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9.0 POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT

9.1 INTRODUCTION

In accordance with the methodology discussed in Section 4.0 and in response to the EIS Requirements Document the potential effects of the environment on the Project were assessed. This assessment was conducted in a step-wise fashion:

- identification of potential interactions between the environment (primarily natural hazards) and the Project;
- description of Project-inherent design features intended to protect the Project as a result of exposure to the environment (description of mitigation measures); and
- identification of potential residual effects and assessment of their significance.

As part of the ongoing Project pre-design and ultimately the final design, these types of potential effects from the environment are considered and the Project modified accordingly.

9.2 INTERACTION OF THE ENVIRONMENT WITH THE PROJECT

Four environmental conditions were identified for which an interaction with the Project can be reasonably expected:

- extreme weather (precipitation, wind);
- extreme marine conditions (wave action, ice);
- climate change; and
- seismic events.

The individual conditions and the potential for specific interactions with the Project are discussed further in Sections 9.4 to 9.7.

9.3 PROJECT DESIGN COMPONENTS

As part of the ongoing Project pre-design a number of features have been integrated with proposed Project works and activities that have been specifically designed to minimize the potential for adverse effects of environmental conditions on the Project. These measures include:

Extreme Weather

- Dimensioning stormwater management system and all new creek channels for low frequency storm events (1 in 100 year, 24 hour (hr), rain events; dimensioning will consider most up-to-date IDF (Intensity, Duration and Frequency) information such as that provided by Environment Canada (http://climate.weatheroffice.ec.gc.ca/prods_servs/index_e.html) as well as the latest research on the potential for the increased frequency of such events.
- Consideration of additional storm water volumes as a result of increased development (Mulgrave Industrial Park) in upstream watersheds in the dimensioning of all new channels.
- Dimensioning of new culvert and bridge structures along the new rail corridor for low frequency storm events (1 in 100 year, 24 hour (hr) rain events).

- Implementation of erosion and sedimentation control plans during the construction phase with sufficiently large dimensioned surface water drainage swales, erosion control swales and holding ponds.
- Scheduling of Project works, i.e., ensuring surface water management infrastructure is in place before the start of large excavation and earth works.
- Development and implementation of Operations Plan that defines weather conditions at which land –based operations (e.g., crane operation for loading and unloading) will be restricted or no longer permitted.

Extreme Marine Conditions

- Monitoring of site-specific oceanographic conditions to generate site-specific design parameters may be required.
- Detailed design and engineering of marine components (wharf and infrastructure such as cranes) on the basis of existing marine data and modeling of potential (extreme) oceanographic conditions (wave height, currents, water levels, ice pressure).
- Detailed design and engineering of marine components in accordance with all applicable standards and regulations.
- Development and implementation of Operations Plan that defines weather conditions at which berthing will no longer be permitted/ vessels will be required to vacate the wharf.
- Monitoring of weather and marine conditions at MIT; routine communication between approaching vessels and MIT with briefing on site-specific weather / marine conditions.

Climate Change

- Consideration of long-term sea level rise in design and engineering of wharf and mooring facilities.
- Consideration of increase in frequency and strength of storms and rainfall events in design and engineering of storm water management system.

In addition to the above, the Project operation will entail monitoring programs and regular facility inspection, maintenance, and repair, in particular of:

- stormwater management and drainage systems;
- shore stabilization works;
- culverts and bridge crossings; and
- water course embankments.

9.4 EXTREME WEATHER

Over the past few years, extreme weather events appear to be occurring more frequently in the Atlantic Region. Recently, Nova Scotia has been subjected to drought, heavy precipitation events and a major landfall hurricane, Hurricane Juan. Based on information from available climate data and sophisticated climate system models, Environment Canada has indicated that extreme events such as drought and local severe storms are increasing in frequency and severity, and are projected to further increase through the next century. Future tropical events are projected to be more intense with climate change. Projections of global warming include a warming ocean, and hence indicate that such a source of energy will continue to intensify tropical features such as Hurricane Juan far beyond the level that has been seen historically (Environment Canada, 2004).

Storms frequently pass close to the Atlantic coast of Nova Scotia, producing highly changeable and severe weather. Extreme weather events have the potential to delay construction of the proposed project, and to damage product moved, proposed project infrastructure and related vessels. Extreme weather events may include wind, heavy rainfall or snowfall, hail, lightning, and fog.

The ocean has a moderating effect on temperature along Nova Scotia's eastern shore, and while attention may have to be given to some materials (reduced ductility) during construction in cold weather, the proposed project is not expected to be affected significantly by the extreme levels of cold or heat typically experienced in Nova Scotia.

9.4.1 Wind

Winds blow predominantly from the south or southwest during summer and from the northwest during winter, although severe storms, including summer hurricanes and winter “nor’easters” may generate strong winds from the northeast. High winds could have an effect on the transfer of product to/from ships. High winds can also increase structural loading on large or tall structures. Due consideration to wind must be given to components design.

9.4.2 Precipitation

The mean annual total precipitation for the proposed project area for the 1971 to 2000 time period was 1538.6 mm. Although rain may occur in any month of the year, rainfall in the proposed project areas is generally highest during fall. Snow and freezing precipitation can occur between October and May, with the largest amounts falling between December and March. Storm precipitation events in the proposed project areas can be severe with extreme daily precipitation as high as 132.1 mm for a 24 hour period.

Extreme rain can result in stoppages of outdoor work, particularly during construction. If unusual wet periods or excessive rain do occur, this can result in project delays and an associated delay in completion and could result in additional capital cost. Heavy rainfall events may also cause work-site erosion during the construction phase. A potential exists for failure of erosion and sediment control structures due to such precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving watercourses with potential adverse environmental effects on fish and fish habitat.

Extreme snowfall can affect winter construction or contribute to unusual flooding during snow-melt. It has the potential to increase structural loadings on facility and temporary buildings. Exceptional early snowfall could delay construction and result in additional work for snow clearing and removal. This could increase construction costs. Early snow cover can minimize or prevent ground freezing and this may also affect winter construction intended at improving work progress and accessibility. Freezing rain, hail, ice and snow can interfere with the operation of vehicles on the highway, as it can cause slippery driving conditions and limit visibility. However, these effects should be no worse than on any other highway crossing Nova Scotia.

9.4.3 Lightning

Severe weather events during which there is lightning are usually of short duration. Therefore, lightning is not considered to be a concern during construction or operation of the facilities.

9.4.4 Fog

Dense inland fog is more prevalent in late spring and early summer. Chilled air above southerly-flowing ocean currents mixing with warm, moisture-laden air moving from the Gulf Stream can generate bands of thick, cool fog off the coast. Dense fog originating inland may reduce visibility and can interfere with the operation of vehicles on the highway. With onshore winds, fog banks can move far inland and can interfere with the operation of vehicles near the coast and with shipping off shore.

9.4.5 Floods

Local flooding may occur at work sites during extreme precipitation events should storm-water retention ponds become filled.

9.5 EXTREME MARINE CONDITIONS

9.5.1 Extreme Winds and Waves

Extreme wind can produce high waves, dense blowing sea foam, heavy tumbling of the sea, and poor visibility. This can affect vessel navigation, the ability to berth or de-berth at MIT and/or to load and unload. Further extreme wind and wave conditions may increase the likelihood for collisions with other ships and grounding. Maximum wave height is primarily a function of wind strength, wind duration, and length of exposed water (fetch). Substantial run-up waves can occur over sloping banks, levees or breakwater during extreme storm events such as tropical storms, hurricanes, and “nor’easters,” especially in combination with the surge that may accompany them.

The extreme wave analysis based on the open ocean climatology described by MSC50 (Meteorological Service of Canada 50-year hindcast - re-analysis of wind and wave forecasts and data for previous 50 years) is provided herein to document the worst case conditions that shipping could encounter in transit to or from the project site. Although extreme wave analysis for design purposes at the project site is outside the scope of this study, analyses of significant wave height (Hsig) and wind speed were conducted on the 50-year hourly time series from MSC50 site 8762. The Fisher-Tippett Type I (also referred to as Gumbel) distribution was used in the analyses (Bury 1975; Gumbel 1958), along with the maximum likelihood curve-fitting method. Annual extremes for Hsig and Wind Speed were obtained by extrapolation on a Gumbel distribution of 50 annual maxima.

Each extreme value was computed for 5, 10, 50 and 100-year return periods. An N-year return period represents the average period of time between exceedances of the N-year extreme value. Yearly extreme Hsig and wind speed are given in the table below.

Table 9.5-1: Yearly Extreme Hsig

Return Period (years)	10	20	50	100
Hsig (m)	3.1	3.3	3.8	4.0
Wind speed, 1-hr average (m/s)	23.8	24.5	26.2	26.9

9.5.2 Extreme Sea Surface Levels and Currents

Some of the energy from wind blowing over the ocean is transferred to the surface layers, affecting the local surface currents. The processes of energy transfer are complex; however, it is generally true that the greater the speed of the wind, the greater the frictional force, and the greater the surface currents. Generally, surface current is typically about 3% of wind speed (Bearman, 1989). The maximum wind speed from MSC50 data node 8762 is 26.75 m/s, which leads to maximum surface current of 0.80 m/s. Maximum observed values, as reported in BIO's Ocean Data Inventory are on the order of 0.60 m/s. Such extreme currents generated during severe storms are almost one order of magnitude stronger than tidal currents in the area of the project (maximum tidal currents of the order of 0.10m/s).

Storm surge, the rise in sea-level that accompanies strong storms, is estimated to be potentially up to half the tidal range, from mean water level (MWL) to high water level (HWL). For Melford, this would mean a surge up to 1.1 m above normal water level. The most damaging extreme water levels occur when the storm surge coincides with high tide, resulting in water levels possibly about twice as high above MWL as is the case for normal HWL. For Melford this would translate into a sea level at 2.2m above MWL if the surge coincides with a large high tide.

While extreme currents may impact the safe operation of vessels during their approach and/or departure from MIT, high water levels could impact the loading and unloading procedures at MIT.

9.5.3 Ice Cover

Ice cover in the marine environment is of relevance to the operation of MIT as it has the potential to limit the navigability of the shipping lanes and affect the safety of the vessels during their approach and/or departure from the terminal.

Ice cover in the eastern portion of the Strait was virtually eliminated by the construction of the Causeway. In an analysis of ice and local climate (O'Neill, 1977), it was concluded that construction of the Causeway has significantly reduced ice coverage generated by low salinity flows through the Strait originating in the Gulf of St. Lawrence.

Table 9.5-2 presents a summary of the ice climate for the Cabot Strait region, from statistics based on records from 1971 to 2000 from the Canadian Ice Service. The maximum extent of ice occurs during February/March, when the frequency of presence of sea ice ranges from 34 to 50 percent and ice is predominantly fast ice and new ice. During April, as ice formed through the winter in the Gulf of St Lawrence exits through the Cabot Strait and then moves southeast around Cape Breton Island, first-year ice can be present in the project area with median concentration less than 1/10.

Table 9.5-2: Ice statistics for Arisag Harbour from Canadian Ice Service, based on 1971-2000 records

Week (month-day)	30-yr median of ice concentration (area of water surface covered by ice as a fraction of the whole area, from 1/10 to 10/10)	Frequency of presence of sea ice (%)	30-yr median of predominant ice type** when ice is present
01-01	Less than 1/10	1-15%	New Ice
01-08	Less than 1/10	0%	Open or Bergy Water
01-15 to 01-22	Less than 1/10	1-15%	New Ice

Table 9.5-2: Ice statistics for Arisag Harbour from Canadian Ice Service, based on 1971-2000 records

Week (month-day)	30-yr median of ice concentration (area of water surface covered by ice as a fraction of the whole area, from 1/10 to 10/10)	Frequency of presence of sea ice (%)	30-yr median of predominant ice type** when ice is present
01-29	Less than 1/10	1-15%	Fast Ice
02-05	Less than 1/10	16-33%	Fast Ice
02-12 to 02-19	Less than 1/10	34-50%	Fast Ice
02-26	Less than 1/10	34-50%	New Ice
03-05 to 03-05	Less than 1/10	34-50%	Fast Ice
03-12	Less than 1/10	16-33%	Fast Ice
03-19	Less than 1/10	34-50%	Fast Ice
03-26	Less than 1/10	16-33%	Fast Ice
04-02	Less than 1/10	1-15%	Fast Ice
04-09	Less than 1/10	1-15%	First-Year Ice
04-16 to 04-23	Less than 1/10	0%	Open or Bergy Water
04-30	Less than 1/10	1-15%	First-Year Ice
05-07 to 12-25	Less than 1/10	0%	Open or Bergy Water

***** Definitions of ice types***

- **New Ice:** Recently formed ice having a thickness up to 10cm, composed of ice crystals which are only weakly frozen together.
- **First-Year Ice:** Sea ice of not more than one winter's growth, with thickness of 30cm to 2m.
- **Fast Ice:** Sea ice that forms along the coast where it remains attached to the shore, to an ice wall, to an ice front, between shoals, or grounded icebergs.
- **Open or Bergy Water:** A large area of freely navigable water in which sea ice and/or ice of land origin is present in concentrations less than 1/10.

9.6 CLIMATE CHANGE

The Government of Canada defines climate change as a change in the average weather that a given region experiences (Natural Resources Canada 2007). "Weather" is the day-to-day variations in parameters such as temperature, precipitation and wind speed experienced over the Earth's surface (Barrow and Lee, 2000). "Climate" is the same conditions averaged over longer time period, usually several decades. A longer time frame is used to smooth out the small scale yearly fluctuations to obtain a true measure of the climate at a particular location. This definition of "average conditions" can be expanded to include information about the variability of climate during the time period in question as well as the information about extreme values.

Climate change is taken into consideration in this environmental assessment because of its influence on the frequency and severity of weather events (e.g., hurricanes, rainfalls etc), as well as on sea level rise and increased flood levels.

There is broad scientific consensus on the anthropogenic causes and projected effects of climate change brought about by global warming. This has led to the adoption of policies related to climate change by various levels of governments (e.g. the Kyoto Protocol; New England Governors/Eastern Canadian Premiers Climate Change Action Plan, 2001; Nova Scotia's Energy Strategy, 2001).

A regional overview of changes to climate and weather is provided by Natural Resources Canada (2007). By 2050, the Maritime Provinces are projected to experience an increase between 2 to 4 C^o in summer temperatures and future warming of 1.5 to 6 C^o during winter can be expected. Storm surges may raise the water level a metre or more above normal. Research suggests that sea level along the Atlantic coast could rise by 70 cm by the year 2100 although sensitivity to sea-level rise ranges from low to high (Natural Resources Canada 2005a). The Strait of Canso area is listed as highly sensitive to sea level rise.

The Intergovernmental Panel on Climate Change (IPCC) is an organization established by the World Meteorological Organization and the United Nations Environment Programme in 1988. Its purpose is "to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation." (IPCC, 2007) IPCC projects that global average sea level will rise between 18 and 60 centimetres in the period of 2090 to 2099 (relative to levels in 1980 to 1999). Sea level rise could impact the coastal zone in the following ways:

- changes in water levels
- changes in wave patterns
- higher storm surge flooding
- reduced duration and thickness of sea-ice coverage
- increased coastal erosion

The precipitation scenario developed by Natural Resources Canada (2005b) shows that relative to the climate period of 1961-1990, parts of eastern Nova Scotia will show a slight decline in total annual precipitation (up to 10%). However, a decline in total precipitation does not correspond to decline in extreme weather events. For example, although the total annual precipitation may decline, precipitation events can occur over a shorter time frame relative to base year giving rise to more extreme weather events.

The above discussion indicates the potential for climate change to increase the likelihood of variations from past experiences, in particular the frequency and severity of severe weather events and therefore associated flood scenarios. Given the relatively short construction period (2 years), the effects of climate change discussed above are not expected to have manifested themselves to a degree that adverse effects on the Project's construction phase are anticipated.

Since the Project is expected to "operate" for at least 20 to 35 years, it is likely to experience local consequences attributed to global climate change. Of primary concern in this context are anticipated extreme marine conditions (wave height, currents) and severe weather events. Future marine conditions are of concern with respect to the safe operation of vessels approaching and leaving the terminal, and the structural integrity of the terminal and its infrastructure (cranes). Extreme weather situations are an issue related to the stormwater management system of the site and its capacity to handle increasingly frequent and severe rainfall events. This is also a concern for the water courses crossed by the proposed new rail and route.

9.7 SEISMIC EVENTS

Although seismic activity on the eastern American seaboard is well known, the large majority of shocks are very small. With the exception of the Grand Banks earthquake of 1929 (magnitude 7.2, resulting in a tsunami causing a number of deaths in southern Newfoundland), all instrumentally determined earthquakes in Atlantic Canada have had magnitudes less than 5.2

(Rast et al, 1979). On January 9, 1982 the largest on-shore quake (magnitude 5.7) in eastern Canada within the last 68 years occurred with an epicentre in northern New Brunswick. Neither this nor previous quakes of magnitude 5 in 1869 and 1904, and 4.5 magnitude in 1855, 1922 and 1937 created notable damage (Basham et al, 1984).

The Strait of Canso is positioned in an area of low to moderate relative hazard (Natural Resources Canada 2006). This results in a 1 in 100 chance each year of experiencing minor to moderate damage (Statistics Canada, 1986).

All buildings that are constructed as part of the Project will conform to Canadian Building Codes and will consider potential seismic activities.

No potential for interaction of the Project with seismic events is anticipated due to the low frequency and seismic forces anticipated in the area, and thus there will be no adverse effects on the Project.

9.8 CONCLUSION

Taking all mitigation measures into account, no interactions between the environment and the Project during any of the Project phases were identified to affect the Project to such a degree that the residual adverse effects on any of the VECs would be considered significant.

In the detailed Project design and engineering stage, extreme weather conditions, extreme marine conditions and effects of climate change will be taken into consideration. In particular, dimensioning of the surface water management system will be based on frequency and severity of future storm events. Elevations and dimensioning of the marine terminal will be based on extreme site-specific marine conditions that are expected to result from climate change effects. Operational plans will be developed for all major components of MIT. These will include a definition of environmental conditions (e.g., fog, wind, wave action) at which normal operations can occur, at which levels specific measure will need to be implemented, or at which levels the operation will cease (e.g., wind force at which crane operation will be terminated). No potential for adverse effects from seismic events have been identified due to the infrequent occurrence and limited magnitude of any such events in the region. In addition to Project features inherent to the design, the operation of MIT will include routine inspection, monitoring, and maintenance. This will ensure that damage to any of the design features or operational aspects will be identified and corrected.

No additional mitigation measures or refinements to the Project are proposed.

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