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SECTION 4

OVERVIEW OF THE ENVIRONMENT

Bear Head LNG

A subsidiary company of Liquefied Natural Gas Limited

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4 OVERVIEW OF THE ENVIRONMENT

4.1 Setting the Scene

As stated in Section 1.8, the intent of this submission is to provide sufficient information to enable consideration of the changes proposed to the LNG project at Bear Head and to update the data bases pertinent to those changes. Substantive reliance has been placed on the work that was done in 2004 in the preparation of the environmental assessment (JWEL, 2004a) of the LNG import project that was proposed and fully approved for construction at the site. Where new field programs or new investigative work have been undertaken, they are referenced.

4.2 Physical Environment

4.2.1 Physiography, Surficial and Bedrock Geology

In the previously accepted environmental assessment (JWEL, 2004a), the Bear Head LNG site was described as low relief near the shoreline with a shallow cove, Bear Island Cove, and several lagoons to the southeast. The relief was described as being more pronounced near the west end of the site and ranging from 10 to 30 m along the coast to 40 m inland.

A road extending east of Bear Island Road has been built for access to the site. This road runs from elevations of 10 m to 30 m, west to east. The road splits the site into north (tank foundations, roads, ditch, swales, etc) and south (jetty ponds) sections. Development elevations can be described by dividing the northern section into quadrants, NW, NE, SW and SE. A cliff slightly north of NW shows a drop from 42 - 32 m. Built platforms on the NW and SW quadrants show elevations of 33 and 30 m, respectively. A drop from SW to the road occurs from 30 - 16 m. Eastern quadrants show elevations of 44 m (NE) and an elevation gradient from 30 - 20 m (SE). A drop occurs from the SE quadrant to the road from 20 - 10 m.

The southern portion of the site contains the jetty pond and runs from the road to the shore. The maximum elevation gradient in this area runs from 30 m to sea level. Other slopes run from 10 m to sea level.

Surficial geology refers to the unconsolidated geologic materials lying on top of bedrock. The Bear Head LNG site is located on the Strait of Canso which passes through the northern part of Chedabucto Bay. The Chedabucto Bay themed region is classified as sedimentary lowland. Most of the rock deposits are sedimentary and were deposited during the late Devonian and Carboniferous periods. The oldest rocks in the area are coarse conglomerates. More recent deposits include salts (Windsor Group), reddish siltstones (Canso Group), and fine sandstones (Riversdale Group), all of which are relatively soft. The landscape was developed by glacial ice moving from northwest of the region into Chedabucto Bay. This

movement deposited red-brown sandy till over the area. Marine erosion resulted in gravel beaches that produce salt marshes and small lagoons (Davis & Brown, 1996b). As shown in Figure 4-1, glacial till can be used to characterize the surficial geology of the site. As shown in this figure, the bedrock and till surfaces are irregular resulting in erratic till depths.

Using the Surficial Geology Map of the Port Hawkesbury Area (Nova Scotia Department of Natural Resources, 2006), the Bear Head LNG site consists of Creignish Hills Till, Sugar Camp Till (with drumlin facies), and till veneer.

The Bear Head LNG site sits on bedrock geology classified as the Cumberland Group. This is an undivided group containing late carboniferous shales, fluvial sandstones, siltstones, thin calcareous fragmented beds, and coal contained in thin seams (JWEL, 2004a). Low cliffs composed of glacial till occur along the shoreline of Chedabucto Bay and the Strait of Canso. Erosion is occurring due to coastal processes, exposing large sections of bedrock that consist of closely jointed and highly weathered sandstone, with bedding layer thickness varying from 10 mm - 200 mm and bedding plane joints of 70 mm spacing or greater (JWEL, 2004a).

4.2.2 Acid Rock Drainage Potential

Acid rock drainage refers to the acidic water that is created when sulphide minerals are exposed to air and water. The Bear Head LNG site is on the Cumberland Group, which is not prone to ARD (JWEL, 2004a).

4.2.3 Hydrogeology and Water Quality

The hydrogeology and hydraulic properties of the various hydrographic units underlying and within 500 m of the Project site are presented below in order of age and occurrence below ground surface.

4.2.3.1 Peat and Organic Deposits

Peat bogs, fens, and marshes between 1 - 15 m deep exist sporadically across the Project site and all areas within 500 m of the property boundary. The sizes of these features are controlled by hydrologic processes; the soil types are caused by geology, topography and climate. These features continuously exchange water between groundwater, surface water and the atmosphere. Based upon hydraulic head differences, these bogs can recharge groundwater tables or act as discharge areas for groundwater. These features are generally classified as having high hydraulic conductivity (Carter, n.d.). Wells are not usually drilled in these areas due to the risk of poor aquifer water quality.

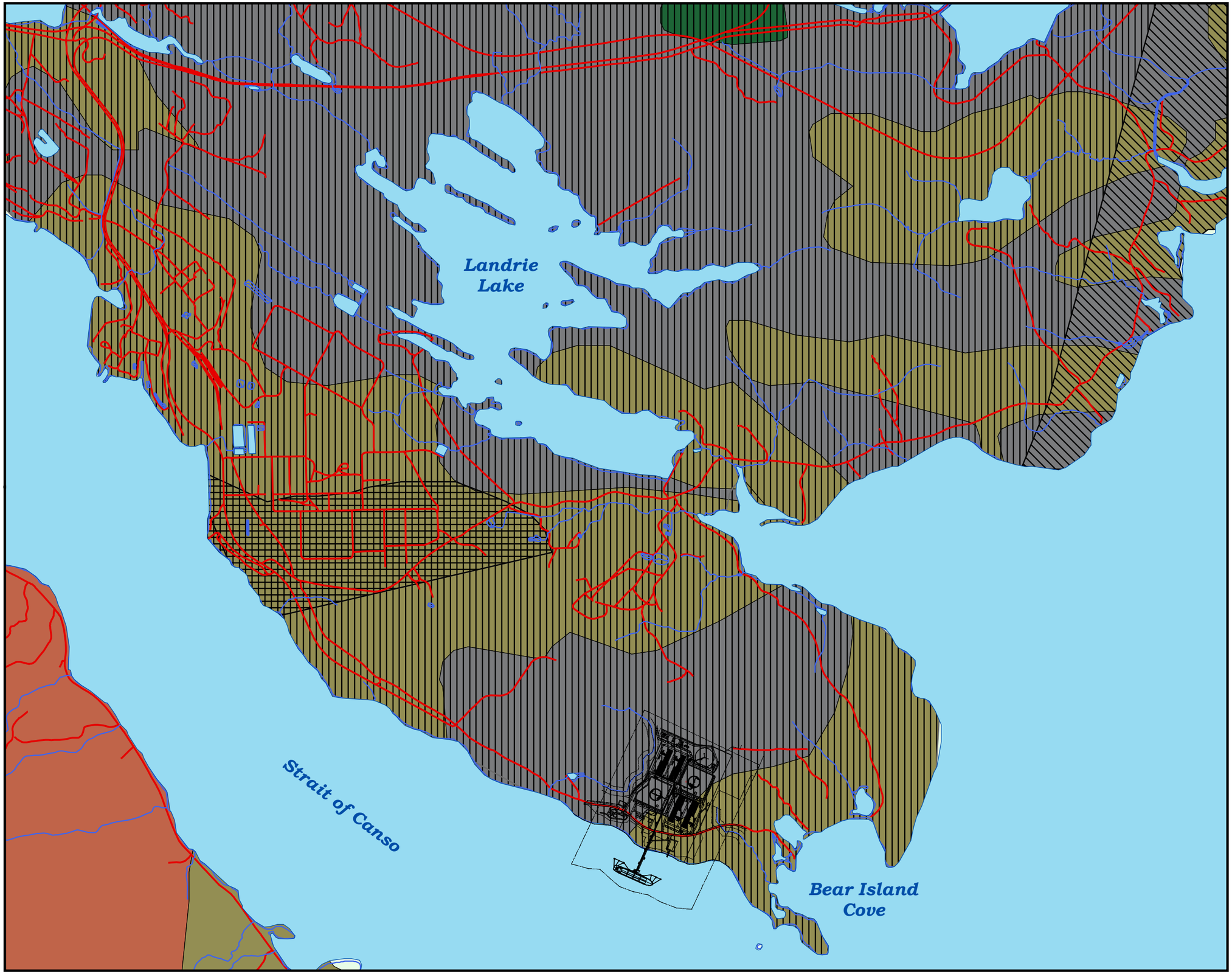

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Figure 4-1

Geology of the Surrounding Region

Bear Head LNG Site Features
Rivers and Streams
Roads
Waterbodies

Bedrock Geology

Cumberland Group
Mabou Group
Windsor Group

Surficial Geology

Bedrock
Silty Drumlin
Silty Till Plain
Stony Till Plain

N
W E
S

0 250 500 750 1,000
Metres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Datum: NAD83
Zone: 20
Scale: 1:25,000
Project Numer: 622560
Date: April 1, 2015

Data Source:
-Canvec (2013) Digital National Topographic System (NTS) topographic dataset for Port Hawkesbury (011F11)
-Nova Scotia Geoscience and Mines Branch

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4.2.3.2 Glacial Till

The Bear Head LNG site is covered in glacial till, consisting of stony, clayey, and silty deposits. These zones usually have low hydraulic conductivity; based upon previous tests, however, dug wells might produce enough water for domestic supplies (JWEL, 2004a). This information will be assessed as part of an upcoming water study for the Project; this will review and update all available well records from the area and the status and results from the monitoring wells that have been established on site.

4.2.3.3 Cumberland Group

The Bear Head LNG site sits upon Cumberland Group bedrock. This group is made up of three principle formations: the Silver Mine, Port Hood and Inverness formations. Although Cumberland Group bedrock is made up of three formations, the Bear Head LNG site sits on an area considered to be undivided, meaning it cannot be placed in a specific formation (JWEL, 2004a).

4.2.4 Water Sources

Water supply means the source water and process of supplying water to residential, industrial and commercial customers. Water can be supplied from groundwater or surface water sources. Water is supplied to the Town of Port Hawkesbury from the Landrie Lake watershed, but as shown in Figure 4-2, the Project site does not fall within this watershed area. The Bear Head LNG site is at a lower elevation than the Landrie Lake watershed, and the Project does not anticipate using water from the lake; it will likely draw water independently from groundwater sources.

During three (3) site visits in 2014 (May 8, October 22, and December 22), water samples were taken from several locations around the Project site. Sampling locations are shown on Figure 4-2; they include Stream A, Stream B and the drainage ditch along the north property boundary. Table 4-1 summarizes the water quality results from the site visits.

It is noted that the waters show low turbidity, low Total Suspended Solids (TSS), and a fairly neutral pH. All analyzed parameters were below the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for Freshwater Aquatic Life (FWAL) except pH, aluminum and boron. A sample taken in Stream A in October had a pH of 5.99 which is below the acceptable pH range of 6.5-8.0. This sample also exceeded the guideline for aluminum, 5 ug/L, with a concentration of 350 ug/L. Four samples taken in Stream A in October exceeded the guideline for boron, 1500 ug/L with concentrations of 2900 ug/L, 2300 ug/L, 2300 ug/L and 2200 ug/L respectively.

Table 4-1: Physical Observations and Water Quality Measurements at the Bear Head LNG Site, Point Tupper, Nova Scotia (2014)

Parameter	Stream A			Stream B			North Ditch	
	May	Oct	Dec	May	Oct	Dec	May	Dec
Temp (°C)	8.3	-	2.1	11.8	-	2.4	17.5	1.5
Oxygen Saturation (%)	65.7	-	94.3	90.4	-	94.5	89.4	82.5
Dissolved Oxygen (mg/L)	7.71	-	13.3	9.78	-	12.9	8.47	11.8
Conductivity (µs)	253.8	580-700	197.6	324.8	460	291.8	649	269.3
Salinity (ppt)	0.2	-	-	0.2	-	-	0.4	-
TSS (mg/L)	<0.5	< 2.0	<0.5	<0.5	< 2.0	<0.5	2.2 (downstream)	1.0
pH	6.1	5.99-7.08	6.8	7.4	7.7	6.6	7.3	7.4
Turbidity (Visual and NTU)	Clear and colourless	0.18-0.38	Very pale yellow	Clear and colourless	0.2	Very pale yellow	Clear and colourless (yellow flow on bottom)	Very pale yellow

The terrestrial footprint of the Bear Head LNG site is 37 ha located on a moderately sloped hillside adjacent to the Canso Causeway. The location of streams and wetlands are shown on Figure 4-2. Based on topography, the site is expected to drain in three directions:

- 18.5 ha to a stream west of the site;
- 18.6 ha toward a sedimentation pond on the eastern portion of the site which drains to a wetland east of the existing development; and
- 5.9 ha south toward the Strait of Canso.

A run-off model of the site was developed based on surface characteristics including soil type, slope and ground cover. Based on historic rain records from the Port Hastings climate station (10 years of data from 1979 to 1989), a runoff simulation was used to estimate mean monthly and annual runoff for the site. The Port Hastings station, located 13 km distant, is considered representative of precipitation at the Bear Head site; it was selected for this simulation based on the length of its monitoring record (monthly records from 1874 to 1989 and daily records from 1961 to 1989). For comparison, the simulation was repeated for the historic pre-development conditions, as well as the anticipated future development. The simulation results are provided in Table 4-2.

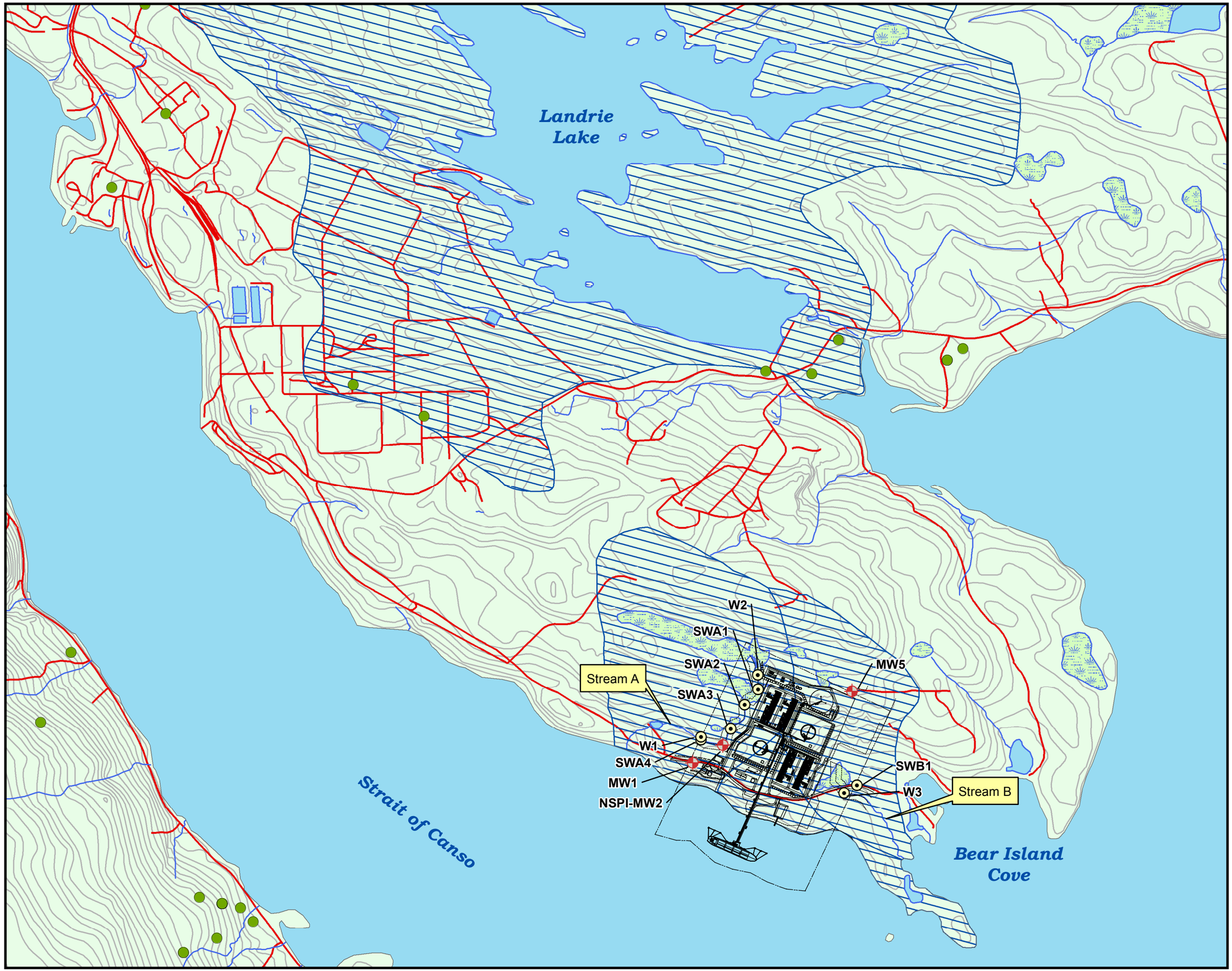

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Figure 4-2
Surface Water and Ground Water Features

- Monitoring Wells (on-site)
- Residential Well
- Surface Water Sampling Site
- Bear Head LNG Site Features
- Contours
- Rivers and Streams
- Water
- Watershed Area
- Wetlands

N
W E
S

0 250 500 750 1,000
Metres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Datum: NAD83
Zone: 20
Scale: 1:20,000
Project Numer: 622560
Date: April 1, 2015

Data Source:
-Canvec (2013) Digital National Topographic System (NTS) topographic dataset for Port Hawkesbury (011F11)
-Nova Scotia Department of Natural Resources

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Table 4-2: Mean Monthly and Annual Site Runoff (mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Past	4.5	2.4	7.3	8.8	4.9	5.7	4.7	4.0	9.9	5.6	11.7	5.6	6.3
Present	5.1	2.9	8.0	9.9	5.4	6.5	5.3	4.4	10.7	6.4	12.7	6.2	7.0
Future	6.0	3.5	9.0	11.3	6.1	7.5	6.1	5.0	11.9	7.6	14.1	7.2	7.9

4.2.5 Climate

Climate data for this section was obtained from the Canadian Government Climate website for Eddy Point which is located at the mouth of the Strait of Canso approximately 6 km from the Bear Head LNG site. The location of Eddy Point is provided in Figure 4-3.

4.2.5.1 General Climate and Weather Patterns

Nova Scotia's climate is subject to variability, with distinctive changes often occurring on a daily basis. The province receives substantial precipitation and temperature ranges throughout the year; these ranges are wide, but not extreme. The summer season is short, the winter longer, and overcast days and coastal fog are common. The arrival of spring can be delayed and fall extended due to the thermal properties of the Atlantic Ocean (Davis & Browne, 1996a).

Winds tend to be predominantly from the west due to the general circulation of warm air from the pole being deflected by the Coriolis Effect, with three main air masses converging on the province. Dry and cold continental arctic air from the northwest, warmer maritime polar air from the north and northeast and cool, moist maritime tropical air from the south or southwest cause the variability in Nova Scotia's weather. Low pressure storm systems frequently hit the region, bringing with them strong north easterly winds and heavy precipitation. Coastal influences result in sea breezes, sea fog, cold inland winds, pack ice and freezing spray. The area is characterized by alternating high and low pressure systems (Davis & Browne, 1996a).

The Project is located in the Atlantic Coastal region. The Strait of Canso is just off of Chedabucto Bay, the largest bay on the Atlantic Coast. The Strait is relatively sheltered, which means it experiences warmer water temperatures during the summer months than other more exposed areas of the Nova Scotia coast. The close proximity to the sea results in cool summers and warm winters (relative to the rest of the province). High amounts of rainfall and heavy sea fog are common (Davis & Browne, 1996b).

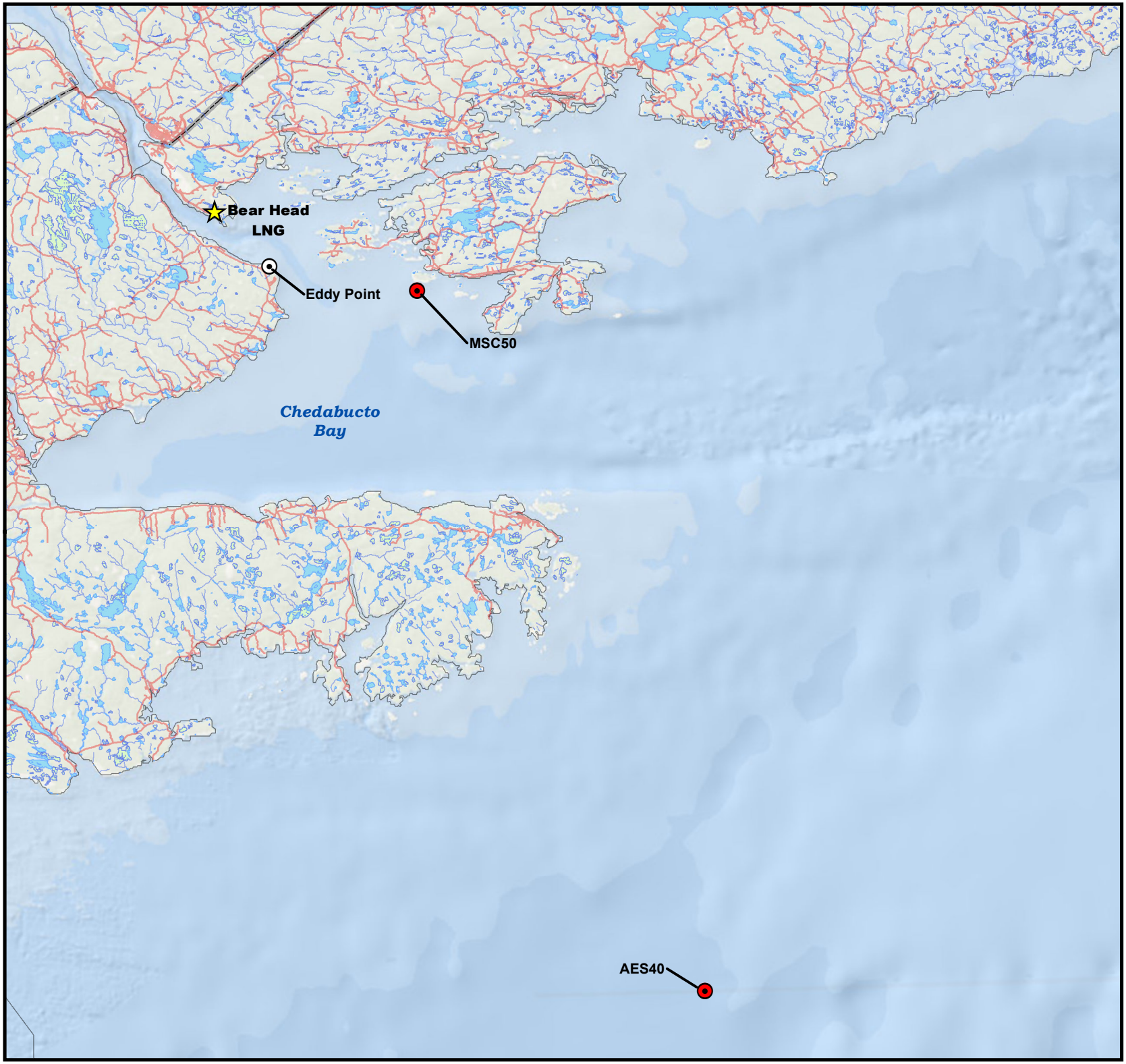

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Figure 4-3

Meteorological Monitoring Stations

- Environment Canada Weather Station
- Offshore Hindcast Dataset
- County Lines
- Rivers and Streams
- Roads
- Waterbodies
- Wetlands

N
W E
S

0 5 10 15
Kilometres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Datum: NAD83
Zone: 20
Scale: 1:400,000
Project Numer: 622560
Date: April 1, 2015

Data Source:
-Canvec (2013) Digital National Topographic System (NTS) topographic dataset
-ANEI Bear Head LNG Terminal Environmental Assessment 2004 (Jacques Whitford)

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The winter brings prevailing winds from the west and northwest, consisting of cold continental arctic air and moister maritime polar air. Cloud cover is heavier, and winds are at their highest during this time of year. Occasional thaws and warm spells can occur due to warm southwest winds generated by storms tracking north. The spring is often delayed due to the Atlantic, and fog is heavy and common due to temperature differences between warming air and the cold ocean waters. Summer is brief, but brings warmer temperatures as the southern edge of the arctic air mass moves northward around June. Fall brings with it heavy rains and storm activity, with the greatest hurricane activity occurring during this period. Offshore waters are at their warmest, prolonging the season; weather between storms can be some of the clearest and most enjoyable of the year. The growing season typically ranges from April to November, lasting in excess of 210 days in western parts of Nova Scotia and less than 190 days in the central and eastern part of the province, including the area of the Project site (Davis & Browne, 1996a).

4.2.5.2 Temperature Normals and Extremes

Average annual climate data by month for Eddy Point is summarized in Table 4-3. The yearly mean temperature is 6.1 °C with an extreme maximum of 33.3 °C and an extreme minimum of -25.6°C. This is typical of Nova Scotia, particularly coastal regions which experience wide, but not extreme, temperature ranges throughout the year.

Table 4-3: Annual Average Climate Data

Month	Avg. Daily Maximum (°C)	Avg. Daily Minimum (°C)	Daily Mean (°C)	Extreme Maximum (°C)	Extreme Minimum (°C)
January	-0.5	-8	-4.6	12.3	-22.9
February	-1.5	-8.6	-5.1	10.6	-25.6
March	1.5	-5	-1.8	14.2	-18.4
April	5.9	-0.9	2.5	27.2	-10.6
May	11.9	3.1	7.5	30.8	-2.8
June	17.5	8.3	12.9	33.3	2.2
July	21.5	13.1	17.3	32.8	7.2
August	22	14.1	18.1	32.2	5.6
September	18.3	10.3	14.3	28.4	2.7
October	12.8	5.5	9.1	22.2	-5.6
November	7.4	1.2	4.3	19	-10.1
December	1.9	-4.9	-1.5	13.6	-25
Year	9.9	2.4	6.1	33.3	-25.6

Source: Atmospheric Environment Branch, Canadian Climate Normals, Eddy Point: 1951-1980

The average annual humidity by month from 1980 -1984 is summarized in Table 4-4; average humidity ranges between 77.5 – 83.2%. The average barometric pressure during this time period was 1,005 mbar with a maximum of 1,041 mbar and a minimum of 948.1 mbar.

Table 4-4: Monthly Average Relative Humidity

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Humidity (%)	79.6	78.9	77.5	79.9	80.7	78.5	80.2	82.1	80.2	79.4	83.2	82.3

Source: Atmospheric Environment Branch

4.2.5.3 Precipitation Normals and Extremes

Average annual precipitation data for Eddy Point is summarized in Table 4-5. The yearly mean rainfall is 1081.4 mm, yearly mean snowfall is 27.96 cm, and yearly mean total precipitation is 134.93 mm.

Table 4-5: Annual Average Precipitation Data

Month	Mean Rainfall (mm)	Mean Snowfall (cm)	Total Precipitation (mm)	Extreme Daily Rainfall (mm)	Extreme Daily Snowfall (cm)	Extreme Daily Precipitation (mm)
January	79.1	69.8	138.2	47.6	19.6	47.6
February	47.1	63.8	105.3	34.5	63	64.3
March	60.4	51.1	116.4	31.3	19.3	31.3
April	71.7	19.0	90.9	34.7	21.6	34.7
May	96.3	1.6	99.8	78.6	22.9	78.6
June	89.2	0.0	89.1	77.2	0.0	77.2
July	96.8	0.0	96.8	61.2	0.0	61.2
August	106.0	0.0	106.0	63.1	0.0	63.1
September	87.0	0.0	87.0	64.5	0.0	64.5
October	107.1	1.7	107.5	55.1	5.6	55.1
November	137.6	11.7	147.6	51.4	19.5	51.4
December	103.1	60.9	164.7	76.8	23.6	76.8
Year	1081.4	279.6	1349.3	78.6	63	78.6

Source: Atmospheric Environment Branch, Canadian Climate Normals, Eddy Point: 1951-1980

4.2.5.4 Wind Normals and Extremes

The prevailing terrestrial wind direction is from the west. During the winter winds come most frequently from the west to northwest and from the south to south west in warmer months. The average wind speed is 20 km/h during summer months and between 12-15 km/h during winter, as shown in Figure 4-4.

4.2.5.5 Adverse Weather

Adverse weather at the Project site includes fog, freezing rain, snow and high winds. Fog is common to the area regardless of season and can cause reduced visibility. It is more prevalent during spring and early summer when warming air interacts with ocean water that is still cool. Fall tends to be the least foggy time of year due to warmer waters and generally clear skies.

Heavy winds and cold air temperatures in the winter often cause sea spray to freeze, which can cause issues with accumulation on vessels, buildings, and could pose an issue to Project infrastructure. Freezing spray can occur from November through to April and is most common when northeasterly winter winds occur alongside freezing temperatures

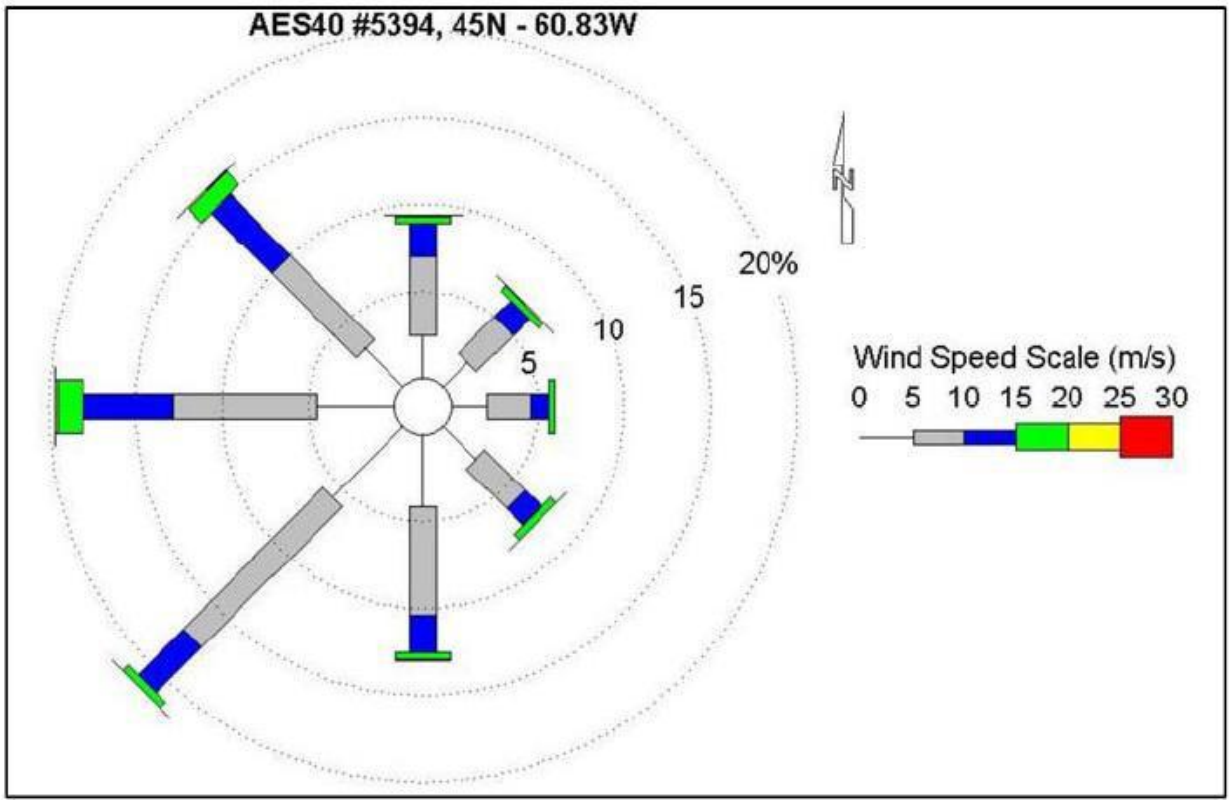

Figure 4-4: Windrose Plot for Eddy Point (JWEL, 2004a)

4.2.6 Ambient Air Quality

In order to characterize the ambient air quality at the Project site, monitoring results from the NAPS station in Port Hawkesbury (approximately 8 km away) for the years 2010 - 2012 were used. Data completeness in the years 2011 and 2012 was greater than 90%. Pollutants measured include sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and fine particulates ($PM_{2.5}$). Monitoring results are compared with the Nova Scotia Air Quality Standards under the *Environment Act* for SO_2, NO_2 and O_3 and with the Canadian Ambient Air Quality Standards (CAAQS) from CCME for O_3 and $PM_{2.5}$. Concentrations of all pollutants were below both sets of standards, indicating that ambient air quality at the site is of a high quality. Maximum ground level concentrations for SO_2 were less than 10% of the provincial requirements and for NO_2 were less than 20%. The results are presented in Table 4-6.

Current industrial emissions from major industrial and power installations in the Port Hawkesbury and Point Tupper area are shown in Table 4-7**.** These estimates of annual emissions were obtained from the National Pollutant Release Inventory (NPRI) for 2013.

4.2.7 Acoustic Environment

A noise assessment of the Bear Head LNG Project was performed by SNC Lavalin. As part of this assessment, monitoring was performed on October 1 and 2, 2014 at one location on the Project site and three residential receptors across the Strait for a period of 24 hours. Subsequent monitoring was also performed between 18:00 and 19:00 at four locations on the site boundary, for two minute periods. The site has limited noise sources, and as such the monitoring performed was considered to be representative of background ambient noise levels. Sound levels when winds exceeded 20 km/h were excluded from the assessment. The location of the baseline noise monitoring sites are shown in Figure 4-5. Noise level measurements are presented as a weighted continuous sound level (L_{Aeq}).

On the Project Site, birds, insects, and the adjacent wind farm could be heard during noise monitoring. An occasional noise of banging on metal could be heard across the strait. At the southernmost site, S3, waves could be heard breaking on the shoreline. A summary of the ambient sound levels measured can be seen in Tables 4-8 and 4-9. It can be seen that L_{Aeq} levels range from 32 – 50 dBA; all measured ambient sound levels are below the noise criteria referenced in the NSE guidelines for environmental noise measurement and assessment.

Table 4-6: Summary of Ambient Air Quality Monitoring Results in Port Hawkesbury

Sulphur Dioxide (SO_2) - ppb				
Year	**1-hour Maximum**	**24-hour Maximum**	**Annual Average**	**% Completeness**
2010	30	4	N.D.	12
2011	27	10	1	91
2012	39	9	1	97
NS AQS	340	110	20	N.A.
Nitrogen Dioxide (NO_2) - ppb				
Year	**1-hour Maximum**	**24-hour Maximum**	**Annual Average**	**% Completeness**
2010	26	11	3	57
2011	41	11	2	94
2012	30	10	2	93
NS AQS	210	N.A.	50	N.A.
Ozone (O_3) - ppb				
Year	**1-Hour Maximum**	**Daily 8-hour Maximum**	**99^e Percentile of Daily 8-Hour Maximums**	**% Completeness**
2010	63	58	54	50
2011	75	62	52	90
2012	60	54	50	98
NS AQS	82	N.A.	N.A.	N.A.
3-year Average	N.A.	N.A.	52	N.A.
CAAQS 3-year Average	N.A.	N.A.	65 for 2015 62 for 2020	N.A.
Fine Particulates ($PM_{2.5}$) - µg/m³				
Year	**Daily Maximum**	**98^e Percentile of Daily Maximums**	**Annual Average**	**% Completeness**
2010	40	22	8	62
2011	29	18	7	95
2012	14	12	6	89
3-year Average	N.A.	17	7.0	N.A.
CAAQS 3-year Average	N.A.	28 for 2015 27 for 2020	10.0 for 2015 8.8 for 2020	N.A.
Source: NAPS, Station 030201, Port Hawkesbury, Nova Scotia.				

Table 4-7: Summary of Industrial Atmospheric Emissions in the Study Area

NPRI Sources	Contaminants (metric tonnes per annum)						
	SO_2	NO_x	CO	VOCs	TPM	PM_{10}	$PM_{2.5}$
ExxonMobil Canada Properties - Point Tupper Fractionation Plant 2013		32	42	81		1.5	1.2
Nova Scotia Power Incorporated/Point Tupper Generating Station (2013)	6,758	1,340	78		117	82	36
Port Hawkesbury Paper LP/Port Hawkesbury Paper (2013)	237	442	421	333	112	61	21
Nova Scotia Power Incorporated/Port Hawkesbury Biomass Cogeneration Power Plant (2013)	47	774	251		81	62	33
Total 2013	**7,042**	**2,588**	**792**	**414**	**310**	**207**	**91**

Source: National Pollutant Releases Inventory for 2013

Table 4-8: Ambient Sound Levels at the LNG Project Site, October 1, 2014

Monitoring Location	Coordinates (ATS77 MTM4)		Measured L_{Aeq} (dBA)	NSE Criteria (7:00 – 19:00) L_{Aeq} (dBA)
	Latitude	Longitude		
S1	4515671	5046815	35	65
S2	4515383	5046637	35	65
S3	4515453	5046228	44	65
S4	4515760	5046396	32	65

Table 4-9: Ambient Sound Levels at Residential Monitoring Sites, October 1–2, 2014

Monitoring Location	Coordinates (ATS77 MTM4)		Approximate Distance from LNG Boundary, Loading Platform (km)	07:00 to 19:00 L_{Aeq} (dBA)	19:00 to 23:00 L_{Aeq} (dBA)	23:00 to 07:00 L_{Aeq} (dBA)	Ldn (dBA)
	Latitude	Longitude					
R1	4517855	5042450	4.4	50	47	43	55
R2	4513977	5044565	1.8	50	43	42	55
R3	4512490	5045776	2.8	50	41	40	54
S5	4515546	5046557	NA	46	39	37	46
			NSE Criteria	**65**	**60**	**55**	**NA**

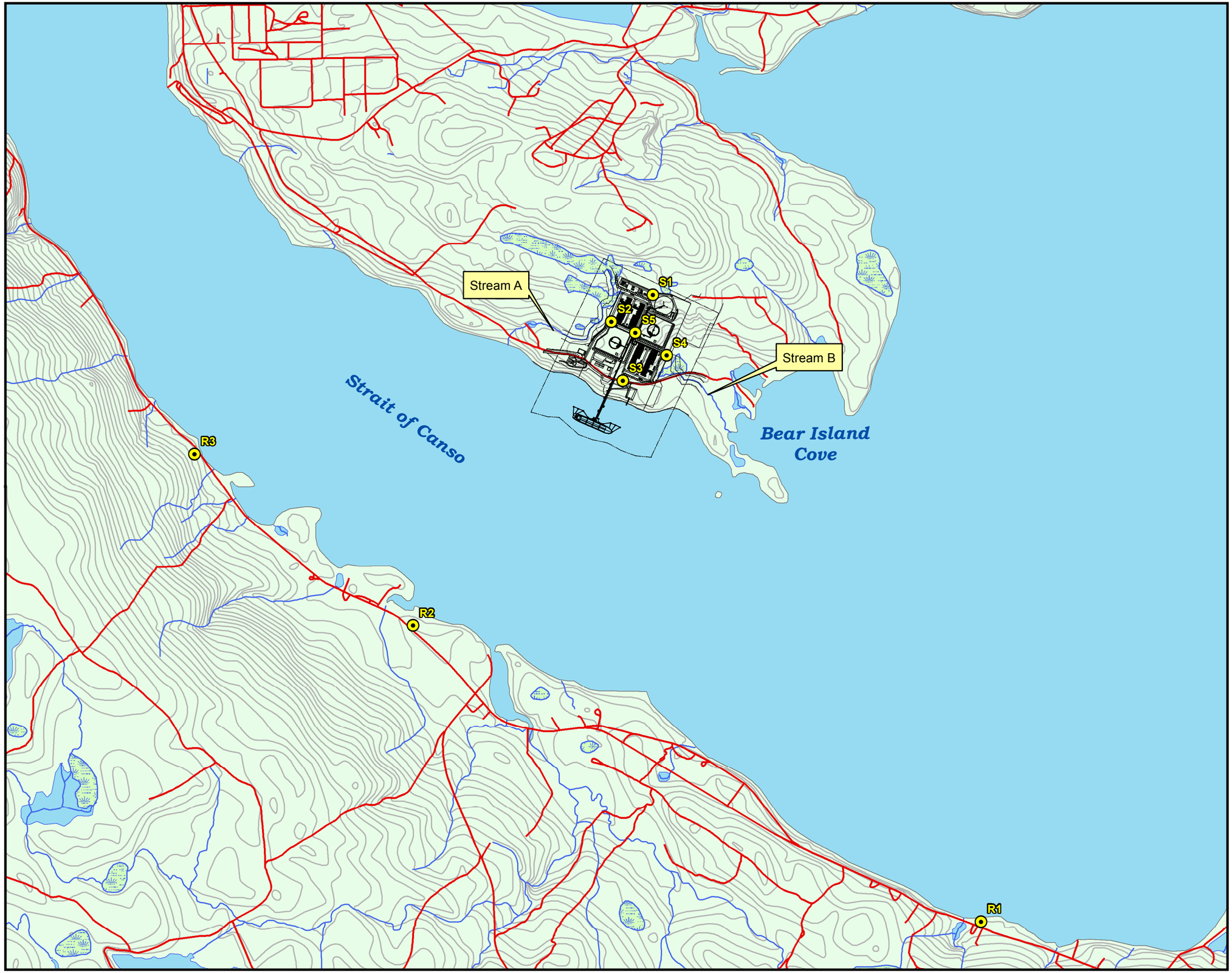

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Figure 4-5
Noise Monitoring Stations

- Noise Monitoring Locations
- Bear Head LNG Site Features
- Elevation
- Rivers and Streams
- Roads
- Waterbodies
- Wetlands

N
W E
S

0 500 1,000 1,500

Metres

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Datum: NAD83
Zone: 20
Scale: 1:25,000
Project Numer: 622560
Date: April 1, 2015

Data Source:
-Canvec (2013) Digital National Topographic System (NTS) topographic dataset for Port Hawkesbury (011F11)
-Noise Monitoring Station Positions - Site Visit

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4.2.8 Physical Oceanography

The proposed Bear Head LNG facility is located on the northeast coast of the Strait of Canso near the entrance to Chedabucto Bay, a large coastal embayment which separates the Strait from the open Atlantic Ocean (Figure 4-6). The site is influenced by oceanographic conditions both in the Strait and adjacent waters. Oceanographic properties of the Strait of Canso are determined by its long (18 km) and narrow (0.8-2 km), fjord-like morphology, and by its deep and U-shaped cross sectional profile (Buckley et al 1974). The key attributes of the southern reach of the Strait of Canso are its general lack of freshwater input, its great length and narrow width, its relatively deep bathymetry, and dominant winds from the west and northwest which align along the axis of the Strait, resulting in weak currents (1-2 km/hr) caused mainly by winds with only a small tidal component (Lawrence, 1973).

The Strait is effectively an artificial harbour created by the construction of the Canso Causeway in 1954-55[1], which cuts it off from open access to St. Georges Bay in Northumberland Strait, Southern Gulf of St. Lawrence; in the process, the construction diminished the current regime and created an ice-free deepwater inlet (Buckley et al 1974). The oceanographic analysis for the earlier environmental assessment (JWEL, 2004a) concluded that: tidal currents at the site are weak (~0.04 m/s; non tidal currents may be many times stronger than the tidal currents; offshore swell is greatly attenuated before reaching the site; local waves are fetch limited; and ice is not an issue at any time during the year (JWEL, 2004a).

Chedabucto Bay is a broad, relatively shallow embayment, approximately 16 km north-to-south and 35 km in east-west dimension, and open along the south and east to the Atlantic Ocean, as shown in Figure 4-6. A shallow shelf (less than 30 m) on the northern side contains a system of islands, of which the largest are Isle Madame and Janvirn Island, and several semi-enclosed bays and passages as shown in Figure 4-6.

4.2.8.1 Bathymetry

Detailed bathymetry is available for both the Strait of Canso (CHS Chart 4306) and Chedabucto Bay (4335, 4307 & 4308). Strait of Canso is relatively deep, varying from 44 m where it meets Chedabucto Bay to more than 60 m in several seabed depressions in the vicinity of the Canso Causeway (Vilks et al 1975; Gregory et al 1993); the maximum depth near the proposed terminal is approximately 44 m (Figure 4-6). At Bear Head, the Strait meets Chedabucto Bay through a relatively deep channel that terminates in central Chedabucto Bay at a sill depth of 35 m (Cranston et al., 1974). Apart from the shelf on the north side of Chedabucto Bay, the depth gradually increases from 30 m in mid-bay to 90-100 m or more on the eastern margin, and reaches 80-90m in a trough on the south side of the bay.

[1] The Canso Causeway officially opened in August 1955.

4.2.8.2 Temperature and Salinity

The physical oceanographic properties of the waters in the study area and in particular at the project site were reviewed from various sources (JWEL, 2004a) and (CBCL 2015). Data sources used in the JWEL, 2004a analyses include temperature, salinity and density and associated interpretation from Lawrence (1972); Cranston *et al.* (1974); and Vilks *et al.* (1975). The hydrographic information reviewed suggests large variability in water properties both seasonal and within seasons (Cranston et al., 1974), suggested to be due to stratification through local warming and freshwater input, modulated by meteorologically-driven circulation.

In particular, a build-up of warmer, fresher surface water at the head end near the Canso Causeway is periodically flushed out and replaced by colder, saltier and more homogeneous ocean water which replenishes the bottom water (JWEL, 2004a; Buckley et al, 1974). Waters in Strait of Canso are typically highly stratified in summer with temperature and salinity in the upper 20 m reaching more than 15°C and less than 29 ppt respectively, with bottom temperatures and salinities (deeper than 35 m) of 3-7°C and 31 ppt, respectively (Stewart and White 2001). Winds towards Chedabucto Bay in the Strait can cause upwelling at the head of the Strait, and net seaward flow caused by prevailing along-Strait northwest winds create an estuarine-like circulation near the mouth (outflow at the surface with a deep return flow—in this case the surface water movement is driven by wind and not freshwater flow)(Buckley et al 1974; Stewart and White 2001). The passage of weather systems, for example, can result in rapid flushing of the surface layers as it does elsewhere along the Atlantic coast (e.g. Heath 1973; Platt et al 1972). As the sill depth at the mouth of the Strait of Canso is well below the depth of the summer thermocline, deeper waters in the Strait can be affected by coastal upwelling / downwelling and by shelf-generated internal waves (JWEL, 2004a).

4.2.8.3 Tides, Storm Surge and Sea Level Rise

Tides

Tides in both Strait of Canso and Chedabucto Bay are semi-diurnal and typically small with a mean range of 1.4-1.5 m (Owens and Bowe, 1977; Gregory et al 1993), and with a large range in both areas of 1.9 - 2 m (Gregory et al, 1993). Highest high water for a large tide at the site is 2.0 m above chart datum (CBCL, 2015).

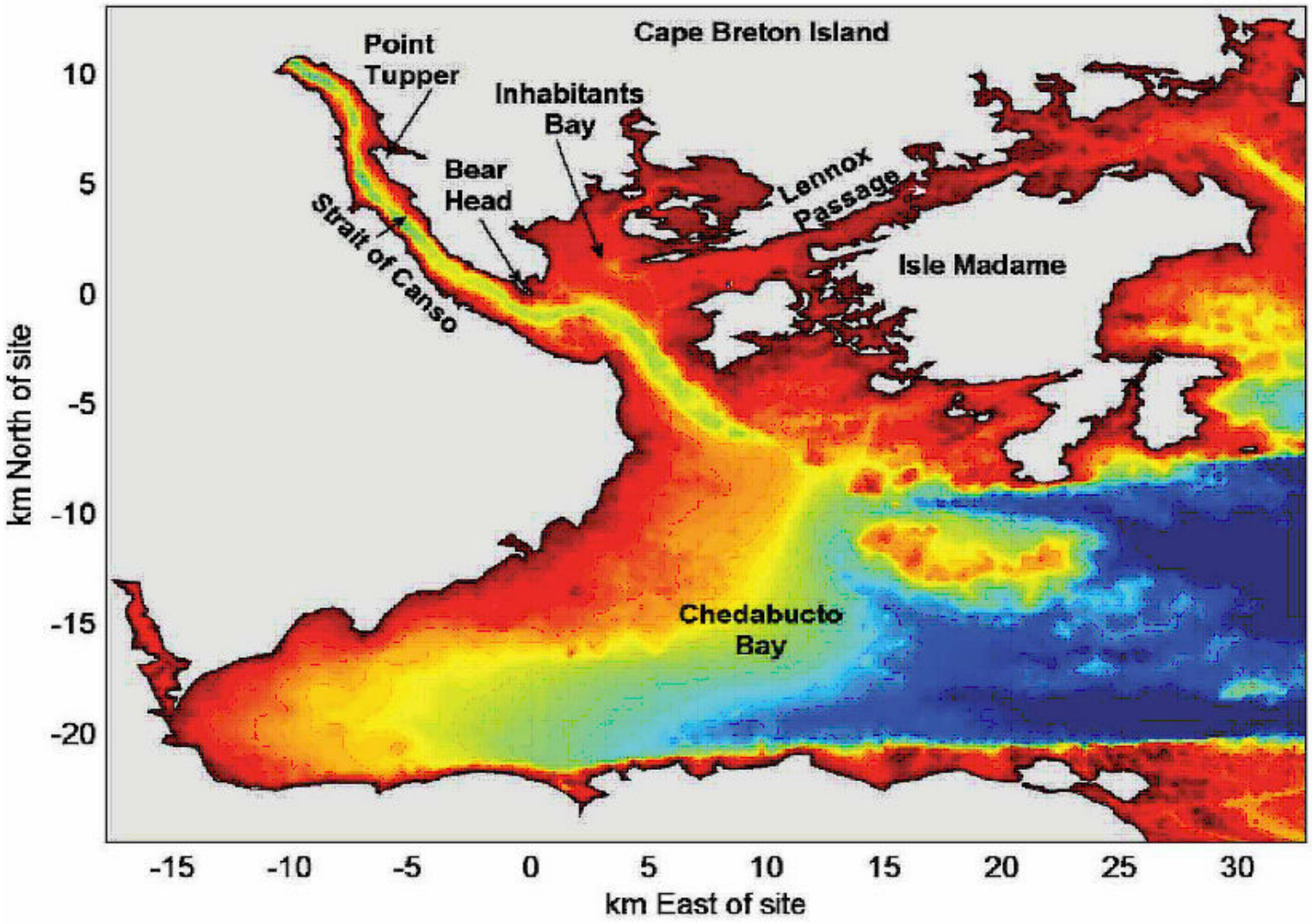

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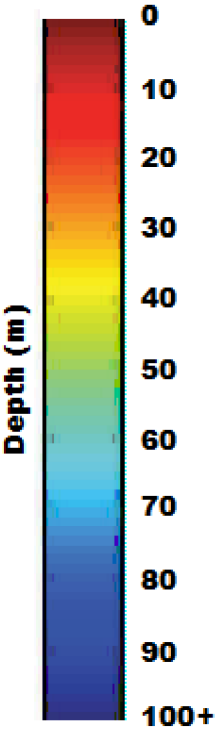
Figure 4-6

Bathymetry and Coastal Features of the Study Area (JWEL 2004a)



Project Numer: 622560
Date: April 1, 2015

Data Source:
-ANEI Bear Head LNG Terminal Environmental Assessment 2004 (Jacques Whitford)

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Sea Level Rise

Mean or relative sea level is not static; it changes with time as a result of factors related to volume of seawater in the ocean, melting of ice caps and sheets, and properties of the earth's crust. In Atlantic Canada in particular, rebound from presence of continental ice sheets during the last glaciation also affects the relative rate of sea level rise in parts of the region. Sea level has been rising in recent times (i.e., within the last 2,500 yrs) at between 25 and 30 cm per century (Shaw et al 1998; Scott et al 1981). This will result in an estimated maximum increase of approximately 0.8 m globally in the next century and over 1 m along the East Coast of Nova Scotia, from Halifax to North Sydney (Zhai et al 2014). For the probable 30-year design life of the Bear Head LNG facility, the estimated sea level increase due to global warming will be approximately 0.4 m (CBCL, 2015).

4.2.8.4 Winds

Wind is the dominant factor influencing currents and marine operations in the study area, and because of the lack of ice cover in winter, wind is important year-round. Wind data is available from several observation stations such as Eddy Point and from regional wind and wave hindcast datasets, summarized in JWEL, 2004a and CBCL, 2015. More general wind and wave data is available from the Transportation Development Centre (TDC 1991). JWEL used the AES40 wind/wave hindcast dataset (AES Oceanweather 2001, AES 1999) with a grid point outside Chedabucto Bay (45.0 N; 60.83 W) and CBCL used the newer MSC50 dataset (Swail et al 2006), at a point in northern Chedabucto Bay (45.5N 61.1W) as well as the AES40 gridpoint in the Atlantic outside the Bay.

Winds at the site are typically strongest in winter, during the months of November through February, when they are predominantly from the north to northwest. They shift to the south to southwest in summer (Figures 4-7 to 4-11). Throughout the year, the most probable wind direction is southwest, while the strongest winds tend to be from the west and northwest (Figure 4-11). Wind tends to be tunneled by the Strait, leading to particularly high winds when the dominant direction is northwesterly (particularly strong) and southeasterly (Environment Canada, 1992). At Eddy Point, the strongest winds occur in winter, during the months of November through February; these are predominantly from the west and northwest, with speeds from 15 to 20 m/s observed more than 10% of the time. In summer, during the months of June, July and August, winds diminish, seldom exceeding 15 m/s, and predominantly from the southwest (nearly 40% of the time). Intermediate wind directions and speeds are observed in the spring and fall. At Port Hastings, located further from the site, high winds are particularly common from mid-December to mid-June, exceeding 9 m/s (18 kts) more than 5 % of the time (JWEL, 2004a).

A maximum windspeed of 25 m/s was observed at Statia Terminals (located about 3.5 km north of the terminal site) during the December 2005 – March 2016 current meter deployment (CBCL, 2015).

Maximum expected hourly windspeed at Port Hawkesbury, a nearby location which is representative of the terminal site, is 35.2 m/s with a 30-second gust speed of 46.6 m/s on a 100-year return period; and approximately 30 m/s (gust speed of 39.3 m/s) on a 10-year return period (CBCL, 2015: Appendix C).

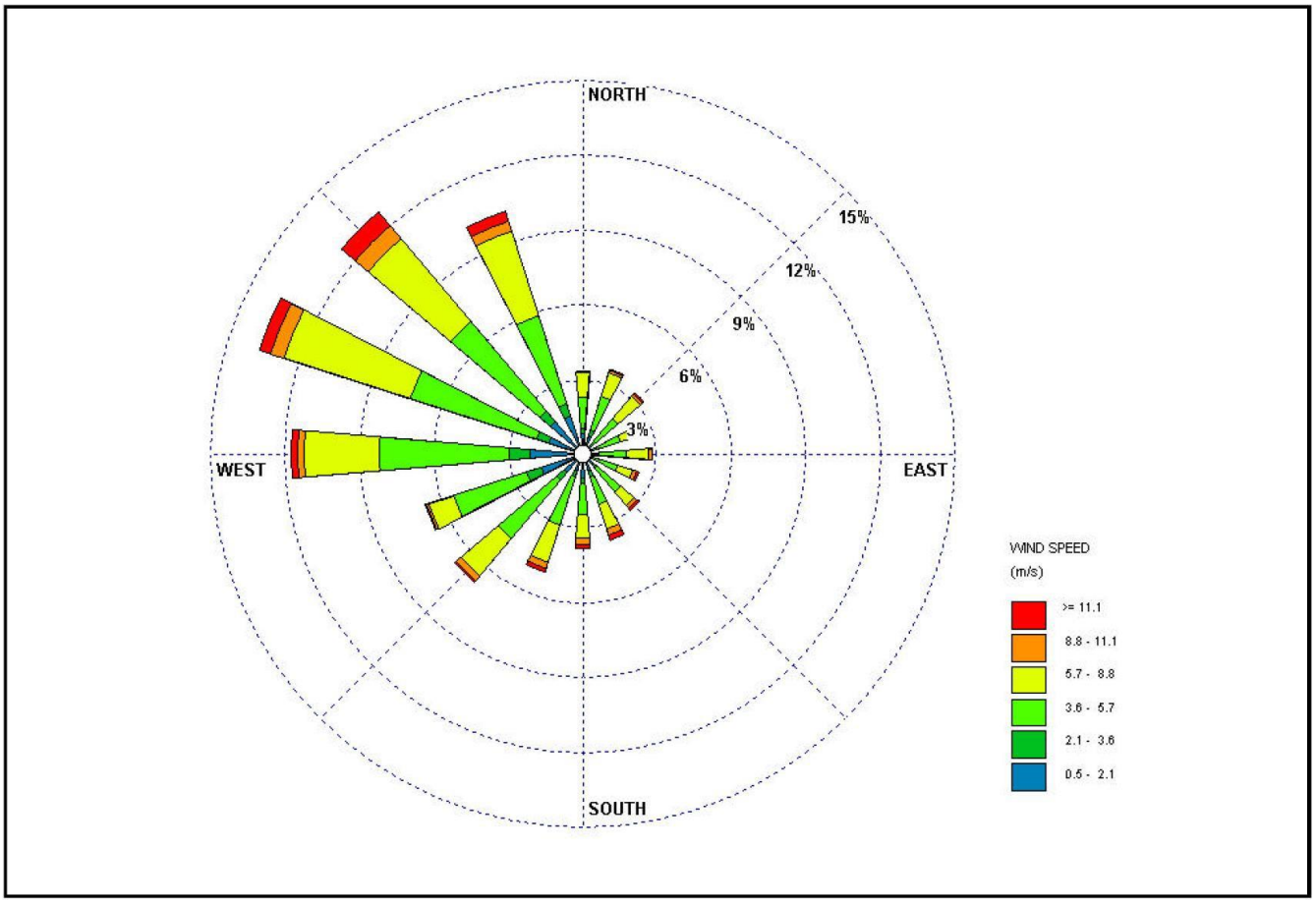

Figure 4-7: Winter wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL 2004a)

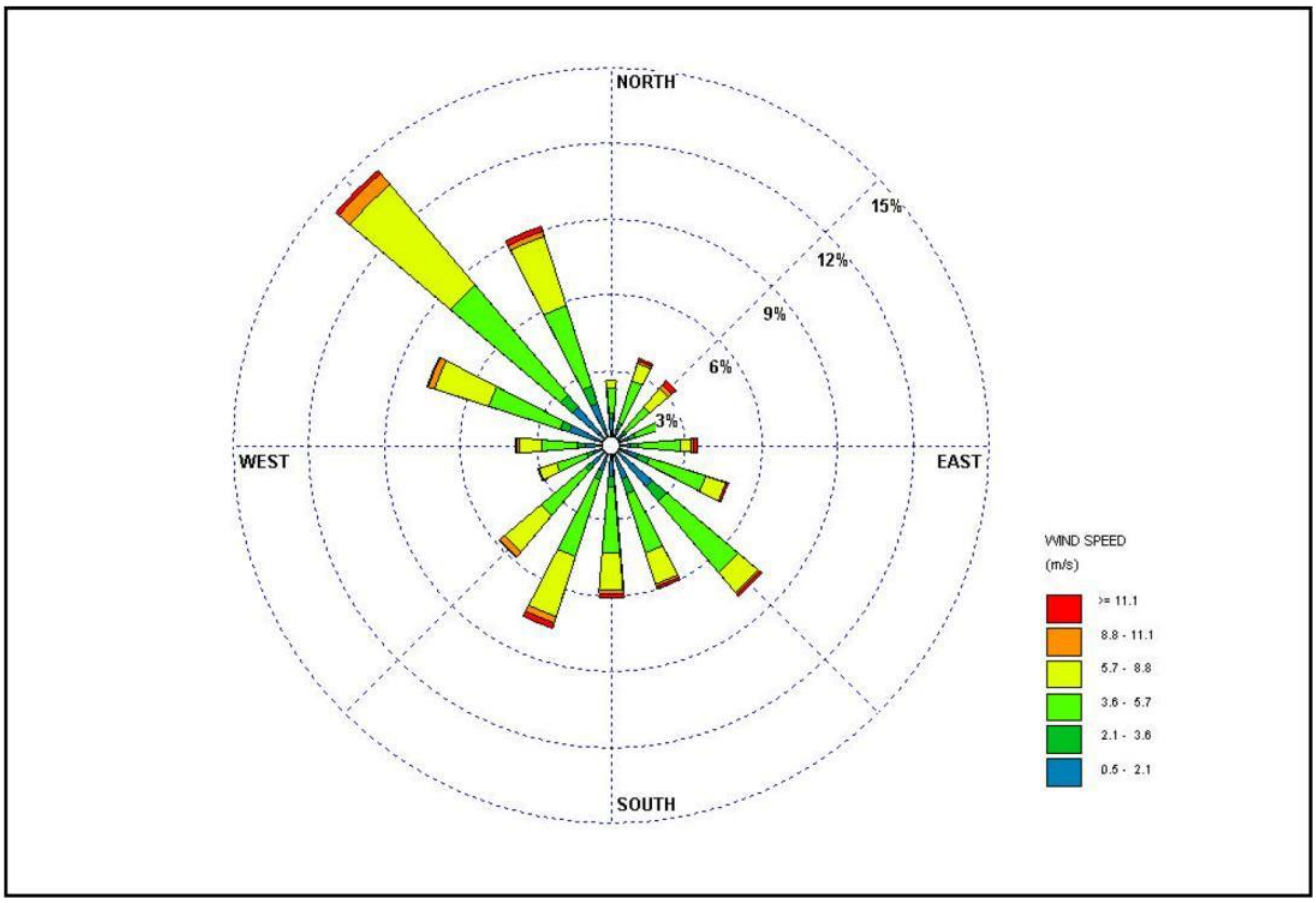

Figure 4-8: Spring wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a)

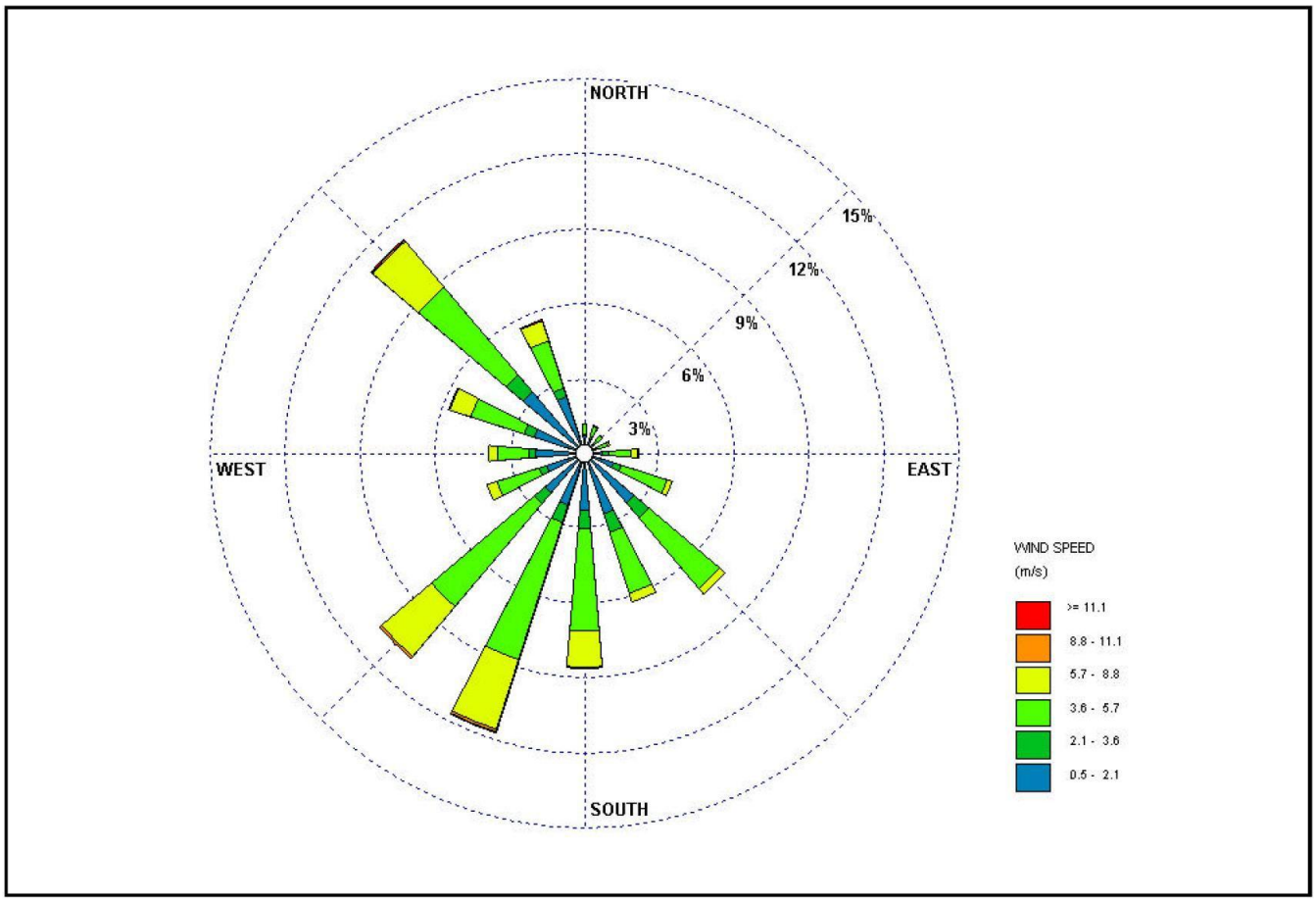

Figure 4-9: Summer wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a)

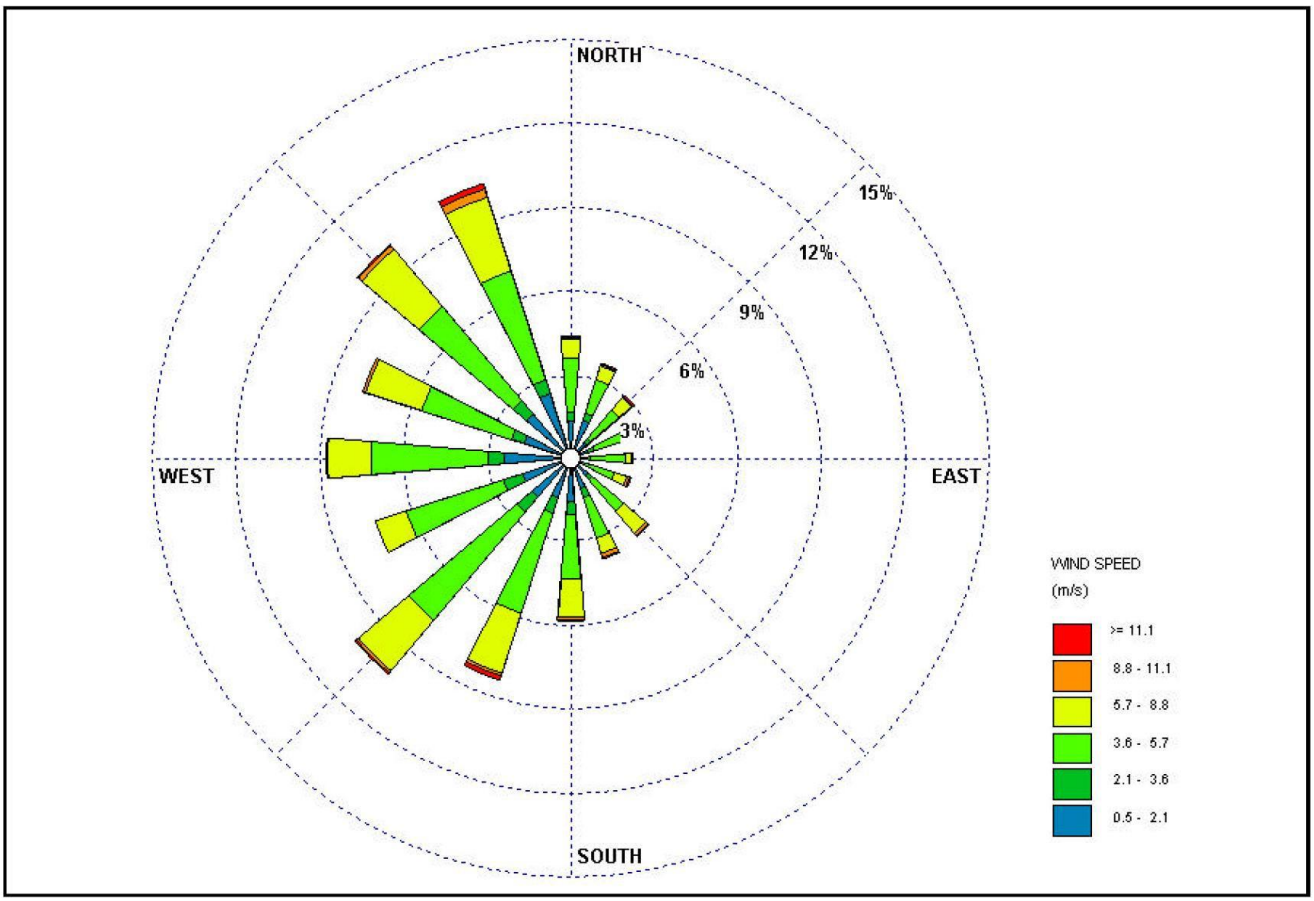

Figure 4-10: Summer wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a)

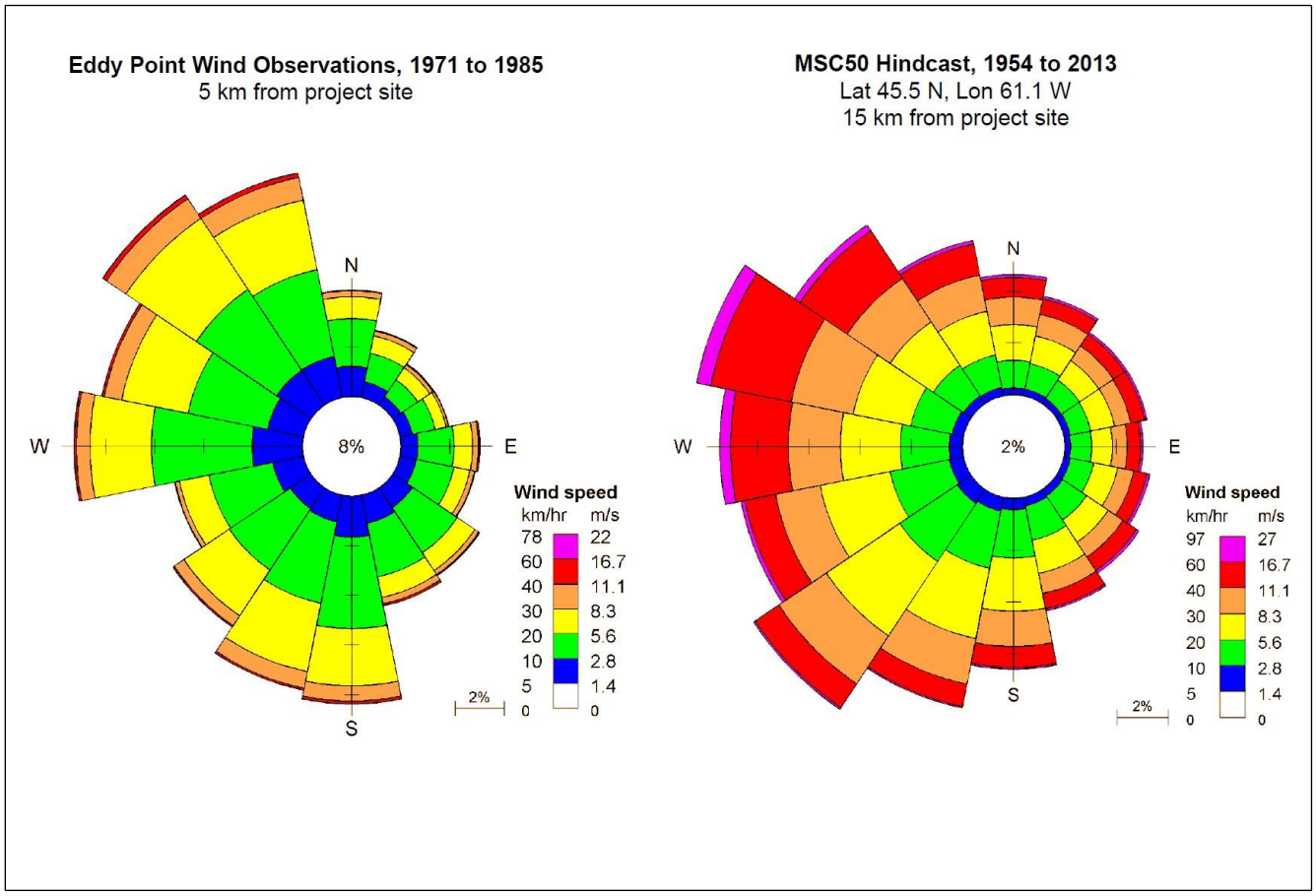

Figure 4-11: Annual wind rose (wind speed, direction, and frequency) from Eddy Point and the MSC50 wind & wave hindcast dataset (CBCL, 2015)

4.2.8.5 Waves

Wave climate in the study area (Chedabucto Bay and Canso Strait) includes an oceanic component generated outside of and strongly influencing Chedabucto Bay, and an inshore component generated locally and reflecting factors such as wind fields, depth and coastal configuration. The proposed terminal site is sheltered from much of the ocean wave activity and is exposed to winds and waves generated mainly from the southeast (CBCL 2015). Wave heights and their severity have been taken into account in the design of the marine facilities.

Extreme significant wave heights of 11.6 m off the mouth of Chedabucto Bay can occur on a 100-year return period (a 100-year return period represents the average time between exceedances of the stated value), but are typically between 8.7 and 9.4 m on a 5- and 10-year return period respectively (Table 4-10) (JWEL, 2004a). The highest significant wave heights are in the January-March period, ranging from 11 to 11.7 m on a 100-year return period (JWEL, 2004a), and are

lowest from June to August (Table 4-11). Wave height, probability and direction are presented in Figure 4-12.

Table 4-10: Yearly Extreme Hsig and Wind Speed, at AES40 grid point 5294 (Scotian Shelf, 45 N; 60 50' W)[2]

Return Period (years)	5	10	50	100
Hsig (m)	8.7	9.4	10.9	11.6
Wind speed, 1-hr average (m/s)	24.3	25.4	27.6	28.6

Table 4-11: Seasonal Extreme Hsig and Wind Speed – 3 Month Running Period Centered on Each Month, at AES40 grid point 5394 (Scotian Shelf, 45 N; 60 50' W)[2]

Return (Years)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
H_{sig} (m)												
5	8.1	8.2	8.2	7.4	6.3	4.9	4.6	5.1	6.1	6.9	7.5	7.7
10	8.8	8.9	9.0	8.1	6.9	5.5	5.1	5.7	6.8	7.7	8.2	8.3
50	10.4	10.4	10.9	9.7	8.4	6.8	6.3	7.0	8.3	9.3	9.6	9.5
100	11.0	11.0	11.7	10.4	9.0	7.3	6.9	7.5	8.9	10.0	10.1	10.0
Wind Speed - 1 hr average (m/s)												
5	23.3	23.3	23.1	21.9	20.0	17.5	16.7	18.1	20.7	22.3	23.1	23.1
10	24.3	24.3	24.6	23.1	21.3	18.7	18.0	19.4	22.2	23.8	24.2	24.0
50	26.3	26.6	28.0	25.9	24.2	21.6	20.9	22.4	25.4	27.1	26.8	26.0
100	27.2	27.6	29.5	27.0	25.4	22.8	22.1	23.7	26.8	28.5	27.9	26.9

The Bear Head LNG terminal site is sheltered from much of the ocean wave activity, but exposed to wind sand waves generated from the southeast (the longest fetch direction being 5.5 km) and along the Strait from the northwest (CBCL 2015). Local waves are significantly smaller than those at the entrance to Chedabucto Bay; the latter can be 7m high, but are reduced to 1 m or less at the site (JWEL, 2004a). Locally generated waves, such as caused by a 25 m persistent wind blowing from the southeast through the Bay generate a maximum significant wave height slightly above 1 m (JWEL, 2004a); (CBCL 2015) (Figure 4-13 and Table 4-12). Significant wave height H_{sig} measured at the site from mid-December 2005 to mid- March 2006 confirmed wave heights of less than 1 m (0.87 m) during a significant storm with windspeeds of 25 m/s; the highest waves were typically of short duration (i.e., < 4 seconds) (CBCL, 2015).

[2] Source JWEL, 2004a

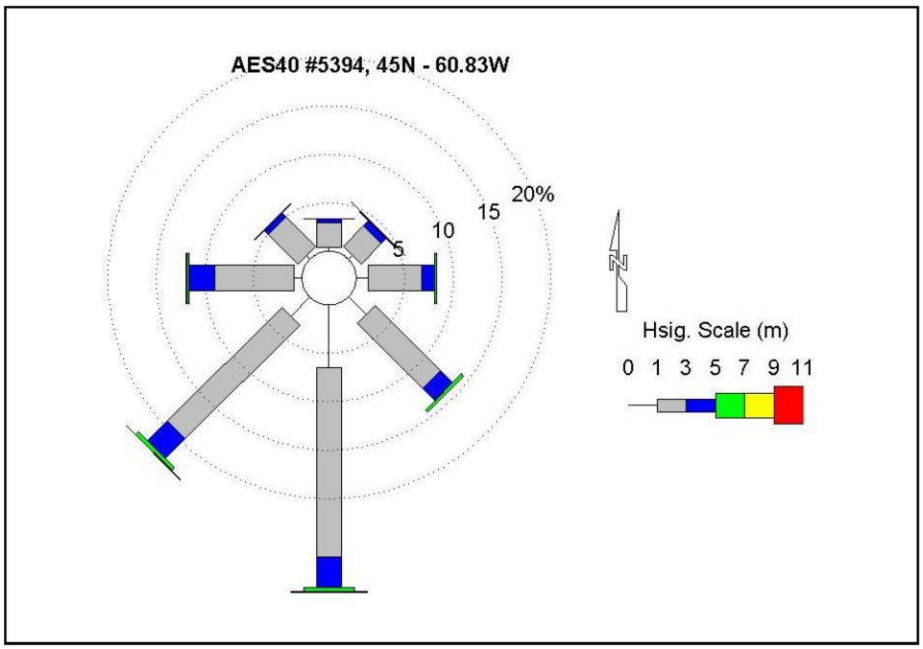

Figure 4-12: Annual significant wave height probability and direction, AES40 grid point 5394 (Scotian Shelf, 45 N; 60 50' W) (Source: JWEL, 2004a)

Table 4-12: Extreme wave and wind statistics for Bear Head LNG Terminal Site[3]

Objective	Wind Speed [m/s]	H_{sig} [m]	Period [s]
Mooring design	23.3	1.1	3.9
Marine structure design			
10-year return	29.7	1.6	4.4
50-year return	33.8	1.9	4.7
100-year return	35.2	2.1	4.8

4.2.8.6 Ice Cover

The Strait of Canso and Chedabucto Bay are ice free in winter (O'Neill, 1977); ice does not therefore interfere with typical wave and current patterns and mixing. Some ice, however, will form in coastal areas and among islands along the coast and occur as drift in the Bay.

[3] Source: CBCL, 2015

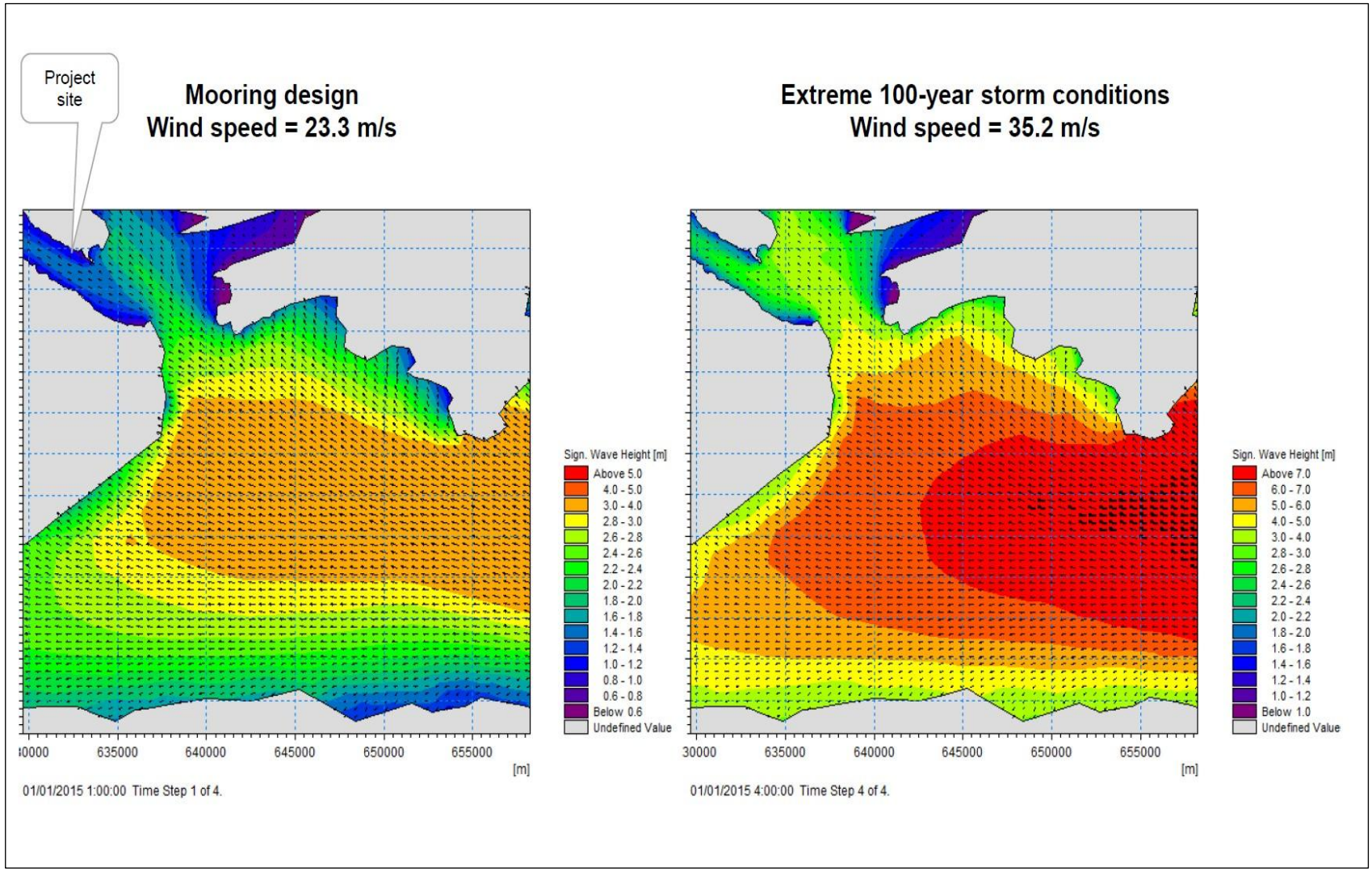

Figure 4-13: Sample modelled extreme waves (significant wave height) for Chedabucto Bay and terminal location based on MSC50 dataset and MIKE21 model calibrated with current meter observations from the terminal site (Source: CBCL 2015)

4.3 Ecological Environment: Terrestrial

4.3.1 Habitat and Vegetation

The greater landscape surrounding Point Tupper is primarily forested, typical of what is found throughout the eastern portions of Cape Breton Island. The landscape is dominated by a matrix of coniferous and mixed forest, with patchy deciduous forest interspersed throughout. Due in part to the long history of industrial forestry and heavy industrial development in the area, the majority of forests in the area are dominated by early seral pioneer species. Little in the way of climax or old-growth forest exists south of Highway 104. Much of the area is poorly drained and is typically colonized by climax species including black spruce, red maple and tamarack. Mesic or dry sites tend to support mixed forest communities composed primarily of black spruce, white pine, red maple, eastern hemlock, trembling aspen, balsam fir and yellow birch. The coastal influence on vegetation can be clearly seen, with salt tolerant conifers, such as white and black spruce, dominating the shoreline.

Much of the site was cleared to accommodate the roads and foundation infrastructure for the proposed LNG import facility. The balance of the site, approximately 50% of the total area, is comprised of undisturbed features such as mixed forest, wetlands, abandoned farmland, streams and marine coastline. Wetlands are common around the margin of the site; these include various habitats including basin bog, sloped fen, and treed and riparian swamps which contain various coniferous and mixed wood trees and several wildlife species.

4.3.1.1 Wetlands

The Project site includes all or part of six wetlands identified in baseline studies for the earlier environmental assessment (JWEL, 2004a) and a later survey (JWEL 2005). These conditions were confirmed in May 2014. Table 4-13 indicates the plant and animal species noted in the 2004 surveys; Table 4-14 provides observations compiled as a result of the surveys conducted in May 2014.

Small parts of two wetlands, and a third small wetland in its entirety, were infilled to construct the base pad for the project, with all alterations authorized and compensated under NSE *Environment Act* water approval 2004-043228. No further alteration to wetlands is anticipated, and the necessary site drainage and erosion and sediment control measures will be maintained to ensure the protection of the remaining wetlands on site.

Table 4-13: Species Identified in Wetlands through Field Survey in 2004 (JWEL, 2004a)

Species	Wetland 1	Wetland 2	Wetland 3	Wetland 4	Wetland 5
Vegetation	Tamarack Black spruce Red maple- Huckleberry Witherod Winterberry Red chokeberry Speckled alder Blackberry Sphagnum moss Burreed Narrow leaved sundew Beakrush Swamp candles Sedges Blue-joint Stunted red maple Winterberry	Speckled alder Winterberry Huckleberry Lambkill Witherod Red maple Black spruce Sphagnum moss Sedge Bog fern Cinnamon fern St. John's wort Mountain white burch Tamarack Bog aster	Tamarack Black Spruce Lambkill Witherod False holly Huckleberry Stunted black spruce Sphagnum moss Bog fern Sedge Red maple Bayberry Beak-rush Small cranberry Cotton-grass Bog aster Southern Twayblade	Stunted black spruce Tamarack Huckleberry False holly Labrador Tea Witherod Sphagnum moss Beak-rush Small cranberry Three-leaved false Solomon's-seal Northern Comandra	Black spruce Tamarack Red maple Huckleberry Winterberry Sphagnum moss Cinnamon fern New York fern Bunchberry Cotton-grass
Birds	American Goldfinch White-throated Sparrow Northern Junco Common Yellowthroat Black-capped Chickadee American Robin Yellow-rumped Warbler Nashville Warbler Yellow-bellied Flycatcher Magnolia Warbler Swamp Sparrow Purple Finch Gold-crowned Kinglet Blue Jay	White-throated Sparrow Common Yellowthroat Black-and-white Warbler Nashville Warbler Olive-sided Flycatcher Blue-headed Vireo Swamp Sparrow Hermit Thrush	Nashville Warbler Common Yellowthroat Swamp Sparrow Northern Flicker	White-throated Sparrow Common Yellowthroat Black-and-white Warbler Hermit Thrush	None detected during field studies
Herpetiles	Green Frog Leopard Frog Pickerel Frog Northern Spring Peeper	Green Frog Adult Pickerel Frog Yellow-spotted Salamander	None detected during field studies	Maritime garter snake Eastern smooth green snake	None detected during field studies
Mammals	None detected during field studies	Hare(Various) White-tailed Deer	None detected during field studies	None detected during field studies	None detected during field studies

Table 4-14: Present Status of Wetlands through Field Survey in May 2014.

Wetland	Observations
Wetland 1	Overall the characteristics of Wetland 1 remained relatively unchanged. Flow into the wetland is managed through several ditch systems and a settling pond. The area which was a slope fen grading into a mixed-wood treed spring swamp, as identified in the 2004 field study, now has a greater proportion of alders and cattails on the western side. No failures, slumping or erosion of the finished site into the wetland area was noted.
Wetland 2	Wetland 2 receives surface water runoff from the northwest drainage ditch and a mediated flow through erosion protection measures including a rock lined ditch, berm and a grassed buffer. There did not appear to be any failures in the erosion protection at Wetland 2 and there was a gradual transition from the developed area to the wetland. The stream which flows through Wetland 2 appeared to be in its natural state.
Wetlands 3 & 4	Wetlands 3 and 4 remained as small swampy areas which included the presence of sphagnum moss tussocks. Wetland 3 is influenced by the stream running through the eastern side which is also the location of Southern Twayblade. It was too early in the season to locate the plants but the habitat appeared to be in a natural state. A buffer zone of forest between the project footprint and the wetland is still intact and there were remnants of snow fencing which marked the general location of the Southern Twayblade.
Wetland 6	Wetland 6 is a treed basin bog and treed sphagnum swamp and habitat appeared suitable for Southern Twayblade, although none were found at the time of the survey. The drainage ditch on the northern boundary is blocked at the end where it meets the wetland, to prevent direct flow of water into the wetland.

The wetlands remaining are shown on Figure 4-14. Wetland 1 is a 1.7 ha combination of slope fen, mixed-wood treed spring swamp and coniferous treed basin bog located entirely within the property boundary on the eastern portion of the site. The wetland is the origin of a stream that exits the southeast part of the site and flows to Bear Island Cove. The water supply for the wetland includes groundwater and runoff from the eastern part of the site, most of which flows through a detention/settling pond before entering the wetland. No rare vascular plants were found in the wetland in the baseline surveys (JWEL, 2004a).

Wetland 2 is a combination of mixed-wood treed stream swamp, coniferous treed stream swamp, and tall shrub-dominated stream swamp on the northwest side of the Project site. This swamp was partly infilled during construction of the base pad, alterations were made and compensation carried out under the NSE approval. No rare vascular plants had been found in the part that was modified (JWEL, 2004a). The remaining and largest portion of this wetland extends west of the base pad. It receives groundwater flow, spillover from the western stream which passes through it, and surface water from ditches on the northeast and northwest sides of the base pad.

Wetland 3 is small (0.1 ha) and consists of a coniferous treed swamp and coniferous treed basin bog. It is located along the western stream near the west side of the base pad (JWEL, 2004a). A population of Southern Twayblade (*Listera australis)* was found near the eastern margin of this wetland within the coniferous treed stream swamp plant community. The Southern Twayblade is an endangered species, currently orange-listed in Nova Scotia and Canada as "*May be at Risk"*. Unofficially, because of more widespread occurrence of *Listera* in Nova Scotia, the species is considered to be less of a concern since it has been found widely in similar types of habitats in Nova Scotia and New Brunswick (S. Blaney, ACCDC, Pers. Comm. 2013). There does not appear to be a threat to the survival of Southern

Twayblade at the site as a buffer zone has been established separating the plant location from the developed area.

Wetland 4 is a small (0.2 ha) coniferous treed basin bog located immediately southwest of Wetland 3 within the property boundary (JWEL 2004a & 2005). The eastern edge of the wetland and the area between it and the western stream, supports a population of Northern Comandra (*Geocaulon lividum*), a rare yellow-listed species (*sensitive to human activities or natural events*). There does not appear to be a threat to the survival of Northern Comandra at the site as a buffer zone has been established separating the plant location from the developed area.

Wetland 6 is a combined treed basin bog and treed sphagnum swamp wetland (0.7 ha) that extends west from the northwest corner of the property. The primary water source of the wetland is precipitation, but some runoff enters the area at the margin and from the main drainage ditch which runs along the northern boundary of the site. The eastern end of the wetland supports a separate population of Southern Twayblade (JWEL, 2007). No alteration to this wetland is anticipated based on the current project plan.

The site also had a coniferous treed slope bog, approximately 0.1 ha in area, located in the southeast corner of the proposed base pad. This wetland was formerly known as wetland 5, and was completely infilled and compensated with the authorization from NSE (2004-043228).

4.3.2 Fauna and Flora

4.3.2.1 Freshwater Fish and Fish Habitat

Two streams in the vicinity of the onshore facilities were surveyed for the presence and quality of fish habitat in 2003 prior to construction (JWEL, 2004a). Both streams were determined not to contain fish habitat (JWEL, 2004a) based on field measurements which showed low pH; an electroseining survey which did not find fish; and an assessment of downstream fish access. Construction at the site in the early stages of the project subsequently modified the upper watershed of the most easterly stream to contain a system of settling ponds; the latter serve to protect a wetland at the head of the stream. Some other site drainage was diverted into this drainage system.

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Figure 4-14
Wetlands and Sensitive Terrestrial Species

Protected Plants

- Geocaulon lividum
- Listera australis

- Bear Head LNG Site Features
- Cart Track
- Elevation
- Roads
- Waterbodies
- Wetlands

N
W E
S

0 100 200 300 400

Metres

Note: Authorized alteration and compensation of former Wetland 5 was completed under NSE Approval (2004-043228)

Map Parameters
Projection: Universal Transverse Mercator (UTM)
Datum: NAD83
Zone: 20
Scale: 1:7,000
Project Numer: 622560
Date: April 1, 2015

Data Source:
-Canvec (2013) Digital National Topographic System (NTS) topographic dataset for Port Hawkesbury (011F11)
-ANEI Bear Head LNG Terminal Environmental Assessment 2004 (Jacques Whitford)
-Site Preparation As-builts, J & T Van Zutphen for Bear Head LNG Corp., April 7, 2006, PN 6143
-Plot Plan, LNG International Limited, March 5, 2015, BH-DG-00-002 Rev C1

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In December 2014 conditions along the west stream (Stream A, Figure 4-15) did not appear to have changed from the initial survey. It is a small intermittent stream which flows adjacent to the project footprint and exits the property, terminating in a settling pond operated by NSPI a few hundred meters to the west. The water level management structure on the pond is a barrier to fish (JWEL, 2004a) and a rock outcrop in a lower section may impede fish when water levels are low or conditions are dry (JWEL, 2004a). Presently the stream exiting the site on the east (Stream B, Figure 4-16) is likely to contain fish habitat; the stream flows from a marsh and black spruce swamp, through a culvert under Bear Island Road, prior to discharging downstream near the coastline into Bear Island Cove. No obstructions to fish passage occur in the downstream stretches. Fish were not observed in either stream during the 2003 baseline survey (JWEL, 2004a), but unidentified fish were observed immediately below the culvert in the downstream section of Stream B during a field survey in May 2014.

Field water quality measurements and chemical analyses of samples taken in December 2014 indicated that water leaving the site in both Stream A and B was acceptable to maintain fish and other aquatic life according to CCME FWAL Guidelines.

Figure 4-15: Stream A west of the project footprint, December 22, 2014

Figure 4-16: Stream B east of the project footprint, May 8, 2014.

The downstream portions of streams A and B could potentially include fish species common to small streams and ponds such as, Speckled (Brook) Trout, Rainbow Smelt, Gaspereau and small minnow or forage species such as Banded Killifish and several stickleback species as well as the threatened American Eel (Canadian Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed) and the federally endangered Atlantic Salmon. The latter migrate through coastal waters to rivers in the area; both the Salmon River and the Inhabitants River, which flow into Chedabucto Bay, are major salmon rivers although populations have declined in recent years (Stewart and White, 2001).

Other species that could occur in the estuarine and marine waters of Bear Island Cove, the Strait of Canso and Chedabucto Bay waters include: Rainbow Trout, Brown Trout, groundfish (cod, flounder), pelagics (mackerel & herring), eels, smelts and shellfish (oyster, lobster, mussels, quahogs, sea scallops and softshell clams). Some of these species, such as the lobster, are commercially farmed in aquaculture sites in the waters of the Strait of Canso, Chedabucto Bay, Arichat Harbour and Cape Auget Bay; there are three finfish and two shellfish aquaculture sites in these areas.

4.3.3 Mammals

Table 4-15 is a record of mammals recorded on the site during earlier field studies (JWEL, 2004a) or that have been recorded in nearby areas during other field studies.

White-tailed Deer and Moose sign were observed near the Bear Head site during field studies; however no wintering areas were identified at the site or in the adjacent area (JWEL, 2004a). Both deer and moose rely on wintering areas during colder months when snowfall is excessive. The moose is the only mammal on the Nova Scotia *Endangered Species Act* that is considered endangered, but this classification only applies to the population on mainland Nova Scotia. The moose population on Cape

Breton Island is abundant and not considered a constraint to development.

Seven bat species occur in Nova Scotia – Hoary Bat (*Lasiurus cinereus*), Silver-haired Bat (*Lasionycteris noctivagans*), Eastern Red Bat (*Lasiurus borealis*), Big Brown Bats (*Eptesicus fuscus*), Eastern Pipistrelles (*Perimyotis subflavus*), Northern Long-eared (*Myotis septentrionalis*) and Little Brown Bat (*Myotis lucifugus*). Northern Long-eared, Little Brown Bat (both most common) and Eastern Pipistrelle are the only ones with significant populations in Nova Scotia, and all three are considered endangered, currently provincially listed as Species at Risk under the Nova Scotia *Endangered Species Act*, as the result of the White-Nose Syndrome fungus disease. The Eastern Pipistrelle is locally abundant only in the southwest of the province (CBCL, 2008). These species likely can occur and pass through the area from time to time, particular in spring and fall during movements from overwintering sites, although their presence is unlikely currently due to the low population levels. All three species need caves, tree cavities or buildings to roost and hibernate, none of which are abundantly available at the site. There are no database records of any of the three species within 5 km of the site and only the Little Brown Bat has been recorded within 100 km of the study area (ACCDC, 2014). Bat populations in Cape Breton have not been affected to the same degree by White-Nose syndrome, a disease that has largely wiped them out elsewhere in the province. Cape Breton thus represents a refugium for reestablishment and thus populations here have elevated conservation significance.

Table 4-15: Mammals Recorded at or near Bear Head site (JWEL, 2004a)

Binomial	Common Name
Lepus americanus	Snowshoe hare
Tamias striatus	Eastern Chipmunk
Tamiasciurus hudsonicus	American red squirrel
Castor canadensis	Beaver
Peromyscus maniculatus	Deer mouse
Clethrionomys gapperi	Gapper's red-backed vole
Napaepzapus insignis	Woodland jumping mouse
Zapus hudsonicus	Meadow jumping mouse
Ondatra zibethica	Muskrat
Mircotus pennsylvanicus	Meadow vole
Erithizon dorsatum	Porcupine
Vulpes vulpes	Red fox
Canis latrans	Coyote
Ursus americanus	American black bear
Procyon lotor	Racoon

Binomial	Common Name
Odocoileus virginianus	White-tailed deer
Alces alces	Moose

4.3.4 Reptiles and Amphibians

The forest, wetland and surface water environments surrounding the site are expected to support many of the common reptile and amphibian species found in Nova Scotia. As the base pad for the project is already in place, habitats and associated reptile and amphibian species will be only marginally impacted. Eleven species of reptiles and amphibian were found at the site prior to development, and sixteen species were identified with potential to occur in southwestern Cape Breton (Table 4-16).

Table 4-16: Reptiles and Amphibians Found at Bear Head site (JWEL, 2004a)

Species	Common Name	Bear Head Site	Southwestern Cape Breton
Plethondon cinereus	Red-backed Salamander	✓	✓
Hemidactylum scutatum	Four-toed Salamander		✓
Ambystoma maculatum	Yellow-spotted Salamander	✓	✓
Ambystoma laterale	Blue-spotted Salamander		✓
Notophthalmus viridescens	Red-spotted Newt		✓
Bufo americanus	American Toad		✓
Pseudacris crucifer crucifer	Northern Spring Peeper	✓	✓
Rana clamitans melanota	Green Frog	✓	✓
Rana sylvatica	Wood Frog	✓	✓
Rana pipiens	Northern Leopard Frog	✓	✓
Rana palustris	Pickerel Frog	✓	✓
Rana septentrionalis	Mink frog		✓
Clemmys insculpta	Wood Turtle		✓[1]
Storeria occipitomaculata	Northern Redbelly Snake	✓	✓
Thamnophis sirtalis	Maritime Garter Snake	✓	✓
Liochlorophis vernalis	Eastern Smooth Green	✓	✓

1. The wood turtle was not detected in the study area during the field studies in 2004, but according to the ACCDC it is "known within 5 km of the study area"

Of the species potentially occurring, the only species of conservation concern with potential to occur at the site is the Four-toed Salamander. The species is provincially yellow-listed (sensitive to human activities); however, since its listing, it has been found more frequently and its distribution is known to be more widespread than indicated by existing records. The species was not found in surveys at the site, but suboptimal habitat was found in the eastern wetland during baseline surveys, and it is likely that it is present within the general study area (JWEL, 2004a). The species nests in dense sphagnum tussocks in saturated Sphagnum near pools or streams.

4.3.5 Birds

4.3.5.1 Breeding Birds

The Project site and surrounding area includes habitats for many different species and types of birds including inland forests; marine coasts and marine coastal waters; islands; and lakes, streams and wetlands. Birds frequenting these habitats may be seen in the vicinity of the Project site. During migrations, many different bird species move through the area and may occur at the site.

Given the site location, a point of land at the junction of the Strait of Canso, Inhabitants Bay and Chedabucto Bay, it is likely to be comparatively more important as a route for migratory movements for songbirds and other species, than areas situated further inland. It has been suggested that during songbird migrations, the Bear Head area may be a 'migration trap' for staging birds about to cross the Strait of Canso to mainland Nova Scotia (Point Tupper Wind Farm EA 2010; J. Kearney, John Kearny and Associates, personal communication 2015). This has, at least in part been countered by the monitoring that has taken place at the Point Tupper Wind Farm[4]. Coastal headlands such as Bear Head can also be major points of concentration for disoriented, off-course, or re-orienting migrants. Bear Head, the approaches to the Strait of Canso through Chedabucto Bay and the area adjacent the causeway are important for stopovers and coastal aggregations of water-associated birds during migration.

Information on the distribution and abundance of birds in the vicinity of the Bear Head LNG export facility has been obtained mainly through general knowledge of the project team and published sources including the Maritime Breeding Birds Atlas (MBBA) database (MBBA, 2013); a review of the ACCDC database (ACCDC, 2014) and site surveys completed for the previous environmental assessment (JWEL, 2004a). At that time the occurrence of birds could be inferred based on the dominant habitat types at, and in the vicinity of, the Project site. The communities in these areas are expected to be similar to those described in 2004 (JWEL, 2004a) as the dominant upland vegetation surrounding the site has not

[4] As a condition of release from the environmental assessment process, three years of carcus monitoring was undertaken at the Point Tupper Wind Farm. No substantive bird or bat kills were recorded. The proponent confirms that there have been no significant kills since monitoring ceased. (Peter Archibald, RESL, Personal Communication 2015)

changed from 2004 to 2014. The MBBA data (Table 1, Appendix D) which presents bird species recorded within the atlas square with potential to breed in the vicinity of the project site based on presence of suitable habitat, gives a good indication of the variety of bird species likely to occur and breed in suitable habitat in the area. The MBBA records show 124 species in the 10 km x 10 km atlas square, of which 101 are either confirmed or probable breeders in the area, and 23 are possible breeders in the area (MBBA 2013). Species recorded in the various habitats present in the study areas in 2004 are presented in Tables 2 and 3 in Appendix D which presents the list of birds recorded in the study area during the field surveys along with their breeding status and overall abundance.

Various raptor species occur in the general vicinity of the Bear Head LNG facility based both on breeding surveys (MBBA 2013) and observations made during site surveys (JWEL, 2004a); these include: Bald Eagle, Osprey, Broad-winged Hawk, Northern Harrier, Northern Goshawk, Sharp-shinned Hawk, American Kestrel, Red-tailed Hawk, Barred Owl, Great Horned Owl, and Northern Saw-whet Owl. During a site visit on December 22, 2014, a potential Osprey nest was observed on a power pole in the southwestern portion of the site. If it is determined that this nest may be disturbed, it will be relocated by a qualified individual. General nesting on the developed portions of the site for these species is not expected; the adjacent forested areas are predominantly second-growth forests and unlikely to contain prime nesting habitat.

4.3.5.2 Rare and Sensitive Birds

Of the birds identified that might breed in the vicinity of the site (MBBA 2013), six (6) species are considered to be rare or sensitive to anthropogenic activities. Four (4) of the species are listed as either endangered or threatened. These are the Barn Swallow, Canada Warbler, Common Nighthawk and Olive-sided Flycatcher. The common Loon and Common Tern are also both sensitive to anthropogenic activities. The Black-backed Woodpecker and Boreal Chickadee, both considered to be uncommon in Nova Scotia, were recorded in the atlas square (MBBA 2013); the Rusty Blackbird was reported in the area in the earlier (1992-2002) MBBA census. The Nova Scotia populations of all of these species are considered to be secure.

As of 2013, Barn Swallows are considered endangered under the NS *Endangered Species Act,* and the provincial general status ranking is "At Risk". The species typically nests in artificial structures such as barns and bridges (NSDNR, 2013), and there are no buildings or other structures at the terminal site in which they could nest. None were seen during the field studies undertaken in 2004, and it is unlikely they will occur at the site.

As of 2013, the Canada Warbler is considered endangered under the NS *Endangered Species Act*, and the provincial general status ranking is "At Risk". Warblers utilize wetlands, swamps, bogs and fens in forest habitats for nesting (NSDNR, 2013); suitable nesting habitat does occur in the surroundings of the site (based on surveys in 2004, JWEL).

As of 2007, the Common Nighthawk is considered threatened under the NS *Endangered Species Act,* and the provincial general status ranking is "At Risk". The Common Nighthawk's habitat varies and can include open areas with little ground cover, such as sand dunes, beaches, logged or burned-over areas, forest clearings, rocky outcrops, rock barrens, peat bogs and pastures (SAR Guide, 2008). The species wasn't observed during any of the field studies in 2004, although suitable habitat does exist along roads and excavations within the present footprint of the site. Exposed gravel and grassed areas in the footprint of the plant site could be used by Common Nighthawk for nesting.

As of 2013, the Olive-sided Flycatcher is considered threatened under the NS *Endangered Species Act,* and the provincial general status ranking is "At Risk". The species has a preference for coniferous forest edges, including forest margins along meadows, rivers, bogs, swamps and ponds as such areas provide breeding habitat. Individuals were observed at the site during field surveys in 2004 (JWEL, 2004a), and there are records of the species from 2.5 to 3 km from the site. Treed wetlands and the forested areas adjacent to the Bear Head facility site provide suitable nesting habitat for the species.

Common Loons are relatively abundant in Nova Scotia, but are sensitive to human activities, particularly around their breeding sites. They are likely only to be seen in flight over the site in transit from large inland, open water bodies used as breeding sites, such as Landrie Lake, or en route between coastal waters in the area. Typically they will be found in the Strait of Canso in most seasons, but in particular during spring and fall migrations, often in large groups. Loons were only occasionally seen during the surveys conducted at the Bear Head facility site (JWEL, 2004a).

Common Terns occupy coastal waters and occasionally forage in inland areas, nesting on coastal islands, sand spits, beaches and occasionally in salt marshes. They are considered sensitive as they can be affected by disturbance at their nesting colonies by predation by gulls on eggs and young, and through the loss of prime nesting sites to gulls. Common Terns do not extensively use the coastal waters adjacent to the Bear Head LNG site based on earlier surveys (JWEL, 2004a). Only marginal Common Tern breeding habitat occurs, and no tern nesting was observed; only occasional sightings were made during the summer field surveys (JWEL, 2004a). Conditions are unlikely to have changed significantly since the earlier surveys. Two (2) tern nesting colonies are known from the general area: one on Scanlan's Island located approximately 10 km northeast; and one on Long Pond on the Strait of Canso approximately 15 km northwest (JWEL, 2004a)(Figure 4-20).

4.3.6 Plants

The Bear Head LNG site was surveyed in 2003-2004 and in 2007 by botanists to determine plant communities, wetland distribution and occurrence of species at risk and prior to development of the base pad, roads and drainage management structures. A literature review and two field surveys in 2003-2004 determined that no rare lichen or bryophyte species had been recorded in the area. Seven (7) rare vascular species had been recorded in the general vicinity of the study area. Suitable habitat

was present for four (4) of these species: Blinks and Hooker's orchids, Yellow Lady's slipper and Northern Comandra (*Geocaulon lividum*); a fifth species of conservation concern, Southern Twayblade (*Listera australis*) was found. In addition to the rare species, the field surveys revealed the presence of 247 species, the majority typical of natural forested uplands and wetlands areas in the area. Only two, the Southern Twayblade (*Listera australis*) and Northern Comandra were rare or endangered (JWEL, 2004a). These two species occurred in wetlands near the west boundary of the site; site development was planned to avoid the plants and leave a buffer zone. For the Twayblade two populations occur: one containing 35 plants (situated in wetland 3, coniferous treed swamp, Figure 4-19), and another with over 100 plants (wetland 6, a treed basin bog and treed sphagnum swamp) (JWEL, 2004a; JWEL, 2007).

A population containing five (5) patches of Northern Comandra occurs in the same general area as the southern population of the Southern Twayblade, on the west side of the property. The status of Southern Twayblade has remained orange: 'May be at Risk'. Unofficially the species is considered to be less of a concern since it has been found widely in similar type of habitats in Nova Scotia and New Brunswick (Sean Blaney, ACCDC, personal communication, 2013). The Northern Comandra is yellow-listed 'Sensitive to Human Disturbance'. For both species, there does not appear to be a threat to survival at the site, as they are separated from the developed area by a forested buffer and a runoff and sedimentation management system.

4.3.7 Species at Risk (SAR)

4.3.7.1 Terrestrial SAR

Species of conservation concern in the general vicinity of Bear Head were determined through a search of the ACCDC database. This database records reliable occurrences of important species, and when combined with the availability of suitable habitat at the site, provides an indication of the potential for species of concern to occur. Two (2) plants and seven (7) animals of particular conservation concern have been found within 5 km of the Bear Head LNG site (Table 4-17)(ACCDC, 2014). All species identified by ACCDC (2014) of conservation concern or to be sensitive or at risk by the federal or the provincial governments are presented in the ACCDC report (Appendix E).

In addition to these species, six (6) avian species at risk, listed under the federal SARA, are found in nearshore areas of the Scotian Shelf. These include the endangered, Roseate Tern (*Sterna dougallii*) and Piping Plover (*Charadrius melodus melodus);* as well as four (4) Species of Special Concern: "Ipswich" Sparrow (*Passerculus sandwichensis princeps*), Harlequin Duck (*Histrionicus histrionicus*), Barrow's Goldeneye (*Bucephala islandica*) and Ivory Gull (*Pagophila eburnea*). None of the species breed in Chedabucto Bay, although all species, with the exception of the Ipswich Sparrow, may occur in the area from time to time.

Table 4-17: Terrestrial Rare Species List

Common Name	Binomial	COSEWIC	SARA	Provincial	Provincial General Status Ranking
FLORA					
Southern Twayblade	*Listeria Australis*	-	-	-	May Be At Risk (Orange Listed)
Northern Comandra	*Geocaulon Lividum*	-	-	-	Sensitive (Yellow Listed)
FAUNA					
Barn Swallow	*Hirundo Rustica*	Threatened	-	Endangered	At Risk (Red Listed)
Canada Warbler	*Wilsonia Canadensis*	Threatened	Threatened	Endangered	At Risk (Red Listed)
Common Nighthawk	*Chordeiles Minor*	Threatened	Threatened	Threatened	At Risk (Red Listed)
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	Threatened	At Risk (Red Listed)
Common Tern	*Sterna Hirundo*	Not at Risk	-	-	Sensitive (Yellow Listed)
Common Loon[1]	*Gavia Immer*	Not at Risk	-	-	May Be At Risk (Orange Listed)
Wood Turtle[2]	*Glyptemys Insclupta*	Threatened	Threatened	Threatened	Sensitive (Yellow Listed)

1. Common loon do not breed at the site but can be found passing through the property and forming groups in the Strait of Canso.
2. No suitable habitat for Wood Turtle is available at the site; the record of the species comes from the watershed of the Inhabitants River, located northeast of the site.

4.3.7.2 Marine SAR

A total of 22 fish species that occur over the Scotian Shelf are listed by COSEWIC including eight (8) species listed as endangered (Atlantic Whitefish, Atlantic salmon - Inner Bay of Fundy and Eastern Cape Breton populations, Cusk, Atlantic Bluefin Tuna, Roundnose Grenadier, Winter Skate, Porbeagle Shark and White Shark); six (6) species listed as threatened (Spotted Wolffish, Northern Wolffish, Acadian Redfish, American Plaice, White Hake & Mako Shark), and eight (8) species of special concern (Atlantic Wolffish, Atlantic Cod, Roughhead Grenadier, Smooth Skate, Thorny Skate, Basking Shark, Blue Shark and Spiny Dogfish) (Table 4-18). Of these species, six (6) are federally listed under SARA (endangered species: Atlantic Whitefish and Atlantic salmon (Inner Bay of Fundy population); threatened species: Spotted and Northern Wolffish; and species of concern: Atlantic Wolffish and Atlantic Cod).

The International Union for the Conservation of Nature (IUCN) lists four species potentially occurring on the Scotian Shelf and Slope, as well as possibly in coastal areas, as vulnerable: Atlantic halibut, yellowtail flounder, barndoor skate, and haddock (Froese and Pauly 2002).

Table 4-18: Characteristics of Federally listed marine & estuarine fish species at risk (Species are highlighted for which suitable habitat is present in the study area. Not all species are likely to occur in the Strait of Canso & Chedabucto Bay)

Species	Description
Atlantic Whitefish (*Coregonus huntsmani*)	The Atlantic whitefish is listed federally as an *endangered* species under SARA and COSEWIC (2010). Historically it is an anadromous fish species and though strays may occur elsewhere, it is largely restricted to the Petite Riviere watershed in southwestern Nova Scotia. Its population is threatened by illegal introduction of exotic fishes and the species is unlikely to occur within the study area.
Atlantic Salmon (*Salmo salar*)	Atlantic salmon that spawn in rivers bordering the Bay of Fundy (Inner Bay of Fundy population) are federally listed as *endangered* under SARA and COSEWIC (2010). A second population (Eastern Cape Breton population), which reside in Cape Breton Island rivers is also listed as *endangered* under COSEWIC (2010). Both populations of Atlantic salmon are threatened by changes in marine ecosystems, habitat destruction, illegal fishing and anthropogenic sources.
Spotted Wolffish (*Anarhichas minor*)	Spotted wolfish are found along the Scotian Shelf. They typically occur in continental shelf or deep trench water depths of 200-750 m and little is known about the species habitat requirements (spawning, nursery and foraging grounds) (COSEWIC 2012). Its population is potentially threatened by commercial fishing (bycatch) and by climate change. It is listed federally as *threatened* under SARA and COSEWIC (2012).
Northern Wolffish *(Anarhichas denticulatus))*	Northern wolffish are found in Scotian Shelf waters and prefer water depths from 500 to 1000 m. Through recovery efforts, species abundance has increased though it is still low compared to historical records (COSEWIC 2012). The population is sensitive to commercial fishing where it can be caught as 'bycatch'. It is listed federally as *threatened* under SARA and COSEWIC (2012).
Atlantic Wolffish (*Anarhichas lupus*)	The Atlantic wolffish abundance and distribution declined sharply in the 1980's to mid-1990 largely due to commercial fishing (directed and bycatch). It is also potentially threatened by climate change and is listed federally as a *species of concern* under SARA and COSEWIC (2012).
Atlantic Cod (*Cantopus virens*)	Atlantic Cod (Maritimes population) inhibit continental shelf waters and stock abundance is low. They are federally listed under SARA as a *species of special concern* (schedule 3) and are threatened by human activities (directed & bycatch fisheries), natural predation and ecosystem changes.
Cusk (*Brosme brosme*)	Cusk are known to occur in the Gulf and Maine and Scotian Shelf and species abundance has been declining since the 1970's. It is listed under COSEWIC as *endangered* and its population is threatened by overfishing on the Scotian Shelf.
Acadian Redfish (*Sebastes faciatus*)	The Acadian Redfish (Atlantic population) population is threatened by commercial fishing (bycatch) and is very sensitive to human activities. It prefers cold waters along slopes of banks and channels and water depths of 150 to 300 m. It is listed under COSEWIC (2010) as a *threatened* species.
Deepwater Redfish (*Sebastes mentella*)	The Deepwater Redfish (Northern population) population is threatened by commercial fishing (bycatch) and very sensitive to human activities. It prefers cold waters along slopes of banks and channels and water depths of 350 to 500 m. It is listed under COSEWIC (2010) as a *threatened* species.
American Plaice (*Hippoglossoides platessoides)*	American Plaice are a non-schooling, flounder species. Its 'Maritime population' is known to occur in the Gulf of St. Lawrence, the Scotian Shelf, Bay of Fundy and Georges Bank. It is listed by COSEWIC (2009) as a *threatened* species due to declining numbers as a result of natural mortality and overfishing.
Atlantic Bluefin Tuna (*Thunnus thynnus*)	Atlantic Bluefin Tuna, a large fish species, occurring as a migrant in the Atlantic Ocean are fished from Scotian Shelf waters in July through December (COSEWIC 2011). Species abundance is in decline due to historic and present-day fishing as well as fishing activities related to forage species and habitat degradation (i.e., 2010 oil spill in Atlantic Bluefin Tuna spawning grounds in Gulf of Mexico). It is listed under COSEWIC (2011) as an endangered species.
Roughhead Grenadier (*Macrourus berglax*)	Roughhead Grenadier is distributed along the upper continental slope and deep continental shelf in North Atlantic waters, typically at depths of 400-1200 m (COSEWIC 2007). It is the only species belonging to the genus *Macrourus* in the North Atlantic and is listed under COSEWIC (2007) as a *species of special concern.* Fishing activities (mainly bycatch) have impacted species abundance and its long-life span may restrict its recovery.
Roundnose Grenadier (*Coryphaenoides rupestris*)	Roundnose Grenadier is a long-lived species that inhabits deep water (typically 800-1000 m depths). Species abundance is in decline and populations are threatened by fishing (directed & bycatch) and human activities. It is listed under COSEWIC (2008) as an *endangered* species.

Species	Description
Smooth Skate *(Malacoraja senta)*	Smooth Skate (Laurentian-Scotian population) species are known to live on the seafloor and prefer soft mud and/or clayey substrates. They typically occur at water depths of 150- 550 m though can be found at other water depths as well. It is listed under COSEWIC (2012) as a *species of special concern*.
Thorny Skate (*Amblyraja radiata*)	This species live on the seafloor, at varying depths (18-1200 m) and on varying bottom substrates (sand, gravel, mud, etc) (COSEWIC 2012). They are listed under COSEWIC (2012) as a *species of special concern*. Declining species abundance is likely related to commercial fisheries and other unknown variables.
Winter Skate (*Leucoraja ocellata*)	Winter Skate (Eastern Scotian Shelf population) is a bottom dwelling species that typically lives on sandy or gravelly bottom substrates. Its life history characteristics (long generation time, low fecundity, etc.) combined with directed fisheries have aided in an increase of its species vulnerability. Abundance of mature species has declined by more than 90% since the 1970's (COSEWIC 2005). It is currently listed under COSEWIC (2005) as a *threatened* species.
White Hake (*Urophycis tenuis)*	White hake (Southern Gulf of St. Lawrence & Atlantic and Northern Gulf of St. Lawrence populations) can be found in Canada along the Scotian Shelf, in the Bay of Fundy as well as in the Gulf of St. Lawrence, slopes of St. Pierre Bank and along the southern Grand Banks. They are commonly found near the bottom and over a fine sediment substrate such as mud (COSEWIC 2013). The southern Gulf of St. Lawrence population are *endangered* and the Atlantic and Northern Gulf of St. Lawrence population, *threatened*, species both listed under COSEWIC (2013).
Sharks	
Basking Shark (*Cetorhinus maximus)*	The Basking Shark (Atlantic population) species is listed by COSEWIC (2009) as a species of *special concern*. They can be found in areas with concentrations of zooplankton in summer and may also utilize deepwater habitats (>1000 m). Due to their low productivity & low fecundity, they are vulnerable to anthropogenic impacts (i.e. by-catch fisheries, vessel collisions, etc.).
Blue Shark (*Prionace glauca*)	Blue Shark (Atlantic population) distribution is widespread and the species is known to migrate. It can be found in offshore surface waters (surface to 350 m depths) and its abundance peak in Atlantic Canada in late summer and fall (COSEWIC 2006). It is listed under COSEWIC (2006) as a species of *special concern* and is largely threatened by fishing activities.
Porbeagle Shark (*Lamna nasus*)	The Porbeagle Shark is associated with continental shelf waters (in deeper basins and along shelf edge at depths less than 200 m) (COSEWIC 2014). Its abundance has declined due to fishing activities. Though directed fisheries have been suspended since 2013, it is still being caught as by catch in other fisheries (i.e. swordfish and tuna) (COSEWIC 2014). It is listed as *endangered* under COSEWIC (2014).
Shortfin Mako *(Isurus oxyrinchus)*	Shortfin Mako shark are associated with warm waters (17-22 °C) and have been documented in waters of Georges & Browns Bank, along the continental shelf waters of Nova Scotia, Grand Banks and the Gulf of St. Lawrence. They are listed under COSEWIC (2006) as a *threatened* species and are threatened by fishing activities.
Spiny Dogfish (*Squalus acanthias*)	The Spiny Dogfish shark is widely distributed along continental shelf waters and is associated with a variety of habitats (intertidal to offshore waters) and depths (surface waters to 730 m depths)(COSEWIC 2010). In Canadian waters it is typically associated with southwestern Nova Scotia waters. It is threatened by directed and by-catch fisheries and is listed under COSEWIC (2010) as a species of *special concern*.
White Shark *(Carcharodon carcharias)*	The (great) White Shark is a seasonal migrant to Atlantic Canada waters. Due to its low reproductive rate it is vulnerable to human impacts. Bycatch fisheries threaten species abundances. It is listed as an *endangered* species under COSEWIC (2006).

4.4 Ecological Environment: Marine

4.4.1 Marine Ecosystem

The Strait of Canso and the adjoining areas of Chedabucto Bay and the Scotian Shelf support a productive, coastal marine ecosystem. Energy to drive the system comes from the sun, both to support growth of plants, and in part to cause movement and mixing through wind-generated currents and waves, as well as providing seasonal water column stratification, which is an important physical element that supports the biological functioning of the system. Currents provide a means for long-distance transfer of organisms and reproductive stages. Tides are important locally,

providing current regimes and mixing to which biological communities are adapted. The marine ecosystem in the area is complex and extensive.

The ecosystem in the area has been described in a number of summary publications (e.g., McCracken, 1979; Stewart and White 2001; Gromack et al 2010; Zwanenburg et al 2006). Key components of the coastal ecosystem include: bacteria (planktonic, benthic); plants (intertidal and subtidal seaweeds and phytoplankton); invertebrate animals (zooplankton in the water column); large commercially important invertebrates such as lobster and sea scallops; other invertebrates (including herbivores, carnivores, detritus and sediment consumers); and vertebrates including marine mammals (whales, dolphins, porpoises and seals) and sea turtles; seabirds and other water-associated birds, and fish, ranging from small species that are typically not a part of a fishery to those that are important as food for other groups of marine animals (sand lance and capelin); and species which support commercial fisheries.

4.4.2 Marine Water and Sediment Quality

4.4.2.1 Water Quality

Organisms living in seawater can potentially be impacted by contaminants, in circumstances such as industrial releases. Although there are a number of industrial sources of effluent in the industrialized part of the Strait of Canso, levels of contaminants are expected to be insignificant or below levels which could harm marine organisms present at the Bear Head LNG marine terminal. The impacts generated by industrial releases into the Strait of Canso have been assessed in numerous studies from the 1970s to the 1990s; these were summarized to 1995 in Stewart and White (2001). By 1995 there were no outstanding contaminant issues; most had been associated with industries including the paper mill (e.g., mercury). In addition to industrial contaminants, levels of nutrients in coastal waters are a global concern. Elevated nutrient concentrations from sewage releases associated with urbanization and industrialization can lead to eutrophication, and the Strait of Canso has experienced some influence from the urban development that has taken place in the Port Hawkesbury, Mulgrave and Point Tupper areas. Shipping and other marine-related activities cause detectable and slightly elevated levels of hydrocarbons in coastal waters.

4.4.2.2 Sediment Quality

Organisms living on or in the seabed are in close contact with sediments and can be affected by constituents both naturally occurring and those which may be present as the result of industrial activity. Sediments often form a sink for contaminants released into the water column, which become associated with particles and form sediments which settle to the seabed; these contaminants can be released when sediments are disturbed.

Contaminant levels in sediments in the vicinity of the proposed Bear Head LNG marine facility (sample locations shown in Figure 4-17) were measured to a water depth of about 11 m below mean low water in 2004 (JWEL, 2004a). With the exception of one sample which had a total PCB level (71.6 µg/kg) and exceeded the 34.1 µg/kg of the Interim Sediment Quality Guidelines (ISQG) for the Protection of Aquatic Life (CCME, 1999) (JWEL, 2004a), measured levels were within acceptable limits. The average PCB level over all stations sampled in the vicinity of the proposed marine terminal was below the CCME IQG (Table 4-19).

The Bear Head LNG marine site is not alone in having low level PCB contamination in the sediments. Similar levels have been observed in other nearshore areas in the Strait of Canso, particularly in proximity to the industrialized section between Point Tupper and Peebles Point (Stewart and White 2001; OceanChem 1987; Tay et al 2010) and at the proposed Melford International Terminal site across the Strait from Bear Head (PCB levels of 110-190 µg/kg were found in three samples in 2007) (AMEC, 2008).

Contaminants from industry, marine activities and sewage from the urban areas surrounding the Strait of Canso are in the sediments, but today they are at relatively low levels. The recent (2004) survey of the mid-Strait of Canso between Peebles Point and Point Tupper, and of deeper water sediments at the common user ocean disposal site and reference areas, indicated that levels of all heavy metals in surface sediments were lower than CCME probable effects levels; cadmium levels were slightly elevated over guideline levels for ocean disposal in some surface sediments; and PCB levels were not above guideline in the silt clay sediments, but continue to be elevated in other areas (Tay et al., 2010).

Table 4-19: Sediment Quality at Bear Head and Strait of Canso, 2003.

Parameters	Units	EQL	CCME ISQG – PEL	ODCA	Bear Head	Strait of Canso[1]
Gravel	%	0.1			12.4-29.7	5.2 - 25.01
Sand	%	0.1			47.5-67.6	16.3 – 40.1
Silt	%	0.1			9.6-14.3	3.4 – 43.8
Clay	%	0.1			7.2-9.2	2.0 – 24.27
Cadmium	mg/kg	0.3	0.7-4.2	0.6	ND	<0.010 – 0.79
Mercury	mg/kg	0.01	0.13-0.7	0.75	0.01	0.03 – 3.1
Copper	mg/kg	2	18.7-108	81	6-8	7-56.6
Zinc	mg/kg	5	124-271	160	37-48	50-130
Lead	mg/kg	0.5	30.2-112	66	11-12	23.9-120
Hydrocarbons (TPH, C6-C32)	mg/kg	3			16.2-26.6	21 – 515.3
Total C6-C10	mg/kg	2.5			All <2.5	
>C10-C21 (fuel)	mg/kg	0.25			2.78 - 4.76	
>C21-C32 (Lube)	mg/kg	0.25			13.4 - 21.9	
PCBs	µg/kg	10	21.5-189	100	<10 – 71.6	48-1395
Pesticides[2]	µg/kg	10	1.19-374		All <10	<5 -62
PAHs[2]	mg/kg	0.05	0.006-0.135	2.5	All <0.05	0.039-2.940