5.2 SOILS

The soils in this area have developed for the most part from sandstones, slates, and shales, giving tills ranging in texture from sandy loam to shaly clay loam (Davis and Browne 1996b).

Based on water well records for the Melford Area, overburden thickness in the area ranges from about 1 to 30 m (3 to 100ft) with an average thickness of about 10 m (33 ft). The soils that developed from this overburden material within the proposed site footprint belong to two soil formations, the Millbrook and Thom formations. The site footprint is mainly comprised of the Millbrook formation, where soils are defined as reddish brown molted, and in some cases friable loam/sandy loam to a gravely clay loam. Parent material is derived from a glacial till from igneous and metamorphic rock. This area has imperfect to good drainage with the soil hosting a high percentage of arability (Figure 5.2-1). The rail corridor hosts a wide range of soil formations including small sections falling within the Millbrook and Halifax formations, as well as two longer stretches falling within the Riverport and Kirkhill formations. These soil formations are generally made up of sandy/shaly loam and are well drained in some areas and imperfectly drained in others.

5.2.1 Soil Capability

The area for the proposed Project footprint falls within an area of soil capability (agricultural use) of class 3 where the remainder of the corridor is a 7. The soil capability class is on a scale of 1-7 where 1 is the best (Canadian Land Inventory, DOA 07’). The class 3 soils that are located in the Project footprint have moderately severe limitations that may restrict a range of crops and/or may require special conservation practices.

5.2.2 Erodible Soils

Through Agriculture Canada, there is a mapping resource produced to address the erodibility of soils (Coote et al., 1992). This risk is scaled and divided in to classifications from low to severe on the assumption of erodibility when soil is bare, unprotected and without vegetation.

The water erosion risk is presented in Figure 5.2-2 for the proposed Project. The map symbols shown in Figure 5.2-2 are explained presented in Table 5.2-1 below. It should be emphasized that these classifications do assume bare and unprotected soil conditions. The proposed site and corridor are generally vegetated and erosion may be negligible. Through appropriate management techniques, any potential soil erosion which may occur can also be significantly reduced (refer to Section 6.2).

Table 5.2-1: Soil Erodibility

Map Symbol (Figure 5.2-2)	Interpretation of Map Symbol
S 4e 360	Dominant soil erodibility – Severe 50 – 79.9% of farmland, Excellent protection by crop management Associative number reference to Water erosion risk legend
S 3e 362	Dominant soil erodibility is "Severe" 30 – 49.9% of farmland, Excellent protection by crop management Associative number reference to Water erosion risk legend
S 1 359	Soil erodibility is Severe < 10% of farmland Associative number reference to Water erosion risk legend
Ss 1 365	Dominant soil erodibility - Severe, Subdominant soil erodibility - Severe < 10% of farmland Associative number reference to Water erosion risk legend
S 1 417	Dominant soil erodibility - Severe < 10% of farmland Associative number reference to Water erosion risk legend
S 1 366	Dominant soil erodibility - Severe < 10% of farmland Associative number reference to Water erosion risk legend
S 2e 369	Dominant soil erodibility - Severe 10 – 29.9% of farmland, Excellent protection by crop management Associative number reference to Water erosion risk legend

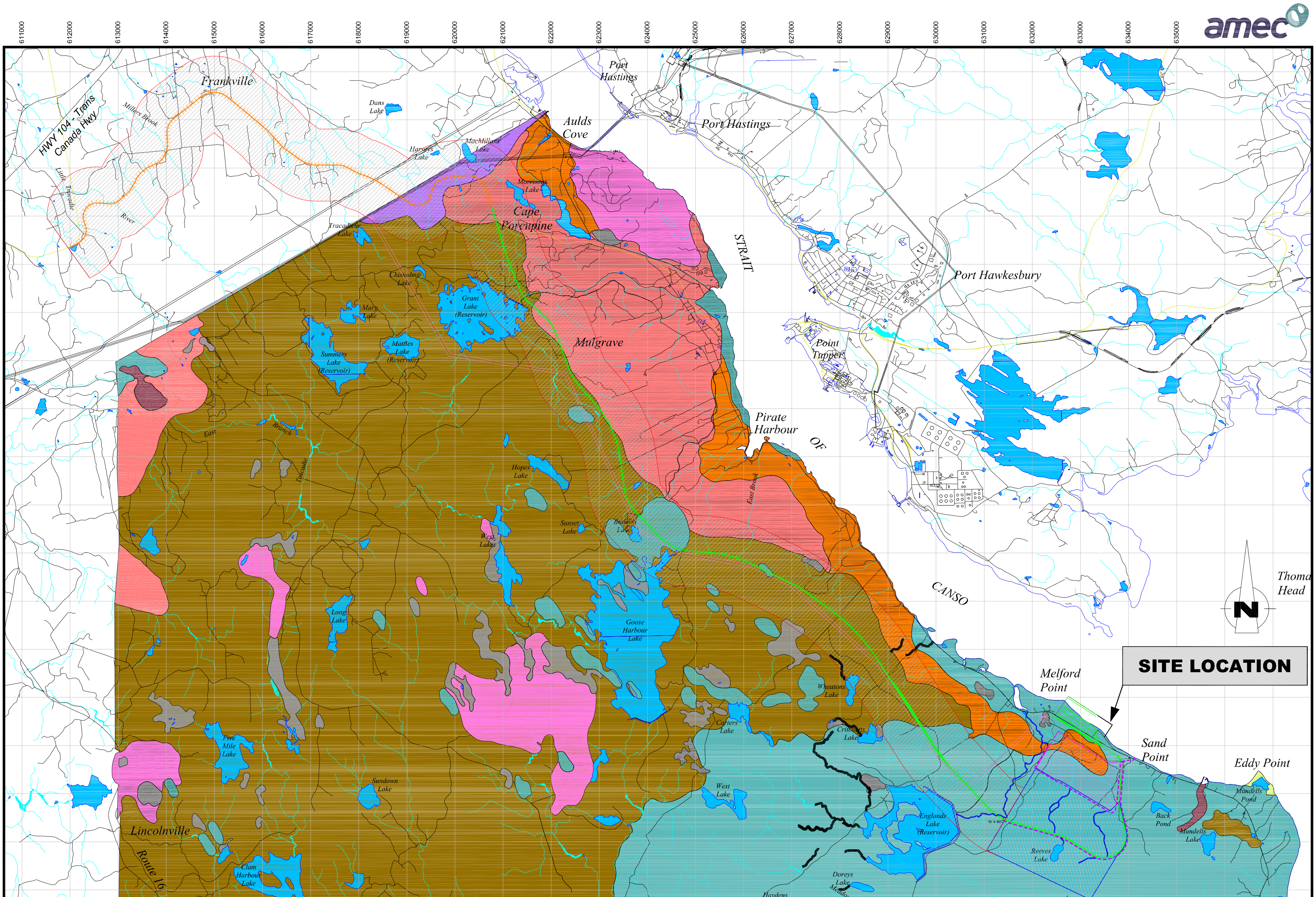
5.2.3 References

Canadian Land Inventory, 2007. Soil Capability for Agriculture. Department of Agriculture http://geogratis.cgdi.gc.ca/cgi-bin/geogratis/cli/agriculture.pl

Coote, D.R.; R. Gordon; D.R. Langille; H.W. Rees; and C. Veer. 1992. Water erosion risk, Maritime Provinces. Canadian Soil Inventory. Centre for Land and Biological Resources Research, Research Branch, Agriculture Canada. Contribution Number 91-10.

Davis, D.S. and S. Browne, 1996. *The Natural History of Nova Scotia: Topics and Habitats*. Volume I. Nimbus Publishing. 518 pp.

Davis, D.S. and S. Browne, 1996. The *Natural History of Nova Scotia: Theme Regions*. Volume II. Nimbus Publishing. 304pp

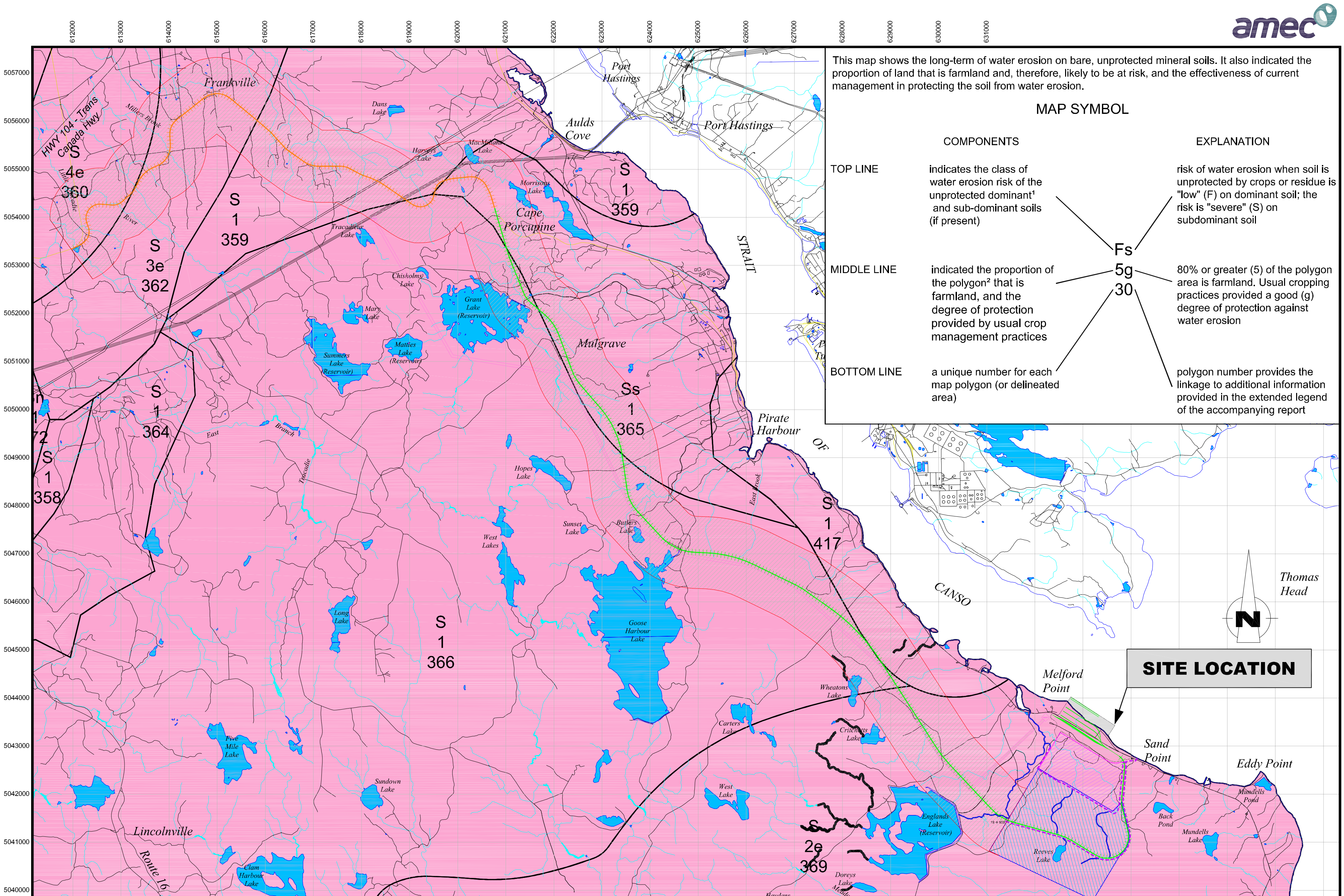


LEGEND:

- Proposed Melford Rail Track
- Proposed Melford Rail Track (On Existing Rail Bed)
- Existing Route 344
- Road Network
- Proposed Melford International Terminal
- Environmental Baseline Study Corridor
- Initial Logistics Park
- Future Logistics Park Expansion
- Proposed NSPI Easement
- Coastal Beach
- Halifax
- Kirkhill
- Middlewood
- Millbrook
- Peat
- Riverport
- Rockland
- Thom

Source:
Guysborough County Soil Map, 1963. Soil Research Institute, Research Branch, Canada Department of Agriculture, Ottawa.

Figure 5.2-1
Melford
International Terminal
Soil Geology
July 2008



LEGEND:

- Proposed Melford Rail Track
- Proposed Melford Rail Track (On Existing Rail Bed)
- Existing Route 344
- Road Network
- Proposed Melford International Terminal
- Environmental Baseline Study Corridor
- Initial Logistics Park
- Future Logistics Park Expansion
- Proposed NSPI Easement
- Risk Of Water Erosion On Bare, Unprotected Mineral Soil

Source:
D.R. Coote et al. 1992. Water erosion risk, Maritime Provinces. Canadian Soil Inventory. Centre for Land and Biological Resources Research, Research Branch, Agriculture Canada. Contribution Number 91-10.

Figure 5.2-2
Melford International Terminal
Water Erosion Risk
July 2008

5.3 AIR QUALITY

5.3.1 Nova Scotia Climate

Nova Scotia has a “temperate continental” climate (Rudloff, 1981) marked by relatively large daily and day-to-day ranges of temperature, especially during the spring and fall, and moderate rainfall. Nova Scotia lies in the "prevailing westerlies" characteristic of mid-latitudes in the northern hemisphere. Within this general circulation are embedded air masses originating at higher or lower latitudes that interact to produce storm systems. Nova Scotia experiences a relatively large number of storm systems that contribute to a roughly twice-weekly shift between fair and cloudy and stormy weather.

The continental climate is modified by Nova Scotia’s surrounding waters (EC, 1990). The Atlantic and Bay of Fundy waters are relatively cold (8-12^{o}C) which helps to keep the air temperature over southwestern Nova Scotia on the cool side in spring and summer. In January, when water temperatures are between 0 and 4 ^{o}C, winter temperatures are moderated. Farther offshore to the east, southeast, and south are the comparatively warm 16 ^{o}C waters of the Gulf Stream that are credited with prolonging warm weather well into October.

Ice conditions in the Gulf of St. Lawrence retard the arrival of spring. Cool summer seas also help stabilize overriding air masses, thus suppressing local storm development. In addition, the merging of contrasting ocean currents (i.e., warm Gulf Stream and the cold Labrador Current) produces a great deal of sea fog that often moves far inland. The climatic normals of the assessment area are described in detail below.

5.3.1.1 Climate Normals for the Region

The description of the climate for the region surrounding the proposed Project site is based upon climate normals and climate extremes from the Port Hastings Station (Table 5.3-1) for 1971-2000 (EC, 2007a). The Port Hastings climate data are considered to be an accurate representation of average climate conditions for the assessment area. The Port Hastings Station is located at an elevation of 23.10 m with latitude 45° 37’ N and longitude 61° 24’ W and is approximately 15 km from the proposed Project site (Figure 5.3-1).

The winter temperatures are moderate along the coast and alteration of Arctic and maritime air causes daily variations in the winter. In Nova Scotia, summers are relatively cool as the ocean acts as a cooling source. Daily average temperatures range from a low of -5.6°C in the month of February to a high of 23°C for the months of July and August. The extreme maximum and minimum temperatures recorded are 37.2°C and -26.7°C, recorded during July and January, respectively (EC, 2007a).

Table 5.3-1: Monthly Climate Normals for Port Hastings (1971 – 2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Daily Average (°C)	-4.9	-5.6	-1.9	3.2	8.7	13.9	18.2	18.5	14.5	9.2	4.1	-1.4
Standard Deviation	1.6	2.2	1.5	1.1	1.3	1.2	1.4	1	1	0.6	1.2	1.9
Daily Maximum (°C)	-0.9	-1.6	2.1	7	13.4	18.7	23	23	18.8	13.1	7.3	2.2
Daily Minimum (°C)	-9	-9.6	-5.8	-0.7	4	9	13.4	13.9	10.1	5.2	0.8	-5
Extreme Maximum (°C)	18.3	16.7	17.8	26.7	31.7	36.1	37.2	32.8	31	29.4	30	20.6
Date (yyyy/dd)	1908/27+	1886/14	1912/17	1977/22	1886/23	1908/30	1892/29	1977/29	1983/06	1885/05	1885/15	1885/11
Extreme Minimum (°C)	-26.7	-26.1	-26.7	-13.3	-6.7	-2.2	-0.6	-17.8	-5.6	-7.2	-12.2	-22.8
Date (yyyy/dd)	1897/21	1912/10	1897/02	1967/02	1913/02+	1911/03	1879/07	1876/13	1911/28	1911/06+	1911/17	1900/15
Precipitation												
Rainfall (mm)	99.4	61.1	103.1	128.6	105.5	114.2	90.8	111.7	113.6	142.5	158.6	128
Snowfall (cm)	48	46.7	29.3	13.5	0.9	0	0	0	0	0.8	4.7	38.2
Precipitation (mm)	147.4	107.2	132.3	142.1	106.4	114.2	90.8	111.7	113.6	143.4	163.3	166.2
Extreme Daily Rainfall (mm)	111.3	127	88.2	61.8	80.5	91.4	78.8	127.8	127	83.8	83.2	66
Date (yyyy/dd)	1978/18	1888/11	1980/08	1986/09	1967/26	1877/18	1983/22	1968/30	1874/07	1876/15	1983/16	1975/22
Extreme Daily Snowfall (cm)	41.9	48.3	30.5	58.4	24.1	0	0	0	0	15.2	14	63.5
Date (yyyy/dd)	1894/12	1902/12	1896/31+	1891/07	1899/02	1874/01+	1874/01+	1874/01+	1874/01+	1907/21+	1900/17	1890/30
Extreme Daily Precipitation (mm)	111.3	132.1	88.2	61.8	80.5	91.4	78.8	127.8	127	83.8	83.2	66
Date (yyyy/dd)	1978/18	1888/11	1980/08	1986/09	1967/26	1877/18	1983/22	1968/30	1874/07	1876/15	1983/16	1975/22
Extreme Snow Depth (cm)	71	105	157	68	5	0	0	0	0	0	11	47
Date (yyyy/dd)	1987/31	1987/25+	1987/17	1987/01	1985/09	1981/01+	1981/01+	1981/01+	1981/01+	1981/01+	1986/20	1982/13+
Days with Rainfall												
>= 0.2 mm	7.5	5.4	8.9	14.5	15.9	14.5	13.7	14.3	14.5	16.1	16.6	11.4
>= 5 mm	5.1	3.6	5.2	7.1	6.3	6.5	5.3	6	5.3	7.3	7.6	6.8
>= 10 mm	3.4	2.7	3.7	4.5	3.3	3.7	3	3.1	3.3	4.6	4.7	3.9
>= 25 mm	1.2	0.56	1.1	1.3	0.95	1.1	0.37	1.3	1.3	1.5	1.8	1.6

Table 5.3-1: Monthly Climate Normals for Port Hastings (1971 – 2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days With Snowfall												
>= 0.2 cm	7	6.1	4.3	2	0.21	0	0	0	0	0.06	1.4	6
>= 5 cm	4.1	3.7	2.5	1.3	0.11	0	0	0	0	0.06	0.33	3.3
>= 10 cm	1.8	1.7	1.3	0.53	0	0	0	0	0	0.06	0.11	1.2
>= 25 cm	0.11	0.28	0.05	0	0	0	0	0	0	0	0	0.17
Days with Precipitation:												
>= 0.2 mm	13.2	10.7	12	15.3	16	14.5	13.7	14.3	14.5	16.2	17.4	16
>= 5 mm	8.6	7.1	7.3	8.1	6.3	6.5	5.3	6	5.3	7.3	7.9	9.7
>= 10 mm	5.3	4.4	4.9	5.1	3.4	3.7	3	3.1	3.3	4.7	4.8	5.3
>= 25 mm	1.5	1	1.4	1.3	0.95	1.1	0.37	1.3	1.3	1.5	1.8	1.8
Degree Days												
Above 24 °C	0	0	0	0	0	0	1		0	0	0	0
Above 18 °C	0	0	0	0.2	0.8	7	41.8		7.2	0.2	0.1	0
Above 15 °C	0	0	0	0.4	3.9	26.6	103.8		31	3.7	0.4	0
Above 10 °C	0.3	0	0.1	2.8	32.2	118	251.9		135.3	35.3	4.7	0.1
Above 5 °C	2.1	0.6	3.7	18.8	125.3	261.3	406.9		282.9	137.2	35.7	5.4
Above 0 °C	16	12.2	33.5	101	272	411.1	561.9		432.9	287.2	130.8	35.6
Below 0 °C	167.2	172.8	95.3	6.1	0	0	0		0	0	6	83.6
Below 5 °C	308.3	302.6	220.5	73.9	8.3	0.2	0		0	5	60.8	208.4
Below 10 °C	461.4	443.3	371.9	207.8	70.2	6.9	0		2.5	58.1	179.8	358.1
Below 15 °C	616.2	584.7	526.8	355.5	196.9	65.4	6.9		48.1	181.5	325.5	513
Below 18 °C	709.2	669.5	619.8	445.3	286.8	135.9	37.9		114.3	271	415.2	606

Source: EC, 2007a

5.3.1.2 Precipitation

Precipitation is slightly greater in the late fall and early winter because of the more frequent and intense storm activity. In most years there is a good supply of rain during the spring and summer. However, drought is not unknown in Nova Scotia.

Nova Scotia is wettest over the highlands of Cape Breton Island, where over 1600 mm of precipitation fall in an average year. The southern coast experiences almost as much, with totals of 1500 mm. By contrast, the north shore along the Northumberland Strait has less than 1000 mm a year.

On average, only about 15 percent of Nova Scotia's total annual precipitation originates as snow. Snowfall is relatively light near the warm Atlantic shore and near the entrance to the Bay of Fundy, where less than 150 centimetres (cm) may fall in one winter. Here, copious rain and freezing rain make up for the scanty snowfalls. Inland, the yearly snowfall increases to 250 cm. As a rule, elevated areas receive the greatest snowfall and have the longest snow cover season.

The snow-cover season, that is, the period when there is at least 2.5 cm of snow on the ground, varies considerably. Usually its duration extends from about 110 days a year along the southern coast to 140 days inland and in areas adjacent to the frozen seas. In coastal areas the snow-cover may come and go. The average annual precipitation in the assessment area is 1538.6 mm, of which approximately 12 percent per cent is in the form of snow. The extreme daily precipitation recorded between 1971 and 2000 was 132.1 mm, which occurred in February (Table 5.3-1). Total monthly precipitation ranges from 90.8 mm to 166.2 mm.

5.3.1.3 Fog and Sunshine

Each year there is an average of 115 days with fog at Canso. Canso is located approximately 30 km from the proposed Project site. It is likely that the proposed Project site will experience similar fog and sunshine conditions. The period from mid-spring to early summer is the foggiest time. Bands of thick, cool fog lie off the coast, produced where the chilled air above the Labrador Current mixes with warm, moisture-laden air moving onshore from the Gulf Stream. With onshore winds these banks of fog move far inland. Sea fog often affects the headlands by day, moving inland and up the bays and inlets at night. At other times of the year fog is much more transient and local in nature.

Because of the extensive fogs, as well as mists, and low cloud, sunshine amounts throughout the province are usually less than half the total possible. Sunshine totals range from 1700 to 1969 hours a year. August is the sunniest month along the coast. Sunless days (days with less than 5 minutes of bright sunshine) amount to between 75 and 90 a year, with a marked seasonal high from November to February. Sunny days, on which less than 70 percent of the sky is covered with cloud in the early afternoon, amount to between 130 to 160, with a peak from July through October.

5.3.1.4 Severe Weather

Storms frequently pass close to the Atlantic coast of Nova Scotia and cross the southern part of Newfoundland, producing highly changeable and generally stormy weather. This region has more storms over the year than any other region of Canada. With a variety of weather conditions from hurricane-force winds to heavy precipitation, storm systems can pass rapidly through or stall and batter the region for several days. Other conditions associated with these storms include freezing spray, reduced visibility in snow, rain, or fog, and numbing wind chills, especially in the storm's wake.

In late summer and fall the remnants of a hurricane or tropical storm are felt at least once a year in Nova Scotia. For example in September, 2003, Hurricane Juan struck Atlantic Canada with peak winds of 165 km/hr. Juan resulted in eight fatalities and over 200 million dollars in damage and was described as the worst storm to hit Halifax since 1893 (EC, 2003).

Thunderstorms are infrequent in Nova Scotia and occur on approximately 10 days of the year. While lightning data for Port Hastings are not reported, the frequency is likely to be in the range of 5-15 days per year (EC, 2007b). The most winter lightning in Canada occurs in an area south of Sable Island, in the Atlantic Ocean. Cold air moving down from the Arctic collides with warmer air rising from the Gulf Stream. This collision creates ideal conditions for thunderstorms and lightning (EC, 2007b).

Tornadoes have been recorded but are rare. Reports of waterspouts over near-shore waters are received yearly. Other severe weather phenomena include ice storms and blizzards. Each year one or two 25 cm snowfalls occur in Nova Scotia. When combined with strong winds, impacts can include property damage and loss of life.

5.3.1.5 Thermal Inversions

Under certain conditions, an atmospheric thermal inversion layer occurs. Thermal inversions result when a layer of cooler air is trapped near ground level by a layer of warmer air above. Under these conditions, the vertical motion of air flow is strongly suppressed. If the base of the inversion lies above the level of the plume, then the volume of air available for dilution is limited. The elevated inversion acts as a lid, restricting vertical mixing, reducing dilution and increasing ground-level concentrations in areas with high emissions.

Temperature inversions are expected to be experienced for short durations in the assessment area due to the influence of the sea-land interphase. The temperature inversions are particularly important due to the ability to hinder dispersion or to promote a phenomenon known as fumigation.

5.3.1.6 Winds

Meteorological station data from Environment Canada (EC) and Hindcast Data was used as representative data for surface winds.

To assess the baseline meteorological data, the most recent five year period from the Eddy's Point Meteorological station was assessed. The Eddy Point meteorological station is located along the shore and is approximately 6 km southeast of the proposed Project location (Figure 5.3-1).

The most recent five year period available is 1980 – 1984. Since the data from Eddy's Point was over twenty years old, Hindcast data from a latitude 45.5 and longitude 61.6 were also assessed. Hindcast data from 1980 – 1984 was compared to data from the same period at Eddy's Point. The older 1980-1984 Hindcast data was then compared to Hindcast data from 2001 – 2005 in order to determine whether there were appreciable differences in wind data between the two time periods. Wind roses are an efficient and convenient means of presenting wind data, and were therefore developed for both data sets. The length of the radial barbs gives the total percent frequency of winds from the indicated direction, while portions of the barbs of different colors and widths indicate the frequency of associated wind speed categories.

Total wind analysis included data from various climatic data stations over five year sample periods. Measured total wind speed, wind direction, and wind class frequency data for the Eddy Point and Hindcast data are shown in Figure 5.3-2. Visual inspection of Figure 5.3-2 shows generally similar wind directions and speeds for both the total Hindcast 2001-2005 and the Hindcast 1980-1984 data sets. The average wind speeds for the total Hindcast (1980-1984) and Hindcast (2001-2005) data sets were 8.08 m/s and 7.84 m/s, respectively (MCS50, 2006). In both cases, the greatest percentages of winds are flowing from the north westerly and south westerly quadrants. Furthermore, Figure 5.3-3 shows that in both data sets the calm winds occur at lower frequencies (> 1.0%) and the higher speed winds occur at greater frequencies. The similarities noted between the Hindcast 2000-2005 and the Hindcast 1980-1984 total wind data sets suggest it is acceptable to infer that 1980-1984 data for Eddy Point is representative of recent meteorological conditions.

5.3.1.7 Seasonal Winds

The seasonal analysis of the meteorological data incorporated the use of the following conventional monthly seasonal definitions:

- Winter (December, January, and February);
- Spring (March, April, and May);
- Summer (June, July, and August); and
- Fall (September, October, and November).

Measured seasonal wind speed and direction data for the Eddy Point (1980-1984) are shown in Figure 5.3-4.

Winds predominately prevail from the northwest quadrant during the winter months. The average winter wind speed recorded for the Eddy Point data set is 5.27 m/s. During the fall season, all of the data sets suggest that the winds predominately prevail form the northwest and southwest quadrants. The average wind speeds recorded during the fall for the Eddy Point data set is 4.55 m/s with a frequency of 5.18 percent for calm winds. Analysis of the spring months indicated that, in all of the data sets, the winds primarily prevail from the westerly quadrants. The average wind speed recorded for the Eddy Point data sets is 4.85 m/s. During the summer months, the data set suggests that the majority of the higher frequency winds prevail from the southwest quadrant.

Therefore, based on this analysis seasonal wind variances are apparent within the Project region. In general, the region appears to experience a greater proportion of higher speed winds blowing from the northwest during the winter months, and a greater proportion of lower speed winds blowing from the southwest during the summer months. It is important to note that an elevated frequency of higher wind speeds during the winter and fall months may be expected, due to greater turbulence resulting from increased differences in the air and water temperatures during these seasons (Sanwell Swan Wooster Inc, 1987).

Table 5.3-2 provides a summary of maximum wind gusts for Eddy Point, NS for the 1980-1984 time periods.

Table 5.3-2: Speed and Direction of Maximum Wind Gusts (km/h) Eddy Point, NS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	83 (SSE)	78 (NW)	81 (SSE)	78 (SE)	76 (NW)	65 (SSW)	65 (NNW)	65 (NW)	63 (SW)	65 (SSE)	91 (NW)	72 (SE)
1981	102 (SW)	83 (SSE)	74 (SE)	74 (SW)	70 (NW)	56 (SW)	56 (NNW)	54 (SW)	59 (NE)	65 (SSE)	74 (SSE)	80 (SW)
1982	81 (SE)	83 (NW)	70 (S)	67 (SW)	56 (SW)	57 (NW)	52 (NW)	74 (NW)	54 (NNW)	63 (N)	78 (NW)	93 (NW)
1983	81 (SSE)	100 (NW)	87 (NNW)	69 (SSE)	72 (SW)	46 (S)	57 (E)	67 (NW)	52 (SE)	61 (N)	80 (SSE)	93 (NW)
1984	76 (NW)	74 (NW)	93 (NW)	65 (E)	61 (SSW)	69 (NNW)	50 (SW)	NA	NA	46 (W)	70 (NW)	74 (SE)

Note: NA denotes data not available.

A review of maximum gust data for the 1980-1984 time period determined that the highest maximum gust was 102 km/hr from the NNE direction.

5.3.2 Regional Air Quality Baseline

Baseline ambient air quality data were obtained from continuous ambient air quality monitoring stations in the Project region and federal emission inventory reports. Information is presented based on regional NSE monitoring at Port Hawkesbury (NSEL 2007a) and the 2005 National Pollutant Inventory Report (EC, 2007c), along with the 2004 GPI Atlantic document; the Ambient Air Quality Accounts for the Nova Scotia Genuine Progress Index (GPI) (GPI Atlantic, 2004).

5.3.2.1 Criteria Air Contaminant Emissions

It is useful to examine the existing releases of air contaminants from local sources in the assessment area. This serves as a benchmark for comparing the emissions related to the proposed Project and to assist in the assessment of cumulative environmental effects. These existing releases of air contaminants are generally classified into two categories: criteria air contaminants (CACs), which include particulate matters, sulphur dioxide, nitrogen oxides, carbon monoxide and greenhouse gases (GHGs).

There are two main communities located in the vicinity and north of the proposed Project location: Port Hawkesbury (approximately 10 kms away, in Richmond County on the Cape Breton side of the Canso Strait) with 2006 population of 3922, and Mulgrave (approximately 11 km away (in Guysborough County on the mainland side of the Strait) with a 2006 population of 879. Adjacent to the town of Port Hawkesbury is the smaller community of Point Tupper which has an industrial park, the Point Tupper Heavy Industrial Park, containing a number of large industries.

Facilities currently operating in the industrial park include a gas fractionation plant, a pulp and paper plant, a power generating station, petroleum storage facility, a large bulk coal terminal and a gypsum loading terminal. Other large industry located in the Strait of Canso area includes a rock quarry and the Mulgrave Marine terminal.

Point Tupper Fractionation Plant, Exxon Mobil Canada
Exxon's Fractionation Plant separates natural gas liquids (the by-product of the processing that occurs at the Goldboro Plant) into propane, butane and condensate. The Fractionation Plant has a processing capability of: 7,000 barrels/day of propane; 3,000 barrels/day of butane; and 10,000 barrels/day of condensate.

Point Tupper, Georgia-Pacific Canada
Georgia-Pacific Canada operates a Gypsum trans-shipment facility in Point Tupper for quarries located in Big Camp and Sugar Camp.

Porcupine Mountain Quarry, Martin Marietta Materials Canada
Martin Marietta operates a 2 MT/y aggregate quarry at Cape Porcupine near the Canso Causeway in the Strait of Canso. This quarry ships a significant volume of product to the United States.

Point Tupper Generating Station, Nova Scotia Power
NSPI operates a 150MW Power Generating Station in Point Tupper Industrial Park. The plant is a thermal generating station that uses coal as a primary source of energy. NSPI also operates a coal-handling terminal in the Strait of Canso.

NewPage Corporation (formerly Stora Enso Port Hawkesbury Limited)
NewPage Corporation's newly acquired Port Hawkesbury Mill has been producing paper since 1962. The plant's capacity is 190,000 tonnes of newsprint on Paper Machine (PM)1 and 360,000 tonnes of super-calendered (also known as coated two-sided) paper on PM2.

5.3.2.1.1 Emission Inventories

This section provides a summary of CAC emissions for all sources in Nova Scotia (Table 5.3-3) and for major regulatory permitted industrial sources (Table 5.3-4) in the area that submit emissions information to the National Pollutant Release Inventory (NPRI). The NPRI is a legislated, nation-wide, publicly accessible inventory of pollutants released, disposed of, and recycled by facilities in Canada. Facilities which meet reporting requirements are required to report to the NPRI under the *Canadian Environmental Protection Act* (CEPA).

Table 5.3-3: NPRI 2005 CAC Emissions of Nova Scotia (tonnes)

Category	TPM	PM_{10}	$PM_{2.5}$	SOx	NOx	VOC	CO	NH_3
Industrial Sources	15254	4652	2484	13919	6681	4005	7882	93
Non Industrial Fuel Combustion	10125	8890	8322	110520	36884	11907	50639	183
Transportation	1379	1376	1210	1940	28083	16114	198818	589
Incineration	584	416	301	0	0	10773	117	1303
Open Sources	33054	83157	15381	6	56	2750	1129	4665
Total	357,864	98,492	27,699	126,431	71890	45,594	258,704	6,840

A review of Table 5.3-3 indicates that the majority of particulate matter and NH_3 emissions in the province originate from open sources. Open sources include agriculture, construction activities, paved and unpaved roads, forest fires, landfill sites, mine tailings, and prescribed burning. Non industrial fuel combustion sources such as commercial and residential fuel combustion, electric power generation, and residential fuel wood combustion generated the most SO_2 and NO_X. The Transportation category accounted for the most volatile organic compounds (VOC) and CO emissions. Transportation sources include air and marine transportation, diesel and gas vehicles and rail transportation.

Table 5.3-4 provides a summary of CAC emissions from regulatory permitted point sources in the area.

Table 5.3-4: Emissions from Permitted Point Sources in the Assessment Area - 2005

Source	Criteria Air Contaminant Emissions (tonnes/year)						
	CO	NO_X	SO_2	VOCs	TSP	PM_{10}	$PM_{2.5}$
Point Tupper Fractionation Plant, ExxonMobil Canada (5019)	26.5	--	--	--	--	1.2	1.2
Point Tupper, Georgia-Pacific Canada (8011)	--	--	--	--	66.2	31.3	9.9
Porcupine Mountain Quarry, Martin Marietta Materials Canada (5012)	--	--	--	--	--	2.9	0.51
Point Tupper Generating Station, Nova Scotia Power (3994)	--	3271	6998	--	286	157.3	68.7
Stora Enso Port Hawkesbury Limited, Stora Enso (2221)	591.7	311.7	560.5	302.1	85.9	43.7	14.7

Legend: -- Emissions not present
Source: Extracted from NPRI 2005 (EC, 2007c)

A review of Table 5.3-4 indicates that out of the list of permitted point sources in the assessment area in 2005, NSPI was the largest emitter of SO_2, NO_X, TSP, PM_{10} and $PM_{2.5}$.

5.3.2.2 Ambient Air Quality Monitoring

Historical data for SO_2 (1975 to 2002) and particulate matter (1974 to 1995) was obtained from the GPI Atlantic document.

5.3.3 Ambient Air Quality Criteria

Table 5.3-5 shows the applicable federal and provincial objectives relating to ambient air quality.

The Government of Canada (2004) National Ambient Air Quality Objectives (NAAQO) are based on a three-tier structure and defined as follows:

- **The Maximum Desirable Level** is the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and the continuing development of control technology.
- **The Maximum Acceptable Level** is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.
- **The Maximum Tolerable Level** denotes time-based concentrations of air contaminants beyond which, because of a diminishing margin of safety, appropriate action is required to protect the health of the general population.

The Canadian Council of Ministers of the Environment (CCME) have developed a Canada-Wide Standard for PM2.5 of 30 µg/m3, based on a 24-hour average over three consecutive years. This standard is to be achieved by 2010 (CCME 2000).

NSE has established maximum permissible ground level concentrations for ambient air quality in Nova Scotia. All approvals issued by the Minister of Environment and Labour contain provisions to ensure that the maximum permissible ground level concentrations are not exceeded.

Table 5.3-5: Federal and Provincial Ambient Air Quality Criteria

Pollutant	Averaging Time Period	NOVA SCOTIA	CANADA			
		Maximum Permissible[a]	Canada Wide Standards[b] (Pending)	Ambient Air Quality Objectives[c]		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Nitrogen Dioxide (µg/m^3)	1 hour	400	-	-	400	1000
	24 hour	-	-	-	200	300
	Annual	100	-	60	100	-
Sulphur Dioxide (µg/m^3)	1 hour	900	-	450	900	-
	24 hour	300	-	150	300	800
	Annual	60	-	30	60	-
Hydrogen Sulphide (µg/m^3)	1 hour	42	-	1	15	-
	24 hour	8	-	-	5	-
Total Suspended Particulate	24 hour	120	-	-	120	400

Table 5.3-5: Federal and Provincial Ambient Air Quality Criteria

Pollutant	Averaging Time Period	NOVA SCOTIA	CANADA			
		Maximum Permissible[a]	Canada Wide Standards[b] (Pending)	Ambient Air Quality Objectives[c]		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Matter ($\mu g/m^3$)	Annual	70	-	60	70	-
PM10 ($\mu g/m^3$)	24 hour	-	-	-	-	-
PM2.5 ($\mu g/m^3$)	24 hour	-	30	-	-	-
Carbon Monoxide (mg/m^3)	1 hour	34, 600	-	15	35	-
	8 hour	12, 700	-	6	15	20

Sources:
[a]Government of Canada 2004
[b]CCME 2000
[c]NSEL 2007b

5.3.3.1 Ambient Air Quality Monitoring Historical Data

Ground-level concentrations of SO_2 have been monitored from 1975 to 2002 at three monitoring stations in the Point Tupper – Port Hawkesbury area: Post office, Landrie Lake, and Point Tupper. Annual average concentrations for the 1975 to 2002 time period are presented on Figure 5.3-5.

A review of Figure 5.3-5 indicates that ambient concentrations of SO_2 measured in the Point Tupper Port Hawkesbury area have decreased significantly since the 1970's. It is noted that from 1975 to 1985, the annual average concentration for SO_2 exceeded the AAQC objective four times at the Point Tupper location. In the late 90's and early 2000's, data from the Landrie Lake location supported the fact that concentrations had decreased from the 1970s. Unfortunately data was not available for Point Tupper location for this time period.

A summary of more recent data for the 5 year period from 2000 to 2005 is presented in Table 5.3-6 for Embree/Granville Street location located in Port Hawkesbury, approximately 1 km from Point Tupper.

Table 5.3-6: Summary of Ambient Air Quality at Continuous Monitoring Sites

Parameter	Averaging Period	Embree/Granville Street Port Hawkesbury	Provincial Permissible Levels	NAAQO Maximum Desirable
SO_2 ($\mu g / m^3$)	One-Hour Maximum	469	900	450
	One-Hour Average	20		
	One-Hour - 99th Percentile	117		
	One-Hour - 75th Percentile	29		
	24-Hour Maximum	148	300	150

Table 5.3-6: Summary of Ambient Air Quality at Continuous Monitoring Sites

Parameter	Averaging Period	Embree/Granville Street Port Hawkesbury	Provincial Permissible Levels	NAAQO Maximum Desirable
	24-Hour Average	20		

During the 5 year monitoring period, the maximum one-hour average SO_2 concentration for Port Hawkesbury was 469 µg/m3. This maximum is much lower than the applicable Provincial regulatory limit of 900 µg/m3 for one-hour average ground-level SO_2 concentrations. However, it is marginally higher than the Maximum Desirable NAAQO of 450 ug/m3.

A review of the table indicates that the one-hour average 99th percentile SO_2 value was 117 µg/m3 and the mean one-hour average SO_2 concentration was 20 µg/m3. These results illustrate that the monitored concentrations are generally low compared to applicable regulatory limits.

Based on a review of the historical data along with the level of industrial activity in the area, it appears that the Point Tupper station exceeded levels in the past due to the monitoring station being located in the industrial park where there is a higher concentration of emissions from industrial activities. The data contained in Table 5.3-6 for the Embree/Granville Street location would be indicative of a suburban environment in the area, removed from the industrial environment of Point Tupper, with lower concentrations of SO_2 measured compared to the more industrial Point Tupper area. The remoteness of the proposed Project site would suggest that baseline air quality concentrations would be even lower than the Embree/Granville location.

Ground-level concentrations of suspended particulate matter have been monitored at four locations in the Point Tupper/Port Hawkesbury area for the time period between 1974 and 1995. Annual average concentrations for the 1974 to 1995 time period are presented on Figure 5.3-6.

5.3.3.2 Greenhouse Gases and Climate Change

GHGs including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) can be emitted from a number of natural and anthropogenic sources. Emissions from biogenic or other sources generally exhibit little variation from one year to the next, and are considered to be nominal when compared to those resulting from the combustion of fossil fuels.

Total GHG emissions are normally reported as CO_2-equivalents (CO_2e). This is accomplished by multiplying the emission rate of each compound by the global warming potential (GWP) relative to CO_2. CO_2e considers the global warming potential of the three main greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The global warming potential of these gases are as follows: CO_2 = 1.0, CH_4 = 21 and N_2O = 310. Therefore, the carbon dioxide equivalency factor (CO_2e) is equal to ((CO_2 mass x 1.0) + (CH_4 mass x 21) + (N_2O mass x 310)).

The Nova Scotia total GHG emissions for the years 1990 and 2004 are presented in Table 5.3-7 (EC, 2007e). Data for the year 2000 and beyond are Projections.

Table 5.3-7: Greenhouse Gas Emissions: Nova Scotia

	1990 Emissions (kt CO_2e)	% of 1990 National Emissions	2004 Emissions (kt CO_2e)	% of 2004 National Emissions
Energy	17,800	4%	21,300	3%
Industrial Processes	272	1%	301	1%
Solvent and Other Product Use	14	4%	14	3%
Agriculture	510	1%	500	1%
Land Use, Land-Use Change and Forestry	N/A	N/A	N/A	N/A
Waste	1,200	5%	910	3%
Total	19,700	3%	23,000	3%

kt = kilotonnes
Source: EC 2007e.

Energy use for stationary combustion sources accounts for almost 63 percent of the CO_2e emitted in Nova Scotia, while transportation accounts for 28 percent of Nova Scotia's CO_2e. In Nova Scotia, the generation of heat and electricity, residential heating, and road transportation account for much of the GHG emissions.

There is an increasing trend in GHG emissions. Between 1990 and 2004, Nova Scotia saw GHG emissions rise by 3,300 kt CO_2e (approximately 17%). This is due largely to an increase in consumer demand for electricity and transportation fuels.

With the exception of the Point Tupper location, particulate matter concentrations appeared to have decreased from the 1970's to 1980's, and have levelled out in the 1980's into 1990's. There were no exceedances of the annual objectives between 1992 and 1995.

5.3.4 References

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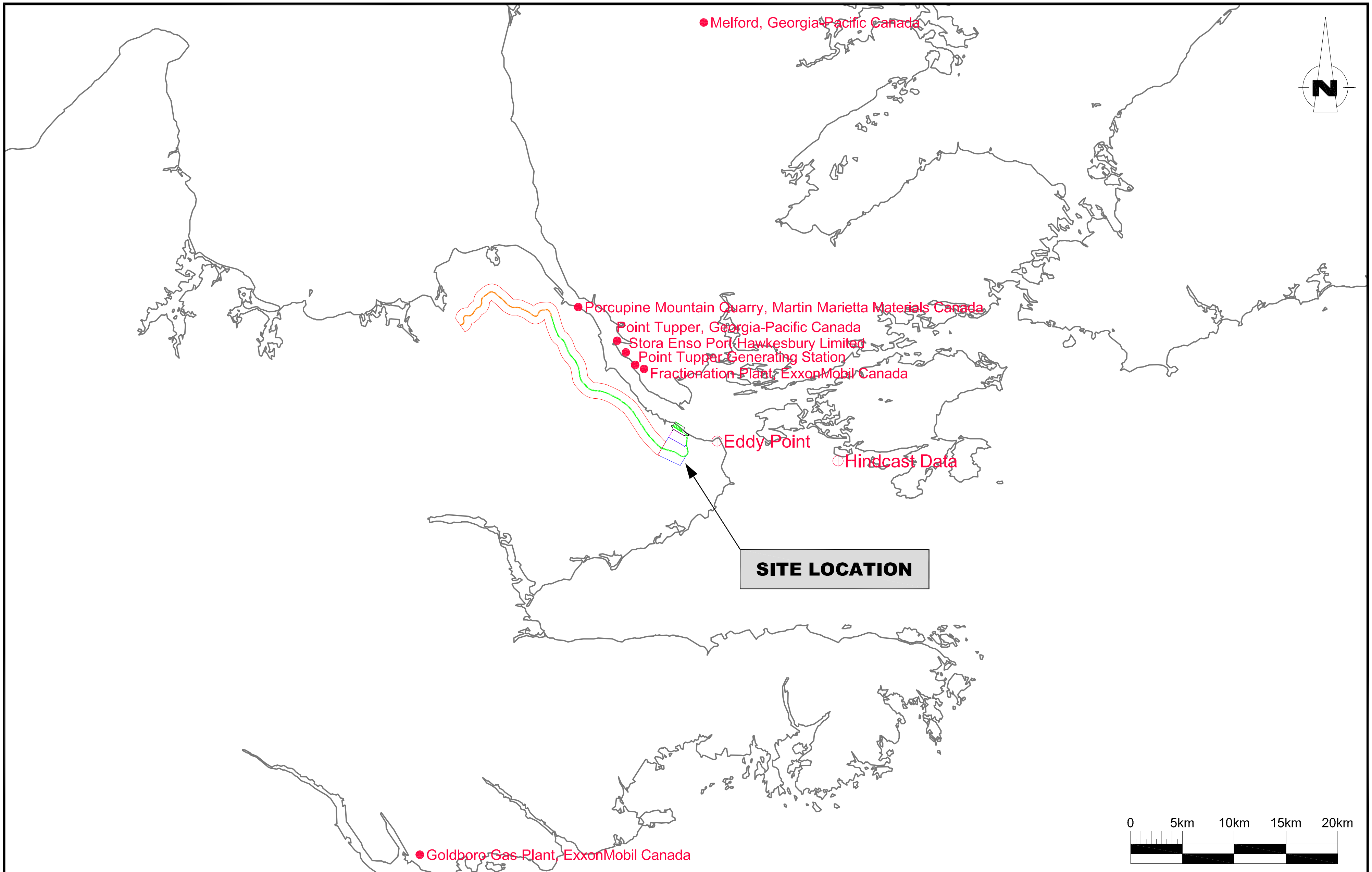


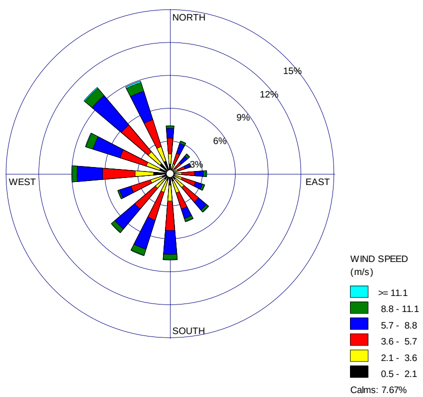
LEGEND:

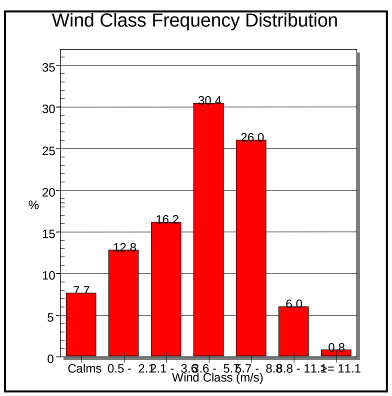
- Proposed Melford Rail Track
- Proposed Melford Rail Track (On Existing Rail Bed)
- Existing Route 344
- Proposed Melford International Terminal
- Environmental Baseline Study Corridor
- Initial Logistics Park
- Future Logistics Park Expansion

Figure 5.3-1
Melford International Terminal
Locations of the Meteorological Stations
Near the Proposed Project Site
July 2008

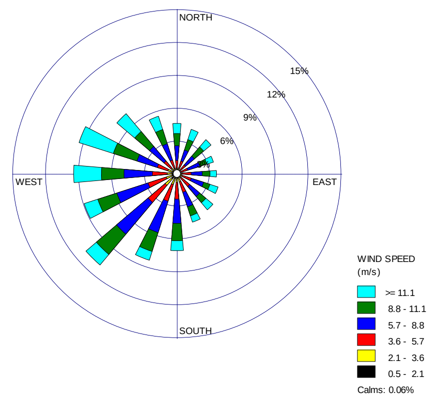
Figure 5.3-2: Summary of Total Wind Speed, Wind Direction, and Wind Class Frequency within the Project Region Based on Climate Monitoring at Eddy Point (1980 - 1984) and Hindcast Climate Modeling (1980 - 1984 and 2001 - 2005).

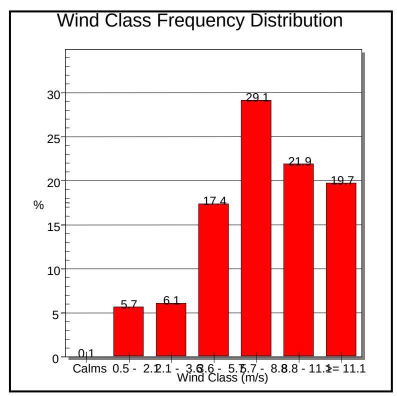
Eddy Point (1980-1984)



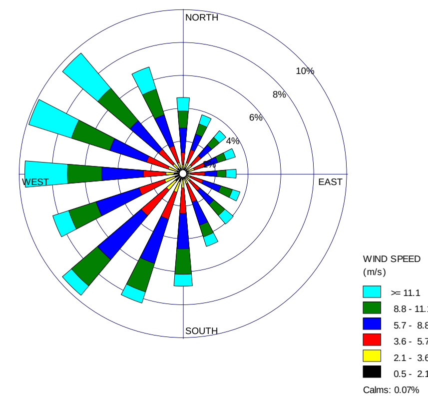


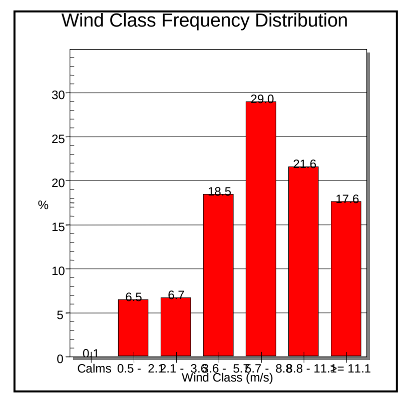
Hindcast (1980-1984)





Hindcast (2001-2005)

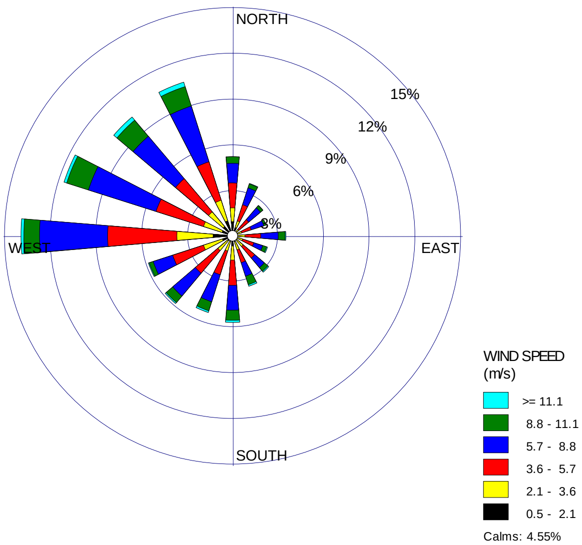




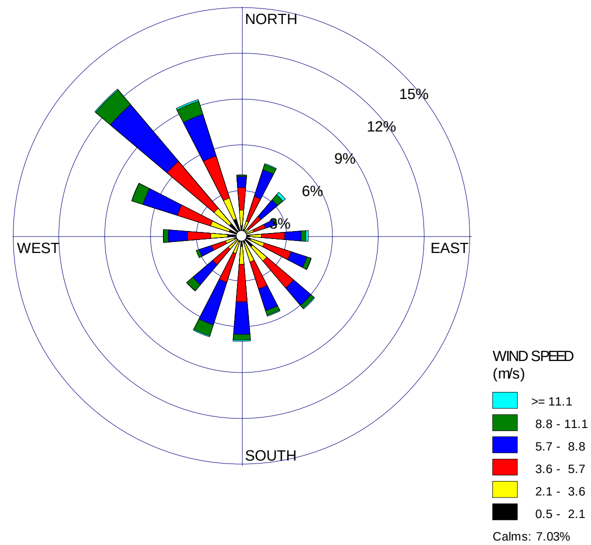
Source: MCS50, 2006

Figure 5.3-3: Summary of Wind Speed and Wind Direction within the Project Region Based on Climate Monitoring at Eddy Point 1980-1984

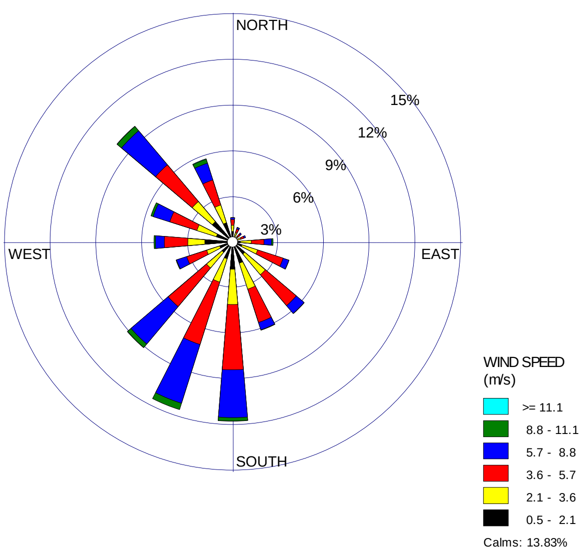
Winter



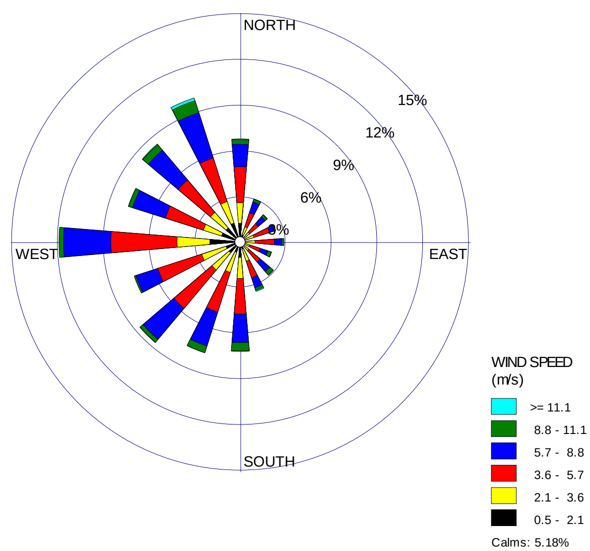
Spring



Summer



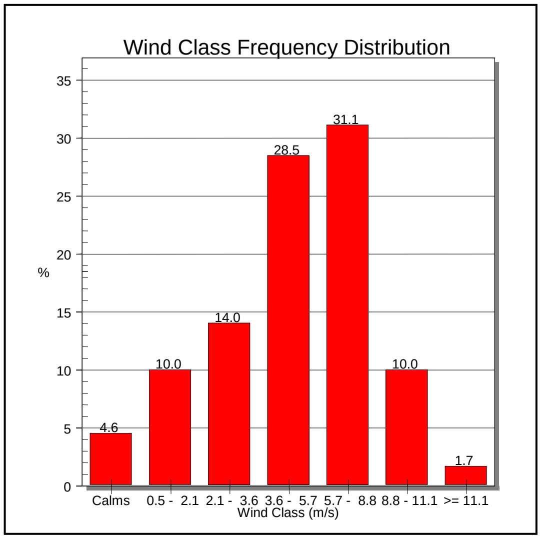
Fall



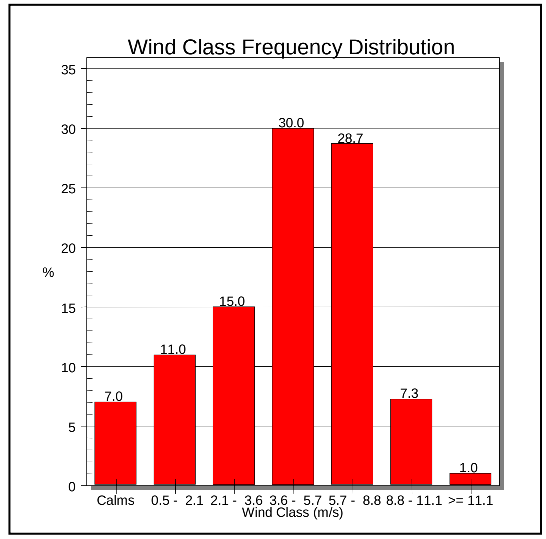
Source: (NSEL, 2007a).
Data Period: Station 118 (January 1, 1980,– December 31, 1984)

Figure 5.3-4: Summary of Wind Class Frequency within the Project Region Based on Eddy Point Climate Monitoring 1980-1984

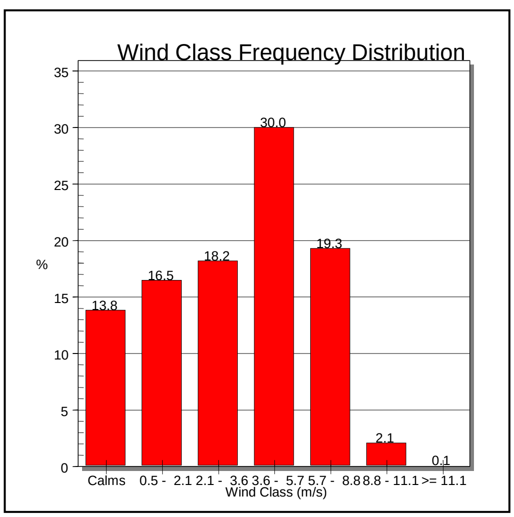
Winter



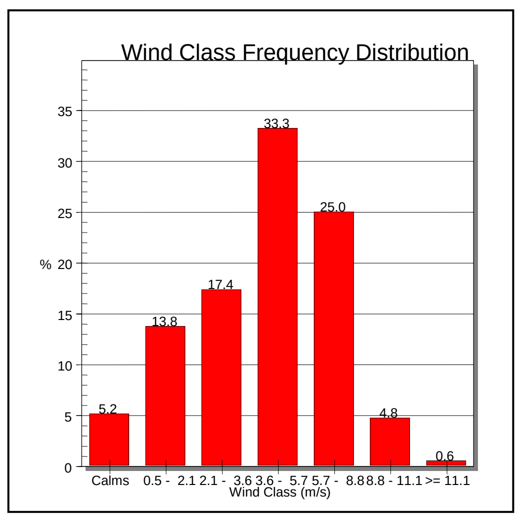
Spring



Summer



Fall



Source: (NSEL, 2007a).
Data Period: Station 118 (January 1, 1980,– December 31, 1984)

Figure 5.3-5: Annual Mean Ambient SO_2 Concentration (ppb) for Point Tupper, Port Hawkesbury Region (1975-2000)

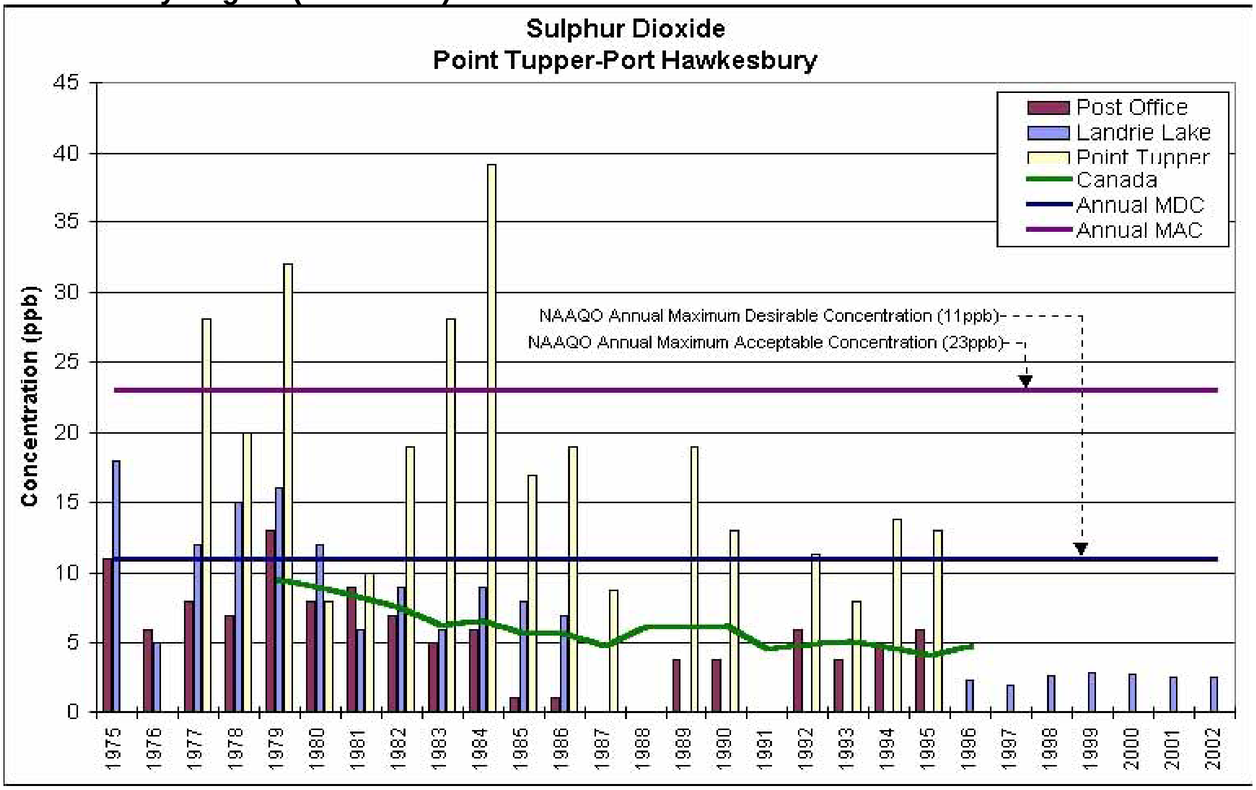
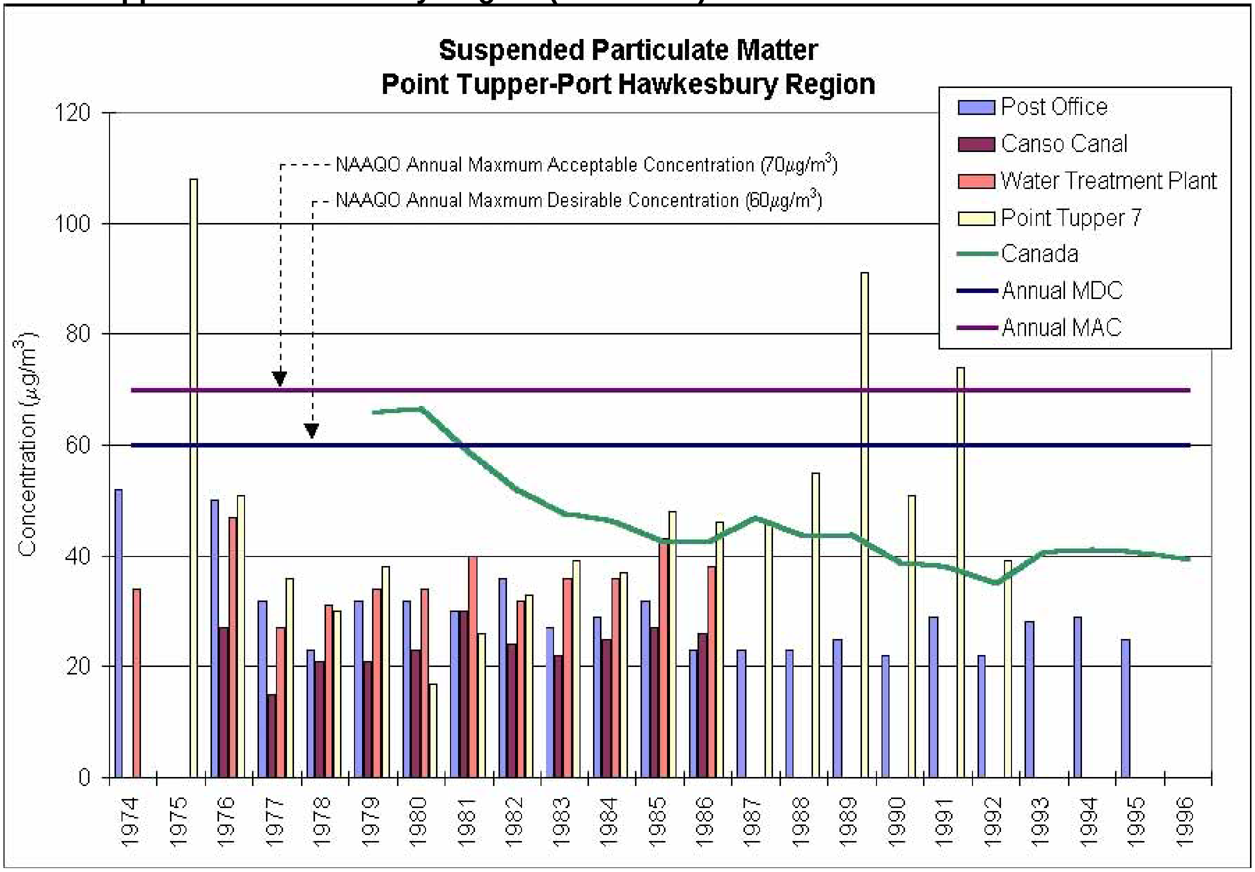


Figure 5.3-6: Annual Mean Concentrations Suspended Particulate Matter (Reg/m^3) for Point Tupper Port Hawkesbury Region (1974-2000)



5.4 NOISE

5.4.1 Background

Both the Federal and Provincial governments provide guidelines on assessment for onshore noise in the following documents:

- Nova Scotia Department of Environment Guideline for Environmental Noise Measurement and Assessment
- Health Canada Draft Guideline on Noise Assessment for CEAA projects.

The Federal draft guideline for noise assessment on CEAA projects requires noise to be characterized in the following ways:

- Baseline noise levels;
- Construction noise levels; and
- Operational noise levels.

The document requires that monitoring be performed at specific sensitive receptor sites including hospitals, schools, day cares, senior's residences, and selected residences in the area.

The Provincial Guideline was developed to facilitate the evaluation of noise pollution in the environment and establish acceptable sound levels. The guidelines for acceptable equivalent continuous sound levels (Leq) are:

- Leq of 65 dBA between 0700 to 1900 hours;
- Leq of 60 dBA between 1900 to 2300 hours; and
- Leq of 55 dBA between 2300 to 0700 hours.

Typical noise guidelines are usually related to time of day, since noise impacts are generally perceived as being of the nuisance variety in terms of human activity, which also varies by time of day. To ensure that a representative sample is collected during any one of the periods, a minimum of two continuous representative hours of data in one period is required, unless the sound being generated is reasonably steady and the Leq is not expected to change drastically.

The context for noise assessment may be assisted by an understanding of typical noise levels for a variety of scenarios/activities. These are described in Table 5.4-1.

Table 5.4-1 Typical Noise Values

Sound Level (dBA)	Descriptor
0-25	Threshold for Normal Hearing
10	Normal Breathing
40 (generally lower limit of ambient sound)	Quiet Office, Quiet Residential Street
50	Rainfall
50-60	Typical Office
60-95	Typical Household Appliances
80-120	Typical Construction Equipment
110	Jet Takeoff

5.4.2 Baseline Noise

The proposed Project location is in a rural area. Currently there are very few sources of noise at and near the MIT site, with the largest contributor to the area being highway traffic along Route 344. Intermittent noise from industries across the Strait, such as Statia Terminals and NewPage, may also be experienced on a variable basis depending upon weather conditions. No such occurrences were experienced during the baseline survey.

Baseline noise monitoring was performed at eight locations between November 12 and November 14, 2007 (Figure 5.4-1). Measurements were taken to comply with NSE guidelines, and varied from day to night but all fell within the NSE designated time periods described above. In some cases, only 1 hour of data was collected as the sound being generated was reasonably steady and the Leq was not expected to change drastically. Given the limited noise sources in the area, this sample can be considered representative of typical noise levels in the area of the Project. Results are reported as Leq and are presented in Table 5.4-2. All sites measured below the guidelines for equivalent continuous sound levels. Supplementary results for additional noise monitoring of sound levels as frequencies is provided in Appendix 5.4-A.

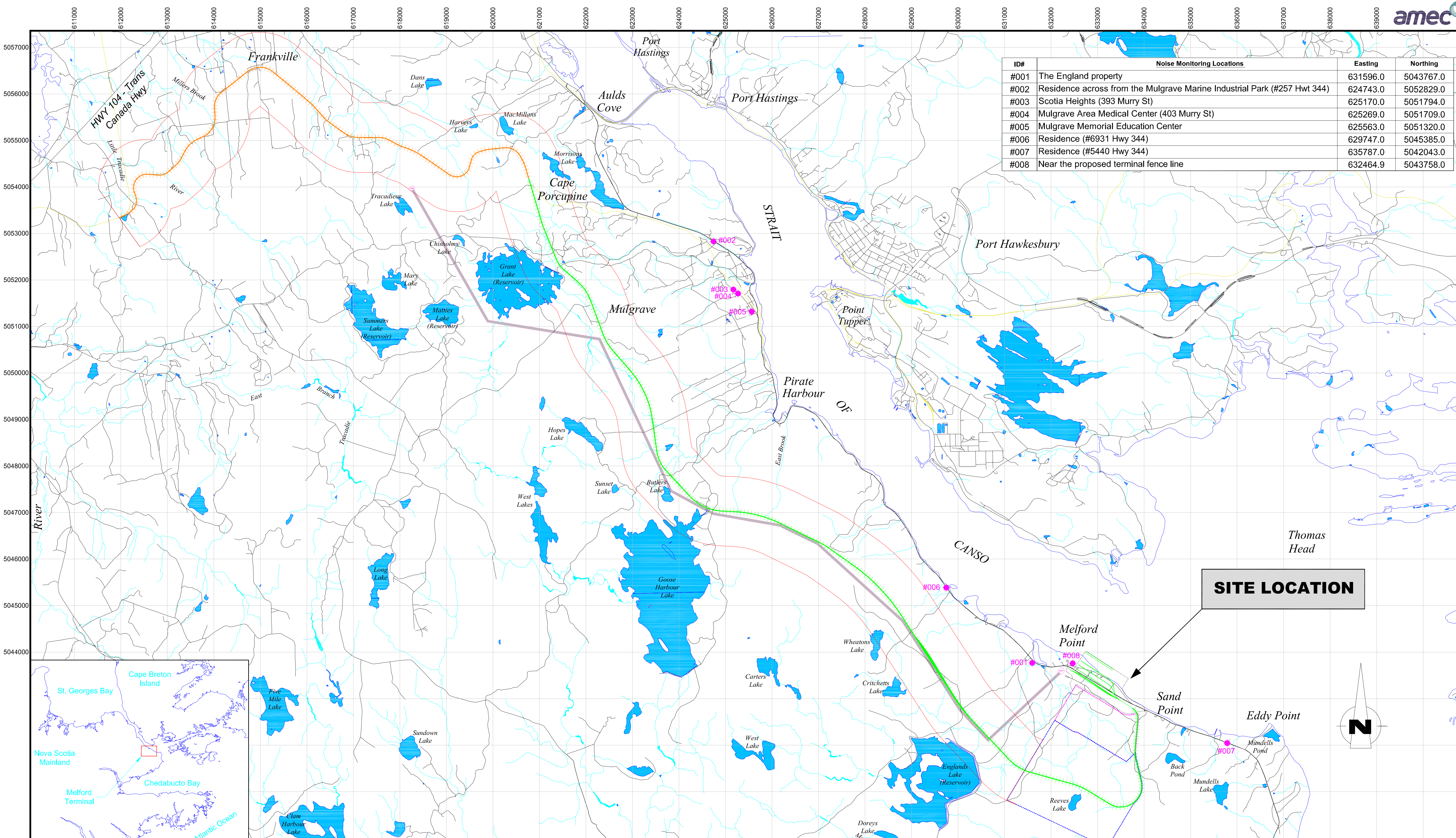
Table 5.4-2 Noise Monitoring Results

Location	Description	Date/Time	Conditions / Observations	Leq – 1-2 hour (dBA)[1]	
				Measured Results	**N.S. Guidelines**
001	The England Property – the designated closest residential receptor to the proposed terminal footprint.	Nov 13, 2007/ 10:28-12:31	Mean daily temperature of approx 1.5 °C and total precipitation < 1mm.	48.2	65
		Nov 13, 2007/ 21:01-23:03		44.4	60
		Nov 13, 2007/ 23:04-4:05		43.1	55
002	Residence Across from the Mulgrave Marine Industrial Park (#251 Hwy 344)	Nov 14, 2007/ 14:21-15:21	Mean daily temperature of approx 5.2 °C.	57.2	65
003	Scotia Heights Retirement Home (#393 Murray St)	Nov 12, 2007/ 20:59-23:00	Mean daily temperature of approx 1.5 °C and total precipitation < 10mm.	41.8	60
		Nov 12, 2007/ 23:00-0:51	Mean daily temperature of approx 1.5 °C and total precipitation < 10mm.	38.9	55
004	Mulgrave Area Medical Center (#403 Murray St)	Nov 14, 2007/ 13:40	Mean daily temperature of approx 5.2 °C.	---	---
005	Mulgrave Memorial Educational Center	Nov 14, 2007/ 14:31-15:31	Mean daily temperature of approx 5.2 °C. The following sources of noise were observed: • Children playing; • Passing cars and an ATV (during the initial stages of data collection); and • The school's PA system (during the final stages of data collection).	46.1	65
006	Residence (#6931 Hwy 344)	Nov 14, 2007/ 10:06-11:06	Mean daily temperature of approx 5.2 °C. Occasional occurrences of passing traffic and noise generated by crows were observed.	60.1	65

Table 5.4-2 Noise Monitoring Results

Location	Description	Date/Time	Conditions / Observations	Leq – 1-2 hour (dBA)[1]	
				Measured Results	N.S. Guidelines
007	Residence (#5440 Hwy 344)	Nov 13, 2007/ 8:34-9:34	Mean daily temperature of approx 1.5 ^{o}C and total precipitation < 1mm.	51.4	65
008	Near Proposed Terminal Fence Line	Nov 13, 2007/ 10:45-12:26	Mean daily temperature of approx 1.5 ^{o}C and total precipitation < 1mm.	44.7	65

--- Parameter not measured at that location
( ) Approximate time of sample collection
[1] Data was combined for sites 003 and 008. An equation was used to determine the Leq.



ID#	Noise Monitoring Locations	Easting	Northing
#001	The England property	631596.0	5043767.0
#002	Residence across from the Mulgrave Marine Industrial Park (#257 Hwt 344)	624743.0	5052829.0
#003	Scotia Heights (393 Murry St)	625170.0	5051794.0
#004	Mulgrave Area Medical Center (403 Murry St)	625269.0	5051709.0
#005	Mulgrave Memorial Education Center	625563.0	5051320.0
#006	Residence (#6931 Hwy 344)	629747.0	5045385.0
#007	Residence (#5440 Hwy 344)	635787.0	5042043.0
#008	Near the proposed terminal fence line	632464.9	5043758.0

LEGEND:

- Proposed Melford Rail Track
- Proposed Melford Rail Track (On Existing Rail Bed)
- Existing Route 344
- Road Network
- Railroad Network
- Proposed Melford International Terminal
- Environmental Baseline Study Corridor
- Initial Logistics Park
- Future Logistics Park Expansion
- Proposed NSPI Easement
- # GPS Locations

Figure 5.4-1
Melford International Terminal
Baseline Noise Monitoring Sites
July 2008

5.5 OCEANOGRAPHIC CONDITIONS

Melford is situated on the south shore at the southern end of the Strait of Canso off Chedabucto Bay. For the purpose of oceanographic analysis, the general exchange of ocean water is of concern and the area of interest includes the entire southern Strait and adjoining waters. The Strait itself is a relatively narrow body of water (1 - 2 km wide) separating mainland Nova Scotia from Cape Breton Island (Section 1.0, Figure 1.1-1). The construction of the causeway, near the middle of the Strait, in 1955, effectively blocked flow and divided the Strait into two oceanographically distinct bodies of water, north and south of the Causeway. The southern portion of the Strait is approximately 15 km long to its southern end at Bear Head, across from Melford, and communicates with Chedabucto Bay through a relatively deep channel. Since the construction of the Canso Causeway, the Strait has become a tidal inlet. Flows to Northumberland Strait are limited to very small volumes associated with the operation of a lock in the Causeway.

The key oceanographic attributes of the southern reach of the Strait of Canso are the lack of freshwater input, the great length and narrow width, and the relatively deep bathymetry. The potentially important oceanographic processes operating at the Melford study site include tides, estuarine flow, wind driven flow, horizontally sheared flows and, because of the depth and proximity to shelf waters, low frequency layered flows due to shelf processes. The latter can potentially provide a very effective mechanism for water renewal within the inlet and have been found to be extremely important flushing mechanisms in other inlets along the Atlantic coast. A quantitative description of the effects of these flows is not simple, however, and much of what is known about this process has been learned during recent extensive studies of Halifax Harbour and Sydney Harbour (COA 2000a; COA 2000b). In these studies, it was found that layered currents were as important as all other mechanisms in contributing to flushing of sewage discharge from the harbour. The weaker tides and lower freshwater input found in the Strait of Canso suggests that layered currents play an even larger role in the overall process of water exchange and renewal there.

5.5.1 Bathymetry

Bathymetry in the study area has been obtained from the Canadian Hydrographic Service (CHS) Chart # 4306, which covers the entire Strait at a scale of 1:25,000 (Figure 5.5-1). The Strait is narrow and relatively deep, greater than 60 m deep in places. The deepest area in the southern Strait is at its north end near the Causeway (Figure 5.5-1). Water depth gradually decreases to the south and is approximately 44 m in the channel near the Melford study area. The channel ends in Chedabucto Bay where it encounters a sill of approximately 35 m depth. This sill is well below the depth of the summer thermocline along the coast and hence currents in the Strait are expected to be directly affected by coastal upwelling/downwelling events and by shelf-generated internal waves.

5.5.2 Hydrography

The density of seawater is determined by temperature and salinity. Ambient seawater density distribution is very important in the analysis of the oceanography of a coastal inlet. When waters are density stratified, with less dense (fresher and/or warmer) water overlaying layers of denser water (saltier and/or cooler), the currents are often quite different between layers. The stratification can change the effect of other oceanographic forces, particularly winds, and will affect the exchange of water within the inlet and between the inlet and surrounding waters. There is a reasonable amount of salinity and temperature data for the Southern Strait of Canso. Lawrence (1972) reports data collected from 1968 - 1970. This represents 5 sampling periods, three in summer (July - August) and two in late fall (November) giving a total of 11 salinity/temperature surveys.

Cranston et al. (1974) report near surface (1 - 5m) salinity and temperature data collected at twenty sites in the Southern Strait during the summer of 1973. Each site was sampled several times at different depths; however, the times are not reported so that the construction of a synoptic picture is not possible. In addition data are not reported to a sufficient level of accuracy for detailed analysis. The range of salinities is 27 - 32 practical salinity units. Vilks et al. (1975) includes a more detailed presentation of what appears to be the same 1973 data. This consists of temperature and salinity contours on a vertical section down the southern reach of the Strait during seven surveys in early May to mid-August. The sample stations reported in Lawrence (1972) were essentially repeated.

The most notable feature of the composite of these data is the large variability in the distribution of water properties throughout the study period. While there is seasonal variability, the most significant variation is within seasons. In fact, the most stratified and least stratified conditions measured in the 1973 surveys were observed in sequential surveys, two weeks apart in August. These results seem to indicate that stratifying influences, local warming and freshwater input are modulated by meteorologically-driven circulation which alternately traps warmer, fresher surface water against the causeway and then flushes it out, replacing it by colder, saltier and more homogeneous ocean water through upwelling processes.

5.5.3 Waves

Directional statistics on wave climate were calculated using wind data from MSC50, a hindcast of hourly data provided by Meteorological Services Canada (MSC50, 2006). The data cover the years 1954 to 2005, inclusive, and include consideration of iced-over periods. The closest MSC50 node to the Melford site was node 8762 (Lat 45.5N, Lon 61.1W, Depth 52.39 m) (Figure 5.5-2).

The predominant wave direction of node 8762 is from the southeast (32 percent of the time). This is also the direction of the highest waves, which is expected, as it provides the longest fetch as well as exposure to offshore waves. Maximum sea state corresponds to a significant wave height of 3.8 meters. Sea states with a significant wave height in excess of 3.5 meters occur only 0.001 percent of the time (Table 5.5-1). Comparatively, sea states with a significant wave height above 1.5 occur approximately 2.5 percent of the time, and sea states with significant wave height less than 1 meter make for 85 percent of the time.

Maximum wave heights in the winter months are greater than those in the summer months (between 3.5 and 4 metres in winter, compared to between 3 and 3.5 metres in summer) (Figures 5.5-3 and 5.5-4). Although the predominant yearly wave direction is from the southeast, in winter months (October-February) wave direction is more distributed through all directions, than it is in the summer months (April-September) (Figures 5.5-3 and 5.5-4).

Table 5.5-1: Yearly Statistics for Frequency of Occurrence of HSIG by Direction for Node 8762

Hs/M	N	NE	E	SE	S	SW	W	NW	TOTAL
3.5 – 4.0	0	0	0	0.001	0	0	0	0	**0.001**
3.0 – 3.5	0	0	0	0.010	0	0	0	0	**0.010**
2.5 – 3.0	0	0	0.012	0.096	0.010	0	0	0	**0.118**
2.0 – 2.5	0	0.004	0.063	0.293	0.089	0.022	0.001	0	**0.472**
1.5 – 2.0	0.036	0.097	0.310	0.878	0.404	0.240	.0147	0.024	**2.136**
1.0 – 1.5	0.476	0.553	1.025	2.488	1.816	2.409	1.460	1.424	**11.651**
0.5 – 1.0	5.275	1.958	1.900	5.885	7.018	8.831	5.950	4.548	**41.364**
0.0 – 0.5	2.611	1.226	1.348	22.811	5.742	4.756	4.156	1.598	**44.247**
TOTAL	**8.399**	**3.839**	**4.659**	**32.462**	**15.078**	**16.257**	**11.713**	**7.594**	**100.00**

Note: significant wave height (HSIG)

As offshore swells from the southeast propagate into the Strait, they are affected by attenuation and refraction and can be expected to result in less severe sea states at the Melford project site than at the MSC node #8762. The only two directions with enough fetch to expose the Melford project site to locally generated waves by storm winds are from the Northeast down Lennox Passage and to a lesser extent from the Northwest down the southern Strait of Canso. The Melford project site is naturally sheltered by the shape of the coast line from swells and locally wind generated waves. Derivation of a complete wave climate at the Melford project site from that at MSC50 node#8762 using a high resolution wave generation and propagation model is beyond the scope of the present study, and may be required at the design stage.

5.5.4 Tides

Tides in the Strait of Canso are semi-diurnal, meaning there are two equal high waters and two equal low waters each day. The two nearest CHS tide stations to Melford are Point Tupper (Station #0576) to the northwest, and Sand Point to the southeast (Station #0563) (Figure 5.5-5). Tides as reported by CHS tide tables (2007) are summarized in Table 5.5-2. The tides in the Strait are weak due to the causeway, because there is no two-way tidal flow between the Gulf and the Atlantic.

Table 5.5-2: Summary of Tide Levels from CHS Tide Tables

Station No.	Station Name	Mean Water Level (m)	Range	
			Mean Tide (m)	Large Tide (m)
0576	Point Tupper	0.9	1.4	2.0
0563	Sand Point	0.9	1.4	2.0

The most thorough analysis of currents in the Strait was conducted by Lawrence et al. (1973). Results reported a mean tidal range of 1.4 metres, which matches the CHS tide station data.

5.5.5 Currents

Analysis of currents in the Strait conducted by Lawrence et al.(1973) show currents very much reduced in magnitude since the construction of the Causeway. Prior to the construction of the Canso Causeway, the differing tidal regimes of the Atlantic Ocean and the Gulf of Saint Lawrence resulted in strong currents through the Strait of the order of 2m/s (NSPI, 2003). After construction of the causeway Lawrence et al. (1973) found the main tidal component to have a magnitude of about 0.02 m/s at a current meter site approximately half way between the causeway and the Melford project site. This is consistent with the maximum tidal currents in the area predicted to be of the order of 0.10m/s (Figure 5.5-6). This figure shows currents in the vicinity of Sand Point as modelled with DFO's WebTide (Dupond et al., 2002).

Current direction is primarily confined to the direction of the Strait channel. Current data for the Strait of Canso, offshore of the Melford area, were extracted from the Bedford Institute of Oceanography (BIO) Ocean Data Inventory (ODI) database (BIO, 2007) (Figure 5.5-7).

The mean values of current speeds from the recorded time series are low and confirm Lawrence et al.'s observations further north in the Strait (Table 5.5-3). Mean values of recorded current speeds across all seasons remain fairly constant, ranging between 0.01 and 0.11 m/s. As well, currents in the upper water column are generally slightly higher than those at deeper depths.

Table 5.5-3: Summary of ODI Mean Current Speeds Offshore Melford, by Season

Season	Depth	Mean current speed range (m/s)	Max current speed range (m/s)
Fall	Upper water column (7-8m)	0.01-0.07	0.18-0.50
	Lower water column (23m)	0.01-0.05	0.22-0.29
Winter	Upper water column (8m)	0.01-0.11	0.13-0.55
	Lower water column (23m)	0.01-0.05	0.09-0.34
Summer	Upper water column (8m)	0.02-0.08	0.14-0.58
	Lower water column (11-12m)	0.01-0.04	0.15-0.31

In contrast with the relative weakness of the tidal currents, current records show maximum speeds up to the order of 0.5m/s in the upper part of the water column and up to order of 0.3m/s in the lower part of the water column in all seasons, indicating that currents in the Strait are dominated by processes other than tides. This data also revealed that currents between 0.1m/s to 0.2m/s occur routinely at sub-tidal frequencies. These low frequency currents are associated with the response of the region to wind forcing and interaction of the stratification of the water column with the bathymetry, on the scale of the continental shelf, and are very difficult to predict. These currents, because of their persistence, are much more effective at transporting water than tidal currents of similar magnitude. The fact that these low frequency currents vary with depth in the water column is consistent with the presence of significant internal waves in the Strait, as has been demonstrated by a limited amount of profiled velocity data (Lawrence et al. 1973). This single set of observations demonstrated that the flow in the Strait was occurring in three distinct layers: a surface and bottom layer with water moving toward the sea while flow at mid-depth was toward land.

5.5.6 Sediment Transport

The change in current climate before and after the construction of the causeway had an effect on the sediment transport in the Strait. Sediment samples taken from area to be dredged indicate that fine particles (silt and clay) make between 8% and 57% of the sediment. During the pre-causeway era, strong tidal currents (about 2m/s) in the Strait of Canso prevented the deposition of fine material, hence the presence of coarse material (gravel and sand) (NSPI, 2003). After construction of the causeway, tidal currents were reduced to just about a few cm/s and maximum observed bottom currents are only about 30cm/s. This drastic reduction in the strength of currents has allowed the slow deposition of the finer material at a rate of 1 to 2 mm per year (Lewis and Keen, 1990; Parrot et al., 2005). The source of sediments in waters to the south of the causeway is likely from local natural sources such as eroding shorelines and small drainage systems, and anthropogenic sources such as urban and industrial wastes (NSPI, 2003).

5.5.7 References

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Lewis C.F.M. and M.J. Keen. 1990. Constraints to development. In: Geology of the Continental Margin of Eastern Canada, Chapter 14. M.J. Keen and G.L. Williams (ed); Geological Survey of Canada, Geology of Canada, No. 2, (also Geological Society of America, The Geology of North America, V. I-1).

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Parrot D.R, M.B. Parsons, V.Kostylev, J. Shaw, and K-L Tay, 2005. Seafloor Character of Canso Strait, Nova Scotia - 50 Years after Completion of the Canso Causeway. Canadian Coastal conference 2005. Published by Natural Resources Canada and Environment Canada.

Figure 5.5-1: Bathymetry of the Study Area

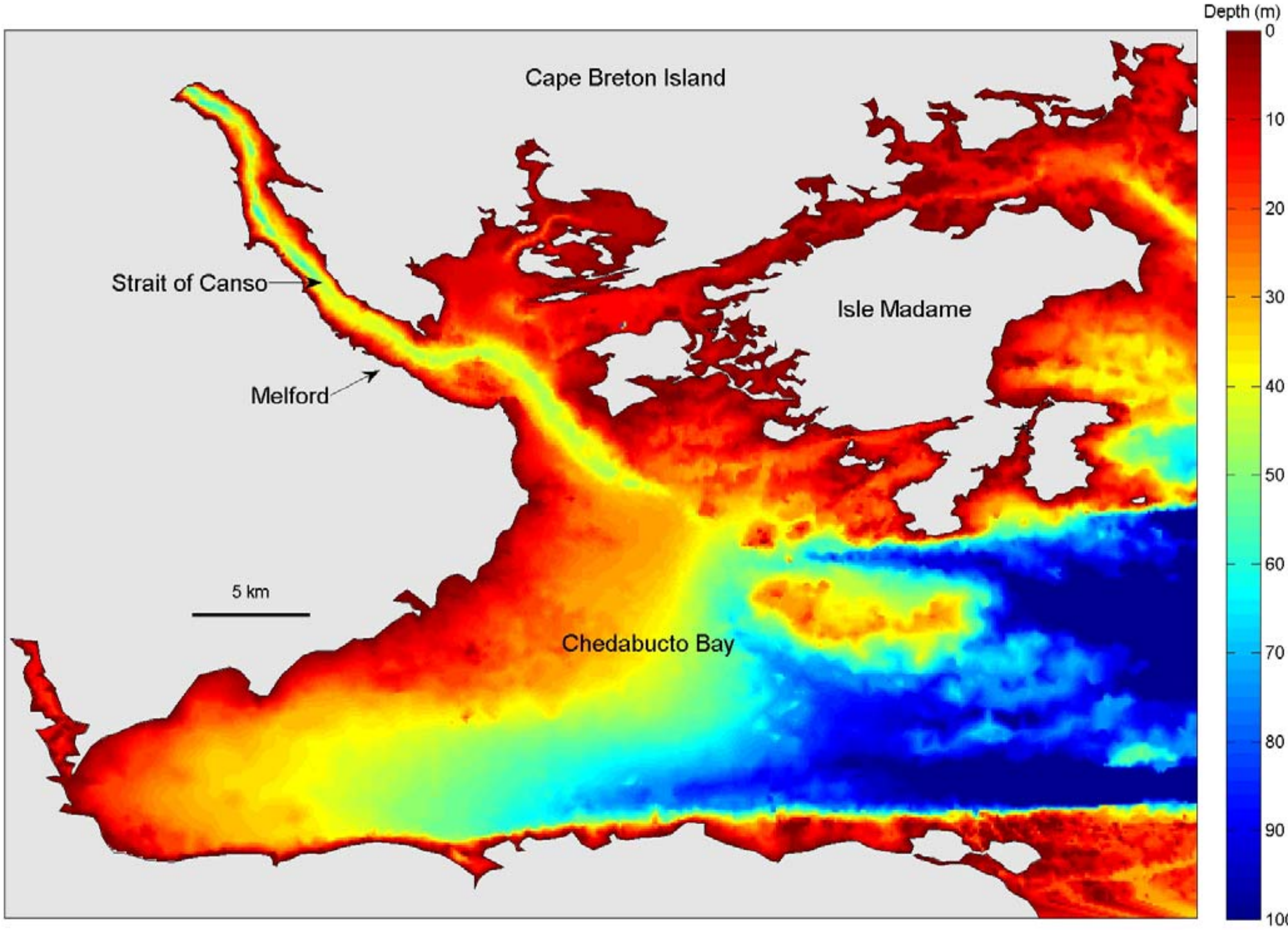

Figure 5.5-2: Location of MSC50 Grid Node 8762

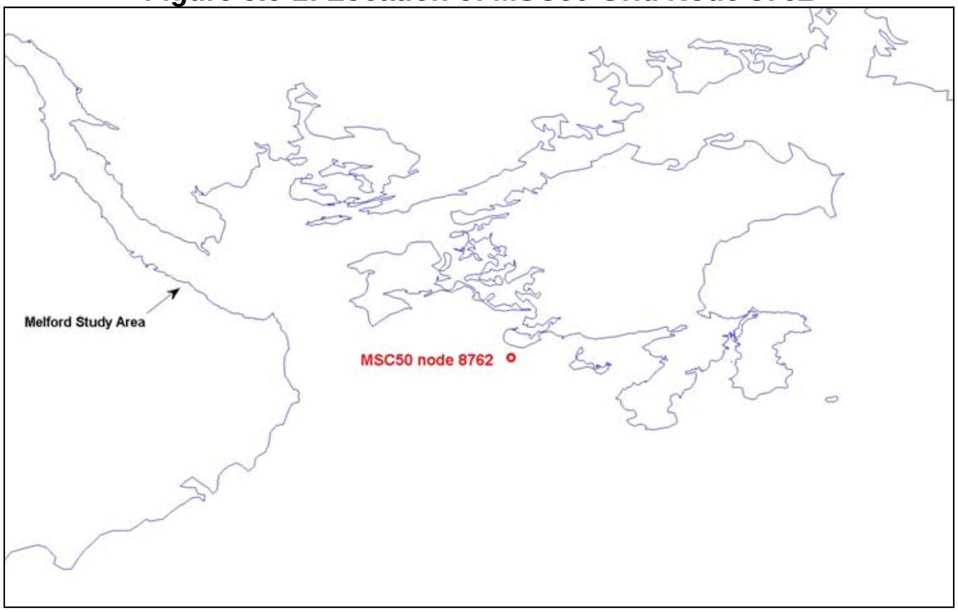

Figure 5.5-3: Annual Wave Rose at MSC50 Grid Node 8762

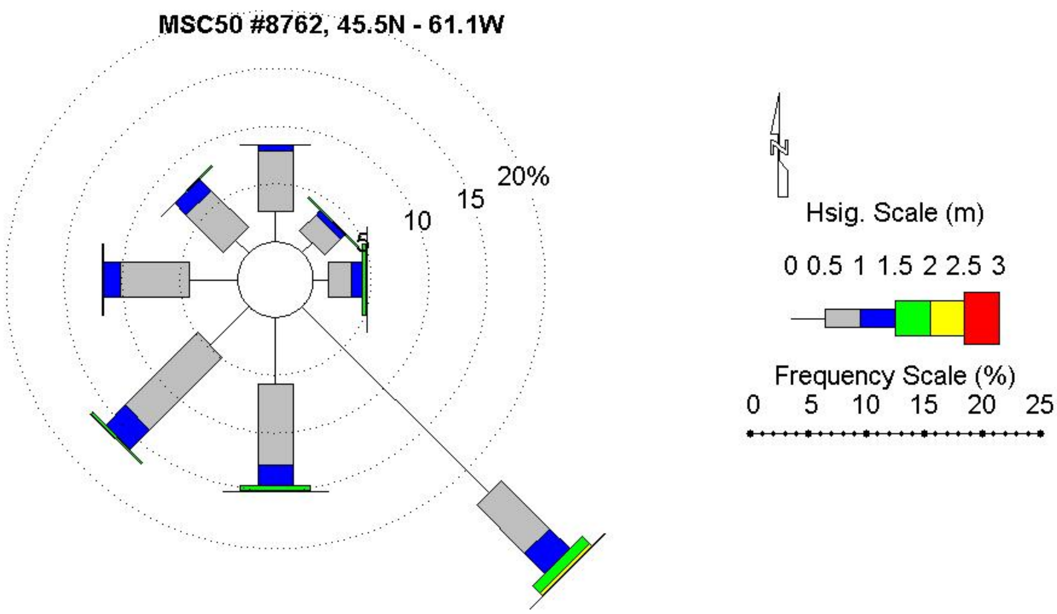

Figure 5.5-4: Monthly Wave Roses at MSC50 Grid Node 8762

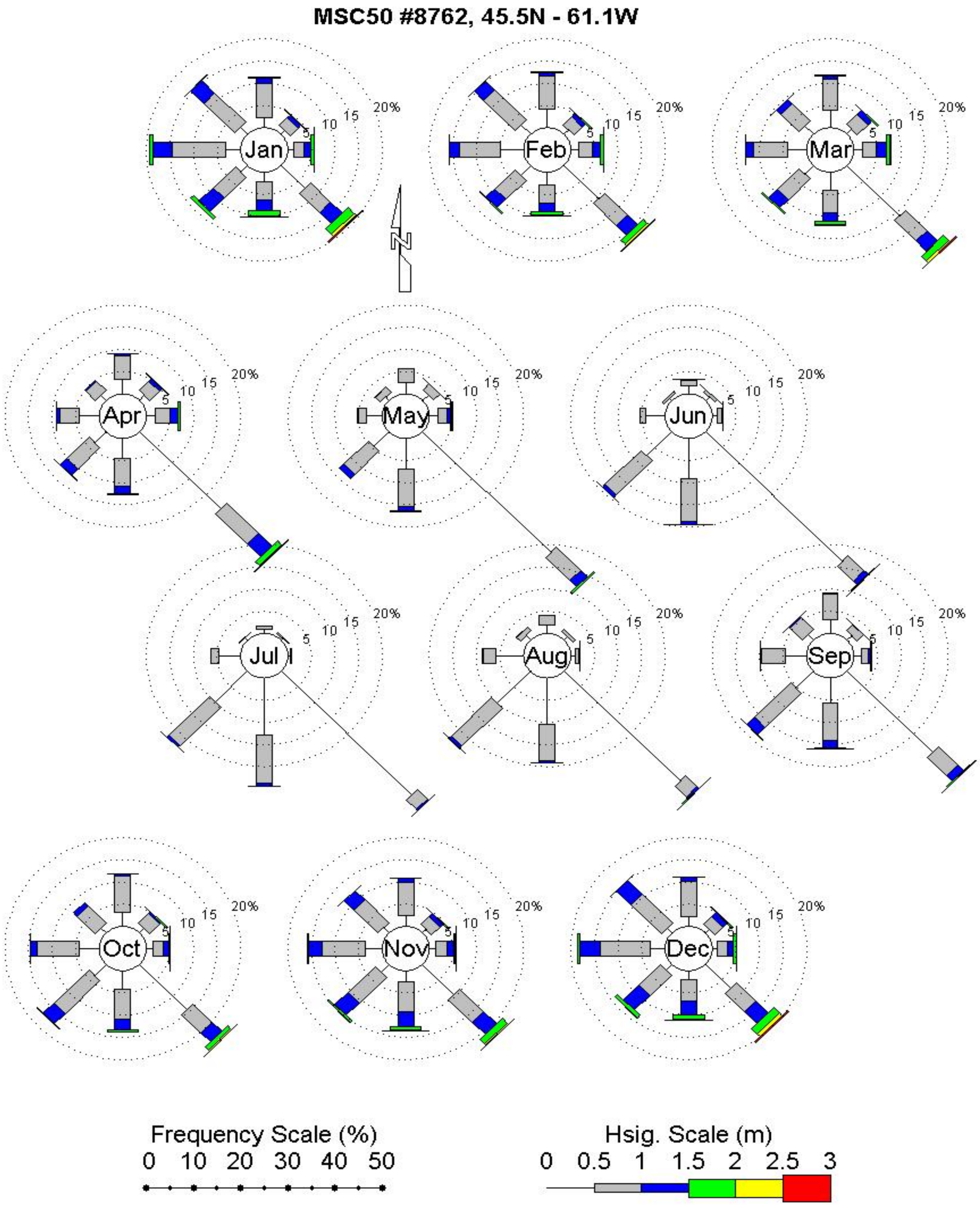

Figure 5.5-5: Canadian Hydrographic Services Tide Stations in the Northumberland Strait (Canadian Hydrographic Services, 2007)

Figure 5.5-6: Webtide Predicted Current Ellipse for 2007

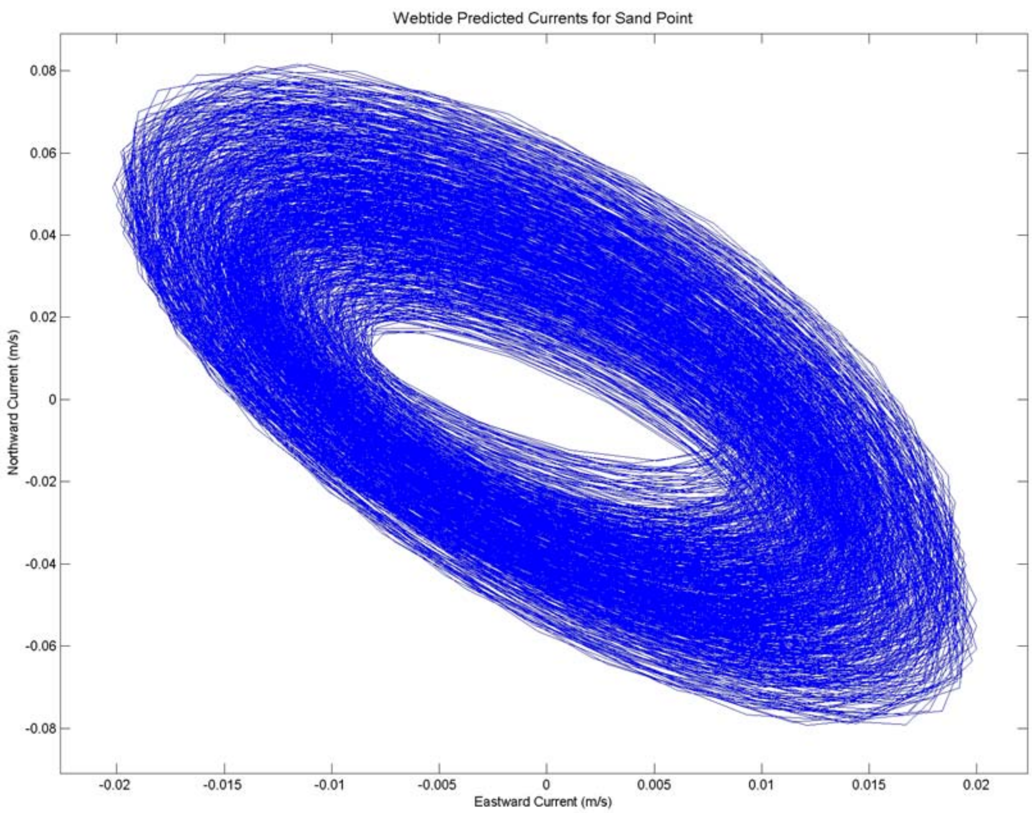

Figure 5.5-7: Location of Current Records from Ocean Data Inventory (BIO)