sediment control measures as per applicable guidelines (e.g., DFO *et al.,* 1981 and NSDE, 1988).
Acid rock drainage erosion to surface waters.	Perform pre-construction surveys and inspect excavations regularly.
	Obtain samples and develop a SBMMP if present (refer to Section 10.1.3).

Potential Effect	Mitigation Measures
	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
	Remediate contaminated soil promptly (if contaminated soils cannot be treated on site, dispose soils off-site at a licensed hazardous waste treatment facility).
	Erosion and sediment control measures will be implemented as described in an EMP. Measures will be specified in site-specific erosion and sediment control plans (temporary stormwater detention, sedimentation ponds, and open swale systems for drainage).
	Ensure Guidelines for Development on Slates in Nova Scotia and Sulphide Bearing Material Disposal Regulations are adhered to.
Permanent alteration of drainage patterns.	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
Non-permanent impacts from modification of freshwater habitat.	Conduct in-water works during non-critical periods.
	Establish a buffer zone of 20 m around freshwater habitat.
	Restrictions on the removal of riparian vegetation.
	Erosion and sediment control measures will be implemented as described in an EMP. Measures will be specified in site-specific erosion and sediment control plans (temporary stormwater detention, sedimentation ponds, and open swale systems for drainage).
Impacts from blasting activities (within or close to freshwater environments).	Manage timing, location, and technical specifications of blasting operations appropriately.
	Avoidance of ammonium nitrate and fuel-oil mixtures.
	Establish an EMP for blasting activities.
	Subdivide large charges, use blasting caps to produce a series of small discrete time-delayed detonations, where practical.
	Implementation and compliance with appropriate setback distances from fish and spawning habitat according to substrate types.
	Deployment of bubble/air curtains as appropriate to disrupt shock waves.
	Complete works during periods of least biological activity/sensitivity, where practicable.
	Removal or exclusion of fish from work area prior to blasting.
	Adherence to federal guidelines on blasting[1].
Impacts related to water crossings.	Conduct in-water works during non-critical periods.
	Adherence to federal and provincial guidelines on watercourse crossings.
	Establish a buffer zone of 20 m around freshwater habitat.
	Restrictions on the removal of riparian vegetation.

Potential Effect	Mitigation Measures
	Erosion and sediment control measures will be implemented as described in an EMP. Measures will be specified in site-specific erosion and sediment control plans (temporary stormwater detention, sedimentation ponds, and open swale systems for drainage).
	Open trench method for stream crossings in the water pipeline ROW; However, large diameter box culverts may be utilized elsewhere, if required. These culverts will be bank to bank with open bottoms, so as not to affect fish habitat in any way.
Impacts related to wastewater.	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
	Utilization of mobile sanitary wastewater treatment units approved under relevant regulations and guidelines to treat sanitary wastewater on-site, or holding tanks for sanitary waste management (determined following the FEED assessment).
Impacts related to contaminated soils.	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
	Remediate contaminated soil promptly (if contaminated soils cannot be treated on site, dispose soils off-site at a licensed hazardous waste hauler).
	Known tailings disposal areas will be fenced and avoided where feasible. A comprehensive RMP will be developed and implemented if this is not possible. Tailings sites may be encapsulated to prevent the emanation of contaminated dust, sediment, surface water, or groundwater.
Impacts related to the improper disposal of waste materials.	Excess construction materials will not be deposited in any watercourse/waterbody or anywhere where they could be reintroduced into the aquatic environment.
	Collect hazardous waste for disposal in accordance with an established waste management plan.
	Oil-water separation and sediment retention, and settling structures will be designed according to Canadian environmental regulation standards.
Accidental discharges and/or malfunctions.	Provisions for spill control outlined in a Contingency Plan.
	All fuelling and maintenance of construction equipment to be completed away from watercourses/waterbodies.
	All on-site fuels, oils, and chemicals stored >50 m from freshwater environments.
	Stormwater management system.
	Spill prevention and clean-up equipment and plans.
	Train all staff in the handling, storage, and disposal of hazardous materials.
	Store chemicals and other hazardous substances in designated locations and in accordance with the manufacturers' recommendations and federal and provincial regulations, where applicable.

Potential Effect	Mitigation Measures
	Utilization of an EPP/EMP prepared specifically for this phase that will prescribe of environmental management measures, mitigation, spill prevention protocols, contingency measures, responsibilities, supervision, and reporting requirements/measures.
Operations Phase	
Contamination, erosion, turbidity, and siltation of the freshwater environment from discharge of water and/or surface water runoff.	Use of suitable backfill materials.
	Line ditches with vegetation for erosion protection and sediment removal.
	Stormwater will be collected and treated to relevant provincial standards in a stormwater facility prior to discharge into Stormont Bay, as per a site-specific Stormwater Management Plan.
	Restrict removal of riparian vegetation alongside banks and ditches of watercourses.
	Oil-water separation and sediment retention, and settling structures will be designed according to Canadian environmental regulation standards.
	Erosion and sediment control measures will be implemented as described in an EMP. Measures will be specified in site-specific erosion and sediment control plans (temporary stormwater detention, sedimentation ponds, and open swale systems for drainage).
Accidental discharges and/or malfunctions.	See above under Construction.

Note:
[1] Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky, 1998).

10.10.4 Summary and Residual Effects

Table 10.10-2 provides the results of the effects assessment for the freshwater environmental habitat VEC for construction and operation phases of the Project. Effects associated with the decommissioning phase are expected to involve similar issues as those discussed for the construction phase.

If appropriate mitigative measures are applied, no significant residual adverse environmental effects on freshwater habitat are predicted to result from the Project. While the risk for encountering acid generating bedrock at the site is low (see Section 10.1), if it should be encountered during construction, acid rock drainage and waste material will be managed according to the Sulphide Bearing Materials Disposal Regulations and the Guidelines for Development on Slates in Nova Scotia (NSE and EC, 1991), which includes requirements for monitoring surface water runoff. In summary, standard feasible mitigation measures will be applied to minimize construction related environmental effects on freshwater habitat in the Project area. The Project-related residual adverse environmental effects on freshwater fish, and fish habitat are not likely to be significant.

Table 10.10-2 Summary of Mitigation and Significance of Residual Effects for Freshwater Aquatic Species and Habitat

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Displacement or loss of aquatic biota; permanent alteration/ damage/ destruction to aquatic habitat.	A	• Freshwater fisheries offset plan. • Restore substrates. • Complete works during periods of least biological activity/sensitivity. Prior removal or exclusion of fish from work area. • Conduct in-water works during non-critical periods. In – water works to take place outside of spawning/fish migration season and will be conducted between June1st and September 30th. • Fish salvage/removal program.	Low to Medium (> 1 permanent watercourse and a portion of 1 waterbody).	Project site and downstream freshwater habitats.	Permanent during lifetime of Project.	NR during lifetime of the Project	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minor
Effects on on - and off-site freshwater habitat as a result of potential runoff and erosion, siltation and turbidity.	A	• Use of suitable backfill materials. • Restrictions on the removal of riparian vegetation. • Establish a buffer zone of 20 m around freshwater habitat. • Management of stormwater quantity and quality to relevant provincial standards. • Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan. • Establish and implement EMP including erosion and sediment control plan.	Low	Project site and downstream freshwater habitats.	Construction Phase and De-commissioning Phase.	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Effects on on - and off-site freshwater habitat as a result of impacts from acid rock drainage.	A	• Precautionary pre-construction surveys. • Develop a SBMMP with NSE. • Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan. • Establish and implement EMP including erosion and sediment control plan.	Low	Project site and downstream freshwater habitats.	Construction and De-commissioning Phase - entire.	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal
Effects on on - and off-site freshwater habitat due to alteration of drainage patterns and infiltration/runoff volumes.	A	• Management of stormwater quantity and quality to relevant provincial standards. • Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan.	Low	Project site and downstream freshwater habitats.	Permanent during lifetime of the Project.	NR	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal
Non-permanent impacts related to habitat modifications.	A	• Conduct in-water works during non-critical periods. • Establish a buffer zone of 20 m around freshwater habitat. • Restrictions on the removal of riparian vegetation. • Establish and implement EPP/EMP including erosion and sediment control plan.	Low	Project site and downstream freshwater habitats.	Construction Phase	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Damage to fish and fish habitat from blasting activities.	A	• Include provisions for blasting in EMP. • Adhere to Guidelines for the Use of Explosives in or Near Canadian Fishery Waters[1]. • Manage timing, location, and technical specifications of blasting operations appropriately, and conduct pre-blast surveys. • Avoid ammonium nitrate and fuel-oil mixtures. • Use of blasting caps to produce a series of small discrete time-delayed detonations; subdivide large charges. • Implementation and compliance with appropriate setback distances from fish and spawning habitat according to substrate types. • Deploy noise generating devices to deter fish from blasting site. • Complete works during periods of least biological activity/sensitivity. • Removal or exclusion of fish from work area prior to blasting.	Low	Project site and downstream freshwater habitats.	Construction Phase	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Effects on on - and off-site freshwater habitat due to watercourse crossings.	A	• Conduct in-water works during non-critical periods. • Adherence to federal and provincial guidelines on watercourse crossings. • Establish a buffer zone of 20 m around freshwater habitat. • Restrictions on the removal of riparian vegetation. • Establish and implement EPP/EMP including erosion and sediment control plan. • Open trench method for stream crossings in the water pipeline ROW; however, large diameter box culverts may be utilized elsewhere, if required. These culverts will be bank to bank with open bottoms, so as not to affect fish habitat in any way.	Low	Project site and downstream freshwater habitats.	Construction phase and De-commissioning Phase.	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal
Effects on on - and off-site freshwater habitat due to impacts from wastewater.	A	• Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan. • Utilization of mobile sanitary wastewater treatment units approved under relevant regulations and guidelines.	Low	Project site and downstream freshwater habitats.	All Phases	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Effects on on - and off-site freshwater habitat due to impacts related to contaminated soils.	A	• Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan. • Remediate contaminated soil promptly (if contaminated soils cannot be treated on site, dispose soils off-site at a licensed hazardous waste hauler). • Spill Control Plan and Contingency Plan.	Low	Project site and downstream freshwater habitats.	Construction phase	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal
Effects on on - and off-site freshwater habitat due to impacts related to improper disposal of waste materials.	A	• Excess construction materials will not be deposited in any watercourse/water body, or anywhere they could be introduced into the aquatic environment. • Collect hazardous waste for disposal in accordance with an established waste management plan. • Oil-water separation and stormwater management system will be designed according to Canadian environmental regulation standards.	Low	Project site and downstream freshwater habitats.	All Phases	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance of Residual Effect
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Non reversible)	Ecological/ Social-cultural and Economic Context	
Contamination, erosion, turbidity, and siltation of the freshwater environment from discharge of wastewater, stormwater and/or surface water runoff.	A	• Erosion and sediment control plan. • Stormwater will be collected and treated in a stormwater facility prior to discharge into drainage channel to Dung Cove Pond, as per a site-specific Stormwater Management Plan. • Oil-water separation and a stormwater management system will be designed according to Canadian environmental regulation standards.	Low	Project site and downstream freshwater habitats.	Infrequent in all Phases.	R	• Recreational and Aboriginal fisheries. • Project site is within an approved Industrial Park.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0
1. Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky, 1998).

10.11 Marine Species and Habitat

The following section describes potential effects from the Project on the environment described in Sections 9.6.2 to 9.6.4.

The marine habitat of Stormont Bay supports a typical range of marine and estuarine species (i.e., fish, shellfish, marine mammals, coastal and seabirds), and provides a migratory path for some fish, such as Atlantic salmon and sea-run trout. Nearshore, shallower areas also support various marine plant species and the barrier beaches of Dung Cove and Red Head stabilize and protect the shoreline and coastal ponds. Lobster is by far the most important species in terms of economic value within the Bay, and thus the emphasis in assessing impacts has been placed on this species.

The majority of potential effects are associated with the construction of a marginal wharf. Its construction will destroy the marine habitat within its footprint. The jetty is a much larger structure but will be built on mono piles so the actual footprint is much smaller, and thus will have fewer adverse effects.

Marine flora is a component of fish habitat and therefore is subject to regulations under the federal *Fisheries Act*. Sections of the *Fisheries Act* prohibiting the introduction of deleterious substances into marine waters are governed by EC. Protection of marine fauna is subject to the same regulations.

10.11.1 Threshold for Determination of Significance

A significant adverse effect on the marine environment and biota is defined as one that is likely to cause any one of the following:

- adverse changes to critical habitats;
- serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery;
- further impairment of the ecological functioning of the biotic community; and/or
- increased ecological risk to a level that long term effects to the health of aquatic biota is predicted.

10.11.2 Effects on Marine Environment (Flora, Fauna and Sensitive Coastal Habitats)

10.11.2.1 Effects of Construction

The construction of the marginal wharf and jetty will have an adverse effect on the marine habitat in the immediate area due to the loss of habitat within the footprint. The marginal wharf footprint will be approximately 36,000 m^2 in size with the jetty footprint measuring approximately 972 m^2 in size. The jetty will be comprised of 77 monopiles and 24 mooring dolphins. This will accommodate the berthing of two vessels. It should be noted that there will be no infill onshore for the jetty, however there will be in all likelihood shoreline protection and armouring.

Construction activities will disturb the substrate in the area and potentially re-suspend sediments. Construction activities closer to and on shore have the potential to release sediment into the marine environment via runoff.

For the purposes of this assessment marine fauna includes fish and shellfish, marine mammals, sea turtles, and benthic invertebrates. Potential interactions from the construction phase include siltation from marine construction, direct mortality of individuals through the process of infilling, loss of habitat from the marginal wharf footprint and avoidance of the area due to noise and other disturbances.

The habitat within the proposed marginal wharf footprint is comprised mainly of hard bottom and kelp. This habitat provides protection and forage for many marine species, particularly invertebrates and small or juvenile fishes. Fish, marine mammals, and sea turtles will be minimally affected as the habitat being lost is not considered limited or critical for species survival and they will be able to easily move to nearby areas. Invertebrates without the ability to move to a new location will be lost during the construction phase, including larval species. Sedimentation from onshore construction activities would smother sessile benthic invertebrates and demersal fish eggs. Eelgrass beds, which also play a significant role as habitat, are outside the proposed footprint of the marginal wharf.

The installation of structures along the cobble barrier beach may cause the integrity of the beach to change, thus possibly subjecting the beach to greater erosion during severe storm events during site preparation and construction. The tailings present at Dung Cove may become disturbed should there be a need to work in this body of water for the installation of piping or other structures associated with the jetty trestle or marginal wharf.

Much of the habitat within the marginal wharf footprint and throughout Stormont Bay is considered to be appropriate for lobsters. The approximate amount of habitat potentially lost as a result of wharf construction is 3 ha and the area of lobster habitat within Stormont Bay is approximately 780 ha. The habitat lost as a result of the marginal wharf construction represents approximately 0.38% of the total habitat available.

Factors that most influence lobster productivity are habitat and food supply (Cobb *et al.,* 1999). The type of fish habitat preferred by lobster, however, changes with age of the animal.

Post-larval lobsters live in burrows until they reach about 25 mm carapace length. For lobsters between 25-50 mm carapace length a coarse substrate and a suitable amount of cover is necessary. Lobsters with a carapace length of >50 mm prefer areas with algae, stones, and large crevices. Some larger lobsters have been observed on compact sand or mud bottoms consolidated by eelgrass. All sizes of lobster have been observed co-existing in areas with large stone size and heavy algal cover. Sand covered in eelgrass had a low abundance of juveniles and adults, while on bare sand bottoms no resident lobsters were observed (National Oceanographic and Atmospheric Association, 1994).

Post-larval lobsters spend a few years "in self-dug tunnels or in the natural crevices under cobble" (Harding, 1992). Post-larvae, in their burrows, feed on plankton and may also prey on small benthic organisms. This habitat provides shelter from potential predators when the post-larval lobsters are still small and quite vulnerable. This part of the life cycle is critical to recruitment to the fishery, and the amount of post-larvae that settle in an area is directly proportional to the number of fishery recruits to that area (Miller, 1997). At the same time, the numbers of post-larvae that settle in an area is an overriding factor in determining an area's productivity.

Noise will be produced via construction of the marginal wharf that will require the placement of steel sheet piling or caissons and infilling and the placement of the jetty piles. These activities will produce noise that can adversely affect marine fauna and may cause marine fauna to move out of the affected areas close to the source. In addition, on-shore blasting may be required for site preparation and contouring which may produce high noise levels for marine fauna.

There is considerable variation in the hearing ability within marine species therefore it is difficult to make general statements about behaviour related to this activity. Potential impacts to marine mammals include interfering with communications, foraging, echolocation, and breeding (David, 2006). Caltran (2001) studied the effects of pile driving on harbour seals and sea lions and found that most individuals vacated the area within 500 m of the activity. Tyack (1982) suggests that avoidance behaviour due to intermittent sounds, such as those produced during pile driving, occurs only when noise levels exceed 160 to 170 decibel millipascals (dB 1mPa).

The physical effects on fish have been examined by Turnpenny and Nedwell (1994) and include the following reactions to noise levels:

- transient stunning at 192 decibel micropascals (dB re 1 µPa);
- internal injuries at 200 dB re 1 µPa;
- egg/larval damage at 220 dB re 1 µPa; and
- fish mortality at 230-240 dB re 1 µPa.

In addition, Pearson *et al.,* (1992) notes that the lower noise threshold that can cause subtle changes in fish behaviour is approximately 160 dB. A study on bottlenose dolphins showed that pile driving has the potential to negatively affect dolphin populations at a distance of up to 40 km. The potential impacts include interfering with communications, foraging, echolocation, and breeding (David, 2006).

Noise can also be produced by vessels being used in the construction stage.

10.11.2.2 Effects of Operation

Aside from accidental spills of deleterious substances, discussed in Section 10.17, there are few impacts to the marine environment during operation of the marginal wharf and jetty. The jetty is not expected to change sedimentation patterns due to the monopole design. The marginal wharf however has the potential to increase sedimentation within its vicinity. This will be confirmed during FEED detailed sediment analysis and bathymetric studies.

The noise generated by propeller cavitations can be up to 83% of the underwater acoustic field surrounding large vessels (Southall, 2005). Effects may occur on marine mammals including changes in behaviour such as avoidance, changes in migration routes, and changes in reproductive or feeding behaviour. Increased vessel traffic in the area has the potential to interfere with marine mammal sound production and communication and may result in an elevated probability of collisions. In animals like cetaceans that are highly dependent on sound, the ability to recognize sound signals in the presence of background noise is important in communicating, detecting predators, locating prey, and, in toothed whales, echo-locating (Lawson *et al.,* 2000).

Propeller wash can negatively affect flora and fauna through the re-suspension of sediment resulting in siltation that can smother invertebrates, cover hard bottoms and negatively affect the ability of species such as mussels and scallops to settle and develop. This effect can also smother marine plants and negatively affect the colonization of plants in the area. Potential adverse effects on marine flora and fauna can also occur from the discharge of wastewater and bilge water from cargo vessels.

If bilge, ballast or wastewater from ships is released while entering or exiting Stormont Bay it can have adverse effects on water quality. This action can also introduce invasive species to the area which may out compete native species and have long term adverse effects on the biota.

Stormwater runoff from the site will be directed to the marine environment which may introduce contaminants into Stormont Bay and adversely affect fauna and flora species.

10.11.2.3 Effects of Decommissioning

Effects associated with the decommissioning phase are expected to involve generally similar issues as those identified for the construction phase. The specific effects on the marine environment will very much depend on the extent of the decommissioning. Of key importance would be the question whether or not the marginal wharf would be removed and the filled in area rehabilitated to pre-development conditions. It is more likely that the marginal wharf will remain in place for use by other developments in the industrial park. However, should the wharf be removed, it would provide an opportunity for beneficial effects through re-construction of natural marine habitat. Any such in-water work would need to be conducted with the necessary mitigation measures to avoid and reduce temporary effects related to sediment loadings and potential accidental contamination (e.g., fuel spills). Decommissioning objectives and approach would be discussed with all relevant stakeholders at the time and would need to be implemented in compliance with the regulatory standards applicable at that time.

10.11.3 Mitigation

10.11.3.1 Construction Mitigation

The construction of the facility will undoubtedly result in some losses and alterations of fish and aquatic habitat which cannot be mitigated. In accordance with the requirements of the *Fisheries Act* and relevant policies of the DFO, Pieridae will be required to offset for these

losses/alterations to the satisfaction of DFO so as to achieve “no net loss” of fish habitat, as outlined in the department’s Policy for the Management of Fish Habitat (DFO, 1986). This EA includes a general strategy with an outline for options for habitat compensation. A detailed Habitat Compensation Plan will be prepared separately from this EA process and as part of Pieridae’s application to DFO for Authorization.

Essentially all of the mitigative actions described in Section 10.3 are also valid for the protection of marine species and their habitats, so the reader is referred to this section. In addition, readers should refer to Section 10.17 relating to impacts on marine species and habitat resulting from accidental spills.

If vessels are used during the construction phase re-suspension of sediments is possible. More delicate eelgrass is north of the marginal wharf and is not anticipated to be near any vessel traffic. Re-suspension of sediments is anticipated to be short term and localized to shallower areas adjacent to the marginal wharf.

Prior to any on-shore blasting activities contractors must review the Guidelines for the use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky, 1998).

The use of tugs will also aid in the abatement of vessel noise from propeller cavitations. Additional mitigation includes working during low tide, working outside sensitive periods (as outlined in Sections 9.6.4.2 and 9.8.2.1), the use of ramped warning signals and masking the noise with bubble curtains (David, 2006). Alternative construction techniques such as vibratory pile-driving will be explored and applied if practical and feasible. Consultation with representatives of both the recreational fishery and the commercial fishery will occur in order to develop seasonal and daily activity schedules which will be the least likely to disrupt these activities.

10.11.3.2 Habitat Compensation

The requirement for habitat offsets and the procedure for doing so under the *Fisheries Act* are outlined in Section 10.10.4.1. Offsets will be required in the marine environment for the destruction of approximately 3 ha of inter and subtidal habitat.

The marginal wharf will sit in a location dominated by a rock substrate with a kelp canopy. In the intertidal zone this provides habitat for invertebrates and small or juvenile fish. In the subtidal it provides habitat for lobsters, which are commercially fished in the area. Planned offsets would address the creation of habitats to serve the fauna anticipated to be affected. At this conceptual stage of the compensation plan there are three main strategies that will be investigated:

- reef creation;
- restoration/creation of algae beds; and
- larval and/or juvenile lobster seeding.

Reef creation is the placement of rock or manufactured structures on flat, soft bottoms to create habitat for both lobsters and other invertebrates such as crabs. Piles of 15 to 20 cm rock in patches 2 m in diameter and 0.5 m in height would attract adult lobsters whereas piles of rock from 2 to 20 cm plus boulders of 45 to 100 cm would be used to provide interstitial spaces for a diversity of crabs and various life stages of lobster (AMEC, 2008b). Depending on the depth where the reefs are placed they will also provide a hard substrate for algae growth or settlement of bivalve spat.

The creation or restoration of algae beds also requires the placement of rock onto the substrate. These rocks provide a base for the settlement of spores and ultimately an algal canopy. Unlike the chance of algae settling on artificial reefs, the targeted algae bed creation has hard substrate placed into areas with appropriate light levels, currents, and waves that will allow the algae to take hold. If armour stone is placed around the marginal wharf, it will serve as an excellent substrate for the creation of algal beds.

Lobster seeding is a relatively new procedure that is being researched in the Maritime Provinces. It involves the release of Stage IV Lobster larvae into the environment to enhance the existing population. Stage IV larvae are the first benthic stage and the hope would be to increase survival by skipping the pelagic stage. This process could be used in conjunction with the placement of artificial reefs within Stormont Bay.

The conceptual habitat compensation plan is based on methodologies proposed for other large scale marine projects such as the construction of the Melford International Terminal and the placement of the Maritime Link.

10.11.3.3 Operation Mitigation

Impacts due to propeller wash re-suspending sediments will be mitigated via the use of tugs to dock LNG vessels at the jetty. The jetty's location is in deep water where marine flora is not likely to be affected. Propeller wash from tugs near the marginal wharf may affect marine flora, however delicate eelgrass beds are north of the marginal wharf and not anticipated to be near any vessel traffic. Re-suspension of sediments is anticipated to be short term and localized to shallower areas adjacent to the marginal wharf. The use of tugs will also aid in the abatement of vessel noise from propeller cavitations.

Bilge, ballast and wastewater releases are controlled by TC via the 'Ballast Water Control and Management Regulations', in agreement with the US Coast Guard requirements and with the International Convention for the Control and Management of Ship's Ballast Water and Sediments. LNG vessels will approach NS with ballast water which will be discharged off-shore in accordance with TC's Ballast Water Regulation. The vessels will leave Stormont Bay fully loaded with LNG. Ballast water issues are not expected to arise under current navigational regulations.

10.11.4 Summary and Residual Effects

Provided the recommended mitigative measures are implemented and compensation efforts are effective, no significant adverse residual environmental effects on marine environment are likely to occur. Table 10.11-1 provides a summary of the residual environmental effects and recommended mitigative action for the marine environment.

Table 10.11-1 Residual Environmental Effects Summary for the Marine Environment

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Permanent loss of habitat through construction of marginal wharf.	A	• Development and implementation of marine fisheries offset plan.	Low	Marginal wharf footprint and immediately adjacent.	Construction phase through to decommissioning.	NR	• Area affected represents approximately 0.38% of lobster habitat within Stormont Bay.	Medium
Noise from pile driving and other construction activities.	A	• Work during low tide. • Work outside of sensitive periods. • Use of ramped warning signals. • Use of bubble curtains. • Avoidance by mobile animals.	Low	Depending on noise level could extend throughout Stormont Bay.	Construction Phase	R	• Potential fish habitat.	Minimal
Destabilization or erosion of barrier beaches along shoreline from construction activities.	A	• Adherence to mitigation described in surface water section. • Avoid shoreline work during peak storm periods in late fall/winter.	Low	Marginal wharf and jetty trestle footprints and immediately adjacent.	Construction Phase	R	• Barrier beach and shoreline stability.	Minimal
Sedimentation from onshore construction activities.	A	• Adherence to mitigation described in surface water section.	Low	Mouths of streams entering Stormont Bay.	Construction Phase	R	• Potential fish habitat.	Minimal
Sedimentation from construction vessels.	A	• Use of tugs for large vessels.	Low	Marginal wharf footprint and immediately adjacent.	Construction Phase	R	• Potential fish habitat.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Operation								
Sedimentation from LNG vessels.	A	• Use of tugs for large vessels.	Low	Marginal wharf and jetty.	Operation Phase	R	• Potential fish habitat.	Minimal
Sedimentation from onshore operations.	A	• Adherence to mitigation described in surface water section.	Low	Mouths of streams entering Stormont Bay.	Operation Phase	R	• Potential fish habitat.	Minimal
Release of bilge and ballast water to Stormont Bay.	A	• Adherence to federal legislation.	Low	Stormont Bay	Operation Phase	R	• Potential fish habitat.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.12 Species at Risk (SAR)

This section deals with SAR, which are defined as any species listed under SARA, NSESA, and COSEWIC, as well as SOCC listed by NSDNR's General Status of Wildlife Species as Red- or Yellow-ranked species.

Table 10.12-1 summarizes the SAR and SOCC which are known (or considered highly possible, for marine fauna species) to occur within the Project footprint, or are of particular concern to regulators (BFL (*Erioderma pedicellatum*)).

Table 10.12-1 Species at Risk (SAR) or Species of Conservation Concern (SOCC) Reported within the Project Area

Scientific Name	Common Name	SARA	COSEWIC	NS General Status	NSESA
Terrestrial Flora					
Vallisneria americana	Tape Grass	--	--	Red	--
Erioderma pedicellatum	BFL	Endangered	Endangered	Red	Endangered
Terrestrial Fauna					
Asio flammeus	Short-eared Owl	Special Concern	Special Concern	Yellow	--
Bucephala islandica princeps (Eastern pop.)	Barrow's Goldeneye	Special Concern	Yellow	--	*Bucephala islandica princeps (Eastern pop.)*
Calidris maritima	Purple Sandpiper	--	--	Yellow	--
Chordeiles minor	Common Nighthawk	Threatened	Threatened	Yellow	Threatened
Contopus cooperi	Olive-sided Flycatcher	Threatened	Threatened	Yellow	Threatened
Bucephala islandica princeps (Eastern pop.)	Barrow's Goldeneye	Special Concern	Yellow	--	*Bucephala islandica princeps (Eastern pop.)*
Euphagus carolinus	Rusty Blackbird	Special Concern	Special Concern	Yellow	Endangered
Gavia immer	Common Loon	--	Not At Risk	Yellow	--
Hirundo rustica	Barn Swallow	No Status	Threatened	Yellow	Endangered
Histrionicus histrionicus pop. 1	Harlequin Duck	Special Concern	Special Concern	Yellow	Endangered
Parus hudsonicus (syn. Poecile hudsonicus)	Boreal Chickadee	--	--	Yellow	--
Passerculus sandwichensis ssp. principes	Ipswich Sparrow (Savannah Sparrow)	Special Concern	Special Concern	Yellow	--
Perisoreus canadensis	Gray Jay	--	--	Yellow	--
Pooecetes gramineus	Vesper Sparrow	--	--	Yellow	--
Sialia sialis	Eastern Bluebird	--	Not At Risk	Yellow	--
Sterna dougallii	Roseate Tern	Endangered	Endangered	Red	Endangered
Sterna hirundo	Common Tern	--	Not At Risk	Yellow	--
Sterna paradisaea	Arctic Tern	--	--	Yellow	--
Wilsonia canadensis	Canada Warbler	Threatened	Threatened	Yellow	Endangered
Alces alces	Eastern Moose (mainland	--	--	Red	Endangered

Scientific Name	Common Name	SARA	COSEWIC	NS General Status	NSESA
americana	pop.)				
Myotis septentrionalis	Northern Long – Eared Bat	No Status	Endangered	Red	Endangered
Myotis lucifugus	Little Brown Bat	No Status	Endangered	Red	Endangered
Martes pennanti	Fisher	--	--	Yellow	--
*Glyptemys insculpta****	Wood Turtle	Threatened	Threatened	Yellow	Threatened
Chelydra serpentina	Snapping Turtle	Special Concern	Special Concern	Green	Vulnerable
Enallagma minusculum	Little Bluet	--	--	Yellow	--
Epitheca semiaquea	Manteled Baskettail	--	--	Undetermined	--
Lestes vigilax	Swamp Spreadwing	--	--	Undetermined	--
Lestes forcipatus	Sweetflag Spreadwing	--	--	Undetermined	--
Danaus plexippes	Monarch Butterfly	Special Concern	Special Concern	Yellow	--
Epeoloides pilosulus	Macropis Cuckoo Bee	No Status	Endangered	--	Endangered
Freshwater Fauna					
Salvelinus fontinalis	Brook Trout (Char)	--	--	Yellow	--
Anguilla rostrata	American Eel	No Status	Threatened	Green	--
Marine Fauna**					
Gadus morhua	Atlantic Cod	No Status	Endangered	--	--
Thunnus thynnus	Atlantic Bluefin Tuna	No Status	Endangered	--	--
Hippoglossoides platessoides	American Plaice	No Status	Threatened	--	--
Salmo salar	Atlantic Salmon (NS Southern Upland Population)	No Status	Endangered	--	--
Acipenser oxyrinchus	Atlantic Sturgeon	No Status	Threatened	--	--
Lamna nasus	Porbeagle	No Status	Endangered	--	--
Squalus acanthias	Spiny Dogfish	No Status	Special Concern	--	--
Leucoraja ocellata	Winter Skate	No Status	Threatened	--	--
Phocoena phocoena	Harbour Porpoise	Threatened (Schedule 2)	Special Concern	--	--
Dermochelys coriacea coriacea	Atlantic Leatherback	Endangered	Endangered	--	--

Notes:
*Considered to have potential to occur within Project footprint based on available habitat and known species range.
**Surveys targeting marine SAR/SOCC have not been conducted.

10.12.1 Threshold for Determination of Significance

A significant adverse effect of Project components or activities on a SAR or SOCC is defined as an effect that causes a decline in abundance and/ or a change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its pre-project level within several generations. A significant adverse effect on sensitive/ critical habitat is defined as an adverse effect that causes a net loss of habitat function.

An adverse effect that does not cause such declines or changes is not considered to be significant.

A positive effect occurs when Project activities help increase abundance or diversity of species or enhances habitat.

10.12.2 Effects on Terrestrial and Freshwater Aquatic Floral SAR

10.12.2.1 Vascular Plants

The only vascular plant SOCC known to occur in the Project footprint is Tape Grass (*Vallisneria americana*, NSDNR Red), which is known to occur in both Dung Cove Pond and Meadow Lake, though the specific locations within these waterbodies are not known. Potential effects on Tape Grass, an aquatic plant species, are expected to be similar to effects on aquatic plant species as a whole, which are discussed in detail in Section 10.7.2, and similar to effects on freshwater fish/shellfish (Section 10.10). Potential effects of the Project phases on flora SAR are summarized in Table 10.12-2.

10.12.2.2 Lichens

This section deals with effects specific to lichen SAR/SOCC which are of special concern to regulators (M. Elderkin, pers. comm., April 2013), i.e., BFL. A discussion of potential impacts of activities in the three Project phases are presented below. Recommended mitigation measures for these impacts are outlined in Section 10.12.5. The proposed monitoring program is outlined in Section 12.0.

Effects of Construction and Decommissioning

Since there are no lichen SAR/SOCC located in the footprint of the LNG facility, temporary work camp, water supply pipeline ROW and Meadow Lake water intake facility, there will be no direct mortality of lichen SAR associated with construction phase activities for these Project components. However, if the water supply pipeline ROW layout should be changed during the final design phase to be located outside of the surveyed buffer, supplementary lichen SAR/SOCC surveys will be required.

Table 10.12-2 Summary of Potential Impacts of the Goldboro LNG Project on Species at Risk (SAR) and Species of Conservation Concern (SOCC) by Project Phase

Priority Species in Project Area Potentially Affected by Project	Critical Habitat Present in Project Footprint	Potential Effects																Specific Comments
		Direct Mortality	Loss of Habitat	Habitat Alteration	Disturbance/ Displacement	Increased Noise	Increased Dust	Blasting Effects	Increased Human Presence	Sedimentation / Erosion	Decreased Air Quality	Decreased water Quality/Quantity	Alterations to Hydrology	Establishment of invasive Species	Increased Site Lighting	Exposure to Contaminant	Accidents and Malfunctions	Creation of Suitable Habitat	
Construction / Decommissioning Phase	**(Effects of Decommissioning and Reclamation Phase expected to be similar, but of lesser magnitude)**																	
Flora SAR/SOCC																		
• Tape Grass	No	x		x						x		x	x	x			x		Effects and Mitigation similar to that for common Vascular Plants (Section 10.7) and Freshwater Fish and Habitats (Section 10.10).
• BFL	No										x						x		Effects and Mitigation similar to that for common Vascular Plants (Section 10.7), Air Quality (10.4) and Accidental Events (Section 10.17).
Terrestrial Mammal SAR/SOCC																		
• Eastern Moose	No	x	x	x	x	x										x	x		Effects and Mitigation see Sections 10.12.3.1 and 10.12.5.2 and Accidental Events (Section 10.17).
• Little Brown Bat; and • Northern Long-Eared Bat.	No		x	x		x		x	x						x	x	x		Effects and Mitigation see Sections 10.12.3.2 and 10.12.5.2 and Accidental Events (Section 10.17).
Bird SAR/SOCC																		
Landbirds (including Passerines, Raptors & Owls): • Olive-sided Flycatcher; • Common Loon; • Barn Swallow; • Rusty Blackbird; • Barn Swallow; • Boreal Chickadee; • Ipswich Sparrow; • (Savannah Sparrow) Gray Jay; • Vesper Sparrow; • Eastern Bluebird ; • Canada Warbler; • Northern Goshawk; • Short-Eared Owl; and • Common Nighthawk.	No		X	X					x						x		X		Effects and Mitigation similar to that for common Birds (Section 10.9).
Seabirds and Waterfowl: • Harlequin Duck; • Common Loon; • Common Tern; • Arctic Tern; and • Roseate Tern.	No		x						x							x	x		Effects and Mitigation similar to that for common Birds (Section 10.9), common Marine Species (10.11) and Accidental Events (Section 10.17).

Priority Species in Project Area Potentially Affected by Project	Critical Habitat Present in Project Footprint	Potential Effects																Specific Comments
		Direct Mortality	Loss of Habitat	Habitat Alteration	Disturbance/ Displacement	Increased Noise	Increased Dust	Blasting Effects	Increased Human Presence	Sedimentation / Erosion	Decreased Air Quality	Decreased water Quality/Quantity	Alterations to Hydrology	Establishment of invasive Species	Increased Site Lighting	Exposure to Contaminant	Accidents and Malfunctions	Creation of Suitable Habitat	
Shorebirds: • Purple Sandpiper	No		x						x							x	x		Effects and Mitigation similar to that for common Birds (Sections10.9) and Accidental Events (Section 10.17).
Invertebrate SAR/SOCC																			
• Little Bluet; • Manteled Baskettail; • Monarch Butterfly; and • Macropis Cuckoo Bee.	No	x	x	x						x		x	x			x-pesticides/herbicides	x	x	Effects and Mitigation similar to that for Freshwater Aquatic Species and Habitat (Section 10.10), Wetlands (Section 10.8), Accidental Events (Section 10.17). Decommissioning / reclamation may create habitat.
Freshwater Fish SAR/SOCC																			
• Brook Trout; and • American Eel.	No	x	x	x				x		x		x	x			x	x	x	Effects and Mitigation similar to that for Freshwater Aquatic Species and Habitat (Section 10.10), and Accidental Events (Section 10.17). Decommissioning / reclamation may create habitat.
Marine Fish SAR/SOCC																			
• American Eel; • Atlantic Cod; • Atlantic Bluefin Tuna; • American Plaice; • Atlantic Salmon; • Atlantic Sturgeon; • Porbeagle; • Spiny Dogfish; and • Winter Skate.	No				x	x			x	x		x				x	x		Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).
Marine Mammal SAR/SOCC																			
• Harbour Porpoise	No	x-ship collisions				x			x-boat traffic							x-ship discharges	x		Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).
Marine Reptile SAR/SOCC																			
• Atlantic Leatherback	No				x-boat traffic	x			x-boat traffic							x-ship discharges	x		Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).
Operations Phase																			
Flora SAR/SOCC																			
• Tape Grass	No									x		x	x	x		x-herbicides, road salt	x		Effects and Mitigation similar to that for common Vascular Plants (Section 10.7), Freshwater Fish and Habitats (Section 10.10), and Accidental Events (Section 10.17).

Priority Species in Project Area Potentially Affected by Project	Critical Habitat Present in Project Footprint	Potential Effects																Specific Comments
		Direct Mortality	Loss of Habitat	Habitat Alteration	Disturbance/ Displacement	Increased Noise	Increased Dust	Blasting Effects	Increased Human Presence	Sedimentation / Erosion	Decreased Air Quality	Decreased water Quality/Quantity	Alterations to Hydrology	Establishment of invasive Species	Increased Site Lighting	Exposure to Contaminant	Accidents and Malfunctions	Creation of Suitable Habitat	
• BFL	No										x						x-fires		Effects and Mitigation similar to that for common Vascular Plants (Section 10.7), Air Quality (Section 10.4) and Accidental Events (Section10.7).
Terrestrial Mammals SAR/SOCC																			
• Eastern Moose	No	x	x	x	x	x			x										Effects and Mitigation also similar to that for common Terrestrial Mammals (Section 10.9) and Accidental Events (Section 10.17).
• Little Brown Bat; and • Northern Long-Eared Bat.	No					x			x						x		x		Effects and Mitigation also similar to that for common Terrestrial Mammals (Section 10.9) and Accidental Events (Section 10.17).
Bird SAR/SOCC -																			
Landbirds (including Passerines, Raptors & Owls): • Olive-sided Flycatcher; • Barn Swallow; • Rusty Blackbird; • Barn Swallow; • Boreal Chickadee; • Eastern Wood Peewee; • Ipswich Sparrow; • (Savannah Sparrow); • Gray Jay; • Vesper Sparrow; • Eastern Bluebird; • Canada Warbler; • Short-Eared Owl; and • Common Nighthawk.	No								x						x				Effects and Mitigation similar to that for common Birds (Section 10.9) and Accidental Events (Section 10.17).
Seabirds and Waterfowl: • Barrow's Goldeneye; • Harlequin Duck; • Common Loon; • Common Tern; • Arctic Tern; and • Roseate Tern.	No		x						x							x	x		Effects and Mitigation similar to that for common Birds (Section 10.9) and Accidental Events (Section 10.17).
Shorebirds: • Purple Sandpiper.	No		x						x							x	x		Effects and Mitigation similar to that for common Birds (Section 10.9) and Accidental Events (Section 10.17).

Priority Species in Project Area Potentially Affected by Project	Critical Habitat Present in Project Footprint	Potential Effects																Specific Comments
		Direct Mortality	Loss of Habitat	Habitat Alteration	Disturbance/ Displacement	Increased Noise	Increased Dust	Blasting Effects	Increased Human Presence	Sedimentation / Erosion	Decreased Air Quality	Decreased water Quality/Quantity	Alterations to Hydrology	Establishment of invasive Species	Increased Site Lighting	Exposure to Contaminant	Accidents and Malfunctions	Creation of Suitable Habitat	
Odonate and Lepidopteran SAR/SOCC																		
• Little Bluet; • Manteled Baskettail; • Swamp Spreadwing • Sweetflag Spreadwing • Monarch Butterfly; and • Macropis Cuckoo Bee.	No	x								x		x				x- pesticides/herbicides	x		Effects and Mitigation similar to that for Freshwater Aquatic Species and Habitat (Section 10.10) and Accidental Events (Section 10.17).
Freshwater Fish SAR/SOCC																		
• Brook Trout; and • American Eel.	No		x							x							x		Effects and Mitigation similar to that for Freshwater Fish and Habitats (Sections 10.10) and Accidental Events (Section 10.17).
Marine Fish SAR/SOCC																		
• American Eel; • Atlantic Cod; • Atlantic Bluefin Tuna; • American Plaice; • Atlantic Salmon; • Atlantic Sturgeon; • Porbeagle; • Spiny Dogfish; and • Winter Skate.	No				x- propeller wash				x-ship traffic					x - ballast water		x-ship discharges			Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).
Marine Mammal SAR/SOCC																		
• Harbour Porpoise	No	x-ship collisions				x			x-ship traffic							x-ship discharges	x		Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).
Marine Reptile SAR/SOCC																		
• Marine Reptile SAR						x			x -boat traffic							x-ship discharges	x		Effects and Mitigation similar to that for common Marine Fauna (Section 10.11) and Accidental Events (Section 10.17).

Note:
No terrestrial Amphibian or Reptile SAR are known to occur on the site or nearby and therefore are not discussed in this table.

During decommissioning, there will be no further removal of forest vegetation for any Project components and associated lichen mortality. Use of vehicles in the footprint of all Project components is short term and in comparatively small numbers, and the exhaust is therefore unlikely to have noticeable adverse effects on lichen SAR/SOCC which may potentially be present in the vicinity of the Project. There is potential for positive effects from the removal of the infrastructure at the LNG facility and termination of LNG tanker visits, since this will result in a reduction of air emissions in the area. This may result in somewhat improved habitat quality on forested areas near the facility, which may enable lichen SAR/SOCC to colonize that habitat, even if they are not currently present. However, lichen SAR/SOCC depend on a range of habitat characteristics, including microclimatic and substrate requirements, and removal of air pollution alone cannot guarantee sufficient habitat quality for lichen SAR/SOCC colonization.

In all phases of the Project, there is potential for adverse effects from accidental fires in case it escapes the Project site, due to loss of habitat or direct mortality. Effects from accidental events are discussed in Section 10.17.

Effects of Operation

There are no air emissions associated with the electrical power requirements at the Meadow Lake water intake structure. Emissions or dust effects from vehicle use in the water supply pipeline ROW as well as at the Meadow Lake water intake facility are not anticipated to significantly impact lichen SAR/SOCC, as vehicles are anticipated to only be present occasionally and for short periods of time.

The LNG facility will include several sources of air emissions, including the LNG tankers, the LNG flare and the power generation plant. Lichens are known to be sensitive to air emission, especially SO_2 and NO_x, and sensitivity varies with species. Many species with cyanobacteria as photobionts, such as BFL are particularly sensitive (Hawksworth and Rose, 1976). Based on provincial predictive modelling (NSE, 2008), several polygons of potential BFL habitat of varying quality are located within the vicinity (within a few hundred metres of the LNG facility). While no BFL or other lichen SAR/SOCC have been found in the Project area, including within mapped BFL polygons (Dillon, 2007b), potential effects of emissions on habitat quality were assessed. This is due in part because BFL and other lichen SAR/SOCC are of special concern to regulators (Elderkin, M., pers. comm., 2013).

Considering the dominant wind direction and proximity of BFL habitat polygons to the LNG facility footprint, there are a limited number of BFL habitat polygons that required a closer look with the respect to the effect of potential SO_2 concentrations. Dominant wind directions are from the north and northwest in the winter, and from the south and west from May to September (see Section 9.3.1.7). While northerly winds direct air emissions out to the ocean, southerly and westerly wind could result in emission effects on lichen habitat that is located downwind of the LNG facility (i.e., north and east of it). Of the above mentioned BFL habitat polygons, one large Category 2 polygon (medium suitability) is located from less than 200 m to approximately 400 m east of the LNG facility along Betty's Cove Brook. Another, much smaller habitat polygon is located approximately 200 m north of the flare (Figure 9.7-1 and 9.7-2). All other habitat

polygons are located more than 500 m downwind of the LNG facility and therefore not included in this assessment.

Hawksworth and Rose (1976) developed a 10-zone scale indicating relative sensitivity of lichen species to SO_2 emissions. According to that 10-zone scale, species like *Lobaria pulmonaria* can grow in areas where the mean winter SO_2 concentrations are below 30 µg/m^3, but *Lobaria scrobiculata* and many cyanolichens require "pure" air (Hawksworth and Rose, 1976). However, other studies indicate that local climatic factors may influence lichen sensitivity, for example reducing the tolerance. Nevertheless, the Hawksworth and Rose (1976) scale can be used to estimate relative sensitivity of lichen species. No scale has been developed for NO_x concentrations.

Predictive air quality modelling at the LNG facility on a highly conservative basis is presented in Section 10.4. Long-term air quality is generally of more importance to lichens than short term concentrations. Therefore, the average "Annual SO_2 Normal" concentrations are used to assess potential effects on lichen habitat (Figure 10.4-8). According to the modelling results, SO_2 concentrations drop quickly with increasing distance from the LNG facility. All BFL habitat polygons are in areas where the annual average SO_2 concentration under normal conditions is 1.5 µg/m^3 or less. Using Hawksworth and Rose's (1976) scale of relative sensitivity, these concentrations should not have any adverse effect on lichens and thus habitat quality in these polygons. Hawksworth and Rose (1976) consider air with less than 10 µg/m^3 SO_2 "pure", and found that sensitive lichens such as *Lobaria scrobiculata*, *Sticta limbata* and *Pannaria* ssp. (the latter two furnish some of the lichen Priority species in NS) may grow in these areas, if other habitat requirements are met. Even considering that local climatic factors influence lichen sensitivity, it is unlikely that the low annual average SO_2 concentration could adversely affect habitat quality in the BFL habitat polygons. Even when looking at 24 hour average concentrations (Figure 10.4-6), the two polygons of Category 1 BFL habitat (high suitability) located about 600 to 800 m north or north east of the LNG facility boundary are in a zone where conservatively predicted annual average SO_2 concentrations are 10 µg/m^3 or less. With the implementation of mitigation measures for air emission control as outline in Section 10.4, significant adverse effects on lichen habitat quality in the BFL habitat polygons from SO_2 emissions are not expected. BFL and other lichen SAR/SOCC are expected to be able to colonize these habitat polygons, if other habitat requirements are met.

It should be noted that the air quality in the assessment area is already influenced by the SOEI plant and by long-range transport of contaminants, but *Lobaria scobiculata* was found in the Project footprint (Section 9.4). However, there will be no effects of a cumulative nature, because the proposed start-up of the LNG facility coincides with the projected shut- down of the SOEI Plant. It should also be noted that the provincial ambient air quality maximum permissible GLCs for SO_2 of 60 µg/m^3 (see Section 9.3.2), according to the Hawksworth and Rose (1976) scale are actually higher than is tolerated by many lichens that are rare in NS.

10.12.3 Effects on Terrestrial Fauna SAR

For most terrestrial fauna SAR/SOCC (including mammals, birds, reptiles, amphibians, odonates and lepidopterans), potential effects are predicted to be similar to those for terrestrial

fauna as a whole (Section 10.9). Potential effects of the Project phases on terrestrial fauna SAR/SOCC are summarized in Table 10.12-2.

The following sections focus on mammal SAR/SOCC which are of special concern to regulators (Elderkin, M., and Pulsifer, M., pers. comm., 2013), including Eastern Moose, Little Brown Bat and Northern Long-Eared Bat.

10.12.3.1 Moose

Mainland Moose, which are listed as Endangered under the NSESA, could potentially be affected by the proposed Project in a variety of ways. Potential impacts to Mainland Moose are summarized in Table 10.12-2. They include:

- loss of habitat (foraging, wintering, calving);
- habitat fragmentation;
- disruption of migratory routes;
- mortality due to vehicle collisions;
- increased poaching levels in area due to increased traffic;
- noise disturbance; and
- exposure to runoff from hazardous materials/contaminated soils.

Habitat loss will occur on the site due to site development and clearing activities for the main Project site, along the water supply pipeline route, at the temporary work camp site, and at the Meadow Lake water intake structure location. Important habitats for Moose tend to be wintering and calving areas. Preferred wintering habitat for Moose in NS typically consists of mature conifer or mixed conifer stands, where snow accumulation is decreased and browse is available, reducing winter energy demands (Parker, 2003). Approximately 37.35 ha of coniferous forest occurring on the Project site will be removed during site development. Despite the abundance of this habitat type within the region, this parcel of habitat may be considered part of a core Moose habitat polygon which encompasses most of Guysborough and Antigonish counties, and may be considered significant, particularly when the large home ranges (25 km^2) of individual Moose are considered. The development of the Project is not expected to affect Moose wintering.

Moose tend to utilize areas associated with aquatic/wetland areas for calving, but will also use islands in beaver ponds and wetland areas with standing water (Parker, 2003). There is little of this habitat on site, and standing water areas occur mostly along the shore, where the exposure likely limits the utility of these locations as calving areas. The low density of Moose in the area, combined with the abundance of similar and much larger wetlands throughout the region results in the proposed Project having very little potential to adversely affect calving.

Land clearing on the Project site (150 ha including the temporary work camp), development of road access to Meadow Lake water intake structure (about 500 m) and the creation of the water supply pipeline spur (500 m) will contribute to habitat fragmentation in the region. The region is crisscrossed by many small logging and ATV roads and the effects of the Project are predicted to be insignificant within the region.

The increased visitation of and/or residency in the region during the construction and operations phases could also lead to impacts on Moose due to increased poaching activity. Mainland Moose are endangered and hunting them is not permitted; however, poaching continues to be a concern. The presence of the Project on the site, combined with strict reporting policies for any suspected Moose hunting activities in the area, will help to mitigate this potential effect.

The construction of the Meadow Lake water intake structure in a rather remote and quiet area may cause some initial short-term disturbance (approximately six months) due to construction noise, and may temporarily deter Moose from the immediate vicinity until work is completed.

It is possible that Moose could be affected by an accident within the Project site resulting in an off-site forest fire. For a discussion of accidental events, possible consequences and preventative measures refer to Section 10.17.

Increased road traffic in the area due to the Project could potentially lead to increased risk of collisions with Moose, potentially leading to mortality. Vehicle use on-site could also result in accidental mortality of Moose, though installation and maintenance of a full perimeter fence should minimize this potential issue. As very few Moose are in the area, it is unlikely that encounters will occur; however, it is important to recognize the importance of each individual Moose within the small Guysborough population.

The development of the Project site could potentially hinder some small-scale seasonal movements of Moose. Fencing around the site will prevent Moose from accessing the site, forcing them to travel around the site boundaries if they desire. However, the low density of Moose in the area, combined with the relatively small distance such a detour would require, in relation to a Moose's home typical territory, results in this effect being insignificant.

As the site is situated along Highway 316, wildlife in the area (including Moose) are already somewhat accustomed to traffic noise. Noise associated with construction and/or decommissioning and reclamation activities may disrupt Moose within several hundred metres of the active area; however, similar habitat is available throughout the adjacent area and impacts at the population level are not expected.

Effects of the decommissioning phase on Moose are considered to be similar to the construction phase, with the addition of the possible recreation of suitable habitats. Decommissioning activities and site reclamation could possibly have slight temporary negative effects on Moose; however, the effect of the resulting reclamation on Moose is expected to be positive, with rehabilitation of suitable terrestrial habitats and possibly wetlands.

10.12.3.2 Bats

Based on their widespread distribution within NS and AMEC's acoustic survey in Sept 2013, two bat species are known to utilize habitats within or adjacent to the Project site. These are the Little Brown Bat and the Northern Long-eared Bat, which will be collectively referred to simply

as bats from this point onward. Of these two species, the Little Brown Bat is more likely to occur on the site than is the Northern Long-Eared Bat as the latter is an interior forest species dependent on mature, contiguous deciduous forests for both roosting and foraging habitat (Sasse and Perkins, 1996; Hutchinson and Lacki, 2000; Lacki and Schwierhojan, 2001; Broders and Forbes, 2004; Carter and Feldhamer, 2005; Broders *et al.,* 2006; Perry *et al.,* 2007; and Henderson and Broders, 2008). There is no such interior forest habitat occurring on the Project site, though some deciduous forest may occur around Meadow Lake.

Endangered bats could potentially be affected by the proposed Project in a variety of ways. Potential impacts to bat SAR/SOCC are summarized in Table 10.12-2. Potential impacts include:

- loss of foraging habitat;
- loss of roosting habitat;
- loss of maternity colony habitat;
- loss of wintering/hibernating habitat;
- blasting effects;
- habitat fragmentation;
- noise disturbances; and
- exposure to hazardous materials and/or contaminated soils or water.

Loss of forested habitat will occur on the site due to site development and clearing activities for the main Project site (about 150 ha), at the temporary work camp site, along the water supply pipeline route and at the Meadow Lake water intake structure. Bats forage in both forested and wetland areas for insects; Northern Long-Eared Bats are more of a forest-interior species which forages primarily within forests, while Little Brown Bats tend to forage more frequently over wetlands (Fenton and Bell 1979). Thus, both species will lose foraging habitat due to loss of forested areas and wetlands from the Project site.

In summer, bats generally roost in trees in forested areas, and may also roost in manmade structures. Females may also form maternity colonies in forested areas, where they gather to rear their young. The loss of forested area on the Project area may result in some loss of roosting habitat and possibly maternity colony habitat for Little Brown Bats. Northern Long-Eared Bats roost preferentially in hardwood trees (Menzel *et al.,* 2002), of which there are relatively few on-site. While the Project may cause some loss of roosting and potential maternity colony habitat, similar habitat is extensive around the Project site, and this impact is not considered to be significant.

While bats are known to sometimes hibernate in abandoned mines, none of the AMOs on the Project site was determined to be a suitable potential hibernaculum during a survey by AMEC biologists in April 2013 (see details in Section 9.4.3). Therefore the Project is not predicted to cause any direct loss of bat hibernation habitat on the site. Hibernacula in the vicinity of the site have not been confirmed. Should they be present, they are unlikely to be affected by the Project, given their location of more than 0.5 km beyond the Project site boundary.

It is possible that increased noise and light emissions from the Project and related human activities, such as increased traffic, may have effects on bat species in the area. Murphy *et al.,* (2009) provided preliminary indications that both light and noise can have a negative impact on bats' foraging activity and that sensitivity to that impact varies between species. Some bat species, such as the Northern Long-Eared, utilize foraging strategy known as gleaning. Gleaning bats rely on their capability to listen for prey rustling sounds in order to capture prey from the ground and water surfaces, rather than capturing them in flight. Such bat species may therefore be more sensitive to increased levels of background noise. Traffic noise has been shown to reduce foraging efficiency in gleaning bats (Siemers and Schaub, 2010), and bats have been shown to avoid traffic-like noise (Schaub *et al.,* 2008). However, once the habitat on the Project site is lost, bats will not be hunting on the Project site, and noise levels are not predicted to be high enough to disrupt bat foraging activities off-site.

There is very little published data on vibration levels from blasting which are sufficient to disturb bats hibernating in caves or abandoned mines. A 1975 thesis by R. Myers entitled "Effects of Seismic blasting on Hibernating *Myotis sodalis* and Other Bats" (cited in West Virginia Department of Environmental Protection, 2006) stated that blasting as close as 30 m from hibernating Tricoloured Bats (*Perimyotis subflavus*) did not disturb them. Myers also stated that there is no reason to think that blasting effects with peak particle velocity reaching 0.02 inches per second would disturb them. A study by the West Virginia Department of Natural Resources, examining a hibernaculum of endangered Indiana bats (*Myotis sodalis*) and Virginia big-eared bats (*Corynorhinus townsendii virginianus*) located near an active quarry, determined that endangered bat populations can prosper even when exposed to blasting vibration levels of 0.06 to 0.2 inches per second (Cited in West Virginia Department of Environmental Protection, 2006). It is therefore unlikely that blasting activities during the construction phase would interfere with bats hibernating in caves in the vicinity of the Goldboro LNG Project, as the closest known potential hibernaculum is over 500 m from the Project site.

Habitat fragmentation has the potential to directly impact bat populations by limiting essential roosting and foraging resources (Fenton 2003; Safi and Kerth, 2004; Lane *et al.*, 2006; and Henderson *et al.*, 2008). Land clearing, development of roads and the creation of the Meadow Lake water supply pipeline will lead to a slight increase habitat fragmentation in the region. The region is crisscrossed by many small logging and ATV roads and the effects of the Project are predicted to be insignificant within the region. This is not expected to have a significant impact on Little Brown bats. Northern Long-Eared bats are dependent on large swaths of continuous deciduous forest; such habitat does not occur on the Project site, which is dominated by coniferous forests of various successional stages.

Spills of hazardous materials on the site are unlikely to affect bats, unless the contaminant is a compound which accumulates in aquatic insects and could accumulate in bats. Such a spill would have to be rather large or of long-term duration, neither of which is likely to occur. Accidents and malfunctions such as spills are discussed in Section 10.17.

Exposure of the buried arsenic contained within the old mine tailings on the site is also unlikely to affect bats via prey species, as arsenic does not bioaccumulate in food webs (Eisler, 2004).

For normal operations no significant adverse effect on bats are likely to occur. For a discussion of malfunction and accidental events, possible consequences and preventative measures refer to Section 10.17.

Effects of the decommissioning phase on bats are considered to be similar to the construction phase, with the addition of the possible recreation of suitable habitats. Decommissioning activities and site reclamation could possibly have slight temporary negative effects on bats, however, the effect of the resulting reclamation on bats is expected to be positive, with rehabilitation of suitable terrestrial habitats and possibly wetlands leading to increased foraging and roosting habitat.

10.12.4 Effects on Marine Fauna SAR

Potential effects on marine fauna SAR and SOCC (including marine fish, marine mammals, and marine turtles) are predicted to be similar to those for marine fauna as a whole, which are discussed in detail in Section 10.11.2. Potential effects of the Project phases on marine fauna SAR and SOCC are summarized in Table 10.12-2.

10.12.5 Mitigation

Mitigation for potential effects on SAR and SOCC are similar to recommendations for terrestrial fauna as a whole (Section 10.9).

10.12.5.1 Terrestrial Flora SAR and SOCC

Vascular Plant SAR

The most basic mitigation measure is the reduction of the Project footprint in order to reduce the size of the area that could potentially impacted (see Section 10.7).

Surveys will be considered prior to construction activities to determine if any Tape Grass specimens occur within the Project footprint. Assuming none occur within the footprint, mitigation measures as described in Section 10.3 and Section 10.10, which aim to maintain water quality and quantity, would be applicable to ensure no adverse affects occur to Tape Grass.

To minimize the introduction of alien and invasive species, which may lead to habitat alteration, disturbed areas should be revegetated immediately. Rehabilitation should be established based on site-specific landscape plans. Local native vegetation should be used for re-vegetation. To that effect, it is recommended that the organic soil layer be stockpiled for later rehabilitation of disturbed areas.

Similarly, re-vegetation of reclaimed areas after the decommissioning of the facilities should use native plant species. Preferably, it should replace forest habitat lost, unless regulators such as NSDNR prefer a different habitat type. If seed mixes are used, they should preferably contain native flora. High quality commercial seed mixes usually do not contain invasive species.

Erosion at disturbed sites should be controlled in order to encourage vegetation. Efficacy of the erosion and sediment control measures, as well the establishment of native flora should be monitored through an EEM program implemented immediately after the construction or rehabilitation.

In addition, construction and transportation equipment should be cleaned from vegetation and soil residues and inspected before entering the Project site. At a minimum, this should be done when the equipment was previously used in other wet or wetland areas. This mitigation has previously been successfully carried out during other projects.

As part of the EMP compliance monitoring, a program of identification and removal of noxious weeds will be established. This program will include consideration for seasonality and risk associated with species known to occur in NS.

Lichen SAR

Standard mitigation measures such as dust control, emissions control, monitoring of air quality targets and minimization of Project footprint as detailed in Sections 10.4, 10.7, and 10.17 will protect lichen SAR/SOCC.

If the pipeline ROW layout is changed during the final design phase to be located outside of the buffer surveyed from lichen SAR/SOCC, supplementary lichen SAR/SOCC surveys would be required.

10.12.5.2 Terrestrial Fauna SAR and SOCC

Mitigation for potential effects to terrestrial habitats, wetlands and terrestrial fauna, is discussed in detail in Section 10.7, Section 10.8, 10.9, and 10.17. These mitigation measures should be sufficient to minimize potential impacts to bird, mammal, reptile, odonate and lepidopteran SAR/SOCC potentially occurring in the Project area.

Moose

Mitigation for potential effects to terrestrial habitats, wetlands and terrestrial fauna, is discussed in detail in Section 10.7, Section 10.8, and Section 10.9. Mitigation measures for mammals should be adequate to mitigate potential effects on Moose in the area.

Standard handling and storage procedures for hazardous material, as well as procedures for handling and disposal of contaminated soils (outlined in Section 10.17), will adequately mitigate the potential for exposure of Moose to any hazardous materials or contaminated soils.

Strict reporting policies for any suspected hunting activities in the area will help to minimize any potential Moose poaching in the Project area.

Fencing the main property and imposing a 50 km/hr speed limit will reduce the potential for vehicle-moose collisions on-site year-round. It will also decrease encounters between humans and Moose.

As the Project will be causing some loss of Mainland Moose habitat, Pieridae is committed to contributing to efforts on conservation of mainland Moose, via support for Mainland Moose Recovery Team and/or the Assembly of NS Chiefs program for Moose recovery being administered by the Unama'ki Institute of Natural Resources. Details will be negotiated and finalized upon EA approval and in consultation with DNR. A Moose Management Plan may also be implemented to provide information and assist in the recovery of Moose in the Project area.

Bats

General mitigation for potential effects to terrestrial habitats and terrestrial fauna is discussed in Section 10.7 and Section 10.9. Mitigation measures for mammals should be adequate to mitigate potential effects on bats in the area.

Standard handling and storage procedures for hazardous material as well as procedures for handling and disposal of contaminated soils (outlined in Section 10.1.3) will adequately mitigate the potential for exposure of bats to contaminants

To further mitigate against adverse effects the Project may have on bats, Pieridae is committed to contribute to the Province's bat recovery program. Specifics will need to be developed in consultation with NSDNR to ensure maximum effectiveness. Potential measures could entail the installation of 'bat houses' around the Project area, in areas unaffected by Project noise and light emissions. This could provide compensation for the loss of summer roosting habitat caused by site clearing. Additional bat monitoring and study could also be undertaken to aid the Province's recovery efforts by obtaining further insight into the significance of off-site AMOs for use as roosts or hibernacula.

10.12.5.3 Freshwater Fauna SAR

Mitigation for potential effects to freshwater fauna and habitats is discussed in detail in Section 10.10.4 and will aid in mitigating potential effects on freshwater fauna SAR/SOCC. To summarize, the loss of freshwater fauna habitat in the Unnamed Watercourse will be mitigated via the Freshwater Habitat Compensation Plan. A fish rescue exercise prior to the removal of the Unnamed Watercourse will minimize direct mortality of Brook Trout and American Eels residing in this watercourse.

Standard sedimentation and erosion control measures should mitigate potential effects on freshwater SOCC. These will be outlined in a project-specific EPP.

10.12.5.4 Marine Fauna SAR (including Fish, Mammals, Reptiles)

Mitigation of potential effects on marine fauna is discussed in detail in Section 10.11.3. A marine Habitat Compensation Plan is also being developed to mitigate the loss of a small amount of marine habitat within the Project footprint.

10.12.6 Summary and Residual Effects

Table 10.12-3 provides the results of the effects assessment for all flora and fauna SAR/SOCC VECs for construction and operation phases of the Project. Effects associated with the decommissioning phase are expected to involve similar issues as those discussed for the construction phase.

Table 10.12-3 provides a summary of recommended mitigation measures and residual environmental effects after successful implementation of the mitigation measures described above. With respect to both the Flora and Fauna SAR/SOCC, Project activities are not likely to result in significant adverse residual effects on vegetation, habitats, or species with implementation of recommended mitigation measures.

Table 10.12-3 Residual Environmental Effects Summary for Species at Risk (SAR)

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction/ Decommissioning and Operations								
Flora SAR/SOCC								
Direct and indirect plant mortality due to displacement or loss of aquatic biota; permanent alteration/ damage/ destruction to SAR aquatic habitat.	A	• Survey for Tape Grass. • Complete works during periods of least biological activity/sensitivity.	Low	Meadow Lake and Dung Cove Pond.	Permanent during lifetime of the Project.	NR during lifetime of the Project.	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor
Indirect plant mortality due to potential runoff and erosion, siltation and turbidity.	A	• Use of suitable backfill materials. • Restrictions on the removal of riparian vegetation. • Establish a buffer zone of 20 m around freshwater habitat. • Management of stormwater quantity and quality to relevant provincial standards. • Establish and implement EPP/EMP including erosion and sediment control plan.	Low	Project site and downstream freshwater habitats.	Construction Phase; Decommissioning phase.	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Indirect plant mortality due to alteration of drainage patterns and infiltration/runoff volumes.	A	• Management of stormwater quantity and quality to relevant provincial standards. • Stormwater will be collected and treated in a stormwater facility prior to discharge into Stormont Bay /recreated watercourse, as per a site-specific Stormwater Management Plan.	Low	Project site and downstream freshwater habitats.	Permanent during lifetime of the Project.	NR during lifetime of the Project.	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor
Displacement or loss of suitable habitat due to the introduction of invasive species.	A	• Construction and transportation equipment to be cleaned from vegetation and soil residues before entering the Project site. • Discourage workers from entering off-site areas. • Re-vegetate or seal disturbed surfaces immediately. • Continue monitoring program (EEM) for noxious weeds.	Low	Local; depends on size of affected area.	All Phases/ Infrequent.	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Deterioration of potential BFL habitat as a result of emissions of gaseous pollutants from the use of internal combustion engines in tankers, from gas flare, power generation.	A	• Emission controls. • All equipment used on-site is to be properly maintained to ensure exhaust emissions are typical for each piece of equipment. • Equipment will conform to current and future regulated emissions standards for state of the art natural gas combustion engines. • Conform to normal industry practices that are known to reduce emissions such as the use of auxiliary engines for container vessel hoteling. • On-going CAC monitoring during operation to confirm effects predictions of the dispersion modelling and to document compliance.	Low	Up to 500 m from LNG facility footprint.	Operations Phase	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal
Indirect plant mortality as a result of fugitive dust emissions from activities such as site preparation, grading and vehicle traffic. Wind erosion of displaced soil may also generate fugitive dust emissions prior to paving or revegetation.	A	• Application of water or dust suppressants. • Covering of haul trucks. • Use of paved roads to the extent possible. • Limiting vehicle speed. • Stabilizing disturbed areas.	Low	Vicinity of LNG facility footprint.	Construction Phase	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Indirect plant mortality due to increase in levels of toxic and deleterious substances due to infrastructure maintenance (herbicides and salt).	A	• Vegetation growth should generally be regulated by physical cutting. • Approved herbicides may be used for the maintenance only if necessary. • Herbicides will be applied according to legal regulations (NSE). • Implement measures outlined in an EPP/ EMP.	Low	Local; depends on size of affected area.	Operation Phase; Short term/ infrequent.	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal
Terrestrial Fauna SAR/SOCC								
Clearing and grubbing will lead to habitat loss or degradation for fauna.	A	• Pieridae to support Mainland Moose and bat recovery efforts. • Minimize disturbed area. • Rehabilitate all temporarily used sites.	Medium	Project site and Pipeline Corridor (150 ha).	Permanent during the lifetime of the Project.	NR during lifetime of the Project.	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor
Clearing of land, pipeline route and road creation will increase habitat fragmentation for fauna.	A	• Minimize Project footprint. • Minimize lay-down areas. • Modify EMP/EPP in response to new species information (if applicable). • Conduct EEM, if required.	Low	Project site and Pipeline Corridor (150 ha).	Permanent during lifetime of the Project.	NR during lifetime of the Project.	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor/ Medium (for Moose Medium)

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Project will lead to increased vehicle traffic in area and may result in direct fauna mortality.	A	• Speed limit of 50 km/hr on site. • Fencing on-site.	Low	General area	All phases	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minimal
Indirect fauna mortality as a result of exposure to contaminants via disturbed contaminated soils or spills.	A	• Proper handling and storage of hazardous materials. • Proper handling of contaminated soils • Adherence to site-specific EPP.	Low	Project site and Pipeline Corridor (150 ha).	All phases	NR	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor
Change in fauna behaviour as a result of noise and light disturbances (including blasting).	A	• Minimize duration of noise disturbance. • Conduct blasting outside of sensitive periods. • Implement mitigation measures regarding noise and light effects on fauna in Section 10.9.4 and Table 10.9-1.	Low	Project site and adjacent lands.	All phases	R	• Area affected by human activity; pristine areas not known. No critical habitat on-site.	Minor
Freshwater Aquatic SAR/SOCC								
Loss of individual Brook Trout and American Eel.	A	• Fish rescue exercise prior to removal of Unnamed Watercourse.	Low	Unnamed Watercourse.	Construction phase	R	• Area affected by human activity; only one small water course on site.	Minor

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Habitat loss via removal of Unnamed Watercourse.	A	• Develop and implement freshwater fisheries offset plan.	Low	Unnamed Watercourse.	Construction phase.	NR during lifetime of the Project.	• Area affected by human activity; only one small water course on.	Medium
Indirect mortality and reduction in suitable habitat due to erosion effects.	A	• Proper sediment and erosion controls, as outlined in EPP.	Low	Dung Cove Pond.	Construction phase.	R	• Area affected by human activity; designated Industrial Park.	Minor
Mortality and reduction in suitable habitat due to sedimentation and siltation.	A	• Proper sediment and erosion controls, as outlined in EPP.	Low	Dung Cove Pond, Gold Brook branch, Meadow Lake and Betty's Cove Brook.	Construction phase.	R	• Area affected by human activity; designated Industrial Park.	Minor
Marine SAR/SOCC								
Loss of fish habitat due to construction of marine wharf and jetty.	A	• Development and implementation of marine fisheries offset plan.	Low	Marginal wharf footprint and immediately adjacent.	Construction phase through to decommissioning.	NR during lifetime of the Project.	• Affected area represents approximately 0.38% of lobster habitat within Stormont Bay.	Medium
Habitat degradation due to sedimentation and turbidity from vessels.	A	• Use of tugs for large vessels.	Low	Marginal wharf footprint and immediately adjacent.	Construction phase through to decommissioning.	R	• Marine SAR/SOCC.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Disturbance and potential change in behaviour due to noise from ship traffic.	A	• Ships will be well maintained and best available technologies for exhaust and pollution control will be used.	Low	Marginal wharf approaches.	Construction phase through to decommissioning.	R	• Marine fish and mammal SAR/SOCC.	Minor
Disturbance and potential change in behaviour due to noise from pile driving and other construction activities.	A	• Work during low tide. • Work outside of sensitive periods. • Use of ramped warning signals. • Use of bubble curtains.	Low	Depending on noise level could extend throughout Stormont Bay.	Construction phase.	R	• Marine fish and mammal SAR/SOCC.	Minimal
Degradation in fish habitat due to the release of bilge and ballast water to Stormont Bay.	A	• Adherence to federal legislation.	Low	Stormont Bay	Operation phase.	R	• Potential fish habitat.	Minimal
Mortality as a result of collisions with ships.	A	• Tugs will be used to bring in ships. They will be going slowly and observations will be made at that time.	Low	Jetty and Approaches.	All phases.	NR	• Potential marine mammal SAR/SOCC.	Medium

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.13 Socio-Economic Environment

10.13.1 Threshold for Determination of Significance

10.13.1.1 Employment and Local Economy

The thresholds for significance of environmental effects of the Project on employment and the local economy are:

- a significant adverse environmental effect is one that results in a Project-related sustained long-term decreased level in employment and economic activity in the community, region or province; and
- a positive environmental effect is one that results in a Project-related sustained increased level of employment and economic activity in the community, region or province.

10.13.1.2 Fishery, Aquaculture, and Marine Harvesting

A significant adverse effect on marine fisheries and aquaculture is defined as one that is likely to cause any one of the following:

- an uncompensated loss of habitat of fish species relevant for commercial, recreational and/or Aboriginal fisheries;
- a sustained decrease in levels of earnings from a fishery due to decreased catch quantity and/or quality, or increased costs of fishing from longer travel times or similar issues; or
- a sustained decrease in levels of earnings from aquaculture activities due to the destruction of a crop.

10.13.1.3 Human Health

A significant adverse air quality effect has been determined to represent a condition where regulatory objectives are regularly exceeded.

The regulatory frameworks for the evaluation of the impacts to Human Health are supervised by a number of government agencies. A number of laws, regulations, and guidelines are relevant to the evaluation of human health, as identified below:

- *Occupational Health and Safety Act* of NS – describes the general guidelines under which worker health and safety will be protected.
- Air Quality Regulations of NS – specifies maximum permissible ground level air concentrations (NSE, 2010b).
- CEPA – establishes ambient air quality objectives for maximum desirable as well as maximum tolerable ground level air concentrations.

- CCME Canadian Environmental Quality Guidelines – includes soil and groundwater guidelines for the protection of human health and guidelines for Canadian drinking water quality (CCME, 1999).
- Atlantic PIRI Reference Document for Petroleum Impacted Sites in Atlantic Canada. Atlantic RBCA Version 3.0 – Provides Tier 1 soil and groundwater concentrations protective of human health from petroleum releases, as well as methods to develop site-specific target levels (RBCA, 2012).

10.13.2 Effects on Employment and Local Economy

Pieridae is committed to maximizing social and economic benefits to the Province, while ensuring the integrity of both the social and natural environment of NS. The following economic impact analysis demonstrates the economic benefits that can be realized from the Project.

10.13.2.1 Economic Impact Analysis Methodology

General

Economic impacts result from increased or decreased demand for goods, services and labour. As expenditures are made, the economy typically expands to meet these increased demands. The businesses that expand to fulfil increased demands will, in turn, increase their own purchases of goods, services and labour creating additional demand in the economy to be met by further increases in supply.

Economic impacts are dependent on the size and type of expenditures, and on the structure of the economy. The amount of the expenditures is important because the magnitude of the economic impacts is positively related to the amount of expenditure. The type of expenditure and the structure of the economy are important because to the extent that the required goods and services are produced locally, the local impact would be greater than if most of these items need to be imported.

Input-Output Modelling

A number of methods are available to estimate economic impact. However, the most common and widely used approach is the well-established Input-Output Model which is built on the fundamental assumption that each producing sector in the economy is dependent on every other sector. This makes it possible to trace “multiplier effects” coming from exogenous (or demand-side) shocks to the economy.

The economic impacts for this analysis were measured using published Detailed-Level 2009 Inter-Regional multipliers (most recent available) for NS, developed by the Industry Accounts Division of Statistics Canada (Catalogue no. 15F0046XDB). The Input-Output Model provides a “snapshot” of how the province’s industries interact with one another in the production and consumption of goods and services.

The multipliers used in this analysis provide estimates of direct, and indirect and induced economic effects on the economy. However, given the limited level of detail regarding Project

expenditures available at the Pre-FEED project development stage, the modelling to account for induced effects likely overstates the economic impacts.

In summary then:

- Direct effects measure the economic effect for an extra dollar's worth of output of a given industry. The direct effect on the output of an industry is a one dollar change in output to meet the change of one dollar in final demand. Associated with this change, there will also be direct effects on GDP, jobs, and imports.
- Indirect effects measure the economic effects due to inter-industry purchases as they respond to the new demands of the directly affected industries. This includes all the chain reaction of output up the production stream since each of the products purchased will require, in turn, the production of various inputs.
- Induced effects measure the changes in the production of goods and services in response to consumer expenditures induced by households' incomes (i.e., wages) generated by the production of the direct and indirect requirements.

Limitations

An important limitation of this analysis is that economic multipliers are to make relative, rather than absolute, comparisons. Economic multiplier analysis is more properly used to determine which of several activities would have the largest economic impact rather than to estimate the absolute level of economic impact for a single activity. Where economic multipliers are used to estimate the impacts of a single activity, the results should be treated as general estimates only, indicating the order of magnitude of the impacts rather than exact levels.

Data Preparation

To prepare the data input for the Input-Output Model, proposed US dollar capital and operation expenditures were converted into Canadian dollars using the prevailing mid-July 2013 exchange rate and then distributed according to expenditures assumed to occur in NS, the rest of Canada or outside the country. Expenditures expected to occur offshore (purchases of imports) are not considered in the Input-Output Model. Expenditures were then grouped by North American Product Classification Codes. Using these inputs the Input-Output Model generates the direct and indirect impacts according to the following economic indicators:

- GDP: captures the value of final goods and services used by the Project, providing a measure of the value-added activity.
- Labour income: provides a measure of wages and salaries.
- Jobs: indicates the numbers (Full-Time-Equivalent), or person-years) employed during construction (over 54 months) or operations (annually recurring).

10.13.2.2 Effects of Construction

Total capital expenditures are anticipated to be in the order of CDN $8.32 billion for the construction and commissioning of the proposed facility as described in Section 3.1. These have been allocated to NS and the Rest of Canada based on best judgement regarding

sourcing and procurement available at the time of writing. Total capital expenditures in NS are anticipated to be in the order of CDN $6.9 billion. The economic assessment for Project construction was based on the Project description and the capital expenditures based on a Class IV estimate (+40%/-40%) of the various programs and / or proposed infrastructure as follows:

- LNG trains;
- utilities and off-site infrastructure;
- cryogenic storage & export jetty;
- buildings;
- conventional transportation;
- management, engineering and procurement;
- supervision (yard and site);
- vendor representatives
- site camp and temporary facilities;
- initial spare parts;
- insurance and bonds;
- commissioning;
- feed gas pipeline;
- cryogenic storages;
- marine works;
- site preparation; and
- other.

In NS, the direct effects of Project construction are estimated to be 22,286 person-years employment, $1.8 billion in wages and salaries, and a $2.7 billion contribution to the provincial GDP. These impacts include on-site employment and are spread over 54 months. Thus, while the jobs figure appears elevated, this translates to about 4,944 jobs per year.

In NS, the indirect and induced effects of Project construction are estimated to be 24,802 person-years of employment, $1.1 billion in wages and salaries, and about $2.0 billion contribution to the provincial GDP. These impacts are also spread over 54 months.

To determine the economic effects of construction across Canada, the total in-Canada capital expenditures ($8.32 billion) were applied to the IO multipliers for all provinces (including NS). The direct and indirect effects of Project construction for all provinces are estimated to be 74,886 person-years employment, $4.7 billion in wages and salaries, and a $7.2 billion contribution to the national GDP. These impacts are also spread over 54 months, across the entire country.

The estimated economic benefits resulting from Project construction are summarized in Table 10.13-1.

Table 10.13-1 Economic Effects of Project Construction

	Direct Effects	Direct and Indirect Effects	Indirect and Induced Effects
NS			
GDP ($millions)	2,656	-	1,978
Labour Income ($millions)	1,746	-	1,117
Jobs (employment in person-years)	22,286	-	24,802
All Provinces			
GDP ($millions)	-	7,169	-
Labour Income ($millions)	-	4,647	-
Jobs (employment in person-years)	-	74,886	-

In addition, the assessed value of the Project is anticipated to generate a property tax of about $6 million per annum during the Project lifetime.

10.13.2.3 Effects of Operation

Total operations expenditures (all allocated to NS) are estimated to be in the order of CDN $34.8 million per annum, excluding property taxes. The economic assessment for Project operations was based on the Project description and the estimated operations expenditures on the following goods and services:

- labour;
- property tax;
- maintenance materials;
- communications;
- welding;
- insulation;
- painting;
- vehicle leasing;
- road maintenance;
- environment monitoring;
- snow clearing;
- business machine rentals;
- office services;
- janitorial;
- audit;
- contingency; and
- miscellaneous.

Total annual capital expenditures at steady-state plant operations are anticipated to be about $41 million, all of which are expected to disbursed in NS. Total operation expenditures include about $6 million for property taxes, and $18.6 million in labour costs. Because there is no multiplier for LNG plant operations in NS, labour expenditures are not included in the Input-Output Model analysis for operations.

For the purposes of the analysis, the total operations cost less taxes and labour expenditures (i.e., $16.2 million) have been modelled. In NS, the direct effects of the non-labour expenditure are estimated to be 24 person-years of employment, $900,000 in wages and salaries, and a $2.6 million contribution to the provincial GDP. The on-site labour expenditure and on-site jobs (about 200) are considered to be additive, so the total direct effect is 224 person-years and $19.5 million in wages and salaries. The GDP contribution would also be significantly higher but this cannot be calculated accurately due to limitations of the model. These benefits will occur for each year of operation over the life of the Project.

In NS, the indirect and induced effects of the non-labour expenditure are estimated to be 15 person-years employment, $620,000 in wages and salaries, and a $1.3 million contribution to the provincial GDP. These effects are understated due to limitations of the model. These benefits will occur for each year of operation over the life of the Project. These impacts do not include the 200 person-years at the plant. These effects do not show up in the modelling results.

The estimated economic benefits resulting from Project operations are summarized in Table 10.13-2.

Table 10.13-2 Economic Effects of Project Operation (Less Labour Costs)

	Direct Effects	Indirect and Induced Effects
NS		
GDP ($millions)	2.7	1.3
Labour Income ($millions)	19.5	0.6
Jobs (employment in person-years)	224	15

Note:
Includes modelled effect and on-site impacts.

10.13.2.4 Effects of Decommissioning

Economic benefits have not been calculated for the decommissioning phase as the after use concept, specific decommissioning activities, and time tables have not been sufficiently defined. Decommissioning costs often approximate construction capital costs and are anticipated to generate significant economic benefits. Decommissioning activities will include works and services related to building and equipment demolition, infrastructure removal, and probably earth works, site contouring and re-vegetation. Decommissioning can be expected to be of rather short duration (many months up to a year) relative to the operation phase.

10.13.2.5 Maximizing Project Benefits

Pieridae's objective is to maximize the economic benefits for the local and regional communities. As such, Pieridae is currently working with local economic development agencies to identify the various businesses that could provide labour, goods and services to the Project in order to maximize NS content, as well as working with local educational institutions to identify local training opportunities.

10.13.2.6 Maximizing Benefits for Aboriginal Communities

Pieridae is committed to encouraging extensive Aboriginal participation in the Project, and to this end, has entered into a Memorandum of Understanding (MOU) with the Assembly of NS Chiefs, through the Kwilmu'kw Maw-klusuaqn (KMK). The purpose of this MOU is to advance a positive collaborative relationship between the Goldboro LNG Project and the Mi'kmaq communities by establishing an agreement for the provision of opportunities and benefits to the Bands. One of the key components of that Collaborative Benefits Agreement (CBA) will be direct participation of First Nation community members in Project activities during construction and operating phases.

While the MOU was negotiated with the KMK on behalf of the Assembly of NS Chiefs, Pieridae has maintained a direct working relationship with Aboriginal communities in close proximity to the Project in order to explore the labour market and to identify training needs that will facilitate First Nation employment in the Project. Based on that, Pieridae expects that Aboriginal people will participate in the Project workforce or otherwise experience direct or indirect economic benefits from the Project development. The expected employment levels cannot be quantified at the time of writing this document, partly since it is subject to the CBA negotiations.

Engagement and inclusion of Aboriginal peoples at the outset of the construction is anticipated to enhance relationships between Aboriginal and non-Aboriginal labour markets thus foster collaborative capacity building and sustained economic development in the region in general.

10.13.3 Effects on Fishery, Aquaculture and Marine Harvesting

Commercial fishing and aquaculture are two important economic activities within the marine environment of Stormont Bay. Commercial fishing takes place almost entirely outside of the estuaries of Country Harbour and Isaac's Harbour and aquaculture occurs only within Country Harbour. Recreational fisheries in the area are small but diverse, and include both freshwater and estuarine components. Brook trout are the primary recreational species. They are fished both in many of the lakes, rivers and streams that flow into Stormont Bay and in the inner parts of the estuary. Mackerel are periodically fished from shore throughout the summer and fall within Stormont Bay. Commercial lobster fishing is the only harvesting that occurs in close proximity to the Project.

10.13.3.1 Effects of Construction

The fleet fishing out of Country Harbour and Isaac Harbour is not large but supports a stable fishery. The construction of the marginal wharf will remove approximately 3 ha in area that was available for both commercial and recreational fishing activities. In addition, effects described for the marine habitat would also have an adverse effect on the local fishery. The fishery may also be affected because of the attraction of fish to lighting from construction activities. Potential sediment runoff or plumes could lead to mortalities and/or displacement of fish species.

Aquaculture operations are not located in the vicinity of construction activities.

10.13.3.2 Effects of Operation

Potential operational impacts to fisheries and aquaculture are associated with Project-related vessels entering and leaving the area. The increase in shipping within the area has the potential to interfere with fishing vessels and increase the ambient underwater noise that may affect the distribution and/or migration of fish movement in the area and decrease catches. Additionally, fishing gear could be lost if vessels do not utilize the marked shipping lanes.

The jetty and marginal wharf extend into Stormont Bay far enough to partially block the entrance to Isaac's Harbour. This could hamper vessels returning to port within Isaac's Harbour. In addition LNG vessels will likely require an exclusion zone around them at sea. This exclusion zone will prevent vessels from working at fishing grounds within the zone.

Aquaculture sites are remote from the site and will not be affected by the terminal operation. An increase in vessel traffic is not anticipated to have any adverse effect on these sites.

10.13.3.3 Effects of Decommissioning

Effects associated with the decommissioning phase are expected to involve generally similar issues as those identified for the construction phase. The specific effects on the marine environment will very much depend on the extent of the decommissioning. Of key importance would be the question whether or not the marginal wharf would be removed and the filled in area rehabilitated to pre-development conditions. It is more likely that the marginal wharf will remain in place. However, should the wharf be removed, it would provide an opportunity for beneficial effects through re-construction of natural marine habitat. Any such in-water work would need to be conducted with the necessary mitigation measures to avoid and reduce temporary effects related to sediment loadings and potential accidental contamination (e.g., fuel spills). Decommissioning objectives and approach would be discussed with all relevant stakeholders at the time and would need to be implemented in compliance with the regulatory standards applicable at that time.

10.13.4 Effects on Human Health

Human health is considered a VEC due to the potential for direct and indirect Project related effects (Section 8.0). The TOR (NSE, 2013a) specifically identifies a Human Health concern due to air quality (see Appendix A; section 11.3 under Atmospheric Resources). Changes to the atmosphere (air quality) associated with plant emissions, accidents, malfunctions, and unplanned events are evaluated in Section 10.4), including a description of the air quality modeling which was conducted for the Project.

Potential sources for human exposure to hazardous material at the site include:

- old mine tailings contaminated soil and potentially contaminated dust and run-off generated from such soils;
- acid generating bedrock contamination in groundwater;
- Project air emissions related to combustion of fossil fuels; and

- chemicals and waste products produced, stored, and/or handled on site (including potential accidental spills).

This section considers potential impacts on other VECs that may function as pathways. These VECs include: Geology, Soil/Sediments (Section 10.1), Groundwater Resources (Section 10.2), and Surface Water Resources (Section 10.3). Based on the current design plan, excavations are not expected into the acid rock formations. This will be confirmed during the initial geotechnical investigations and, if required, a SBMMP will be implemented. Human health can also be exposed to hazardous material through consumption of natural foodstuffs. In this context, other VECs may be linked indirectly including terrestrial vegetation and wildlife, and freshwater and marine fish products. The potential effects on these environmental VECs are being evaluated in a cumulative way to assess potential effects/changes to human health.

In order to protect public and worker health Pieridae will develop a comprehensive preventative Health and Safety Program (Section 3.7) that will be implemented throughout the Project, including construction, operation, and decommissioning. To avoid and minimize effects on environmental VECs as pathways to public and worker health the Project will implement an EMP and EPP as discussed in Section 3.7.2 and Section 3.7.3. In addition, Pieridae is committed to also applying a comprehensive set of environmental mitigation measures for all related VECs, which are summarized in Section 14.0. Monitoring programs (Section 12.0) will ensure effectiveness of these measures and regulatory compliance. An adaptive management approach (Section 3.7.4) will facilitate adjustments to environmental and health management, should deficiencies be identified.

Potential risks to workers will be carefully assessed during FEED and site specific worker health and safety procedures will be developed as part of a workplace HASP. That will include consideration of all applicable regulatory requirements and industry best management practices. Therefore, the remainder of this section will focus on the potential for exposure of the general public and other VECs, particularly with respect to off-site impacts.

10.13.4.1 Residual Environmental Effects Evaluation Criteria

In order to evaluate whether any potential impacts on human health are significant, exposure point concentrations are compared to human health criteria (i.e., Provincial and Federal guidelines). Criteria to protect human health have been established through the laws, regulations, and guidance documents identified above. Table 10.13-3 summarizes the relevant criteria for contaminated material that might be spilled or released during construction, operation, or decommissioning. Modelled exposure point concentrations which exceed criteria shown in Table 10.13-3 will be considered a significant adverse effect

Criteria are not shown in Table 10.13-3 to address worker health and safety. These will be established as part of the Project HASP development (Section 3.7.1).

Table 10.13-3 Public Health Criteria for Evaluation of Soil Chemistry Residual Effects

Chemical	Soil (mg/kg)											
	CCME				Atlantic RCBA Version 3.0 Tier I Risk-Based Screening Level							
					Residential				Commercial			
					Potable		Non-Potable		Potable		Non-Potable	
	Agri.[1]	Res./Park[2]	Comm.[3]	Industrial[4]	Coarse-grained Soil	Fine-Grained Soil	Coarse-grained Soil	Fine-grained Soil	Coarse-grained Soil	Fine-grained Soil	Coarse-grained Soil	Fine-grained Soil
Petroleum Hydrocarbons												
Gasoline					39	140	39	330	450	520	450	10,000
Diesel/#2					140	220	140	4,400	7,400	840	7,400	7,700
#6 Oil					690	970	690	8,300	10,000	4,700	10,000	10,000
VOCs												
Benzene	0.05	0.5	5	5	0.03	0.01	0.16	1.5	0.03	0.01	1.8	11
Toluene	0.1	0.8	0.8	0.8	0.38	0.08	14	120	0.38	0.08	160	680
Ethyl Benzene	0.1	1.2	20	20	0.08	0.02	58	430	0.08	0.02	430	430
Xylenes	0.1	1	17	20	11	2.3	17	160	11	2.3	200	650
Metals												
Arsenic	12	12	12	12								
Chromium (hexavalent)	0.4	0.4	1.4	1.4								
lead	70	140	260	600								
Mercury	6.6	6.6	24	50								
Criteria Air Pollutants												
CO												
H_2S												
NO_2												
Ozone												
SO_2												
TSS												

Notes :
1. Agricultural Land Use
2. Residential/Parkland Uses
3. Commercial Land Use
4. Industrial Land Use

10.13.4.2 Potential Receptors

Humans that may be potentially affected by construction, routine facility activities, as well as accidents, malfunctions, and unplanned events are primarily those that live in the near the Project site. The nearest communities to the Project site are Goldboro and Seal Harbour. Nearest residences are located approximately 300 m from the property boundary on Red Head and along Webb's Cove and 800 m on the east side of Betty's Cove Brook (Figure 9.3-1). The primary sensitive community features and service receptors in the area of the Project include the Goldboro Interpretive Centre, Isaac's Harbour Villa Senior Apartments, and Isaac's Harbour Medical Centre (Figure 9.3-1). Residents in the vicinity of Goldboro all use private wells, as described in Sections 9.2.1.6 and 9.10.5.

The following sections describe potential impacts to public health during construction, operation, and decommissioning. These impacts, as well as mitigative measures, are summarized in Table 10.13-5 below.

10.13.4.3 Effects of Construction

During construction, there are several activities that could potentially impact human health:

- dust generation during facility and roadway construction, in particular concerns with arsenic and mercury that are residuals of mining operations;
- air emissions from construction equipment and vessels transporting construction materials and equipment;
- water and waste management and control; and
- air emissions from vehicular traffic to the construction locations.

Dust generation during facility and roadway construction could occur, although potential impacts are expected to be localized. As part of the EMP, a dust control plan will be implemented during construction to address this issue and provide controls to minimize dust and specify monitoring requirements. This is of particular concern in areas where mine tailings are found (Figure 9.1-5). As discussed in Sections 9.1.2.5 and 9.6.2.1, sediment/tailing samples in Dung Harbour have been shown to have elevated concentrations of arsenic ranging from 14 mg/kg to 1700 mg/kg, well above the Canadian Environmental Quality Guideline for soil of 12 mg/kg, considering either residential or industrial land use, as shown in Table 9.1-1. Concentrations of mercury in this area slightly exceed the residential guideline of 6.6 mg/kg in only one sample. Since the tailings in this area are wet, particulate generation is unlikely. However, handling of this material by workers will be conducted with adequate health and safety controls, and re-use at the ground surface in other locations will be prevented. Such use could result in transport as particulates and potential exposure to the public.

Two other known tailings areas are found in locations potentially within the Project site (see Figure 9.1-5). In addition, others may be identified during construction activities. Health and safety controls will be used to protect workers involved in activities in these areas, and potential for airborne transport will be minimized.

Air emissions from construction equipment and vessels transporting equipment and materials will be localized with limited transport, due to their sporadic nature and emissions close to ground surface. Air emissions of vehicular traffic to the construction site will also occur, however, many of the workers will be located at the site, and much of the equipment and materials will be transported to the site by sea. Therefore, traffic to and from the site during construction will be minimized (see predicted traffic volumes in Section 3.2.10 and 10.15). As the site is fairly isolated from residents, schools and businesses of the area, the impact to the public are expected to be insignificant, approaching background concentrations at off-site locations.

Water and waste management should not pose a hazard to public health or worker safety during construction. The primary concern is preventing runoff or other transport of soils impacted by mining. Construction practices in such areas will be governed by the EMP (Sections 3.7.2) and will include provisions to identify and isolate contaminated soils and control runoff and potential soil erosion.

Equipment and materials storage during construction will consist of building materials, process components, and other items needed for construction. The Project's EMP (Section 3.7.2) will require storage of all potentially hazardous materials in one or more designated locations. Spills could occur from construction equipment kept on-site during this period, or from stored fuels, or other liquid materials needed for equipment or construction. Such spills are likely to be of small volume and localized, as large quantity storage is not expected during the construction period. Nevertheless, uncontrolled spills could impact groundwater and potentially migrate to private supply wells. As discussed in Section 3.7.2, the Project will establish an EMP which will include a management plan for hazardous materials and an Emergency Response Plan that will be implemented during construction to provide specific requirements for storage, prevention, and response to spills to minimize any potential impact.

10.13.4.4 Effects of Operation

During facility operation, there are several activities that could potentially impact public health:

- air emissions from marine vessel traffic and uploading;
- air emissions during vapourization/regassification of LNG to natural gas;
- air emissions during power generation;
- facility wastewater discharges;
- air emissions from vehicular traffic; and
- potential spills during materials transfer and storage.

Air emissions from marine vessel traffic are unlikely to impact humans, since the shipping lane is quite distant from human receptors. However, during hoteling and unloading of LNG ships (approximately 24 hours), engines will be idling. Emissions are expected to occur over this period. These impacts are considered in the modeling of air emissions, as discussed below.

Section 10.4 estimated emissions from Project components during operation and modeled air GLC based on these emissions. The highest predicted pollutant air concentrations are

compared to NS Maximum Permissible Concentrations. This comparison (Table 10.4-9) shows that all regulatory standards are met. In addition, the highest predicted pollutant concentration is not likely to be where there are any receptors. Table 10.4-10 indicates that maximum estimated concentrations at identified sensitive receptors are much lower than the highest predicted concentrations. These comparisons indicate that air emissions during facility operation are not likely to pose a health risk.

The Project's EMP and associated Hazardous Materials Management Plan and Emergency Response Plan will ensure that materials that could result in spills are stored in designated locations, proper handling protocols are followed, and that spill prevention and response equipment is in place, and response procedures are followed should a spill occur. In addition, the site's stormwater management systems will ensure control of runoff, opportunities for containment, and quality monitoring. This will minimize any impacts to soils and groundwater that could result in potential impacts to human health. Many of the spill containment measures in terms of facility design and component siting are described in Sections 3.5 and 3.6.

Expected wastewater discharges from the facility have been described in Section 3.5. Effluents from the facility will be treated to applicable quality standards and are not expected to present a hazard to health or safety.

10.13.4.5 Effects of Decommissioning

During facility decommissioning there are several activities which could potentially impact public health:

- decommissioning of the waterfront facilities and pipelines;
- decommissioning of the LNG liquefaction and storage facilities;
- demolition and removal of the power plant and all other site facilities and utilities;
- reclamation of the Project area; and
- vehicular traffic.

The on-site tailings potentially affected by the Project will have been delineated, isolated and/or removed as part of the initial site preparation at the onset of the constriction phase. As such, mobilization of contaminants from former tailings areas is likely not an issue during decommissioning. However, the Hazardous Materials Management Plan from the construction phase (as part of RMP in the EMP) will need to be reviewed and updated, if required, to govern any work associated with tailings areas.

Decommissioning and demolition of the LNG facilities could increase the probability of spills and airborne emissions of dust. Reclamation of the Project site could also potentially increase dust levels on and off-site. The EMP for the decommissioning phase will address similar issues as for the construction phase and include components such as a RMP, an Emergency Response Plan, and a Dust Control Plan to minimize the disturbance/release of hazardous materials.

The potential for impacts from dust created by vehicular traffic during the decommissioning phase is expected to be reduced from that during the construction phase due to the anticipated

shorter duration of the decommissioning activities and the reduced number of workers involved. As such significant adverse effects from vehicle generated dust are not predicted. A summary of the residual effects on Human Health is provided in Table 10.13-7 (end of Section 10.13).

10.13.5 Effects on Visual Landscape

10.13.5.1 Visibility

The proposed Project, in particular individual high elements (see Table 10.13-4), are expected to be visible from the near-by communities of Goldboro, Isaac's Harbour, and Drum Head and associated key view points. For Isaac's Harbour North, Seal Harbour, and Coddle Harbour, the Project is expected to be less visible as a function of distance, topography and the screening effects of the vegetation cover. However, the top features, such as the flare stacks, are expected to be generally visible from all of these locations. During night time, reflections of the lighting in the night sky will also be visible from all of these locations as well as the aeronautical obstruction lighting of the stacks.

Table 10.13-4 Project Components Visible Height

Project Component	Approximate Height (m)
High Pressure Flare Stack	100 – 180[1]
LP Flare Stack	40
Incinerator Stack (including refrigerant compressor)	40
Power Plant Stack (including emergency diesel general)	40
LNG Storage Tanks	50
LNG Tanker deck height	30
LNG Tanker pilot house height	38

Note :
1. The final height of the high pressure flare will be determined on air quality requirements.

For the traveling public along Isaac's Harbour Road and local sections of Marine Drive (Highway 316 including the anticipated realigned Highway 316 segment), most of the Project components will be visible. Most of the development is also expected to be visible from boats leaving Isaac's Harbour or approaching it from off-shore.

10.13.5.2 Changes in Visual Character

The impact of the Project on landscape character is a function of the contrast in form, height, colour, and shape between the Project components and the surrounding landscape. With the exception of the currently barely visible SOEI gas plant and the three small scale wind turbines, the absence of similar structures (marine facility, tank facilities, liquefaction plant, and tankers) or other industrial facilities, the new development is expected to appear in contrast with the existing rural landscape.

The single most visible feature will be the high pressure flare stack (Table 10.13-4). The stack must be high enough to eliminate excessive GLC of air emissions. Based on preliminary air quality monitoring, the height is likely to be closer to 100 m but may ultimately be adjusted following FEED. While the high pressure flare stack may be only slightly taller than the existing stack at the SOEI gas plant (approximately 90 m), it will be located on top of higher terrain on the ridge overlooking Isaac's Harbour. The stack will be approximately 1.5 m in diameter.

The upper half of the storage tanks will also be quite visible from locations around Isaac's Harbour, and although much lower than the main stack, would be much more noticeable due to their physical dimension (each approximately 100 m in diameter).

The new elements are considered to permanently change the existing landscape character from a visually coherent rural landscape to a landscape composed of stark visual contrasts between rural and industrial elements. It should be noted that this transition of visual character has been anticipated since the Municipality zoned the site for use as industrial park. To date, there have been no stakeholder comments that expressed concern for Project-related effects on the area's visual aesthetics (see Section 13.1.13).

Since the proposed water supply pipeline is located adjacent to the existing M&NP pipeline and the Meadow Lake intake area is not visible from any vantage point, there are no receptors or potential visual effects identified for that part of the Project.

10.13.5.3 Potential Receptors, View Points

Potential receptors include the traveling public using Marine Drive (Route 316) as well as Isaac's Harbour Road (Figure 9.3-1). While Isaac's Harbour Road is used predominantly by local residents, Marine Drive is used by local residents and seasonally also by tourists traveling along the NS's North Shore. Further, potential receptors are residents of the nearest communities, i.e., Goldboro, Isaac's Harbour, Isaac's Harbour North, Drum Head, Seal Harbour, and Coddle Harbour (Figure 1.7-1). In particular, locations along the south shore of Isaac's Harbour (i.e., Isaac's Harbour Community) are more likely to have an unobstructed view of the Project, since they face the open harbour; whereas, properties along the north shore (i.e., Goldboro community) are more likely to have view-obstructing buildings, trees, or terrain between them and the Project. Communities to the southeast and east will not see the marine components or most buildings, since these are located on the opposite side of the ridge, but will have a clear view of the main stack. Boats entering Isaac's Harbour from off-shore or leaving the Harbour would have an unobstructed view of the Project, in particular the marine jetty and moored LNG vessels.

Key view points in the area are considered to be associated with the (Figure 9.3-1):

- Goldboro picnic area;
- Goldboro church and cemetery;
- Goldboro community centre; and
- Isaac's Harbour church and cemetery.

10.13.6 Effects of Construction

There will be a short term impact to the visual landscape due to the changes in visual character and visibility in the area as the Project is being constructed. The majority of construction activities will be largely hidden from direct view by local communities. Travelers on the realigned Route 316 will pass between the existing SOEI gas plant and the Project site and

would have a clear view of some construction activities. Residents in the southern part of the harbour, particularly near Holly Point, will also be able to see some construction activities. Construction related shipping, particularly the shear leg (crane equipped barge) or pile driving rigs, may be visible in the lower Isaac's Harbour during short periods of construction. There may also be some visible emissions during construction, such as dust or exhaust plumes; however, these would be very temporary occurrences. Overall, the visual impact of construction will be relatively minor and restricted to daytime until the various Project components are starting to take shape late in the overall schedule such as the high pressure flare stack, the storage tanks, and the marine jetty.

10.13.6.1 Effects of Operation

There will be a long term impact to the visual landscape due to changes in visual character and the Project's visibility. Visual impact for near-by residences (within approximately 3 km) and travelers along Route 316 are expected to be major. There are approximately 100 residences located within 3 km of the site. The nearest residents are located approximately 500 m from the proposed LNG facility around Webb's Cove.

The majority of structures at the LNG facility will be obscured from local communities by view-obstructing terrain and vegetation. Some of the lower stacks (40 m) may be barely visible above the tree tops to parts of Isaac's Harbour. During daytime, the LNG storage tanks are expected to be visible to residents around most of Isaac's Harbour. Due to the alignment of the tanks, the "end-on" point of view will present only one tank width (about 100 m) to many viewers, and the lower portion of the tanks will be obscured by intervening terrain and forest cover. The high pressure flare stack will be visible from locations in all local communities, due to the great height and location at the approximate peak of the ridge. The physical structure will be relatively narrow (only 1.5 m in diameter) and so will not dominate the horizon. However, the stack will project a small flame at most times and will have aeronautical obstruction lighting (for air craft safety) and therefore, the high pressure flare stack will also be visible at night. During major flaring events, the flame would be much larger and therefore much more visible, in particular during the night time. These however, are infrequent events and of short duration.

The marine operations will also have some visual effect on local communities. The marginal wharf and jetty (particularly the berthing area) will be visible to parts of Isaac's harbour, and Drum Head. These will have some lighting at night, but will be minimized to the amount necessary for safe operation. Tankers will arrive on average every three to four days during the year. Each tanker spends approximately 24 hours manoeuvring into harbour, taking on LNG and leaving. There may be times when two tankers are present. Tankers will also have lighting. The marine components range in height up to 38 m but are generally lower than 30 m, so the number of viewers that may see marine components will be limited by intervening terrain.

For the traveling public, the visual exposure to the development represents a rather short section along Route 316. Only the tall flare stack will be visible from sections of Route 316 at locations beyond the edge of the LNG facility.

10.13.7 Effects of Decommissioning

There would be a reduction in impact to the visual landscape as the Project is decommissioned and the area is re-purposed. As with construction, there would be some temporary activities visible to the nearest residents, including infrequent dust or exhaust plumes, and shipping activities. The decommissioning phase provides an opportunity to re-establish site conditions that closely resemble pre-development conditions. However, the neighboring lands in the industrial park may have been developed by then and, depending on the Municipality's planning objectives, the Goldboro LNG site may be transformed to suit other industrial or commercial uses. Depending on that next use, certain visual elements would be expected to be removed; particularly the high pressure flare stack and the LNG storage tanks. The jetty would likely be decommissioned, but the wharf may continue to operate in some reduced fashion.

10.13.8 Mitigation

10.13.8.1 Fishery, Aquaculture, and Marine Harvesting

The marginal wharf may alter navigation into Isaac's Harbour; however, the wharf will be well lit and marked on all navigation charts for the area. The navigation lighting and other marking of the wharf will follow the recommendations of TC. The very low level of boating activity in Isaac's Harbour is not expected to result in any important navigation issues with respect to marine facilities.

The magnitude of construction impacts to fisheries will be related to the seasonal timing of activities. Impacts will be greater if activities occur during the relevant fishing seasons, particularly the lobster fishing season, which runs from mid-April to late June. The marginal wharf is not a major fishing area, and most fishing tends to occur further out into the harbour, limiting the potential for disruption to traditional fishing patterns. In addition, little fishing activity takes place in the central deep water part of the bay where the larger LNG and cargo vessels will be transiting. Aids-to-Navigation will be modified as described in Section 3.3.18.

As with freshwater fish habitat, standard mitigating measures (Section 10.3.3 and Section 10.10.4) to control onshore sediment release and small spills will be implemented to ensure the aquaculture operations in the marine environment are not adversely affected by construction activities.

Potential operational impacts are associated with shipping entering and leaving the bay, but may also be related to other marine traffic traveling around the proposed marginal wharf into and out of Isaac's Harbour. However, the entrance to Isaac's Harbour reduces to a similar width as the marginal wharf covers another 500 m further into Isaac's Harbour. Furthermore, the marginal wharf is located in an area of comparatively shallow water, leaving the deeper water portion of the entrance unaffected. The wharf itself will be equipped with navigation aids, such as lights and fog horns, as required by TC, mitigating other navigation concerns.

Mitigation for loss of fishing habitat is detailed in Section 10.11.3. A compensation plan will detail the Projects initiated to create new habitat within Stormont Bay. The habitat created will be targeted for commercially fished species.

Exclusion from fishing grounds due to incoming or outgoing LNG vessels will be mitigated via communication between fishers and the vessels. Impacts associated with commercial fisheries other than lobster should be minor. For example, fishermen may have to shift gillnets set for herring or mackerel in the central part of the bay. To mitigate in such a situation, advance notice of ship arrivals and departures to ensure fishermen can manage their gear without damage. The potential effect on overall catch or the cost of fishing is from vessel interference is anticipated to be insignificant, but will be addressed through consultation with the marine fisheries authorities and the local fishing community.

Aquaculture operations could be significantly affected by a large spill, which is discussed in Section 10.17. Aquaculture sites are likely located distant enough from the Project site to avoid impacts due to sedimentation.

10.13.8.2 Human Health

Mitigation for potential Project effects on soil is described in Section 10.1.3. The main concern for Project activities involved with soil is the tailings associated with former mining activities. A comprehensive RMP will be developed and implemented in order to determine the location, extent and safe management of tailings within the construction site. The objective will be to prevent the suspension of contaminants in the air or the run off or deposition of contaminated material in surface water, sediment or groundwater, which could provide for exposure pathways to human health. Based on the RMP, the Project's HASP for the construction and decommissioning phases will prescribe specific protection measures (e.g., use of personal protective gear) for workers involved in tailings management work.

Mitigation for potential Project effects on groundwater is described in Section 10.2.3. Proper precautions such as a hazardous material management system, secondary containment, leak detection systems, and monitoring alarms will be incorporated into the Project design and processes as appropriate. This, together with the Project Emergency Response Plan and HASP will minimize the risk for significant groundwater contamination and subsequent human exposure.

Mitigation for potential Project effects on surface water is described in Section 10.3.3. The related risk to human health during construction is the possibility of contaminated silt-laden runoff into various surface waters (and subsequent human exposure). The main mitigative measure will be the Project's Stormwater Management Plan which, during construction and decommissioning, will be complemented with an Erosion and Sediment Control Plan. In particular, mitigation measures during construction will include existing vegetated surfaces, silt fences, granular stabilization materials, ditch checks, etc. for sedimentation and erosion control. Settling/detention ponds will be used, as appropriate, to achieve acceptable stormwater-quality objectives. Mitigation measures related to potential impacts from spills or leaks of hazardous materials are the same as those discussed above for groundwater.

Mitigation for potential Project effects on ambient air quality due to Project emissions is described in Section 10.4.5. The Project will use state of the art equipment that will conform to industry emissions standards, as these standards are developed in the future with the intention to further reduce emissions as new emissions reducing technologies become available.

10.13.8.3 Visual Landscape

Given the dimension and nature of the proposed development, measures to avoid or minimize visual impacts are limited. Flare stacks will be kept as low as possible without compromising air quality requirements, and flaring will be minimized through process optimization. The LNG facility grounds will include screening vegetation to reduce visibility from roadsides and the nearest residences. Ornamental plantings will be established to provide for an aesthetically pleasing appearance of the site perimeter, main entrance and administration area. Good house and ground keeping on-site and along the property boundary will be enforced to contribute to the image of an overall well managed industrial facility. If required, screening could also include off-site plantings at key view points (i.e., sensitive receptors such as the senior citizens home, churches and cemetery's – see Figure 9.3-1) to obstruct views or to direct views away from the plant site. This would be undertaken in consultation and cooperation with affected receptors or the Municipality. Mitigation for effects on Ambient Lighting (Section 10.6.3) is also applicable to visual landscape for night time. The provisions of interpretive opportunities that promote an understanding of the Project (Section 3.1.10) are also considered to reduce negative perception.

10.13.9 Summary and Residual Effects

10.13.9.1 Employment and Local Economy

The Project is predicted to involve a total capital expenditure of about $6.9 billion in NS and a further $1.42 billion in the rest of Canada. Capital expenditures will generate significant numbers of jobs and make substantial contributions to labour income and provincial and national GDP. These impacts will be a one-time occurrence but be spread over a period of approximately 54 months making a lasting and major improvement to local economic conditions.

During the operation phase, total expenditures, including property taxes, are estimated to be in excess of $41 million each year. Annual expenditures for labour are estimated to be about $18.6 million, creating about 200 permanent full-time jobs at the plant. The annual expenditures for other goods and services associated with plant operations will generate direct and spin-off jobs, as well as make important contributions to other labour income, and provincial and national GDP. These impacts will be a recurring event resulting in substantial benefits accruing to the province and the country for each and every year of Project operations. Table 10.13-5 (below) summarizes the residual environmental effects for visual landscape.

Due to the predicted economic benefits of the Project, there is strong support of the Project in the region (86% of the population supports the Project; most of those identified economic benefits as their main reason). See Section 13.1.15 below.

10.13.9.2 Fishery, Aquaculture and Marine Harvesting

Provided the recommended mitigative measures are implemented and compensation efforts are effective, no significant adverse residual environmental effects on fisheries and aquaculture activities are likely to occur. Table 10.13-6 (below) provides a summary of the residual environmental effects and recommended mitigative action for the marine environment.

Table 10.13-5 Residual Environmental Effects Summary for Employment and Local Economy

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction, Operation, and Decommissioning								
Temporary shortages in regional services, goods, and labour, during construction and decommissioning.	A	• Minimized by coordination with SOEI gas plant owners, and other regional LNG and industrial developers, business communities, labour unions, Chambers of Commerce, and regional economic development agencies.	Regional	Regional	Construction period (5 years). Decommissioning period (1 year).	R	• Strong government and community support, following many years of regional economic decline.	Minor
Employment and expenditures in the regional, provincial, and national economies.	P	• Maximized by local procurement practices and coordination with business communities, labour unions, Chambers of Commerce, and regional economic development agencies.	Construction: $6.9 Billion in NS, and $1.42 Billion in the rest of Canada. Operation: $40 Million in NS, annually.	Provincial and National.	Project lifetime (25 to 50 years).	R	• Strong government and community support, following many years of regional economic decline.	Beneficial (significance not rated).
Inclusion of Aboriginal communities in opportunities for employment and economic benefits.	P	• Maximizing benefits: MOU and subsequent CBA.	Unknown (to be negotiated).	Regional	Project lifetime (25 to 50 years).	R	• Mi'kmaq interests identified in MEKS.	Beneficial (significance not rated and dependent on outcome of negotiations).

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

Table 10.13-6 Residual Environmental Effects Summary for Fishery, Aquaculture and Marine Harvesting

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Permanent loss of habitat through construction of marginal wharf and jetty.	A	• Development and implementation of marine fisheries offset plan.	Low	Marginal wharf footprint and immediately adjacent.	Construction phase through to decommissioning.	NR	• Approximately 0.38% of lobster habitat within Stormont Bay.	Medium
Exclusion from fishing grounds due to construction activities.	A	• Consultation with local fishers.	Low	Marginal wharf and jetty footprints.	Construction phase.	R	• Fishing grounds near construction sites.	Minimal
Sedimentation from onshore construction activities leading to degradation of fish habitat.	A	• Adherence to mitigation described in surface water section.	Low	Mouths of streams entering Stormont Bay.	Construction phase.	R	• Potential fish habitat.	Minimal
Operation								
Permanent loss of fishing habitat.	A	• Implementation of marine fisheries offset plan.	Low	Marginal wharf footprint and immediately adjacent.	Construction phase through to decommissioning.	NR	• Approximately 0.38% of lobster habitat within Stormont Bay.	Medium
Sedimentation from onshore operations leading to degradation of fish habitat.	A	• Adherence to mitigation described in surface water section.	Low	Mouths of streams entering Stormont Bay.	Operation phase.	R	• Potential fish habitat.	Minimal
Release of bilge and ballast water to Stormont Bay leading to degradation of fish habitat.	A	• Adherence to federal legislation.	Low	Stormont Bay	Operation phase.	R	• Potential fish habitat.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Exclusion from fishing zone by LNG vessels and increased marine traffic.	A	• Consultation with local fishers.	Low	Stormont Bay	Operation phase.	R	• Potential fish habitat.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.13.9.3 Human Health

The Project is not likely to have significant adverse effects on human health. A comprehensive human health and environmental management system will be in place to avoid and minimize environmental contamination. As a result, the exposure of humans to contaminants is not likely to be significant. This includes direct exposure as well as indirect exposure via pathways such as air, surface water, or groundwater. The site activities that are of key concern for human health are those associated with the mobilization of contaminants from tailings sites. Risk management planning will specifically address this issue and prescribe management measures to reduce residual risks to acceptable levels. In addition, during construction and demolition activities, an air quality monitoring plan (including particulate monitoring) and drinking water well surveys will be implemented to confirm the effectiveness of the protective measures for workers and nearby residents. Table 10.13-7 (below) summarizes the residual environmental effects for human health.

10.13.9.4 Visual Landscape

The Goldboro LNG Project will change the local landscape character by introducing a large industrial facility into a rural and marine setting. Project components will be visible from many locations in the near-by communities during day time. From these locations, the development will remain visible during the night due to aeronautical obstruction lighting, the pilot flame on the flare stacks, and lighting at the onshore and marine components. General light reflections against the night sky will also be visible in nearby communities and locations that do not have a direct view of specific Project components. Nevertheless, the effects on visual landscape aesthetics are not considered to be significant. No public concerns have been expressed during consultation with the local communities. Also, the number of potential receptors with direct views of the entire facility or major facility components is relatively small. Further, the change in the visual character of the landscape is in line with the land use objectives formulated by the Municipality in its zoning of the Project site and adjacent lands for use as industrial park.

Negative effects on regional tourism from visual impacts are expected to be minor. There is a relatively low level of visitation at present and necessary hotellerie, restaurant, and commercial services are almost absent in the immediate local communities. Increased tax revenues will be available for improving regional tourism infrastructure and promoting the area to potential visitors. This is expected to mitigate potential adverse visual effects on tourism to insignificant levels and may provide for overall beneficial effects (see Section 10.14.5 below). There will be an opportunity to rehabilitate the visual landscape following decommissioning, therefore the effects are not permanent. Table 10.13-8 (below) summarizes the residual environmental effects for visual landscape.

Table 10.13-7 Residual Environmental Effects Summary for Human Health

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Site preparation (e.g., clearing, grubbing, blasting, grading) related increased dust levels and potential releases of contaminants from mine tailings into air, surface or groundwater environments that function as pathways to human health.	A	• EMP including RMP with specifics on mine tailings and dust control program. • Well water survey. • HASP.	Medium	Project site and nearest receptor locations.	Construction phase.	R	• Industrial Park in rural setting; no potential public receptors at or adjacent to the site.	Minor
Water quality impairment as a result of wastewater discharges with implications for human health.	A	• On-site waste water treatment plant and effluent discharge monitoring.	Low	Project site; only one watercourse on-site.	Construction phase.	R	• Industrial Park in rural setting; no potential public receptors at or adjacent to the site to receptors.	Minor
Human health effects from impaired air, ground and surface water quality resulting from equipment maintenance, refuelling, and hazardous material handling and storage, and vehicular traffic.	A	• EMP including hazardous materials management plan and emergency response plan. • Designated storage areas for hazardous materials. • On-site Stormwater Management Plan. • Well water survey. • HASP.	Medium	Project site and nearest receptor locations.	Construction phase.	R	• Industrial Park in rural setting. • No potential public receptors at or adjacent to the site.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Operation								
Human health effects as a result of exposure to air emissions from the liquefaction of natural gas to LNG, on-site power generation, and vehicular traffic.	A	• Air emission controls and air quality monitoring. • On- and off-site noise abatement measures and monitoring. • HASP.	Low (air emissions well within maximum permissible GLC; off-site noise levels will meet regulatory guidelines).	Project site and nearest receptor locations.	Operations phase.	R	• Industrial Park in rural setting. • No potential public receptors at or adjacent to the site.	Minimal
Human health effects as a result of exposure to impaired surface water quality from wastewater discharges.	A	• On-site waste water treatment plant and effluent discharge monitoring. • EMP (waste and hazardous material management plans). • Designated storage areas for hazardous materials. • HASP.	Low (discharges within regulated limits).	Project site and nearest receptor locations.	Operations phase.	R	• Industrial Park in rural setting. • No potential public receptors at or adjacent to the site.	Minimal
Decommissioning								
Decommissioning related increased dust levels and potential releases of contaminants from mine tailings into air, surface or groundwater environments that function as pathways to human health.	A	• EMP specific to decommissioning phase including RMP with specifics on mine tailings management and dust control program. • Well water survey. • HASP.	Medium	Project site and nearest receptor locations.	Decommissioning phase.	R	• Industrial Park in rural setting.	Minor

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Human health effects from impaired air, ground and surface water quality resulting from decommissioning related equipment maintenance, refuelling, hazardous material handling and storage. and vehicular traffic.	A	• EMP with dust control plan. • Hazardous materials management plan and emergency response plan. • On-site Stormwater Management Plan. • Designated storage areas for hazardous materials. • Well water survey. • HASP.	Low	Project site and nearest receptor locations.	Decommissioning phase.	R	• Industrial Park in rural setting.	Minor
Water quality impairment as a result of decommissioning wastewater discharges with implications for human health.	A	• On-site waste water treatment plant and effluent discharge monitoring.	Low	Project site; only one watercourse on-site.	Decommissioning phase.	R	• Industrial Park in rural setting.	Minor

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

Table 10.13-8 Residual Environmental Effects Summary for Visual Landscape

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Change in visual character of local landscape from rural to industrial (including shipping activities) and occasional dust and exhaust plumes.	A	• Provide screening at roadside. • Good housekeeping practices at construction site. • EMP with dust control plan. • Use properly shielded lighting for construction areas. • Interpretive site(s) to improve Project awareness and reduce negative perception.	Low	Lower Isaac's Harbour, Holly Point, nearshore (boaters).	Construction phase.	R	• Located in a designated industrial park. Intervening terrain and forest cover obscures most construction activity from local communities.	Minimal
Operation								
Change in visual character of local landscape from rural to industrial, including tall flare stack and large storage tanks. Regular shipping activities and safety lighting on stack and marine components.	A	• Provide strategic plantings as visual screens along roadside segments. • Provide for strategic plantings as visual screens at off-site sensitive receptors in consultation with location owners/operators/tenants. • Ornamental plantings along parts of site perimeter, entrance, administration. • Good house and ground keeping. • Use standard operating practices to minimize light trespass at night. • Interpretive site(s) to improve Project awareness and reduce negative perception.	High	Direct visibility: All local communities within 3 km, including approximately 100 residences; travelling public (Hwy 316) Visibility of light reflections in night sky: >3 km.	Operation phase.	R	• Development in line with municipal land use objectives. • Site located in a designated industrial park. • Visual aesthetics not raised by public as a concern.	Medium

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.14 Existing and Planned Land Uses

10.14.1 Threshold for Determination of Significance

A significant effect on existing and planned land uses is any uncompensated loss of land based resource value or permanent change in regional access (current) or future opportunities to develop land based resources.

10.14.2 Effects on Land Ownership, Mining, and Sub-surface Rights

The land required for the LNG facilities is under option with, and will be purchased from, the MODG. The Project use is in line with MODG's Municipal Planning Strategy. The area of interest for the LNG facilities has been designated as I-3, Industrial Resource and specifically targets natural gas processing, including liquefaction, gasification and transport facilities, marine/container terminals, including wharves and storage facilities, and temporary uses related to industrial development. Consequently, the proposed Project is an acceptable use of land for this area.

The land required for the water pipeline and water intake structure at Meadow Lake is a combination of private and crown land. Negotiations will need to be undertaken for the pipeline easement and water intake structure.

There are no active mines in the area, but there are claims to the subsurface rights. Mineral rights holders must obtain permission of the landowner to access the site for mineral exploration.

10.14.3 Effects on Agriculture

There are no agricultural uses within the proposed construction envelope or the zone of influence of the Project. In addition, the Soil Capability Class for this area is "unsuited for agriculture" (Hilchey *et al.,* 1964) (See Sections 9.1.3.5 and 9.8.1). Therefore no interaction between the Project and agriculture has been identified.

10.14.4 Effects on Forestry Resources

The proposed LNG site is located in a forested area, but is considered to be non-merchantable (Section 9.8.3). The proposed water pipeline will follow the existing M&NP easement and access roads. There is very little potential for commercial forestry in the area since merchantable volumes are relatively low over the majority of the area, averaging less than 10 cords per acre. Therefore interaction between construction and operation-related Project activities is expected to have no to minimal effects on forestry. It should be noted that during site clearing any merchantable timber will be salvaged.

10.14.5 Effects on Tourism and Recreation

The population in the region has decreased over the past ten years. Anecdotal comments during the Open House meetings in Goldboro indicated that seasonal visitation in 2013 (to date) are low. Consequently, the demand on existing services for tourism, culture, and recreational facilities is relatively low. The temporary significant increase in local population during construction and a moderate increase during operation presents opportunities for developing

local services; which would improve long term tourism by providing necessary hotellerie, restaurant, and commercial support; which is currently absent. No long-term competition between workers and tourists is predicted as the worker accommodations will be coordinated with the municipality and local community, and taken into consideration in the sizing of the temporary work camp design. Therefore, no significant adverse impacts are anticipated during any of the Project phases.

With respect to maximizing benefits of the Project for Tourism, Pieridae will work with local recreation and tourism organizations by providing the Project's anticipated employment numbers to enable service providers and operators in the recreation and tourism industry to include anticipated demands in their business plans. The Community Liaison Committee (CLC) established as part of the stakeholder consultation (see Section 13.1.10) may also assist the local community to maximize opportunities for provision of tourism and recreation services to the Project workforce and new visitors. Pieridae will inform Project workers about environmental and community sensitivities and stewardship in the area.

Pieridae is planning on operating an information centre at the Project site. The centre will open during construction and will be expanded as the Project evolves. Exhibits and information material will inform about such topics as LNG, liquefaction technology, LNG tanker technology, energy markets, and some cultural history, such as the Black Loyalist community and former Red Head Cemetery associated with the Project area. The information centre would be maintained throughout Project operation. By increasing awareness and insight into LNG technology and the significance of the Project, the centre is expected to reduce potential adverse perceptions of the Project and provide interpretive opportunities for local residents, students, recreational visitors and tourists alike.

During decommissioning the temporary workforce will continue to provide for economic benefits and potential demands for recreational and touristic services. Pieridae will be communicating the facility's closure well in advance to provide administrators, service providers and operators adequate time to adjust their business plans to potential market changes and to minimize adverse effects.

10.14.6 Mi'kmaq Interests

The MEKS prepared for this EA (Appendix L) highlights the Mi'kmaq nation long-standing relationship with, and attachment to, the region in and around Goldboro, NS. The region holds historical significance to the Mi'kmaq nation and to the development of relationships between European settlers and the Mi'kmaq. While the Project area is not home to present day Mi'kmaq communities, it was in this region that Mi'kmaq demonstrated local hunting, trapping and gathering practices to newcomers, thus fostering a lasting relationship of peace and friendship with the French, and eventually other European inhabitants of the *Eskikewa'kik* area. This intimate relationship between the Mi'kmaq and the region is demonstrated with the extensive awareness of flora and fauna resources in the Project area despite the interruption in use of the area due to development and national Aboriginal policies. The existence of numerous species of plants, fish, and game in the Project area that are known to be culturally significant to

Mi'kmaq is evidence that the site was likely used by the ancestors of today's local Mi'kmaq communities.

While there is presently limited involvement of Band members in the Project site, it was clearly evident that the land had been used in the past (within living memory) for food gathering and recreation. The decision to continue to use this area has been affected by a number of historical factors (most significantly centralization policies to move Mi'kmaq families to reserves) and demographic factors. A rapidly growing youth population that is pursuing education and alternative training has resulted in a slight de-emphasis on hunting within the rapidly growing communities (it is likely that firearms legislation and hunter training requirements may also be a factor in the decline in hunting amongst Mi'kmaq youth).

It is also clear from the research that, traditionally, decisions related to hunting and fishing has been based on opportunistic access to food resources that are most abundant. As a result, there may be future interest in fishing, hunting and possibly gathering in the Project area as land-use changes, and urbanization and other developments impact areas currently used by Mi'kmaq hunters and fishers. In keeping with traditional decision-making practices, an important attribute of the ecological knowledge system, areas such as the Project site would logically be considered for harvesting activities due to its easy access from main transportation routes.

Potential Project-related effects on the natural environment and land resources with potential significance for Mi'kmaq interests are listed in Table 10-14-1. The table includes mitigation measures aimed to minimize the overall ecological effects of the Project on the site and adjacent lands. Pieridae is committed to support Mi'kmaq interests, minimize adverse Project effects, and maximize Project benefits in a collaborative approach to Project planning and development (see Section 10.14.7.3). This is expected to include all phases of the Project.

Table 10.14-1 Potential Impacts to Mi'kmaq Interests

Potential Impacts	Assessment of Significance	Mitigation
Construction		
Disturbance of archaeological Resources.	• Archaeological resources are irreplaceable and of extreme importance. Being the only source of information on Mi'kmaw pre-contact history, land use, occupancy and culture, archaeological information from the site should be preserved and protected.	While there has not been a confirmed Mi'kmaq archaeological significance of the Project site, observations will be maintained during all construction activity and should evidence be uncovered all activity will cease in the area until Mi'kmaq archaeological experts have had an opportunity to examine the site, and determine appropriate action.

Permanent loss of wildlife and plant resources within the immediate Project footprint.	• The species of significance to Mi'kmaw identified within the Project areas, in particular medicinal plants, are also present within the surrounding areas. The permanent loss of some of (or access to) these specimens within the Project area is not expected to significantly limit Mi'kmaw use of these resources.	Efforts will be made to minimize the potential impact by containing all activity to within the Project footprint. Transferring significant flora and fauna to suitable nearby habitat will be implemented if warranted and feasible as determined through ongoing dialogue with Mi'kmaq communities.
Construction, Operation and Decommissioning		
Noise disturbance will adversely impacts local wildlife resources.	• Increased sound levels resulting from the Project's construction activities can harass wildlife hunters in the Project area of significance to Mi'kmaq. Because of the local nature of these impacts, their significance on local Mi'kmaw harvesting activities is limited.	Noise mitigation will include several measures as noted in Section 10.5.3.
Contamination of surrounding vegetation, wetlands and water bodies through dust and other airborne pollutants.	• The level of depreciation of local food and medicinal plants for human consumption is determined to be not significant, as are the impacts of a deteriorating quality of animal browse and water/wetland habitats on local fish and wildlife. Even though the radius of these impacts will undoubtedly extend beyond the boundaries of the Project area, their effects on Mi'kmaw resource activities is expected to be limited.	Predicted GLC remain well within applicable air quality standards. Appropriate mitigation measures to further reduce emission levels have been determined in Sections 10.7.3, 10.8.3, 10.9.4 and 10.10.4.
Contamination of marine and shoreline habitats surrounding the shipping terminal through possible fuel, oil or waste discharge associated with Project related vessel traffic.	• The likelihood of fuel/oil/waste pollution is undetermined. Potential impacts of such occurrences on the surrounding marine and shoreline ecosystems are also unassessed, but may be wider-ranging depending on factors such as season and marine currents. The significance of such potential impacts on the Mi'kmaw fishery is undetermined.	Considerations for avoidance and reducing the risk for accidents and malfunctions have been an integral part of the work on design, construction and operation of the Project. This is outlined in Sections 3.6 and 3.7. Appropriate mitigation measures are further discussed in Section 10.17.

10.14.7 Mitigation

10.14.7.1 Land Ownership, Mining, and Sub-surface Rights

In general there are no mitigation requirements regarding land ownership, mining, and sub-surface rights. The proposed LNG facility is an acceptable use of land for this area. The land required for the water pipeline and water intake structure at Meadow Lake is a combination of private and crown land. Negotiations will need to be undertaken for the pipeline easement and water intake structure.

There are no active mines in the area, but there are claims to the subsurface rights. Mineral rights holders must obtain permission of the landowner to access the site for mineral exploration.

10.14.7.2 Tourism and Recreation

Demand on existing services for tourism, culture, and recreational facilities in the vicinity of the Project are relatively low. An increase in population would provide enhanced commercial opportunity and benefit the regional communities. In order to maximize benefits and minimize adverse effects the following mitigation measures will be implemented:

- Informing of Project workers about environmental sensitivities and stewardship in the area.
- Close communication and consultation with local recreation and tourism organizations , service providers and operators on Project related employment numbers, possible recreational needs, and opportunities. This will be of particular importance prior to construction and well in advance of decommissioning in order to enable the recreation and tourism industry to adjust to the changing market conditions.
- Creation of a CLC that will address any concerns, community preferences, and opportunities raised by the local residents.

10.14.7.3 Mi'kmaq Interests

In keeping with the principles and statements of the United Nations Declaration on the Rights of Indigenous Peoples, Pieridae is committed to applying information from the MEKS (Appendix L) in the future planning and development of the Goldboro LNG Project. Accordingly, Pieridae will maintain ongoing dialogue with the Mi'kmaq communities during construction, operations, and decommissioning. The basis for this continued engagement has been established through a MOU between Pieridae and Mi'kmaq communities which commits both side to the signing of a CBA. The CBA will ensure a long-term cooperation and, most importantly, Project benefits for the Mi'kmaq communities including employment opportunities, training, and education.

10.14.8 Summary and Residual Effects

Table 10.14-2 summarizes the residual environmental effects for existing and planned land uses. No significant adverse impacts are anticipated as a result of the LNG facility at the Goldboro Industrial Park as this is an acceptable use of land for this area. In addition, with proper negotiations for land required for the water pipeline and water intake structure at Meadow Lake, no significant adverse impact is anticipated. Impacts to tourism and recreation are anticipated to be positive following the use of mitigation measures. The Project is expected to provide beneficial opportunities to Mi'kmaq communities through a collaborative approach to Project planning and development.

Table 10.14-2 Residual Environmental Effects Summary for Existing Land Use

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction, Operation, Decommissioning								
Effect on land use capacity due to construction/ operation of Goldboro Industrial park; capacity not negatively affected as a result of decommissioning.	P (capacity utilized as per Land Use Plan objectives).	• Not required.	High	Project site 120 ha.	Life of Project	R	• Site designated for industrial use (Goldboro Industrial Park).	Positive effect significance not rated.
Land use capacity reduced through ROW / lease agreements on private and crown lands for water intake structure and water supply pipeline; capacity fully restored upon decommissioning.	A	• Negotiations with land owners.	Low	Pipeline corridor / Meadow Lake intake site (about 10 ha).	Life of Project	R	• Private land owners and crown land; for most part a pipeline ROW is already in place, i.e., restrictions on land use already in place.	Minimal
Reduction in mining land use capabilities during construction/ operation; capacity fully restored upon decommissioning.	A	• Negotiations with land owners (mineral rights holders must obtain permission of the landowner to access the site for mineral exploration).	Medium	Project site plus water pipeline corridor / Meadow Lake intake site (about 130 ha).	Life of Project	R	• Site designated for industrial use; all gold mining activities in area have ceased.	Minimal

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Effects on tourism and recreation as a result of environmental effects associated with construction, operation and decommissioning phases.	A	• Operation of Information Centre to provide interpretative opportunities / reduce negative perception. • Promotion of environmental awareness among Project workers. • Implementation of all identified environmental mitigation measures and monitoring programs. • Consultation with CLC on additional measures.	Low	Local	All Phases	R	• Local area has very little recreation and tourism infrastructure and services.	Minor
Effects on tourism and recreation as a result of increased revenues and demand during construction, operation and decommissioning phases.	P	• Communication of employment numbers early on to service providers, operators and administrators in recreation and tourism industry and organizations to facilitate business plan adjustments to changes in demand. • Coordination of recreational needs of workforce with local recreation and tourism industry and organizations. • Operation of Information Centre to provide interpretative opportunities / reduce negative perception. • Consultation with CLC on additional measures.	Medium	Local to Regional	Life of Project	R	• Local area has very little recreation and tourism infrastructure and services.	Positive effects: significance not rated.

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Opportunities for Aboriginal employment and sharing in regional economic benefits.	P	• Maximizing benefits: MOU and subsequent CBA.	Unknown (to be negotiated).	Region	All Phases	R	• Mi'kmaq interests identified in MEKS.	Beneficial (significance not rated and dependent on outcome of negotiations).
Potential impacts on Mi'kmaw resources.	A	• Mitigation for all other relevant VECs are applicable to Mi'kmaq interests.	Negative effects are local and do not include regionally scarce resources.	Region	All phases	R	• Mi'kmaq interests identified in MEKS.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.15 Transportation

10.15.1 Threshold for Determination of Significance

A significant effect on transportation would be any temporary or permanent change in traffic volume or character (i.e., Project specific activities) that exceeds the current road design performance level or reduces public safety.

10.15.2 Effects on Transportation

The Project area includes traffic related effects on the approximately 77 km site access route that includes sections of Trunk 7, Route 276 and Route 316.

A Traffic Impact Review of Project site Access Roadways has been conducted for the Goldboro LNG Project (Appendix M), in which construction related impacts on traffic volume have been assessed using recent data to update the results of a previous 2007 study (ARTM, 2007). Future conditions have been predicted for "count years" corresponding to the construction peak period in 2017 and the operations period as of five years post construction in 2024.

10.15.2.1 Effects of Construction

Since construction is expected to start during 2015 with the operational phase starting approximately mid-2019, construction phase traffic impacts have been estimated for 2017. Combined commuter worker and delivery truck trips will include approximately 205 two-way vehicle trips during both morning (AM) and afternoon (PM) peak hours.

Daily construction vehicle trips of 200 passenger vehicles and five semi-trailer arriving at the site during the AM peak hour and leaving during the PM peak hour, distributed to access route road sections, have been added to projected 2017 background DHVs (Appendix M; Table 3) to provide estimated 2017 DHVs that include site generated construction trips which are shown in Table 10.15-1.

Since construction vehicle trips are moderate and projected 2017 DHVs on the access route road sections are low to moderate, it is expected that the access route road sections will provide satisfactory performance while accommodating construction site generated trips.

In order to further minimize the change in traffic volumes and potential impacts on road safety, a number of general mitigation measures have been implemented as described in Section 10.15.3.

Table 10.15-1 Estimated 2017 Two-Way Design Hourly Volumes (DHVs) during Construction Phase

Location	Background 2017 DHVs [1]		Construction Phase Vehicle Trips [2]		Estimated 2017 DHVs with Construction Trips [3]	
	AM	PM	AM	PM	AM	PM
Trunk 7 – 1.0 km South of Highway 104	390	480	65	65	455	545
Trunk 7 – 1.0 km South of Salt Springs	235	240	65	65	300	305
Route 276 – Halfway Trunk 7 and Route 316	60	65	65	65	125	130
Route 316 – 1.0 km South of Route 276	55	70	85	85	140	155
Route 316 – 1.5 km north of Isaac's Harbour	40	70	105	105	145	175
Route 316 – Goldboro Area north of the Project site	40 [4]	70 [4]	145	145	185	215
Route 316 – South of the Project site	40 [4]	70 [4]	60	60	100	130

Notes:
1. Projected background 2017 DHVs are taken from Appendix M; Table 3.
2. Construction trips have been distributed to access route road sections in accordance with the trips distributions included above.
3. These are the estimated 2017 DHVs that include vehicle trips generated by the construction phase.
4. Since recent counts are not available for these road sections, projected 2017 DHVs have been assumed to be the same as those in the section north of Isaac's Harbour.

Oversized Loads

It is possible for construction related traffic in a project of this scale to include oversized loads (i.e., very wide, long, or heavy). Such traffic may require special markings, traffic control measures, and/or temporary traffic interruptions. All oversized loads transported on public roads will require a Special Moves Permit from NSTIR; which sets out rules for conducting such activities. At a minimum, special moves would be conducted outside of peak traffic hours.

10.15.2.2 Effects of Operation

Since the operational phase is expected to start approximately mid-2019, operational phase traffic impacts have been estimated for 2024, five years after completion of the construction phase.

Daily personnel work trips of 55 vehicle trips arriving at the site before 0800 hours and leaving after 1630 hours, distributed to access route road sections, have been added to projected 2024 background DHVs (Appendix M) to provide estimated 2024 DHVs that include site generated operational trips which are shown in Table 10.15-2.

Since operational personnel trips are low and projected 2024 DHVs on the access route road sections are low to moderate, it is expected that the access route road sections will provide satisfactory performance while accommodating operational site generated trips.

Table 10.15-2 Estimated 2024 Two-Way Design Hourly Volumes (DHVs) during Operational Phase

Location	Background 2024 DHVs [1]		Operational Phase Vehicle Trips [2]		Estimated 2024 DHVs with Operational Trips [3]	
	AM	PM	AM	PM	AM	PM
Trunk 7 – 1.0 km South of Highway 104	430	530	17	17	447	547
Trunk 7 – 1.0 km South of Salt Springs	260	265	17	17	277	282
Route 276 – Halfway Trunk 7 and Route 316	65	70	17	17	82	87
Route 316 – 1.0 km South of Route 276	60	75	22	22	82	97
Route 316 – 1.5 km north of Isaac's Harbour	45	75	28	28	73	103
Route 316 – Goldboro Area north of the Project site	45 [4]	75 [4]	39	39	84	114
Route 316 – South of the Project site	45 [4]	75 [4]	17	17	62	92

Notes:
1. Projected background 2024 DHVs are taken from Appendix M; Table 3.
2. Operational trips have been distributed to access route road sections in accordance with the trip distributions included above.
3. These are the estimated 2024 DHVs that include vehicle trips generated by the operational phase.
4. Since recent counts are not available for these road sections, projected 2024 DHVs have been assumed to be the same as those in the section north of Isaac's Harbour.

10.15.2.3 Effects of Decommissioning

Potential effects of decommissioning would be similar to construction but generally lower magnitude. Mitigation would also be similar to the construction phase.

10.15.3 Mitigation

A number of mitigation measures have been incorporated into the design in order to minimize construction related effects on traffic safety, as follows:

- use of local and on-site wharf to import large material to the site;
- work camp adjacent to construction site;
- project-specific bus services and car pooling;
- locate spoil areas as close to the site as possible;
- scheduling of work related traffic outside of peak hours;
- road upgrades (by municipality); and
- relocation of Hwy 316 around LNG facility (NSTIR).

In addition, standard permits and industry best practices will be followed if special moves or other traffic interruptions are necessary on public roads.

10.15.4 Summary and Residual Effects

Since Project generated vehicle trips on the access route road sections will be very low to moderate, both during construction (peak in 2017) and operation (post-2024), it is expected that the access route road sections will provide satisfactory performance while accommodating construction phase site generated trips.

Table 10.15-3 summarizes the residual environmental effects for transportation.

Table 10.15-3 Residual Environmental Effects Summary for Transportation

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Increased traffic volume due to large construction workforce and potential oversized loads or occasional traffic interruptions.	A	• Use local and on-site wharf to import large machinery and equipment. • Work camp adjacent to construction site. • Project-specific bus services and car pooling. • Locate spoil areas close to the site. • Schedule work related traffic outside peak hours. • Road upgrades (by municipality). • Comply with permits / industry best practices when special moves or traffic interruptions are necessary on public roads.	Low to moderate.	77 km site access route including parts of Trunk 7, and Routes 276 and 316.	Temporary during 4-5 year construction with peak in 2017.	R	• Access route currently assessed as underutilized with enough capacity to perform satisfactorily under construction traffic loadings.	Minimal
Operation								
Increase in traffic volume due to permanent workforce and potential oversized loads or rare traffic interruptions.	A	• Comply with permits and industry best practices when special moves or traffic interruptions are necessary on public roads.	Low	77 km site access route including parts of Trunk 7, and Routes 276 and 316.	Continuous during life of Project.	R	• Access route currently assessed as underutilized with enough capacity to perform satisfactorily under long term traffic loadings.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.16 Archaeological Resources

10.16.1 Threshold for Determination of Significance

Each archaeological resource within the Project area has been evaluated according to its relative importance based on its cultural and physical integrity, existing documentation, and the expected impact on those resources. Archaeological significance is weighted as low, moderate or high where:

- Low importance indicates that a site has been previously impacted or destroyed so that archaeological context is not present, the site is of an age that is not considered to be of archaeological value (i.e., post 1950), or that the site does not contain archaeological resources that can further existing knowledge or research.
- Moderate importance indicates that the site is relatively intact, may contain in situ artifacts and/or features, is associated with a cultural or ethnic group or historic period that is under represented in the archaeological record, and may or may not be impacted (in the past, present, or future) by natural or cultural factors.
- High importance indicates that a site contains in situ features that are associated with a cultural group or historic period that is under represented in the historic and/or archaeological record, is potentially threatened by natural or cultural factors, and can further existing knowledge or research. On the other hand, highly important archaeological sites may be unique so that their loss or neglect would result in a missed opportunity to observe and study prototypes, anomalies, or attempts at adaptation that cannot be found elsewhere.

It is important to informatively evaluate all archaeological sites that are threatened by development, either as a result of direct impact or as a cumulative or residual effect of development, as archaeological sites are non-renewable resources and impact is permanent. The magnitude of potential residual adverse effects on an archaeological resource is directly tied to its archaeological importance. Ground disturbing activities associated with construction, operation, and decommissioning of this Project could have significant adverse effects on archaeological resources. If unmitigated, these activities such as grubbing, grading, and excavation could result in the permanent loss of irreplaceable archaeological resources and the knowledge that can be gained from them. Erosion of coastal features and deterioration of archaeological features as a result of construction, operation, or decommissioning may have the same negative effect. However, in-filling of archaeological features without disturbance to the resource is deemed an insignificant effect, assuming that the location, extent, nature, and importance of the site have been recorded in detail prior to in-filling. Except in the case of coastal erosion and gradual deterioration of archaeological resources, the frequency of significant impacts on archaeological resources is typically a result of a single activity.

10.16.2 Effects on Archaeology

Because of the localized nature of archaeological resources, the significance of residual adverse effects is dependent on localized impact areas (i.e., building footprints, underground service corridors, transmission and rail corridors including rights-of-way, site grading, etc.).

10.16.2.1 Effects of Construction

Each archaeological resource within the Project impact area was evaluated during previous surveys (Davis, 2004; Davis, 2007a; Davis, 2007b) according to its relative significance based on the cultural and physical integrity of each resource, existing documentation, and the expected impact on those resources (Table 10.16-1).

Table 10.16-1 Relative Significance of Sites within the Project Impact Area

Archaeological Site or Resource	Archaeological Sensitivity	Cultural Sensitivity	Expected Impact
Red Head Cemetery	High	High	Yes
Hattie's Belt	Low	Unknown	Unknown
Giffin Lead	Medium	Unknown	Unknown
Skunk Den Mine	High	Unknown	Unknown
David Buckley House	Low	Unknown	Unknown
Buckley Farm	High	Unknown	Unknown

As indicated in Table 10.16-1, while Red Head will be impacted by Project construction, it is not yet known what the impact of the Project will be on the other four heritage resources, and one potential resource (Buckley Farm), identified within the Project impact area.

Since the sensitivity of Red Head Cemetery is high, any impacts on as yet unidentified subsurface resources would be significant (particularly in the case of additional grave sites). Mitigation will be required for this location.

The precise Project footprint for the various construction activities has not been identified with respect to the other known archaeological sites/resources and therefore the potential for disturbance is poorly defined. In the event that ground disturbing activities are conducted in the vicinity of the other archaeological features, there is potential for significant impacts through destruction of artifacts or loss of site integrity. As the Project design progresses through FEED stages, the actual potential for impacts will be reassessed and further studies may be necessary. In the event that ground disturbing activities are planned in the vicinity of the other identified locations, particularly those with high sensitivity, then mitigation will be required.

10.16.2.2 Effects of Operation

The only expected impacts to archaeological resources during the operation phase are associated with the potential continued rise in coastal water levels. A rise in sea level and wakes created by ship berthing as a result of the operation of the wharf may cause erosion to known archaeological sites at Sculpin Cove (1-5), on Hurricane Island, in Dung Cove (Dung Cove and Giffins Mill), and the location of McMillan Mine. It is possible for new archaeological features associated with these locations to be revealed by ship wake generated shore erosion. If that occurred, mitigation would be required.

10.16.2.3 Effects of Decommissioning

There are no anticipated effects on archaeological resources resulting from the decommissioning of the proposed Project.

10.16.3 Mitigation

Mitigation measures are recommended for this Project based on the results of the preliminary investigations conducted for the Project area in previous years and a review of any possible gaps in that research as it may pertain to the present Project. The recommended mitigation measures fall into two categories, Pre-construction and Construction archaeological activities.

10.16.3.1 Mitigation Measures during Pre-construction Phase

Recommended pre-construction archaeological activities includes visual surveys of nine shoreline heritage resources identified by previous studies (Sculpin Cove 1-5, McMillan Mine, Hurricane Mine, Dung Cove, and Giffin's Mill) to identify if coastal erosional activities have impacted these resources since their identification and to record a pre-Project baseline. It is also recommended that a visual survey be conducted of the east portion of the Project impact area, possibly following brush clearing, in another attempt to identify the location of the historically documented Buckley Farm. It is also recommended that visual surveys be conducted for the two end sections of the Meadow Lake water main right-of way that were not included in previous ARIA investigations. Finally, an archaeological construction Monitoring and Contingency Plan (protocols) will be developed in case potential archaeological resources or human remains are impacted during construction. It is also recommended that Archaeological Awareness and Sensitivity Training be provided to construction crews prior to ground disturbance activities to inform work crews of the level of importance and sensitivity of potential resources.

10.16.3.2 Mitigation Measures during Construction Phase

It is recommended that archaeological monitoring of construction sub-surface ground disturbances within the immediate vicinity (30 m) of identified heritage resources within the Project impact area. Presently, these areas include Red Head (registered Site BgCj-1), Giffin Lead, Skunk Den Mine, Hattie's Belt, and David Buckley House.

10.16.4 Summary and Residual Effects

Table 10.16-2 provides the results of the effects assessment for the archaeological resources VEC for construction phases of the Project. Effects associated with the decommissioning phase are expected to involve similar issues as those discussed for the construction phase.

Should the recommended pre-construction archaeological mitigation measures and the construction and operational monitoring be implemented, there are no anticipated residual effects to archaeological resources for this Project.

Table 10.16-2 Residual Environmental Effects Summary for Archaeological Resources

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Non reversible)	Ecological/Social-cultural and Economic Context	
Construction								
Ground disturbing activities in the vicinity of identified archaeological features.	A	• Conduct pre-construction surveys and construction monitoring where Project activities threaten identified sites.	High to Low depending on site sensitivity.	Identified archaeological sites and resources (approximately 15 locations in close proximity to the Project footprint.	Disturbance/destruction of archaeological features and loss of heritage information is permanent.	NR	• Site(s) of identified high sensitivity both culturally (Black Loyalists) and archaeologically.	Minimal
Operation								
Exclusion from fishing zone by LNG vessels and increased marine traffic.	A	• Conduct periodic monitoring along shoreline during operation to identify impacts from ship generated wave erosion.	High to Low depending on site sensitivity.	Shorelines of Hurricane Island, Sculpin Cove, Dung Cove, and Betty's Cove.	Disturbance/destruction of archaeological features and loss of heritage information is permanent.	NR	• Site(s) of unknown sensitivity, possibly high.	Minimal

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0

10.17 Malfunctions and Accidental Events

Accidents and malfunctions are considered unplanned events. In contrast to regular Project operations and procedures, accidents and malfunctions can involve temporary non-compliance with applicable criteria. The assessment focuses on those events (scenarios) that are considered credible in the context of the Project. The EA does not intend to address all conceivable abnormal occurrences, but rather, to address only those scenarios that have a reasonable probability of occurring (considering the specific aspects of site conditions and Project design) that may have an environmental effect or consequence.

10.17.1 Accident and Malfunction Scenarios

As discussed in Section 3.6, a detailed HAZID will be conducted during FEED. For EA purposes a preliminary list of potential accident and malfunction scenarios was identified. This is based on the Pre-FEED preliminary work on accidents and malfunctions and the study team's professional judgement pertaining to such scenarios. The scenarios evaluated in this EA involve the on-shore and marine environments and include:

- spill of fuels, lubricants, chemicals or hazardous material;
- fire;
- LNG leaks and fire;
- vessel collision;
- failure to properly exchange ballast water; and
- worker accidents.

10.17.2 Assessment of Potential Environmental Effects

An assessment of the potential effects of the above listed scenarios has been conducted and documented in table format. For each scenario, Table 10.17-1 below provides:

- an overview of the circumstances involved that lead to and/or characterize the scenario;
- the type and quantities of materials potentially released or spilled in the scenario; and
- the mitigation and management measures in place and/or to be established to avoid the occurrence of the scenario or to minimize its environmental effects.

The table also provides a conclusion as to whether or not the scenario is considered to lead to significant adverse environmental effects and/or the likelihood of the scenario to occur.

Table 10.17-2 (below) summarizes which VECs could potentially be affected by the identified scenarios without taking into account mitigation such as environmental management planning, spill prevention planning, and emergency response planning.

Table 10.17-1 Accidents and Malfunction Scenarios

Scenario	**Project Phase & Component** JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
1. Spill of fuel, lubricants or other chemicals or hazardous materials.	<u>Construction:</u> OF, JW, SH <u>Operation:</u> OF, JW, SH <u>Decommissioning:</u> OF, JW, SH	**Overview of circumstances:** <u>Spills may occur:</u> • At the storage locations from ruptured fuel lines. • From on-site vehicle and/or tanker truck accidents. • During on-site refuelling and maintenance operations. • From accidents involving vehicles accessing the wharf/jetty. • During equipment, vehicle, machinery maintenance on-shore or at marine infrastructure. **Materials released:** • Fuels (e.g., diesel, gasoline). • Other potentially hazardous materials used on-site: engine coolants, waste oil, hydraulic fluids, de-icing compound. • Quantities limited to size of individual on-site fuel storage tanks, fuel tanker truck, and equipment tanks. **Management features (Construction, Operation, Decommissioning):** • No storage of vessel fuel on-site; no refuelling of vessels at the terminal. • On-site storage of equipment fuel, lubricants, and other potentially hazardous materials in designated and properly designed places and in limited volumes. • No storage of any such substances on wharf and jetty. • No refuelling of vessels / vehicles at wharf/jetty. • Storage and handling in compliance with WHMIS procedures and all other applicable regulatory requirements. • Site stormwater management system with shut off valve, retention capacity, and effluent quality monitoring station. • Operating plans and EMPs, following applicable regulations, to prescribe detailed protocols for management of fuels, lubricants, hazardous materials (e.g., safe storage practices, spill prevention, regulatory compliance, and containment measures as per WHMIS and Material Safety Data Sheets (MSDSs)). • Emergency response planning to prescribe on-site, wharf and jetty response equipment, personnel and training; responsibilities; emergency response measures; communication and reporting; coordination with local/regional response teams. • Pieridae to actively work with local industry and municipalities to coordinate individual emergency response capabilities and develop regional response protocols.	Storage of fuel, lubricants or other chemicals or hazardous materials will be limited to designated on-shore locations. There will be no storage of such substances on wharf and jetty. The stored volumes of on-site fuel containers are limited to the operational needs of the facility. Given these limited volumes of materials, the EMP, inspection, and emergency response planning and management features that will be in-place, significant adverse environmental effects are not likely to occur.

Scenario	Project Phase & Component JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
		Remedial action: • the emergency response procedure will be implemented immediately upon the detection of the release of fuels and or hazardous materials. • clean up will occur to the appropriate standards in compliance with regulatory requirements.	
2. Fire (no LNG leak).	<u>Construction:</u> OF, JW, SH <u>Operation:</u> OF, JW, SH <u>Decommissioning:</u> OF, JW, SH	**Overview of circumstances:** • The most obvious locations for fire potential will be; vehicles, fuel storage facilities and buildings, and mechanical shops. • From an environmental impact perspective, the most critical of these is the fuel storage where there may be sufficient fuel to sustain a fire event for long periods of time; or where fires may lead to explosions of fuel tanks and spread to adjacent forest vegetation. • Fires involving storage containers may cause release of potentially hazardous substances or explosions. **Materials released:** • Products of combustion will be smoke and carbon particulates. **Management features:** • Fire fighting water supply and hydrant systems at the Goldboro LNG site (on-shore and marine components) to be developed in consultation with local fire chief and emergency response services and in accordance with building code and all other applicable standards. • Fire detection and protection systems will be provided in critical locations such as fuel and lubricant storage tanks. • Emergency response planning to prescribe on-site response equipment, personnel and training; responsibilities; emergency response measures; communication and reporting; coordination with local/regional response teams; ESD shut in procedures for fire fighting. • Forest fire on adjacent lands to be included in potential training and response requirements. • Establishment of “Fire Safe“ operating procedures. • Pieridae to actively work with local industry, municipalities, and local/regional emergency response services to coordinate individual emergency response capabilities and develop regional response protocols. **Remedial action:** • The emergency response procedure will be implemented immediately upon the detection of a fire. • Firefighting equipment and an emergency response vehicle equipped with firefighting equipment will be deployed immediately.	Facility fire at Goldboro LNG (not involving LNG) does not present any abnormal environmental hazard or risk beyond any other location. Fire surveillance, response measures, adequate crew training, coordination with local emergency response services will mitigate the extent of the fire damage. Significant adverse environmental effects are unlikely to occur.

Scenario	**Project Phase & Component** JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion

3. LNG leaks and fire involving LNG.	<u>Construction:</u>
	OF, JW (commission)
	<u>Operation:</u>
	OF, JW
	<u>Decommissioning:</u>
	OF, JW (decommissioning)
		Overview of circumstances:
		• LNG leaks in piping, storage, and transfer infrastructure could result in:
		  • flammable gas clouds from leaks producing a flash fire on ignition;
		  • pool or jet fires generating high thermal radiation on structures, process plant, buildings or people;
		  • explosion overpressures from ignition of a flammable gas cloud in a congested region of the facility; and
		  • BLEVEs arising from failure of a vessel containing a pressurized liquid above its boiling point.
		• Any of the above could result in death and serious injuries to on-site workers and damage facility components.
		• Exposure to cryogenic LNG and LNG vapour clouds could result in personal death and injuries related to freezing burns or asphyxiation.
		• Fires could also trigger fires in other on-site locations, trigger explosions and may spread to adjacent forest vegetation (Scenario 2).
		Materials released:
		• Products of combustion will be smoke and carbon particulates.
		• LNG fires / explosions may cause other fires involving containers at the facility which may release potentially hazardous substances (see Scenario 2).
		Management features:
		• Prevention and minimizing risk through design, construction operation in compliance with applicable regulatory requirements including LNG-specific codes and standards (see discussion in Section 3.6).
		• HAZID analysis, qualitative and quantitative risk assessment during Pre-FEED and FEED and as part of regulatory approval process.
		• Integration of comprehensive facility design features and operational procedures as a result of above design and analysis processes.
		• Establishment of vapour dispersion exclusion zone and thermal radiation exclusion zone as per code requirements.
		• Fire fighting water supply and hydrant systems at the Goldboro LNG site to be developed in consultation with local fire chief and emergency response services and in accordance with building code and all other applicable standards.
		• Fire detection and protection systems will be provided in critical locations such as fuel and lubricant storage tanks.
		• Emergency response planning to prescribe on-site response equipment, personnel and training; responsibilities; emergency response measures; communication and reporting; coordination with local/regional response teams; ESD shut in procedures for fire fighting.
		• Establishment of “Fire Safe“ operating procedures.
			LNG leaks, releases and potential fires involving LNG will be systematically analyzed, addressed and planned for during all development phases. Rigorous regulatory requirements associated with comprehensive management measures, prevention, and contingency planning, will make this an extremely rare event (this is supported by the industry’s safety record – see Section 3.6.2).
			
			Significant adverse environmental effects are unlikely to occur.

Scenario	Project Phase & Component JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
		• Pieridae to actively work with local industry, municipalities, and local/regional emergency response services to coordinate individual emergency response capabilities and develop regional response protocols. **Remedial action:** • The emergency response procedure will be implemented immediately upon the detection of a fire/LNG release. • Note: There are no long-term environmental impact from LNG release to the environment as LNG is colourless, odourless, and leaves no residues; LNG clean up not required; clean up would focus on secondary effects.	
4. Marine: Release or spill of LNG at marine terminal.	Construction: Not Applicable Operation: OF,SH Decommissioning: Not Applicable	**Overview of circumstances:** This event considers: • Accidental discharge of LNG. **Materials released and quantities:** • Release of cryogenic LNG. **Management features:** • Inherent safe design (i.e., double tank with inner tank composed of nickel/steel and outer tank composed of concrete). • Spill response plan. • Emergency response plan. • Effective emergency planning and preparedness. • Operating procedures and training.	The equipment and facilities will be designed to strict design codes. Operational procedures will be prepared to ensure the transport, handling and process systems are operated within the design parameters. All employees and contractors will be trained in operational procedures and environmental emergency response procedures to ensure safe operation of tanker unloading and facility operation. Significant adverse environmental effects are unlikely to occur.
5. Marine: Vessel collision.	Construction: SH Operation: SH Decommissioning: Not applicable	**Overview of circumstances:** • This event considers the accidental collision with the wharf at the Goldboro LNG facility or grounding of a shipping vessel destined for or departing from Goldboro LNG facility. • Vessel collisions within Scotian Shelf involving pollution incidents are rare events (as per state of the Scotian Shelf report (DFO, 2012)). • Accidents with support and service vessels are considered to be too small to cause a significant environmental effect.	Modern vessels are equipped with advanced communications, radar, weather forecasting, and navigational equipment operated by certified crews do not present a significant hazard for accidental dock collision and or grounding. Navigation route is without

Scenario	Project Phase & Component JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
		Materials released: • Except in the case of a total vessel break up, no materials will be discharged. • With the increased use of with double-hulled vessel, the exterior hull can be ruptured without jeopardizing the integrity of safe vessel operations. • Discharge of vessel cargo (LNG) is not likely; vessels will be manoeuvring at low speed; in case cryogenic LNG is released – refer to Scenario 3. • Vessel fuel tanks are positioned in safe locations within the interior of the ship. In any event, the bunker C product requires heating to allow the fuel to be moved. In the worst case event of the vessel sinking, the bunker C would stay contained within the fuel tanks. The cool water temperature would not permit the bunker C to migrate far, if at all. • The Marine Diesel Oil (Petroleum Distillate Fuel) would flow in the case of a tank rupture. In the worst-case scenario, about 100 tons of the Marine Diesel Oil fuel would be discharged to the environment. In calm seas this can be contained by booms and collected by absorbent materials. In the more likely case of rough seas causing the hypothetical accident, dispersal of the Marine Diesel Oil would be extensive particularly in the wave zone near the shoreline. The Marine Diesel Oil like all diesel fuel oils will evaporate quickly. The spilled material and any contaminated materials may be hazardous to animal/aquatic life. **Management features:** • Vessel traffic is managed by Canadian Coast Guard. • All LNG vessels approaching/departing Goldboro LNG to follow procedures and protocols developed during the TERMPOL review process. • All LNG vessels will be under the jurisdiction of the Canadian Coast Guard and expected to be subject to mandatory pilotage requirements. • Goldboro LNG to permit only reputable ship operators to dock at the facility. • Goldboro LNG to contribute to enforcement of strict communications, approach speed and docking procedures. • As part of its policies, Pieridae will require vessel owners/operators to maintain and enforce spill prevention and emergency plans. • Emergency response planning, equipment, training, protocols to be developed as part of TERMPOL review process. • EMPs will be developed and implemented including spill prevention and emergency response protocols related to vessel accidents at or near the Goldboro LNG dockside. • Goldboro LNG to actively work with local industry, municipalities, and TC to coordinate individual emergency response capabilities and develop regional response protocols.	particular obstacles or navigational issues (excepting two buried undersea pipelines) and will be defined during TERMPOL in consultation with TC and communicated to the local fishing community and boat operators. The likelihood of such an accident to occur is considered to be extremely low. Significant adverse environmental effects are unlikely to occur.

Scenario	Project Phase & Component JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
		Remedial action: • The emergency response procedure will be implemented immediately upon the detection of a fire/LNG release. • If fuel spills into marine environment: immediate containment; removal / clean up in accordance with regulatory requirements. • Recovered product to be disposed in approved manner. • Note: There are no long-term environmental impact from LNG release to the environment as LNG is colourless, odourless, and leaves no residues; LNG clean up not required; clean up would focus on fuels and oils released to marine environment.	

6. Marine: Failure to properly exchange ballast water.	Construction:
	SH
	Operation:
	SH
	Decommissioning:
	Not applicable
		Overview of circumstances:
		• Typically, vessels are expected to arrive at the Goldboro LNG fully loaded so that the release of ballast water is not an issue. Instead of releasing ballast water, vessels are likely to take up ballast water at the terminal after unloading and prior to departure.
		• For vessels destined for Goldboro LNG, which are sailing under ballast water and intend to load LNG, the Canadian Ballast Water Control and Management Regulations require the vessel operator to exchange ballast water at sea, which in this case would be while in transit through the Atlantic. Should the vessel be unable to exchange ballast water at sea, e.g., due to weather and/or safety considerations or failure of the on-board ballast water pump system, ballast originating outside of the Strait of Canso may be discharged in Canadian waters outside of prescribed exchange zones or at the Goldboro LNG terminal (ballast water will be discharged as part of the normal loading procedure as the vessel takes on cargo).
		Materials released:
		• Ballast water; potentially several thousand tonnes originating from outside of Scotian Shelf.
		Management features:
		• Ballast exchanges are mandated by the IMO ballast water guidelines and the Canadian Ballast Water Control and Management Regulations under the *Canada Shipping Act*. The implementation of these guidelines and regulations are the responsibility of the shipper.
		• In accordance with the regulations, vessel operators must carry a ballast water management plan on board. The plan must specify such aspects as:
		  • ballast water management processes to be used and procedures to be followed;
		  • procedures to be followed for co-ordinating ballast water management with Canadian authorities;
		  • detailed description of the on-board ballast water system and the system's design specifications;
		  • on-board responsible officer; and
		  • ballast water reporting form and reporting requirements.
		• The implementation of the ballast water management plan is the responsibility of the vessel operator.
			The likelihood of exceptional circumstances to arise that prevent the proper ballast water exchange is considered low.
			Existing TC regulations are considered to provide effective procedures for the implementation, monitoring and reporting of ballast water exchange and for the determination of mitigation measures for discharge/exchange under exceptional circumstances.
			Significant adverse environmental effects are unlikely to occur.

Scenario	Project Phase & Component JW-Jetty and Wharf; SH-Shipping/Vessel Transport OF – Onshore Facilities	Description	Conclusion
		• In accordance with the Canadian Ballast Water Control and Management Regulations, if exceptional circumstances (equipment failure, weather/ safety considerations) prevent a proper ballast water exchange, TC is to be notified as soon as possible by the vessel. The Minister of Transport determines in consultation with the master of the ship mitigation measures prior to the discharge / exchange of ballast water in Canadian waters. This will involve considerations of the nature of the ballast water, the likelihood of introduction of harmful aquatic organisms, safety and environmental conditions, and may result in decisions such as ballast water retention, discharge at sea in an alternate exchange zone, treatment prior to discharge etc. • Compliance monitoring as part of TC's routine ship inspections. • Pieridae to monitor proper implementation of ballast water exchange practices (Pieridae to stipulate in its policies, that vessel operators using Goldboro LNG comply with the Canadian Ballast Water Control and; upon request, provide Pieridae with a copy of the completed ballast water reporting form). **Remedial action:** • Not applicable.	
7. Worker Accidents on shore, marginal wharf and jetty.	Construction: OF, JW Operation: OF, JW Decommissioning: OF, JW	**Overview of circumstances:** • During the construction and decommissioning phases, conventional construction accidents related to hoisting and rigging, working near heavy equipment, excavations, working at height, welding, and cutting may occur. • During the operations phase, conventional accidents related to operating and maintaining process equipment (i.e., working on energized systems, welding, and cutting, working at height) may occur. **Materials released and quantities:** • Not applicable. **Management features:** • Worker HASP, permitting system for energized systems and hot works. • Approved contractors list at ISO 9000 standards. • Health and safety culture. • Emergency response plan and on-site EHS. **Remedial action:** • Not applicable.	Accidents, malfunctions, and unplanned events will be prevented and mitigated by taking a systematic approach to safeguarding worker health and safety and establishing a safety culture within the organization. This will be achieved by the development and implementation of a Worker HASP, the EHS management system, the emergency response plan, and the marine terminal manual. Significant adverse environmental effects are unlikely to occur.

Table 10.17-2 Malfunctions and Accidents - Potentially Affected VECs

Valued Environmental Components (VEC) Accident and Malfunction Scenarios	Accident And Malfunction Scenarios					
	Spill of fuels, lubricants, chemical or hazardous material	Fire	LNG leaks and fire	Vehicle collision	Marine: Failure to properly exchange ballast water	Worker Accidents
Biophysical Environment						
Soil /Sediment Quality	●					
Groundwater Quality	●					
Surface Water (freshwater quality)	●					
Air Quality	●	●	●			
Terrestrial Habitat (flora / fauna)						
Vegetation	●	●	●			
Breeding and Migratory Birds	●	●	●			
Mammals	●	●	●			
Wetlands	●	●	●			
Freshwater Environment						
Freshwater Habitat	●					
Freshwater Biota (fish, invertebrates)	●					
Marine Species and Habitat						
Marine Wildlife (fish, mammals, sea-birds) and Habitat	●		●	●	●	
Sediment transport						
Species at Risk (SAR)	●	●	●	●	●	
Socio-Economic Environment						
Population, Economy, Property Values, Employment	●	●	●			●
Human Health and Safety	●	●	●	●		●
Existing and Planned Land Uses	●		●			
Commercial Fisheries and Aquaculture	●		●	●	●	
Transportation	●	●	●			●
Tourism & Recreation		●	●	●		
Visual Aesthetics		●	●	●		
Emergency Services Infrastructure	●	●	●	●		
Aboriginal Use of Land and Resources	●	●	●	●	●	

10.17.3 Mitigation

The Project will be designed, constructed and operated consistent with all applicable engineering, navigation and environmental management practices and within the applicable regulatory framework to avoid accidents and malfunctions. In particular, this will include the requirements set out in the Code of Practice – Liquified Natural Facilities of the NSDE (NSDE, 2005) and the CSA Z276, the CSA's Liquified Natural Gas standard (see Section 3.6). In the event that upset conditions occur, responses will be in compliance with the applicable laws and regulations.

As part of the Project development, potentials for malfunctions and accidents are being systematically addressed throughout the planning and design process. As such the Pre-FEED Project design included comprehensive HAZID and risk assessment studies (CB&I 2013c and 2013d). The studies were used during Pre-FEED to establish a conceptual site layout and design features that conform to LNG specific standards and codes (Section 3.6.3). The HAZID and risk assessment will be detailed during FEED (Section 3.6.4).

To address, manage and respond to these events, EMPs with detailed emergency response plans will be developed for the Project and specific components and activities (Section 3.7).

These measures will be specified in component-specific operational plans and EMPs (e.g., specific to power plant, liquefaction plant, LNG storage, marine jetty and loading, marginal wharf, road transportation). General mitigative measures for the Project will address such issues as (see also Section 3.7.2):

- emergency preparedness;
- emergency response;
- spill prevention;
- containment;
- clean up/ site remediation;
- maintenance and monitoring;
- responsibilities;
- training, drills;
- audits; and
- reporting.

Specific mitigative design features for the Project are (see also Section 3.6):

- Plant Emergency - ESD, fire extinguishers, leak and fire detection systems, constructed berms around chemical containment areas.
- Plant Layout - spacing of equipment, site preparation for future expansion during the construction phase.
- LNG Storage Tanks - double shell nickel/steel and concrete.

- Transfer piping from LNG facility to ship - powered emergency release couplers, ship and facility ESD (ESD x2).

Mitigation and management measures applicable to specific malfunction and accident scenarios are listed in Table 10.17-1 below. These measures will be further developed as part of the FEED work (see discussion in Section 3.6) and as a component of the overall efforts on health and safety and environmental management planning discussed in Section 3.7.

10.17.4 Conclusion

A series of potential malfunction and accident scenarios have been identified that are considered to have a reasonable probability of occurring during the life of the Project. These scenarios are associated with potential adverse effects on VECs related to the terrestrial, marine and socio-economic environment. A comprehensive set of measures have been identified to plan for and respond to any of these accident and malfunction scenarios. This includes comprehensive analyses of malfunctions and accidents during the design phase (FEED and subsequent operations planning) and facility-specific emergency response planning. Further included is Pieridae's commitment to an active contribution to the development and implementation of a regionally coordinated approach to emergency preparedness and response.

Malfunctions and accident scenarios associated with LNG leaks are considered extremely rare events. Danger to people and property adjacent to the site will be minimal. Personal injury (e.g., freezing burns; asphyxiation) is expected to be limited to the immediate vicinity of the LNG release. The likelihood of their occurrence is being reduced to acceptable levels through facility design, construction, and operation that adhere strictly to LNG-specific codes, standards, and other regulatory requirements. Further HAZID studies and qualitative and quantitative risk assessments will be conducted as part of FEED to document compliance and to obtain regulatory approval pursuant to the *Nova Scotia Energy Resources Conservation Act*, the *Pipeline Act* and the Nova Scotia Gas Plant Facility Regulations. Safety requirements for the marine operations (e.g., vessel approach/departure, vessel mooring, loading, tug assist, navigational aids) that are addressed in the preliminary shipping study (CB&I and Royal Haskoning DVH, 2013) will be detailed during FEED and as part of the voluntary TERMPOL planning process (Section 3.3.19). This process will be completed in close cooperation with Transport TC, Canadian Coastguard, and the Canadian Pilotage Authorities.

All other identified malfunctions and accident scenarios are considered to represent events associated with one or more of the following characteristics (see also Section 3.6.2):

- substances involved are commonly used on construction sites, their characteristics are well known;
- quantities of released contaminants are expected to be small;
- adverse effects remain localized and are reversible;
- circumstances are generally well understood;
- proven technologies are available for effective containment, clean up and remediation; and

- project-specific operation, environmental management and contingency plans have proven to provide adequate and effective management tools.

Based on the above, and assuming the implementation of all identified mitigation and management measures, significant adverse environmental effects of malfunctions and accidents on any of the VECs are not likely to occur.

10.18 Effects of the Environment on the Project

10.18.1 Introduction

In accordance with the methodology discussed in Section 8.0 and in response to the EA TOR (Appendix A), the potential effects of the environment (primarily natural hazards) on the Project were assessed. As part of the ongoing Project pre-design and ultimately the FEED, these types of potential effects from the environment are considered and the Project modified accordingly. The types of natural environmental issues or events that were considered to have the potential for adverse effect on the Project include:

- severe weather;
- extreme marine conditions;
- climate change; and
- seismic events and/or tsunami.

10.18.2 Threshold for Determination of Significance

A significant effect of the environment on the Project would be one that results in:

- a long term delay in Project schedule during construction;
- a long-term interruption in service, such as ship-to-shore product transfer at the LNG terminal or marginal wharf;
- damage to plant-site infrastructure such that human health and safety is at risk; or
- damage to plant-site infrastructure that would not be technically or economically feasible to repair.

Minor effects of the environment on the Project would be ones that result in a short term delay in construction schedule, frequent short-term disruptions in service, and increased operating or maintenance costs.

10.18.3 Severe Weather

Over the past few years, severe weather events appear to be occurring more frequently in the Atlantic Region (Richards and Daigle, 2011). Hurricane Juan remains the largest landfall hurricane on record for NS, and is considered to represent a plausible upper bound water level for the purpose of contingency planning.

Storms frequently pass close to the Atlantic coast of NS, producing highly changeable and severe weather. The storms may include high wind, heavy rainfall or snowfall, hail, lightning, and fog. As such, these events have the potential to delay construction of the proposed Project, to disrupt loading of LNG tankers, and damage proposed Project infrastructure and related vessels.

The ocean has a moderating effect on temperature along NS's eastern shore, and while attention may have to be given to some materials (reduced ductility) during construction in cold weather, the proposed Project is not expected to be affected significantly by the extreme levels of cold or heat typically experienced in NS.

10.18.3.1 Wind

Winds blow predominantly from the south or southwest during summer and from the northwest during winter, although severe storms, including summer hurricanes and winter "nor'easters" may generate strong winds from the northeast. High winds could cause some delays in the construction schedules. During operation high winds may also impact the vessel operation and LNG loading (see Section 10.18.4). High winds can also increase structural loading on large or tall structures. Due consideration to wind must be given to components design.

10.18.3.2 Precipitation

The 1982 to 2002 mean annual total precipitation for the Project area was 1438 mm. Although rain may occur in any month of the year, rainfall in the Project area is generally highest during fall. Snow and freezing precipitation can occur between October and May, with the largest amounts falling between December and March. Storm precipitation events in the Project area can be severe – the 100, 200 and 500 year 24 hour-duration events estimated to be 152 mm, 162 mm and 175 mm, respectively.

Heavy rain can result in stoppages of outdoor work, particularly during construction. If unusual wet periods or excessive rain do occur, this can result in Project delays and an associated delay in completion and additional cost. Heavy rainfall events may also cause work-site erosion during the construction phase. A potential exists for failure of erosion and sediment control structures due to such precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving watercourses with potential adverse environmental effects on fish and fish habitat. Local flooding may occur at work sites during extreme precipitation events should stormwater retention ponds become filled.

Severe snowfall can affect winter construction or contribute to unusual flooding during snow-melt. It has the potential to increase structural loadings on facility and temporary buildings. Exceptional early snowfall could delay construction and result in additional work for snow clearing and removal. This could increase construction costs. Early snow cover can minimize or prevent ground freezing and this may also affect winter construction intended at improving work progress and accessibility. Freezing rain, hail, ice and snow can interfere with the operation of vehicles on the highway, as it can cause slippery driving conditions and limit visibility.

10.18.3.3 Lightning

Severe weather events during which there is lightning are usually of short duration. All tall features of the Project will be grounded therefore lightning is not considered to be a concern during construction or operation of the facilities.

10.18.3.4 Fog

Dense inland fog is more prevalent in late spring and early summer. Chilled air above southerly-flowing ocean currents mixing with warm, moisture-laden air moving from the Gulf Stream can generate bands of thick, cool fog off the coast. Dense fog originating inland may reduce visibility and can interfere with the operation of vehicles on the highway. With onshore winds, fog banks can move far inland and can interfere with the operation of vehicles near the coast and with shipping off shore.

10.18.4 Extreme Marine Conditions

10.18.4.1 Extreme Winds and Waves

Extreme wind can produce high waves, dense blowing sea foam, heavy tumbling of the sea, and poor visibility. This can affect vessel navigation, the ability to berth or de-berth at the jetty and/or to load and unload. Further extreme wind and wave conditions may increase the likelihood for collisions with other ships and grounding. Maximum wave height is primarily a function of wind strength, wind duration, and length of exposed water (fetch). Substantial run-up waves can occur over sloping banks, levees or breakwater during extreme storm events such as tropical storms, hurricanes, and “nor’easters,” especially in combination with the surge that may accompany them.

Isaac’s Harbour is open to the ocean and to easterly gales that can bring large waves ashore. However, the predominant winds are from the Northwest and Southwest, and easterly winds at sea generally shift to northeast, thus reducing wave force within Isaac’s Harbour.

High winds and heavy seas at reduced temperatures can cause freezing spray conditions. Freezing spray can occur between November and April; however the potential for moderate or greater vessel icing from freezing spray is greatest in February. Safe work aboard a vessel can be impeded by freezing spray, as could some work tasks at the marginal wharf and LNG jetty.

Sea spray carried as high winds causing waves to break over rocks can lead to long-term corrosion on exposed oxidizing metal surfaces and structures.

10.18.4.2 Extreme Sea Surface Levels and Currents

Some of the energy from wind blowing over the ocean is transferred to the surface layers, affecting the local surface currents. The processes of energy transfer are complex; however, it is generally true that the greater the speed of the wind, the greater the frictional force, and the greater the surface currents. Surface current is typically about 3% of wind speed (Bearman, 1989). The maximum wind speed (100 year return) from MSC50 data node 8086 is 27.4 m/s, which leads to an estimated maximum surface current of 0.82 m/s. Such extreme currents generated during severe storms are almost one order of magnitude stronger than average tidal currents in the area of the Project (approximately 0.10 m/s).

Storm surge, the rise in sea-level that accompanies strong storms, is estimated to be potentially up to half the tidal range, from mean water level to high water level. For the area, this would

mean a surge up to 1.1 m above normal water level. The most damaging extreme water levels occur when the storm surge coincides with high tide, resulting in water levels possibly about twice as high above mean water level as is the case for normal high water level. For the area this would translate into a sea level at 2.2 m above mean water level if the surge coincides with a large high tide.

While extreme currents may impact the safe operation of vessels during their approach and/or departure from jetty, high water levels could impact the loading and unloading procedures at jetty.

10.18.4.3 Ice Cover

Sea ice forms along NS's Atlantic coast during January, February and March, peaking in late February and March. Sea ice formed in the Gulf of St. Lawrence can also drift through the Cabot Strait onto the Scotian Shelf and pile up along the coast when winds are from the north and east. Ice accumulations occur mainly between the second week of February and the second week of May.

In the coastal area around Country Harbour, the frequency of occurrence of ice could be up to 33% during the first week of March and between 1% and 15% in February and the rest of March. The 30-year median of the predominant ice type is new or grey-white ice (less than 30 cm thick) in February, grey ice (less than 15 cm thick) during the first week of March, and first year ice (up to 70 cm thick) for the rest of March (ExxonMobil, 2013).

When carried away to sea by winds and currents, the coastal ice cover melts and does not hinder navigation. The likelihood of Gulf of St. Lawrence ice occurring at the development site is very low; less than 1%. However, the formation of ice in the shallow coastal waters must be taken into account when designing the marginal wharf and LNG jetty.

Icebergs originate from glaciers in Greenland and drift with the Labrador Current and typically decay on the Grand Banks of Newfoundland. According to a few local residents, icebergs have never been seen in the Project area. Only one iceberg has been reported in the Project area in the last 60 years (ExxonMobil, 2013), and the probability of future iceberg occurrences is low.

10.18.5 Climate Change

The Guide to Considering Climate Change in Project Development in NS (NSE, 2011b) identifies potential issues of concern and provincial expectations for planning and design of new projects. All projects should, as a minimum, identify whether or not there are potential hazards from climate change that could affect the Project. If potential hazards are identified then Pieridae should use the guide to assess the risk and identify possible adaptation options.

Adaptation consists of actions to reduce the consequences or avoid impacts of climate change on a project, thereby reducing potential for costly modifications to projects in areas prone to climate change impacts. By addressing climate change at an early stage in a project's

development, proponents can potentially reduce operational costs associated with emissions and the maintenance of vulnerable infrastructure.

Due to the location at the shore and the ship transportation both during construction and operation, the Project is considered to be in a zone of high concern. Also, the lifetime of the Project extends over a long enough period that effects of climate change will likely be evident at the site. Therefore, the potential interaction with the Project must be assessed, and incorporated into Project design and planning.

Key climate change predictions are presented in Section 9.3.1.8. Over the life of the Project, there is a predicted minor increase in average temperature and rainfall; which will cause relatively small changes in regional hydrology. The number of very hot and very cold days, annually, is predicted to remain about the same for Guysborough County (Richards and Daigle, 2011). Extreme snowfall may be slightly less frequent, and ice formation may also be slightly less. Therefore, these factors present no significant design concern for the Project.

There is a predicted sea level rise of approximately 45 cm and resulting increase in potential storm surge flood elevation over the Project lifetime. This would result in the extreme (100 year return) storm surge flood level (above the higher highwater at large tide) rising from approximately 2.8 m (currently) up to 3.25 m (in 2050).

One other important issue related to climate change is the generally accepted prediction that the number and perhaps severity of extreme weather events will increase (Richards and Daigle, 2011). This is as yet poorly defined using current knowledge and techniques, such that the absolute number or severity of seasonal storms cannot be predicted beyond recent trends. However, the best available professional judgment is that these will increase in NS over the lifetime of the Project.

An increase in extreme marine-related events (including increased storm intensity, winds, ocean waves, and storm surges) could result in an increased number of operation disruptions at the marine terminal. It is possible that extreme events could increase the likelihood of accidents or malfunctions if structures were not designed to withstand frequent storms, which could lead to environmental impacts on marine fish, marine mammals, and birds. Sea level rise of the amount predicted is not by itself expected to have any potential impact on the Project. As with other weather related threats, the key to mitigation is incorporating appropriate climate information into the design. Climate change predictions with respect to rising sea level and increased frequency of storm events will be considered in the FEED stage of the Project, including consultation with the NSE Climate Change Directorate.

10.18.6 Seismic Events

Although seismic activity on the eastern American seaboard is well known, the large majority of shocks are very small. With the exception of the Grand Banks earthquake of 1929 (magnitude 7.2, resulting in a tsunami causing a number of deaths in southern Newfoundland), all instrumentally determined earthquakes in Atlantic Canada have had magnitudes less than 5.2

(Rast *et al*., 1979). On January 9, 1982 the largest on-shore quake (magnitude 5.7) in eastern Canada within the last 68 years occurred with an epicentre in northern New Brunswick. Neither this nor previous quakes of magnitude 5 in 1869 and 1904, and 4.5 magnitude in 1855, 1922 and 1937 created notable damage (Basham *et al.*, 1984).

The Isaac's Harbour River may have developed along a fault or shear zone, in which the river would have been able to more easily carve into bedrock which is already broken and thus, more easily eroded. These same geological structures are believed to be responsible for the surplus of water discharging at the Isaac's Harbour River relative to total precipitation.

All buildings that are constructed as part of the Project will conform to Canadian Building Codes and will consider potential seismic activities.

No potential for interaction of the Project with seismic events is anticipated due to the low frequency and seismic forces anticipated in the area, and thus there will be no adverse effects on the Project.

10.18.7 Security (Terrorism)

An unlikely but potentially catastrophic event would be an act of terrorism. The LNG facility will have a perimeter chain link fence with access to the facility through a manned security gatehouse. Plant staff will gain access to the facility via an addressable card reader system.

The facility will feature a digital video monitoring and retrieval system. This system will permit the security services to monitor the facility on a continuous basis. This will be supplemented with an intrusion alarm connected to the gatehouse.

Plant-wide alarms and communication systems, both fixed and portable will be established.

Coordination will be undertaken with TC and US Customs and Boarder Protection that will assist this facility in the maintenance of security. Requirements under the International Ship and Port Facility Security Code (Australian Government Department of Infrastructure and Transport, 2004) will be implemented as well as any future requirements.

10.18.8 Mitigation

As part of the ongoing Project pre-design a number of features have been integrated with proposed Project works and activities that have been specifically designed to minimize the potential for adverse effects of environmental conditions on the Project. These measures include:

Severe Weather:

- Dimensioning stormwater management system and all new creek channels for low frequency storm events (1 in 100 year, 24 hour, rain events; dimensioning will consider most up-to-date Intensity, Duration and Frequency information such as that provided by EC (http://climate.weatheroffice.ec.gc.ca/prods_servs/index_e.html) as well as the latest research on the potential for the increased frequency of such events.
- Consideration of additional stormwater volumes as a result of increased development (Goldboro Industrial Park) in upstream watersheds in the dimensioning of all new channels.
- Implementation of erosion and sedimentation control plans during the construction phase with sufficiently large dimensioned surface water drainage swales, erosion control swales and holding ponds.
- Scheduling of Project works, i.e., ensuring surface water management infrastructure is in place before the start of large excavation and earth works.
- Development and implementation of Operations Plan that defines weather conditions at which land-based operations (e.g., crane operation for loading and unloading) will be restricted or no longer permitted.

Extreme Marine Conditions:

- Monitoring of site-specific oceanographic conditions to generate site-specific design parameters may be required.
- Detailed design and engineering of marine components (wharf and infrastructure such as cranes) on the basis of existing marine data and modeling of potential (extreme) oceanographic conditions (wave height, currents, water levels, ice pressure).
- Detailed design and engineering of marine components in accordance with all applicable standards and regulations.
- Development and implementation of Operations Plan that defines weather conditions at which berthing will not be permitted/vessels will be required to vacate the jetty.
- Specific consideration of extreme marine conditions in the TERMPOL review process in the development of design and operational plans and navigational aids and procedures in consultation of TC, Canadian Pilotage Authority, and Canadian Coast Guard.
- Monitoring of weather and marine conditions at the jetty; routine communication between approaching vessels and jetty with briefing on site-specific weather / marine conditions.

Climate Change:

- Consultation with the NSE Climate Change Directorate for best information and recommended mitigation measures.
- Consideration of long-term sea level rise in design and engineering of wharf and mooring facilities.

- Consideration of increase in frequency and strength of storms and rainfall events in design and engineering of stormwater management system.

In addition to the above, the Project operation will entail monitoring programs and regular facility inspection, maintenance, and repair, in particular of:

- stormwater management and drainage systems;
- shore stabilization works; and
- watercourse embankments.

10.18.9 Conclusion

Taking all mitigation measures into account, no interactions between the environment and the Project during any of the Project phases were identified to affect the Project to such a degree that the residual adverse effects on any of the VECs would be considered significant.

In the detailed Project planning and FEED stage, severe weather conditions, extreme marine conditions and effects of climate change will be taken into consideration. In particular, dimensioning of the surface water management system will be based on frequency and severity of future storm events. Elevations and dimensioning of the marine terminal will be based on extreme site-specific marine conditions that are expected to result from climate change effects. Operational plans will be developed for all major components of the marginal wharf and LNG jetty in close consultation with all relevant agencies. These will include a definition of environmental conditions (e.g., fog, wind, wave action) at which normal operations can occur, at which levels specific measure will need to be implemented, or at which levels the operation will cease (e.g., wind force at which crane operation will be terminated).

No potential for adverse effects from seismic events has been identified due to the infrequent occurrence and limited magnitude of any such events in the region. In addition to Project features inherent to the design, the operation will include routine inspection, monitoring, and maintenance. This will ensure that damage to any of the design features or operational aspects will be identified and corrected.

10.19 Cumulative Effects

Individual projects and/or project components may produce residual environmental effects that are not significant, but when combined with the effects of other project components or other projects and activities, these effects may become a concern, as they may cause a cumulative adverse effect. For the purposes of the assessment, it is assumed that the existing status or condition of each VEC reflects the influence of other past and current projects and activities occurring within or outside of the Project area. It also assumes (unless there is evidence to the contrary, such as predictable down or upward trends in a population) that these existing activities will continue to be carried out in the future and will have similar effects as are currently observed. The assessment has, therefore, integrated the cumulative effects of these ongoing projects and activities. The Cumulative Effects Assessment (CEA) presented in this section thus focuses on the effects of other future projects and activities, as considered and assessed for each VEC.

A scoping exercise was conducted for the Project including:

- identification of VECs and rationale for their selection;
- definition of the spatial and temporal boundaries for the CEA; and
- identification of future planned, and/or foreseeable other projects or activities that could impact VECs in combination with the Project.

Although at insignificant levels, potentials for residual effects have been identified for almost all VECs analyzed in the direct effects assessment (Section 10.0). Consequently, all VECs (except agriculture) were considered in the CEA. The rationale for the VECs has been established as part of the direct effects assessment of the Project (Section 8.3).

The predictions of the direct effects assessment are associated with VEC-specific spatial and temporal boundaries (included in VEC definitions in Section 8.3.4). The same boundaries have been applied in the CEA.

Other past, present, and/or foreseeable projects or activities that have a potential to act in combination with the Project have been identified through a screening exercise, which is discussed below. The information on other projects was obtained from the following sources:

- MODG (MacDonald, G., pers. comm., 2013);
- NSE, Environmental Assessment Division (online registry) (NSE, 2013g);
- NSTIR (Ward, B., pers com., 2013); and
- Canadian Environmental Assessment Agency (online registry) (the Agency, 2013).

10.19.1 Identification of Other Projects and Activities

The identification of other projects and activities relevant to the CEA considered the potential for:

- spatial overlap;
- temporal overlap; and
- overlap with respect to the type of effects.

The scoping was conducted in a step-wise fashion. Firstly, potentially relevant projects were identified based on agency and public consultation and the team's own familiarity with the developments in the region. Next, each of the identified projects and activities were reviewed as to whether or not there was a potential to cause effects on any of the VECs that may overlap with the effects of the subject Project (spatial overlap). If an effect was likely, then these effects were discussed with emphasis on the temporal extent (temporal overlap). Where an overlap of the temporal boundaries was identified, the question was investigated whether or not the type of effects may be similar (i.e., overlap with respect to the type of effect).

The results of the scoping identified a number of projects and activities that may, in the future, interact with residual effects of the Goldboro LNG Project. These projects include:

Planned/ Certain:

- Route 316 road realignment; and
- closure of SOEI gas plant.

Reasonably Foreseeable:

- regional oil and gas developments;
- future industrial developments in the Goldboro Industrial Park; and
- Provincial, national, and GHG emissions.

Each of the Projects/activities is considered in the following sections.

10.19.2 Effects Assessment

As mentioned earlier, the CEA does not specifically consider past and present projects and activities. These projects and activities are captured by description of the baseline conditions and their effects will have been evaluated in the assessment of effects of the Project. The potential for cumulative environmental effects with future projects (planned and certain, and reasonably foreseeable projects) is discussed below.

The significance of beneficial cumulative effects of future projects on these VECs has not been evaluated in further detail. A general assessment is provided in 10.2.4.

10.19.2.1 Route 316 Road Realignment

This includes the realignment of Route 316 by the province/municipality contemporary with the Project construction. This will involve an approximately 5 to 7 km long road construction around the north edge of the Project area. There may also be abandonment and decommissioning of a small section of the current road alignment (east and/or west of the Project footprint). The road realignment is expected to be completed prior to commencement of major Project construction activities, and the two construction periods will not overlap temporally. However, operation of the new road section will obviously continue over the lifetime of the Project. Key issues for consideration include habitat fragmentation and potential adverse effects on fish and fish habitat as a result of stream crossings and potential discharges to surface water environments.

The location of the new road is expected to be planned around potential development areas in the Goldboro Industrial Park as well as the Project footprint. This area is currently in various stages of forest management, including clear-cut, regenerating, immature, and mature growth. Currently, the M&NP pipeline easement (approximately 35 m wide) separates the industrial park from larger forest areas to the north. The Project will include a small additional pipeline corridor to the existing width (approximately 6 -10 m more). The road realignment will contribute to this fragmentation by its new 40 - 50 m wide highway right-of-way. The combined effect of existing and new fragmentation could reduce passage of terrestrial wildlife to the industrial park property. As stated in the direct effects assessment for terrestrial habitat (Section 10.7), there is no critical habitat in the industrial park, and the property is not part of any known wildlife migration pattern. Furthermore, the habitat is ultimately destined to be lost as part of the municipal plan to actively promote development. Given the relatively remote location of the site in a region that is largely forested, it is expected that terrestrial wildlife will continue to find adequate habitat north of the municipal boundaries to support sustainable populations. Therefore, the significance of potential cumulative habitat fragmentation is expected to be minor.

There is a concern though that future developments in an around the Project site could adversely impact the Mainland Moose population. The Project site is not considered to represent high quality Moose habitat but the area is known to be visited by Moose. As such, gradual habitat loss, fragmentation and increased human activities by Goldboro LNG and the road realignment could contribute to a reduced presence of that species in the area. Similarly, these factors could contribute to a cumulative adverse effect on bats which are known to utilize the area. To mitigate against these adverse effects, Pieridae is committed to contribute to the province's recovery programs for Mainland Moose and bats. Pieridae is also open to coordinate its contribution with efforts by the municipality or potential future industrial park users to provide for synergies and maximize effectiveness of any such conservation and recovery efforts.

The Goldboro LNG and the highway realignment projects have only one watercourse in common; they will both cross Betty's Cove Brook. Residual effects from road operation would be identical to existing conditions at the current crossing further downstream. Since traffic at the current crossing will likely be reduced to almost nil, the total road related impacts can be

expected to remain the same; therefore, no additional cumulative effects are predicted compared to present. The potential impacts on fish and fish habitat and mitigation have been addressed in Section 10.10.

10.19.2.2 Closure of SOEI Gas Plant

The existing SOEI gas plant will continue to operate until 2019 and is currently proposed to be decommissioned at that time. The gas plant operation has been taken into account in the. Assessment of the individual VEC's in previous sections and have been determined as not resulting in significant adverse effects. The decommissioning activities could have adverse and beneficial effects, namely, temporary small increases in local traffic increased dust and noise levels, and heightened employment opportunities. However, the extent of these impacts is unknown as the SOEI decommissioning schedule and the specific activities have not been determined yet. The adverse impacts are not expected to be significant though. The decommissioning will not overlap with the Goldboro LNG construction phase, as by 2019 those activities are scheduled to be completed. The adverse effects of the regular Goldboro LNG Project operation provide for little potential for overlap between Goldboro LNG operations related impacts and gas plant decommissioning effects. Any cumulative traffic volumes would still be well below those experienced during the Goldboro construction phase and which are not predicted to be significantly adverse. And cumulative dust levels would be insignificant as the Goldboro LNG facility operation is not expected to generate notable dust emissions. Overlap related to noise impacts are also not considered significant as they would be short term and compensated by the dismantling of the SOEI flare stack, currently a major local noise source. Further, the gas plant's decommissioning would be subject to regulatory review and approval and thus subject to approval conditions for environmental mitigation and monitoring.

While the closure of the SOEI gas plant will mean over the long term a reduction in local employment, this will be significantly offset by the projected economic benefits of the Goldboro LNG Project. Therefore, the net cumulative effects of the Project with the SOEI gas plant closure are predicted to be short term minor increases in residual effects on dust and noise levels and traffic volumes.

There will also be some interaction related to GHG emissions; which is discussed below.

10.19.2.3 Other LNG Developments in the Region

Existing and planned (reasonably foreseeable) future projects related to oil and gas development have been considered that, together with the Project, could cause cumulative effects. These include one LNG terminal at Bear Head (Richmond County, NS) and one at Melford(Guysborough County, NS) . The Bear Project obtained EA approval in 2004 and some site work has been undertaken but construction activities have been terminated and, at this point in time, the future of the Project is somewhat uncertain. Should the site development at the Bear Head location resume within the near future, there is a possibility for time overlap with the Goldboro LNG Project construction and operation phases.

Pieridae for the LNG export terminal in Melford, H-Energy, has signed an option on two 300-acre parcels of land adjoining the seashore in Melford and intends to undertake a feasibility study. As such the Project's implementation is likely not to coincide with the Goldboro LNG construction phase; however, it is foreseeable that there would be some time overlap in the operation phases of the two facilities.

The LNG facilities at Melford and Bear Head, should they be realized, would be located about 50 km to the north and northeast of the Goldboro LNG site. Given that distance, neither construction nor operational effects are expected to overlap spatially with those of the Goldboro LNG Project. The only exception would be the Projects' interactions with the economic environment and GHG emissions. Economic interactions relate mainly to issues of economic sustainability (supply and demand related to services and labour) and economic benefits. Interaction related to GHG emissions are of concern with respect to their potential contributions to global climate change (discussed below).

10.19.2.4 Future Developments in the Goldboro Industrial Park

While there are currently no other projects planned in the Goldboro Industrial Park, the municipality continues to actively promote development of the property and there has been recent interest expressed by potential developers for the site. Therefore, it is reasonably foreseeable that the site will experience additional development during the Project lifetime. While it is not possible to foresee all of the potential interactions, without knowing the nature of possible future developments, there are some potential issues that will be common to any development including:

- habitat loss;
- increased use of freshwater resources; and
- increased road transportation.

The inevitable result of development in the industrial park property will be the reduction of terrestrial habitat that is currently present. The assessment of direct effects on terrestrial habitat on the Goldboro LNG site has highlighted the potential impacts particularly on Moose. However, no critical habitat has been identified, and the property is not part of any known wildlife migration pattern. The nature of potential impacts and possible mitigation may be similar for other projects in the industrial park property. However, it is possible that the cumulative effects of the habitat loss may adversely impact Moose and bat populations in the region. The potential significance of the cumulative habitat loss on these populations is unknown. However, as discussed in context of the Route 316 Road Realignment, in an effort to minimize or compensate for the LNG facility's potential adverse effects on Moose and bats, Pieridae is committed to contribute to the province's recovery programs for these species.

Future developments in the industrial park would almost certainly require some use of freshwater from surface water or groundwater sources. If this water requirement was large, then the obvious choice for sourcing would be Meadow Lake. According to the NS Guide to Surface Water Withdrawals, water allocations are based on the principle of "first-come, first-

served", and it would be the responsibility of future users to demonstrate that the additional water withdrawal is compliant with regulatory requirements. Such activity would require a provincial water permit, subject to regulatory review and approval. Therefore, the potential for cumulative impacts on surface water resources is negligible.

Any future occupant of the industrial park will contribute to local traffic volumes. As stated in the direct effects assessment (Section 10.15), the current and future traffic volumes would remain below design service levels during the Project lifetime. It is expected that a future project that included a very large workforce during construction or operation would be required to undergo an EA process that would include the potential impacts on transportation. Any future development(s) in the industrial park that employed a few hundred additional workers, would not likely cause road service levels to be exceeded and cumulative impacts are expected to be minimal.

10.19.2.5 Provincial, National, and Global Greenhouse Gas (GHG) Emissions

As part of the direct effects assessment for Air Quality and Climate Change (GHG) (Section 10.4), it has been estimated that the Project will contribute annually approximately 3,778 kt of CO_2, which would result in an increase in CO_2 emissions of approximately 15% to the Provincial levels and 0.5% to the Canadian levels. It is recognized that global GHG emissions are largely responsible for accelerating climate change, with significant impacts at all levels (i.e., regional, provincial, national, and global). All projects and activities that burn fossil fuels produce GHG compounds, including several of those described above. These are by definition cumulative effects and it is important for all proponents, regulatory agencies, and governments to investigate and where feasible to make use of available options for reducing GHG emissions.

The significance of Project impacts on climate change has a global and a regional aspect. It is beyond the scope of one proponent to address the global significance of climate change. The contribution of Project related GHG to global emissions is extremely small (only 0.5% nationally and far smaller internationally). Mitigation for global impacts would require coordination of regional and international agencies and development of national policies and regulations for significant reduction of GHG emissions. In this context, the Project related GHG emissions on global climate change are not significant. However, in the regional context, governments are establishing policies and regulations which support the national and international efforts. In NS, such policies expect proponents to actively implement provincial policies regarding minimizing of GHG emissions. In this context, the Project related contribution to regional GHG emissions is significant. Pieridae is committed to comprehensive GHG management planning that aims at reducing the Project's GHG emissions and supporting government initiatives to off-setting GHG emissions, during Project planning, construction, and operation, for the lifetime of the Project.

With the implementation of such measures, it is expected that Project related GHG emissions will be mitigated.

10.19.3 Mitigation

10.19.3.1 Route 316 Road Realignment

There is no special mitigation recommended for potential cumulative effects with the road realignment. It is assumed that NSTIR will develop the road applying its own comprehensive environmental and best management practices. With that, and Goldboro LNG's mitigation measures for Terrestrial Habitat and Vegetation (Section 10.9), Fauna Species at Risk (Section 10.12. and Freshwater Aquatic Habitat and Species (Section 10.10) cumulative effects are not expected to be significant.

10.19.3.2 SOEI Gas Plant

It is possible that the SOEI gas plant decommissioning may begin prior to the end of Project construction. In that event, Pieridae would make every reasonable effort to coordinate with the SOEI gas plant operators, when temporally overlapping activities may occur, in order to avoid conflicts with local traffic, or provision of local services. Should the timing be opportune, it may be possible for some trained workers to transition locally from the end of the construction for the Goldboro LNG Project to the decommissioning for the SOEI gas plant, thus further enhancing the greater benefits to the local economy.

10.19.3.3 Other LNG Developments in the Region

Given the geographic separation between the other foreseeable LNG projects, there is little mitigation recommended for potential cumulative effects with other LNG developments in the region. For potential adverse effects on the economy close consultation and coordination will be required with the business communities, labour unions, Chambers of Commerce, and regional economic development agencies with respect to schedules and anticipated demand levels for goods and services. This will mitigate against potential shortages in supply of goods and services. Otherwise the economic cumulative effects are considered to be beneficial.

Pieridae intends to maximize the Project's benefits for the local communities through its procurement process, however regional economic spin-offs and developments from Goldboro LNG and other LNG developments are largely beyond Pieridae's control and mandate but provide economic development opportunity for the regional municipalities and the Province.

With respect to cumulative effects of GHG emissions, this is seen as largely a regulatory responsibility. Pieriade is committed to contribute in consultation with the NSE Climate Change Directorate to GHG off-sets and is open to coordinating such efforts with other LNG terminal operators for potential beneficial synergies and maximizing the effectiveness of the off-sets (see also discussion below).

10.19.3.4 Future Developments in the Goldboro Industrial Park

There is no special mitigation recommended at this time for potential cumulative effects with future developments in the industrial park. Pieridae is open for discussion with the other (future) industrial park users and the municipality to contribute to a coordinated approach to the use of water resources. Such coordination may also be effective in minimizing or compensating for

adverse cumulative effects on Moose and bats by consolidating contributions to the Province's Moose and bat recovery programs. At the time of decommissioning, it may be possible to rehabilitate the site, depending on the after use objectives by the municipality and the next owner. Depending on the level of rehabilitation / re-naturalization of the site this would mitigate some of the direct and cumulative effects of the Project on local terrestrial habitat.

10.19.3.5 Provincial, National, and Global Greenhouse Gas (GHG) Emissions

The mitigation described for direct effects on Air Quality and Climate Change (GHG) (Section 10.4) are also applicable to GHG related climate change. This is particularly relevant at the regional level of significance. Pieridae will provide mitigation for Project related GHG emissions proactively through the development of a GHG Management Plan, in consultation with NSE Climate Change Directorate and will adhere to applicable provincial and national GHG regulations and policies during the Project lifetime. Similarly to the above, Pieridae is also open for discussions with the other industrial park users, other LNG facility operators, municipalities, the region and the Province to contribute in a coordinated approach to GHG mitigation and off-sets.

10.19.4 Summary and Residual Effects

The results of the CEA are summarized in Table 10.19-1. With the exception of GHG related emission levels, which could be significant relative to the NS GHG reduction targets, none of the potential residual effects are considered significant.

Table 10.19-1 Summary - Residual Cumulative Effects and Significance

Other Projects	Potential Cumulative Effects (VEC related) (Adverse or Positive)	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context	
Route 316 realignment, and Future development in Goldboro Industrial Park.	Adverse. habitat fragmentation and loss of wildlife habitat including habitat used by Mainland Moose and bats.	• Goldboro LNG: Pieridae is committed to contribute to the province's Mainland Moose and bat recovery programs. Pieridae is also open to coordinate its contribution with efforts by the municipality or potential future industrial park users to provide for synergies and maximize effectiveness of any such conservation efforts. • Route 316 realignment/ Future developers: contribute to the province's Mainland Moose and bat recovery programs.	Provincial (SAR listed at provincial level).	Regional	Project lifetime	NR	• Mainland Moose population is provincially listed SOCC • Two bat species present in the area endangered in NS..	Medium. .
Route 316 realignment, and Future development in Goldboro Industrial Park.	Adverse. Indirect impacts on local surface water from dust and contaminated run-off.	• Goldboro LNG: Standard mitigation in compliance with regulatory requirements and industry best management practices. • Route 316 realignment/ Future developers: expected will implement similar mitigation.	One small watercourse (Betty's Cove Brook).	Local	Project lifetime	R	• Number of stream crossings will remain the same as at present.	Minimal

Other Projects	Potential Cumulative Effects (VEC related) (Adverse or Positive)	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context	
SOEI gas plant (closure).	Adverse. Increased local traffic, dust, and noise during gas plant decommissioning/ Goldboro LNG construction/ operation.	• Standard mitigation in compliance with regulatory requirements and industry best management practices.	Regional	Regional	Short term	R	• Local road network is currently underutilized relative to service level.	Minimal
SOEI gas plant (closure), and Regional LNG developments.	Adverse. Economic effects from temporary shortages in regional services, goods, and labour.	• Minimized by coordination with SOEI gas plant owners and other regional LNG and industrial developers, business communities, labour unions, Chambers of Commerce, and regional economic development agencies.	Regional	Regional	Short term and periodic.	R	• Strong government and community support, following many years of regional economic decline.	Minimal
SOEI gas plant (closure), Future development in Goldboro Industrial Park, and Regional LNG developments.	Positive. Economic effects from employment and expenditures.	• Maximized by local procurement practices and coordination with business communities, labour unions, Chambers of Commerce, and regional economic development agencies.	Provincial	Provincial	Project lifetime	R	• Strong government and community support, following many years of regional economic decline.	Major. Opportunity for synergistic benefits to local and regional economies.

Other Projects	Potential Cumulative Effects (VEC related) (Adverse or Positive)	Mitigation	Significance Criteria for Residual Environmental Effects					Significance**
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context	
SOEI gas plant, and Regional LNG developments.	Adverse. Contribution to climate change as a result of national and global GHG emissions.	• All GHG emitters: Compliance with national policy and regulation of GHG emissions, including measures for off-setting GHG emissions. Coordination of regional and international agencies is required.	Goldboro LNG GHG production: annually: 0.5% of national emissions.	Global	On-going	NR	• Global issue that requires active participation by all major GHG producing nations.	Minimal
Provincial, national, global GHG emissions.	Adverse. Contribution to total provincial GHG emissions.	• All GHG emitters: Proactive mitigation through development of a GHG Management Plan, in consultation with NSE Climate Change Directorate and implementation of GHG off-sets.	Goldboro LNG GHG production: annually: 15% of NS emissions.	Regional	On-going	NR	• Provincial policies exist that support national and global efforts of regulators to reduce impacts of climate change. Currently, there are no GHG emission standards for emitters in Nova Scotia.	Medium. Significant with respect to Provincial GHG reduction targets; significance related to Climate Change unknown.

Notes:
* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 8.0
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 8.0