Environmental Impact Statement: Trans-Canada Highway (TCH) Extension Project – Cornwall Phase IIB, Cornwall, Queens County, PE

Project No. 121811889

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Sign-off Sheet

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(signature)

Dale Conroy, Project Manager

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Abbreviations

AC CDC	*Atlantic Canada Conservation Data Centre*
BMP	Best Management Practices
$CaCl_2$	calcium chloride
CCCSN	Canadian Climate Change Scenarios Network
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEPA	*Canadian Environmental Protection Act*
CCME	Canadian Council of the Ministers of Environment
CMA	census metropolitan area
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CO_2e	carbon dioxide equivalent
CRA fisheries	Commercial, Recreational, and Aboriginal fisheries
DFO	Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
EIA	environmental impact assessment
EIS	environmental impact statement
EMP	environmental management plan
GCDWQ	Guidelines for Canadian Drinking Water Quality
GHG	greenhouse gas
km	kilometre
GDP	gross domestic product
LAA	local assessment area

m	metre
MCPEI	Mi'kmaq Confederacy of Prince Edward Island
$MgCl_2$	magnesium chloride
NaCl	sodium chloride
OLA	Outdoor Living Area
PDA	project development area
PEI	Prince Edward Island
PEI CLE	Prince Edward Island Department of Communities, Land and Environment
PEI *EPA*	Prince Edward Island *Environmental Protection Act*
PEI TIE	Prince Edward Island Department of Transportation, Infrastructure and Energy
PSEPP	Project-specific environmental protection plan
RAA	regional assessment area
RoW	right-of-way
SARA	*Species at Risk Act*
SSP	steel sheet pile
SOCC	Species of Conservation Concern
TCH	Trans-Canada Highway
TSS	total suspended solids
VC	valued component

1.0 INTRODUCTION

The Prince Edward Island Department of Transportation, Infrastructure and Energy (PEI TIE) is proposing to construct, operate and maintain a new roadway referred to as the Trans-Canada Highway (TCH) Extension Project: Cornwall Phase IIB (the "Project"). The Project consists of 7.8 km of new four-lane roadway with associated interchanges, overpasses and a watercourse crossing, located between North River and Clyde River, PEI.

1.1 OVERVIEW OF THE PROJECT

The proponent (PEI TIE) is proposing to realign the TCH in Cornwall, Queens County, PEI. The Project involves the construction and operation of a new highway that will range between two and four lanes of traffic, including:

- a 61 m (200 ft.) wide, 7.8 km long corridor between North River and Clyde River, PEI, beginning just west of the existing intersection in North River
- a diamond interchange at the Cornwall Road
- three overpass structures (at the Linwood, Bannockburn, and Baltic Roads)
- a watercourse crossing over the Clyde River
- a trumpet interchange where the new highway will join the existing TCH in Clyde River, PEI
- temporary work space development beyond the RoW on properties currently owned by PEI TIE that may be used as borrow pits or laydown areas during construction

For the purpose of this Environmental Impact Statement, the right-of-way (RoW) encompasses the 7.8 km long and 61 m wide corridor, and the associated interchanges, bridges, and overpasses.

The Project Development Area (PDA) comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes the RoW as well as and the associated properties owned by PEI TIE which may be used during construction as borrow pits or laydown areas. Figure 1.1 outlines the RoW and PDA for this Project.

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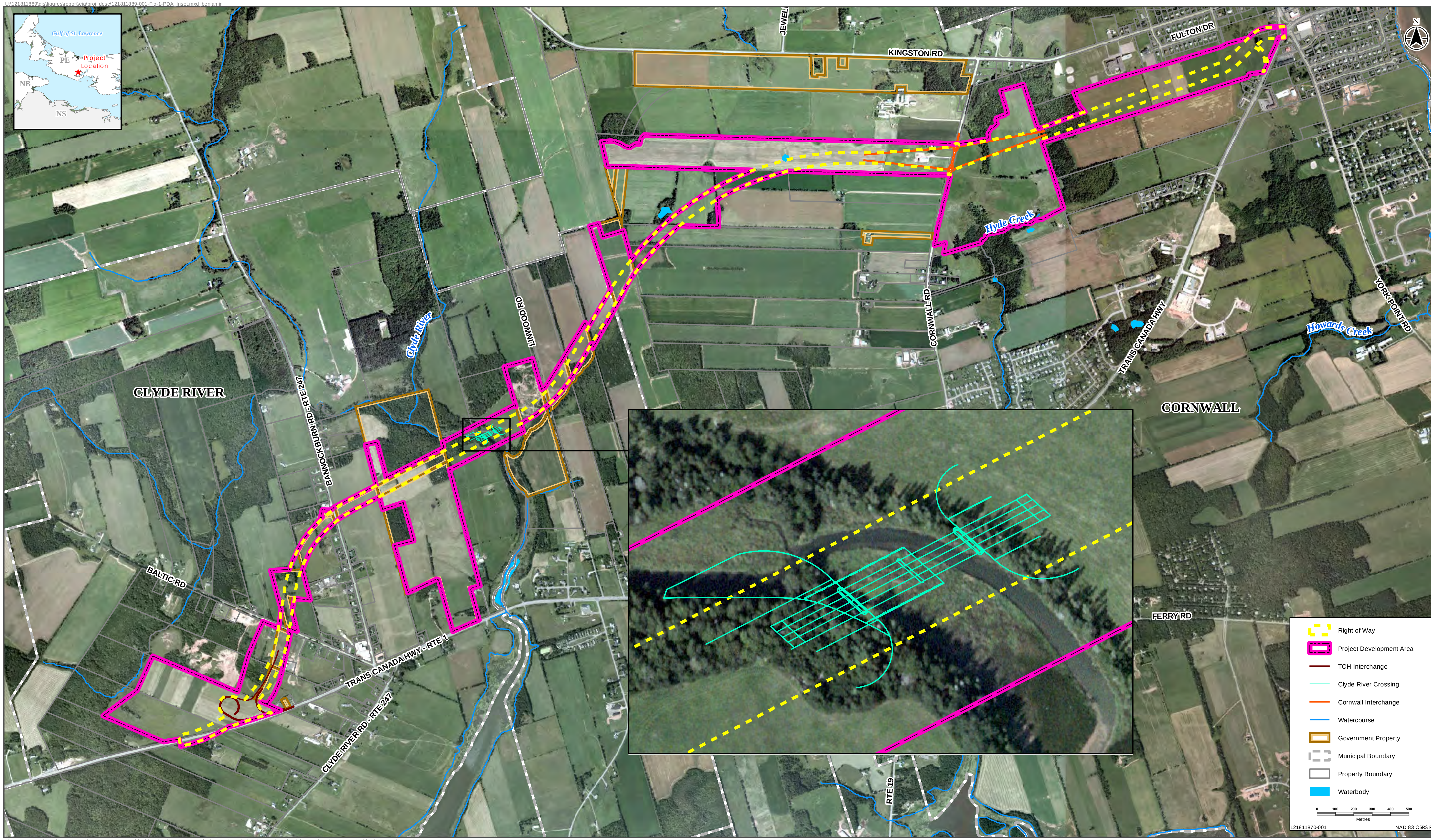

Last Modified: 6/7/2017 By: jbenjamin

Source: Base data, imagery and project data provided by the Government of Prince Edward Island. Rare Species Observation data provided by Stantec Consulting Ltd.

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121811889 - PEI CORNWALL PERIMETER HIGHWAY

Project Overview

Figure 1.1

1.2 PROJECT TITLE, PROJECT PROPONENT, AND AUTHOR OF PROJECT DESCRIPTION

The Project title and details of the Project Proponent and the environmental consultant hired by the Proponent to author this Environmental Impact Statement (EIS) are as follows:

Project Title:	Environmental Impact Statement: Trans-Canada Highway (TCH) Extension Project – Cornwall Phase IIB, Cornwall, Queens County, PE
Project Proponent:	Prince Edward Island Department of Transportation, Infrastructure and Energy 3rd Floor Jones Building Charlottetown, PE C1A 7N8
Proponent's Principal Contact Person For the purposes of this report:	Ms. Shelley Cole-Arbing Environmental Coordinator Tel: (902) 368-5095 Fax: (902) 368-5425 Email: slcole@gov.pe.ca
Environmental Consultant and Principal Contact Person for this report:	Mr. Dale Conroy, M.Sc. Senior Associate, Environmental Services Stantec Consulting Ltd. 165 Maple Hills Avenue Charlottetown, PE C1C 1N9 Tel: (902) 566-2866 Fax: (902) 566-2004 Email: dale.conroy@stantec.com

The PEI TIE "*provides for essential transportation systems for the travelling public and the effective and efficient transport of goods. It provides the infrastructure for government services in building construction, crown land management, building maintenance and accommodations. The department works to improve Prince Edward Island's physical assets including energy supply and distribution*" (PEI TIE 2016a).

The PEI TIE is the owner of the Project, and will design, engineer, construct, commission, operate, and maintain the Project.

1.3 PROJECT LOCATION

The Project will begin at the existing TCH and Route 248 intersection in North River, and travel west for 7.8 km. The new highway will join the existing TCH with a trumpet interchange approximately 1.5 km west of the Bannockburn Road and existing TCH intersection in Clyde River.

1.4 PROPERTY OWNERSHIP

The PDA is approximately 189.5 ha and the RoW is approximately 50.1 ha. Approximately 60% of the land required for the highway is currently owned by PEI TIE. The remaining properties within the Project area are currently in negotiations to be acquired by PEI TIE.

1.5 FUNDING

The Project will be funded in part by the federal government under the New Building Canada Fund, Provincial Territorial Infrastructure Component – National and Regional Projects. Thirty-two and a half million dollars ($32.5M) in funding will be granted through this federal funding program. The remainder of the Project ($32.5M) will be financed by the PEI Government, for a total of $65M.

1.6 REGULATORY FRAMEWORK

1.6.1 Provincial Jurisdiction

Based on the Prince Edward Island *Environmental Protection Act* (PEI *EPA*), an environmental impact assessment (EIA) is required to be conducted for this Project. A scoping document outlining the proposed scope of the EIA for the Project activities was submitted to the Prince Edward Island Department of Communities, Land, and Environment (PEI CLE) on February 23, 2017.

The framework for EIAs being carried out in PEI is set out in Section 9 of the PEI *EPA*.

The interpretation of the Act is provided in Section 1 of the Act. The term "undertaking" is interpreted to include any project which: (i) may cause the emission or discharge of any contaminant into the environment; (ii) have an effect on any unique, rare, or endangered feature of the environment; (iii) have a significant effect on the environment or necessitate further development which is likely to have a significant effect on the environment; or (iv) cause public concern because of its real or perceived effect or potential effect on the environment.

A major highway development is considered to be an undertaking under the PEI Environmental Impact Assessment Guidelines (PEIDELJ 2010).

Section 9(1) of the Act states that "no person shall initiate any undertaking unless that person first files a written proposal with the Department and obtains from the Minister written approval to proceed with the proposed undertaking."

Section 9(2) of the Act states that the Minister, in considering a proposal submitted pursuant to Section 9(1), may require the proponent to carry out an EIA and to submit an EIS; and to notify the public of the proposed undertaking and to provide opportunity for the public to comment.

Based on the requirement of the Act, an EIA is required for the Project and must be submitted to the Minister for approval. The PEI Environmental Impact Assessment Guidelines (PEIDELJ 2010) have been used to guide this part of the EIA.

1.6.2 Federal Jurisdiction

There is no known trigger for the Project to require an environmental assessment under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). The Project is not listed under the Regulations Designating Physical Activities under CEAA 2012, and there are no federal properties within the PDA, so an environmental assessment under CEAA 2012 is not required.

1.6.3 Permitting

1.6.3.1 Navigation Protection Act

The *Navigation Protection Act* (NPA) is intended to protect specific inland and nearshore navigable waters (as identified on the list of "Scheduled Waters" under the NPA) by regulating the construction of works on those waters and by providing the Minister of Transport with the power to remove obstructions to navigation. A "work" is defined as any structure, device or thing—temporary or permanent—made by humans that is in, on, over, under, though or across any navigable water. It also includes the placement of fill or the excavation of materials from the bed of any navigable water.

1.6.3.2 Fisheries Act

The *Fisheries Act* serves to protect fish and fish habitat federally, section 35 of the *Fisheries Act* defines contravention of the act as "serious harm" to fish which constitute a commercial, recreational, or Aboriginal (CRA) fishery. Under the Act, the requirement to gain authorization will apply only where a project results in "serious harm" to a CRA fishery. An alteration of fish habitat must be deemed to be permanent to be of regulatory consequence under the Act.

The Act also includes sections which require the provision of sufficient water and unimpeded passage for fish (Section 20 and 21) and prohibit the deposit of deleterious substances (Section 36). Projects that have the potential to obstruct fish passage, modify flow or result in entrainment (i.e., water withdrawal, pumping or hydroelectric intakes) may result in "serious harm" and may require an authorization. Deleterious substances include any substance that degrades the quality of water in an area frequented by fish to the point of causing harm or damage to fish or fish habitat; this section of the Act is generally enforced by Environment and Climate Change Canada (ECCC).

1.6.3.3 Watercourse, Wetland, and Buffer Zone Activity Guidelines

The purpose of the Watercourse, Wetland and Buffer Zone Activity Guidelines is to protect the water quality and aquatic habitat of the streams, rivers, lakes, and wetlands in Prince Edward

Island from unmitigated works in or near watercourses and wetlands. The regulation requires the issuance of a permit by the PEI CLE.

A Watercourse, Wetland, and Buffer Zone Activity Permit is required before the following:

- physical modification of the bed or banks of a watercourse or wetland, including infilling, excavation or realignment
- construction of a building or structure within 15 m of a watercourse or wetland
- operation of heavy equipment in a watercourse or wetland; or within 15 m of a watercourse or wetland
- disturb the flow of water which contribute to watercourses or wetlands
- Any disturbance of the ground or removal of vegetation within 15 m of a watercourse

2.0 PROJECT INFORMATION

2.1 PROJECT PURPOSE

The PEI TIE is proposing to construct of a 7.8 km long roadway between North River and Clyde River, PEI. The new highway will range between two and four lanes of traffic and the highway RoW will be approximately 61 m wide. While the existing TCH will continue to operate as a local road, this new extension will provide a shorter, more efficient route for traffic traveling to/from North River and Clyde River. The new alignment will ease traffic flow by redirecting thousands of tractor-trailers and cars that currently pass through Cornwall every day (PEI TIE 2016b).

Cornwall Town Council, on behalf of residents and businesses, has been requesting government for this new route to improve public safety and assist economic growth in Cornwall since the mid-1990s (PEI TIE 2016b).

Reports dating back to 1979 (PEI TPW 2000; UMA Engineering 1992; PEI TPW 1989; ADI Limited 1979) have shown increases in traffic volumes between North River and Cornwall. These increases are associated with increase in the work force, land development, and changes in travel patterns. Additionally, the TCH serves as the main road through the Town of Cornwall, which has seen significant growth in recent years. Directing large volumes of traffic through the center of the town is a safety concern and also acts as a barrier to movement through the town.

2.2 PROJECT ALTERNATIVES

2.2.1 Alternatives to the Project

Alternatives to the Project are functionally different ways of achieving the same end. The only alternative to the Project would include the "do nothing" scenario (null alternative). The null alternative to the Project would result in no effect on the environment in the area as this alternative would result in no change of environmental features (e.g., terrestrial environment).

2.2.2 Alternative Means of Carrying out the Project

2.2.2.1 Constraints Analysis

At the request of PEI TIE, a preliminary constraints assessment was conducted by Stantec (2016), evaluating the environmental and socioeconomic constraints for four potential highway routes.

The other potential routes (Figure 2.1) for the perimeter highway that were provided by PEI TIE (including the Project RoW) all originate just west of the York Point Road and TCH intersection within North River and terminate southwest at the TCH within Clyde River and are:

- Option 1, a 7.8 km route that deviates to the south of the current route being assessed at the Cornwall Road crossing and to the north, towards the current route between Cornwall Road and Lindwood Road.
- Option 2, a 7.8 km route that deviates to the south of the current route being assessed at the Cornwall Road crossing.
- Option 3, a 7.6 km route that follows a straight line southwest between the Cornwall Road and Lindwood Road crossings, south of the current route being assessed.

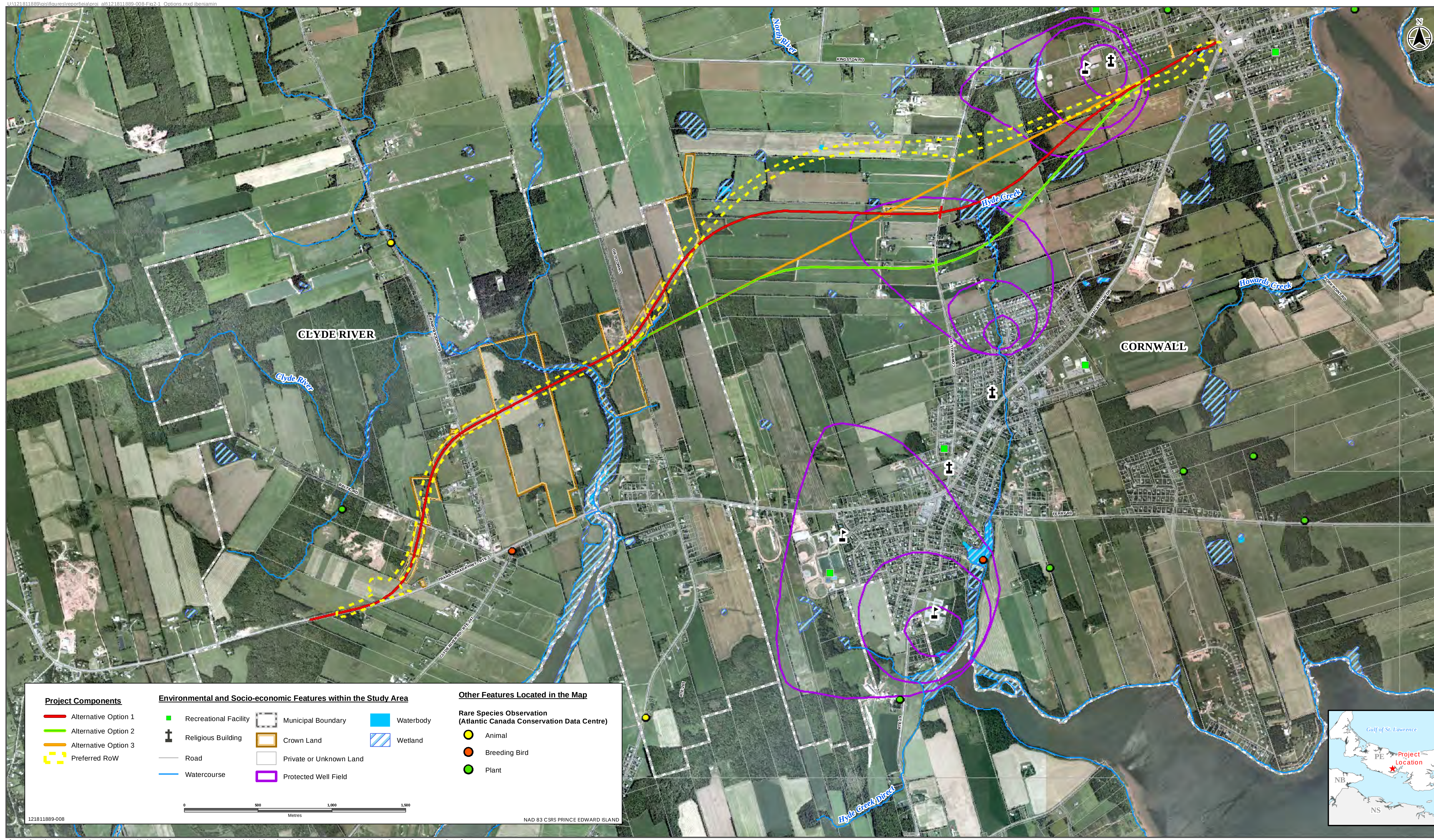
A desktop review of pertinent data available from various sources was conducted to identify and analyze potential environmental and socioeconomic constraints for the four potential route options. The assessment determined that overall, the current route being carried forward in this assessment possessed the environmental and socioeconomic characteristics that are best suited for the highway. The physical criteria reviewed were not found to be a differentiator among the routes, due to their relatively similar attributes and the relative proximity of the routes to each other. The consistent higher ranking scores of the current route being assessed across the socioeconomic and environmental criteria categories compared to the other options supports the overall top-ranked weighted score.

Landowner comments from the landowner information session were also taken into consideration in the analysis of the route options. Some comments received suggested that current route being assessed was the preferred option over the others, due to having the least impact associated with environmental and socioeconomic criteria for the properties along this route.

The results of the assessment were used to assist PEI TIE in choosing a final route for the Project, and the current route being assessed was determined to be the preferred route.

2.2.2.2 Landowner Feedback/Consideration

A noise feasibility study was conducted by MMM Group (2017). The results of the study indicated that noise impacts as a result of the Project would be greater than 5 decibels at three receivers along the Fulton Drive subdivision. The PEI TIE has committed to installing a berm to mitigate noise in this area, and the predicted noise levels with the berm in place were modeled in the feasibility study.



Source: Base data, imagery and project data provided by the Government of Prince Edward Island. Rare Species Observation data from the Atlantic Canada Conservation Data Centre.

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Highway Route Options

Figure 2.1

A public meeting was held with residents in this subdivision and the results of the noise feasibility were presented. Residents requested that the highway extension be aligned further away from their properties, in addition to the berm installation. The PEI TIE designed a new alignment, as requested by the public, where the Project travels near the Fulton Drive subdivision. A follow-up meeting was held on March 9, 2017, where PEI TIE presented the new alignment, and the predicted noise levels of this new alignment with the installation of the berm. See Figure 2.2 for the original and new alignments near the Fulton Drive subdivision.

2.3 PROJECT OBJECTIVES

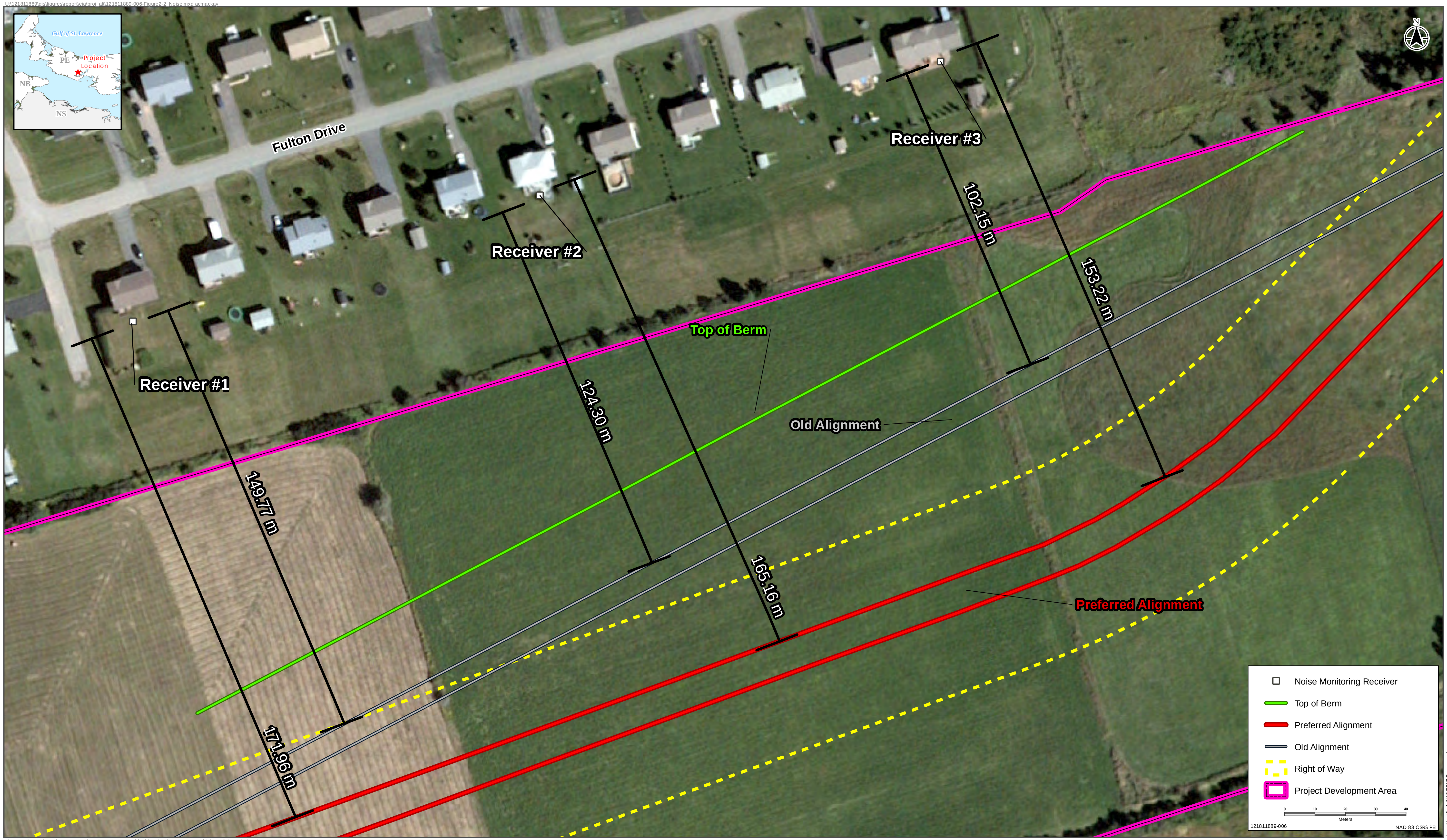
The main objective of the Project is to ease traffic flow through Cornwall by providing an alternative route around the town and to improve public safety. The new alignment will redirect tractor-trailers and cars that currently pass through Cornwall every day. With the construction of the new TCH extension, the Project will also:

- remove upwards of 100 accesses onto the TCH
- provide opportunities for improving accesses to services in Cornwall
- six fewer traffic lights approaching the west side of Charlottetown
- reduce idling
- provide community development opportunities for local business operators and residential development

2.4 PROJECT ACTIVITIES

A general overview of the Project activities to be undertaken is presented in this section. The description includes activities during construction, and operation phases. The useful service life of the Project, with applicable maintenance is 50 years or more into perpetuity. As a result, decommissioning and abandonment of the Project is not expected to occur and is therefore not considered in the assessment. Future activities associated with decommissioning and/or abandonment of the Project will be assessed pursuant to environmental legislation applicable at that time.

The key project phases, activities, and physical works are identified in Table 2.1. These key project phases and activities are representative of the activities that have the potential to interact with the environment.



Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

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Adjustment of Trans-Canada Highway Realignment near Fulton Drive

Figure 2.2

Table 2.1 Summary of Project Phases, Components and Activities

Project Phase and Activities	Description of Activities
Construction	
Site Preparation	Installation of sediment control structures, surveying, vegetation clearing, grubbing, and removal or modification of buildings.
Roadbed Preparation	Preparing the roadbed to base elevation (including access roads), such as excavation, placement of fill material, and ditching and drainage management.
Installation of Structures	Installation of watercourse crossing (i.e., bridge), overpass structures and associated structures (i.e., off ramps and roundabouts).
Surfacing and Finishing	Paving, highway marking, and installation of signs, guardrails, and lighting.
Temporary Ancillary Elements	Development, use, and removal of temporary ancillary structures and facilities.
Emissions and Wastes	During construction activities, release of air contaminants to the atmosphere (e.g., combustion gases from vehicles and heavy equipment, and the generation of airborne dust, (i.e., fugitive dust from roadways and construction activities)), sound emissions (e.g., from construction activities or from vehicle/equipment movements), surface runoff, and solid waste disposal.
Operation	
Infrastructure Maintenance	Repair of the asphalt surface, structure repairs, periodic maintenance of roadway drainage systems, shoulder grading, localized pavement repair, and line repainting.
Winter Maintenance	Snow removal and ice control (e.g., application of salt and/or sand).
Vegetation Management	Clearing and mowing of vegetation along the PDA may include both manual and mechanized cutting.
Emissions and Wastes	During maintenance activities, release of air contaminants to the atmosphere (e.g., combustion gases from vehicles and heavy equipment, and the generation of airborne dust, (i.e., fugitive dust from roadways and maintenance activities)), sound emissions (e.g., from maintenance activities or from vehicle/equipment movements), light emissions, surface runoff, and solid waste disposal.

Further details on these phases and activities are provided in the sections that follow.

2.5 CONSTRUCTION

Construction activities will begin immediately following government approval of the EIA and the receipt of all necessary permits and authorizations. Construction activities are expected to begin August 2017. While the operation of the Project will begin in fall 2019, construction activities will continue until 2020. The following is a brief description of construction activities that are typical for construction of a highway. These activities will be managed by PEI TIE in accordance with the department's Environmental Protection Plan (EPP) and with a Project-specific Environmental Protection Plan (PSEPP).

2.5.1 Site Preparation

The following project works are required to prepare the land for highway construction:

- clearing of the highway corridor
- grubbing of the highway corridor
- construction of temporary watercourse crossings (if necessary)
- removing and stockpiling of topsoil and overburden
- grading and leveling in advance of highway construction

Erosion and sedimentation control techniques will be implemented with all physical works to reduce erosion of exposed areas and sedimentation of surface water. Dust control measures will be taken, where necessary, during site preparation to minimize the potential environmental effects of fugitive dust to offsite locations.

2.5.2 Roadbed Preparation

Roadbed preparation includes activities associated with construction of the road base prior to surfacing and finishing, such as:

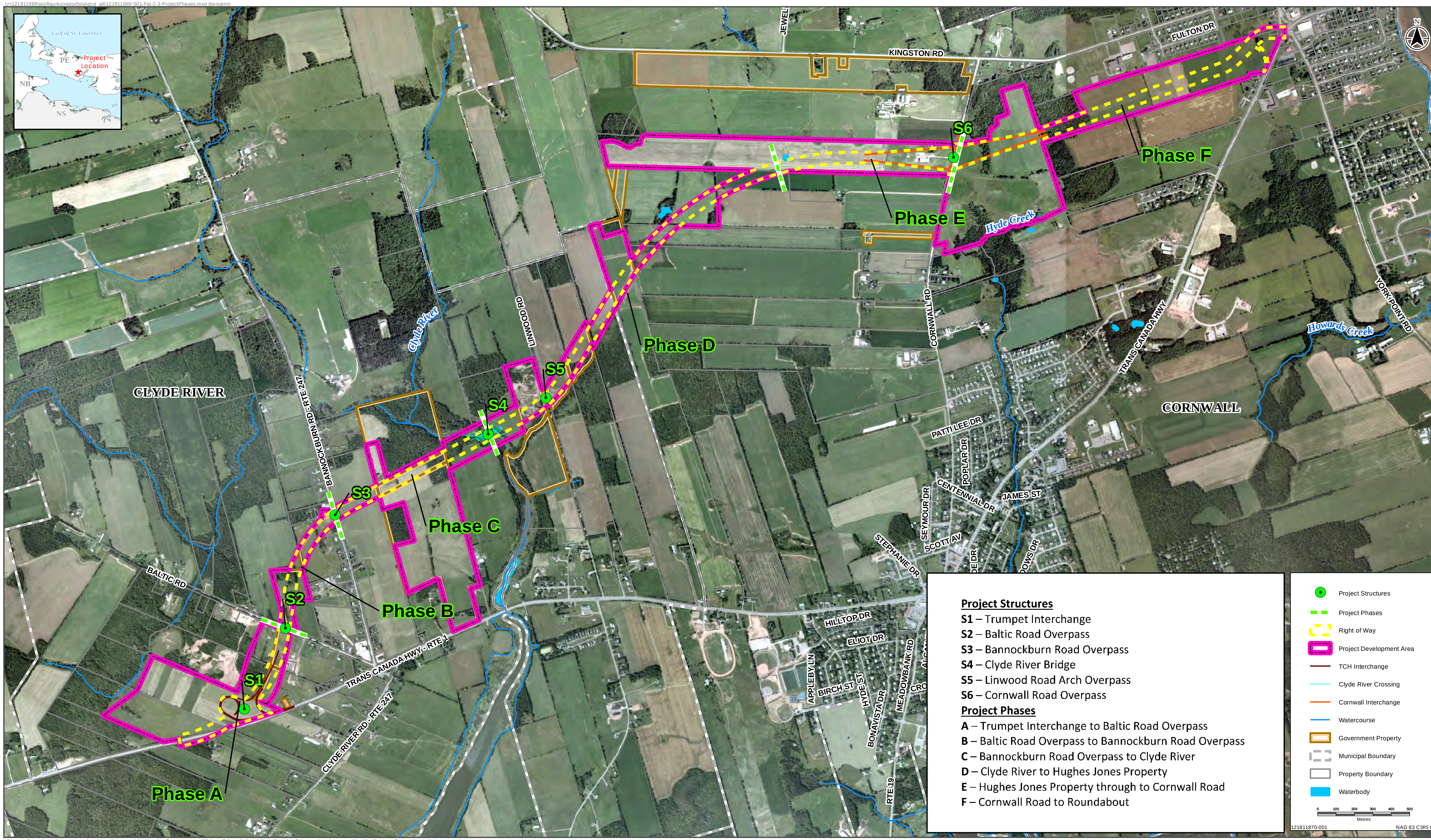
- excavating
- placing fill, cutting, and grading
- upgrades to local access roads (if necessary)
- ditching and drainage management
- work progression (includes stabilization of exposed soils)

The Project design and construction is aimed at achieving a balanced cut (excavation) and fill operation so that the borrowing of material occurs within the PDA and the associated work phases.

Table 2.2 summarizes the cut and fill material required for each phase of the Project. Work phases and associated schedule are outlined in Section 3.3. Figure 2.3 shows the proposed work phases and structures for the Project.

Table 2.2 Cut and Fill Summary

Project Phase	Cut (m^3)	Fill (m^3)	Net (m^3)
Cut fill subbase	361,857	628,665	266,807 (fill)
Phase A (Trumpet interchange to Baltic Road overpass)	35	29,277	29,241 (fill)
Phase B (Bannockburn Road to Baltic Road)	2	201,673	201,670 (fill)
Phase C (Clyde River Bridge to Bannockburn Road)	5,604	90,044	84,439 (fill)
Phase D (Clyde River to Hughes Jones property)	108,289	83,966	24,322 (cut)
Phase E (Hughes Jones property to Cornwall Road)	99,065	34,142	64,922 (cut)
Phase F (North River Roundabout to Cornwall Road Interchange)	138,220	98,597	39,623 (cut)
Phase C (Bannockburn Road overpass to Clyde River)	5,604	90,044	84,440 (fill)
S6 (Cornwall Road overpass)	99,064	34,142	64,922 (cut)
Totals	**721,523**	**1,172,473**	**450,950 (fill)**



Source: Base data, imagery and project data provided by the Government of Prince Edward Island. Rare Species Observation data provided by Stantec Consulting Ltd.

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Project Phases and Structures

Figure 2.3

2.5.3 Installation of Structures

Structures installed for this Project will include the following:

- a watercourse crossing (bridge) over the Clyde River (Structure-4 (S-4))
- two interchanges in Clyde River (S-1) and over the Cornwall Road (S-6)
- three overpass structures (at the Bannockburn (S-2), Baltic (S-3) and Linwood Roads (S-5))

The following sections describe the construction activities associated with installing these structures, associated construction time, and equipment used during these activities.

2.5.3.1 Clyde River Bridge

As part of the Project, a bridge will be constructed over the Clyde River. The 150 m long bridge will be constructed at a height of approximately 15 m off the water, with two abutments and a maximum of three piers. The construction of this structure will include the following activities:

- Installing environmental controls
- Maintaining environmental controls
- Installing steel sheet pile (SSP) wall cofferdam and removal of organic material and store for re-use
- Driving steel pipe piles, placing reinforcement bars, constructing formwork and pouring concrete pile-caps for piers
- Constructing formwork, placing reinforcement bars, and pouring new concrete piers and pier caps
- Reinstating wetland organic material and cut-off SSP cofferdam
- Constructing temporary trestle structure and realigning the stream channel. Removing trestle after stream relocation. Placing rip-rap slope protection
- Driving steel pipes, placing reinforcement bars, and pouring concrete pile-caps for abutments
- Placing new girders on sub-structure
- Constructing formwork, installing reinforcing bars, and placing and curing concrete deck
- Constructing approach roads, placing random rip-rap, topsoil, and hydroseeding
- Completing construction of approach roadways; waterproofing and placing asphalt bridge deck
- Decommissioning, installing guardrail and site clean up

The amount of construction time for the Clyde River Bridge is estimated to be 42 weeks. Equipment on site will include, but not be limited to: excavators, cranes, pile drivers, floating barge/work platform tandem trucks, concrete mixer trucks, concrete pumps, boom trucks, bull dozers, rollers, graders, and asphalt spreaders.

2.5.3.2 Clyde River Interchange and Cornwall Road Interchange

As part of the Project, there will be two interchanges constructed: a trumpet interchange at Clyde River Road and a diamond interchange at Cornwall Road. The PDA widens beyond the 61 m RoW at these interchange locations. The construction of these structures will include the following activities:

- Installing environmental controls
- Maintaining environmental controls
- Driving steel pipe piles and pouring concrete to construct new sub-structure (i.e., abutments)
- Erecting pre-cast, pre-stressed concrete girders onto sub-structure
- Constructing formwork, installing reinforcing bars, and placing and curing concrete deck
- Constructing approach roads; placing rip-rap at steep slopes and storm water drainage areas off of structures, topsoil, and hydroseeding
- Completing construction of approach roadways, asphalt bridge deck

The amount of construction time is estimated at 18 weeks. Equipment on site will include, but not be limited to: excavators, cranes, pile drivers, work platform tandem trucks, concrete mixer trucks, concrete pumps, boom trucks, bull dozers, rollers, graders, and asphalt spreaders.

2.5.3.3 Bannockburn and Baltic Road Overpass Bridges

As part of the Project, there will be an overpass bridge constructed at each of the Bannockburn and Baltic Roads. The construction of this structure will include the following activities:

- Installing environmental controls
- Maintaining environmental controls
- Driving steel pipe piles and pouring concrete to construct new sub-structure (i.e., abutments)
- Erecting pre-cast, pre-stressed concrete girders onto sub-structure
- Constructing formwork, installing reinforcing bars, and placing and curing concrete deck
- Constructing approach roads; placing rip-rap at steep slopes and storm water drainage areas off of structures, topsoil, and hydroseeding
- Completing construction of approach roadways, asphalt bridge deck

The amount of construction time for the overpasses is estimated to be 16 weeks/structure. Equipment on site will include, but not be limited to: excavators, cranes, pile drivers, tandem trucks, concrete mixer trucks, concrete pumps, boom trucks, bulldozers, rollers, graders, and asphalt spreaders.

2.5.3.4 Linwood Road Arch

As part of the Project, there will be an arch constructed at the Linwood Road. The construction of this structure will include the following activities:

- Mobilizing the site and installing environmental controls
- Maintaining environmental controls
- Excavating to underside of footing elevation
- Forming and placing reinforcement bars, and placing concrete for new footings
- Installing arch panels
- Constructing new roadway cross section within arch and beyond ends of arch
- Backfilling the arch. Constructing approach roadways. Placing rip-rap slope protection
- Placing asphalt roadway, installing guardrails, hydroseeding, cleaning up the site

The amount of construction time is estimated at eight weeks. Equipment on site will include, but not be limited to; excavators, backhoe, cranes, concrete ready-mix trucks, tandem trucks, bulldozers, rollers, graders, and asphalt spreaders.

2.5.4 Surfacing and Finishing

Surfacing and finishing includes activities associated with the completion of the highway prior to commissioning, such as:

- Paving
- Highway marking
- Installing signage, lighting, guardrails

2.5.5 Temporary Ancillary Elements

The construction and decommissioning of temporary ancillary elements includes activities associated with the development and removal of temporary ancillary Project elements, such as:

- Temporary access roads
- Borrow areas
- Petroleum storage areas
- Laydown and staging areas
- Materials and equipment (transportation, storage, and handling)

The temporary ancillary Project elements will be located on the properties where the PDA is extended beyond the RoW and on properties currently provincially owned.

2.5.6 Emissions and Wastes

2.5.6.1 Air Contaminants

Releases of air contaminants to the atmosphere will consist mainly of combustion gases from the operation of on-site construction equipment and large trucks used to deliver equipment to the site. There may also be some fugitive dust generated as a result of excavation activities. The predominant source of greenhouse gases (GHG) will be from fuel combustion in heavy equipment and trucks. Nominal quantities of GHGs will be released from clearing. During construction, air contaminants may be released from the following activities:

- Fuel combustion in heavy equipment during clearing and site preparation (e.g., excavators, dozers)
- Fuel combustion in passenger vehicles moving to and from the site, as well as on-site
- Fuel combustion in trucks transporting equipment and material
- Dust from site preparation activities (e.g., land clearing)
- Dust from vehicle and equipment movements on unpaved roads
- Dust from loading and unloading of overburden and topsoil
- Dust from stockpiling of overburden and topsoil

Topsoil and overburden stockpiled during construction will be seeded and re-vegetated periodically. The generation of airborne dust from these sources is therefore considered to be nominal. Topsoil and overburden are transferred by trucks to stockpiles. While material handling may generate dust, it is assumed that the material is wet and that minimal dust is generated.

The emissions will remain largely confined to the Project area and the immediately adjacent areas, as these activities will be transient (i.e., carried out to construct one part of the highway, then moving on to another area) and will be of short duration.

2.5.6.2 Sound Emissions

Sound emissions and vibration will result from the operation of heavy equipment and from transportation vehicles on Project access roads. Similar to air contaminants, noise will be temporary and of short duration.

2.5.6.3 Surface Runoff

Site run-off from precipitation events will be carefully managed. An erosion and sedimentation plan will be incorporated into the PSEPP. Watercourse and wetland alteration mitigation measures (e.g., erosion and sedimentation control measures) will be employed during construction, and ground disturbance will be held to a minimum outside the required construction zones. Management of site run-off will employ best practices such as containment ditches, and silt curtains to avoid or mitigate potential environmental effects to watercourses.

2.5.6.4 Waste Disposal

There will be disposal of some general construction wastes such as wood, steel, cardboard or other packaging, and other construction wastes. These materials will be disposed of at approved construction and demolition disposal sites. All merchantable timber from site clearing will be sold, and remaining brush will be stockpiled or covered by fill or Project facilities. No burning of waste will be carried out during construction. Soil and overburden will be stockpiled for future use in reclamation activities. The PEI TIE, or its contractors, will re-use or recycle waste materials where possible, and dispose of other wastes at approved facilities.

Any liquid hazardous materials (e.g., waste oils and lubricants) generated by contractors on-site will be collected and disposed of using approved hazardous materials collectors.

2.6 OPERATION

Operation of the highway is expected to begin fall of 2019. Potential interactions with the environment that may occur from the operation of the highway are covered in the sections below.

2.6.1 Infrastructure Maintenance

General highway maintenance activities retain roadways at a reasonable level of service, comfort, and safety and typically take place during the summer months. The rate of degradation of the pavement surface will be determined by the volume of traffic, proportion of heavy trucks, certain vehicle characteristics (e.g., radial tires), and the structure and quality of pavement. The repair of the asphalt surface may involve excavation or removal of the existing pavement and subgrade, patching and leveling, grading and gravelling, surface treatment, and asphalt concrete overlays. Disruption to the public from these repairs would be temporary and infrequent in nature.

Periodic maintenance of roadway drainage systems may be required. This may involve the replacement or repair of culverts and re-establishment of the drainage ditches.

Other highway maintenance activities include shoulder grading, localized pavement repair, and line repainting. Disruption to the public from these repairs will be temporary and infrequent in nature.

2.6.2 Winter Maintenance

Winter highway operation activities generally involve snow removal and ice control to reduce traffic disruptions and safety hazards. Snow removal involves plowing services provided by or contracted out and supervised by PEI TIE. When snow banks build up along the highway, the banks may be winged back or the snow is removed and dumped at a suitable site (i.e., not in wetlands or environmentally sensitive areas). Road ice is managed through the application of salt and sand. Salt can melt ice, or stop the formation of ice, and is applied to roads to retain clear driving lanes within a reasonable time after a storm. Sand is applied to icy or snow-packed road surfaces to provide traction.

Road salts that contain inorganic chloride salts are considered "toxic" as defined in Section 64 of the *Canadian Environmental Protection Act* (CEPA). Recognizing that a total ban of road salt could potentially compromise human safety, the focus is on implementation of measures that optimize winter road maintenance practices so as not to jeopardize road safety while minimizing the potential environmental effects. Therefore, Environment Canada has categorized road salt as a Track 2 substance, requiring Life-Cycle Management. In 2004, Environment Canada released the "Code of Practice for the Environmental Management of Road Salts" (Environment and Climate Change Canada 2004). The environmental effects of increased chloride concentrations in the natural environment were a large part of the reason for the development of the Code of Practice. The focus of road salt risk management is on implementation measures that optimize winter road maintenance practices, while minimizing the use of road salt, particularly near areas that may be sensitive to road salt. Environment Canada determined that the development and refinement of Salt Management Plans is the best mitigation against potential environmental effects from road salt use.

The chemical composition of road salt used on PEI is sodium chloride (NaCl), with ferrocyanides in the form of Prussian Blue ($C_{18}Fe_7N_{18}$) or Yellow Prussiate of Soda ($Na_4Fe(CN)_6$) added as anti-caking agents. Road salt is used to de-ice the main arterial routes (i.e., Route 1, 1a, 2, 3, and 4), whereas a blend of 6% salt and 94% sand is used on the remaining provincial roadways. Salt application rates vary based on outdoor temperature and can range from 65 kilogram/kilometre/lane (kg/km/ln) at a temperature of -2 °C, to up to 100 kg/km/ln at temperatures reaching -12 °C. Due to reduced performance in cold weather, salt is generally replaced with sand on main arterial routes at temperatures below -12 °C. Pre-wetting is employed by PEI TIE during road salt application to reduce the salt application rate and this is considered a Best Management Practice (BMP) under the Code of Practice. Pre-wetting involves the application of a brine solution to the salt just prior to road application to aid in adherence of the salt to the roadway while improving melting capabilities of the salt. The brine solution applied by PEI TIE is a 23.3% salt solution applied at an application rate of 45 millilitre/square metre (mL/m^2). Further information can be found in PEI TIE's Salt Management Plan, which also includes their commitment to optimizing road salt use in PEI through improved operational efficiency, newer technology, and the implementation of BMPs. Health Canada's Guidelines for Canadian Drinking Water Quality (2010) has set an aesthetic objective of chloride in drinking water at ≤250 milligrams per litre (mg/L). The PEI TIE has established an internal policy to deal with cases where road salt application may have caused elevated levels of chloride in nearby potable wells.

2.6.3 Vegetation Management

Growth of vegetation within the PDA may interfere with the lines of sight required for safe use of the highway. Clearing/mowing along the PDA is part of PEI TIE's regular maintenance to maintain sight lines and may involve both manual and mechanized cutting. The PEI TIE does not use herbicide application for the control of vegetation.

2.6.4 Emissions and Wastes

During operation, the Project has the potential for the release of solid waste, air contaminants, light emissions, and noise during highway use, inspection, maintenance and repair. Surface runoff may occur within the highway corridor.

2.6.4.1 Air Contaminants

During operation, air contaminants may be released from the following activities:

- fuel combustion from passenger vehicles using the new highway
- fuel combustion in mobile equipment
- fuel combustion in vehicles traveling to and from the site to conduct inspection and maintenance, as well as on-site
- dust from the movement of vehicles and equipment on unpaved roads

Emissions from local vehicle traffic were assessed in the Greenhouse Gas Assessment for the Proposed Trans-Canada Highway (TCH) Extension Project – Cornwall IIB (Appendix A).

During routine operation, vehicle support will be required during inspection, maintenance and repair of the existing infrastructure, access road maintenance and vegetation management.

Topsoil and overburden stockpiled during operation activities such as maintenance and repair will be temporary. The generation of airborne dust from these sources is considered to be nominal. Topsoil and overburden will be transferred by trucks to stockpiles. While material handling may generate dust, it is assumed that the material is wet and that minimal dust is generated.

The emissions from maintenance activities will remain largely confined to the Project area and the immediately adjacent areas, as these activities will be transient (i.e., carried out to maintain one part of the highway, then moving on to another area) and will be of short duration.

2.6.4.2 Emissions

Sound emissions and vibration will result from vehicle traffic using the new highway, as well as the operation of heavy equipment and from vehicles on Project access roads. Similar to air contaminants, noise will remain largely confined to the Project area and the immediately adjacent areas.

Light emissions will result from the use of highway lights in order to provide a secure and safe roadway for nighttime highway traffic.

2.6.4.3 Storm Water Runoff

Storm water runoff will be managed through the grading of the PDA and the collection and conveyance of generated runoff via storm water infrastructure. The use of best-management-practices, such as vegetated swales, check dams and detention ponds, may be used to control quantity and quality of runoff. The use of infiltration-based BMPs for runoff control will be avoided within groundwater supply areas. A storm water management plan will be incorporated into the PSEPP.

2.6.4.4 Solid Waste Disposal

There will be disposal of some general operational wastes such as wood, steel, cardboard or other packaging. These materials will be disposed of at approved disposal sites. No burning of waste will be carried out during operation. Soil and overburden will be stockpiled for future use in reclamation activities. The PEI TIE, or its contractors, will re-use or recycle waste materials where possible, and dispose of other wastes at approved facilities.

Any liquid hazardous materials (*e.g.*, waste oils and lubricants) generated by contractors on-site will be collected and disposed of using approved hazardous materials collectors.

2.7 PROJECT SCHEDULE

The Project is expected to begin construction August 2017, following the receipt of all necessary permits and authorizations, and the completion of detailed engineering design. Table 2.3 outlines the progression of construction activities by year. See Figure 2.3 outlining the associated work phases and structures.

Table 2.3 Schedule for Construction Activities

Year	Construction Activities
2017	• Earthwork for Phase F • Earthwork for Phase D • S-5
2018	• Phase A&C – Earthwork between S1 and Clyde River • Earthwork for Phase E • Granular from Phase A to F • S-3 • Beginning S-4 • S-6
2019	• S-1 • S-2 • Completing S-4 • Granular and asphalt base from Phase A to F
2020	• Asphalt seal from Phase A to F
Notes: Phase A – Trumpet interchange (S-1) to Baltic Road overpass (S-2) Phase B – Baltic Road overpass to Bannockburn Road overpass (S-3) Phase C – Bannockburn Road overpass to Clyde River Phase D – Clyde River to Hughes Jones property Phase E – Hughes Jones property through to Cornwall Road Phase F – Cornwall Road to North River roundabout S-4 – Clyde River bridge S-5 – Linwood Road arch overpass S-6 – Cornwall Road Interchange	

Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation of the Project is expected to continue for several decades. The useful service life of the Project, with applicable maintenance is 50 years or more into perpetuity.

3.0 STAKEHOLDER CONSULTATION AND INDIGENOUS RIGHTS HOLDERS ENGAGEMENT

The consultation and engagement plan, and summary of initial results in support of this EIA is described in the following subsections. Consultation and engagement will take place at various points during the EIA process. As some activities will take place after registration and submission of the EIA, these results will be updated as needed.

3.1 REGULATORY CONSULTATION

Regulatory Consultation has been conducted with several regulatory agencies throughout the course of the environmental assessment. Meetings were held with the PEI CLE to discuss the project, scope of the EIS, and EIA application for the proposed project. Discussions were held with the department of Aboriginal Affairs & Archaeology, Transport Canada - Navigation Protection Program (TC-NPP) and Fisheries and Oceans Canada (DFO) regarding the project. PEI TIE will continue to engage and consult with all stakeholders as the Project progresses.

Table 3.1 outlines the regulatory consultation considered in the EIA.

Table 3.1 Regulatory Consultation Considered in the EIA

Consultation	Status
In the request for proposal (RFP) for the Project, PEI TIE requested that the EIA consider the potential effects of proposed highway lighting on potential receivers within the RoW.	A lighting assessment was conducted for this Project and is discussed in Section 5.0.
The PEI CLE requested that the EIA consider the potential effects of the Project on hedgerows within the PDA.	Hedgerows are discussed in Section 8.4.2.3
In the request for proposal (RFP) for the Project, PEI TIE requested that the EIA consider the potential effects of the Project on existing groundwater resources and potential well field development	The potential effects of the Project on existing groundwater resources and potential well field development are discussed in 7.4 and 7.2.2.3, respectively.
In the request for proposal (RFP) for the Project, PEI TIE requested that the EIA consider the potential effects of climate change on the Project	The effects of climate change on the Project are discussed in Section 10.0.

Consultation	Status
Authorization requirement under the TC-NPP	Discussions were held with Transport Canada on April 6, 2017, and it was determined that the Project would not require an application to the TC-NPP.
Authorization under Section 35(2) of the *Fisheries Act* for serious harm to fish	An application was submitted to DFO on May 12, 2017 via PEI CLE, to assess if an Authorization under Section 35(2) is required for this Project. If an Authorization is required due to serious harm to fish, a habitat offsetting plan will be developed and implemented by the proponent pending DFO-Fisheries Protection Program approval.
Watercourse, Wetland and Buffer Zone Activity Permit Authorization	An application was submitted to PEI CLE on May 12, 2017.

3.2 PUBLIC AND STAKEHOLDER ENGAGEMENT

PEI TIE has conducted consultation ranging from public open house sessions to meetings with affected landowners. Details of consultation activities and key issues raised are summarized in Table 3.2.

A GHG assessment was requested by the Standing Committee on Transportation to estimate the changes in GHGs released to the atmosphere associated with the Project. The GHG assessment (Stantec 2017) is attached in Appendix A.

A noise feasibility study was conducted by MMM Group in January 2017. The results of the study indicated that noise impacts as a result of the Project would be greater than 5 decibels at three receivers along the Fulton Drive subdivision (refer to Figure 2.2 for receiver locations).

A public meeting was held with residents in this subdivision and the results of the noise feasibility were presented to attendees. Residents requested that the highway extension be aligned further away from their properties, in addition to a berm installation. As requested by the public, the PEI TIE designed a new alignment, at some distance to the Fulton Drive subdivision. A follow-up meeting was held on March 9, 2017, where PEI TIE presented the new alignment (refer to Figure 2.2 for the new alignment).

A preliminary constraints assessment was conducted by Stantec in August 2016, evaluating the environmental and socioeconomic constraints for four potential highway routes. As a part of the constraints assessment an information session was held for nearby landowners. Issues related to the socioeconomic environment identified during the by the information session were taken into consideration during the selection of a preferred route.

PEI TIE commissioned MRSB Group (MRSB) to prepare a socioeconomic impact analysis for the Project (MRSB 2017). As part of the analysis, MRSB conducted interviews with 15 stakeholders, including Town of Cornwall, the Community of Clyde River, the North River Fire Department, local businesses, developers and planners (commercial and residential), and representatives from the transportation sector. Findings of the analysis can be found in their report titled "Socio-Economic Impact Analysis Report of the Trans-Canada Highway Extension – Cornwall Phase IIB on the Town of Cornwall" (MRSB 2017).

Table 3.2 Summary of Information Provided/Key Issues Raised During Consultation

Stakeholder Consultation	Information Provided/Key Issues Raised
Municipal	
Town of Cornwall - Letter of Support October 21, 2015	• letter in support of the Project to the Minister of Transportation, Infrastructure, and Environment
Announcement of the Cornwall Perimeter Highway June 28, 2016 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• funding announcement for the Project
Landowners	
Potentially Affected Landowners Meeting August 3, 2016 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• initial project overview with four options provided • discussed process • gathered input from potentially affected landowners
Affected Landowners Meeting September 7, 2016 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• PIE TIE announcement of preferred route • outlined process going forward, including land acquisition and environmental impact assessment
Fulton Drive Residents Meeting November 9, 2016 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• meeting with residents of Fulton Drive to address concerns over proposed highway construction project • concerns included noise and dust during construction, and the aesthetics of the highway

Table 3.2 Summary of Information Provided/Key Issues Raised During Consultation

Stakeholder Consultation	Information Provided/Key Issues Raised
Bannockburn, Baltic, and Cornwall Rd. Residents Meeting February 22, 2017 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• reviewed the proposed project with residents of the Bannockburn, Baltic, and Cornwall Roads who are within 500 m of the proposed alignment • residents expressed concerns regarding the findings of a noise assessment carried out by MMM • PEI TIE committed having additional monitoring completed in May 2017
Fulton Drive Residents - Follow-Up Meeting March 9, 2017 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• follow-up meeting to discuss adjustments PEI TIE made to the proposed alignment in response to concerns identified by residents of the Fulton Drive subdivision • specific information included details of the berm to be constructed behind their subdivision (as requested by the residents), information on plans to control dust during construction, and a request to tweak the alignment of the highway to move it further away from Fulton Drive and closer to the existing TCH
MacRae Drive & TCH Residents Meeting April 6, 2017 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• discussed residents' concerns related to the proposed highway construction, including safety and timing for individuals who need to access the existing TCH in a high traffic situation, and noise and aesthetics associated with the construction project • PEI TIE committed to constructing a berm to assist with noise attenuation and to act as a visual barrier and agreed to provide a turn round area in the Cornwall Business Park
Public Open House	
Public Meeting September 13, 2016 APM Centre 37 Lowther Dr. Cornwall, PE C0A 1H0	• TIE announcement of preferred route • outlined process going forward, including land acquisition and environmental impact assessment
Clyde River Community Council Meeting September 20, 2016 Riverview Community Centre 718 Clyde River Road Clyde River, PE C0A 1H0	• TIE attended resident's meeting to provide updated information on the proposed highway construction • outlined process forward including land acquisition and environmental impact assessment

Stakeholders and the general public will be invited to participate in the environmental assessment process of the Project in several ways. The Proponent is planning to hold a public open house to present information on the Project, answer questions, and collect comments and feedback. The open house will be held no less than 15 days after the EIS is registered with PEI CLE. A report summarizing the open house, including all comments and questions received, will be prepared and submitted to PEI CLE. The EIS will be posted on the website of the government of PEI (www.gov.pe.ca) along with other Project-related information. A copy of the EIS will also be available for public review at the Charlottetown office of PEI CLE, which is located on the fourth floor of the Jones building at 11 Kent Street.

3.3 INDIGENOUS RIGHTS HOLDERS

Indigenous Rights Holders are First Nations bands or representative First Nations assemblies or groups that may have interest in or interaction with Project components. This includes associated government departments within the applicable regions.

The province adopted Duty to Consult Guidelines in 2009. In 2010, PEI TIE adopted a Departmental Protocol to address the Duty to Consult Guidelines. As part of fulfilling the Crown's duty to consult, PEI TIE notified MCPEI of the Project and provided a description of the proposed works in a letter dated September 20, 2016. A follow-up meeting was held on September 26, 2016 to discuss details of the Project. The MCPEI indicated in a letter dated December 15, 2016, that based on the Project details and research on the area, the Mi'kmaq of PEI do not object to the Project as proposed. No further engagement and consultation activities are planned at this time. In the event changes to the project location occur, MCPEI would be notified at that time. Should any information regarding First Nations current use of the Project Site be identified during the regulatory approval process for the Project, this information will be presented to the regulators for consideration.

4.0 ENVIRONMENTAL ASSESSMENT SCOPE AND METHODS

The scope of the EIA of the Project, as required under the PEI Environmental Impact Assessment Guidelines, is described in this chapter. The methods used to carry out the EIA are presented below.

4.1 SCOPE OF THE ASSESSMENT

The potential environmental effects of the Project are assessed in the EIA. The scope of assessment includes all activities necessary for the construction and operation of the Project. Environmental effects are assessed separately for each phase of the Project (i.e., construction and operation), where relevant, as well as for credible accidents, malfunctions, and unplanned events. The assessment is conducted within defined assessment boundaries and in consideration of defined residual environmental effects criteria aimed at determining the significance of the environmental effects.

4.1.1 Scope of the Project

The scope of the undertaking that is the subject of the environmental assessment includes:

- a 61 m (200 ft.) wide, 7.8 km long corridor between North River and Clyde River, PEI, beginning just west of the existing intersection in North River
- a diamond interchange at the Cornwall Road
- three overpass structures (at the Linwood, Bannockburn, and Baltic Roads)
- a watercourse crossing over the Clyde River
- a trumpet interchange where the new highway will join the existing TCH in Clyde River, PEI
- temporary work space development beyond the RoW

4.1.2 Factors to be Considered

The EIA considers the following factors:

- the environmental effects of the physical activities associated with the Project, as assessed by selecting valued components (VCs) to address potential effects that may be substantive or the main issues of concern
- mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project, including requirements for follow-up or monitoring
- changes to the Project that may be caused by the environment
- the environmental effects of malfunctions or accidents that may occur in connection with the Project
- cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out

- comments from the public, Indigenous persons, and stakeholders received with respect to the Project

4.1.3 Scope of Factors to be Considered

The scope of factors to be considered in the EIA is described below as it relates to valued components (VCs). The VCs are defined as broad components of the biophysical and human environments that, if altered by the Project, would be of concern to regulatory agencies, Indigenous persons, resource managers, scientists, stakeholders, and/or the general public.

An important part of the assessment process is the early identification of VCs upon which the process can be focused for a meaningful and effective assessment. The VCs for this EIA were selected by considering:

- regulatory issues, guidelines, and requirements
- knowledge of the Project, its components, and activities
- knowledge of existing conditions where the Project will be located
- issues raised by regulatory agencies, the public, Indigenous persons or groups, and stakeholders
- the scope of factors to be considered in the EIA
- the professional judgment of the study team

4.1.3.1 Selection of Valued Components

The EIS report will consider a variety of environment interactions that may arise from the Project components and activities, as well as from effects of the environment on the Project (Section 10.0) and accidents, malfunctions, and unplanned events (Section 11.0). The EIS report considers these interactions in terms of their importance to ecological and social integrity. It is generally accepted that EIAs should be efficient and focused on those issues of greatest importance to the public, stakeholders and resource managers. The primary focus of the report will be concentrated on biophysical and socioeconomic elements of concern that may require special mitigation or consideration.

"Environment" is defined to include not only biological systems (air, land, and water) but also human conditions that are affected by changes in the biological environment. The VCs relate to ecological, social, or economic systems that comprise the environment.

Based on the activities outlined in the Project Description (Section 2.0), the scope of the assessment (Section 4.1), and the EIA methods described above, the potential interactions between the Project and the environment are summarized in Table 4.1.

Table 4.1 Selection of Valued Components

Project Phases	Atmospheric Environment	Aquatic Environment	Water Resources	Terrestrial Environment	Socioeconomic Environment	Transportation	Heritage Resources	Current Use of Land and Resources for Traditional Purposes by Indigenous Persons
Construction	✓	✓	✓	✓	✓	-	-	-
Operation	✓	✓	✓	✓	✓	-	-	-

Decommissioning and abandonment activities are not expected to occur until the end of life of the Project, which is expected to be at least 50 years from the start of the operation and maintenance phase. It is not possible to determine with any certainty the potential environmental effects of decommissioning and abandonment activities, nor the regulations and policies that might apply, a century into the future. Therefore, neither the decommissioning and abandonment phase, nor potential activities to be conducted as a part of it, are assessed in detail as part of this EIA; it is expected that they will be assessed in accordance with regulations in place at that time.

The rationale for including these VCs, and the factors to be considered in this EIA are shown in Table 4.2.

Table 4.2 Selected Valued Components

Valued Component (VC)	Rationale for Inclusion in EIA Registration	Factors to be Considered
Atmospheric Environment	Project-related emissions of particulate matter, combustion gases, and sound may affect the atmospheric environment and/or be perceptible to nearby receptors. There is potential for changes in ambient night time light levels to affect residents within 500 m from the Project.	• Air quality • Greenhouse gases (GHGs) • Noise • Lighting
Aquatic Environment	The Project will span and/or run adjacent to watercourses. Interactions with aquatic environment, however unlikely, could occur because of potential crossing and/or proximity to these watercourses.	• Fish populations (freshwater and estuarine) • Fish habitat • Surface water quality
Water Resources	The Project may overlap or run adjacent to wells. There may be public concern regarding potential interactions with drinking water. The Project has the potential to interact with surface water and groundwater resources during construction and operation.	• Groundwater
Terrestrial Environment	The Project may be located in or adjacent to wildlife habitat. Therefore, there are potential interactions with terrestrial wildlife species (wildlife including birds, mammals (including bats), and herpetiles; flora), as well as wildlife habitats including wetlands, and any local species of conservation concern or species at risk for wildlife or vegetation.	• Plant and wildlife (including birds and bats) species and communities, and their habitats, including wetland habitats • Species at risk (i.e., *Species at Risk Act* Schedule 1 species) and Species of conservation concern (i.e., Committee on the Status of Endangered Wildlife in Canada listings and any species of concern of PEI CLE)
Socioeconomic Environment	The Project has the potential to interact with land use near the Project, including privately owned land, industrial land, and commercial (tourism) and recreational land use, as well as protected areas. Potential effects on visual quality may be of public concern with residents living near the Project area. Project construction and operation has the potential to interact with labour and economy through employment and expenditures.	• Existing land uses in the area of the proposed routes, including residential, commercial, and industrial properties, as well as protected areas. • Local and regional economic and employment benefits of the Project • Social context • Resource use

Table 4.2 Selected Valued Components

Valued Component (VC)	Rationale for Inclusion in EIA Registration	Factors to be Considered
Transportation	The Project will maintain and improve a vital transportation link between North River and Clyde River and is intended to facilitate safe and effective movement of vehicles.	• Transportation of construction materials to the Project location. • Ongoing movement of passenger vehicle and heavy truck traffic between North River and Clyde River.
Archaeology and Heritage Resources	The Project may be carried out within areas with potential for archaeological or heritage resources. Physical disturbance of land may affect such resources.	• Archaeological and heritage resources potentially located within the project development area that may be subject to disturbance
Current Use of Land and Resources for Traditional Purposes by Indigenous Persons	First Nations consultations are required for any Projects crossing public lands.	• Current Use of Land and Resources for Traditional Purposes by Indigenous Persons that may be affected by the Project

Five VCs were selected to facilitate a focused and effective EIA process that complies with government requirements and supports public review:

- atmospheric environment (Section 5.0)
- aquatic environment (Section 6.0)
- water resources (Section 7.0)
- terrestrial environment (Section 8.0)
- socioeconomic environment (Section 9.0)

Three VCs have been excluded from further assessment as there are no substantive interactions expected between the Project and the VCs. These VCs include:

- transportation
- archaeology and heritage resources
- current use of land and resources for traditional purposes by Indigenous persons

The following sub-sections provide rationale for not including transportation, archaeology and heritage resources, and current use of land and resources for traditional purposes by Indigenous persons for further assessment.

Transportation

The Project will begin at the existing TCH and Route 248 intersection in North River, and travel west for 7.8 km, where the new highway will join the existing TCH with a trumpet interchange approximately 1.5 km west of the Baltic Road and existing TCH intersection in Clyde River. The proposed route crosses 73 properties, including 6 businesses, 20 residences, and 3 farm structures within 100 m of the proposed PDA.

The long-term environmental effects of the Project are expected to be positive with an improved transportation network through Cornwall, PEI. Environmental effects on Transportation during the construction phase of the Project are anticipated to be localized, short-term, and minimal in number. Construction activities may result in temporary traffic disruptions or disturbances. Where possible, these disruptions will be minimized and timed to avoid both daily and seasonal peak traffic periods.

In consideration of planned mitigation measures and minimal disruptions to the transportation network, Transportation is not expected to be substantive and will not be carried forward for further assessment.

Archaeology and Heritage Resources

Heritage Resources are those resources, both human-made and naturally-occurring, related to human activities from the past that remain to inform present and future societies of that past.

A search of the provincial database, as well as a walkover of the PDA, was conducted by the provincial archaeologist. Four areas of interest were identified and further analysis of those identified areas has been requested. Outside those areas, it was determined that the probability for archaeological, heritage, or cultural resources in the PDA is low. Any discovery of an archaeological, heritage, or cultural resource as part of the Project would be an unplanned event.

The Historic Places of Prince Edward Island Mapping Application (Historic Places of Prince Edward Island nd) indicates that there are no provincially designated historic sites located within the PDA. Additionally, no designated historic sites were identified in a search of the Canadian Register of Historic Places (Canada's Historic Places nd).

Environmental effects on archaeology and heritage resources resulting from the construction phase of the Project are anticipated to be localized and minimal in number. In the event a discovery is made the effects would likely be long-term. Further, the project-specific environmental protection plan (PSEPP) will include mitigation for archaeology and heritages resources, as well as a contingency plan for the discovery of a heritage resource during construction.

In consideration of planned mitigation measures and lack of identified archaeology and heritage resources within or adjacent to the Project, archaeology and heritage resources is not expected to be substantive and will not be carried forward for further assessment.

Current Use of Land and Resources for Traditional Purposes by Indigenous Persons

The current use of land and resources for traditional purposes by Indigenous people pertains to the use of land and resources for traditional purposes and to determine where the Project has the potential to interact with those lands and resources.

The PDA of the proposed highway is located on land considered to be within Mi'kmaq traditional territory. There are two Mi'kmaq First Nation communities in PEI, Lennox Island First Nation and Abegweit First Nation, represented by the Mi'kmaq Confederacy of Prince Edward Island (MCPEI). Lennox Island First Nation is located along the northwestern coastal region of the Province (Lennox Island First Nation 2013). Abegweit First Nation consists of three reserves in different geographic locations in eastern parts of the Province (Morell Rear Reserve #2, Rocky Point Reserve #3, and Scotchfort Reserve #4) (Abegweit First Nation 2015).

While the Project lies within traditional territory of the Mi'kmaq, portions of the land on which the PDA is located on has been privately owned by various landowners for a number of years. A number of the properties have had a variety of uses including residential, commercial, forested, and agricultural. The province of Prince Edward Island owns a number of properties along the PDA.

As part of fulfilling the Crown's duty to consult, PEI TIE notified MCPEI of the Project and provided a description of the proposed works in a letter dated September 20, 2016. The MCPEI indicated in a letter dated December 15, 2016, that based on the Project details and research on the area, the Mi'kmaq of PEI do not object to the Project as proposed. A copy of the letter can be found in Appendix B. Consultation with the provincial office of the Aboriginal Affairs Secretariat indicated that there are no records of current Indigenous land and resource use in the area.

No further engagement and consultation activities are planned at this time. In the event changes to the project location occur, MCPEI would be notified at that time. Should any information regarding First Nations current use of the Project Site be identified during the regulatory approval process for the Project, this information will be presented to the regulators for consideration.

Environmental effects on Current Use of Land and Resources for Traditional Purposes by Indigenous Persons resulting from the construction phase of the Project are anticipated to be localized, short-term, and infrequent.

In consideration of the lack of identified current use of land and resources for traditional purposes by indigenous persons within or adjacent to the Project, current use of land and resources for traditional purposes by indigenous persons is not expected to be substantive and will not be carried forward for further assessment.

4.2 ENVIRONMENTAL ASSESSMENT METHODS

An overview of the methods used to conduct the EIA of the Project is provided in this section. The EIA has been completed using the methodological framework developed by Stantec to meet the requirements of EAs in federal and provincial jurisdictions in Canada, including the requirements of the PEI EPA. These methods are based on a structured approach that:

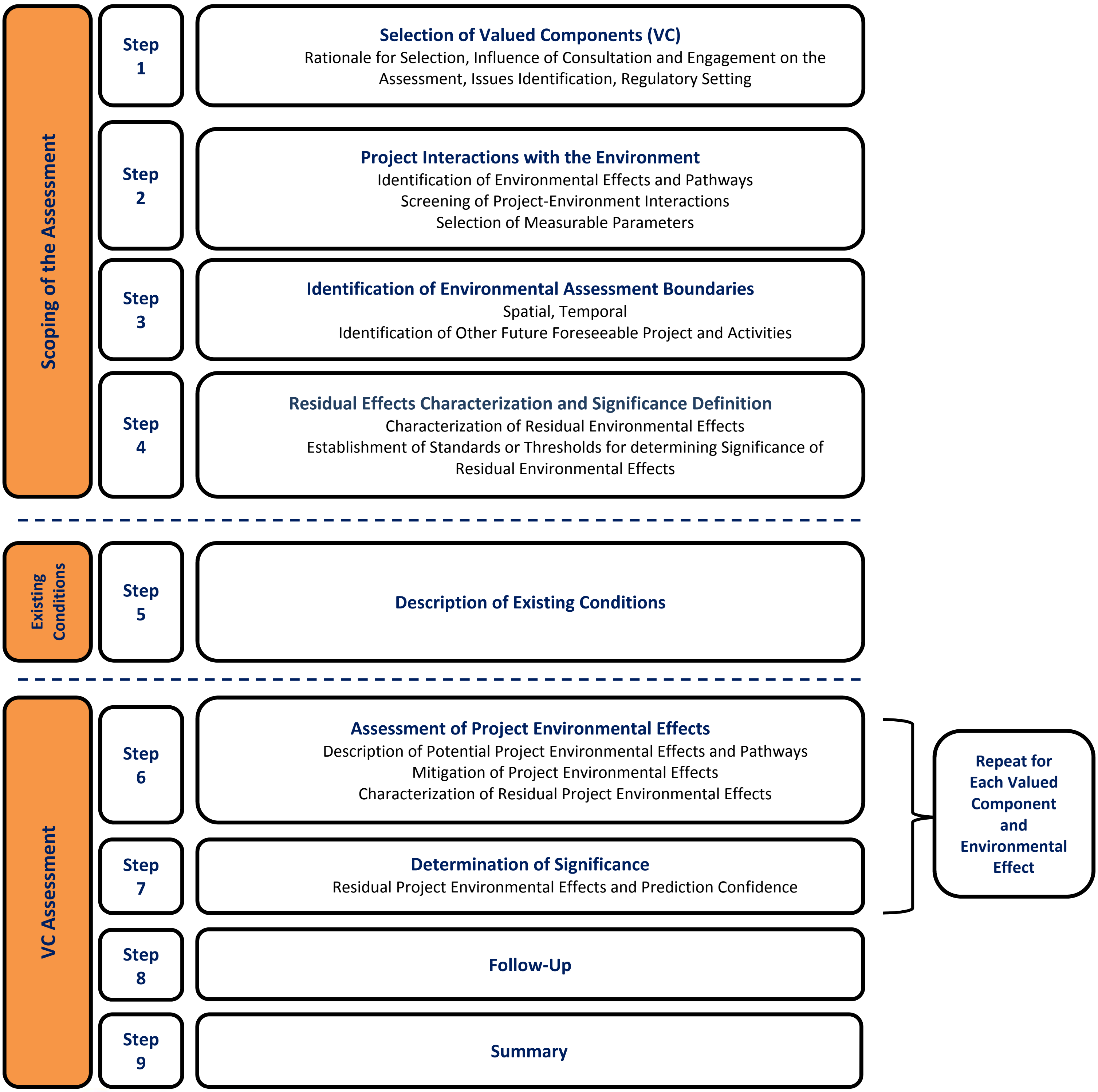
- focuses on issues of greatest concern
- considers the issues raised by the public and stakeholders
- integrates engineering design and programs for mitigation and follow-up into a comprehensive environmental planning process

The Project-related environmental effects are assessed using a standard framework for each VC, with tables and matrices used to facilitate and support the evaluation. Residual Project-related environmental effects (i.e., those environmental effects that remain after the planned mitigation measures have been applied) are characterized for each individual VC using specific criteria. These are magnitude, geographic extent, duration, frequency, timing, reversibility, and environmental/socioeconomic context. The significance of residual Project-related environmental effects is then determined based on pre-defined standards or thresholds (i.e., significance criteria).

A cumulative effects assessment was requested by the PEI TIE for this Project (as the request of PEI CLE. Cumulative environmental effects consider the residual environmental effects of the Project with the residual environmental effects of other physical activities (i.e., where there is overlap between the residual environmental effects of other physical activities and those of the Project) for projects or activities that have been or will be carried out. Any overlapping residual environmental effects are assessed to determine if they could be significant when acting cumulatively.

The environmental effects assessment methodology for each VC involves the generalized steps, as shown graphically in Figure 4.1.

Figure 4.1 Environmental Assessment Flow Chart



5.0 POTENTIAL ENVIRONMENTAL EFFECTS ON ATMOSPHERIC ENVIRONMENT

The atmospheric environment can be characterized by four components: air quality, climate, sound quality, and lighting. These components of atmospheric environment are described as follows:

- Air quality is characterized by the measure of the constituents of ambient air, and includes the presence and the quantity of air contaminants in the atmosphere.
- Climate is characterized by the composite of generally prevailing meteorological conditions of a region, including temperature, air pressure, humidity, precipitation, sunshine, cloudiness and winds, throughout the seasons, averaged over a number of years (typically a 30-year period of record). Project-based releases of GHGs are used as an indicator of potential environmental effects on climate. The assessment of potential environmental effects of climate on the Project is addressed in Section 10 (effects of the environment on the Project).
- Sound quality is characterized by the type, character, frequency, intensity, and duration of noise (unwanted sound) in the outdoor environment. The audible frequencies for humans are in the range of 20 to 20,000 Hertz (Hz). Vibration, identified as oscillations in matter that may lead to unwanted sound or stress in materials, is also considered as part of sound quality.
- Lighting is characterized by the three following attributes: light trespass, glare, and sky glow. Badly designed lighting or excessive lighting can result in these three types of obtrusive lighting, causing effects that range from a minor nuisance to a disruptive environmental effect.

For the purpose of Project components, combustion gases and particulate matter are considered in relation to air quality, and GHGs released during combustion processes are considered in relation to climate change. Noise is assessed using sound pressure levels and consideration of vibration levels. Lighting is assessed in the context of changes to existing levels.

5.1 SCOPE OF ASSESSMENT

5.1.1 Regulatory and Policy Setting

The Prince Edward Island *Environmental Protection Act–Air Quality Regulations* apply to the Project for air quality objectives. There are no applicable provincial sound quality, GHG, or lighting regulations governing the Project. In the request for proposals (RFP) for the Project (PEI TIE 2017), PEI TIE specifically requests that a lighting assessment be conducted for the EIA to consider the potential effect of lighting on the Project.

5.1.2 Potential Environmental Effects, Pathways, and Measurable Parameters

Based on the knowledge of the Project and its associated activities, the following potential environmental effects were selected for the assessment of the atmospheric environment: change in air quality; change in GHGs; change in sound quality; and change in lighting.

Table 5.1 provides the criteria that are used to characterize residual environmental effects on the atmospheric environment.

Table 5.1 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for the Atmospheric Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Air Quality	• The Project has the potential to release air contaminants (most notably particulate matter) to the atmosphere during construction and operation	• Ambient concentrations of air contaminants at ground level in micrograms per cubic metre ($\mu g/m^3$), including sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), total particulate matter (PM), and particulate matter less than 2.5 microns ($PM_{2.5}$)
Change in Greenhouse Gases	• The Project has the potential to release GHGs to the atmosphere during construction and operation	• Quantities of GHGs released (tonnes CO_2e)
Change in Sound Quality	• The Project has the potential to increase sound pressure levels during construction and operation which has the potential to cause negative environmental effects on humans, terrestrial wildlife, and nearby structures	• Sound pressure level, SPL (A-weighted decibels, dB(A)) • Peak particle velocity (mm/s)
Change in Lighting	• Project lighting can have adverse effects on human health, through changes in night time lighting, and disruptions to sleep and circadian rhythm, and increased glare leading to unsafe conditions. o Light Trespass – Excess illuminance from project sources on nearby receptors o Glare – Contrast between project lighting and background lighting o Sky Glow – Ratio of upward directed lighting to total lighting	• Change in light trespass in units of lux • Changes in glare in units of candela (cd) • Changes in sky glow in units of magnitude/$arcsec^2$

5.1.3 Boundaries

5.1.3.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the atmospheric environment are defined below, and illustrated in Figure 5.1:

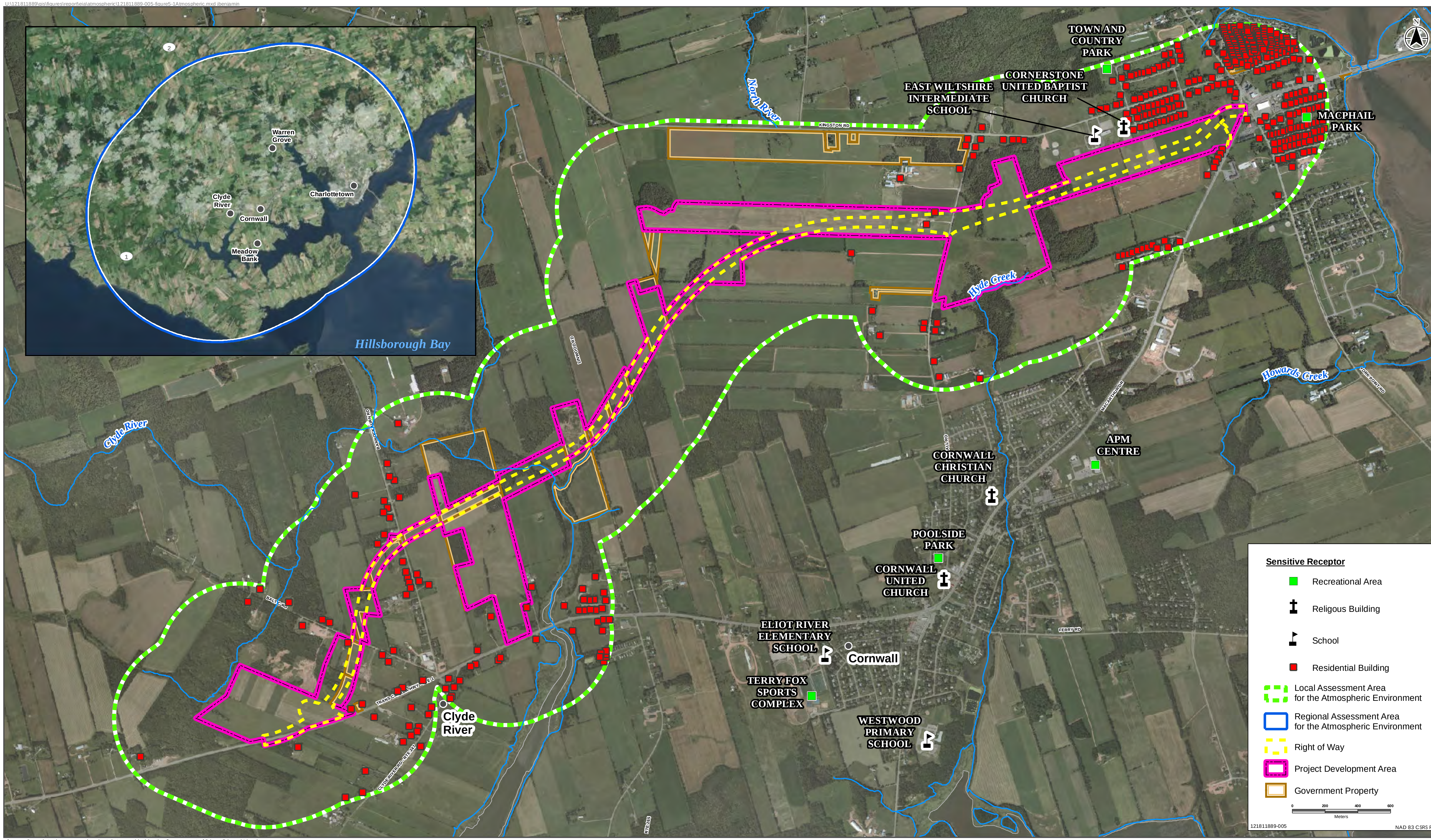
- Project Development Area (PDA): The PDA comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes a 7.8 km long, 61 m wide corridor, as well as interchanges, bridges, and overpasses, and properties owned by PEI TIE that may be used as borrow pits or laydown areas during construction.
- Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence, and encompassing the likely zone of influence. For the atmospheric environment specifically, the LAA is inclusive of the PDA and is defined as a 500 m perimeter around the Project.
- Regional Assessment Area (RAA): The RAA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RAA also accommodates a wider geographic area for atmospheric context. To assess a change in air quality and a change in noise, the RAA is equivalent to the Cornwall airshed, approximately 10 km out in each direction. Since GHGs are a global concern, the RAA for GHGs is global. These RAA's were selected in recognition of the global nature of the potential environmental effects of a Change in GHG Emissions on global climate.

5.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on atmospheric environment include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.

5.1.4 Residual Environmental Effects Description Criteria

Table 5.2 provides the criteria that are used to characterize residual environmental effects on the atmospheric environment.



Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

Stantec

Atmospheric Environment Assessment Area Boundaries

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Figure 5.1

Table 5.2 Characterization of Residual Environmental Effects on Atmospheric Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect	**Positive**—an effect that moves measurable parameters in a direction beneficial to atmospheric environment relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to atmospheric environment relative to baseline. **Neutral**—no net change in measurable parameters for the atmospheric environment relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no measurable effects. **Low**—a measurable change but within the normal range of variability; cannot be distinguished from baseline conditions. **Moderate**—measurable change but unlikely to pose a serious risk or benefit to the atmospheric environment or to represent a management challenge. **High**—measurable change that is likely to pose a serious risk to the atmospheric environment and, if negative, represents a management challenge.
Geographic Extent	The geographic area in which an environmental, effect occurs	**PDA**—residual environmental effects are restricted to the PDA. **LAA**—residual environmental effects extend into the LAA. **RAA**—residual environmental effects interact with those of other projects in the RAA.
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event**—occurs once **Multiple irregular event**—occurs at no set schedule **Multiple regular events**—occurs at regular intervals **Continuous**—occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual environmental effect restricted to the construction or operation phase of the Project. Includes effects to the atmospheric environment of less than 1 year. **Medium-term**—residual environmental effect restricted to the construction or operation phase of the Project. Includes effects to the atmospheric environment of between 1 and 5 years. **Long-term**—residual environmental effect extends beyond 5 years.

Table 5.2 Characterization of Residual Environmental Effects on Atmospheric Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases	**Reversible**—the environmental effect will cease during or after the Project is complete, the results of the effect will allow the atmospheric environment to recover to baseline. **Irreversible**—the environmental effect will persist after the life of the Project, even after mitigation measures are enacted. The atmospheric environment will not recover to baseline.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Low Socioeconomic Resiliency**—Sparsely populated region with relatively few service centres. **Medium Socioeconomic Resiliency**—A mix of sparsely populated areas along with more populated, urban centres. **High Socioeconomic Resiliency**—Densely populated area with several urban centres.

5.1.5 Significance Definition

5.1.5.1 Change in Air Quality

For a change in air quality, a significant adverse residual environmental effect on the atmospheric environment is defined as the following:

- one where project-related releases of air contaminants degrade the quality of the ambient air such that the Project-related concentrations (combined with background) are likely to exceed relevant regulatory criteria for ambient air quality, and are of concern relative to the geographical extent of predicted exceedances, their frequency of occurrence and the presence of potentially susceptible receptors (e.g., humans, wildlife, vegetation, soils or waterbodies). If the residual effects on air quality do not meet this definition, they are deemed to be not significant.

5.1.5.2 Change in Greenhouse Gases

As identified in guidance provided by the Canadian Environmental Assessment (CEA) Agency on assessing climate change in environmental assessments, "the contribution of an individual project to climate change cannot be measured" mainly because the effect on climate change is very small for any one project releasing GHGs to the atmosphere. However, the magnitude of GHGs released to the atmosphere may be considered in the context of: i) sector profile, ii) National Pollutant Release Inventory (NPRI) statistics and analysis, iii) provincial, iv) national, and v) global quantities released. Therefore, for GHGs released to the atmosphere, a significant adverse residual environmental effect on the atmospheric environment is one where there is an exceedance of legislated targets to reduce GHG emissions. Assessment of Project residual effects will focus on estimation of GHG releases, mitigation and evaluation of Project GHG releases in relation to provincial, federal and global GHG totals (The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment 2003). A GHG management plan is required for medium and high emitters as per CEA Agency guidance.

5.1.5.3 Change in Sound Quality

Sound quality is typically characterized in terms of the type, character, frequency, intensity, and duration of sounds in the outdoor environment. Since the human ear does not respond to sound on a linear scale, ambient sound pressure levels are characterized using a logarithmic decibel (dB) scale, with the A-weighted (dB(A)) scale being the most commonly used for environmental sound assessments. Measured parameters for environmental sound or noise (defined as unwanted sound) are often expressed as an "equivalent sound level" (L_{eq}) which represents an equivalent energy level over a specified period of time (e.g., 1-hour or 24-hours).

A number of jurisdictions, including the province of Ontario and the United States Environmental Protection Agency (US EPA), have established specific regulatory limits for sound pressure levels from industrial or construction activities. Although noise from specific industrial sources in PEI is sometimes regulated under the Certificates of Approval (COA) process, the PEI CLE has not established an ambient sound pressure level guideline or threshold limit for general application in the province. Generally, provincial requirements dictate that noise should be controlled such that it does not cause substantial loss of enjoyment of the normal use of any property, or substantial interference with the normal conduct of business. The City of Charlottetown Nuisance Bylaw states that persons who use gas-powered or electrical tools or equipment are guilty of an offense if it generates excessive noise (City of Charlottetown, 1989); however, the term "excessive noise" is not formally defined. In some cases, the COA for point sources of industrial sound emissions have established noise limits for different times of the day.

The Ministry of Transportation of Ontario (MTO) has established a guideline with criteria for ambient sound levels in the Environmental Guide for Noise (MTO 2006). The MTO Noise Guide identifies a Noise Sensitive Area (NSA) as being a noise sensitive land use (urban or rural) with an Outdoor Living Area (OLA) associated with the land use. NSAs include:

- Private homes (e.g., single family residences)
- Townhouses
- Multiple unit buildings (e.g., apartments with outdoor living areas for use by all occupants)
- Hospitals or nursing homes with outdoor living areas for the patients

According to the MTO Noise Guide, mitigation effort is to be investigated for a noise increase above the ambient level of ≥ 5 dBA or a projected noise level ≥ 65 dBA. Noise mitigation measures must be technically, economically, and administratively feasible. For the purpose of this EIS, sound pressure levels as a result of Project activities will be compared to the MTO Noise Guide.

For a change in sound quality, a significant adverse residual environmental effect is one that causes a change in sound quality where the noise guideline level is frequently exceeded at a receptor. For this assessment, the frequency exceedance criteria have been established as more than 12 days per year. As noted above, the current criteria established by MTO is a ≥ 5 dBA change or ≥ 65 dBA.

5.1.5.4 Change in Lighting

The basis for design of highway lighting used by PEI TIE is the Transportation Association of Canada's (TAC) Guide for the Design of Roadway Lighting (2006). The preface to the guide states "*In preparing the document, design standards and design practices from North America, Australia, New Zealand and Europe were researched. A conscious effort has been made to base the recommendations of the Guide on proven practice. The majority of the Guide is, therefore, based on existing recommended practices of the Illuminating Engineering Society of North America (IESNA) and the Commission Internationale De l'Eclairage (CIE)*". The CIE has developed guidelines and recommendations to limit light pollution and associated impacts to humans and wildlife. Many lighting design elements adhere to these guidelines through design standards developed by the Illuminating Engineering Society (IES), who have adopted IDA and CIE guidelines and recommendations for use in developing new outdoor lighting guidance and standards.

The CIE has established guidelines for light trespass and glare for various levels of urbanization (or environmental zones) and time of day. Four environmental zones have been established by the CIE as a basis for outdoor lighting assessment (CIE 2003). The four zones are listed in Table 5.3.

Table 5.3 Environmental Zones

Zone	Surrounding	Lighting Environment
E1	Natural	Intrinsically dark
E2	Rural	Low distinct brightness
E3	Suburban	Medium distinct brightness
E4	Urban	High distinct brightness
SOURCE: CIE 2003		

The maximum values recommended by CIE for light trespass (illuminance) by environmental zone and time of day are presented in Table 5.4.

Table 5.4 Recommended Maximum Values of Light Trespass (Illumination) in Environmental Zones

Time of Day	Environmental Zones			
	E1 Natural	E2 Rural	E3 Suburban	E4 Urban
Pre-curfew (19:00–23:00)	2 lux	5 lux	10 lux	25 lux
Post-curfew (23:00–6:00)	0 lux	1 lux	2 lux	5 lux
SOURCE: CIE 2003				

The maximum values recommended by CIE for glare (intensity of luminaires) by environmental zone and time of day are presented in Table 5.5.

Table 5.5 Recommended Maximum Values for Glare (Intensity of Luminaires) in Designated Directions

Time of Day	Environmental Zones			
	E1 Natural	E2 Rural	E3 Suburban	E4 Urban
Pre-curfew (19:00–23:00)	2,500 cd	7,500 cd	10,000 cd	25,000 cd
Post-curfew (23:00–6:00)	0[1] cd	500 cd	1,000 cd	2,500 cd
NOTE: [1] If for public lighting value may be up to 500 cd				
SOURCE: CIE 2003				

Reference levels of sky glow are presented in Table 5.6. As the number increases, the sky is more dominated by the natural background; the lower the number, the greater the degree of sky glow that is caused by reflection of lighting from the atmosphere.

Table 5.6 Reference Levels of Sky Glow

Sky Glow (mag/arcsec^2)	Corresponding Appearance of the Sky
21.7 (Rural)	The sky is covered with stars that appear large and close. In the absence of haze the Milky Way can be seen to the horizon. The clouds appear as black silhouettes against the sky.
21.6	The above with a glow in the direction of one or more cities is seen on the horizon. Clouds are bright near the city glow.
21.1	The Milky Way is brilliant overhead but cannot be seen near the horizon. Clouds have a greyish glow at the zenith and appear bright in the direction of one or more prominent city glows.
20.4	The contrast to the Milky Way is reduced and detail is lost. Clouds are bright against the zenith sky. Stars no longer appear large and near.
19.5	Milky Way is marginally visible, only near the zenith. Sky is bright and discoloured near the horizon in the direction of cities. The sky looks dull grey.
(18.5 Urban)	Stars are weak and washed out and reduced to a few hundred. The sky is bright and discoloured everywhere.
SOURCE: Berry 1976	

A significant environmental effect on lighting is defined as an increase in Project-related light emissions such that the CIE guidelines for light trespass and glare in a rural environment (E2) are exceeded and the resulting conditions related to sky glow would be altered toward those of a suburban environment.

5.2 EXISTING CONDITIONS OF THE ATMOSPHERIC ENVIRONMENT

The atmospheric environment is described in the context of meteorology/climate, air quality (ambient and emissions, greenhouse gases released) and acoustics/noise.

5.2.1 Methods

A review of the relevant climate, air quality, and noise data from various sources (Government of Canada, NAV CANADA, CCME, Environment and Climate Change Canada (ECCC)) was undertaken, which included previous environmental assessments and publicly available reports from various researchers and government. Although the review of previous studies and existing information provided some information on the atmospheric environment in the Project location, and specifically at the regional and local spatial scales, it was determined that additional information and data were required to support the assessment for the currently proposed Project. Specifically, noise and lighting data were required in the atmospheric environment along the PDA. Field studies were undertaken in the spring of 2017 to supplement the existing data.

Data and information collected during field studies described below were used to characterize the existing conditions for the atmospheric environment.

5.2.1.1 Field Methods

A noise feasibility study was conducted by MMM Group (2017). Existing and future noise levels at 15 receiver locations were modeled in the study using the Traffic Noise Model software package version 2.5 (TNM 2.5). Two scenarios (with and without the Project) were modeled, based on traffic data forwarded to MMM Group by PEI TIE for the year 2032.

A baseline light monitoring assessment was conducted along the RoW. The assessment was conducted to characterize the existing ambient light environment at the Project site and surrounding areas where Project activities could influence nighttime light levels. Data collected includes sky glow and light trespass readings.

5.2.2 Overview

5.2.2.1 Meteorology

Annual climate normals for the Environment and Climate Change Canada weather station nearest to the Project site (Charlottetown) indicate that January is typically the coldest month, with a mean daily temperature of -7.7 degrees Celsius (°C). On average, July is typically the hottest month having a mean daily temperature of 18.7 °C.

The mean annual precipitation is reported to be 1,158.2 millimeters (mm). October is typically the wettest month with an average rainfall amount of 110.3 mm, while January is the snowiest month with an average recorded snowfall of 73.3 centimeters (cm) (Government of Canada 2017).

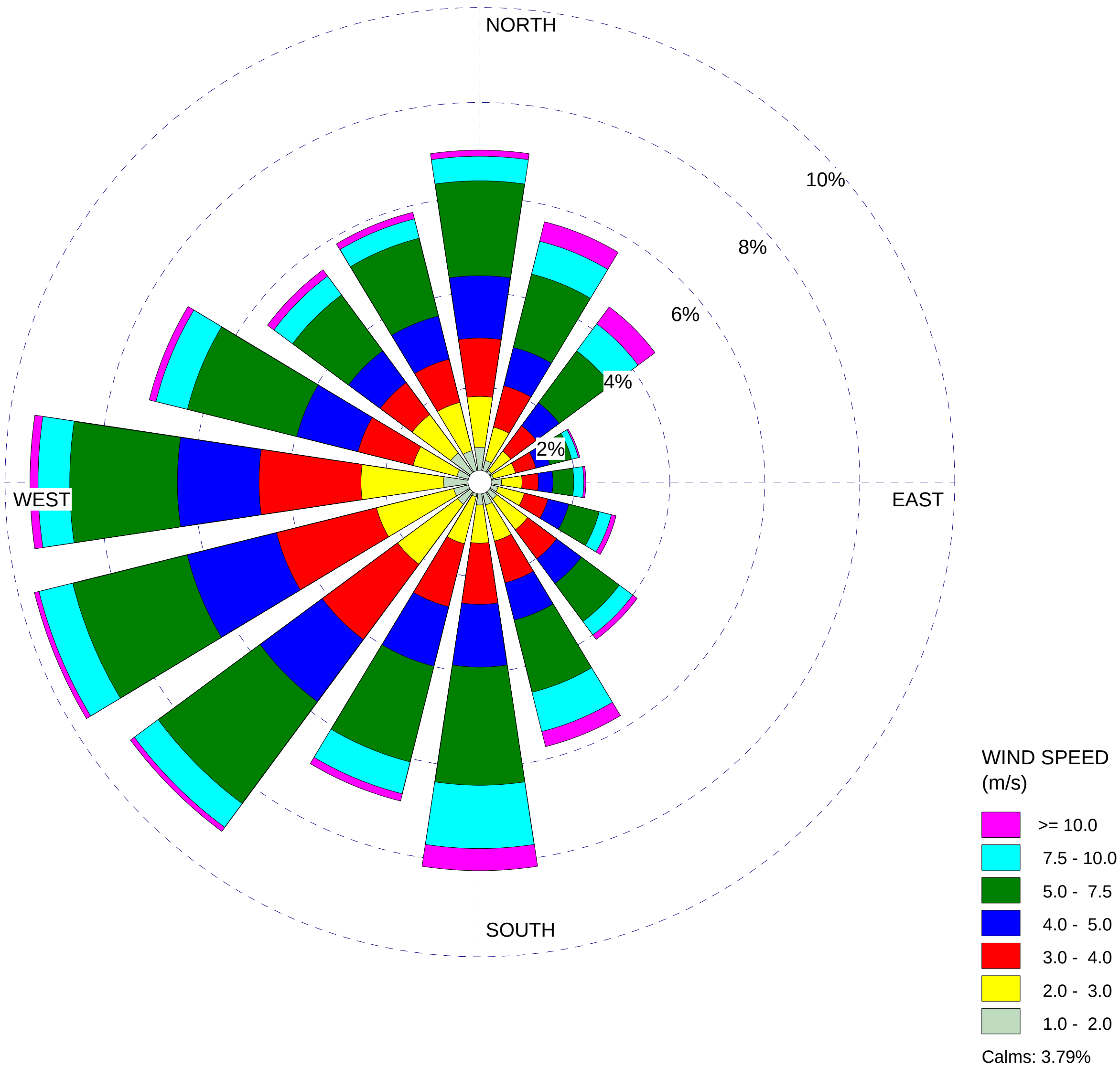
A wind rose plot for the Charlottetown airport (2009-2014) is provided in Figure 5.2. Winds most frequently blow from the southwestern quadrant, with the west and west-southwest directions being most dominant. High wind speeds occur most frequently from the northeast and southerly directions. Low wind speeds occur most frequently from the west and southwesterly directions.

WIND ROSE PLOT:

Figure 5.2: Winds at the Charlottetown Airport (2009-2014)

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2009 - 00:00 **End Date: 12/31/2014 - 23:00**	MODELER:	Stantec
	CALM WINDS: **3.79%**	TOTAL COUNT: **52375 hrs.**	
	AVG. WIND SPEED: **4.51 m/s**	DATE: **9/24/2015**	PROJECT NO.: **121811889**

WRPLOT View - Lakes Environmental Software

5.2.2.2 Ambient Air Quality

Overview

Steady wind patterns in the area tend to disperse most air contaminants released into the region at most times of the year. Generally, climate conditions provide good dispersion of air contaminants and frequent rainfall helps to remove air contaminants from the atmosphere. Ambient air quality in PEI also benefits from the infusion of relatively clean oceanic air masses from the North Atlantic (NAV CANADA 2000). Occasionally, air masses from central Canada or the eastern seaboard to the south may transport air contaminants such as ozone into the area, causing degradation in air quality. At other times, the weather is dominated by high-pressure air masses that produce low wind speeds and poor dispersion of local emissions, which can lead to elevated concentrations of air contaminants and reduced air quality (NAV CANADA 2000).

The existing air contaminants in PEI, presented below, are based on NPRI reported data for 2015. This was the most recent year of quality-assured, published data at the time of conducting the assessment. The NPRI requires industrial facilities to report specific air contaminant emissions to ECCC when facility reporting thresholds are met. The closest industrial facilities to the PDA are the BioVectra Inc. - Douglas J Hennesey Biochemical Centre (approximately 3 km east), Elanco – Animal Health Business (approximately 5 km east), and BioVectra Inc. - Regis and Joan Duffy BioPharmaceutical Centre (approximately 8 km northeast).

In 2015, 13 PEI facilities reported criteria air contaminant emissions to the NPRI. Table 5.7 provides a summary of provincial and national air contaminant emissions as reported to the NPRI for the 2015 calendar year.

Table 5.7 Comparison of Provincial and National Air Contaminant Emissions (2015)

Value	Combustion Gases			Particulate Matter	
	Sulphur Dioxide (tonnes)	Nitrogen Oxides as Nitrogen Dioxide (tonnes)	Carbon Monoxide (tonnes)	PM (tonnes)	$PM_{2.5}$ (tonnes)
Provincial Total Reported	136	214	94	35	17
National Total Reported	986,793	623,866	879,317	175,833	49,406
Provincial Percent of National	0.014	0.034	0.011	0.020	0.034

Source: ECCC 2016a

PEI's contribution to the national total releases of air contaminants is low, approximately 0.023% of the national totals, on average.

Releases to the Atmosphere

In the vicinity of the Project, local road traffic, agricultural activity and small-scale industrial activities are the predominant sources of air contaminants released to the atmosphere. Generally, climate conditions provide good dispersion of air contaminants and frequent rainfall scavenges air contaminants from the atmosphere.

Emissions from motor vehicles can have a noticeable influence on air quality in the Cornwall airshed. The contribution of vehicle emissions to air quality depends on a variety of factors including, but not limited to, the local meteorology, the number of vehicles in operation, the average age of the vehicles, and the state of repair of vehicles. Vehicle emissions can be both a local and regional problem, where emissions from large urban centres may also be transported by long-range transport of air pollutants and pose challenges to local air quality in areas hundreds of kilometres from their origin.

5.2.2.3 Greenhouse Gases (GHGs)

There are currently no standards or guidelines for greenhouse gas (GHG) concentrations in ambient air (provincial or federal), nor are there any emission limits with respect to GHG releases from individual sources or sectors in place provincially (PEI) or federally at this time.

The provincial government has prepared A Strategy for Reducing the Impacts of Global Warming (Government of PEI 2008) which outlines plans to reduce GHG emissions by 500,000 tonnes of CO_2e per year, to meet its self-imposed target to reduce GHG emissions to 75% to 85% below 2001 levels by 2050. The plan includes reductions in GHG emissions via the following areas: Energy Efficiency and Conservation; Renewable Energy; Transportation; Agriculture; Public Education and Awareness and; Government Leading by Example (Government of PEI 2008).

The federal government released the Regulatory Framework for Industrial Greenhouse Gas Emissions in 2008 (Government of Canada 2008). This framework outlines a regulatory regime involving 18 target industrial sectors and the draft regulations were scheduled to be published in the Canada Gazette in the fall of 2008. This was followed by an announcement in July 2009, that the GHG reporting threshold for emitters was reduced to 50,000 tonnes (t) carbon dioxide equivalent (CO_2e) per year. Any facility emitting more than the 50,000 t CO_2e threshold in the 2010 calendar year must report to ECCC via the Electronic Data Reporting (EDR), a system managed by Statistics Canada.

In May 2015, the Government of Canada (ECCC 2016b) submitted the country's Intended Nationally Determined Contribution to the United Nations Framework Convention on Climate Change. This submission included Canada's plan to reduce its GHG emissions by 30% below 2005 levels by 2030. The federal government will develop new regulatory measures under its sector-by-sector approach, which would include the following:

- Regulations aligned with recently proposed actions in the United States to reduce methane from the oil and gas sector
- Regulations for natural gas-fired electricity
- Regulations for the production of chemicals and nitrogen fertilizers

The ECCC's Facility Greenhouse Gas Emissions Reporting Program (GHGRP) (ECCC 2017a) provides information and data on GHG emissions from Canadian facilities for the 2012 calendar year. Any facility with annual GHG emissions of 50,000 tonnes of CO_2e or higher is required to report to the program.

The Government of Canada established the GHGRP in March 2004 under the authority of Section 46 of the *Canadian Environmental Protection Act*, 1999 to collect GHG emissions information annually from the largest emitting Canadian facilities on a mandatory basis. To date, facility-reported GHG information has been collected and published through ECCC's GHGRP for the period 2004 to 2012.

The quantities of GHGs released to the atmosphere from the province of PEI have been reported in Canada's national inventory report for 2015 as 1.80 megatonnes (Mt) CO_2e, and 722 Mt for Canada (ECCC 2016c). On this basis, PEI represents a small fraction of Canada's GHG releases annually (0.25%).

Global emissions of GHGs were estimated to be 43.6 billion tonnes CO_2e in 2013 (latest available data), excluding land use change and forestry (World Resources Institute 2017). Therefore, on this basis Canada's contribution to global GHG emissions is approximately 1.7%.

There is one facility in PEI which exceeds the ECCC reporting threshold, producing 50,332 t CO_2e in 2015 (ECCC 2016c). This accounts for approximately 3% of the total reported provincially and less than 0.02% of the national reported total for 2015.

GHG Assessment

A GHG assessment was conducted by Stantec (Appendix A) to estimate the changes in GHGs released to the atmosphere associated with the Project. Five different operating scenarios are assessed. These include studying traffic and associated GHG emissions with different combinations of intersections, roundabouts and the new highway, focusing on the years 2017, 2019 and 2032.

The two scenarios of 2017 (without and with the roundabouts) illustrate the change in GHGs due to the change in the three interchanges only, from signalized intersections to roundabouts. The difference is a decrease of approximately 274 tonnes of GHGs per year. This suggests there is some reasonable benefit associated with the change from signalized intersections to roundabouts, from a GHG perspective.

The traffic scenarios of 2019 illustrate a hypothetical change between traffic with three roundabouts and no new highway operating, to three roundabouts and the new highway in operation. The vehicle traffic is similar, and vehicle distribution is similar, although not identical. The traffic is expected to flow much freer with the new highway in operation. The results show a decrease in GHGs by 353 tonnes/year for the change in traffic pattern.

The GHG assessment estimates a 30% decrease in GHG emissions from 2017 to 2032. The total GHGs released during those years is 149,850 tonnes, with an accumulated decrease of 28,378 tonnes, or 19% of the total. The decrease is a function of changes in vehicle distribution and change in model year (emissions control technology) that directly affect the emission factors.

The quantities of GHGs released during the construction of the new roadway were also estimated as part of this assignment. These estimates were made using data on the quantities of fuel burned in vehicles, heavy equipment and trucks that would be used to transport building materials (aggregate, asphalt) to the site, and to clear the site and build the roadway.

The total construction emissions of GHGs (in CO_2e) are estimated to be approximately 3,552 tonnes over the anticipated construction period, which is an average of about 592 tonnes per year.

5.2.2.4 Acoustic Environment

There are currently no ambient sound pressure level guideline or threshold limit for general application in the province.

A noise feasibility study was conducted in January 2017 by MMM Group (2017). This study followed the MTO Noise Guide, where a Noise Sensitive Area (NSA) is defined as a noise sensitive land use (urban or rural) with an OLA associated with the land use. NSAs include:

- Private homes (e.g., single family residences)
- Townhouses
- Multiple unit buildings (e.g., apartments with outdoor living areas for use by all occupants)
- Hospitals or nursing homes with outdoor living areas for the patients

There were 15 worst-case receiver locations identified along the PDA to represent the above NSAs. The summary of existing sound levels (modeled with TNM 2.5 by MMM Group) at each receiver are listed below in Table 5.8.

Table 5.8 Existing Sound Levels (MMM Group 2017)

Receiver	Existing Sound Levels in dBA Leq (24)	Receiver	Existing Sound Levels in dBA Leq (24)
R1	39.0	R9	35.5
R2	38.0	R10	52.2
R3	39.5	R11	52.4
R4	47.1	R12	39.5
R5	45.9	R13	40.0
R6	34.8	R14	36.0
R7	28.0	R15	33.9
R8	49.6		

The range of existing sound levels listed above are typical for a rural and quiet suburb settings. Details on how the existing sound levels were modeled are provided in the feasibility study (MMM Group 2017) attached in Appendix C.

5.2.2.5 Lighting

Existing sources of light include exterior lighting on residential homes and small businesses and street lights. Such exterior lighting would tend to be shielded slightly more during the spring and summer months due to vegetation, than during the winter months when there is less vegetation and the potential for reflection of light when the ground is snow covered.

A baseline light monitoring event was conducted to characterize the existing ambient light environment at the Project site and surrounding areas where Project activities could influence nighttime light levels. Baseline monitoring at each viewpoint included measurements of illuminance (lux) and sky glow. Illuminance was measured using a conventional, integrating hemispherical light meter (Extech EA33) with a resolution of 0.01 lux. Sky glow was measured using a Unihedron Sky Quality Meter with lens (SQM-L). This meter was developed for astronomical applications to document the level of sky brightness, measured in units of magnitudes/square arc-second ($mag/arcsec^2$). In addition to the light measurements, panoramic photographs were taken at each location to document the view during the day and during the night using a high quality (Canon 60D) digital camera.

Baseline monitoring was completed on April 19, 2017 at three locations either adjacent to or with unobstructed views of the Project. The baseline monitoring locations are representative of areas that could be affected by Project-associated lighting. These are:

- Location A — Fulton Drive subdivision
- Location B — Cornwall Road
- Location C — Bannockburn Road

Figure 5.3 shows lighting assessment monitoring locations A through C relative to the RoW. Panoramic photographs taken from the three baseline monitoring locations are included in Appendix D. The panoramic photographs were taken during nighttime hours and are intended to portray the existing environment so that visual perception of the current conditions is better understood. The photographs were taken facing the area of the proposed highway. Additional information pertaining to the three baseline light monitoring locations is provided in Table 5.9.

Table 5.9 Baseline Ambient Light Measurement and Receptor Locations

Location No.	Site Location (UTM Zone 10U)		Site Description
	Easting (m)	Northing (m)	
A	20T 0484432	20T 5122307	Fulton Drive subdivision, north of the proposed highway
B	20T 0483247	20T 5120476	Cornwall Road, south of the proposed highway
C	20T 0479983	20T 5119676	Bannockburn Road, south of the proposed highway

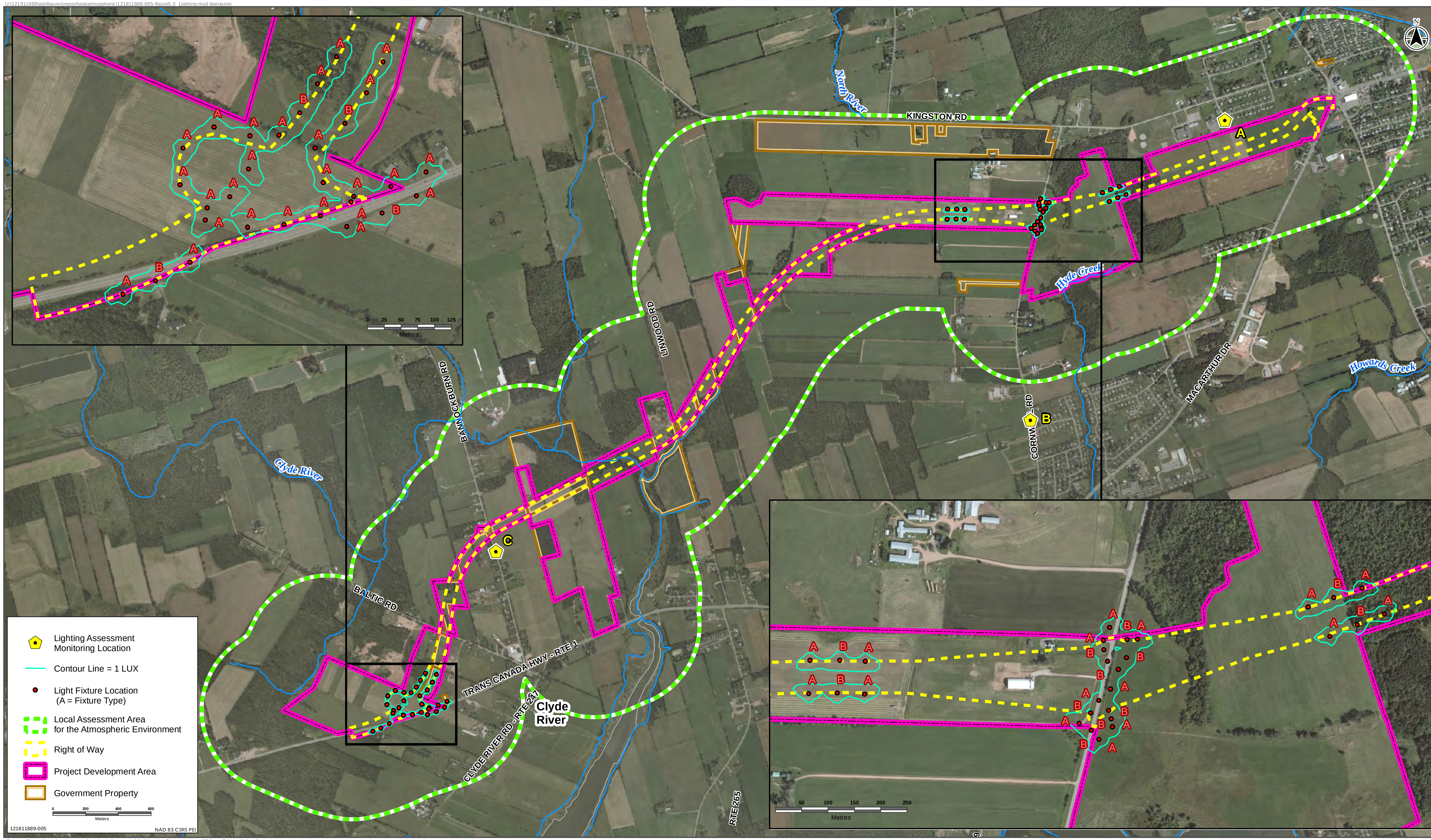
Results of the baseline light monitoring event are shown in Table 5.10. Measurements of incident light were below 1 Lux at each monitoring location.

Table 5.10 Measured Sky Glow and Light Trespass Readings

Location No.	Average Sky Brightness (mag/arcsec^2)	Light Trespass[1] (Lux)	CIE Environmental Zone	Date
A	19.95	0	E2	April 19, 2017
B	20.25	0	E2	April 19, 2017
C	21.01	0	E2	April 19, 2017
NOTES: [1] Lux levels were below instrument detection limit				

Based on the ambient light levels (both sky glow and light trespass), the location of the Project and surrounding areas are considered to be rural environmental zones, category E2 (see Table 5.3), with light trespass measurements consistently below 1 Lux, less than the CIE guidelines for light trespass in a rural area (see Table 5.4).

U:\121811889\gis\figures\report\eia\atmospheric\121811889-005-figure5-3_Lighting.mxd jbenjamin



Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

Lighting Assessment Monitoring Locations and Results

Stantec

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Figure 5.3

5.3 PROJECT INTERACTIONS WITH THE ATMOSPHERIC ENVIRONMENT

The Project will interact with the atmospheric environment during construction and operation. These interactions between the Project and the atmospheric environment may result in a change in air quality, greenhouse gases, sound quality and/or lighting. Table 5.11 identifies the project physical activities that might interact with the atmospheric environment to result in the environmental effects. These interactions are indicated by check marks, and are discussed briefly below, and in detail in Section 5.4 in the context of effects pathways, standard and project-specific mitigation, and residual environmental effects. A justification is also provided below for non-interactions (no check marks).

Table 5.11 Potential Project-Environment Interactions and Effects on the Atmospheric Environment

Project Components and Physical Activities	Potential Environmental Effect			
	Change in Air Quality	Change in Greenhouse Gases	Change in Sound Quality	Change in Lighting
Construction				
Site Preparation	-	-	-	-
Roadbed Preparation	-	-	-	-
Installation of Structures	-	-	-	-
Surfacing and Finishing	-	-	-	-
Temporary Ancillary Elements	-	-	-	-
Emissions and Wastes	✓	✓	✓	-
Operation				
Infrastructure Maintenance	-	-	-	-
Winter Maintenance	-	-	-	-
Vegetation Management	-	-	-	-
Emissions and Wastes	✓	✓	✓	✓
Notes: ✓ = Potential interactions that might cause an effect. – = Interactions between the project and the atmospheric environment are not expected.				

The construction activities will result in releases of air contaminants to the atmosphere, consisting mainly of combustion gases from the operation of on-site construction equipment and large trucks used to deliver equipment to the site. There may also be some fugitive dust generated as a result of excavation activities. The operation activities will result in releases of air contaminants to the atmosphere, consisting mainly of combustion gases from the operation of on-site maintenance equipment. There may also be some fugitive dust generated as a result of vegetation management activities. The change in air quality as a result of construction and operation activities is therefore considered under emissions and wastes.

The construction activities will result in releases of GHGs, predominantly from fuel combustion in heavy equipment and trucks. The operation activities will result in releases of GHGs, predominantly from fuel combustion in passenger vehicles traveling on the highway and heavy equipment from maintenance/management activities. The change in GHGs as a result of construction and operation activities is therefore considered under emissions and wastes.

The construction activities will result in sound emissions, predominantly from the operation of heavy equipment and from transportation vehicles on Project access roads. The operation activities will result in sound emissions, predominantly from the operation of passenger vehicles traveling on the highway and heavy equipment from maintenance/management activities. The change in sound quality as a result of construction and operation activities is therefore considered under emissions and wastes.

Construction activities will not result in a change in lighting, as construction activities will occur during daylight hours only. Safety lighting may be installed during construction, but is not expected to cause a change in lighting. The operation activities will result in lighting emissions, predominantly from highway lighting during nighttime hours and lighting from passenger vehicles traveling on the highway. The change in lighting as a result of operation activities is therefore considered under emissions and wastes.

5.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON THE ATMOSPHERIC ENVIRONMENT

5.4.1 Analytical Assessment Techniques

The assessment of potential environmental effects on the atmospheric environment was conducted using both desktop information and the results of field surveys.

GHGs are released into the atmosphere principally from fuel combustion. Other GHG sources, such as fugitive releases, are not relevant to the Project. Emissions of GHGs from diesel combustion in construction equipment, as well as from the operation of the Project were estimated in the GHG Assessment (Stantec 2017) and used to assess the change in GHGs for this Project.

A noise feasibility study was conducted by MMM Group, in which predicted future noise levels with the proposed Project in place and the predicted future noise levels without the Project were compared to determine the noise impact. Results from this noise study were used to assess the change in sound quality.

A lighting assessment was conducted at various locations throughout the PDA. The assessment was conducted during the daytime and nighttime by qualified technicians.

5.4.2 Assessment of a Change in Air Quality

5.4.2.1 Project Pathways for Change in Air Quality

During construction, emissions from activities such as site preparation and the construction of various Project components will result in increases in the overall level of emissions. Increased emissions may cause an increase in ground-level concentrations of air contaminants. The duration of construction is expected to begin in 2017 and completed by 2020.

During operation, emissions from activities such as traffic and operation of vehicles during Project maintenance will result in increases in the overall level of emissions.

5.4.2.2 Mitigation for Change in Air Quality

The PEI TIE will assess potential opportunities to reduce emissions throughout construction. Throughout both construction and operation, PEI TIE will control emissions from Project activities by implementing the following mitigation measures:

- manage vehicle and equipment emissions by conducting regular maintenance on all machinery and equipment
- control construction-related fugitive road dust, through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis
- prohibit the burning of waste materials
- reduce haul distances to disposal sites

5.4.2.3 Residual Project Environmental Effects for Change in Air Quality

Based on the above, the residual environmental effects of the Project are predicted to be adverse during construction, since they will add to existing air contaminant concentrations in the LAA. Based on experience with construction project air contaminant emissions, the main concern in relation to air quality is dust, which can approach ambient objectives in dry, windy periods. Other air contaminants are not expected to contribute measurably to existing ambient levels most of the time during construction.

The residual environmental effect of the Project are predicted to be adverse during operation, since they will also add to existing air contaminant concentrations in the LAA. Similar to construction, the main concern to air quality from traffic and the use of maintenance equipment is dust. Other air contaminants are not expected to contribute measurably to existing ambient levels most of the time during operation.

5.4.3 Assessment of a Change in GHGs

5.4.3.1 Project Pathways for Change in GHGs

The activities associated with the construction of the highway involve excavation and transporting of Project supplies. Releases of GHGs will occur in small quantities from fuel combustion in heavy equipment and trucks used for Project activities. The quantities of GHGs released to the atmosphere during Project construction are expected to be very small in comparison to provincial and national totals.

Landscaping activities during construction will involve some earth movement for leveling, along with the laying of sod and the planting of vegetation. These activities are likely to generate minimal GHG emissions. The quantities of GHGs released to the atmosphere during Project landscaping activities are expected to be very small in comparison to provincial and national totals.

According to the GHG Assessment (Stantec 2017), the total construction emissions of GHGs (in CO_2e) are estimated to be approximately 3,552 tonnes over the anticipated construction period.

Overall, the results of the assessment suggest that differences in the quantities of GHGs released to the atmosphere between the existing baseline and the operation of the new highway are not large, initially. The differences are relatively small (less than 10% of the reference year) in the first year of operation. The difference increases to about 30% less GHG emissions in 2032, thus reducing over all emissions and resulting in a positive effect on GHG emissions in the province.

5.4.3.2 Mitigation for Change in GHGs

Emissions of GHGs will be reduced to the extent practical by:

- using construction equipment that is well maintained
- reducing haul distances to disposal sites

5.4.3.3 Residual Project Environmental Effects for Change in GHGs

Construction activities will result in small releases of GHGs due to fuel combustion in heavy equipment and trucks. With mitigation, construction of the Project is expected to result in a small fraction of annual PEI GHG emissions.

The GHG Assessment (Stantec 2017) suggests that difference in the quantities of GHGs released to the atmosphere between baseline and the operation of the new highway will be a slight decrease, initially. The differences are relatively small (less than 10% of the reference year) in the first year of operation. The difference increases to about 30% less GHG emissions in 2032. Therefore, during operation, the reduction in emissions would have a positive effect on GHG emissions in the province. Therefore, the residual environmental effects of operation on a change in GHGs are expected to be positive compared with existing conditions, with a net decrease in GHG emissions estimated.

5.4.4 Assessment of a Change in Sound Quality

5.4.4.1 Project Pathways for Change in Sound Quality

Sound pressure levels at nearby sensitive receptors may increase during construction when construction equipment is operating.

The operation of the highway may cause a noticeable increase in sound pressure levels at sensitive receptors near the Project with passenger vehicles traveling on the highway and operation of maintenance vehicles and equipment. Increases in sound pressure level or vibration at sensitive receptors may cause a loss of enjoyment of property as well as sleep loss.

Predicted future noise levels with the proposed Project in place and the predicted future noise levels without the Project were compared to determine the noise impact (MMM 2017). The Traffic Noise Model software package version 2.5 was used to model existing and future noise levels at 15 receivers, with and without the Project, based on traffic data provided by PEI TIE for the year 2032. According to the MTO Noise Guide, mitigation effort must be investigated for a noise increase above the ambient level of ≥ 5 dBA or a projected noise level ≥ 65 dBA. According to the MTO Noise Guide, noise mitigation measures must be investigated and are to be technically, economically, and administratively feasible.

The PEI TIE has committed to installing a noise berm along the Fulton Drive subdivision, as well as realigning the highway approximately 20 to 50 m away from the three receivers in this area to reduce noise levels (Figure 2.2). The predicted increase in sound levels are expected to be greater than 5 dBA at the remaining receivers. These receivers were further investigated and noise mitigation is not considered to be economically feasible in these areas. The predicted sound levels with the operation of the Project (in 2032), however, are not predicted to exceed the criterion of 65 dBA at these receivers and therefore no noise mitigation has been recommended at these locations as mitigation is not feasible.

5.4.4.2 Mitigation for Change in Sound Quality

Mitigation proposed for sound may include:

- use of well-maintained construction equipment with appropriate mufflers
- use of acoustical barriers near loud sources (e.g., power generators)
- size construction equipment to smallest needed to perform the work
- complaint follow-up and response procedure to be included in the PSEPP
- restrict construction activities to daylight hours only
- realignment of the highway along the Fulton Drive subdivision

- install a noise berm along the Fulton Drive subdivision

5.4.4.3 Residual Project Environmental Effects for Change in Sound Quality

Residual environmental effects on sound quality during Project construction are expected to be adverse in direction, low in magnitude, to be limited to the LAA, and to be short-term in duration. The effects are characterized as reversible because once the construction activities cease, the sound pressure levels in the LAA will return to baseline levels.

The PEI TIE has committed to installing a berm near the Fulton Drive subdivision to mitigate noise at this location. The remaining locations where the increase in sound levels are predicted to be greater than 5 dBA, it was determined that mitigation was not economically feasible. Nevertheless, sound levels in these areas remain below the 65 dBA criterion.

A public meeting was held with residents in this subdivision and the results of the noise feasibility were presented. Residents in this area were not satisfied with the predicted noise levels with the installation of the berm and had requested that the highway extension be aligned further away from their properties, in addition to the berm installation. The PEI TIE redesigned the alignment, as requested by the public, where the Project travels near the Fulton Drive subdivision. The new alignment is 20-50 m further from the receivers than the original alignment.

A follow-up meeting was held on March 9, 2017, where PEI TIE presented the new alignment, and the placement of the noise berm. See Figure 2.2 for the original and new alignments near the Fulton Drive subdivision. The public seemed generally satisfied with the efforts that PEI TIE had made with plans to reduce noise levels during operation of the Project in this area.

Based on the results of the assessment (MMM Group 2017), and the planned mitigation, the residual environmental effects on sound quality during Project operation are expected to result in a change in sound quality that will be adverse, low in magnitude, within the LAA, occurring continuously, long-term in duration, and reversible.

5.4.5 Assessment of a Change in Lighting

5.4.5.1 Project Pathways for Change in Lighting

The Project has potential to interact with the existing ambient light environment. During construction, the Project activities will occur during daylight hours only, and is therefore not expected to interact in any substantive way with the existing ambient light environment. During operation, Project activities associated with exterior lighting have the potential to cause adverse effects on the ambient lighting environment.

The assessment of a change in ambient light from the operation of the Project focuses on the potential effects that Project exterior lighting could have on light trespass, glare, and sky glow in the areas where light fixtures are to be installed. The assessment techniques for light trespass is quantitative and are based on the current lighting design for the Project. The assessment techniques for glare and sky glow is qualitative.

The quantitative assessment for light trespass involved:

- gathering information on the current lighting conditions in and surrounding the assessment area (refer to Section 5.2)
- modelling light trespass from operation activities
- determining if the predictions are below or above CIE criteria for a rural environment (E2)

For the qualitative assessment of glare and sky glow, conclusions were drawn based on the baseline ambient light data gathered for this Project and design information provided by the client.

Highway lighting is required to provide a secure and safe roadway for highway traffic during nighttime hours. There will be two models of highway lighting installed. These units could be similar to those manufactured by LED Roadway Lighting of Amherst, NS, referred to as: NXT36 and NXT60 or alternatively, SAT48 or SAT72 fixtures. Generally, there will be fixtures placed around the roundabouts and at the exit and entrance ramps of the diamond interchange at Cornwall Road, as well as the approaches to and along the trumpet interchange (Figure 5.3). The light fixtures will meet the guidelines set out in the TAC Guide for Design of Roadway Lighting.

Light trespass was predicted using the AGi32 photometric analysis software to predict lux levels from highway lighting. AGi32 is an industry standard software package used for industrial lighting design. Features of AGi32 include capabilities of:

- creating 3D models of project site layouts to scale that incorporate distribution optics, mounting height, tilt, rotation, electrical power, and reflections
- utilizing international standard photometry data for luminaires
- providing realistic textures and colours for objects and buildings created in the 3D model
- inserting calculation areas and points, via 3D objects, into the model to represent receptor locations

The maximum predicted levels of light trespass from the operation of the Project (i.e., operation of the highway lights) in the areas where highway lighting is to be installed are shown in Figure 5.3. An angle of 10° to the horizontal was assumed for each fixture based on information provided by the client. Light trespass was predicted to be below 1 lux beyond 50 m from each fixture. Light trespass was therefore predicted to adhere to the CIE guidelines for a rural environment (i.e., environmental zone 2, E2). The mitigation (Section 5.4.5.2) incorporated into the assessment was designed to specifically limit illuminance off-site and reduce incidence of light trespass.

With the mitigation measures proposed below (Section 5.4.5.2), Project operation is not expected to have a significant contribution to glare or the existing sky glow.

5.4.5.2 Mitigation for Change in Lighting

Mitigation proposed for light trespass, glare and sky glow include:

- a maximum tilt of 10º from the horizontal will be part of the installation procedures to reduce stray lighting and glare issues
- the use of full cut-off light fixtures will be used where practical to lower the effects of glare by directing light downward as much as possible. Full cut-off fixtures will also reduce stray light emissions that contribute to sky glow
- light fixtures will primarily be located on the side of the highway such that the unavoidable light spill off the RoW area is not directed toward the receptors
- the lighting poles will be located so that the lights are not directed toward oncoming traffic on nearby roads on or off the RoW because of the objectionable nuisance and safety hazard this may present
- roadway lighting will be installed adhering to the guidelines set out in TAC's Guide for the Design of Roadway Lighting

5.4.5.3 Residual Project Environmental Effects for Change in Lighting

With the proposed mitigation, an increase in Project-related light emissions (light trespass, glare, and sky glow) such that the CIE guidelines for light trespass and glare in a rural environment (E2) are exceeded and the resulting conditions related to sky glow would be altered toward those of a suburban environment is not likely. Based on this light assessment, existing sky glow levels in and surrounding the Project site are currently typical of a rural environment, and they are not anticipated to increase substantively due to the proposed Project. Therefore, no significant adverse effects are predicted.

5.4.6 Summary of Residual Project Environmental Effects on the Atmospheric Environment

The residual Project environmental effects for the atmospheric environment described above are summarized in Table 5.12.

Table 5.12 Summary of Project Residual Environmental Effects on the Atmospheric Environment

Residual Environmental Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Air Quality	C	A	L	LAA	MT	R	R	H
	O	A	L	LAA	MT	R	R	H
Change in Greenhouse Gases	C	A	L	LAA	MT	R	R	H
	O	P	L	RAA	MT	IR	R	M
Change in Sound Quality	C	A	L	LAA	MT	R	R	M
	O	A	M	LAA	LT	C	R	M
Change in Lighting	O	A	L	LAA	LT	R	I	M

KEY
See Table 5.2 for detailed definitions.

Project Phase:
C: Construction
O: Operation

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent
NA: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
L: Low Resiliency
M: Medium Resiliency
H: High Resiliency

The magnitude of a change in air quality is predicted to be low, because existing air quality is considered good and adequate mitigation is available and planned to manage emissions. The geographic extent is limited to the LAA, but mostly concentrated within the PDA. The duration and frequency are predicted to be medium-term and continuous, respectively. Timing is applicable because wind-borne dust may be more prevalent during dry, windy conditions. The effects are characterized as reversible, because once the construction activities are completed, ambient air quality concentrations will return to background levels. The ecological and socioeconomic context is common, as there are other sources within the LAA that release air contaminants (e.g., local traffic).

During operation, the Project would have a small positive effect on GHG emissions in the province (see Appendix A for the GHG Assessment). The geographic extent is global for GHG emissions as climate change is a global phenomenon. The duration of GHGs is considered medium-term and frequency is predicted to be multiple regular event (during equipment operation only). The effects are characterized as reversible because GHG emissions will cease once construction activities end. The released GHGs remain in the atmosphere for a relatively long time after being emitted, ranging from decades to thousands of years depending on the GHG; however, they are removed from the atmosphere over time (US EPA 2017).

The residual environmental effects of the Project on a change in the acoustic environment are predicted to be adverse, since they will change the condition of the acoustic environment in a negative way. The geographic extent is limited to the LAA, as sound energy is expected to attenuate to (or near to) background levels at the LAA boundary. The effects are concentrated within the PDA. The duration is predicted to be long-term and the frequency is predicted to be continuous.

The residual environmental effects of the Project on a change in lighting are predicted to be adverse, since they will change the condition of the ambient light environment in a negative way. However, the use of highway lighting increases public safety, and without it, could lead to a more adverse effect to the traveling public and nearby residents (e.g., noise from vehicles accidents and emergency service vehicles at night disturbing their sleep). The geographic extent is limited to the LAA, as highway lighting is expected to attenuate to (or near to) background ambient light levels at the LAA boundary. The effects are concentrated within the PDA. The duration is predicted to be long-term and the frequency is predicted to be a regular event.

5.5 DETERMINATION OF SIGNIFICANCE

5.5.1 Significance of Residual Project Effects

5.5.1.1 Air Quality

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in air quality from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on previous experience with similar projects, and a good understanding of the general effects of construction activities on air quality and the effectiveness of mitigation measures discussed in Section 5.4.2.2.

5.5.1.2 GHGs

The residual effects of the Project during construction are predicted to be adverse, since there will be an increase in GHG emissions, but low in magnitude as the quantities of GHGs released to the atmosphere during Project construction are expected to be very small in comparison to provincial and national totals. With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in the GHGs from Project activities during construction are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects of construction equipment operation on GHGs and the effectiveness of mitigation measures discussed in Section 5.4.3.2.

Emissions of GHGs during operation will be small in comparison to provincial and national emissions. Further, as determined in the GHG Assessment (Stantec 2017), the estimates in savings of GHGs from the traffic use of the new highway is expected to be a small positive effect on GHG emissions in the province. The GHG Assessment suggests that difference in the quantities of GHGs released to the atmosphere between baseline and the operation of the new highway are not large, initially. The differences are relatively small (less than 10% of the reference year) in the first year of operation. The difference increases to about 30% less GHG emissions in 2032. Therefore, the residual environmental effects of operation on a change in GHGs are expected to be slightly positive compared with existing conditions, with a net decrease in GHGs released to the atmosphere in the future.

5.5.1.3 Sound Quality

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in the sound quality from Project site preparation activities during construction and operation are predicted to be not significant. This conclusion has been determined with a medium level of confidence based on a good understanding of the general effects of construction equipment operation on sound pressure levels and the effectiveness of mitigation measures discussed in Section 5.4.4.2.

5.5.1.4 Lighting

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in lighting from Project operation are predicted to be not significant. This conclusion has been determined with a medium level of confidence based on previous experience with similar projects and the effectiveness of mitigation measures discussed in Section 5.4.5.2.

5.6 PREDICTION CONFIDENCE

Prediction confidence is considered moderate based on available data, and proposed mitigation measures.

5.7 FOLLOW-UP AND MONITORING

No follow-up or monitoring is currently suggested for the Project.

6.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON THE AQUATIC ENVIRONMENT

In this chapter, potential effects related to Project construction and operation are assessed in relation to the aquatic environment. Accidents, malfunctions, and unplanned events such as erosion and sediment control failures, and hazardous material spills are discussed in Section 11.0. Project environmental effects arise from the interactions between the project and aquatic environment and consider proposed mitigation measures. Any residual project environmental effects after the implementation of mitigation measures are evaluated for significance. A monitoring plan is also presented.

The Project has the potential to interact with waterbodies along the highway RoW. Construction and operation activities have the potential to change the aquatic environment through alteration of freshwater and estuarine habitats, increased risk of fish mortality or changes in water quality. The Aquatic Environment was selected as a VC for environmental assessment due to the importance as an ecosystem component, the associated regulatory protection, and its social importance.

For this VC, fish includes all species of fish and shellfish that are fished commercially, recreationally or by Indigenous groups and reside within the PDA or use the associated habitat during any life stage. Water quality is assessed in relation to the guidelines for the protection of aquatic life and aquatic habitats. The Aquatic Environment VC is intrinsically linked to the Terrestrial Environment VC (Section 8.0) through riparian vegetation and wetlands.

6.1 SCOPE OF ASSESSMENT

The assessment of aquatic environment considers the importance of freshwater and estuarine habitat as an ecosystem component and the associated regulatory protection and social importance. This section describes the regulatory and policy setting, the social topics included in the assessment from consultation and engagement with stakeholders and First Nations, and the boundaries of the assessment. The potential environmental effects from the Project and their pathways are identified along with the measurable parameters and the significance criteria for the evaluation of environmental effects on the aquatic environment as a result of the Project.

6.1.1 Regulatory and Policy Setting

The key federal and provincial acts, and regulations that apply to the aquatic environment in Prince Edward Island are:

- *Fisheries Act*
- *Species at Risk Act*
- *Prince Edward Island Environmental Protection Act*

- *Wildlife Conservation Act*
- *Prince Edward Island's Watercourse and Wetland Protection Regulations – Environmental Protection Act*

Key acts and regulations are supported by federal, provincial, and non-governmental policies and guidelines, including:

- Fisheries Protection Policy Statement (DFO 2013)
- Policy for the Management of Fish Habitat (DFO 1986)
- Watercourse, Wetland, and Buffer Zone Activity Guidelines (PEI CLE 2012)
- Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME 1993)

6.1.1.1 Fisheries Act

The *Fisheries Act* serves to protect fish and fish habitat federally, section 35 of the *Fisheries Act* defines contravention of the act as "serious harm" to fish which constitute a commercial, recreational, or Aboriginal (CRA) fishery. The Fisheries Protection Policy Statement (DFO 2013) defines "serious harm" to CRA fish and fish that support a fishery as:

- The death of fish
- A permanent alteration to fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes
- The destruction of fish habitat of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes

Under the Act, the requirement to gain authorization will apply only where a project results in "serious harm" to a CRA fishery. An alteration of fish habitat must be deemed to be permanent to be of regulatory consequence under the Act. This assessment of "serious harm" to fish and fish habitat within the Local and Regional Assessment Areas is described in Section 6.2.

The Act also includes sections which require the provision of sufficient water and unimpeded passage for fish (Section 20 and 21) and prohibit the deposit of deleterious substances (Section 36). Projects that have the potential to obstruct fish passage, modify flow or result in entrainment (i.e., water withdrawal, pumping or hydroelectric intakes) may result in "serious harm" and may require an authorization. Deleterious substances include any substance that degrades the quality of water in an area frequented by fish to the point of causing harm or damage to fish or fish habitat; this section of the Act is generally enforced by Environment and Climate Change Canada (ECCC). DFO will review the EIA and should additional information be required a Request for Review will be submitted to DFO for determination of serious harm to fish.

Table 6.1 summarizes the relevant requirements for the Project under the *Fisheries Act* and regulations.

Table 6.1 Relevant Directives under the *Fisheries Act*

Regulations	Nature of Directive	Relevance to Project	Federal Authority
Section 20(1)	Regulate designs that provide the free passage of fish without harm and maintain a flow of water sufficient to allow the free passage of fish.	Design of watercourse crossings and provision of fish passage.	DFO
Section 35(1)	Provide protection of fish and fish habitat.	Design of watercourse crossings and proximity of work areas near watercourses	DFO
Section 35(2)	Permit authorizations for the alteration of fish habitat.	Obtain authorizations for habitat alterations, if required	DFO
Section 36	Implement mitigation as per guidelines to prevent introduction of deleterious substances into fish bearing waters.	Working within 15 m of a watercourse with heavy equipment (fuel spill prevention, erosion protection)	DFO/ECCC

6.1.1.2 Wildlife Conservation Act/Species at Risk Act

The Prince Edward Island *Wildlife Conservation Act* includes provisions for the protection of species at risk and their habitats. Species at risk include plants, animals, or other organisms that are endangered or threatened because of sensitivity to human activities or natural events. Species at risk in PEI are listed under the Federal *Species at Risk Act* (SARA). The AC CDC search of the PDA returned no freshwater or estuarine Species at Risk listed as endangered or threatened under Schedule 1 of SARA (AC CDC 2016).

6.1.1.3 Environmental Protection Act — Watercourse, Wetland, and Buffer Zone Activity Guidelines

The purpose of the Watercourse, Wetland and Buffer Zone Activity Guidelines is to protect the water quality and aquatic habitat of the streams, rivers, lakes, and wetlands from unmitigated works in or near watercourses and wetlands. The regulation requires the issuance of a permit by the PEI CLE.

A Watercourse, Wetland, and Buffer Zone Activity Permit is required before the following:

- Physical modification of the bed or banks of a watercourse
- Modification of flow of water
- Any disturbance of the ground or removal of vegetation within 15 m of a watercourse

Watercourse, Wetland, and Buffer Zone Activity Permits, issued by PEI CLE, will be required as the Project will be conducted adjacent to multiple watercourses. The permits are required for work that will create a temporary or permanent change within 15 m of a watercourse or wetland. All conditions of the permit will be adhered to.

6.1.2 Potential Environmental Effects, Pathways, and Measurable Parameters

Based on the knowledge of the Project and its associated activities, the following potential environmental effect was selected for the assessment of the aquatic environment: change in fish populations.

Table 6.2 provides the criteria that are used to characterize residual environmental effects on the aquatic environment.

Table 6.2 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for the Aquatic Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in fish populations	• Destruction or alteration of habitat arising from disturbance of the watercourse during site and roadbed preparation, installation of watercourse crossing structures and temporary ancillary elements, and winter maintenance. • Direct mortality of fish resulting from installation of structures within watercourses during construction or operation.	• Areal extent of altered or lost fish habitat (m2). • Baseline water quality (pH, dissolved oxygen, temperature, turbidity, and total suspended solids (TSS)) and subsequent monitoring. • Mortality of fish (number of fish killed).

6.1.3 Boundaries

6.1.3.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the aquatic environment are defined below, and illustrated in Figure 6.1:

- Project Development Area (PDA): The PDA comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes a 7.8 km long, 61 m wide corridor, as well as interchanges, bridges, and overpasses, and properties owned by PEI TIE that may be used as borrow pits or laydown areas during construction.
- Local Assessment Area (LAA): The LAA includes a 300 m buffer around the RoW centerline. The LAA was selected to encompass all areas with the potential to have indirect effects to fish or fish habitat. The LAA is where environmental effects are reasonably expected to occur and are measurable to a high degree of confidence. For example, the LAA includes sufficient upstream and downstream aquatic habitat at all crossings to assess anticipated measurable environmental effects from construction and operation.
- Regional Assessment Area (RAA): The RAA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RAA accommodates a wider geographic area than the LAA to provide ecological context. The RAA encompasses the Clyde River, Hyde Creek, and North River watersheds in which the Project is located.

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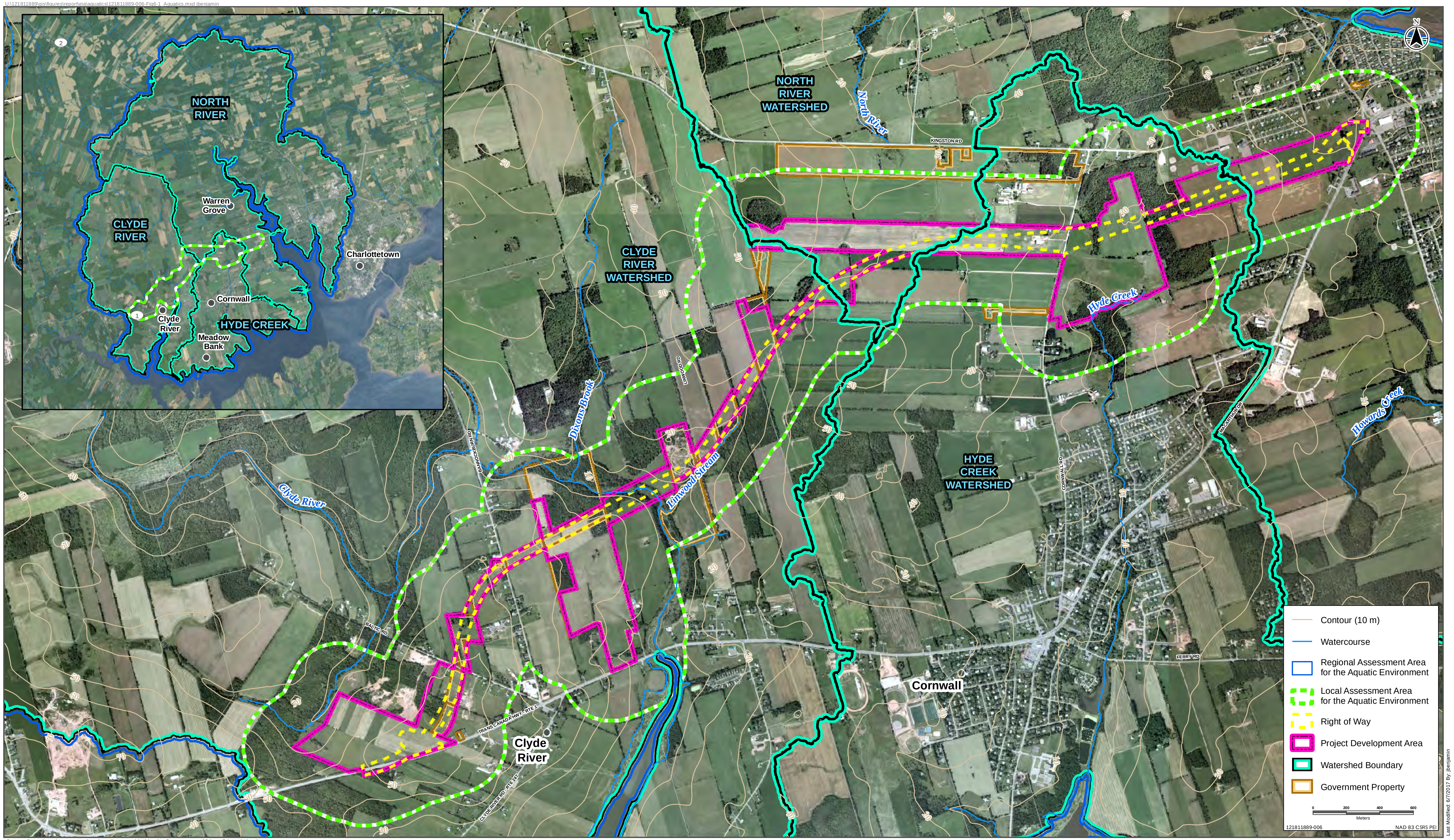


Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

Stantec

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Aquatic Environment Assessment Area Boundaries

Figure 6.1

6.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the aquatic environment include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.

6.1.4 Residual Environmental Effects Description Criteria

Table 6.3 provides the criteria used to characterize residual environmental effects on the aquatic environment.

Table 6.3 Characterization of Residual Environmental Effects on the Aquatic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect	**Positive**—an effect that moves measurable parameters in a direction beneficial to the aquatic environment relative to baseline **Adverse**—an effect that moves measurable parameters in a direction detrimental to the aquatic environment relative to baseline **Neutral**—no net change in measurable parameters for the aquatic environment relative to baseline
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no measurable change **Low**—a measurable change anticipated in low-sensitivity habitats and no measurable mortality risk to non-listed species **Moderate**—a measurable change in fish habitat or anticipated mortality risk to non-listed species **High**—a measurable change in the aquatic environment from a change in sensitive habitat or habitat designated as important to listed species or anticipated mortality to listed species.
Geographic Extent	The geographic area in which an environmental effect occurs	**PDA**—residual environmental effects are restricted to the PDA **LAA**—residual environmental effects extend into the LAA **RAA**—residual environmental effects extend into the RAA

Table 6.3 Characterization of Residual Environmental Effects on the Aquatic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event**—occurs once **Multiple irregular events**—occurs at no set schedule **Multiple regular events**—occurs at regular intervals. **Continuous**—occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual environmental effect restricted to the construction or operation phase of the Project. Includes effects to the aquatic environment of less than 1 year **Medium-term**—residual environmental effect restricted to the construction or operation phase of the Project. Includes effects to the aquatic environment of between 1 and 5 years **Long-term**—residual environmental effect extends beyond 5 years
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible**— the effect is likely not permanent and the measurable parameter will recover to baseline conditions after Project completion **Irreversible**—the environmental effect will persist after the life of the Project, even after mitigation measures are enacted. The aquatic environment will not recover to baseline
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed**—the area is relatively undisturbed or not adversely affected by human activity **Disturbed**—area has been substantially previously disturbed by human development or human development is still present

6.1.5 Significance Definition

A significant adverse residual environmental effect on the aquatic environment is one that results in:

- increased mortality of species at risk fish where recovery to baseline is uncertain or unlikely
- a change to the productivity or sustainability of a CRA fishery
- a permanent alteration to or the destruction of fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats and results in a decrease in the sustainability of the populations or the local fisheries
- a decrease in water quality to a level which induces mortality or diminishes the ability of fish to use such habitats and results in a decrease in the sustainability of the populations or the local fisheries

- serious harm as defined by the *Fisheries Act*, that cannot be mitigated or offset

Applicable legislation and regulations used to characterize the significance determinations for the alteration or destruction of fish habitat, or changes in water quality include the following:

- *Fisheries Act*
- *Canadian Environmental Protection Act*
- *Species at Risk Act*
- PEI's Watercourse, Wetland, and Buffer Zone Activity Guidelines
- The Fisheries Protection Policy Statement (DFO 2013)
- Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME FAL)

6.2 EXISTING CONDITIONS FOR THE AQUATIC ENVIRONMENT

In this section, the existing aquatic habitat conditions are described for the LAA. The understanding of the existing conditions enables a more accurate assessment of potential project environmental effects on the aquatic environment. This section also describes the methods used to obtain data on the existing conditions and an overview of freshwater and estuarine habitat, fish presence, and water quality.

6.2.1 Methods

A review of relevant fish and fish habitat data from various sources (e.g., DFO, PEI CLE, AC CDC, COSEWIC) was undertaken, which included previous environmental assessments and publicly available reports from various watershed or community groups, researchers, and government. Although the review of previous studies and existing information provided some information on the aquatic environment in the Project location, and specifically at the regional and local spatial scales, additional information and data were required to support the assessment for the currently proposed Project. Specifically, fish habitat data were required for the aquatic habitat along proposed highway RoW. Field studies were undertaken in 2016 to supplement the existing data.

Data and information collected during field studies described below were used to characterize the existing conditions for the aquatic environment.

Field Methods

A fish habitat survey was conducted along the Clyde River, Dixons Brook, and Linwood Brook. This survey was conducted to characterize the aquatic environment near the proposed Clyde River crossing. For the proposed project the potential interaction between the construction of the highway and watercourses would occur where the riparian zone and watercourse channel cross the RoW; therefore, the surveys were developed to focus on this area. Data collected included stream width and riparian zone characteristics.

No electrofishing was conducted along the proposed RoW. During planning and development of the survey it was assumed that all watercourses which provided fish habitat either contain or support CRA fisheries. Historical data on fish presence was used, where available.

6.2.2 Overview

Land use in the Clyde River drainage basin upstream from the existing crossing on the Trans-Canada Highway is predominately agricultural, comprising 74% of the land use. The remaining land use is composed of forest cover (18%), residential/commercial or industrial development (7%), and wetland (1%) (Oak Meadows Inc. 2016). The Clyde River begins 5 to 6 km upstream of the Project and flows downstream of the Project into the West River estuary, which is a branch of the Charlottetown Harbour.

There are three watercourses within the LAA, with one watercourse crossing the RoW. The proposed crossing location is upstream of the existing highway crossing on Clyde River in an estuarine area. The head of tide extends approximately 600 m above the proposed crossing (Oak Meadows Inc. 2016). At this location, tidal influx and a wide flood plain promote the growth of salt marsh vegetation. The relatively steep banks are vegetated primarily with white spruce, balsam fir, poplar, and white birch before transitioning to pasture lands (Oak Meadows Inc. 2016). The other two watercourses in the LAA, Linwood and Dixons Brooks, run adjacent to the proposed RoW, and are tributaries to the Clyde River. While not crossed by the Project, the proximity of the watercourses to the Project may result in interactions during construction and operation.

Fish Presence

Information on fish species presence was obtained from a literature review of the area, existing knowledge, and the Clyde River Fish Habitat Assessment (Oak Meadows Inc. 2016). Electrofishing for sportfish species in the main branch of the Clyde River and the north branch upstream of the proposed crossing was completed from 2011 to 2016 by the Central Queens Wildlife Federation (Oak Meadows Inc. 2016). Brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), and Atlantic salmon (*Salmo salar*) have all been captured within the previous five years. Overall, the density of brook trout decreased from 2011 to 2015, though a higher than average number of juvenile (first year) brook trout were captured in 2016 resulting in an increase in density from 2015 (Oak Meadow Inc. 2016). Rainbow trout were captured in all years but densities were generally lower than brook trout. Atlantic salmon densities are the lowest of the sportfish sampled with captures in 2012 and 2015 in the north branch of the Clyde River adjacent to Bannockburn Road (Figure 5.1).

Neither alewife (*Alosa pseudoharengus*) or blueback herring (*Alosa aestivalis*) (together commonly referred to as Gasperau) have been observed in the Clyde River in recent decades though appear to continue to spawn in the West River in freshwater habitats above the head of tide (Oak Meadows Inc. 2016).

Fish inhabiting the Clyde River are expected to include species of cyprinids (minnows), salmonids, perches, eel, cyprinids, and smelt (Cairns 2002, Oak Meadows Inc. 2016). Table 6.4 lists the species anticipated to occur within the PDA (estuarine habitat), LAA (estuarine habitat) and RAA (freshwater and estuarine habitats).

Table 6.4 Fish Species Presence

Common Name	Scientific Name	Potential Presence in:		
		PDA	LAA	RAA
American eel	*Anguilla rostrata*	✓	✓	✓
Atlantic salmon	*Salmo salar*	✓	✓	✓
Brook trout	*Salvelinus fontinalis*	✓	✓	✓
Mummichog	*Fundulus heteroclitus*	✓	✓	✓
Ninespine stickleback	*Pungitius pungitius*	✓	✓	✓
Rainbow smelt	*Osmerus mordax*	✓	✓	✓
Rainbow trout	*Oncorhynchus mykiss*	✓	✓	✓
Threespine stickleback	*Gasterosteus aculeatus*	✓	✓	✓
White perch	*Morone americana*	✓	✓	✓
Note: Data adapted from Cairns 2002., Scott and Crossman 1998, and Oak Meadows Inc. 2016.				

Species at Risk

The Prince Edward Island *Wildlife Conservation Act* includes provisions for the protection of species at risk and their habitats. Species at risk include plants, animals or other organisms that are considered to be endangered or threatened due to sensitivity to human activities or natural events. Species at risk in PEI are listed under the Federal *Species at Risk Act*. The AC CDC search of the PDA returned no aquatic Species at Risk listed as endangered or threatened under Schedule 1 of SARA (AC CDC 2016).

Species of conservation concern (SOCC) include species not afforded protection under SARA. While not afforded official protection under SARA, there is potential for these species to be added to SARA if continuous population declines are observed. In PEI, two SOCC have the potential to inhabit the LAA (Table 6.5).

Table 6.5 Fish Species of Conservation Concern

Common Name	Scientific Name	COSEWIC Status[1]	SARA Status[1]
American eel	*Anguilla rostrata*	Threatened	-
Atlantic salmon (Gaspe-Southern Gulf of St. Lawrence population)	*Salmo salar*	Special Concern	-

Notes:
1: Government of Canada. April 2017. Species at Risk Public Registry according to the *Species at Risk Act* – Schedule 1
- Not listed under the respective Act

The presence of American eel and Atlantic salmon would likely be temporary during periods of migration or staging for upstream migration.

Fish Habitat

Fish habitat was assessed in the Clyde River and tributaries (Linwood and Dixons Brooks) adjacent to the Project. The proposed highway RoW will cross the Clyde River below the head of tide with the habitat at this location estuarine. Linwood and Dixons Brooks are located outside the proposed highway RoW and as such are briefly described.

The Clyde River at the proposed crossing location was described in the Clyde River Fish Habitat Report (Oak Meadows Inc. 2016) as a 12 to 14 m wide channel in a flood plain of between 60 and 65 m wide. The proposed crossing is located on a turn in the river, with the channel running on the outside of the bend along the north bank. Most of the floodplain is composed of salt marsh which occupies the inside of the bend. The salt marsh width at the proposed crossing location is between 45 and 50 m wide and described as stable (Oak Meadows Inc. 2016).

The steep river banks are moderately stable and vegetated including many large white pine and hemlock, mixed with red and black spruce (*Picea mariana*) and interspersed with balsam fir. Near the river's edge, some yellow birch and red maple add diversity and stability for the banks (Oak Meadows Inc. 2016). Where the salt marsh has deflected the river to the edge of the floodplain, bank erosion has destabilized some of the large trees.

There is a spring surfacing to the west of the proposed crossing which flows a distance of approximately 10 m into the Clyde River. This spring provides habitat for mummichog (*Fundulous heteroclitus*).

Dixons Brook is upstream of the proposed highway RoW and is on average 1.5 m wide. The substrate was predominantly gravel with low fractions of fines (silt or sand) observed. Woody debris is abundant along the reach surveyed with large numbers of juvenile brook trout observed in the shallow pools along the brook. Approximately 200 m upstream from the confluence with the Clyde River livestock access has destabilized the banks and the riparian zone width decreases. A private culvert was noted 600 m upstream from the confluence which at the time of the survey appeared to be impassable to brook trout, as none were observed upstream.

Linwood Brook is downstream of the proposed crossing. The headwaters of Linwood Brook border on the proposed highway RoW. At high tide water floods marsh habitat for the first 50 m of Linwood Brook, beyond this the marsh vegetation is replaced by balsam fir and white birch. At this point the brook is 2 to 3 m wide with juvenile brook trout observed. Linwood road passes over the brook approximately 400 m upstream from the Clyde River confluence. The culvert at this location appears to pass fish, with the potential exception of smelt. Another culvert was identified 400 m upstream from the Linwood road; this private crossing does not appear to allow the passage of fish into the upper reaches.

Water Quality

Water quality data for the Clyde River was obtained from the Provincial Surface Water Quality Database (Government of Prince Edward Island 2016). Station CR-1 was sampled periodically between 1984 and 2016, this location is situated above the head of tide and the data is representative of the freshwater water quality upstream of the proposed crossing location. Water quality parameters relevant to the project, and freshwater fish and fish habitat, were selected to define the freshwater quality in the Clyde River. Water quality at the proposed crossing location is within the Clyde River estuary and as such is likely to have higher pH and conductivity from the influx of salt water. TSS and nutrient concentrations are likely to fluctuate from the concentrations in Table 6.6 during the tidal cycle.

Table 6.6 Clyde River Water Quality (Freshwater Station CR-1)

Parameter	Date	Samples	Minimum	Average	Maximum
pH (pH units)	1986 to 2012	165	4.6	7.5	8.5
Conductivity (uS/cm)	2001 to 2016	66	98	215	587
Total Phosphorous (ug/L)	1986 to 2012	187	<5	113	4503
Nitrate (as N) (mg/L)	1986 to 2016	255	0.1	2.5	4.1
Total Suspended Solids (mg/L)	1986 to 2016	239	<1	17	939
Chloride (mg/L)	1986 to 2008	195	<1	13	90

6.3 PROJECT INTERACTIONS WITH THE AQUATIC ENVIRONMENT

The Project will interact with the aquatic habitat during construction and operation. These interactions between the Project may result in a change in fish populations. Table 6.7 identifies the physical project activities that might interact with fish and fish habitat to result in the environmental effects. These interactions are indicated by check marks, and are discussed in detail in Section 6.4.2 in the context of effects pathways, standard and project-specific mitigation, and residual environmental effects. A justification is also provided for non-interactions (no check marks).

Table 6.7 Potential Project-Environment Interactions and Effects on the Aquatic Environment

Project Components and Physical Activities	Potential Environmental Effect
	Change in fish populations
Construction	
Site Preparation	✓
Roadbed Preparation	✓
Installation of Structures	✓
Surfacing and Finishing	-
Temporary Ancillary Elements	✓
Emissions and Wastes	✓
Operation	
Infrastructure Maintenance	✓
Winter Maintenance	✓
Vegetation Management	-
Emissions and Wastes	✓
Notes: ✓ = Potential interactions that might cause an effect. – = Interactions are not expected between the Project and the aquatic environment.	

Project activities that are not expected to interact with the aquatic environment or will be managed through industry standards and will be occasional events with low risk of interaction were not assessed further, including surfacing and finishing during construction, and vegetation management during operation (Table 6.7).

6.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON THE AQUATIC ENVIRONMENT

This section describes the potential interactions between the Project and the aquatic environment as identified in Section 6.3. Interactions between the Project and the aquatic environment that could result in a change in fish populations were assessed for each Project phase using the identified analytical assessment techniques. Accidents, malfunctions and unplanned events are discussed separately in Section 11.0.

6.4.1 Analytical Assessment Techniques

A determination on the type and quality of habitat for particular fish species was based on a site-specific study (Oak Meadows Inc. 2016) and professional judgement. Assessment techniques took into consideration DFO's measures to avoid causing serious harm to fish and fish habitat through avoidance, mitigation and offsetting, as applicable to determine predictable effects.

To determine if there would be an effect on CRA fish species the analytical assessment looked at the abundance of fish captured within the LAA through existing data and compared it to the overall population status's and distributions of fish species within the RAA.

6.4.2 Assessment of a Change in Fish Populations

A change in fish populations may result from interactions between the aquatic environment and the Project during construction and operation. The assessment of change in fish populations defines the project environmental effect pathways for each phase of the Project, the mitigation measures to be put in place to reduce environmental effects on fish populations, and the resulting residual environmental effects, whether the effects are positive or negative.

6.4.2.1 Project Pathways for a Change in Fish Populations

The Project is expected to interact with the aquatic environment throughout the life of the project. The pathways for a change in fish populations are discussed in terms of construction and operation.

Construction

During construction, it is anticipated that site preparation, installation of road crossing structures, and construction of temporary ancillary elements may directly interact with the aquatic environment. Surface run-off from these activities and roadbed preparation may indirectly interact with the aquatic environment.

Site preparation, especially clearing, has the potential to decrease the abundance of riparian vegetation along watercourses, which may reduce bank stability, increase erosion, suspended sediment concentrations, and nutrient concentrations in the watercourse (DFO 2010). The loss of stream shading may result in increased stream temperatures during summer months (Teti 1998). Reducing riparian vegetation may reduce the diversity and abundance of the aquatic food supply through the reduction of invertebrates and their food sources (DFO 2010).

The use of equipment within 15 m of the watercourse for site preparation and installation of the Clyde River crossing structure may result in increased suspended sediment concentrations and physical alteration of watercourse habitats. Soil may be mobilized by equipment working within 15 m of the watercourses, which may enter the watercourses and alter ecological conditions such as water quality and stream habitat. Sediment entering watercourses may reduce visibility affecting predator or prey awareness or, if concentrations of sediment are high enough, damage gills (DFO 2010). Direct routes to the watercourse may be created from equipment rutting or ditching; these features may create a pathway for sediment or contaminants to enter the watercourse. The crossing of watercourses by clearing or construction equipment and crews offers the potential for physical alteration of the watercourse bed and banks. The alteration of the bed and banks may change fish habitat quality and the suitability for life processes.

Temporary ancillary elements, such as the storage of soil within 15 m of a watercourse, may change water quality by increasing suspended sediment and nutrient concentrations if the soil was to enter the watercourse. An increase in nutrient concentration may lead to eutrophication of watercourses which is generally made evident by increased growth of aquatic plants and algae.

Watercourse crossings, such as the proposed bridge crossing of the Clyde River, may result in alteration of fish habitat within the PDA. During construction, temporary or permanent fill placed below the high water mark may alter the quantity or quality of habitat. Permanent habitat reduction may occur if the footprint of the bridge abutments or piers are located within the channel or below the high-water mark. Narrowing of the channel may result in an obstruction in fish passage or scouring of the substrate from increased velocities.

Emissions and wastes during construction consists of potential erosion from project activities.

Operation

During operation, maintenance activities such as infrastructure maintenance and winter maintenance, may directly change fish populations. Infrastructure maintenance may include work to bridge abutments or in-water structures, which has the potential to alter fish habitat through changes in substrate and water quality. Winter maintenance has the potential to mobilize salt, sand, and debris that may enter the watercourses and increase chloride and suspended sediment concentrations, which may alter ecological conditions such as water quality and river habitat. Sediment entering the watercourses may alter habitat and reduce visibility, thereby affecting predator or prey awareness or, if concentrations of sediment are high enough, damage gills (DFO 2010).

6.4.2.2 Mitigation for the Aquatic Environment

The following section outlines regulations (i.e., Watercourse and Wetland Protection Regulations*)*, codified measures (PEI Watercourse, Wetland, and Buffer Zone Guidelines, DFO Measures to Avoid Harm), proven mitigation and industry BMPs. The following measures will be implemented to reduce the environmental effects of the interactions between the Project and the aquatic environment during all stages of the Project, and will be included in the PSEPP.

- The PSEPP will include general construction BMPs, a spill management plan and an erosion and sediment control plan. All employees and contractors working on the Project will be trained on the PSEPP prior to starting work. Plan temporary access roads, borrow pits and stockpile areas to avoid watercourses, and allow a 15 m buffer where possible.
- Machinery will arrive on-site in clean condition and be maintained free of fluid leaks, invasive species, and noxious weeds.
- No washing, fueling, or maintenance of vehicles or equipment will occur within 30 m of a watercourse without secondary containment.
- No storage of fuel will occur within 30 m of a watercourse or wetland.
- Clearing of vegetation within the RoW will occur by hand within 15 m of a watercourse. Outside of the area required as part of the RoW, laydown or storage areas, a riparian buffer with a width of 15 m will remain on each bank.
- Where required, temporary watercourse crossings will be installed to allow equipment to cross over each watercourse; the temporary crossings will be designed in accordance with the Watercourse, Wetland, and Buffer Zone Guidelines and completely span the watercourse. No watercourses will be forded by equipment.
- If rutting is observed leading up to a watercourse crossing, erosion protection such as brush matting or log corduroy will be installed at the approaches.
- Where possible, in-water works will be scheduled to avoid sensitive biological periods such as spawning and egg incubation times for those fish that may use the habitat within PDA. If in-water construction activities are required during these periods, DFO will be consulted for additional mitigation.
- The Clyde River crossing habitat, realignment and proposed structure will be reviewed with DFO for determination of effects to fish and fish habitat. If an Authorization under Section 35(2) of the *Fisheries Act* is required due to serious harm to fish a habitat compensation plan will be developed and implemented by the proponent pending DFO-Habitat approval.
- During the channel realignment, the Clyde River will be isolated from the construction area using steel cofferdams with work completed in the dry. If present, fish will be removed from the isolated area before excavation or infilling begins.
- Any pumps used to move water from Clyde River will be screened as per DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines.
- Fish-outs will be conducted for all sections of Clyde River that are isolated for construction.
- Any rock used below the high-water mark will be clean and free of contaminants or fines.
- The construction contractor will be required to have an Environmental Control Manager on site at all times during construction.
- A water quality monitoring program for total suspended solids (TSS) will be conducted during construction to verify sedimentation and erosion controls are working.
- Runoff during operation will be directed into vegetated areas away from watercourses to reduce the potential for contaminants entering watercourses.

6.4.2.3 Residual Project Environmental Effects for the Aquatic Environment

Residual Project environmental effects on the aquatic environment from construction, and operation are anticipated to occur during the installation of the Clyde River crossing and winter maintenance. Emissions and wastes carried in overland runoff are expected to constitute a portion of the potential effects during construction and operation and may affect fish populations habitat by reducing habitat quantity, habitat quality, and water quality. Habitat quantity and quality may be changed due to the proposed realignment of the Clyde River channel within the floodplain. Water quality has the potential to change due to an increase in suspended solids during the construction of the Clyde River crossing and an increase in chloride levels from salt application during winter operation.

Installation of the Clyde River crossing will interact with the aquatic environment through the channel realignment and subsequent infilling of the existing Clyde River channel. The channel realignment will be designed to mimic the existing channel in its physical dimensions and substrate. The realigned channel will be developed in the dry from a temporary trestle structure installed in the floodplain. Once the realigned channel has been constructed the existing channel will diverted to the realigned channel, pumped dry, and infilled. Fish isolated in the former channel will be removed and transported out of the Project area or into the realigned channel. This proposed plan of developing the realigned channel will allow fish passage throughout the construction process. When creating the diversion channel, local hydrological and geomorphological conditions, and their effects on the fish habitat, will be taken into account to promote rapid reestablishment of fish populations (Newbury and Gaboury 1993). The failure of engineered habitat has most often been attributed to the failure to consider hydraulic principles and the need to consider long-term stability under hydraulic extremes (Hunt 1988; Frissell and Nawa 1992 in Clarke 2016).

Infilling of the existing channel will alter approximately 675 m^2 of estuarine habitat, with the realigned channel providing 850 m^2 of constructed habitat using natural materials. The realigned channel will be designed to withstand hydrological stresses and include natural habitat features found in the existing channel. Enhancements to the diversion channel could be incorporated based on management suggestions from the Clyde River Fish Habitat Assessment (Oak Meadows Inc. 2016) including a suitable salmonid pool, rock deflectors, cross vanes, cover logs, or other forms of fish habitat cover.

The diversion channel would begin to support aquatic life after construction beginning with periphyton (algae, cyanobacteria, microbes, and detritus) at the base of the food web, providing a food source for invertebrates, which in turn provide a food source for fish. Based on projects completed in the Northwest Territories and Newfoundland, a constructed channel can take between three and ten years to establish sufficient periphyton or organic matter to support invertebrate levels that are similar to natural channels (Gabriel et al. 2010; Jones et al. 2008, Scruton et al. 2005). Gabriel et al. (2010) found that the benthic macroinvertebrate community in a diversion channel was well established three to four years after the habitat was opened, by comparing to a nearby reference stream. In a review conducted by DFO on habitat compensation in Newfoundland, connectivity with natural watercourses was noted as an important factor in successful establishment because this allows free movement of nutrients, invertebrates and fish between the diversion and the remainder of the watershed (Clarke 2016).

Construction of the Clyde River crossing is proposed to take up to 42 weeks with two weeks allotted to realign the river. This portion of work, which has the greatest potential to release sediment, will be scheduled to coincide with DFO's timing window (June 1 to September 30 for PEI) to reduce the risk to fish and fish habitat.

There are two general spawning periods for fish in the PDA: fall and spring. Salmonids (i.e., Atlantic salmon, rainbow trout, brook trout) spawn in the fall with the eggs incubating in the gravel substrate throughout winter and emerging in April to June the following year (Scott and Crossman 1998). Other anadromous species, such as white perch and rainbow smelt, spawn in the spring. The incubation period for these spring spawners is considerably shorter based on the warmer water temperatures in early spring as compared to winter. By July of a typical year most of the anadromous species have completed spawning, the adults have returned to saltwater, and the juvenile fish are mobile and capable of escaping threats. The remaining fish species in the PDA (i.e., mummichog and the two stickleback species) may be spawning between in the months of July and August when in-water Project activities are expected to occur. These species are either coastal marine or estuarine spawners and would be more tolerant of fluctuations in TSS concentrations.

While most cut and fill activities required for the river crossing and channel diversion will be temporary and localized, some potential exists for adverse effects on fish habitat in the PDA and LAA from sedimentation and increased suspended sediment concentrations. In general, the deposition of sediment in watercourses reduces habitat variability and oxygen permeability (Young et al. 1991; Cobb et al. 1996) which leads to decreased egg and fry survival rates (Everest et al. 1987). In extreme cases benthic invertebrate production, periphyton, and fish communities can be altered (Erman and Erman 1984; Noel et al. 1986; Valiela et al. 1987; Culp 1996). Fish communities can be altered through behavioral changes, such as reduction in feeding, growth impairment (Mcleay et al. 1984, Crouse et al 1981), physiological effects (e.g., gill damage), or death (Newcombe and McDonald 1991). In estuarine waters, such as those at the proposed Clyde River crossing, a substantial proportion of suspended sediments results from the resuspension of fine, unconsolidated sediments and detritus by tidal action and currents (Appleby and Scarratt 1989). Concentrations of estuarine suspended sediments can exceed those levels coming from freshwater sources (CCME 2002). Suspended sediments in the water during construction are expected to be similar to fluctuations in suspended sediments from tidal action and are not anticipated to exceed the CCME guidelines for suspended solids for the protection of aquatic life (CCME 2002). A water quality monitoring program for TSS will be conducted during construction to verify sedimentation and erosion controls are working.

Stream infilling and realignment is expected to be localized to the PDA, and occur only once during construction. With the inclusion of the diversion channel, effects are expected to be adverse though temporary as over time the diversion channel is expected to develop into productive aquatic habitat. Based on the quantity and quality of habitat altered, the short duration of construction the Clyde River crossing, and the habitat available within the 42 km^2 Clyde River watershed, the Project is not anticipated to reduce the overall productivity of the river nor modify the fish assemblages within.

During operation, ditches alongside the highway will direct runoff into low lying areas which may include watercourses and buffer zones. Highway runoff may contain elevated levels of debris and salt as compared to overland drainage. Three common deicing salts are used on highways in PEI: sodium chloride (NaCl), magnesium chloride ($MgCl_2$), and calcium chloride ($CaCl_2$). The common element in all deicing salts is chloride, which is commonly monitored as an indicator of salt presence in freshwater systems. Baseline freshwater lake or river chloride concentrations in the Atlantic region are typically <10 mg/L though may occur naturally at concentrations up to 20 mg/L (CCME 2002). Data from the PEI Surface Water Database station in the Clyde River (upstream of tidal influence) indicate similar concentrations with an average of 13 mg/L (see Table 6.6 above). Studies on the effects of salt types were shown to have variable impacts to salmonid development with calcium chloride and sodium chloride reducing growth (length and weight) in salmonids at concentrations of 860 and 3,000 mg/L Cl, respectively (Hintz and Relyea 2017). Magnesium chloride was shown to have no effects on juvenile salmonid growth at concentrations up to 3,000 mg/L (Hintz and Relyea 2017). The reduced growth caused by calcium chloride and sodium chloride at early-life stages has the potential to negatively affect salmonid recruitment and population dynamics. Chloride concentrations measured in highway runoff are mainly between 1,000 and 10,000 mg/L, but can range up to 31,000 mg/L (Environment Canada Health Canada 2001); these chloride concentrations are likely to dilute with stormwater prior to entering watercourses. It is unlikely that chloride concentrations will occur at high enough levels in natural watercourses to effect fish populations.

Naturally occurring sources of chloride in coastal areas, such as the PDA, include sea spray and seawater intrusion (CCME 2002). Seawater intrusion at the Clyde River crossing is expected to reduce the effect of road salt on the aquatic environment at this location. The headwaters of Linwood Brook are above the tidal influence and may be susceptible to highway runoff and effects from increasing salt. Given that the upper reach of Linwood Brook is at its closest approximately 30 m from the highway, design mitigation will include diversion of highway runoff away from the watercourse. Directing the highway runoff along vegetated ditches and into vegetated areas promotes percolation and phytoabsorption of chloride, reducing chloride levels entering the watercourse.

In relation to the Project, emissions and waste from highway runoff are not anticipated to reduce the productivity of the watercourses crossed by the Project nor modify the fish assemblages within. Effects from highway runoff are expected to be adverse, low in magnitude, and localized to the LAA. Runoff is a long-term effect anticipated to occur irregularly over the life of the Project and is considered reversible at the end of the project.

6.4.3 Summary of Residual Project Environmental Effects on the Aquatic Environment

The residual Project environmental effects for the aquatic environment described above are summarized in Table 6.8.

Table 6.8 Summary of Project Residual Environmental Effects on the Aquatic Environment

Residual Environmental Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in fish populations	C	A	L	LAA	MT	S	I	D
	O	A	L	LAA	LT	IR	R	D

KEY
See Table 6.3 for detailed definitions

Project Phase:
C: Construction
O: Operation

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent
NA: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

6.5 DETERMINATION OF SIGNIFICANCE

6.5.1 Significance of Residual Project Effects

The residual Project environmental effects as a result of construction and operation of the Project on the aquatic environment are considered to be adverse, low in magnitude, and localized in extent. Construction residual Project environmental effects will occur once during construction of the Clyde River crossing and are considered medium-term in duration based on the ability of the stream to re-establish aquatic populations over time. The channel realignment is permanent and considered irreversible. Elevated suspended sediment concentrations are anticipated to occur within the LAA, with habitat alteration limited to the area of channel infill. The residual Project environmental effects as a result of highway runoff during operation are characterized as adverse, low in magnitude, and spatially limited to the LAA. The effects are considered long-term as they will occur as irregular events over the life of the project. With the existing disturbed Clyde River habitat, mitigation outlined, and the environmental protection measures described, the residual environmental effects on the VC are predicted to be not significant.

6.6 PREDICTION CONFIDENCE

The prediction confidence is high for the determination of significance on environmental effects to the aquatic environment. With the current state of knowledge on the potential effects to fish populations, the limited spatial scale of effects in a relatively small PDA, and the implementation of proven mitigation measures which reflect accepted BMPs, effects to the aquatic environment are expected to be low.

6.7 FOLLOW-UP AND MONITORING

During construction, a monitoring program will be implemented to measure TSS at locations upstream and downstream of the Clyde River crossing as well as other potential receptors for sediment laden water (i.e., Linwood Brook). Provincial stations CR-1 (upstream) and WR-19 (downstream) can be included in the monitoring program for continuity with local datasets.

CCME have developed Water Quality Guidelines for the Protection of Freshwater Aquatic Life (PAL) (CCME 2002). These guidelines provide guidance for short-term (< 24 hour) and long-term (<30 days) exposure to increased TSS.

7.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON WATER RESOURCES

7.1 SCOPE OF ASSESSMENT

For the purpose of the assessment, water resources is defined as water that is available for human use as potable supply, or for other industrial, agricultural, commercial and residential uses. As groundwater is the sole supply of potable water and primary supply of water for other uses on PEI, the assessment of water resources will focus on groundwater. Surface water and the role surface water has in relation to aquatic life is described in Section 6.0. Accidental release of hazardous material and the interaction with water resources is addressed in Section 10.0

7.1.1 Regulatory and Policy Setting

Effects on water resources are subject to provincial regulations:

- Drinking Water and Wastewater Facility Operating Regulations (PEI EPA) – the Drinking Water Wastewater Facility Operating regulations provide regulatory guidance on both the sampling requirements (parameters analysed and frequency of analysis) of municipal water sources and outlines the requirements for completion of a well field protection program for municipal wells, including the delineation of groundwater capture zones and emergency response plans for accidental release of contaminants within the capture zones.

- Water Well Regulations (PEI EPA) – the Water Well regulations inform the construction of residential and municipal wells, including required setbacks and casing depths, as well as the proper abandonment procedure for obsolete wells.

And provincial and federal policies, codes and guidelines, including:

- Guidelines for Canadian Drinking Water Quality (GCDWQ; Health Canada 2017) – the GCDWQ provide concentration thresholds for a selection of chemical and biological water parameters that, if exceeded, may result in adverse effects to human health or degrade the quality of the water for household use. Values are reported as maximum allowable concentrations (MAC) or aesthetic objectives (AO).

- Code of Practice for the Environmental Management of Road Salts (Environment and Climate Change Canada 2004) – the code provides guidance and best management practices for the use of road salt and includes the requirement for jurisdictions to create Salt Management Plans to govern the use of salt on roadways.

- PEI TIE Salt Management Plan: Level I, II and III Manuals (PEI TPW 2005a,b,c) – in response to the code, PEI TIE has developed a Salt Management Plan which includes information on loading rates, identification of vulnerable areas and training information for salt/sand truck operators.

7.1.2 Potential Environmental Effects, Pathways, and Measurable Parameters

Interactions with water resources are expected throughout the life of the Project. These interactions, if unmitigated, have the potential to result in residual environmental effects to water resources through a change in groundwater quality or quantity. Table 7.1 provides the criteria that are used to characterize residual environmental effects on water resources.

Table 7.1 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for Water Resources

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Groundwater Quantity	• Alteration of groundwater quantity to potable well receptors through alteration of flow paths when dewatering excavations during construction.	• Potable well volume (m^3) and water levels (metres below grade; (mbg)).
Change in Groundwater Quality	• Alteration of groundwater quality through alteration of flow paths when dewatering excavations during construction, infiltration of surface runoff during operation.	• Potable well water quality (exceedance of GCDWQ MAC or AO values for metals, general chemistry, bacteria).

7.1.3 Boundaries

7.1.3.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of water resources are presented in Figure 7.1 and are defined below:

- Project development area (PDA): The PDA comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes a 7.8 km long, 61 m wide corridor, as well as interchanges, bridges, and overpasses, and properties owned by PEI TIE that may be used as borrow pits or laydown areas during construction.

- Local assessment area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. For water resources, the LAA includes the PDA and a 250 m buffer around the PDA. The LAA is primarily defined by the estimated area of influence of surface runoff and road salt application and the interaction with the local groundwater table.

- Regional assessment area (RAA): The RAA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). For the purpose of this assessment, the RAA is considered bounded by the LAA.

7.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on atmospheric environment include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.

Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

Stantec

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Water Resources Assessment Area Boundaries

Figure 7.1

7.1.4 Residual Environmental Effects Description Criteria

Table 7.2 provides the criteria that are used to characterize residual environmental effects on water resources.

Table 7.2 Characterization of Residual Environmental Effects on Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect	**Positive**—an effect that moves measurable parameters in a direction beneficial to groundwater relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to groundwater relative to baseline. **Neutral**—no net change in measurable parameters for the groundwater relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no measurable change to the available drawdown in a well, or water quality compared to baseline conditions **Low**—a measurable change but less than 1 m drawdown expected in shallow groundwater wells, or groundwater quality changes that exceed baseline conditions, but are less than the GCDWQ. **Moderate**—measurable change more than 1 m but less than 5 m of drawdown expected in shallow groundwater wells, or groundwater quality changes that exceed baseline conditions, and the GCDWQ for a period less than 30 days. **High**—measurable change of more than 5 m of the lowest available drawdown expected in shallow groundwater wells, or groundwater quality that exceeds baseline conditions and the GCDWQ for a period exceeding 30 days.
Geographic Extent	The geographic area in which an environmental, effect occurs	**PDA**—residual environmental effects are restricted to the PDA. **LAA**—residual environmental effects extend into the LAA.
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event**—occurs once **Multiple irregular event**—occurs at no set schedule **Multiple regular events**—occurs at regular intervals **Continuous**—occurs continuously

Table 7.2 Characterization of Residual Environmental Effects on Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual environmental effect restricted to the duration of the construction period or less. **Medium-term**—residual environmental effect extends through the construction period but less than the life of the Project. **Long-term**—residual environmental effect extends throughout the life of the Project.
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases	**Reversible**—the effect is likely to be reversed after completion of Project phase (construction or operation). **Irreversible**—the effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Unique**—area includes features or characteristics that are unique to the LAA or region **Common**—area includes features or characteristics that are common to the LAA or region.

7.1.5 Significance Definition

7.1.5.1 Change in Groundwater Quantity

A significant adverse residual environmental effect on groundwater quantity is defined as:

- one that results in a decrease of groundwater quantity of nearby potable groundwater wells, measured as a decrease in potable well yields and/or groundwater levels that precludes the use of the groundwater well as a potable water source.

7.1.5.2 Change in Groundwater Quality

A significant adverse residual environmental effect on groundwater quality is defined as:

- one that results in a change in groundwater quality of nearby potable water wells, measured as an increase in concentrations of groundwater contaminants and/or constituents in potable wells over pre-construction concentrations, to concentration values exceeding the GCDWQ (Health Canada 2017).

7.2 EXISTING CONDITIONS FOR WATER RESOURCES

7.2.1 Methods

Information used in the assessment of water resources was obtained through publicly available data sources and includes information from available soils and bedrock maps, aerial imagery, and information provided via government sources (provincial and municipal) with respect to municipal well yields, well field locations and protection zones, and potable water quality analyses.

Based on the availability of publicly available information, field studies were not deemed necessary to characterize the existing conditions for water resources.

7.2.2 Overview

Groundwater is the sole source of potable drinking water used by residents within PEI. Municipal water distribution systems service larger towns and cities within the province, while rural users rely on residential potable wells. The eastern extent of the PDA begins in the Town of Cornwall and continues east, moving through primarily agricultural areas, to a termination point on the TCH, approximately 1 km west of the intersection of the Bannockburn and Baltic roads. The largest concentration of residential potable wells is located within the western extent of the RoW and are associated with residences along the Bannockburn and Baltic roads and the TCH. The municipal water distribution system servicing the Town of Cornwall is located primarily to the south/southeast of the PDA; however, the LAA intersects the well field protection zones of two well fields servicing this system.

7.2.2.1 Geology and Surficial Soils

Based on regional geological maps, the PDA is underlain by Upper Paleozoic/Lower Permian era Pictou Group Megacyclic Sequence III consisting of redbeds with conglomerate, sandstone and siltstone (van de Poll 1977). According to well logs for the area, bedrock is shallow with depths ranging from less than 2 m to approximately 10 m, with an average depth of 3 to 4 m (Q. Li, pers. comm., April 27, 2017).

Maps of surficial deposits within the project area show several soil types intersecting the LAA. Primary soil types consist of glacial deposits of clay, clay-silt and clay-sand phase tills and ablation moraines consisting of stony sands. Bedrock outcrops are noted in the area of the Bannockburn and Baltic roads in Clyde River (MacDougall et al. 1988). A topographic high is located in the area of the TCH at the western limit of the RoW. Regionally, the groundwater in this area is expected to flow radially from this point into the Clyde River and its local tributaries, which meanders under the TCH and both the Bannockburn and Baltic roads. A second topographic high is located south of the central section of the PDA, with flow moving radially towards the Clyde River to the west, and Hyde Creek to the east.

7.2.2.2 Residential Potable Wells

The majority of the LAA passes through agricultural farmland with minimal residential development. Residences serviced by individual potable wells within the LAA are concentrated on the western extent of the RoW, along the Bannockburn and Baltic roads and a section of the TCH. The LAA includes sections of farmland acquired by PEI TIE that may be used for staging and laydown, but are in further proximity to the RoW. The majority of construction activities and the entirety of operation activities will be conducted within the RoW. The distribution of wells within the LAA is presented in Table 7.3 as proximity to the RoW. There is no provincially available database of well locations for the province of PEI. Aerial imagery was used to locate residences within the LAA and each residence was assumed to have an individual potable well on site. There are approximately 38 potable well locations identified within the LAA, with 11 of these wells located at a distance greater than 250 m from the RoW. Seven residential potable wells are located within 100 m of the RoW, with three wells located within the RoW and requiring abandonment in accordance with the applicable regulations. The wells requiring abandonment are currently located on the Baltic and Cornwall Roads (see Figure 7.1).

Table 7.3 Approximate Distribution of Potable Wells in the LAA

Well Location by Road	Approximate No. of Wells	Distribution of Wells Within Proximity to RoW		
		0-100 m	100-250 m	>250 m
Cornwall Road	4	2	1	1
Trans-Canada Highway	9	2	1	6
Bannockburn Road	17	2	12	3
Baltic Road	8	1	6	1

A regional groundwater quality summary for the Cornwall and Clyde River watersheds is presented in Table 7.4. The data were downloaded from an online database of potable well groundwater quality results, maintained by PEI CLE, which reports minimum, maximum and average concentration values based on available results for a given area (PEI CLE 2017). In general, average groundwater concentrations in the Cornwall/Clyde River area indicate a hard, alkaline groundwater. Average concentrations within both watersheds were below the relevant GCDWQ for all measured parameters. Guideline exceedances were reported for maximum values of chloride (5,490 mg/L), manganese (1.297 mg/L), nitrate-N (10.5 mg/L), sodium (2,272 mg/L), sulfate (572.8 mg/L), and uranium (0.022 mg/L) within the Cornwall watershed. Guideline exceedances were reported for maximum values of nitrate-N (10.6 mg/L) and uranium (0.022 mg/L) within the Clyde River watershed. Average and maximum values of sodium and chloride are reported to be higher in the Cornwall watershed.

Table 7.4 Groundwater Quality Summary for Potable Wells in the Cornwall/Clyde River Area

Parameter	Guidelines for Canadian Drinking Water Quality	Parameter Concentrations (mg/L)[1]			No. of Samples	Parameter Concentrations (mg/L)[1]			No. of Samples
		Min.	Avg.	Max.		Min.	Avg.	Max.	
		Cornwall Watershed				Clyde River Watershed			
Total Alkalinity	-	0	129.63	234	100	0	115.08	191	79
Dissolved Arsenic	0.01 (MAC)	0	0.00018	0.005	40	0	0.00015	0.005	33
Dissolved Cadmium	0.005 (MAC)	0	0	0	29	0	0	0	20
Dissolved Calcium	-	0.5	37.72	176.1	71	0	28.93	55.47	61
Chloride	250 (AO)	4.8	92.84	**5,490.00**	100	0	36.68	207.71	79
Dissolved Chromium	0.05 (MAC)	0	0	0	29	0	0	0	20
Dissolved Iron	0.3 (AO)	0	0.00106	0.045	69	0	0	0	53
Dissolved Magnesium	-	0.11	22.11	298.4	71	0	14.21	29.08	61
Dissolved Manganese	0.05 (AO)	0	0.005532	**1.297**	69	0	0.00057	0.023	54
Dissolved Nickel		0	0	0	29	0	0.00043	0.009	21
Nitrate-N	10 (MAC)	0	3.66	**10.5**	102	0	3.05	**10.6**	79
pH	-	6.9	7.92	8.5	100	7.1	7.96	8.6	79
Dissolved Phosphorous	-	0	0.05	0.15	71	0	0.05	0.09	61
Dissolved Potassium	-	0.96	3.57	77.23	71	0	1.4	2.75	61
Dissolved Selenium	0.05 (MAC)	0	0	0	38	0	0.00015	0.005	33
Dissolved Sodium	200 (AO)	3.85	48.89	**2,272.00**	71	0.86	19.93	99.32	61
Sulfate	500 (AO)	0.34	16.91	**572.8**	71	0	6.05	15.94	61
Dissolved Uranium	0.02 (MAC)	0	0.00213	**0.022**	42	0	0.001	**0.022**	34

Notes:
- = no guideline; MAC = maximum acceptable concentration; AO = aesthetic objective
BOLD VALUES = exceed Guidelines for Canadian Drinking Water Quality
[1]concentration values reported as '0' are assumed to have been below the reportable laboratory detection limit for the method of analysis
Source: PEI CLE 2017, accessed 10-May-17

7.2.2.3 Municipal Well Field Protection Zones

There are three municipal well fields identified within the Cornwall water distribution system; East Wiltshire, North Gate and Meadowbank. The East Wiltshire well field consists of two drilled wells with a combined average pumping rate of 100 gallons per minute (gpm), the North Gate well field consists of one drilled well with an average pumping rate of 60 gpm, and the Meadowbank well field consists of three drilled wells with a combined average pumping rate of 125 gpm. Details of well construction are unknown. These well fields feed the distribution system servicing the core residential areas within Cornwall and North River, and service approximately 1,500 connections. A well field protection zone has been delineated for each well field using groundwater modelling (CBCL Limited 2015). Zones are dependent on travel time of contaminants to the well head, and are delineated using knowledge of local soil, bedrock and groundwater conditions. Zones A, B and C are outlined as follows:

- Zone A – indicates a 250 day travel time area delineated radially from the well head, with primary constraints in this area associated with restriction of sources of fecal contaminants (sanitary piping, septic tanks/disposal fields) within the area, as well as hydrocarbon and chemical sources.
- Zone B – indicates a 5 year travel time area delineated radially from the well head, with primary constraints in this area associated with restriction of hydrocarbon and chemical sources. Fecal contaminant restrictions do not apply within this zone.
- Zone C – indicates a 25 year travel time area delineated radially from the well head, with primary constraints in this area associated with persistent chemical sources, typically chlorinated solvents, and some hydrocarbon sources.

The entirety of the Cornwall/North River distribution system is located to the south/southeast of the LAA; however, the LAA crosses through zones A, B and C of the East Wiltshire well field and zone C of the North Gate well field. Requirements for protection zone delineation and well field protection planning are outlined in the *Drinking Water and Wastewater Facility Operating Regulations*.

7.3 PROJECT INTERACTIONS WITH WATER RESOURCES

The Project will interact with water resources through construction and operation. These interactions between the Project and water resources may result in a change in groundwater quality and/or quantity. Table 7.5 identifies the Project-related physical activities that might interact with water resources to result in the environmental effects. These interactions are indicated by check marks, and are discussed in detail in Section 7.4 in the context of effects pathways, standard and project-specific mitigation, and residual environmental effects. A justification is also provided for non-interactions (no check marks).

Table 7.5 Potential Project-Environment Interactions and Effects on Water Resources

Project Components and Physical Activities	Potential Environmental Effect	
	Change in Groundwater Quantity	Change in Groundwater Quality
Construction		
Site Preparation	✓	-
Roadbed Preparation	✓	-
Installation of Structures	✓	-
Surfacing and Finishing	-	-
Temporary Ancillary Elements	✓	-
Emissions and Wastes	-	-
Operation		
Infrastructure Maintenance	✓	-
Winter Maintenance	-	✓
Vegetation Management	-	-
Emissions and Wastes	-	✓
Notes: ✓ = Potential interactions that might cause an effect. – = Interactions between the project and water resources are not expected.		

The runoff of storm water during construction activities is considered under emissions and wastes and is predicted to be the sole potential source contributing to a change in groundwater quality during these activities. However, the implementation of erosion and sediment control BMPs is expected to control and convey storm water runoff from exposed areas to adjacent surface water bodies during the construction period and is not expected to have an adverse effect on groundwater quality during construction. A change in groundwater quantity is associated with dewatering activities as a result of excavation below the local water table that may occur during site preparation, roadbed construction or installation of structures. In areas where the final roadbed elevation is set below the existing grade, the installation of permanent drainage features may be required below the roadbed to dewater the subsurface soils. If required, this activity may extend into the operational life of the Project. If temporary access roads are required as a temporary ancillary element, dewatering of excavations may be required during this activity. Dewatering is not predicted to be associated with surfacing and finish activities as no excavation is predicted. No changes in groundwater quantity or quality are expected as a result of emissions and wastes from the site during construction.

Erosion and sediment control BMPs are to be employed during any works that require exposure of the ground to avoid the runoff of sediment-laden storm water. As a result, changes in groundwater quality are not predicted during infrastructure maintenance. During operation, vegetation management is expected to take place using manual or mechanized cutting and does not include the use of herbicides to control growth. As a result, this activity is not considered to have an effect on groundwater quantity or quality. There are no dewatering activities likely to be associated with winter maintenance or emissions and wastes.

7.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON WATER RESOURCES

7.4.1 Analytical Assessment Techniques

The assessment of residual environmental effects on water resources was completed using publicly available sources of desktop information, including geological and soils mapping, drilled well logs, and water quality analysis results for potable wells near the Project area.

7.4.2 Assessment of a Change in Groundwater Quantity

7.4.2.1 Project Pathways for a Change in Groundwater Quantity

Potential environmental effects during construction are limited to activities surrounding dewatering of excavations during construction; however, if permanent subsurface drainage is required in areas where the roadbed elevation is below existing grade, the potential effects associated with this activity may continue through the operation life of the Project as part of infrastructure maintenance. A potential change in groundwater quantity is possible as a result of extended and continued dewatering of excavations that are dug to a depth below the local water table. If this activity is undertaken in the vicinity of a potable well, it is possible that water levels in wells could be affected by the removal of volumes of water from the aquifer. The *Water Well Regulations* require new drilled wells to be cased to a depth of 12 metres below grade (mbg) and reduced casing lengths are only allowed under special permit. A change in groundwater quantity due to dewatering is only likely in the scenario of a low-yield shallow or dug well of older construction being in close proximity to dewatering activities.

7.4.2.2 Mitigation for a Change in Groundwater Quantity

Mitigation measures relating to a change in groundwater quantity include:

- limiting the spatial and temporal extent of dewatering activities.
- identifying and completing water level monitoring of potable wells within 30 m of proposed dewatering activities.

7.4.2.3 Residual Project Environmental Effects for a Change in Groundwater Quantity

Residual Project environmental effects as a result of Project activities on groundwater quantity are expected to be adverse, reversible, low in magnitude and limited to the PDA. The ecological and socioeconomic context of the PDA is considered unique due to the presence of the well fields for the Town of Cornwall; however, the Project is not expected to change that context. Project interaction with groundwater quantity is long-term and continuous if subsurface roadbed dewatering is implemented during construction, but will be limited to potable wells in close proximity to the activity. The changes to water levels from shallow dewatering of excavations or road subsurface up to 5 mbg are anticipated to be greatest at the dewatering location, and are anticipated to be less than 5 m, decreasing to non-measurable changes within 30 m of the dewatering. No existing water wells are known to be present within 30 m of the PDA.

7.4.3 Assessment of a Change in Groundwater Quality

7.4.3.1 Project Pathways for a Change in Groundwater Quality

During operation, groundwater quality may be adversely impacted through the infiltration of dissolved contaminants generated by the use of road salt during winter maintenance activities and/or the runoff of storm water, which can carry contaminants from the RoW.

7.4.3.2 Mitigation for a Change in Groundwater Quality

Mitigation measures relating to a change in groundwater quality include:

- the abandonment of wells associated with structures or operations being removed or displaced as a result of construction activities
- the avoidance of staging construction materials, storage of chemicals or fuels, vehicle re-fueling within 100 m of a residential potable well or within the Town of Cornwall well field protection zones A and B
- the avoidance of infiltration-based storm water management within municipal well field protected zones to reduce infiltration of storm water from winter maintenance activities into the portion of the aquifer within these zones
- the adherence to the PEI TIE Salt Management Plan during winter maintenance activities
- the installation of signage along the RoW within municipal well field protection zones providing emergency contact information for spill reporting

7.4.3.3 Residual Project Environmental Effects for a Change in Groundwater Quality

Residual Project environmental effects as a results of Project activities on groundwater quality are expected to be adverse, irreversible, low in magnitude, and long-term in duration. Interactions are expected to be frequent and reversible and the ecological and socioeconomic context of the LAA is considered unique due to the presence of the well fields for the Town of

Cornwall; however, the Project is not expected to change that context. The extent of interaction is limited to the LAA, with the majority of activity during the operation phase limited to the Project RoW. Predicted changes to groundwater quality within the LAA are expected to be contained to wells within 100 m of the RoW. It is expected that outlined mitigation measures will limit the extent to which roadway surface runoff and road salt application interacts with the local groundwater table, through limitation of infiltration-based storm water management BMPs and management of salt application through the PEI TIE Salt Management Plan.

7.4.4 Summary of Residual Project Environmental Effects on Water Resources

The residual Project environmental effects for water resources described above are summarized in Table 7.6.

Table 7.6 Summary of Project Residual Environmental Effects on Water Resources

Residual Environmental Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Groundwater Quantity	C/O	A	L	PDA	LT	C	R	U
Change in Groundwater Quality	O	A	L	LAA	LT	R	R	U

KEY
See Table 7.2 for detailed definitions.

Project Phase:
C: Construction
O: Operation

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent
NA: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
U: Unique
C: Common

7.5 DETERMINATION OF SIGNIFICANCE

7.5.1 Significance of Residual Project Effects

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in groundwater quantity or change in groundwater quality from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on a good understanding of the general effects of construction and operation activities on water resources and the effectiveness of mitigation measures discussed in Sections 7.4.2.2 and 7.4.3.2.

7.6 PREDICTION CONFIDENCE

Prediction confidence is considered moderate based on the reliance on publicly available data, and proposed mitigation measures.

7.7 FOLLOW-UP AND MONITORING

A baseline water well survey of potable wells within 100 m of the RoW is recommended prior to the construction phase of the Project. This survey will identify all groundwater users within this area, and will provide baseline data to confirm if predictions of potential impacts to groundwater quality have occurred because of winter maintenance activities or surface runoff.

8.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON THE TERRESTRIAL ENVIRONMENT

In this chapter, potential effects related to Project construction and operation are assessed in relation to the terrestrial environment. The terrestrial environment can be characterized by two components: vegetation and wildlife species, and wetlands. Accidents, malfunctions, and unplanned events such as erosion and sediment control failures, and wildlife encounters are discussed in Section 11.0. Project environmental effects arise from the interactions between the Project and terrestrial environment and consider proposed mitigation measures. Any residual Project environmental effects after the implementation of mitigation measures are evaluated for significance. Follow-up and monitoring are also presented.

The terrestrial environment has been selected as a valued component (VC) based on potential interactions between the Project and vegetation and wildlife, including species at risk (SAR) and species of conservation concern (SOCC), and wetlands, including wetland area and wetland function.

8.1 SCOPE OF ASSESSMENT

This section defines and describes the scope of the assessment of potential environmental effects on the terrestrial environment.

8.1.1 Regulatory and Policy Setting

8.1.1.1 Vegetation and Wildlife Species

The assessment of vegetation and wildlife focuses on SAR and SOCC. SAR include those species listed as *extirpated*, *endangered*, *threatened*, or *special concern* by the federal *Species at Risk Act* (SARA) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Of these species, those that are included on Schedule 1 of SARA currently have regulatory protection. In PEI, on lands under provincial jurisdiction, SAR are protected under the provincial *Wildlife Conservation Act*. Although the offenses under the provincial act are similar to the prohibitions under SARA, there are currently no associated regulations identifying species that are protected by the act. Species that are described above, but not included on Schedule 1 of SARA currently have no regulatory protection, are included in this definition of SAR because it is possible that they may become protected within the timeframe of Project construction.

The goals of SARA include: preventing the extirpation or extinction of wildlife species; providing recovery strategies for species included on Schedule 1 of SARA; and managing species listed as *special concern* so that they do not become *endangered* or *threatened*. Under SARA, it is forbidden to kill, injure, harass, destroy the residence of, destroy the critical habitat of, capture or take an individual designated as *extirpated*, *endangered*, or *threatened* on federally regulated lands or designated critical habitat elsewhere.

SOCC are not listed under federal or provincial legislation but are considered rare in PEI, or their populations have been evaluated as unsustainable. SOCC are here defined as non-SAR species ranked *S1* (critically imperiled), *S2* (imperiled), or *S3* (vulnerable) in PEI by the Atlantic Canada Conservation Data Centre (AC CDC 2017). SOCC are included in this VC as a precautionary measure, reflecting observations and trends in their provincial population status. SOCC are often important indicators of ecosystem health and regional biodiversity, and could become SAR during the construction of the Project.

The *Migratory Birds Convention Act* (MBCA) protects migratory birds and their nests within all lands in Canada. Most birds are covered under the MBCA in Canada, with the exception of some bird families (e.g., cormorants, pelicans, grouse, quail, pheasants, ptarmigan, hawks, owls, eagles, falcons, kingfishers, crows, and jays). The MBCA is the enabling statute for the *Migratory Birds Regulations*. Section 6 of the *Migratory Birds Regulations* states that without the authorization of a permit, the disturbance, destruction, or taking of a nest, egg, nest shelter, eider duck shelter, or duck box of a migratory bird, or possession of a migratory bird, carcass, skin, nest, or egg of a migratory bird are prohibited. Although there are no authorizations to allow construction-related effects on migratory birds and their nests, BMPs and guidelines (e.g., *Migratory Birds Convention Act: A Best Management Practice for Pipelines* (Canadian Energy Pipeline Association and Stantec 2013), *Incidental Take Avoidance Guidelines* (ECCC 2016d)) are available to facilitate compliance with the MBCA.

8.1.1.2 Wetlands

Wetlands are defined as lands that are permanently or temporarily submerged or saturated by water near the soil surface for long enough to maintain wet or poorly drained soils, support plants adapted to saturated soil conditions, and have other biotic conditions characteristic of wet environments (Government of Canada 1991).

A federal mandate for wetland conservation is provided by *The Federal Policy on Wetland Conservation* (Government of Canada 1991). Policy goals apply on federal lands and waters, to federal programs where wetland loss has reached critical levels, and to federally designated wetlands such as Ramsar sites. None of these conditions apply to the PDA. Wetland protection goals in PEI are described in *A Wetland Conservation Policy for Prince Edward Island* (PEIDEEF 2007). Similar to the federal policy, the provincial policy promotes a no net loss of wetlands and wetland function within the province; and a mitigation approach that favours avoidance, then minimization, and finally, compensation.

Wetlands are protected in PEI under the *Environmental Protection Act*, and the associated *Watercourse and Wetland Protection Regulations* (WAWA Regulations). The WAWA Regulations prohibit anyone from altering a watercourse or wetland or the water flow within, or engaging in a list of activities, without first obtaining a license or a Watercourse or Wetland Activity Permit. Prohibited activities include (but are not limited to) draining or excavating, infilling with any material, operating heavy equipment or motor vehicles on a wetland, and disturbing or altering ground or vegetation in any manner (including cutting live trees or shrubs from wetlands classed as types other than wooded swamps). In addition, a license or Buffer Zone Activity Permit is required for a number of listed activities, such as ground and soil disturbance, within 15 m of the boundary of a watercourse or wetland.

8.1.2 Potential Environmental Effects, Pathways, and Measurable Parameters

Based on the knowledge of the Project and its associated activities, the following potential environmental effects were selected for the assessment of the terrestrial environment: change in vegetation and wildlife; and change in wetland area and function.

Table 8.1 provides the criteria that are used to characterize residual environmental effects on the Terrestrial Environment.

Table 8.1 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for the Terrestrial Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Vegetation and Wildlife	• Vegetation clearing, grubbing, and other ground disturbance within the PDA may have an effect on vegetation and wildlife SAR/SOCC, if they are present, and will change vegetation communities and habitat for wildlife. • Sensory disturbance related to construction and operation activities can lead to avoidance by wildlife species. • Construction and operation of the Project could lead to an increase in wildlife collisions.	• Loss of vascular plant or wildlife SAR or SOCC (number of individuals or populations) • Loss of vegetation communities (ha) • Loss or alteration of wildlife habitat (ha) • Habitat avoidance (number of individuals displaced) • Mortality of wildlife (number of individuals killed)
Change in Wetland Area and Function	• Vegetation clearing, grubbing, and other ground disturbance within the PDA may result in wetland loss and change wetland area and function. • Compaction of wetland soils could alter wetland function within the PDA and adjacent areas. • Application of salt and sand for winter maintenance could result in changes to wetland function in areas adjacent to the RoW.	• Loss of wetland area (ha) • Change in wetland function (assessed qualitatively)

8.1.3 Boundaries

8.1.3.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the terrestrial environment are defined below, and illustrated in Figure 8.1.

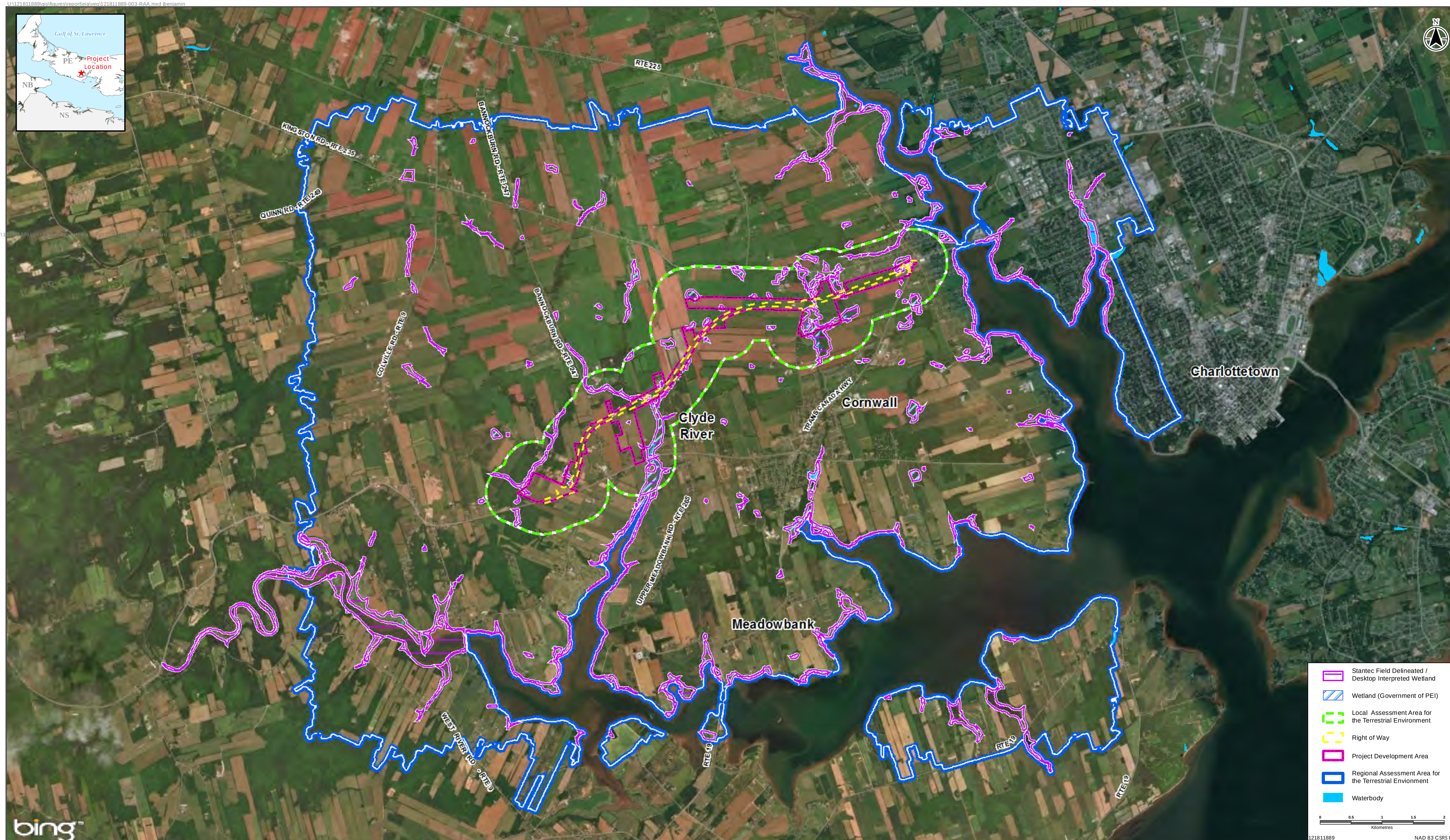
- Project Development Area (PDA): Project development area (PDA): The PDA comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes a 7.8 km long, 61 m wide corridor, as well as interchanges, bridges, and overpasses, and properties owned by PEI TIE that may be used as borrow pits or laydown areas during construction.

- Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence, and encompassing the likely zone of influence. For the terrestrial environment specifically, the LAA includes the PDA and a 500 m buffer around the PDA. The LAA is primarily defined by wildlife and wildlife habitat, where noise may penetrate wildlife habitats. The area of potential direct or indirect effects on vegetation and wetlands is expected to be much smaller than that for wildlife and wildlife habitat.

- Regional Assessment Area (RAA): The RAA accommodates a wider geographic area for ecological context, and is also the area within which Project-related environmental effects may overlap or interact with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). For the terrestrial environment, the RAA is defined as the extent of the land use data currently available for the Project. The extent of these data is an area roughly 10 km by 13 km surrounding the Project and including a portion of Charlottetown in the east and West River in the south.

8.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on terrestrial environment include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.



Last Modified: 6/7/2017 By: jbenjamin

Source: Base data, imagery and project data provided by the Government of Prince Edward Island. Rare Species Observation data provided by Stantec Consulting Ltd. Service Layer Credits: © Harris Corp, Earthstar Geographics LLC Earthstar Geographics SIO © 2017 Microsoft Corporation

Stantec

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Terrestrial Environment Assessment Area Boundaries and Features

Figure 8.1

8.1.4 Residual Environmental Effects Description Criteria

Table 8.2 provides the criteria used to characterize residual environmental effects on the terrestrial environment.

Table 8.2 Characterization of Residual Environmental Effects on the Terrestrial Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect	**Positive**—an effect that moves measurable parameters in a direction beneficial to the terrestrial environment relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to the terrestrial environment relative to baseline. **Neutral**—no net change in measurable parameters for the terrestrial environment relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no measurable change from baseline conditions. **Low**—a measurable change from baseline conditions, but within the range of natural variability, and does not adversely affect the ongoing viability of terrestrial populations or overall function of wetlands within the LAA. **Moderate**—a measurable change from baseline conditions outside the range of natural variability, but does not adversely affect the ongoing viability of terrestrial populations or overall function of wetlands within the LAA. **High**—a measurable change from baseline conditions that affects the ongoing viability of terrestrial populations or overall function of wetlands within the LAA.
Geographic Extent	The geographic area in which an environmental effect occurs	**PDA**—residual environmental effects are restricted to the PDA. **LAA**—residual environmental effects extend into the LAA. **RAA**—residual environmental effects extend beyond the LAA, into the RAA.
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event**—occurs once. **Multiple irregular event**—occurs at no set schedule. **Multiple regular event**—occurs at regular intervals. **Continuous**— occurs continuously.

Table 8.2 Characterization of Residual Environmental Effects on the Terrestrial Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual environmental effect restricted to the duration of proposed construction. **Medium-term**—residual environmental effect extends beyond construction through to twenty growing/breeding seasons. **Long-term**—residual environmental effect extends beyond twenty growing/breeding seasons.
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible**—the effect is likely not permanent and the measurable parameter will recover to baseline conditions after Project completion. **Irreversible**—the effect is likely permanent.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Unique**—area includes features or characteristics that are unique to the LAA or region. **Common**—area includes features or characteristics that are common to the LAA or region.

8.1.5 Significance Definition

8.1.5.1 Change in Vegetation and Wildlife

For a change in vegetation and wildlife, a significant adverse residual environmental effect on the Terrestrial Environment is defined as one or more of the following:

- one which results in a decline in abundance or change in distribution of species (evaluated by either the alteration of vegetation communities they inhabit, a reduction in wildlife dispersal or migration, or direct mortality of individuals) such that their long-term survival within the RAA is substantially reduced
- one which results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of SARA
- in the case of any SAR/SOCC, any non-compliance with the management plans (developed as a result of Section 65 of SARA) currently in place

8.1.5.2 Change in Wetland Area and Function

For a change in wetland area and function, a significant adverse residual environmental effect on the terrestrial environment is defined as:

- one which results in an unauthorized permanent net loss of wetland function
- one which results in the loss of important function (i.e., one that would result in a significant effect on another VC that relies upon wetlands) at the RAA level

8.2 EXISTING CONDITIONS OF THE TERRESTRIAL ENVIRONMENT

Existing conditions for the terrestrial environment were surveyed in 2016, and reported on in *Technical Report – Terrestrial Environment: Cornwall Perimeter Highway Project* (Appendix E). This document includes methods and results of breeding bird, vegetation, and wetland surveys conducted in support of the Project. This section describes any changes that have occurred or new information that has been obtained since the submission of the technical report.

8.2.1 Methods

The PDA was altered in April 2017 from what had been previously reported on in the technical report in November 2016. Vegetation and wetland surveys conducted in 2016 were completed within the "Project Development Area" illustrated in Figure 1 of the technical report, plus an additional 15 m buffer on either side where land permissions allowed (Appendix C). Breeding bird surveys were completed within the "Study Area" on Figure 1 of the technical report (Appendix E). Additional wetland interpretation was completed within unsurveyed portions of the current PDA and within the LAA. Updated land use metrics were calculated within the PDA and LAA.

Surveys targeting overwintering bird species were conducted within the PDA on March 10, 2017. Additional May bird migration surveys, late spring and mid-summer vegetation and wetland surveys targeting SAR and SOCC, and a June acoustic bat survey will be conducted in 2017 and reported on under separate cover.

8.2.2 Overview

8.2.2.1 Vegetation Communities, Wildlife Habitat, and Wetlands

Updated vegetation community and wildlife habitat data (including wetlands) and other land use data within the RoW, the altered PDA, the LAA, and RAA, are presented in Table 8.3.

Table 8.3 Land Classification within the RoW, PDA, LAA, and RAA

Land classification	RoW		PDA		LAA		RAA	
	Hectares	%	Hectares	%	Hectares	%	Hectares	%
Agricultural	39.5	79.0	153.5	81.3	797.5	63.3	6,729.2	57.6
Crops, Fallow Fields, etc.	38.4	76.8	149.7	79.3	772.6	61.3	6,533.0	55.9
Hedgerows	1.1	2.1	3.7	2.0	24.9	2.0	196.2	1.7
Anthropogenic	2.4	4.8	6.1	3.2	184.5	14.6	2,461.1	21.1
Forest	4.9	9.7	11.1	5.9	178.6	14.2	1,980.7	17.0
Hardwood	2.6	5.1	6.2	3.4	97.6	7.7	1,143.5	9.8
Mixedwood	1.3	2.6	1.4	0.8	43.3	3.4	502.5	4.3
Softwood	1.0	2.0	3.7	2.0	33.4	2.6	289.0	2.5
Clearcut	0	0	0	0	4.9	0.4	46.2	0.4
Wetland	3.3	6.5	18.1	9.6	100.1	7.9	512.0	4.4
Coastal Marsh	0.4	0.8	1.2	0.6	25.7	2.0	366.0	3.1
Freshwater Marsh	1.8	3.6	10.8	5.7	20.4	1.6	51.0	0.4
Hardwood Treed Swamp	0.1	0.3	1.1	0.6	12.4	1.0	18.1	0.2
Mixedwood Treed Swamp	0.1	0.3	3.7	2.0	31.7	2.5	38.2	0.3
Shallow Water Wetland	0	0	0	0	0.3	0.02	15.2	0.1
Softwood Treed Swamp	0.7	1.3	0.9	0.5	5.4	0.4	5.4	0.1
Tall Shrub Swamp	0.1	0.2	0.1	0.1	3.7	0.3	17.6	0.2
Sand Dune	0	0	0	0	0	0	0.6	0.01
TOTAL	50.0	100.0	188.8	100.0	1260.7	100.0	11,683.6	100.0

Although the individual areas and percentages have changed slightly from what was presented in the technical report, the trends remain the same. The most prevalent land use class is "Agricultural" regardless of spatial scale, though it does represent more of the PDA (81%) than of the LAA and RAA (63% and 58%, respectively). Anthropogenic land use, including residential areas and roads, are relatively more common in the LAA and RAA than in the PDA. Wetlands account for less than 10% of the total area at any scale, and only 4.4% within the RAA as wetlands were not interpreted outside of the LAA (Figure 8.1 and the Terrestrial Mapbook in Appendix F).

Although not addressed in the technical report, the agricultural land use class includes hedgerows, which account for 1.1 ha (2.1%) of the RoW and 3.7 ha (2.0%) of the PDA. Hedgerows make up a relatively small percentage of the RoW and PDA, but are known to be ecologically important within an agriculturally-dominated landscape. Hedgerows can contain a relatively large proportion of the vascular plant richness of a surrounding agricultural area. They can have an effect on the microclimate of adjacent fields, reducing wind speeds and soil evaporation, and as a result reduce soil erosion and nutrient run-off (Forman and Baudry 1984). Hedgerows also provide important functions for wildlife, providing habitat or acting as refugia, corridors, or even barriers, depending on the wildlife species and characteristics of the hedgerows. Hedgerows can be a source of food and often provide the only source of cover within the wider landscape. This cover allows smaller animals to hide from predators, gives birds a place to roost, non-ground nesting birds a place to build nests, and provides a perch for insectivorous birds and birds of prey to hunt from. Hedgerows also act as a dispersal corridor for smaller wildlife that would generally not cross an open field (Baudry et al. 2000; Forman and Baudry 1984). The effectiveness of hedgerows in performing these functions depends on several characteristics, including hedgerow size (height, length, depth), and structural diversity (i.e., the presence and density of trees, shrubs, and ground vegetation) (Hinsley and Bellamy 2000). The specific functions of hedgerows within the RoW and PDA were not evaluated as that is outside of the scope of this assessment, but it is assumed that they likely provide many of these functions to some extent.

8.2.2.2 Vascular Plants

During 2016 field surveys, 266 vascular plant species were observed in the surveyed area, including one SAR and five SOCC. Following the submission of the technical report, the AC CDC released updated S-Ranks for the Maritime Provinces; several species observed during these surveys now have new S-Ranks that differ from those reported in the technical report. The majority of the changes were from *S5* to *S4*, but one species, eastern hemlock (*Tsuga canadensis*) changed to *S3* and is now considered an SOCC.

Eleven butternut trees (*Juglans cinerea*, SNA) were observed in the surveyed area near Linwood Drive, ranging in age from seedlings to young trees (Terrestrial Mapbook in Appendix F). Although butternut is federally-listed as *endangered* on Schedule 1 of SARA, none of the observed individuals are located on federal land, the species is not native to PEI and is considered exotic to the island (AC CDC 2016), and it is not protected by any legislation in PEI.

Of the six SOCC observed during 2016 vegetation surveys, five are located within the PDA. Macoun's cudweed (*Pseudognaphalium macounii*, *S2*) and yellow ladies'-tresses (*Spiranthes ochroleuca*, *S1*) were both observed within an abandoned field near the western end of the Project, south of Baltic Road (Figure 8.1). Twenty eastern hemlock trees ranging in size from 10 cm to over 60 cm DBH (diameter at breast height) were observed near Clyde River (Figure 8.1). Dotted smartweed (*Polygonum punctatum*, *S2S3*) was recorded on the eastern bank of Clyde River, and bog yellowcress (*Rorippa palustris*, *S3*) was observed at the edge of a wetland within an abandoned gravel pit (Figure 8.1). Two heart-leaved paper birch trees (*Betula papyrifera* var. *cordifolia*, S2) were noted within the LAA just outside of the PDA within an immature mixedwood stand to the east of Cornwall Road (Figure 8.1). Six eastern hemlock trees, ranging from small saplings to mature trees, were observed within the LAA in a mature mixedwood stand adjacent to a riparian wetland east of Linwood Road (Terrestrial Mapbook in Appendix F).

Additional vegetation surveys are planned for late spring and mid-summer 2017 within the adjusted PDA, and will be reported on in an addendum to this EIS.

8.2.2.3 2016 Breeding Bird Surveys

Field surveys focused on breeding birds within the PDA and surrounding area were conducted over three mornings between June 30 and July 2, 2016. During these surveys, 42 species were identified. An additional nine species were observed incidentally (i.e., between survey points, or during wetland and vegetation surveys conducted outside the breeding season). Of the 51 species observed, two were SAR and five were SOCC (Table 8.4).

Table 8.4 Bird SAR and SOCC reported near the PDA

Common name	Scientific Name	SARA	COSEWIC	AC CDC S-rank[1]
eastern wood-pewee	*Contopus virens*	no schedule, no status[2]	*special concern*	*S3B*
Canada warbler	*Cardellina canadensis*	Schedule 1, *threatened*	*threatened*	*S3B*
killdeer	*Charadrius vociferous*			*S3B*
red-tailed hawk	*Buteo jamaicensis*			*S3B*
pileated woodpecker	*Dryocopus pileatus*			*S1*
northern waterthrush	*Parkesia noveboracensis*			*S3B*
bay-breasted warbler	*Setophaga castanea*			*S3B*

[1] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable, S4 = apparently secure, S5 = secure, SNA = not applicable (typically exotic species), SX = Presumed Extirpated (AC CDC 2017)

[2] proposed to be added to Schedule 1 of SARA as *special concern* (Government of Canada 2017)

8.2.2.4 2017 Winter Bird Surveys

Six species were identified within or adjacent to the PDA during winter bird surveys conducted in 2017 in support of the Project (Table 8.5). Each of the species observed are ranked as *S5* by the AC CDC, and are considered common and secure in PEI.

Table 8.5 Bird Species Observed during Winter Bird Surveys in 2017

Common Name	Scientific Name	AC CDC S-Rank
common merganser	*Mergus merganser*	*SUB, S5N*
belted kingfisher	*Megaceryle alcyon*	*S5B*
American crow	*Corvus brachyrhynchos*	*S5*
common raven	*Corvus corax*	*S5*
black-capped chickadee	*Poecile atricapilla*	*S5*
golden-crowned kinglet	*Regulus satrapa*	*S5*

Additional migratory bird surveys are planned for May 2017, and will be reported on in an addendum to this EIS.

8.3 PROJECT INTERACTIONS WITH THE TERRESTRIAL ENVIRONMENT

The Project will interact with the terrestrial environment through the construction and operation phases. These interactions between the Project and the terrestrial environment may result in a change in vegetation and wildlife and a change in wetland area and function. Table 8.6 identifies the Project physical activities that might interact with the terrestrial environment to result in the environmental effects. These interactions are indicated by check marks, and are discussed in detail in Section 8.4 in the context of effects pathways, standard and project-specific mitigation, and residual environmental effects.

Table 8.6 Potential Project-Environment Interactions and Effects on the Terrestrial Environment

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Vegetation and Wildlife	Change in Wetland Area or Function
Construction		
Site Preparation	✓	✓
Roadbed Preparation	✓	✓
Installation of Structures	✓	✓
Surfacing and Finishing	✓	✓
Temporary Ancillary Elements	✓	✓
Emissions and Wastes	✓	✓
Operation		
Infrastructure Maintenance	✓	✓
Winter Maintenance	✓	✓
Vegetation Management	✓	✓
Emissions and Wastes	✓	✓

Notes:
✓ = Potential interactions that might cause an effect.
– = Interactions between the project and the terrestrial environment are not expected.

8.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON THE TERRESTRIAL ENVIRONMENT

This section describes the potential interactions between the Project and the terrestrial environment as identified in Section 8.3. Interactions between the Project and the terrestrial environment that could result in a change in vegetation and wildlife or a change in wetland area or function were assessed for each Project phase using the identified analytical assessment techniques. Accidents and malfunctions are discussed separately in Section 11.0.

8.4.1 Analytical Assessment Techniques

The assessment of potential environmental effects on the terrestrial environment VC was conducted using a combination of field-collected data, aerial-photo interpreted data, and publicly available information. Vegetation and wetland field surveys were conducted throughout the majority of the RoW and a portion of the PDA (i.e., throughout a previous PDA and a 15 m buffer). The surveys were conducted during the growing season by qualified biologists with experience in botany, wetland delineation and classification, and wildlife.

Publicly available information was used for portions of the PDA and LAA that were not surveyed in the field. Information on vascular plant locations was obtained from the AC CDC. Wetlands outside of surveyed areas of the LAA were determined through PEI CLE wetland data and aerial photo interpretation. Additional vegetation surveys are planned for the entire PDA in early June and mid-July 2017. Wetland surveys of previously unsurveyed portions of the PDA are planned for summer 2017. The results of these vegetation and wetland surveys will be provided in an addendum to this EIS and any changes to the assessment will be described within.

8.4.2 Assessment of Change in Vegetation and Wildlife

8.4.2.1 Project Pathways for Change in Vegetation and Wildlife

Construction

Construction of the Project has the potential to interact with vegetation and wildlife through a loss of or change in vegetation communities and wildlife habitat, physical disturbance to vascular plant SAR or SOCC, sensory disturbance and habitat avoidance by wildlife, and a change in mortality rates for wildlife species.

Heavy machinery used during clearing and site preparation (i.e., grubbing and excavation) will remove all vegetation and alter soils, resulting in a loss of vegetation communities, and direct loss of any vascular plant SAR or SOCC that may occur within the PDA. It is expected that any loss of vegetation communities and vascular plant SAR or SOCC will occur during site preparation, and that other activities associated with the construction phase of the Project will not directly interact with vegetation communities and vascular plant SOCC. Of exception, temporary ancillary elements could require clearing and grubbing in additional areas.

Grubbing may remove topsoil and the associated seedbank, and heavy machinery driving through the site will cause soil compaction. Removing and compacting soil will result in a change in habitat quality for plants in any areas that may not be completely developed. Thus, any areas that are cleared and grubbed and then allowed to revegetate may have different plant communities establish because of altered habitat characteristics.

Vegetation communities and wildlife habitat quality in areas adjacent to the PDA can also be altered by edge effects. Edge effects occur though removal of adjacent vegetation, particularly overstory trees, which results in changes to abiotic factors such as temperature, humidity, wind, and light availability. Alterations to these habitat conditions can affect which plant species survive in an area, including SAR and SOCC if they are present. The rarity of SAR and SOCC is often related to their specific habitat requirements; small changes to their habitat can result in loss of individuals. Edge effects can also change vegetation communities and the presence of SAR and SOCC adjacent to cleared areas through the introduction of invasive vascular plant species. Invasive species are typically strong colonizers and competitors and once established, can change vegetation communities by out-competing native vegetation. Invasive species can be introduced and spread throughout the PDA by use of equipment that was used in areas with invasive plants.

Heavy equipment operated during construction activities, particularly during site preparation, could result in interactions with wildlife and wildlife habitat. These interactions include direct habitat loss through vegetation removal, change in habitat through edge effects, sensory disturbance, and the direct mortality of wildlife. Although equipment moving through the PDA during construction will typically be heavy equipment operating at reduced speeds, these vehicles may still interact with slow-moving wildlife, or species and life stages with limited mobility such as unfledged birds, herpetiles, and young small mammals. Destruction of nests, dens, and burrows within the PDA is possible. This interaction with heavy machinery could occur throughout the various activities planned to occur during the construction phase, including installation of structures, surfacing and finishing, and temporary ancillary elements. An increase in wildlife mortality could also occur as a result of collisions between wildlife (particularly birds and herpetiles) and construction equipment. In particular, lighted equipment can attract birds during migratory periods. This phenomenon occurs most often during poor weather conditions and at night (Avery et. al 1976; Longcore and Rich 2004; Ogden 1996; Wiese et al. 2001).

Following site preparation, ground nesting species including SAR and SOCC such as common nighthawk (*Chordeiles minor*, *threatened* under SARA, *S3B,S4M*) and killdeer (*Charadrius vociferus*, *S3B,S3M*) may begin nesting in the PDA. Mortality of ground nesters could occur during roadbed preparation and temporary ancillary elements if these activities occur during the breeding season.

All construction activities, including site preparation, roadbed preparation, installation of structures, surfacing and finishing, and temporary ancillary elements, could cause indirect habitat loss resulting from sensory disturbance. Sensory disturbance resulting from light and noise of construction equipment could result in reduced productivity or nest abandonment, which could lead to an indirect change in mortality rates for wildlife species. Some wildlife species may also experience temporary habitat loss via avoidance (Bayne et al. 2008). Increased predation of small mammals or herpetiles may occur as they flee cover in response to construction noise.

Operation

Operation of the Project has the potential to interact with vegetation and wildlife through a loss of or change in vegetation communities and wildlife habitat, loss of vascular plant SAR or SOCC, sensory disturbance and habitat avoidance by wildlife, and a change in mortality rates for wildlife species.

Application of salt or sand to the roadbed for winter maintenance could interact with vegetation and wildlife and cause a change in the vegetation communities adjacent to the PDA. This could occur through sedimentation, changes to soil and water salinity, changes to soil fertility, and direct damage to vascular plants. Vascular plant SAR and SOCC located adjacent to the PDA could be adversely affected, either through direct damage or a change in habitat to an extent that is no longer tolerable.

Similar to clearing during construction, vegetation management will result in the periodic disturbance to wildlife habitat, and could interact with nests or immobile young if this activity occurs during breeding season.

The presence of a highway is expected to lead to indirect habitat loss through sensory disturbance, and an increase in wildlife mortality. Although there is currently a highway in the area and the amount of traffic passing through the area is not expected to change, vehicles travelling on the new highway will typically operate at higher speeds, which will result in increased noise in adjacent habitats, and increased risk of collisions with wildlife. The highway will also represent an additional barrier to wildlife movement within the LAA.

8.4.2.2 Mitigation for Change in Vegetation and Wildlife

Mitigation measures relating to a change in vegetation and wildlife include:

- Known locations of individuals of vascular plant SAR (butternut) and SOCC will be flagged and avoided, when possible.
- Site preparation will be confined to the area required for Project construction.
- No tree clearing will occur outside of the RoW unless necessary for the Project.
- Clearing and grubbing activities will be avoided in vegetated areas during the regional nesting period for migratory birds (April 15 to August 31).
- Some clearing is expected to occur in non-forested areas within the PDA in August, 2017. Prior to the commencement of any clearing activities, breeding bird surveys will be conducted to determine if any nesting activity is occurring at that time. If active nests are observed in the area to be cleared, additional mitigation will be employed such as flagging setbacks and avoidance of nests until the young have fledged.
- Approved noise arrest mufflers will be used on equipment to reduce potential environmental interactions between noise and wildlife.
- Full cut-off lighting (i.e., no illumination occurs above an angle of 90°) will be used during construction and operation to reduce attraction to migrating birds.
- Known instances of invasive vascular plant species will be removed from the site prior to the start of construction activities, to limit their spread.
- Equipment will arrive on site free of soil or vegetative debris to reduce the potential introduction and spread of invasive plant species.
- Vehicles and equipment will be preferentially operated on previously disturbed ground to reduce the change in vegetation communities, wildlife habitat, and wetlands.
- Vehicles will be operated at posted speed limits and will yield to wildlife.
- The size of temporary workspaces will be limited.
- Construction site wastes that might attract wildlife will be properly stored and disposed of.

- Natural regeneration will be the preferred approach to revegetation but when this is not effective a native seed mix will be used to reduce the potential for the introduction of invasive plant species.
- Trees and shrubs would be planted as seedlings or saplings, as required, and would be native species.

8.4.2.3 Residual Project Environmental Effects for Change in Vegetation and Wildlife

Construction activities are expected to result in a permanent disturbance of up to 47.6 ha of vegetation communities and wildlife habitat within the RoW (not including the 2.4 ha of anthropogenic land use). This primarily includes agricultural land use, including fields and to a lesser extent, hedgerows. Additional temporary disturbance will occur within the PDA outside of the RoW in non-forested and non-wetland habitats that may be used for cut-and-fill, laydown areas, or other temporary workspaces. These activities may result in the temporary disturbance of up to 113.2 ha of agricultural land and 3.8 ha of anthropogenic land use.

The effects hedgerows can have on abiotic conditions such as wind speed, evaporation, and soil drying (and corresponding influences on soil erosion and nutrient runoff) are most notable adjacent to the hedgerow (Forman and Baudry 1984). The loss of hedgerows will have limited effect on the environmental conditions of surrounding agricultural fields as the majority of these areas will also be lost as a result of the Project. In some areas, hedgerows contribute to an important proportion of the vascular plant diversity within the surrounding area; however, the LAA contains many wooded areas that contribute to the diversity of vascular plants in the area. The main expected loss of function associated with the loss of hedgerows within the RoW is their ability to act as wildlife corridors. Removal of hedgerows within the RoW will affect the ability of wildlife to travel between areas to the north and south of the RoW.

The Project will result in the permanent loss of approximately 4.9 ha of forest, primarily hardwood, and 3.1 ha of wetland, largely freshwater marsh. The loss of forested and wetland area within the RoW represents a loss of habitat for vascular plants and wildlife, including wildlife SAR. Several avian SAR, such as Canada warbler and eastern wood pewee, and SOCC such as pileated woodpecker, have been observed in the LAA and are known to use forested habitats. As there is no tree harvesting planned outside of the RoW, no hedgerows or forests within the PDA outside of the RoW are expected to be affected by the Project. This loss of forest represents 2.7% of forest in the LAA, and 0.2% of forest in the RAA. Although the Project will contribute to fragmentation and edge effects, these are considered minimal in consideration of the already highly fragmented landscape. There is no interior forest within the RoW or PDA; thus, the Project will not result in a reduction of interior forest. With the exception of two wetland types (freshwater marsh and softwood treed swamp), effects to vegetation communities and habitat types within the PDA are approximately proportional to their abundance within the LAA and RAA.

There is potential for the Project to result in the introduction or spread of invasive vascular plant species. The RoW is within a largely disturbed landscape that currently contains invasive species; thus, introduction of invasive species has already occurred, and the spread of invasive species within the RoW and PDA will not be a new interaction for the area. This spread of invasive species as a result of the Project will be reduced through mitigation, but will likely continue as a result of other non-Project activities that currently occur within the PDA and LAA.

With mitigation, the construction of the Project is expected to interact minimally with vascular plant SAR or SOCC. All vascular plant SAR and SOCC within the PDA but outside of the RoW will be avoided. Of the 11 butternut trees observed in the surveyed area, only one seedling is within the current RoW and will be lost as a result of the Project. Despite its national status as a SAR, butternut is considered exotic within PEI, and the loss of a single individual will not have an effect on the status of the population. The Project will also result in the loss of a single Macoun's cudweed plant, a single yellow ladies'-tresses plant, and four eastern hemlock trees ranging in size from 10 cm to 40 cm DBH, located within the RoW. The Macoun's cudweed and yellow ladies'-tresses that will be lost are the only individuals of these species that were observed in this area. The closest other known record of Macoun's cudweed is approximately 19 km from the Project, and the closest other known record of yellow ladies'-tresses is nearly 60 km from the Project (AC CDC 2016). However, both of these species typically grow in disturbed landscapes, and likely occur in other, closer locations but have simply not been recorded. Although four hemlock trees will be lost, at least 22 additional trees will be maintained in the PDA and LAA. It is not expected that the long-term survival of these species within the RAA will be substantially reduced as a result of the Project.

Construction of the Project will also result in some sensory disturbance to wildlife, including two avian SAR and five avian SOCC that have been observed within the PDA and surrounding areas. Alteration of adjacent habitats will occur through edge effects, largely through sound disturbance. These edge effects will occur in habitats that contain no interior forest and are currently highly fragmented by agriculture and anthropogenic land uses; thus, sound disturbance is not expected to be a new interaction with wildlife using these habitats. In addition, the majority of construction activities will occur outside of the breeding season for these species. With mitigation, sound disturbance is not expected to have an effect on breeding success of avian species, including avian SAR. The potential for increased predation of small mammals and herpetiles fleeing cover in response to construction noise will be temporary. In addition, it is expected to be a limited increase relative to existing conditions as the PDA crosses existing roads and large portions of the PDA are located in actively maintained farming fields where farming equipment is frequently operated.

With mitigation, construction of the Project is expected to result in adverse, low magnitude changes to vegetation and wildlife. Most of these changes will be restricted to the PDA, although sensory disturbance to wildlife will extend into the LAA. Effects will occur during a single event of long-term duration for changes to vegetation communities, wildlife habitat, and vascular plant SAR and SOCC; and medium-term duration for sensory disturbances to wildlife. Effects to vegetation communities, wildlife and vascular plant SAR and SOCC are expected to be irreversible, while sensory disturbance to wildlife will be reversible. The ecological and socioeconomic context is common as these habitats are found elsewhere in the surrounding LAA and RAA.

It is expected that the majority of Project interactions with vegetation and wildlife will occur during the construction phase, and operation will have very few interactions with vegetation and wildlife. During winter maintenance, vegetation communities and wildlife habitat may be affected by road salting and sanding. The distance where potential changes to vegetation communities resulting from the application of salt to the roadway will occur will vary depending largely on the slope of the roadside, the abiotic factors of the area, and the type of plants affected, but is typically within 10 m of the roadside edge (Transportation Research Board 1991).

The operation of the new highway will cause sensory disturbance to wildlife similar to what is currently experienced on the existing highway, although increased speeds may result in some additional noise, and is expected to result in an increase in vehicle collisions with wildlife (Section 11.3.5).

With mitigation, the operation phase of the Project is expected to result in a change to vegetation and wildlife that will be adverse and low in magnitude. These changes will extend into the LAA and some changes will occur at regular intervals (e.g., vegetation management and winter maintenance) while others, such as sensory disturbance and wildlife mortality, will occur continuously. Changes to vegetation and wildlife associated with operation will be long-term in duration and are expected to be reversible. The ecological and socioeconomic context is common as these habitats are found elsewhere in the surrounding LAA and RAA.

8.4.3 Assessment of Change in Wetland Area and Function

8.4.3.1 Project Pathways for Change in Wetland Area and Function

Construction

Construction of the Project has the potential to interact with wetland area and function through a loss of or change in wetland vegetation communities, disturbance and habitat loss for vascular plant and wildlife SAR or SOCC, soil compaction, and alteration of hydrology and hydrological-related functions both within and adjacent to the PDA. No direct wetland disturbance is planned within areas of the PDA outside of the RoW, but disturbance within the RoW can have indirect effects within adjacent areas.

Heavy machinery used during site preparation such as grubbing and excavation will remove all vegetation within wetlands and alter soils, resulting in both a loss of and change to wetlands. Soil compaction and rutting within the PDA can alter the hydrology or drainage, which may also interact with wetlands outside the PDA. If culvert installation does not allow for sufficient hydrology maintenance, upgradient wetlands could experience impoundment and edges of downgradient wetlands could slowly convert to upland. Site preparation can also result in erosion and sedimentation (considered emissions and wastes), which can negatively interact with wetlands.

Roadbed preparation will presumably result in further compaction to soils within the PDA. This compaction will result in the loss of wetland area and function within the PDA, and could further alter hydrology of adjacent wetlands, potentially resulting in a change in wetland function outside of the PDA. The installation of structures includes watercourse crossings. The watercourse crossing at Clyde River will require the removal of wetland soils, which could alter wetland function. Although the soils will be replaced, the change to wetland function could be long-lasting. During surfacing and finishing, creation of an impervious surface will remove water absorption within the road footprint, increasing the velocity of water entering wetlands downstream of the PDA and potentially altering hydrological function of downstream wetlands. This interaction will continue throughout the operation phase.

The construction of temporary ancillary elements can interact with wetlands in all of the ways described above for other construction activities, removing wetland area and function, and potentially altering wetland function outside of the PDA. The construction of the Project could lead to increased erosion and sedimentation associated with soil disturbance.

Operation

Operation of the Project has the potential to interact with wetland area and function through a change in wetland vegetation communities, loss of wildlife SAR and SOCC habitat, loss of wetland vascular plant SAR or SOCC, and alteration of hydrology.

Infrastructure maintenance includes maintenance of drainage systems, such as culverts and ditches. This kind of work can temporarily or permanently alter hydrology within the PDA and areas downstream, and lead to erosion and sedimentation.

Application of salt or sand to the roadbed for winter maintenance could enter the surrounding environment through runoff. Salt and sand are considered emissions and wastes that could affect wetlands adjacent to the PDA through change to their vegetation communities brought about by sedimentation, changes to soil and water salinity, and changes to soil fertility.

Although no herbicides will be used for vegetation control within wetlands, vegetation management could disturb wetlands where it occurs within wetlands or within 15 m of a wetland boundary. Effects could occur through direct disturbance to vegetation by machinery, changes to hydrology through rutting and compaction of soil, erosion and sedimentation, and the introduction of invasive plants.

8.4.3.2 Mitigation for Change in Wetland Area and Function

Mitigation measures relating to a change in wetland area or function include:

- Site preparation will be confined to the area required.
- Disturbance to wetlands located within the PDA but outside of the RoW will be avoided, when practicable. Temporary work spaces will be located outside of wetlands.
- Although not anticipated, clearing of wetlands outside of the RoW that may be required will occur during frozen ground conditions, when practicable, and grubbing will not occur, to reduce the permanent loss of wetland function.
- Culverts will be designed to accommodate both peak and low flows, to reduce changes to hydrology within wetlands up and down gradient of the RoW.
- Known instances of invasive vascular plant species will be removed from the site prior to the start of construction activities, to limit their spread.
- Equipment will arrive on site free of soil or vegetative debris, to reduce the potential introduction and spread of invasive plant species.
- Vehicles and equipment will be preferentially operated on previously disturbed ground to reduce the impact to wetlands.
- The size of temporary workspaces will be limited.
- Standard erosion and sedimentation control measures will be employed outlined in the PSEPP, particularly to avoid silt-laden runoff into wetlands.
- Standard dust control measures will be implemented to avoid sedimentation of wetlands outlined in the PSEPP.
- Quarried, crushed material will be used for temporary road access in and near wetlands that will not be entirely lost, to reduce the risk of introducing or spreading exotic and/or invasive vascular plant species.
- Natural regeneration will be the preferred approach to revegetation but when this is not effective a native seed mix will be used to reduce the potential for the introduction of invasive plant species.
- Loss of wetland will be compensated for as required according to a plan to be developed in coordination with, and approved by, PEI CLE.

8.4.3.3 Residual Project Environmental Effects for Change in Wetland Area and Function

The Project will result in the permanent loss of approximately 3.1 ha of wetland, largely freshwater marsh. As wetlands are planned to be avoided outside of the RoW, no additional loss of wetland area is anticipated, although temporary disturbance of up to 17.7 ha within the larger PDA could occur. This RoW loss represents approximately 3.1% of wetlands in the LAA, and 0.6% of wetlands within the RAA. With compensation, no net loss of wetland function is expected within the RAA. Thus, the loss of wetland area and wetland function will be medium-term (restricted to the period between the start of construction and the completion of wetland compensation (if required) or the return of the wetland to its pre-construction functionality). With successful wetland mitigation, the change in wetland area and function during construction will be adverse, low in magnitude, and primarily restricted to the RoW, although some hydrological changes may extend to wetlands within the LAA. Changes to wetland area and function resulting from construction will be restricted to a single event of medium-term duration, and are considered reversible with compensation. The ecological and socioeconomic context is common as similar wetlands are found elsewhere in the surrounding LAA and RAA.

Wetlands that are cleared for line of sight (during both construction and operation) but are not within the road construction footprint may experience a change in wetland function resulting from a change in vegetation (i.e., the removal of trees and some shrubs), but will not experience a loss of wetland area. If hand clearing occurs in wetlands that are not lost to road construction, the expected change in function would be primarily a change in wildlife habitat.

Sediment and erosion controls are expected to reduce the potential downstream interaction between salt and sand runoff and wetland function. The distance where potential changes to wetlands resulting from the application of salt to the roadway will occur will vary depending largely on the slope of the roadside, the abiotic factors of the area, and the type of plants affected, but is typically within 10 m of the roadside edge (Transportation Research Board 1991). With mitigation, disturbance during the operation phase will result in a change in wetland area and function that will be adverse, low in magnitude, within the LAA, occurring at regular (or slightly irregular) intervals (i.e., depending on the growth rate of the vegetation), long-term in duration, and reversible. The ecological and socioeconomic context is common as similar wetlands are found elsewhere in the surrounding LAA and RAA.

8.4.4 Summary of Residual Project Environmental Effects on the Terrestrial Environment

The residual Project environmental effects for the terrestrial environment described above are summarized in Table 8.7.

Table 8.7 Summary of Project Residual Environmental Effects on the Terrestrial Environment

Residual Environmental Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Vegetation and Wildlife	C	A	M	LAA	MT/LT	S	I/R	C
	O	A	L	LAA	LT	R/C	R	C
Change in Wetland Area and Function	C	A	M	LAA	MT	S	R	C
	O	A	L	LAA	LT	R/C	R	C

KEY
See Table 8.2 for detailed definitions.

Project Phase:
C: Construction
O: Operation

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent
NA: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
U: Unique
C: Common

8.5 DETERMINATION OF SIGNIFICANCE

8.5.1 Significance of Residual Project Effects

The construction phase of the Project will result in both temporary and permanent disturbance to vegetation communities and wildlife habitat, including wetland, within the PDA. However, with mitigation, the Project is not expected to result in a decline in abundance or change in distribution of species such that their long-term survival within the RAA is substantially reduced. As the Project is not located on federal land and no native species listed under SARA are expected to be affected by the Project (as butternut is considered exotic to PEI), the Project is not expected to result in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of SARA. Similarly, the Project is not expected to result in the non-compliance with any management plans (developed as a result of Section 65 of SARA) currently in place. It is expected that wetland loss occurring as a result of the Project will be compensated for, and therefore no unauthorized permanent net loss of function will occur. No loss of important wetland function at the RAA level is expected to occur as a result of the Project. With mitigation and environmental protection measures, residual environmental effects on the terrestrial environment during construction and operation of the Project are predicted to be not significant.

8.6 PREDICTION CONFIDENCE

Prediction confidence in the assessment of vegetation communities, wildlife and wildlife habitat is high because of the quality of the desktop and field data available and application of well-established and proven mitigation and environmental protection measures. Prediction confidence in the assessment of vascular plants (specifically SAR and SOCC) and wetlands is medium because the entire PDA has yet to be surveyed. If the results of the 2017 vegetation and wetland survey work support the results of this environmental assessment, the prediction confidence will then be high.

8.7 FOLLOW-UP AND MONITORING

Follow-up work for this assessment of environmental effects on the terrestrial environment will include completion and analysis of 2017 spring bird migration surveys, early spring and mid-summer vegetation surveys within the PDA, wetland surveys within previously unsurveyed portions of the PDA, and acoustic bat surveys within the PDA, to verify the predictions included in this assessment. No monitoring is currently suggested for the Project, but this will be re-evaluated following the completion of 2017 terrestrial surveys.

9.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON SOCIOECONOMIC ENVIRONMENT

In this chapter, potential effects related to Project construction and operation are assessed in relation to the socioeconomic environment. Accidents, malfunctions, and unplanned events such as fire and vehicle collisions are discussed in Section 11. Project environmental effects arise from the interactions between the project and socioeconomic environment and consider proposed mitigation measures. Any residual project environmental effects after the implementation of mitigation measures are evaluated for significance.

Socioeconomic environment has been selected as a VC because of the potential for interactions between the Project and the local, regional, and provincial economies. Project-related employment and purchases of goods and services may benefit the local economy, or may have negative consequences related to wage inflation or labour shortages due to increased demand.

Socioeconomic environment has also been selected as a VC because of the potential for interactions between the Project and with current and future land uses near the Project. As a result of the Project there will be a change in land use in the immediate area surrounding the Project.

9.1 SCOPE OF ASSESSMENT

9.1.1 Regulatory and Policy Setting

As discussed in Section 1.6.1, the framework for EIAs being carried out in PEI is set out in Section 9 of the PEI EPA. This does not include assessment of socioeconomic environment; however, comments from the Technical Review Committee on the Project specified that components of the socioeconomic environment be included in the EIS.

Key provincial and municipal acts and regulations that apply to the socioeconomic environment in Prince Edward Island are listed below.

- *Planning Act* – The objectives of the *Planning Act* are to provide for efficient planning and development of public services at the municipal and provincial level. The Act also provides means to resolve conflicts respecting land use and provides an opportunity for public participation in the planning process.

- Town of Cornwall Official Plan - The Town of Cornwall Official Plan guides the physical, social, and economic development of the Town of Cornwall concerning the nature, extent, and pattern of land use and development within the Town (Town of Cornwall 2014). The Town of Cornwall has developed the Official Plan under the *Planning Act*.

- *Lands Protection Act*- the Island Regulatory and Appeals Commission is responsible for administering this Act, including making recommendations to government on applications for land purchases governed by the Act. This includes land purchases of more than 5 acres.

- *Roads Act*- the alteration of a public road, including an alteration that requires the acquisition of land, is regulated under the PEI *Roads Act*.

9.1.2 Potential Environmental Effects, Pathways, and Measurable Parameters

Throughout the life of the Project (construction and operation phases only), there will be potential interactions with the socioeconomic environment, such as changes in employment levels, changes in business activities, temporary restrictions to land access, and the loss of private land. These potential interactions are assessed as effects in terms of a change in employment and economy, and a change in land use. The potential effect pathways are listed in Table 9.1 along with the associated measurable parameters, which will serve to inform the characterization of the potential residual environmental effects related to a change in the socioeconomic environment.

Table 9.1 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for the Socioeconomic Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Employment and Economy	• Change in employment and/or economy (*e.g.*, the Project will generate short-term and limited employment and business activity during Construction, and to a lesser extent during Operation). • The highway realignment will bypass the Town of Cornwall, which may result in a loss of business activity from through traffic.	• Direct employment. • Project expenditures on goods and services.
Change in Land Use	• Project activities during construction will result in temporary access restrictions. • Project activities will result in disturbance to and loss of private land.	• Loss of land for other land uses. • Loss of access (road access to property).

9.1.3 Boundaries

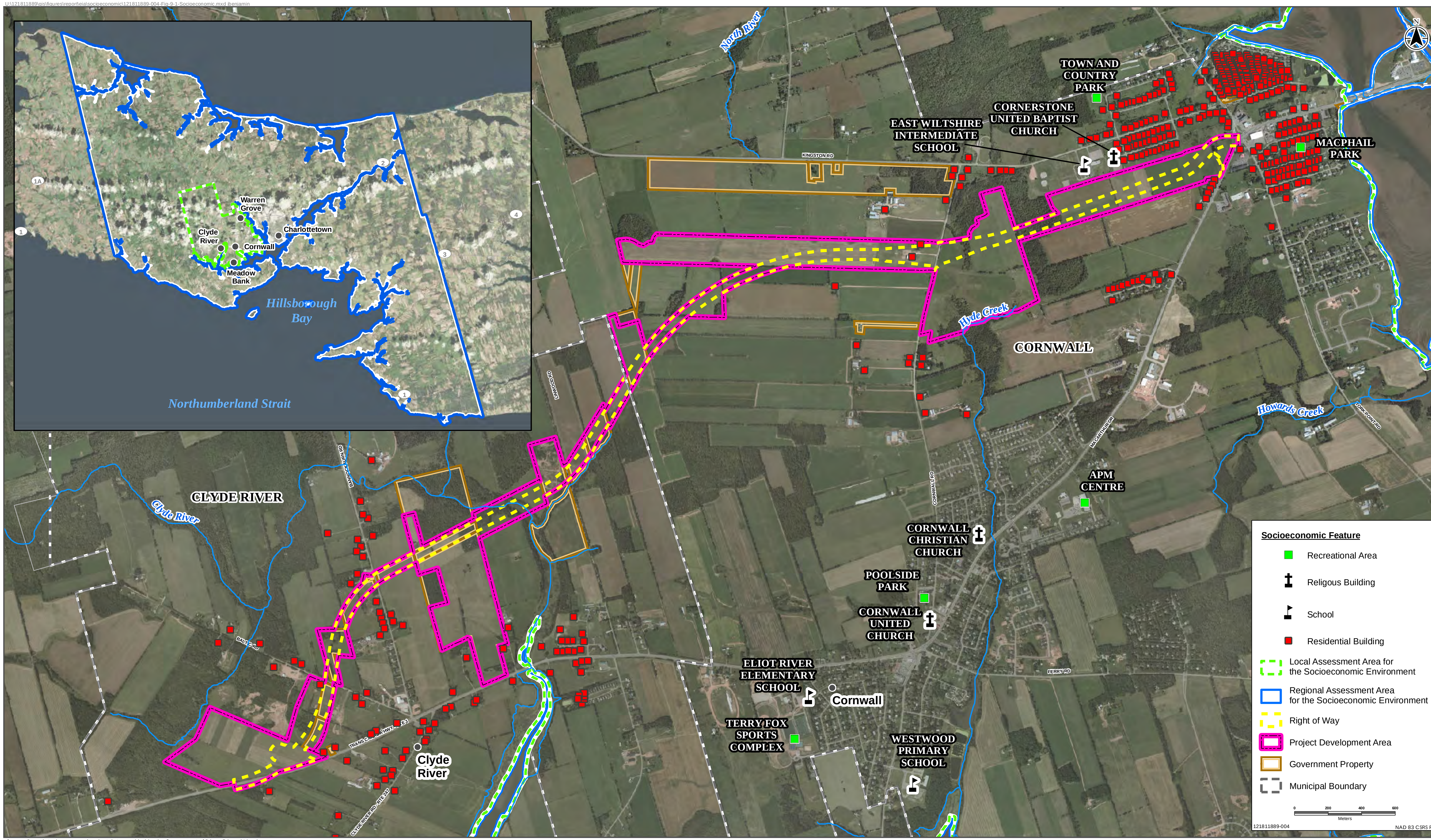
9.1.3.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the socioeconomic environment are presented in Figure 9.1 and defined below:

- Project Development Area (PDA): The PDA comprises the immediate area of physical disturbance associated with the construction and operation of the Project. The PDA includes a 7.8 km long, 61 m wide corridor, as well as interchanges, bridges, and overpasses, and properties owned by PEI TIE that may be used as borrow pits or laydown areas during construction.
- Local Assessment Area (LAA): the LAA represents the area where indirect or secondary environmental effects of the Project on the socioeconomic environment are likely to be the most pronounced. The LAA includes the PDA and the Town of Cornwall, the communities of Clyde River, Meadowbank, and Warren Grove, and the Township of Lot 31.
- Regional Assessment Area (RAA): The RAA encompasses an area that both establishes context for the determination of the significance of Project effects and is also the area within which Project-related environmental effects may overlap or interact with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). For the socioeconomic environment, the RAA includes the LAA as well as Queens County.

9.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the aquatic environment include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.



Source: Base data, imagery and project data provided by the Government of Prince Edward Island.

Socioeconomic Environment Assessment Area Boundaries

Stantec

121811889 - PEI CORNWALL PERIMETER HIGHWAY

Figure 9.1

9.1.4 Residual Environmental Effects Description Criteria

Table 9.2 provides the criteria used to characterize residual environmental effects on the socioeconomic environment.

Table 9.2 Characterization of Residual Environmental Effects on Socioeconomic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect	**Positive**—an effect that moves measurable parameters in a direction beneficial to the socioeconomic environment relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to socioeconomic environment relative to baseline. **Neutral**—no net change in measurable parameters for the socioeconomic environment relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no detectable effects. **Low**—a measurable change from baseline conditions, but within the normal range of variability; cannot be distinguished from baseline conditions **Moderate**—measurable change from baseline conditions, but unlikely to pose a serious risk or benefit to the VC or to represent a management challenge. **High**—measurable change from baseline conditions that is likely to pose a serious risk to the selected VC and, if negative, represents a management challenge.
Geographic Extent	The geographic area in which an environmental, effect occurs	**PDA**—residual environmental effects are restricted to the PDA. **LAA**—residual environmental effects extend into the LAA. **RAA**—residual environmental effects interact with those of other projects in the RAA.
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event** – occurs once. **Multiple irregular event**—occurs at no set schedule. **Multiple regular event**—occurs at regular intervals. **Continuous**— occurs continuously.
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual environmental effect restricted to the duration of the construction period or less. **Medium-term**—residual environmental effect extends through the construction period but less than the life of the Project. **Long-term**—residual environmental effect extends for the life of the Project (and beyond).

Table 9.2 Characterization of Residual Environmental Effects on Socioeconomic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases	**Reversible**—the effect is likely to be reversed after activity completion and reclamation. **Irreversible**—the effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Low Socioeconomic Resiliency**—Sparsely populated region with relatively few service centres. **Medium Socioeconomic Resiliency**—A mix of sparsely populated areas along with more populated, urban centres. **High Socioeconomic Resiliency**—Densely populated area with several urban centres.

9.1.5 Significance Definition

There are no predefined thresholds to determine the significance of residual environmental effects to the socioeconomic environment. Residual environmental effects of the Project will be assessed in the context of reasonably expected changes in the future socioeconomic environment that are anticipated or planned for by: municipal, and provincial governments; Indigenous Groups; private businesses; or households, and land users. If the residual environmental effects of the Project are adverse and not reasonably expected, they will also be assessed by the extent to which these groups can cope with the adverse residual environmental effects.

A significant residual environmental effect is one that is adverse, of high magnitude, is distinguishable from normal variability, and cannot be managed with current or anticipated programs, policies, or mitigation measures.

9.2 EXISTING CONDITIONS OF THE SOCIOECONOMIC ENVIRONMENT

This section describes existing socioeconomic conditions within the assessment areas.

9.2.1 Methods

Information on baseline conditions was primarily obtained from spatial analysis and baseline research. Baseline research included a review of statistical data sources and published reports. These published reports include a socioeconomic impact analysis and economic impact analysis commissioned by PEI TIE and conducted by MRSB (2016; 2017). These reports include information collected from interviews with stakeholders, case studies, and statistical analyses.

9.2.2 Overview

9.2.2.1 Population

The 2016 census reported a population total of 142,907 individuals in PEI. The LAA had a population of 8,479 in 2016, while the RAA had a population total of 82,017 (Statistics Canada 2013a). Table 9.3 shows the change in population from 2011 to 2016.

Table 9.3 Population 2011 and 2016, Province, RAA and LAA

Location	Population 2016	Population 2011	% Change
Provincial Total	142,907	140,204	1.9
Total RAA	82,017	77,866	5.3
Total LAA	8,479	8,077	5.0
Source: Statistics Canada 2017a			

The highest level of growth was in the RAA with a 5.3% increase in population from 2011 to 2016, higher than the national average of 5.0%. Growth within the LAA was equal to the national average and consistent with the RAA. However, the increase in population of the province as a whole from 2011 to 2016 was 1.9% which is substantially lower than growth in the LAA, RAA, and the national average.

The population of PEI is ageing, following trends throughout many provinces in Canada. Information on age collected as part of the 2016 census has not been released at the time of the preparation of this report; however, in 2011 the median age of PEI was 42.8, up 2 years from 40.8 in 2006 (Statistics Canada 2017b; 2013a; 2007). The population projections for Canada, provinces, and territories predict that the median age of PEI residents will continue to increase in small increments, with the median age becoming 46 years by 2036 (Statistics Canada 2012a).

Indigenous Population

Information from the 2016 census has not been released at the time of preparation of this report (Statistics Canada 2017b). In 2011, approximately 2% of the total population of PEI identified themselves as Indigenous people. Indigenous population data for the LAA and RAA are presented in Table 9.4.

Table 9.4 Indigenous Population

Location	Indigenous Population
Provincial Total	2,230
Total RAA	1,070
Total LAA	160
Source: Statistics Canada 2013a	

All Indigenous communities on PEI are Mi'kmaq, with two Mi'kmaq First Nations groups:

- Lennox Island First Nation
- Abegweit First Nation

The Abegweit First Nation community has three reserves in the province with a total registered population of 369. Rocky Point Reserve, is located southeast of the Town of Cornwall, within the Charlottetown census metropolitan area (CMA) and is near the LAA. In 2011, Rocky Point had a registered population of 49 people (Statistics Canada 2012b). All other reserves from both Indigenous communities do not fall within the assessment areas (AANDC 2015).

9.2.2.2 Employment & GDP

Table 9.5 provides information on PEI's Gross Domestic Product (GDP) from 2005 to 2015. The GDP of PEI has grown consistently from 2005-2015, with growth ranging from 2.7% to 6.0% and an average growth rate of 3.8% (Statistics Canada 2016).

Table 9.5 Gross Domestic Product, 2005-2015

Economic Indicator	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gross Domestic Product (millions of Canadian dollars)	4,257	4,425	4,630	4,754	4,927	5,222	5,424	5,573	5,752	5,955	6,186
Source: Statistics Canada 2016											

According to the province's 42nd annual statistical review of the economy (PEIDF 2016), GDP by industry for PEI expanded 1.5% in 2015. Leading growth sectors in the province were: real estate and rental and leasing (up by $23.0 million or 3.5%), retail trade (up by $7.7 million or 2.3%), finance and insurance (up by $7.0 million of 2.8%), construction (up by $5.9 million or 2.5%), and agriculture, forestry, fishing and hunting (up by $5.5 million of 1.8%). Sectors showing the largest declines were administrative and support, waste management and remediation services (down by $4.2 million or 3.1%), information and cultural industries (down by $2.0 million or 1.6%), and public administration (down by $1.6 million or 0.3%).

PEI has typically relied on its primary industries such as agriculture, fisheries, and tourism for the main source of its economic revenues. However, through the Island Prosperity Strategy the province is now diversifying towards new service-based industries. While primary industries still play a large role in the PEI economy, sectors such as information technology, bioscience, and aerospace are becoming major economic contributors (Government of PEI 2017). Some of the major employment sectors in PEI include:

- aerospace
- agriculture
- fisheries/aquaculture
- bioscience
- tourism
- information technology

In 2011, the labour force of the province was 78,060, the participation rate for the province was 68.4%, a small increase from 68.2% in 2006 (Statistics Canada 2013a; 2007). Between 2006 and 2011, the number of persons employed in PEI grew by 3% from 66,855 individuals to 68,640; however, the employment rate fell slightly from 60.7% to 60.1%. The province's unemployment rate also decreased during this time, increasing from 11.1% to 12.1%. This was still higher than the Canadian averages at both times, 6.6% and 7.8% respectively (Statistics Canada 2013; 2007).

Table 9.6 provides information on employment by sector for PEI as of 2011. In 2011, the main sources of employment in PEI were Other Services, which employed 20,610 individuals or 26.8% of the labour force, business services (10,110, or 13.1%), retail trade (8,860, or 11.6%), and agriculture and other resource based industries (7,690, or 10%). The lowest source of employment in the province consisted of wholesale trade (1,785, or 2.3%), and finance and real estate (2,745, or 3.6%).

Table 9.6 Employment - Industries (2011)

Sector	Experienced Labour Force by Industry in PEI (total)	Experienced Labour Force by Industry (by %)
Total Experienced Labour Force	76,950	100
Agriculture and Other Resource-based Industries*	7,690	10.0
Construction	5,520	7.2
Manufacturing	5,950	7.7
Wholesale Trade	1,785	2.3
Retail Trade	8,860	11.6
Finance and Real Estate	2,745	3.6
Health Care and Social Services	7,520	9.4
Educational Services	6,160	8.0
Business Services**	10,110	13.1
Other Services***	20,610	26.8

Notes:

* Includes the industries of agriculture, forestry, fishing and hunting; mining, quarrying and oil and gas extraction; and utilities.

** Includes industries of transportation, information and cultural services, professional services, management of companies, and administrative support.

*** Includes arts, entertainment, and recreation; accommodation and food services; public administration; and other services.

Source: Statistics Canada 2013

There are five tourism regions in PEI: North Cape Coastal Drive, Green Gables Shore, Red Sands Shore, Charlottetown, and Points East Coastal Drive. The RAA includes the Green Gables Shore, Charlottetown, and Red Sands Shore regions, and communities in the LAA are located primarily in the Red Sands Shore region. In 2016, the occupancy rate in Green Gables Shore was 50.1%, up 4.3% over the previous year. The occupancy rate of the Charlottetown region increased 3.9% to 53.3% between 2015 and 2016, and in the Red Sands region, the rate increased 6.1% to 33.7% (Tourism PEI 2015; 2016).

9.2.2.3 Traffic volume

The TCH runs directly through the Town of Cornwall, and carries both local and through traffic. The PEI TIE estimates that by 2019 traffic along the TCH will exceed 7,000 vehicles along the section west of the Meadowbank Road and 15,000 vehicles along the section east of the Meadowbank Road (MRSB 2017, Appendix G).

9.2.2.4 Land Use

The Project is in Queen's County, extending 7.8 km from the community of North River in the Town of Cornwall to the community of Clyde River. The PDA crosses a mixture of agricultural (131.0 ha), forested (10.6 ha), industrial (4.6 ha), and residential land (0.7 ha).

Over 50% of land in the Town of Cornwall is in active agricultural use, other land uses include residential and commercial. The town includes three schools and several recreational facilities, as well as many commercial businesses. The Town of Cornwall Official Plan (Town of Cornwall 2014) identifies the potential for future residential and commercial development and anticipates an in-migration of residents and commercial businesses due to affordable tax rates and land prices (MRSB 2017).

9.3 PROJECT INTERACTIONS WITH THE SOCIOECONOMIC ENVIRONMENT

The Project will interact with the socioeconomic environment through construction and operation. These interactions between the Project and the socioeconomic environment may result in a change in employment and economy and/or land use. Table 9.7 identifies the Project physical activities that might interact with the socioeconomic environment to result in the environmental effects. These interactions are indicated by check marks, and are discussed in detail in Section 9.4 in the context of effects pathways, standard and project-specific mitigation, and residual environmental effects.

Table 9.7 Potential Project-Environment Interactions and Effects on the Socioeconomic Environment

Project Components and Physical Activities	Potential Environmental Effect	
	Change in Employment and Economy	Change in Land Use
Construction		
Site Preparation	✓	✓
Roadbed Preparation	✓	✓
Installation of Structures	✓	✓
Surfacing and Finishing	✓	✓
Temporary Ancillary Elements	✓	✓
Emissions and Wastes	✓	✓
Operation		
Infrastructure Maintenance	✓	✓
Winter Maintenance	✓	✓
Vegetation Management	✓	✓
Emissions and Wastes	✓	✓

Notes:
✓ = Potential interactions that might cause an effect.
– = Interactions between the project and the Socioeconomic Environment are not expected.
NA = Not applicable
* = All Project activities requiring the presence of workers and/or expenditures.

9.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON THE SOCIOECONOMIC ENVIRONMENT

This section describes the potential interactions between the Project and the socioeconomic environment as identified in Section 9.3. Interactions between the Project and the socioeconomic environment that could result in a change employment and economy or land use were assessed for each Project phase using the identified analytical assessment techniques. Accidents, malfunctions, malfunctions and unplanned events are discussed separately in Section 11.

9.4.1 Analytical Assessment Techniques

The assessment of potential environmental effects on the socioeconomic environment was conducted using information collected from socio-economic and economic impact analyses conducted by MRSB (MRSB 2016, 2017, Appendix G), as well as other publicly available information.

The MRSB socio-economic impact analysis includes information gathered from a literature review and the input of key community stakeholders through interviews. The socio-economic impact analysis report summarizes the key findings from the interviews and literature review and includes information on transportation and traffic flow, commercial development, and residential development (Appendix G). The MRSB economic analysis includes an estimation of annual direct, indirect, and induced economic impacts on PEI as a result of construction of the Project for each year of the construction period and as a cumulative total over the construction period. The methods used to make these estimates are provided in the report (Appendix G).

9.4.2 Assessment of a Change in Employment and Economy

9.4.2.1 Project Pathways for Change in Employment and Economy

Project-associated demand for labour (direct, indirect, and induced) and goods and services will create employment and business opportunities within the LAA and RAA and will generate tax revenue for governments. Project expenditures on goods and services could generate positive economic effects through contracts with local companies in PEI. A variety of management, accounting and payroll, engineering, and construction personnel will be required during construction. These workers may be employed by PEI-based construction or engineering firms. During operation, no additional employment beyond current staff levels are anticipated.

Temporary traffic disruptions may occur along existing roadways at various points along the PDA because of construction. These disruptions may result in decreases in clientele to local businesses if these disruptions lead motorists to avoid the area.

During operation, the project is anticipated to re-direct approximately 8,100 vehicles per day that are currently passing through the Town of Cornwall. There may be a decrease in “drop-in” clientele from travelers using the new alignment TCH instead of the existing highway. Businesses may see a decrease in sales from these customers. Businesses, such as Save Easy, however, may see an increase in walking traffic once heavy truck traffic decreases.

9.4.2.2 Mitigation for Change in Employment and Economy

Project effects on employment and economy are anticipated to be largely beneficial because employment and business opportunities will be created within the LAA and RAA during all Project phases, in conjunction with taxes paid to municipal and provincial government for Project-related goods and services during construction.

Where the Project competes for skilled labour and goods and services potential exists for increased labour costs and price inflation. Because anticipated Project demands for labour and goods and services are small and short-term, the magnitude of potential adverse effects on labour costs and price inflation are anticipated to be low.

Mitigation measures related to the potential effects to local businesses include:

- Business owners were consulted prior to the start of construction
- Throughout the construction phase, the PEI TIE will communicate with landowners and interested stakeholders regarding construction activities and progress
- Standard traffic control measures will be followed
- Temporary detours will be provided if necessary

9.4.2.3 Residual Project Environmental Effects for Change in Employment and Economy

Construction

An economic impact analysis was conducted by MRSB (MRSB 2016, Appendix G). This analysis includes an estimation of annual direct, indirect, and induced economic impacts on PEI as a result of construction of the Project for each year of the construction period and as a cumulative total over the construction period. The analysis includes information on construction activities completed in 2016 and that will be conducted in 2021 which are not included in the EIS. Only the economic impacts which will occur between 2017 and 2020 are considered in this section.

The Project is expected to have a one-time construction cost of $54.15 million from 2017 to 2020 (excluding the acquisition of land and associated costs). From 2017 to 2020, the Project is expected to have a cumulative total economic impact of approximately $37.3 million contribution to the GDP of PEI, with annual impacts ranging from $12.7 million to $2.8 million (MRSB 2016). In 2015, the provincial GDP was $6,186 million. From 2017 to 2020, the cumulative federal and provincial tax revenue generated by the purchase of Project-related goods and services is estimated to range from $2.7 million to $540,000, and to total $7.4 million for the construction period.

A variety of personnel will be required during construction, who will potentially be employed by local construction and engineering firms. From 2017 to 2020, the Project is anticipated to require 452.8 full time equivalent (FTE) positions in total and 165.5 (FTE) positions at its peak in 2018. The 2011 census reported that the total construction labour force in the province was 5,520 individuals.

Due to the relatively small number to FTEs and regional expenditures on goods and services within the RAA, the Project is not anticipated to result in labour shortages or affect the supply of goods and services such that wage or price inflation occurs.

Residual environmental effects on employment and economy during Project construction are expected to be positive in direction, low in magnitude, to extend throughout the RAA, to be short-term in duration occurring continuously within moderate socioeconomic resiliency and to be reversible.

Operation

Project operation is not anticipated to require any additional employment and expenditures beyond current levels and will not result in changes to local employment levels.

A socioeconomic impact assessment was conducted for the Project in 2017 by MRSB (Appendix G). As noted in the report, although there may be a reduction in the number of drop-in customers traveling through the town via the TCH, the Town of Cornwall is of a sufficient size that the local population will sustain local businesses. In additional, signage along the new highway may be installed to inform travelers of the services offered in the town to encourage drop-in clients (MRSB 2017).

The existing TCH will be reclassified as a collector highway. This re-classification will reduce access restrictions and allow for additional access for commercial and residential developers, as well as improved access to current commercial and recreational facilities. There is potential for these reduced restrictions to result in more commercial development within the town which will benefit the local economy and may increase business at existing establishments, or allow existing establishments to grow. Residential growth in the town will also benefit local businesses (MRSB 2017).

Residual environmental effects on employment and economy during Project operation are expected to be positive in direction, low in magnitude, to be limited to the LAA, to be permanent in duration occurring continuously within moderate socioeconomic resiliency and to be irreversible.

9.4.3 Assessment of a Change in Land Use

9.4.3.1 Project Pathways for Change in Land Use

During construction, the Project will result in changes in residential, commercial, and agricultural land use within the PDA as land is acquired for the highway. This includes changes to agricultural land use including the loss of portions of property intersected by the PDA and changes or interruptions to access to portions of agricultural land adjacent to the Project. There is also the potential for sections of agricultural land to be divided by the PDA, resulting in the creation of small areas of property that are no longer feasible for agricultural use.

The Project may result in changes, disruption, or loss of access to nearby residential or commercial properties as well as the potential for loss of enjoyment to nearby properties as a result of noise, dust, and other air emissions related to construction activities. Traffic disruptions may also occur along existing roadways at various points along the PDA as a result of construction.

During construction, Project-related effects on recreational land use may include disruptions due to noise, dust, and air emissions. There may also be changes in access to areas for recreational use (*e.g.,* ATV and snowmobile use) because access to areas of the PDA may be limited for safety reasons. The construction of a watercourse crossing at the Clyde River may also result in a temporary disruption of use of the river for recreation (e.g., fishing).

During operation, there is the potential for the residents of nearby properties to experience noise and air emissions that result from operation of the Project, which could affect residential land use within the LAA. Project related noise and air emissions are discussed in detail as part of the atmospheric environment in Section 5.0.

It is not anticipated that operation of the project will result in changes to recreational use.

9.4.3.2 Mitigation for Change in Land Use

Mitigation measures relating to a change in land use include:

- Landowners will be compensated at fair market value for loss of land and/or buildings. In the event that expropriation of property becomes necessary, lands will be expropriated as per the PEI *Expropriation Act*, at fair market value. The purchase of private land will be limited to only that which is strictly necessary for the construction and operation of the Project.
- Access to lands will be maintained where possible and temporary detours will be provided, if necessary. Temporary access roads will be constructed in accordance with landowner agreements. Access to property will be maintained in the long term in compliance with Section 24 of the PEI *Planning Act*.
- Reasonable accommodation will be provided to allow agricultural operations access to adjacent lands during construction.
- Temporary ancillary facilities will not be located in sensitive habitats (e.g., wetlands and old growth forest areas).
- Construction-related fugitive road dust will be controlled through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis.
- Standard traffic control measures will be followed.
- Throughout the construction phase the PEI TIE will communicate with landowners and interested stakeholders regarding construction activities and progress.
- Permanent noise control devices installed as part of the Project will be maintained during Project operation.

9.4.3.3 Residual Project Environmental Effects for Change in Land Use

Construction activities will result in effects to land use within the RoW. Some of these effects are permanent due to property acquisition. However, these effects originate in the construction phase of the Project and will be mitigated through compensation, at fair-market value, for the acquisition of the property.

There are three buildings within the PDA which will be purchased by PEI TIE and removed prior to construction. The buildings are primarily residential dwellings, agricultural buildings and accessory structures such as garages or sheds. Any municipal or provincial permits required to remove the buildings will be obtained by the contractor carrying out the demolition and wastes generated will be disposed of at an approved facility.

To reduce the effect of the Project on nearby residential properties, measures will be implemented to control noise, dust, and air emission. Air emissions will be maintained within provincial limits and noise emissions will not exceed provincial guidelines at the closest residences, and are not expected to result in nuisance effects. Levels of noise, dust, and air emissions during operation of the Project are expected to be greatly reduced during operation of the Project. The Project will result in a reduction in through traffic along the existing highway, which runs through several residential areas. This will result in a positive effect to residents of these areas because nuisance noise, dust, and air emission will be reduced. The effects of the Project on the atmospheric environment are discussed in further detail in Section 5.0.

Traffic disruptions may occur along existing roadways at various locations along the PDA because of construction activities. These disruptions may lead to changes in access, detours, and increased wait times. Standard traffic control procedures will be implemented to reduce interruptions and maintain traffic flow. PEI TIE will provide information throughout the construction phase of the Project to potentially-affected landowners and interested stakeholders to keep them informed of construction activities and progress.

Construction activities may interact with recreational land use, and may limit access to informal recreational areas. These effects are expected to only occur during construction and should cease during operation of the Project.

Residual environmental effects on land use during Project construction are expected to be adverse in direction, low in magnitude, to be limited to the LAA, to be short term and/or permanent in duration occurring continuously within moderate socioeconomic resiliency and to be irreversible.

Residual environmental effects on land use during Project operation are expected to be positive in direction, low in magnitude, to be limited to the LAA, to be permanent in duration occurring continuously within moderate socioeconomic resiliency and to be irreversible.

9.4.4 Summary of Residual Project Environmental Effects on Socioeconomic Environment

The residual Project environmental effects for the socioeconomic environment described above are summarized in Table 9.8.

Table 9.8 Summary of Project Residual Environmental Effects on the Socioeconomic Environment

Residual Environmental Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Employment and Economy	C	P	L	RAA	ST	S	R	M
	O	P	L	LAA	P	C	I	M
Change in Land Use	C	A	L	LAA	P/ST	C	I	M
	O	P	L	LAA	P	C	I	M

KEY
See Table 9.2 for detailed definitions.

Project Phase:
C: Construction
O: Operation

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent
NA: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
L: Low Resiliency
M: Moderate Resiliency
H: High Resiliency

9.5 DETERMINATION OF SIGNIFICANCE

9.5.1 Significance of Residual Project Effects

A significant adverse residual environmental effect to the socioeconomic environment would occur if the Project results in an adverse effect that is of high magnitude, distinguishable from normal variability, and of which cannot be managed with current or anticipated programs, policies, or mitigation measures.

Project residual environmental effects on employment and economy are largely anticipated to be beneficial, creating employment and business opportunities within the RAA. Residual environmental effects of the Project on employment and economy are anticipated to be not significant.

Project residual environmental effects on land use are anticipated to be adverse; however, through mitigation these residual environmental effects are expected to be low in magnitude. Residual environmental effects of the Project on land use are not predicted to be significant.

9.6 PREDICTION CONFIDENCE

Prediction confidence is considered moderate based on available data, and proposed mitigation measures.

9.7 FOLLOW-UP AND MONITORING

No follow-up or monitoring is recommended for the socioeconomic environment VC.

10.0 ASSESSMENT OF EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Effects of the environment on the Project are associated with risks of natural hazards and influences of nature on the Project. These effects may arise due to forces of nature associated with weather, climate, climate change, seismic activity, or forest fires. Potential effects of the environment on any project are typically addressed through design and operational procedures developed in consideration of expected normal and extreme environmental conditions. Effects of the environment, if unanticipated or unmanaged, could result in adverse changes to Project components, schedule, and economic viability.

As a matter of generally-accepted engineering practice, designs and design criteria tend to consistently overestimate and account for possible forces of the environment. Engineering design, therefore, inherently incorporates a considerable margin of safety so that a project is safe and reliable throughout its lifetime. The PEI TIE will monitor any observed effects of the environment on the Project, and take action, as necessary, to repair and upgrade Project infrastructure and modify operations to permit the continued safe operation of the facility.

10.1 SCOPE OF ASSESSMENT

Potential effects of the environment on the Project relevant to conditions potentially found in PEI include:

- climate and climate change considerations, such as severe weather, including:
  - air temperature and precipitation
  - fog and visibility
  - winds
  - extreme weather events, including:
    - electrical storms
    - tornadoes
    - ice storms (e.g., sleet, freezing rain)
- seismic activity
- forest fire(s) from causes other than the Project

10.1.1 Regulatory and Policy Setting

Direction on the scoping of effects of the environment on the Project for this assessment has been influenced by previous requests from PEI CLE that future climate conditions be considered by proponents. In the request for proposals (RFP) for the Project (PEI TIE 2017), PEI TIE specifically requests that the EIA consider the potential effect of climate change on the Project.

10.1.2 Potential Environmental Effects, Pathways and Measurable Parameters

Potential resultant effects of the environment on the Project may include:

- reduced visibility and inability to maneuver construction equipment
- delays in receipt of construction material or in carrying out construction activities
- changes to the ability of workers to access the site (e.g., if a road were to wash out)
- damage to infrastructure
- increased structural loading and damage to infrastructure
- corrosion of exposed oxidizing metal surfaces and structures, perhaps weakening structures and potentially leading to malfunctions to highway light structures
- Loss of electrical power resulting in loss of lighting at night while driving on the highway

These and other changes to the Project can result in delays or damage to the Project processes, equipment, and vehicles. The effects assessment is therefore focused on the following effects:

- change in Project schedule
- damage to infrastructure

Some effects, such as damage to Project infrastructure (e.g., electrical, or piping), can also result in consequential effects on the environment (e.g., spills or other releases to the environment). These environmental effects are addressed as accidents, malfunctions, and unplanned events in Section 11.0.

10.1.3 Boundaries

10.1.3.1 Spatial Boundaries

The spatial boundaries for the assessment of effects of the environment on the Project include the areas where Project-related activities are expected to occur. For the purpose of this assessment, in PEI the spatial boundaries for effects of the environment on the Project are limited to the PDA, as defined in Section 1.1.

Where consequential environmental effects are identified, they are considered within the boundaries of the specific zone of influence of those consequences. Accidental events that could arise as a result of adverse effects of the environment (e.g., from spills or other releases to the environment) are addressed in Section 11.0.

10.1.3.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential effects of the environment on the Project include construction and operation. Construction is expected to begin August 2017. Operation of the Project is scheduled to begin in fall 2019, while construction will continue until 2020. Operation is anticipated to continue for the life of the Project. The useful service life of the Project, with applicable maintenance, is 50 years or more, into perpetuity.

10.1.4 Residual Environmental Effects Description Criteria

A significant adverse residual environmental effect of the environment on the Project is one that would result in:

- a substantial change of the Project schedule (e.g., a delay resulting in the construction period being extended by one season)
- damage to the Project infrastructure resulting in a substantial increase in a health and safety risk to the public
- damage to the Project infrastructure (e.g., a road washout or a structure failure) resulting in business interruption
- damage to the Project infrastructure resulting in repairs that could not be technically or economically implemented

10.2 EXISTING CONDITIONS FOR EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Existing conditions are described for climate (including weather), seismic history, and forest fire activity. Climate change is discussed in Section 10.3.

10.2.1 Climate

Climate is defined as the statistical average (mean and variability) of weather conditions over a substantial period of time (typically 30 years), and an accounting of the variability of weather during that period (Catto 2006). The relevant parameters used to characterize climate are most often variables measured near the Earth's surface such as temperature, precipitation, and wind, among others.

The current climate conditions are generally described by the conditions of the most recent 30-year period (1981 to 2010) for which the Government of Canada (2017) has developed statistical summaries, referred to as climate normals. The closest weather station to the Project with available historic data is in Charlottetown, PEI, located approximately 8 km east of the Project.

10.2.1.1 Air temperature and precipitation

The average monthly temperature in Charlottetown has ranged between -7.7 °C (January) and 18.7 °C (July) (Table 10.1). Extreme maximum temperature was 34.4 °C (August 1944) and the extreme minimum temperature was -30.5 °C (January 1982).

Charlottetown averages 1,158.2 mm of precipitation per year, of which, approximately 887.1 mm fell as rain and 290.4 cm as snow. Extreme daily precipitation in Charlottetown ranged from 57.2 mm (December) to 106.4 mm (October). On average, there have been six days each year with rainfall greater than 25 mm. Snowfalls with accumulation greater than 25 cm occur on average one day per year (Government of Canada 2017).

Table 10.1 Air Temperature and Precipitation Climate Normals, Charlottetown (1981-2010)

Month	Temperature (°C)					Precipitation (mm)					Mean No. of Days with							
	Averages			Extreme		Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Extreme Daily Rainfall (mm)(Year)	Extreme Daily Snowfall (mm)(Year)	Temperature (°C)				Snow (cm)		Rain (mm)	
	Max	Min	Avg	Max (Year)	Min (Year)						>=30	>=20	<=-20	<=-30	>=10	>=25	>=10	>=25
JAN	-3.4	-12.1	-7.7	15.1 (1999)	-30.5 (1982)	34.1	73.3	101	74.4 (1978)	51.8 (2009)	0	0	2.9	0.03	1.9	0.23	1.2	0.2
FEB	-2.9	-11.7	-7.3	13.3 (1976)	-29.8 (1993)	29.8	58.3	83.2	53.1 (1953)	74.4 (2004)	0	0	2.7	0	1.4	0.27	1.1	0.2
MAR	0.9	-7	-3.1	16.3 (1999)	-23.9 (1948)	44.1	44.1	86.3	44.2 (2008)	33.8 (1967)	0	0	0.43	0	1.1	0.07	1.5	0.23
APR	7.2	-1.2	3.1	24.4 (2004)	-13.6 (1995)	59.7	24.4	83.7	58.7 (1962)	38.1 (1946)	0	0.33	0	0	0.63	0.03	2	0.21
MAY	14.3	4.1	9.2	31.2 (1977)	-6.7 (1946)	87.2	3.7	91	70.4 (1990)	17.4 (1990)	0	5	0	0	0.1	0	2.7	0.53
JUN	19.4	9.6	14.5	32.2 (1944)	-1.1 (1947)	98.8	0	98.8	86.3 (1988)	0 (1943)	0.07	13.6	0	0	0	0	3.3	0.79
JUL	23.3	14.1	18.7	33.9 (1975)	3.3(2009)	79.9	0	79.9	74 (2002)	0 (1943)	0.33	25	0	0	0	0	2.3	0.64
AUG	22.8	13.7	18.3	34.4 (1944)	2 (1989)	95.7	0	95.7	94.8 (2010)	0 (1943)	0.43	24.1	0	0	0	0	2.7	0.83
SEP	18.6	9.6	14.1	31.5 (2001)	-0.6 (1950)	95.9	0	95.9	65.4 (1987)	0.4 (1989)	0.1	10.1	0	0	0	0	3.3	0.96
OCT	12.3	4.4	8.3	25.2 (2010)	-6.7 (1974)	110.3	1.7	112.2	106.4 (1967)	21.6 (1974)	0	1.1	0	0	0	0	4.2	0.83
NOV	6.3	-0.5	2.9	21.3 (1982)	-15 (1989)	93	19.2	112.5	65.8 (2005)	30.5 (1955)	0	0.07	0	0	0.37	0.03	3.3	0.6
DEC	0.5	-7	-3.3	16.7 (1950)	-28.1 (1980)	58.6	65.6	118.1	50.4 (1980)	49.7 (2004)	0	0	0.53	0	2.1	0.23	2	0.37
Annual	**9.9**	**1.3**	**5.7**	**-**	**-**	**887.1**	**290.4**	**1158.2**	**-**	**-**	**0.93**	**79.3**	**6.5**	**0.03**	**7.6**	**0.86**	**29.6**	**6.4**

Source: Government of Canada 2017

10.2.1.2 Fog and Visibility

Fog is defined as a ground-level cloud. It consists of tiny water droplets suspended in the air and reduced visibility to less than 1 km (Government of Canada 2016). "Days with fog" are days when fog occurs and horizontal visibility is less than 1 km (thick fog) and 10 km (fog) (Phillips 1990). The months with a measured increase in hours of reduced visibility (< 1 km) is between December and April (Government of Canada 2017) (Table 10.2). Days with fog in PEI are relatively low throughout the year, as the surrounding provinces act as a barrier from the southerly fog off the Bay of Fundy (Phillips 1990). The Charlottetown weather station has experienced, on average, 190.8 hours (7.95 days) per year when visibility is less than 1 km.

Table 10.2 Visibility - Climate Normals, Charlottetown (1981-2010)

Visibility (hours with)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
< 1 km	29.4	25.1	28.4	25.4	17	10.9	5.7	4.5	4.2	2.8	11.4	26.1	190.8
1 to 9 km	136.6	117.6	116.5	107	90.1	80	69.2	73	56.3	58.1	91.6	135	1130.9
> 9 km	578	534.2	599.1	587.7	636.9	629.2	669.1	666.5	659.5	683.1	617	582.9	7443.1
Source: Government of Canada 2017													

10.2.1.3 Wind

Monthly average wind speeds measured at the Charlottetown weather station range from 13.3 to 18.6 km/h (Figure 10.1). From October to February, the dominant wind direction is from the west, with winds predominantly blowing from the north during March and April, from the south during May and June, and from the southwest during July to September (Government of Canada 2017).

Maximum hourly wind speeds measured at the Charlottetown weather station range from 64 km/h to 105 km/h, while maximum gusts for the same period range from 93 km/h to 177 km/h (Government of Canada 2017). Extreme wind events are not common in Charlottetown. Over the last three decades, there have been an average of 7.9 days per year with winds greater than or equal to 52 km/h and 1.8 days per year with winds greater than or equal to 63 km/h (Government of Canada 2017).

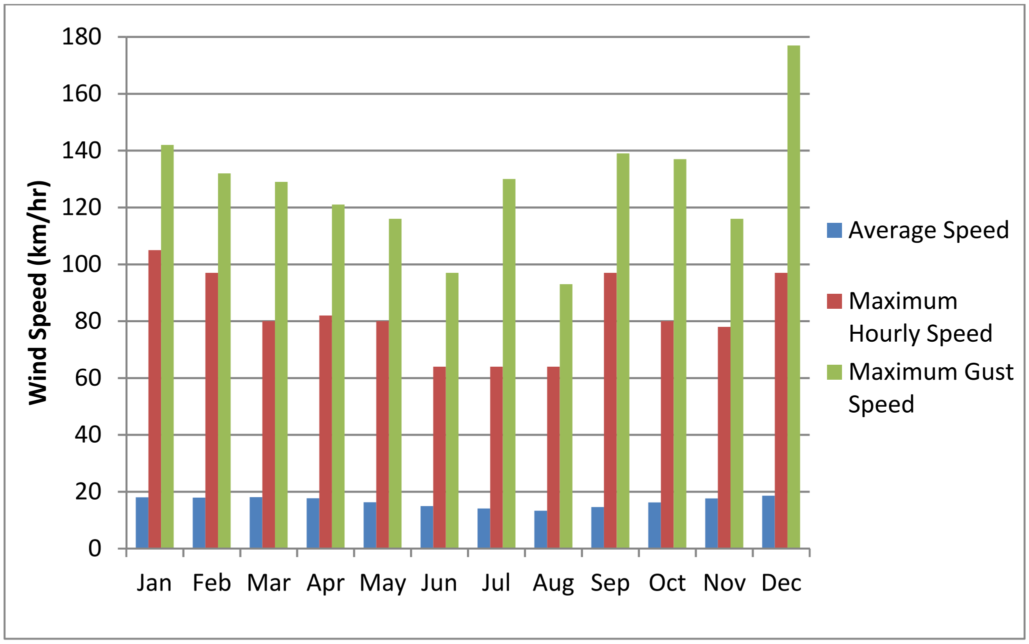


Figure 10.1 Predominant Monthly Wind Direction, Monthly Mean, Maximum Hourly and Maximum Gust Wind Speeds (1981 to 2010) at Charlottetown, PE

10.2.1.4 Extreme Weather Events

Extreme precipitation and storms can occur in PEI throughout the year, but tend to be more common and severe during the winter. Winter storms generally bring high winds and combination of snow and rain. Extreme snowfall events in the winter of 2014/2015 affected much of PEI. Some areas received as much as 551 cm of snow which broke the provincial record for the most snowfall recorded in one year. These events threatened public safety and transportation systems all across PEI (University of Prince Edward Island 2015).

Tornadoes are rare, but do occur in PEI. According to the National Research Council Canada (2011), PEI is considered part of Canada's tornado zone. Tornadoes are classified on a scale known as the Fujita scale. F0 Tornadoes (weak tornadoes) have occurred in PEI. They have winds ranging between 40 and 117 km/h, where there may be some light damage, tree branches broken off, shallow-rooted trees pushed over, and sign boards damaged (NOAA nd). These tornadoes; however, are typically the end of wind systems traveling from other provinces (Government of PEI 2010).

Thunderstorms during the early summer typically attenuate as they cross the Northumberland Strait, from New Brunswick, due to the cold waters of the Strait. As the summer progresses; however, water temperatures warm up and are able to sustain or strengthen thunderstorms as they travel across the Strait to PEI (NAV CANADA 2000).

10.2.1.5 Storm Surges and Waves

Rising sea levels and more frequent and severe weather has also brought about an increase in frequency of storm surges. Storm surges are defined as the elevation of water resulting from meteorological effects on sea level. During the past 15 years, storm surges have resulted in property destruction in all four Atlantic Provinces (Vasseur and Catto 2008). In Atlantic Canada, storm surges have been higher in coastal waters and highest in the Gulf of St. Lawrence (Bernier et al. 2006).

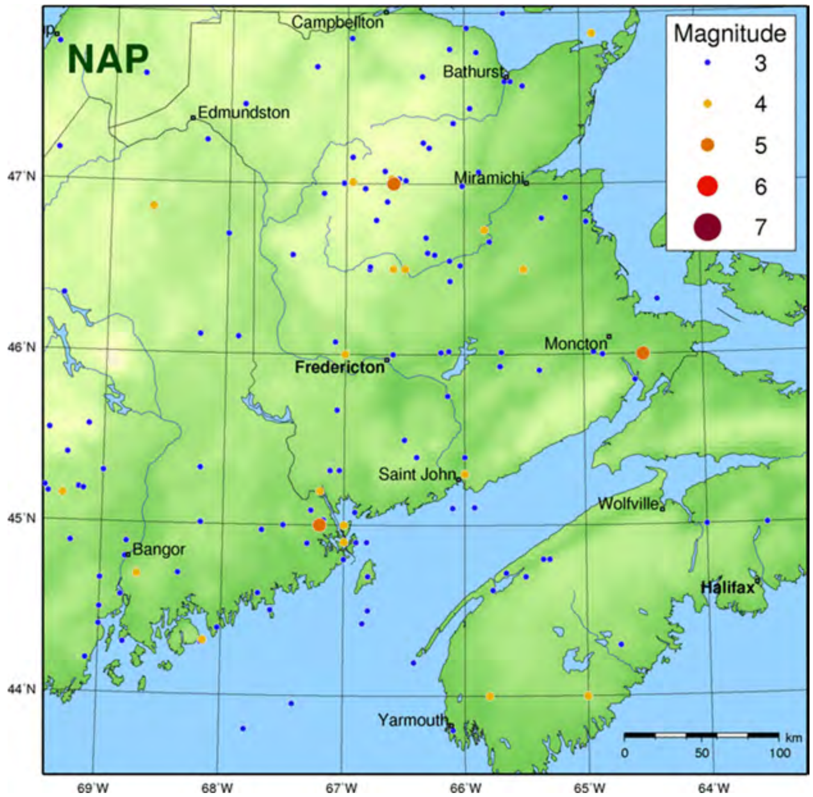
The province of PEI is vulnerable to coastal flooding as a result of storm surges and sea level rise (NRCan 2014). On January 21, 2000, a storm surge in conjunction with a high tide produced water levels of 4.23 m above chart datum in Charlottetown. There was damage to wharves, a lighthouse was removed from its foundation, and parts of downtown Charlottetown were flooded. This historic storm resulted in $20 million in damage to property and infrastructure across PEI (NRCan 2014).

10.2.2 Seismic Activity

Seismic activity is dictated by the local geology of an area and the movement of tectonic plates comprising the Earth's crust. Natural Resources Canada (NRCan) monitors seismic activity throughout Canada and identifies areas of known seismic activity in order to document, record, and prepare for seismic events that may occur.

The closest seismic zone to the Project is the Northern Appalachians seismic zone (see Figure 10.2) (NRCan 2013), which includes most of New Brunswick and extends southwards into New England and Boston. It is one of five seismic zones in southeastern Canada, where the level of historical seismic activity is low. Historical seismic data recorded throughout eastern Canada has identified clusters of earthquake activity.

PEI does not lie within a seismic zone (Government of PEI 2010); therefore, seismic activity is not further assessed.



Source: NRCan 2013

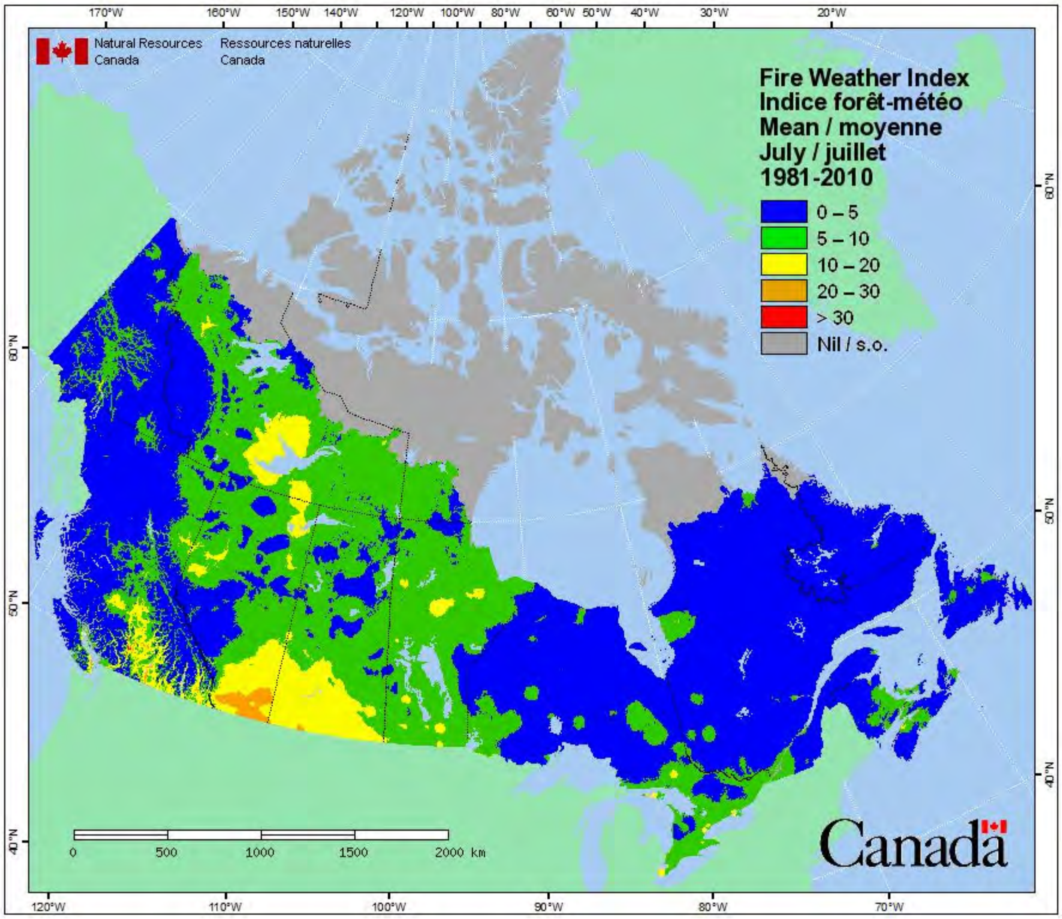
Figure 10.2 Northern Appalachians Seismic Zone

10.2.3 Forest Fires

The Fire Weather Index is a component of the Canadian Forest Fire Weather Index System. It is a numeric rating of fire intensity. It combines the Initial Spread Index and the Buildup Index, and is a general index of fire danger throughout the forested areas of Canada (NRCan 2017).

Forest fires in PEI are usually caused by burning off old grass, incinerating trash, removing brush from land clearing or conversion operations, or from equipment sparks (PEI CLE 2015).

The mean Fire Weather Index for July for PEI (i.e., normally the driest month of the year), when risk of forest fire is typically the greatest, is rated from 5-10 (for years 1981-2010) (Figure 10.3). This is in the lower range of possible risk which, at the highest range, can exceed 30 on the Fire Weather Index (NRCan 2017).



Source: Natural Resources Canada 2017

Figure 10.3 Average Fire Weather Index for the Month of July (1981-2010)

The province of PEI has 40 fire departments (Government of PEI 2007). The Charlottetown Fire Department is a composite department consisting of two stations with a career fire chief and deputy fire chief, two district volunteer chiefs, two deputy district volunteer chiefs, 80 volunteer firefighters, fire inspector, prevention officer, six permanent firefighters and six seasonal staff.

10.3 ASSESSMENT OF EFFECTS OF THE ENVIRONMENT ON THE PROJECT

10.3.1 Effects of Climate on the Project

In assessing the potential effects of the environment on the Project, both current climate and climate change must be considered.

As discussed in Section 10.2, while climate is defined as average weather conditions over 30 years, climate change is the change in climate over two or more 30 year periods (Catto 2006). The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer.

A combination of observed trends, theoretical understanding of the climate system, and numerical modeling demonstrates that global warming is increasing the risk of extreme weather events today (Huber and Gulledge 2011). Numerous climate-related conditions, linked primarily to global warming, have been observed across Atlantic Canada and globally. Many believe that these changes to the climate regime will accelerate over the next century, as has occurred with global temperatures over the past two decades (IPCC 2007). For example, increased temperatures, and changing precipitation patterns and intensity, could lead to more storm events, increasing storm intensity, rising sea levels, storm surges, and coastal erosion and flooding, all of which could affect infrastructure. Those most relevant to the Project over the next 50 to 100 years are changing precipitation patterns, and increased number and intensity of extreme storms (Vasseur and Catto 2008).

Predicting the future environmental effects of climate change for a specific area using global data sets is problematic due to generic data and larger scale model outputs that do not take into account local climate. The Canadian Climate Change Scenarios Network (CCCSN) combined data from 24 international climate models to calculate new projections for Canada (CCCSN 2009). This ensemble approach (multi-model means/medians) has been demonstrated to likely provide the best projections for climate change because using a mean or median of many models reduces the uncertainty associated with any individual model. The mean monthly temperature and precipitation values were predicted for three levels of projected climate change (low, moderate, and high) for the period of 2041-2070 compared to the baseline period of 1961-1990 (CCCSN 2009).

The overall mean annual maximum temperature increases projected, under the ‘high’ scenario, for PEI between years 2041 and 2070 range from 2.4°C to 2.7°C. The projected increases in average summer and winter temperatures for the Cornwall area are 2.4°C and 3.1°C, respectively (CCCSN 2009).

The overall mean changes in annual average precipitation (% increase) projected, under the ‘high’ scenario, for PEI between years 2041 and 2070 range from 2.66% to 5.11% increase. The projected increases in average summer and winter precipitation for the Cornwall area are 0.94% and 6.92%, respectively (CCCSN 2009).

Climate change predictions include increased temperature, and precipitation, changes in seasonal patterns, along with the possible increase in magnitude and frequency of extreme weather events (Government of New Brunswick 2017). PEI has already been affected by increased temperatures and extreme weather events, and will continue to be affected in the future as today's trends continue.

Considering the potential pathways of effects related to current climate and climate change, and based on the data reviewed, the most relevant and important pathways to assess here are the effects of severe weather on the Project.

10.3.1.1 Project Pathways for Effects of Climate on the Project

The potential effects of climate and climate change, or more specifically severe weather, must be considered during infrastructure development. Extreme temperatures and severe precipitation, fog and visibility, winds and extreme weather events could potentially cause:

- reduced visibility and inability to manoeuver equipment
- delays in construction/operation activities and delays in receipt of materials
- inability of personnel to access the site (e.g., if a road were to wash out)
- damage to infrastructure
- increased structural loading

During construction, extreme low temperatures have the potential to reduce the malleability of construction materials used in Project components (e.g., ancillary facilities) and increase susceptibility to brittle fracture.

Snow and ice have the potential to increase loadings on Project infrastructure (e.g., substation, termination site). Extreme snowfall can also affect winter construction activities by causing a delay in construction or a delay in delivery of materials, and resulting in additional effort for snow clearing and removal. Construction activities are expected to occur during the spring, summer, and fall; therefore, extreme snowfall during construction is not anticipated.

Extreme precipitation contributing to unusual flooding during snowmelt and extreme rainfall events could potentially lead to flooding and erosion. Flooding and erosion could in turn lead to the release of total suspended solids (TSS) in runoff and related environmental effects. These activities and associated ensuing events are considered accidental events, and are discussed in Section 11.0.

During operation, the PDA could experience heavy rain, snowfall and freezing rain events that are capable of causing an interruption of services such as highway closure, or a delay in travel.

Reduced visibility due to fog could make manoeuvring of equipment difficult in the early part of the day. However, these short delays are anticipated and can often be predicted, and allowance for them will be included in the construction schedule. Disruption of construction activities and delays to the schedule will be avoided by scheduling tasks that require precise movements for periods when the weather conditions are favourable.

Wind storm events could potentially cause reduced visibility (due to blowing snow or rain) and interfere with maneuvering of equipment or transporting materials or staff movements. Wind also has the potential to increase loadings on Project infrastructure and cause possible damage. During electrical storms, for example, fault currents may arise in electrical systems, potentially resulting in danger to personnel and damage to infrastructure. This can occur where Project infrastructure is close to the grounding facilities of electrical transmission line structures, substations, generating stations, and other facilities that have high fault current-carrying grounding networks. A lightning strike could also ignite a fire (see Section 11.3.2 for a discussion of fire as an accidental event).

10.3.1.2 Mitigation for Climate

To address the potential effects of climate (air temperature, precipitation, fog and visibility, winds and extreme weather events), all aspects of the Project design, materials selection, planning, and maintenance will consider normal and extreme conditions that might be encountered throughout the life of the Project. Work will also be scheduled, where feasible, to avoid predicted times of extreme weather for the safety of crews and Project infrastructure.

The effects of severe weather will be further mitigated through:

- careful and considered design in accordance with factors of safety, best engineering practice, and adherence with standards and codes
- engineering design practices that will consider predictions for climate and climate change
- inspection and maintenance programs that will reduce the deterioration of the infrastructure and will help to maintain compliance with applicable design criteria and reliability of the transmission system

Further to responsible design and construction of the Project, and ongoing inspection and maintenance, the selection of materials that are able to withstand temperatures and loads will more than adequately address climate concerns. The selection of materials that withstand potential environmental stressors related to climate will include engineering specifications that contain design specific provisions, such as:

- critical structures (e.g., intakes, power tunnel, powerhouse, tailrace, power lines) that will be constructed with resilient materials to prevent brittle fracture at low ambient temperature conditions
- critical structures (e.g., power house, power lines) that will be constructed to withstand the structural loading expected with high winds and weight associated with ice and snow
- winterization and freeze protection

10.3.1.3 Residual Environmental Effects of Climate on the Project

The potential effects of climate on the Project during the construction and operation phases will be considered and incorporated in the planning and design of Project infrastructure. This will be done to reduce the potential for Project delays and long-term damage to infrastructure, taking into account the existing and predicted climate conditions. Inspection and maintenance programs will reduce the deterioration of the infrastructure and will help to maintain compliance with applicable design criteria and reliability of the highway. Significant residual adverse effects of climate on the Project, or interruption to the Project schedule, are not anticipated.

10.3.2 Effects of Forest Fires on the Project

10.3.2.1 Project Pathways for the Effects of Forest Fires on the Project

The effects of forest fire on the Project may include:

- reduced visibility and inability to manoeuver construction and operation equipment due to smoke
- delays in receipt of materials and supplies (e.g., construction materials) and in delivering products
- changes to the ability of workers to access the site (e.g., if fire blocks access to transportation routes)
- damage to infrastructure
- loss of electrical power resulting in reduced visibility at night

10.3.2.2 Mitigation for Forest Fires

In the event of a forest fire in close proximity to Project components there is potential risk of damage to exposed Project infrastructure.

If a forest fire were to break out in direct proximity to the Project, emergency measures would be in place during construction and operation to quickly control and extinguish the flames prior to contact any flammable structures (i.e., wood). Project personnel would conduct an immediate assessment of the fire scene and risks associated with containing any spread, and extinguishing the fire. If deemed safe, site personnel would attempt to contain and extinguish the fire. Even if Project personnel are able to contain and extinguish the fire, site personnel would immediately notify the local fire department and give details of the fire.

If warranted by risk to personal safety, staff would be evacuated to a safe area and would be prepared to assist firefighters if necessary. The crew member would direct firefighters and give detailed routing to the closest possible access point(s) at which a fire suppression operation can be initiated and, if necessary, shall station a person to direct the firefighters to the best access point(s).

10.3.2.3 Residual Environmental Effects of Forest Fires on the Project

Project structures will be constructed primarily of asphalt, concrete and steel, which are not typically affected by fire, and the majority of materials handled during construction and operation are not flammable.

If a forest fire were to occur in direct proximity to the Project, emergency measures would be in place to quickly control and extinguish the flames prior to contact with Project components. In addition, the cleared safety buffer zone established around Project components further decreases the likelihood of a forest or a brush fire causing substantive damage to the Project. Although there is potential for natural forest fires to occur in or near the PDA, significant residual adverse effects of forest fires on the Project, or interruption to the Project schedule, are not anticipated.

10.4 DETERMINATION OF SIGNIFICANCE

The effects of the environment on the Project are considered in all infrastructure decisions, including the design, construction and operation of the Project. The Project will be designed, constructed and operated to maintain safety, integrity and reliability in consideration of existing and reasonably predicted environmental forces in the PDA. Given the mitigation measures described above, there are no environmental attributes that, at any time during the Project, are anticipated to result in:

- a substantial change to the Project construction schedule (e.g., a delay resulting in the construction period being extended by one season)
- a substantial change to the Project operation schedule (e.g., an interruption in servicing such that production targets cannot be met)
- damage to Project infrastructure resulting in increased safety risk

The PEI TIE will use an adaptive management approach in its activities throughout the life of the Project to monitor any observed effects of the environment and adapt (e.g., repair/replace) the Project infrastructure or operations as needed. Accordingly, the residual adverse effects of the environment on the Project are rated not significant.

11.0 ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS

This section provides an assessment of selected accidents, malfunctions, and unplanned events potentially associated with Project components and activities that, if they occurred, could result in adverse environmental effects.

11.1 APPROACH

In this section, potential accidents, malfunctions, and unplanned events that could occur during any phase of the Project are described and assessed. The focus is specifically on credible accidents that have a reasonable probability of occurrence, and for which the resulting environmental effects could potentially be significant.

The general approach to assessing the potential environment effects of the selected scenarios involve:

- consideration of the potential event that may occur during the life of the Project, including its likelihood of occurrence
- description of the safeguards established to protect against such occurrences
- consideration of the contingency or emergency response procedures applicable to the event
- significance determination of potential residual adverse environmental effects

Criteria used for determining the significance of adverse residual environmental effects with respect to accidents, malfunctions, and unplanned events generally relate to effects on the sustainability of biological and human environments. Where applicable, significance criteria and definitions are the same as those for each VC.

11.2 IDENTIFICATION OF KEY ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS

The following accidents, malfunctions, and unplanned events have been selected for consideration in this assessment and are described in greater detail in the following sections:

- Erosion and Sediment Control Failure: The temporary failure or loss of effectiveness of erosion and sedimentation control measures that may release sediment into the aquatic environment or result in soil erosion.
- Fire: Consists of a fire in a Project component. The focus is on the consequence, and not the mechanism by which it occurs.
- Hazardous Materials Spill: Spills of fuel, petroleum products, and/or other chemicals used on site or in Project components.

- Vehicle Collison: Project-related vehicle accidents that could occur on road transportation network.
- Wildlife Encounter: Encounters by Project-related workers or the general public with wildlife during construction or operation, including wildlife collisions.

VCs in Section 4.3.4 with reasonable potential to interact with these scenarios causing adverse environmental effects include (Table 11.1):

- atmospheric environment
- aquatic environment
- water resources
- terrestrial environment
- socioeconomic environment

Table 11.1 Potential Interactions between Project Activities and Accidents, Malfunctions, or Unplanned Events

Accident, Malfunction, or Unplanned Event	Atmospheric Environment	Aquatic Environment	Water Resources	Terrestrial Environment	Socioeconomic Environment
Erosion and Sediment Control Failure		✓		✓	
Fire	✓	✓		✓	✓
Hazardous Material Spill		✓	✓	✓	✓
Vehicle Collision					✓
Wildlife Encounter				✓	✓

Interactions between Project activities and selected accidents, malfunctions, and unplanned events are not expected to occur for other VCs.

While not assessed here, the discovery of heritage resources on site during construction will be discussed in the PSEPP. A contingency plan for the discovery of a heritage resource will also be included in the PSEPP.

11.3 ASSESSMENT OF ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS

11.3.1 Erosion and Sediment Control Failure

Erosion prevention and/or sediment control failure can occur during construction activities due to the exposure of soil from clearing, excavation of land, or failure of planned controls. If it were to occur, it would most likely happen due to site clearing, grubbing, and grading during the construction phase of the project.

This scenario has the potential to interact with the aquatic or terrestrial environment, as failure could result in the unintended erosion of land and/or the release of silt into the surrounding aquatic environment. An accidental release of sediment or sediment-laden water may adversely affect a watercourse or wetland, or another receiving environment outside of the PDA.

11.3.1.1 Risk Management and Mitigation

For the implementation of erosion and sediment control measures, the focus is on proper installation, maintenance, and inspection to avoid the potential for failure. Erosion prevention measures are to be implemented during construction, if necessary, to reduce or eliminate the likelihood of land erosion and resulting sedimentation of watercourses.

Erosion controls may include:

- reducing the quantity of open ground/exposed soils on site
- re-vegetating or re-seeding exposed areas
- covering exposed areas with geotextile or mulch until vegetation is established (where possible)
- use of riprap where erodible soils may be present (e.g., steep slopes along the right of way)

Sediment controls may include:

- silt fencing – used along contours of exposed land to capture sediment contained in runoff
- silt curtains – used within and along the stream crossing to prevent intrusion of sediment into Clyde River
- wattles – used on slopes perpendicular to the direction of flow to lessen runoff velocities and capture sediment runoff
- settling ponds – used to capture large volumes of runoff and retain the runoff for a period of time to allow for settling of sediment
- coffer dams – used to allow construction work below the waterline after the area has been pumped dry
- diversion ditches – used to redirect surface water away from an area by directing it through a shallow ditch

- tap drains – used to redirect surface and groundwater away from an area by directing it through a pipe
- french drains – used to redirect surface and groundwater away from an area by directing it through a gravel or rock-lined trench

The use of these measures will be reviewed during the detailed engineering phase of Project design. Chosen measures will be installed as per the PSEPP and undergo routine inspection, most importantly before and after rainfall events. In the unlikely event that a failure of one of these measures occurs and silt from the Project site reaches a water source, efforts will be made to control the dispersion of sediment and isolate the affected area from unaffected habitat prior to repairing the source of the failure.

11.3.1.2 Potential Residual Environmental Effects and their Significance

If a failure of an erosion prevention and/or sediment control measure were to occur, the aquatic or terrestrial environments may be affected as a failure could result in the unintended erosion of land or the release of silt into the surrounding environment. The worst case involving a sediment control failure would be the accidental sedimentation of a wetland or watercourse/water body.

In consideration of the mitigation to be implemented and the monitoring, inspection, and response measures to be undertaken, the residual adverse environmental effects of an erosion or sediment control failure on the aquatic environment or the terrestrial environment during all Project phases are rated not significant. This determination is made with a high level of confidence given the known and proven techniques and response procedures to be implemented to prevent or respond to an erosion and sediment control failure. However, in the unlikely event that a protected species was harmed, it could represent a significant adverse environmental effect. A significant effect arising from this possibility is considered unlikely.

11.3.2 Fire

There is potential that a fire could occur during Project activities. A fire affecting Project components would likely involve a vehicle or other heavy equipment used during construction and operation. It is also possible that Project-related machinery could ignite a fire or nearby combustible materials (e.g., grass, brush, trees).

This scenario has the potential to interact with the atmospheric, terrestrial, aquatic, and socioeconomic environments. A fire could result in damage to equipment and property, damage to land and vegetation, mortality of wildlife, release of chemical or silt laden water into the surrounding environment, and smoke emissions.

11.3.2.1 Risk Management and Mitigation

The following mitigation measures will be applied to reduce the probability of a fire and any associated adverse effects:

- vehicles and equipment on-site will be equipped with fire extinguishers sized and rated as appropriate
- Project staff will be trained in the use of fire extinguishers and will be familiar with the location of the nearest extinguisher
- vehicles are to avoid parking in areas with long grass to minimize the risk of fire caused by the heated vehicle undercarriage, and vehicles will not be allowed to idle when not in use (except for periods of extreme cold weather)
- waste that may be soaked with flammable materials (i.e., oily rags) will be stored in appropriate containers, kept away from flammable materials, and disposed of in an appropriate and timely manner

Fire response activities will be carried out in accordance with the PSEPP. As the Project location is not remote, local emergency response services are available nearby in short delay. In the unlikely event that a fire does occur, Project staff will contact emergency response services immediately.

Project staff on-site will be at a high level of training and readiness. Community and provincial emergency response crews will be called in to provide response to fire threats.

11.3.2.2 Potential Residual Environmental Effects and their Significance

If fire were to occur, there is potential for an effect on the atmospheric, terrestrial, and aquatic environments through smoke and destruction of habitats and resulting runoff, and any loss of infrastructure or equipment may have an effect on the socioeconomic environment. As portions of the PDA are within wooded areas, fire prevention and rapid extinguishing of fire, if it were to occur, is essential to reduce effects to the atmospheric, terrestrial, and aquatic environments and prevent loss of infrastructure.

With planned mitigation and response procedures, the occurrence of a widespread fire is unlikely. Thus, in consideration of the low likelihood of a fire, the mitigation to be implemented, and the response measures to be undertaken, the residual adverse environmental effects of a fire on the aquatic environment, terrestrial environment, atmospheric environment, or socioeconomic environment during all Project phases are rated not significant. This determination is made with a high level of confidence given that much of the PDA is not forested and the proximity of emergency response services in the event of a fire. However, in the unlikely event that a fire was widespread, there is potential to result in wildlife mortality or destruction of sensitive habitats, which could be considered a significant environmental effect on the terrestrial environment if species at risk were to be affected. A significant effect arising from this possibility is considered unlikely.

11.3.3 Hazardous Material Spill

A hazardous material spill can occur in any environment where fuels, lubricants, and hydraulic fluids are used or stored. Hazardous materials may be used during both construction and operation of the Project. Potential scenarios involving the release of hazardous material would most likely be the rupture of a hydraulic line or loss of fuel from a vehicle.

This scenario has the potential to interact with the terrestrial, aquatic, and socioeconomic environments, as well as with water resources. A hazardous material spill could result in surface water contamination, adverse effects to the aquatic environment, adverse effects to wetlands, and the ingestion/uptake of contaminants by wildlife.

11.3.3.1 Risk Management and Mitigation

Response to a hazardous material spill will be carried out as outlined in the PSEPP, including mitigation and procedures for spills within the wellfield protection zone. PEI TIE has a Spill Response Plan which includes procedures to prevent and respond to a spill, including:

- relevant staff will be trained in the timely and efficient response to a hazardous material spill
- PEI TIE will follow their contingency plan for Fuel and Hazardous Materials Spills and will ensure that the Canadian Coast Guard Maritimes Regional Office's Environmental Emergencies 24-hour report line at 1-800-563-9089 is notified where required, according to the contingency plan
- hazardous materials will not be stored on-site in large quantities, and will use secondary containment (e.g., drip trays)
- preventative measures, including routine vehicle inspections and buffers surrounding sensitive areas, will be implemented

In the unlikely scenario of a hazardous material spill reaching a body of water or other nearby sensitive area, immediate measures will be taken to stop the spill and isolate the affected area as soon as possible. An assessment of the affected area will be conducted and remediation will be completed as required.

11.3.3.2 Potential Residual Environmental Effects and their Significance

Depending on the quantity and type of material released and the location of the spill, a hazardous material spill could potentially affect water resources and components of the terrestrial and aquatic Environments. Remediation efforts may also have an effect on the socioeconomic environment (e.g., demand for emergency services). The worst case for a land-based hazardous material spill would likely be a loss of petroleum hydrocarbon product or chlorinated solvent within a wellfield protection zone. As a hazardous material spill could affect public health and/or harm wildlife, efforts will be focused on prevention measures. In the unlikely event that a spill occurred, it would be expected to be a small quantity, and rapidly contained and cleaned up.

Given the expected limited spill volume, the low likelihood of large spill scenarios, and anticipated effectiveness of response plans (including spill containment), it is assumed that none of these spills would result in a release to adjacent properties.

In consideration of the mitigation and response measures to be undertaken, the residual adverse environmental effects of a hazardous material spill on the aquatic environment, terrestrial environment, socioeconomic environment, or water resources during all Project phases are rated not significant. This determination is made with a high level of confidence given the known and proven techniques and response procedures to be implemented to prevent or respond to a hazardous material spill. However, in the unlikely event that a protected species was harmed, it could represent a significant adverse environmental effect. A significant effect arising from this possibility is considered unlikely.

11.3.4 Vehicle Collision

During the construction phase of the Project, various vehicles will be in motion around the Project site and there is the potential for a vehicle collision to occur, including a vehicle-to-vehicle collision, vehicle-to-pedestrian collision, or vehicle collision with surrounding private property or Project infrastructure. A vehicle collision may also occur by the motoring public during the operation phase. If a vehicle collision were to occur, loss or damage to a vehicle, equipment or Project infrastructure could affect the socioeconomic environment. Injury to humans and loss of life could also occur. There is also potential for fire and hazardous materials to be released into the environment—these latter aspects are addressed in previous sections.

11.3.4.1 Risk Management and Mitigation

The following mitigation measures will be applied to reduce the probability of a vehicle collision and any associated adverse effects:

- traffic control measures will be implemented, as needed, to reduce the likelihood of a vehicle-to-vehicle or vehicle-to-pedestrian collision
- strict security measures will be in place during construction to prevent the general public from the work site, to avoid a vehicle-to-pedestrian collision
- Project staff will operate vehicles with due care and attention while on-site
- Project staff will be appropriately licensed to operate vehicles on-site
- vehicles are to observe traffic rules and trucks will use only designated truck routes
- if a collision does occur, Project staff are to immediately phone local emergency services

If a vehicle collision results in a hazardous material spill or fire, a hazardous material spill response (see Section 11.3.3) or fire response (see Section 11.3.2) must be implemented in addition to the outlined vehicle collision response.

11.3.4.2 Potential Residual Environmental Effects and their Significance

The most likely effect of a vehicle accident during construction would be the damage of a vehicle, damage to infrastructure, and potential work stoppage. During construction, it is anticipated that vehicle speeds on site will be low and a substantive collision is thus considered to have low probability. During operation, the worst case involving a vehicle collision would most likely involve loss of life of a life or the release of a hazardous material, but given that the very nature of the Project is to improve traffic flow and public safety in this dangerous stretch of highway, the probability of a serious vehicle collision would be expected to be less than currently.

In consideration of the mitigation and response measures to be undertaken, the residual adverse environmental effects of a vehicle collision on the socioeconomic environment during all phases of the Project are rated not significant. This determination is made with a high level of confidence given the planned mitigation and the very nature of the Project that is intended to improve public safety. A vehicle collision resulting in a serious injury or loss of life for a Project employee or member of the public could be considered in a significant environmental effect. However, since the Project is intended to improve the safety of the motoring public compared to currently, such an accident is considered less likely to occur than currently.

11.3.5 Wildlife Encounter

As sections of the Project area are within potential wildlife habitat, an encounter with wildlife during Project construction and operation is possible. As the Project construction and operation phases require the use of vehicles and other maintenance equipment, there is potential for a wildlife collision with this equipment, representing an interaction with the terrestrial environment.

The worst case involving a wildlife encounter would be the death of a listed wildlife species due to a collision with a vehicle. Additionally, if a vehicle accident were to occur, loss or damage to a vehicle, equipment, private property, or Project infrastructure could affect the socioeconomic environment.

11.3.5.1 Risk Management and Mitigation

To reduce the likelihood of contact with or harm to wildlife species, the following mitigation measures will be applied:

- firearms are prohibited on the Project site
- food waste must be removed from the work area and disposed of off-site
- wildlife will not be harvested, harassed, harmed, or fed by PEI TIE personnel and contractors
- site clearing will be completed outside peek breeding bird months (May 1 to August 31) to avoid critical life stages, where possible

11.3.5.2 Potential Residual Environmental Effects and their Significance

A wildlife encounter with a Project component could involve a Project vehicle striking a wildlife species. A wildlife encounter could have an effect on the socioeconomic environment if damage to Project infrastructure or vehicles were to occur as a result. However, in the event of a wildlife encounter that causes the death of an individual, it is not expected to result in population-level changes; therefore, the effect on the terrestrial environment is considered low.

A wildlife encounter with a listed species at risk that results in its death would be of overall greatest concern and could be considered a significant environmental effect, but such an encounter is unlikely to occur.

In consideration of the mitigation and response measures to be undertaken, the residual adverse environmental effects of a wildlife encounter on the terrestrial environment or the socioeconomic environment are rated not significant. This determination is made with a high level of confidence because of the low likelihood of a listed wildlife species being affected by the Project.

11.4 DETERMINATION OF SIGNIFICANCE

PEI TIE will be developing a PSEPP to prevent and efficiently respond to accidents, malfunctions, or unplanned events. Given the nature of the Project and credible accident and malfunction scenarios, and proposed mitigation and response planning, the residual adverse environmental effects of all Project-related accidents, malfunctions, and unplanned events on all potentially affected VCs during all phases of the Project are rated not significant, with a high level of confidence.

12.0 CUMULATIVE ENVIRONMENTAL EFFECTS

12.1 INTRODUCTION

This chapter identifies projects or activities (associated with other undertakings) with residual environmental effects that could interact cumulatively with the residual environmental effects of the Project. Cumulative environmental effects include changes to the environment that are caused by a project activity in combination with other past, present, and future human actions or projects. An assessment of cumulative environmental effects was conducted for the Project at the request of PEI CLE. Cumulative environmental effects are typically assessed for projects where:

- the Project is assessed as having residual environmental effects
- the residual environmental effects overlap and therefore, could act cumulatively with residual environmental effects of other past, present, or reasonably foreseeable future physical activities

The environmental effects of past and present projects or activities have been considered in the description of existing conditions. For example, noise emissions produced by roadways, such as Cornwall or Bannockburn Roads, have been considered in the baseline acoustic environment and are considered in the assessment of Atmospheric Environment (Section 5).

Past and present activities include other linear developments (such as roadways, transmission lines); suburban development (including Cornwall Business Park, Northgate subdivision and Fulton Drive subdivision), and agriculture (pasture and row crops).

Future projects and activities are considered if they are reasonably foreseeable with defined construction schedules and enough project details to allow for meaningful assessment; are currently undergoing an environmental assessment; or are currently going through a permitting process. There were no current or future projects in the vicinity of the project (North River to Clyde River) which were reasonably foreseeable at the time of reporting.

12.2 DESCRIPTION OF CUMULATIVE INTERACTIONS

This section describes the past, present, and future projects and activities, their residual environmental effects, and the potential to overlap spatially or temporally with the Project.

12.2.1 Other Linear Developments

Other linear developments include roads, power transmission infrastructure, and other corridors which are present in the area near the Project.

The project crosses several existing roadways. These are mostly less travelled rural and local roads. Currently, there is one asphalt resealing project planned in the area (PEI TIE 2017). Recently completed linear projects include the infrastructure upgrades and two new roundabouts to address safety along the TCH between Popular Island and Maypoint Road intersection in 2016. Work in North River to install a new roundabout and infrastructure upgrades to address safety concerns between the North River Intersection and the Popular Island roundabout have recently just started and will be completed prior to initiation of the Project.

The transmission line nearest to the Project is the high-voltage line from West Royalty to Bedeque (Y-109), situated 6 km from the Project (PEI Energy 2012).

The presence of other roads or transmission line corridors in the area has potential for limited adverse effects on the environment including fragmentation and loss of habitat, and direct mortality of wildlife through vehicle strikes and strikes with transmission infrastructure.

Potential residual environmental effects associated with the presence of linear features includes increased human access to remote areas (e.g., vehicle/ATV access along transmission lines), fragmentation and loss of wildlife habitat, occasional disturbance from ongoing maintenance, and potential increases in GHGs, noise, or atmospheric emissions.

12.2.2 Suburban Development

Suburban development activities in the area are common and ongoing with land use transitioning from forested, agriculture, or undeveloped land, to suburban development. Activities occur throughout the year and consist of clearing, grubbing, and grading private lands. Local streets and related infrastructure (e.g., water, sewer) are built to support the residential developments, including a number in or around the Town of Cornwall, North River, and East Wiltshire.

Suburban activities have the potential to result in the direct removal of terrestrial habitat and plant communities, and increased nutrients to surface water (i.e., runoff). Suburban development can result in the crossing of watercourses, which may lead to sedimentation and alteration of physical habitat units.

Construction activities and future development in the Town of Cornwall are anticipated to result in positive social and economic changes in the region due to increased economic activity. This economic activity could result in modest increases in property values, increased demand for products and services, and increased tax revenues for municipal governments and the province.

12.2.3 Agriculture

Agriculture, including pasture land and crop land, occupies approximately 58% of the 10 km area around the Project (i.e., the RAA). Historical and current agricultural development in these areas have likely resulted in the direct removal of terrestrial habitat and plant communities, increased nutrients to surface water (i.e., runoff), increased nutrients to groundwater (i.e., nitrates), and potential increases in GHG, noise, or atmospheric emissions (i.e., dust). The development of lands for agricultural uses has likely decreased the diversity of vegetation and wildlife through the creation of homogenous habitats.

12.3 ASSESSMENT OF CUMULATIVE ENVIRONMENTAL EFFECTS

This section describes the potential cumulative environment effects between the VCs identified for the Project and other undertakings or activities, discussed in Section 12.2.

Table 12.1 highlights the potential for interactions between the residual environmental effects of the Project and the existing or future physical activities identified. These interactions are described in further detail below. Interactions between the Project and the remaining VCs are not anticipated to result in residual environmental effects, therefore, an assessment of cumulative environmental effects for those VCs has not been conducted.

Table 12.1 Potential Cumulative Environmental Effects

Planned and Future Activity	Atmospheric Environment	Aquatic Environment	Water Resources	Terrestrial Environment	Socioeconomic Environment
Linear Developments	✓	✓	-	✓	✓
Suburban Development	-	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓

12.3.1 Cumulative Environmental Effects on the Atmospheric Environment

Air Quality

During construction the Project has the potential to result in air contaminant emissions, mainly dust generation. Mitigation will be implemented for these potential effects (Section 5.4.2.2), including conducting regular maintenance on all machinery and equipment, road watering on an as-needed basis, and reducing haul distances to disposal sites.

Other undertakings in the area, such as other linear developments or agriculture, have potential to generate airborne dust and release combustion gases to the atmosphere. There are no other linear development projects expected to occur at the same time as the construction phase of the Project; therefore, would not contribute to overlapping effects with the Project. Agricultural activity has potential to cause increased dust emissions; however, as the generation of airborne dust is primarily a concern during Project construction, overlap with agricultural activities is expected to be short-term.

Other future projects would be subject to approvals and permits to determine the acceptability of their environmental effects and outline any required mitigation. Therefore, cumulative environmental effects between the Project construction and other linear developments and agricultural activities on air quality are not expected to be substantive.

Greenhouse Gases

Potential changes in GHGs may result from fuel combustion in heavy equipment and trucks during construction of the Project. Mitigation (Section 5.4.3.3) including, using construction equipment that is well maintained and reducing haul distances to disposal sites will be implemented for these potential effects. During operation, the Project is expected to reduce emissions, therefore, having a positive effect on GHG emissions in PEI.

Other linear developments and agricultural activities have the potential to result in similar environmental effects as the Project. It is unlikely that future activities would occur during the construction phase of the Project as no other developments are known at this time. Other linear developments would be subject to approvals and permits which would include required mitigation. Agricultural activities in the area are expected to be ongoing and remain consistent for the foreseeable future; therefore, agricultural activities were likely captured in baseline conditions.

Considering the positive net change on GHG emissions in the province resulting from the Project, cumulative environmental effects between the Project and linear developments and agricultural activities on GHGs are therefore not expected to be substantive.

Sound Quality

Project-related noise may be generated during construction from heavy equipment and during operation from vehicle traffic. Mitigation (Section 5.4.4.2) will be implemented for these potential effects, including restricting construction to daylight hours, establishment of a noise complaint system, and installation of a noise berm (e.g., planned near the Fulton Drive subdivision).

Other linear developments and agricultural activities have the potential to act cumulatively with sound quality. Sound pressure levels associated with other linear developments are expected to be subject to approvals and permits which would determine the acceptability of their environmental effects and outline required mitigation to reduce or eliminate adverse environmental effects. Agricultural activities in the area are expected to be ongoing and remain consistent for the foreseeable future; therefore, agricultural activities were likely captured in baseline conditions.

Other future projects would be subject to approvals and permits to determine the acceptability of their environmental effects and outline any required mitigation. Cumulative environmental effects between the Project and linear developments and agricultural activities on sound quality are therefore not expected to be substantive.

Lighting

Construction activities are planned for the daytime hours, at times when daylight is sufficient to light up the work areas. Lighting from the Project may be needed during Construction for safety reasons – for example, to illuminate areas at night to prevent vehicles from inadvertently using the wrong travel lanes, where the new highway intersects with existing roadways. Lighting during operation originates mainly from the light standards as described in Section 5.4.5 and from the vehicle traffic.

Mitigation (Section 5.4.5.2) will be implemented for these potential effects, including restricting construction to daylight hours, using full cut-off light fixtures on the highway where practical, installing lighting poles at locations so that the lights are not directed toward oncoming traffic, and adhering to the guidelines set out in TAC's Guide for the Design of Roadway Lighting. With the planned mitigation, the potential effects on lighting and nighttime sky at nearby sensitive receptors is not expected to be substantive.

Other linear developments, industries and agricultural activities have the potential to act cumulatively with Project lighting. Lighting associated with other linear developments is expected to be subject to approvals and permits and associated design requirements to reduce or eliminate any substantive adverse environmental effects. There are no existing or planned industries in the PDA that would have any substantive lighting components. Agricultural activities in the area are expected to be ongoing with some lighting after daylight hours. These are expected to be temporary, short in duration, and local to activities during planting and harvesting. Lighting from those activities is therefore not expected to overlap with the Project in a substantive way.

Provided that other planned linear developments, future industries or agricultural activities subscribe to the energy efficient and reduced lighting design guidelines, the cumulative environmental effects between the Project and linear developments, industries and agricultural activities on lighting are therefore not expected to be substantive.

12.3.2 Cumulative Environmental Effects on the Aquatic Environment

Project construction and operation activities have the potential to result in the loss or alteration of fish habitat, direct mortality of fish during in-water works, and potential changes in water quality. These potential effects will be reduced with the implementation of mitigation outlined in Section 6.4.2.2. Mitigation includes: conducting in-water works outside of the higher biological risk period (July 1 to September 30) when practicable, the installation of sediment and erosion control measures, and implementation of spill prevention measures. The assessment of environmental effects (Section 6.4.2.2) determined these effects would be localized and temporary; following channel realignment and subsequent habitat re-establishment, it is anticipated that aquatic habitats will return to near baseline conditions.

Other undertakings in the area have the potential to result in similar environmental effects on the aquatic environment. For example, the use and maintenance of roadways, agriculture, and residential developments, all have the potential to contribute to sediment or other contaminants accumulating in the aquatic environment. It is expected that other undertakings in the area will meet required regulations with respect to in-water construction timing restrictions, follow government and industry guidelines for sediment control, implement spill prevention and response procedures, and abide by the federal *Fisheries Act,* among other requirements. Therefore, it is not anticipated that environmental effects from other undertakings in the area will cumulatively interact with the Project to exceed regulatory thresholds for the protection of the aquatic environment. Cumulative environmental effects between the Project and other past, present, or future linear developments, suburban development, and agricultural activities on the aquatic environment are therefore not expected to be substantive.

12.3.3 Cumulative Environmental Effects on Water Resources

Groundwater Quality

Changes to groundwater quality and quantity are possible as a result of extended and continued dewatering of excavations that are dug to a depth below the local water table and as a result of road salt use during winter maintenance activities and/or the runoff of storm water. Mitigation (Section 7.4.2.2 and 7.4.3.2) including limiting the extent of time dewatering activities take place during construction, identifying and completing water level monitoring of potable wells within 30 m of proposed dewatering activities, adherence to the PEI TIE Salt Management Plan during winter maintenance activities and avoidance of infiltration-based storm water management within municipal well-field protected zones will be implemented to limit the possibility of this potential effect.

Suburban developments and agricultural activities have the potential to act cumulatively to cause effects on groundwater quality and quality. It is expected that any future suburban development in the area would be either part of the municipal water system or, in the case of private wells, would be subject to the provincial *Water Well Regulations* for new well installation. Agricultural activities in the area are expected to be ongoing and remain consistent for the foreseeable future, therefore, the demand for irrigation water is not expected to increase and there are no expected cumulative environmental effects with the Project.

With the implementation of mitigation, cumulative environmental effects with suburban development or agricultural activities are not considered to be substantive.

12.3.4 Cumulative Environmental Effects on the Terrestrial Environment

Potential Project-related environmental effects on vegetation and wetlands includes the potential for a loss of plant SOCC and plant communities during the clearing, and the potential for a loss of wetland area or change in wetland function. These effects will be reduced through mitigation (Section 8.4.2.2), which includes reducing the area of physical disturbance where practicable and allowing portions of the PDA to regenerate, where possible. The Project will result in a change in vegetation and wetlands during construction; however, with the implementation of recommended mitigation, the environmental effects will be localized and are unlikely to affect the sustainability of habitats and populations.

Other undertakings in the area, such as other linear developments, suburban development or agriculture are likely to result in similar effects to vegetation and wetlands. It is expected that the other linear developments will be required to mitigate any losses to plant SOCC and wetlands, and no long-term overlapping effects with the Project on vegetation and wetlands is expected. Future suburban developments are unlikely to result in substantive environmental effects on plant communities and wetlands in a way that would cause a measurable change from current conditions that would be above regulatory thresholds, or that would affect the ongoing viability of vegetation communities and vascular plant SOCC in the RAA. Agricultural activities in the area are expected to be ongoing and remain consistent for the foreseeable future, therefore, there are no cumulative environmental effects with the Project.

Potential Project-related environmental effects on wildlife and wildlife habitat include a change in habitat availability, habitat connectivity, and mortality risk from construction and operation activities. These effects will be reduced through the implementation of mitigation (Section 8.4.2), which includes: implementing construction BMPs to reduce conflicts with sensitive species and life cycle phases; avoiding clearing and grubbing activities in vegetated areas during the regional nesting period for migratory birds (April 15 to August 31); and full cut-off lighting street lighting (i.e., no illumination occurs above an angle of 90°). These mitigation measures are expected to reduce potential increases in the mortality risk to wildlife.

Future linear developments and ongoing agricultural activities may increase wildlife mortality risk through a number of mechanisms including the removal of nests, dens, burrows and hibernacula, and vehicle collisions. Agricultural activities are likely to continue at historical levels of intensity within the region and are therefore unlikely to interact cumulatively with the Project to increase effects to wildlife and wildlife habitat beyond the levels currently experienced. It is assumed mitigation to reduce wildlife mortality risk will also be implemented as part of other undertakings.

Cumulative environmental effects between the Project and linear developments, suburban development, and agricultural activities on the terrestrial environment are therefore not expected to be substantive.

12.3.5 Cumulative Environmental Effects on the Socioeconomic Environment

Change in Employment and Economy

Potential interactions during construction include tax revenue generation and contribution to the provinces GDP. Potential interactions during operation include a reduction in the number of drop-in customers traveling through the town of Cornwall via the TCH and the reduction of access restrictions which will allow additional access for commercial and residential developers, as well as improved access to current commercial and recreational facilities. Mitigation (Section 9.4.2.2) will include communication with landowners and interested stakeholders regarding construction activities and progress, standard traffic control measures, and detours, as necessary.

Suburban developments have the potential to act cumulatively to cause changes in employment and economy. It is expected that changes in access will result in future commercial and residential growth within the Town of Cornwall, which will benefit the local economy and may increase business at existing establishments or allow existing establishments to grow. This will result in positive potential changes to employment and economy in the RAA.

Cumulative environmental effects between the Project suburban development on a change in employment and economy are therefore not expected to be substantive.

Change in Land Use

Potential changes to existing land uses may include the loss of or change to land access. Potential interactions during construction may include temporary increase in traffic, permanent loss of agricultural land, and reduction in access to recreational land use. Potential interactions during operation may include restrictions on the permissible uses of land within the PDA. Mitigation will be implemented for these effects (Section 9.4.2.2) including consulting and accommodating stakeholders where possible, communicating construction schedules, and implementing traffic control and access control measures within the PDA. It is expected that the change in land use attributable to the Project will provide an important component of transportation infrastructure in Prince Edward Island including the resultant economic benefits.

Cumulative environmental effects on land use in conjunction with other projects or activities could be expected for landowners where the PDA crosses the Cornwall, Bannockburn, or Baltic Roads. Those landowners may have already been or continue to be affected by changes in land use because of the construction and operation of local roads, and they may see further effects because of the Project. These cumulative environmental effects can be limited with the implementation of recommended mitigation.

Early planning stages of the Project reduced the number of properties required to a minimum number that is necessary to conduct work. Properties that have been/will be purchased for the Project were assessed and landowners were offered compensation that was determined to be acceptable to all parties. In the case of expropriation, lands will be expropriated as per the PEI *Expropriation Act*, at fair market value. Therefore, project activities are not anticipated to cause disruption, wide spread restrictions, or the degradation of land and resource use to a point where it cannot generally continue at current levels. Economic benefits from increased industrial development will create long-term economic and land use benefits for nearby communities. Cumulative environmental effects between the Project and linear developments, suburban development, and agricultural activities on land use are therefore not expected to be substantive.

12.4 SUMMARY AND DETERMINATION OF SIGNIFICANCE

In summary, the Project will result in environmental effects that have the potential to overlap with similar effects from other undertakings in the area. Residual environmental effects from Project activities are predicted to be not significant. It is understood that other undertakings in the area will be required to reduce potential environmental effects through compliance with government standards and permit stipulations, further reducing the potential for cumulative environmental effects. No additional mitigation is recommended. Cumulative environmental effects during all phases on all affected VCs are not expected to be substantive.

13.0 SUMMARY

Stantec conducted an EIA of the Trans-Canada Highway (TCH) Extension Project – Cornwall Phase IIB (the "Project") proposed by the PEI Department of Transportation, Infrastructure and Energy. The Project involves the construction and operation of a 7.8 km long, four-lane roadway with associated interchanges, overpasses and a watercourse crossing, located between North River and Clyde River, PEI.

13.1 SCOPE OF THE EIA

An EIA of the Project components and activities is required under Section 9(1) of the PEI *Environmental Protection Act* (PEI *EPA*). This EIS follows the Stantec environmental assessment methodology that has been adapted to meet the requirements of the PEI *EPA*.

The potential environmental effects of the Project were assessed in this EIS. The scope of assessment included all activities necessary for the construction and operation of the Project. Environmental effects were assessed for each phase of the Project (i.e., construction and operation), where relevant, as well as for credible accidents, malfunctions, and unplanned events. The assessment was conducted within defined spatial and temporal boundaries for the assessment and in consideration of defined residual environmental effects rating criteria aimed at determining the significance of the environmental effects. The assessment considered measures that are technically and economically feasible that would mitigate significant adverse environmental effects of the Project.

13.2 ENVIRONMENTAL EFFECTS ASSESSMENT

Atmospheric environment, aquatic environment, water resources, terrestrial environment, and socioeconomic environment were the VCs identified for detailed assessment. These were identified by the study team (based on experience and professional judgment) as being the key VCs for which substantive interactions with the Project were anticipated or could occur. A separate analysis of the potential effects of the environment on the Project was also conducted.

It is concluded in this EIS that the potential environmental effects during all phases of the Project for the VCs are rated not significant. This conclusion was reached in consideration of the nature of the Project, the nature and extent of its environmental effects, and the planned implementation of proven and effective mitigation. The environmental effects of accidents, malfunctions, and unplanned events were rated not significant. Effects of the environment on the Project were rated not significant due to design consideration and compliance with codes and standards that will mitigate against a significant adverse effect on the Project. In most cases, the environmental effects and significance predictions were made with a high level of confidence by the study team.

13.3 OVERALL CONCLUSION

Based on the results of the EIA, it is concluded that, with planned mitigation, the residual environmental effects of the Project, including cumulative effects, during all phases are rated not significant.

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