ENVIRONMENTAL ASSESSMENT REGISTRATION

Highway 101
Digby to Marshalltown Corridor

February 2017

Prepared for:

Nova Scotia Department of Transportation and
Infrastructural Renewal
Johnston Building, 4th Floor
1672 Granville St.
Halifax, NS

Prepared by:

Stantec Consulting Ltd.
102 - 40 Highfield Park Drive
Dartmouth, NS

Project No. 121414143

Highway 101 Digby to Marshalltown Corridor Environmental Assessment Registration

Prepared for:
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Johnston Building, 4th Floor
1672 Granville Street, PO Box 186
Halifax NS B3J 2N2

Prepared by:
Stantec Consulting Ltd.
102 – 40 Highfield Park Drive
Dartmouth NS B3A 0A3

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Executive Summary

This Project involves the construction, operation, and maintenance of 4 kilometres (km) of new 100-series highway from Exit 26 in Digby to Middle Cross Road in Marshalltown. The Digby to Marshalltown corridor is the first phase of the Digby to Weymouth North Corridor Project, a multi-phased project with an overall total length of 26 km. The remaining sections of the corridor will be assessed in a subsequent environmental assessment(s) (EA) when the phases progress through the planning stage of the project. The new highway will be constructed initially as a two-lane, controlled access corridor with a design speed of 110 km/hr and posted speed of 100 km/hr. Construction for the initial two lanes is planned to begin in 2017. Sufficient right of way will be purchased initially so that a four-lane highway can be constructed; however, the schedule for this construction has not been determined. It is anticipated that the highway will be maintained and remain in operation indefinitely.

Highway 101 is part of the National Highway Core System, and stretches approximately 300 km from the Highway 102 interchange in Bedford to Starrs Road in Yarmouth. It provides a vital link serving the Annapolis Valley area and provides connections to provincial entry points at ferry terminals in both Digby and Yarmouth.

This Project is subject to provincial regulatory approval under the Nova Scotia *Environment Act*. This EA has been prepared to satisfy requirements for registration of a Class I Undertaking under the *Environment Assessment Regulations* since it is over 2 km in length and will be designed for four lanes of traffic.

NSTIR has met with regulatory agencies, local municipal governments, local community representatives, and the general public about this current Project, dating back to the early 1990s. Since then, NSTIR has also engaged with the Kwilmu'kw Maw'klusuaqn Negotiation Office (KMNO), Millbrook First Nation, and Sipekne'katik First Nation to gain an understanding of Aboriginal issues and concerns and provide Project updates. In 2016, a Mi'kmaq Ecological Knowledge Study (MEKS) was also completed for the Project by Mainland Mi'kmaq Development Inc. (MMDI).

The EA focuses on Valued Components (VCs) which are components of the biophysical and socio-economic environments that, if altered by the Project, may be of concern to regulatory agencies, the Mi'kmaq of Nova Scotia, scientists, and/or the general public. Eight VCs have been selected for this assessment to focus the EA on the most important Project-environment interactions, including:

- atmospheric environment;
- groundwater resources;
- fish and fish habitat;
- vegetation;

- wetlands;
- wildlife and wildlife habitat;
- land use; and
- archaeological and heritage resources.

This assessment includes an evaluation of the potential Project-related environmental effects for construction, operation and maintenance, and accidents and malfunctions. Potential Project-related effects from Project construction include direct and indirect effects to the terrestrial and aquatic environments through loss or alteration of habitat and/or mortality of wildlife species including species of conservation interest (SOCI). Construction activities may also restrict or change access to lands and resources used by community members and the general public. Adverse effects related to Project operations and maintenance activities are predicted to be similar to the ongoing operation and maintenance of the current Highway 101.

In general, potential adverse effects on these VCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods recommended in this document. Mitigation, including best management practices, site-specific measures, and habitat compensation have been proposed to reduce or eliminate potentially adverse effects for each VC. With respect to the mitigation of effects on fish and fish habitat and wetlands, compensation to offset predicted losses is proposed in accordance with the *Fisheries Act* and Nova Scotia Wetland Conservation Policy, respectively.

With the implementation of the proposed mitigation (including compensation) and monitoring, no significant adverse residual environmental effects are predicted for most VCs due to routine Project construction or operation and maintenance activities. Residual environmental effects of the operation and maintenance of the Project on the acoustic environment are predicted to be not significant, assuming that NSTIR undertakes monitoring of traffic noise levels along the new highway that might be considered significant for certain receivers.

The main purpose of a 100 series highway network in Nova Scotia is the safe, convenient and efficient movement of large volumes of people and goods over long distances at high speeds while reducing negative economic, social and environmental impacts. This Project will provide benefit to the local region as well as the Province of Nova Scotia as it will improve the current safety performance and level of service along this stretch of Highway 101.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF APPENDICES

Abbreviations

°C	degrees Celsius
AADT	average annual daily traffic
AC CDC	Atlantic Canada Conservation Data Centre
ASTM	American Society for Testing and Materials
ATV	all-terrain vehicle
BMP	best management practices
CAC	criteria air contaminant
CAIT	Climate Analysis Indicators Tool
CCA	Canadian Construction Association
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act*
CFIA	Canadian Food Inspection Agency
cm	centimetre
CMM	Confederation of Mainland Mi'kmaq
CO	carbon monoxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRA	commercial, recreational, or Aboriginal
CSSP	Canadian Shellfish Sanitation Program
dBA	decibel
DFO	Fisheries and Oceans Canada
DU	designatable unit
EA	environmental assessment
ECCC	Environment and Climate Change Canada
ECM	environmental compliance monitoring
ECP	environmental control plan
EEM	environmental effects monitoring
EGSPA	*Environmental Goals and Sustainable Prosperity Act*
EMO	Emergency Management Office
EMP	Environment Management Plan
EPP	Environmental Protection Plan
Generic EPP	Generic EPP for the Construction of 100 Series Highways
GHG	greenhouse gas
GPR	Ground Penetrating Radar
GUDI	Groundwater under the Direct Influence
h	hour
ha	hectare
HADD	harmful alteration, disruption or destruction
HMVK	hundred million vehicle kilometres

iBoF	Inter Bay of Fundy
IRVM	Integrated Roadside Vegetation Maintenance
km	kilometre
KMKNO	Kwilmu'kw Maw-klusuaqn Negotiation Office
L	litre
LiDAR	Light Detecting and Ranging
m	metre
mASL	metres above sea level
MBCA	*Migratory Birds Convention Act*
MEKS	Mi'kmaq Ecological Knowledge Study
MKS	Mi'kmaq Knowledge Study
mm	millimetres
MDI	Mainland Mi'kmaq Development Inc.
MPS	Municipal Planning Strategies
NAPS	National Air Pollution Surveillance Program
NCNS	Native Council of Nova Scotia
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPA	*Navigation Protection Act*
NPRI	National Pollutant Release Inventory
NS	Nova Scotia
NS ESA	Nova Scotia *Endangered Species Act*
NSCCH	Nova Scotia Communities, Culture and Heritage
NSDNR	Nova Scotia Department of Natural Resources
NSDOE	Nova Scotia Department of Environment
NSE	Nova Scotia Environment
NSP	Nova Scotia Power
NSTIR	Nova Scotia Transportation and Infrastructure Renewal
NSTPW	Nova Scotia Transportation and Public Works
O_3	Ozone
OAA	Office of Aboriginal Affairs
PAHs	Polycyclic Aromatic Hydrocarbons
PDA	project development area
PDO	property damage only
PM	Particulate Matter
PM_{10}	particulate matter less than 10 microns
$PM_{2.5}$	particulate matter less than 2.5 microns
POLs	Petroleum Oils Lubricants
RCAp	Rapid Chemical Analysis Program
RDA	Regional Development Authority
RoW	right-of-way
RWIS	road weather information system
SANS	Snowmobilers Association of Nova Scotia

SAR	species at risk
SARA	*Species at Risk Act*
SMP	Salt Management Plan
SO2	sulphur dioxide
SOCI	species of conservation interest
SPL	Sound Pressure Levels
TAC	Transportation Association of Canada
TDS	Total Dissolved Solids
TSP	total suspended particulate
TSS	total suspended solids
US EIA	United States Energy Information Administration
US EPA	United States Environment Protection Agency
VC	valued component
WC	watercourse crossing
WSS	Wetlands of Special Significance
WVDA	Western Valley Development Authority

1.0 INTRODUCTION

Nova Scotia Transportation and Infrastructure Renewal (NSTIR) proposes to construct a new 4 kilometre (km) 100-series highway from Exit 26 in Digby to Middle Cross Road in Marshalltown, Digby County, Nova Scotia (the Project). On behalf of NSTIR, Stantec Consulting Ltd. (Stantec) has prepared this environmental assessment (EA) to satisfy requirements for registration of a Class 1 Undertaking under the Environmental Assessment Regulations.

1.1 PROJECT OVERVIEW AND BACKGROUND

This Project involves the construction, operation, and maintenance of 4 km of new 100-series highway from Exit 26 in Digby to Middle Cross Road in Marshalltown. The Digby to Marshalltown corridor is the first phase of the Digby to Weymouth North Corridor Project, a multi-phased project with an overall total length of 26 km. The remaining sections of the corridor will be assessed in a subsequent EA(s) when the phases progress through the planning stage of the project.

Figure 1.1 identifies the extent of highway construction that is included within the scope of this EA. Figure 1.2 indicates some of the planned future highway construction that is not within the scope of the proposed Project. Future extension of Highway 101 west of Seely Brook and a planned grade-separated interchange at Marshalltown will be included in the scope of a future EA.

The new highway (see Figure 1.1) will be constructed initially as a two-lane, controlled access corridor with a design speed of 110 km/hr and posted speed of 100 km/hr. Construction for the initial two lanes is planned to begin in 2017. Sufficient right of way will be purchased initially so that a four-lane highway can be constructed; however, the schedule for this construction has not been determined. It is anticipated that the highway will be maintained and remain in operation indefinitely.

The Project consists of the following main components, as shown on Figure 1.1:

- new two-lane roadway
- modifications to two ramps at Exit 26 (Digby)
- new roundabout at Exit 26 eastbound off-ramp
- watercourse crossings, including an arch structure for Seely Brook
- access road on north side of new roadway
- bridge structure for the existing recreational trail west of Exit 26
- construction of an at-grade intersection at Middle Cross Road (Marshalltown)
- partial re-alignment of a major Nova Scotia Power (NSP) transmission line that crosses the corridor near Digby
- realignment of existing highway at both ends of the Project
- future addition of twinned highway from Exit 26 to Seely Brook
- temporary ancillary elements.

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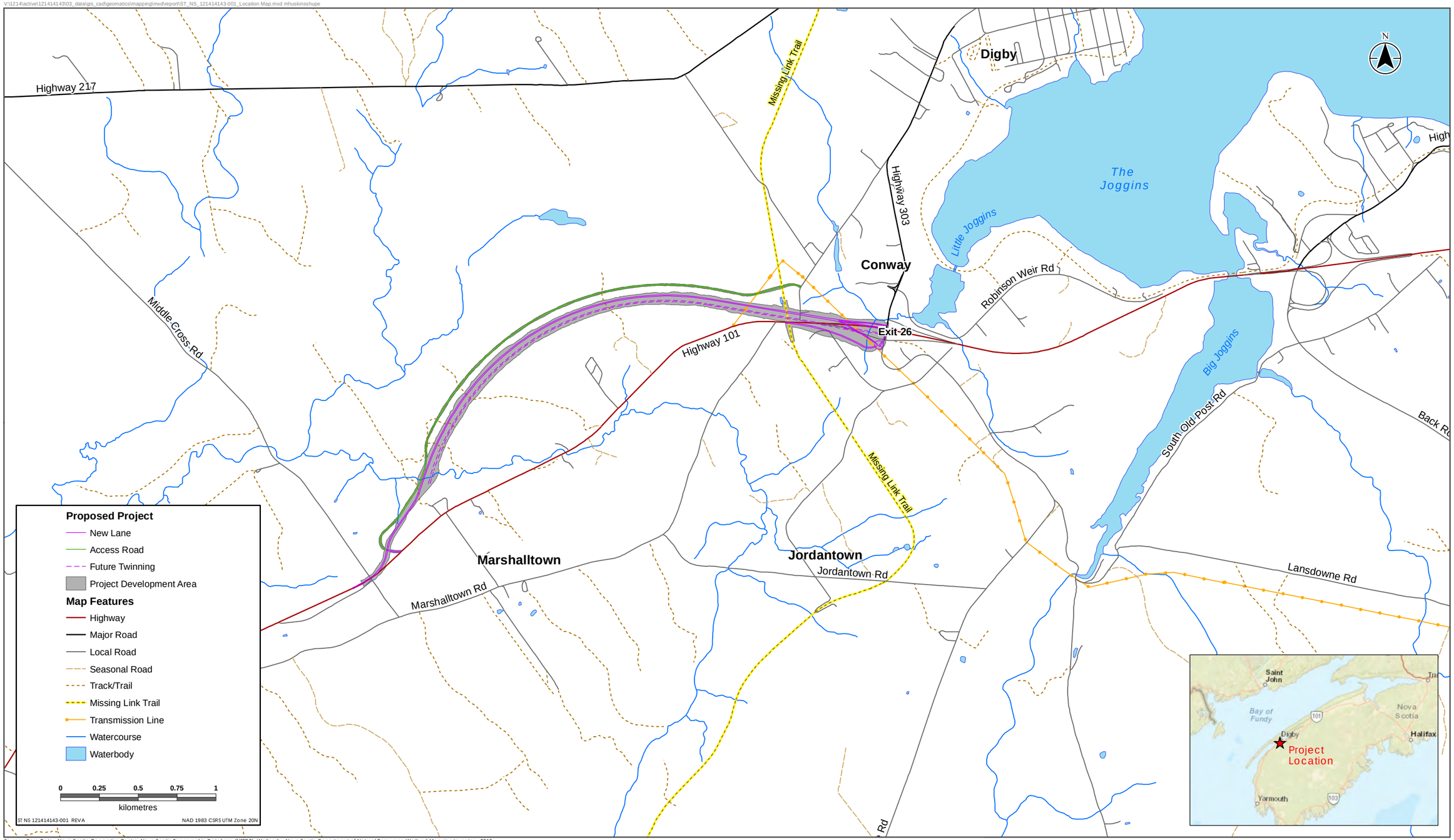

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Project Location

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HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 1.1

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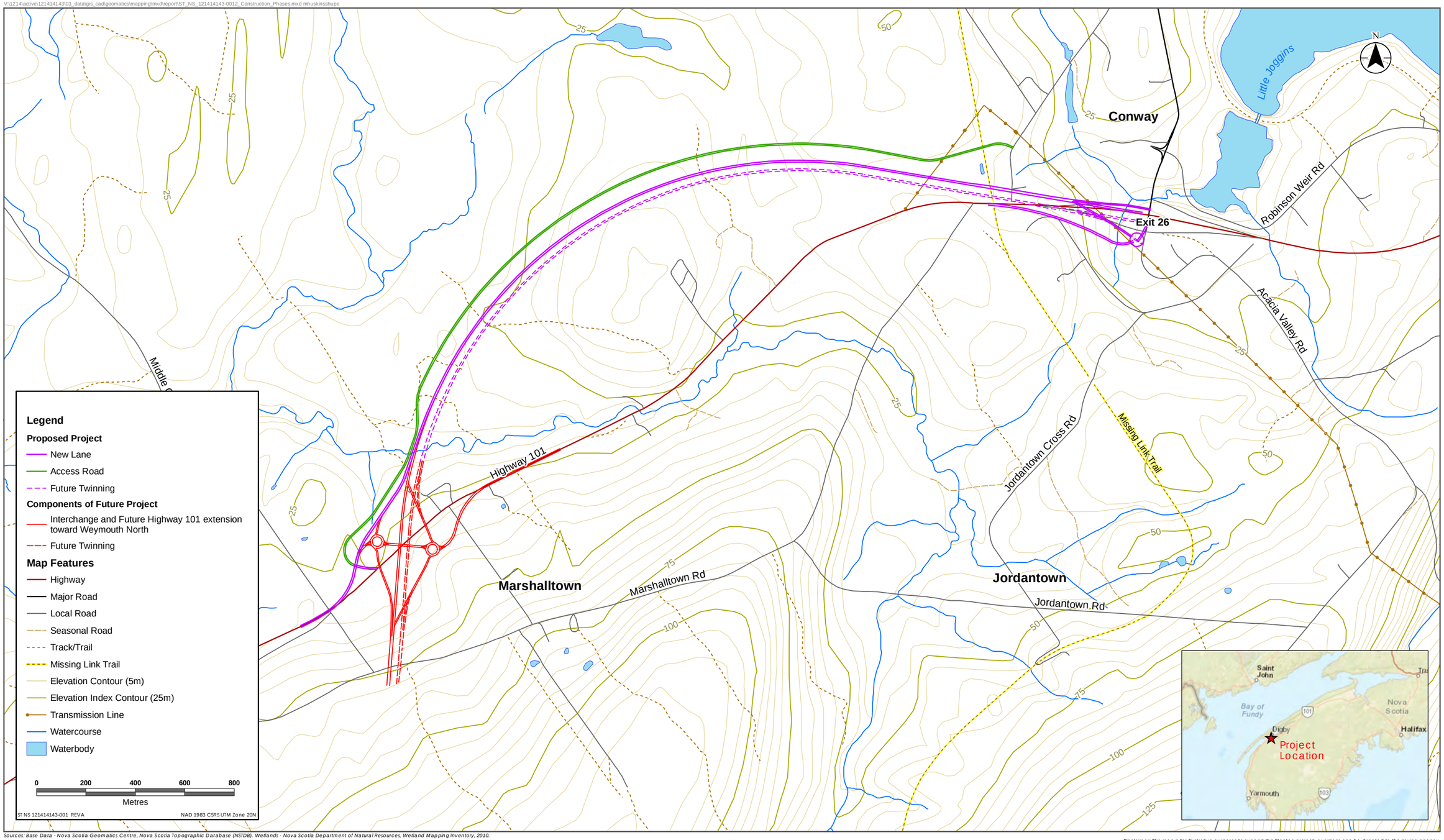

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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Proposed Highway Alignment - Both Current and Future Phases

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HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 1.2

Components of future work to be included in the scope of a subsequent EA (s), as shown on Figure 1.2, include:

- grade-separated interchange near Middle Cross Road
- future new two-lane highway southwestward from Seely Brook
- future twinning from Seely Brook westward.

A more detailed description of the Project is provided in Section 2.0.

The coordinate for a centre point along the PDA is 278,064.116 and 4,942,031.547 meters (65°47'46.923"W and 44°35'50.614"N).

NSTIR started planning work for the full 26 km (Digby to Weymouth) in 1991. Open houses were conducted in 1992 and 1999. An EA for the Project was initiated in 2000 when the Project was subject to federal and provincial EA processes under the superseded *Canadian Environmental Assessment Act* and provincial *Environment Act*. The EA was submitted in 2002/2003 as a Class II EA, but withdrawn when the EA regulations changed to require only a Class I EA registration. With changes in NSTIR priorities, the project was not re-registered. Field studies were conducted in 2001 and 2002 based on regulatory guidance at that time. This EA is based on the studies undertaken in 2001 and 2002, with updated information as applicable where Project details and environmental conditions may have changed, including 2016 field survey results and public engagement activities.

1.2 PURPOSE AND NEED FOR THE UNDERTAKING

The main purpose of a 100 series highway network in Nova Scotia is the safe, convenient and efficient movement of large volumes of people and goods over long distances at high speeds while reducing negative economic, social, and environmental impacts.

Highway 101 is part of the National Highway Core System, and stretches approximately 300 km from the Highway 102 interchange in Bedford to Starrs Road in Yarmouth. It provides a vital link serving the Annapolis Valley area and provides connections to provincial entry points at ferry terminals in both Digby and Yarmouth.

Highway 101, Digby to Marshalltown, is the first phase of the Digby to Weymouth North Corridor Project, a multi-phased project with an overall total length of 26 km. NSTIR began planning work for the full corridor in 1991, and has since reserved a corridor for the completion of this section of Highway 101. Traffic along the 26 km section of Highway 101 from Digby (Exit 26) to Weymouth North (Exit 27) has increased considerably since construction of the highway in the 1970s. Residential and commercial development has increased along the proposed alignment creating a larger traffic volume than was planned for during design of the existing highway. Expansion of the tourism industry both in Digby County and in Nova Scotia has resulted in large numbers of vehicles traveling to and from national and international ferry systems located in Digby. Other current traffic includes local traffic, commercial trucks on their way from Yarmouth

and/or Windsor, long-haul tractor-trailer vehicles, and various small business, courier, utility, and commuter traffic. Slower speeds moving local traffic mixed with faster moving through traffic impedes the efficient movement of goods and people, thereby resulting in a lower level of service. The proposed Highway 101 roadway will increase efficiencies which in turn will improve safety for the traveling public.

This portion of Highway 101 is the only portion of the 300 km long segment of roadway from Bedford to Yarmouth which has not been upgraded to a 100-series controlled access standard highway; it currently functions at a Trunk standard. Two lane controlled access highways generally have speed limits of 100 km/h. The lack of vehicle access control and numerous conflict points between vehicles and pedestrians along the existing road are potential safety concerns for both local and through traffic. Roadside development and reduced speed limits (80 km/hr and 90 km/hr sections) also affect the convenience, cost, and efficiency of operation for through traffic. Bypassing the existing Highway 101 from Exit 26 in Digby to Middle Cross Road in Marshalltown will separate high speed through traffic from slower speed local traffic, thus decreasing travel times for through traffic and improving the overall safety of the highway.

Previous upgrades to the existing highway have not adequately addressed problems including: high travel speeds; blind crests; an increase in truck traffic; and, uncontrolled access from numerous intersections and driveways (NSTIR 2000). Further upgrades to the existing route (*e.g.*, widening) are impossible due to various developments, both residential and commercial, along the alignment.

The existing section of highway from Digby to Marshalltown has an average annual daily traffic (AADT) of approximately 5,410 vehicles per day (NSTIR 2015). Approximately 26 km of the 300 km existing Highway 101, from Digby to Weymouth North, in not a controlled access highway. This uncontrolled access section, which is located between two controlled access highway which funnel high-speed traffic through an area commonly used as a local road, poses safety concerns (NSTIR 2015).

The relative safety of a section of highway is evaluated by comparing the Digby to Marshalltown collision rates to the average collision rates for all similar highways in the Province. The Digby (Exit 26) to Marshalltown Highway 101 is considered as a "100 Series No Access Control" road. Collision rates are expressed as number of collisions per hundred million vehicle kilometres (HMVK). Motor Vehicle Collision Rates for Numbered Highways and Sections 2010 to 2014 (NSTIR 2016) indicates that the five-year average collision rate for all '100 Series Full Access Control' highways in Nova Scotia is 52.4 collisions per HMVK.

The five year 2010 to 2014 collision rates for the Highway 101 section from Exit 26 (Digby) to Middle Cross Road (Marshalltown) is included in Table 1.2.1. The overall five-year average collision rate for the 3.87 km long section is 47.7 collisions per HMVK.

Table 1.2.1 Number of Collisions and Collision Rates for Highway Section Exit 26 to Middle Cross Road (Marshalltown) - 2010 to 2014

Year	AADT	HMVK [1]	Number of Collisions				Collision Rates [3]			
			PDO [2]	Injury	Fatal	Total	PDO	Injury	Fatal	Total
2010	5,240	0.0740	2	1	0	3	27.0	13.5	0	40.5
2011	5,240	0.0740	3	3	0	6	40.5	40.5	0	81.1
2012	5,410	0.0764	3	0	0	3	39.3	0	0	39.3
2013	5,410	0.0764	2	2	0	4	26.6	26.2	0	52.3
2014	5,410	0.0764	1	1	0	2	13.1	13.1	0	26.2
Totals		0.3773	11	7	0	18	29.2	18.6	0	47.7

NOTES:
1. 'HMVK' = Hundred Million Vehicle Kilometers
2. 'PDO' = Property Damage Only
3. Collision rates are 'number of collisions per HMVK'

The Western Valley Development Authority (WVDA), which is the local Regional Development Authority (RDA) created in 1994, prioritized transportation within the Western Valley in their *Vision 2000* document. The WVDA is described as a partnership between the provincial and federal governments, the seven municipalities within the Counties of Annapolis and Digby, and residents of these municipalities (PRAXIS 2000). Various consultations and surveys managed by the WVDA highlighted the need for the completion of the Digby to Weymouth North portion of Highway 101. In their strategic plan, the WVDA recognized the need for highway improvement and to "work with government partners to improve road transportation infrastructure, including the completion of Highway 101 between Digby to Weymouth" (WVDA 1999). Completion of the 4 km proposed alignment from Digby to Marshalltown is a step towards accomplishing the WVDA's goal of addressing priorities for local infrastructure and facilities, and a key step in meeting the objectives of the 100-series highway network to which this section belongs.

In summary, the Project is important to the Province of Nova Scotia for the following reasons:

- Bypassing the existing Highway 101 will separate high speed through-traffic from slower speed local traffic, thus decreasing travel times for through traffic and improving the overall safety and comfort for motorists traveling on Highway 101
- It will improve safety by reducing emergency response times to communities between the exits
- It will extend the life of the existing asset, specifically the existing Highway 101 and roads connecting to the highway system
- It will complete the first phase (Digby to Marshalltown, Figure 1.1) of the upgrade to a 100-series controlled access standard highway, the only portion of the 300 km long segment of Highway 101 roadway from Bedford to Yarmouth which has not been upgraded.

1.3 IDENTIFICATION OF THE PROPONENT

Name of Undertaking: Highway 101 Digby to Marshalltown Corridor

Name of Proponent: Nova Scotia Department of Transportation and Infrastructure Renewal

Postal Address: PO Box 186
Halifax NS B3J 2N2

Street Address: Johnston Building
1672 Granville Street
Halifax, NS

Tel: (902) 424-2297

Fax: (902) 424-0532

Email: tpwpaff@novascotia.ca

Environmental Assessment Contact

Name: Mr. Ian MacCallum

Official Title: Environmental Analyst

Address: Same as Above

Tel: (902) 424-7262

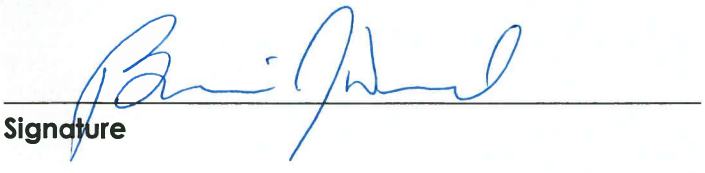
Fax: (902) 424-7544

Email: Ian.MacCallum@novascotia.ca

Proponent Executive

Name: Mr. Brian Ward

Official Title: Director, Highway Engineering Services



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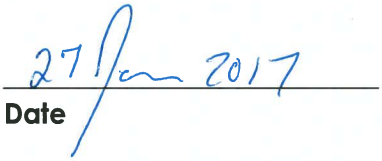


Date

1.4 REGULATORY CONTEXT

The Project will require an EA in accordance with the provincial *Environmental Assessment Regulations* made pursuant to *the Environment Act*. The Project will be subject to the requirements associated with a Class I Registration under the *Environment Assessment Regulations* since it is over 2 km in length and will be designed for four lanes of traffic. A summary of key provincial legislation relevant to the Project is provided below in Table 1.4.1.

Table 1.4.1 Key Provincial Legislation Relevant to the Environmental Assessment

Legislation	Regulating Authority	Relevance
Environment Act and Associated Regulations	Nova Scotia Environment (NSE)	The Project will require EA approval in accordance with the *Environmental Assessment Regulations*. In addition to EA approval, the Project will require other approvals under the *Activities Designation Regulations* of the Act, including Water Approvals to authorize alterations to wetlands and watercourses. Approvals under the *Activities Designation Regulations* are granted by NSE. *Air Quality Regulations* under the Act specify ambient air quality maximum permissible ground level concentrations.
Nova Scotia *Endangered Species Act* (NS ESA)	Nova Scotia Department of Natural Resources (NSDNR)	NS ESA provides for the protection, designation, recovery, and other relevant aspects of conservation of species at risk in the Province, including habitat protection. The Act prohibits killing or disturbing endangered or threatened species, destroying, or disturbing its residence (habitat) and destroying or disturbing core habitat. Species assessed by the NS Species at Risk Working Group as endangered threatened, or vulnerable are listed under the NS ESA are legally protected.
Environmental Goals and Sustainable Prosperity Act (EGSPA)	NSE	In 2007, EGSPA established specific goals associated with air quality, water quality, renewable energy, ecosystem protection, contaminated sites, solid waste reduction, sustainable purchasing, and energy efficiency building. In particular, goals associated with climate change and air quality improvements have implications for Project design and mitigation.
Special Places Protection Act	Nova Scotia Department of Communities, Culture and Heritage (NSDCCH)	This Act provides for the preservation, protection, regulation, exploration, excavation, acquisition, and study of archaeological and historical remains and paleontological sites, which are considered important parts of the natural or human heritage of the Province.

Other provincial regulations, policies, and guidelines are discussed throughout this document, where relevant.

The Project is not a designated physical activity under the *Regulations Designating Physical Activities* of the *Canadian Environmental Assessment Act*, 2012 (CEAA, 2012) and the Project does not occur on federal crown lands; therefore, there is no requirement to conduct a federal EA or s. 67 determination under CEAA, 2012.

An authorization under Section 35(2)(b) of the *Fisheries Act* may be required for "serious harm" to fish associated with watercourse crossing construction at Seely Brook. With respect to the mitigation of effects on fish and fish habitat, compensation to offset predicted losses is proposed in accordance with the *Fisheries Act*.

No authorizations are expected to be required under the *Navigation Protection Act* (NPA) as Seely Brook is not on the list of "Scheduled Waters" under the NPA.

Key federal environmental legislation that applies to the Project is summarized in Table 1.4.2.

Table 1.4.2 Key Federal Legislation Relevant to the Environmental Assessment

Legislation	Regulating Authority	Relevance
Canadian Environmental Protection Act, 1999 (CEPA, 1999)	Environment and Climate Change Canada (ECCC)	CEPA, 1999 pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other items, CEPA, 1999 provides a wide range of tools to manage toxic substances, and other pollution and wastes.
Fisheries Act	DFO, ECCC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals, and their habitats. Under the *Fisheries Act*, no person shall carry on any work, undertaking, or activity that results in serious harm to fish that are part of a commercial, recreational, or Aboriginal (CRA) fishery, or to fish that support such a fishery, unless this activity has been authorized by the Minister of Fisheries and Oceans. Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish. The Government of Canada is currently undertaking a review of environmental and regulatory processes, including restoring lost protection and introducing modern safeguards to the *Fisheries Act*.
Migratory Birds Convention Act, 1994 (MBCA)	ECCC	Under the MBCA, it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. The Act also prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds.
Navigation Protection Act (NPA)	Transport Canada	The 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

Table 1.4.2 Key Federal Legislation Relevant to the Environmental Assessment

Legislation	Regulating Authority	Relevance
		obstructions to navigation. The Government of Canada is currently undertaking a review of environmental and regulatory processes, including restoring lost protection and introducing modern safeguards to the *Navigation Protection Act*. As stated above, Seely Brook is not on the list of Scheduled Waters.
Species at Risk Act (SARA)	DFO/ECCC/Parks Canada	*SARA* is intended to protect species at risk in Canada and their "critical habitat" (as defined by *SARA*). The main provisions of the Act are scientific assessment and listing of species, species recovery, protection of critical habitat, compensation, permits and enforcement. The Act also provides for development of official recovery plans for species found to be most at risk, and management plans for species of special concern. Under the Act, proponents are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or minimize effects. All activities must comply with *SARA*. Section 32 of the Act provides a complete list of prohibitions.

Since February 23, 2007, a tri-partite forum consisting of Mi'kmaq, Nova Scotian and Canadian governments has dealt with environmental, economic and social issues related to Aboriginal and Treaty rights in Nova Scotia (see http://novascotia.ca/abor/office/ for further details on the "Made in Nova Scotia Process"). The NS Office of Aboriginal Affairs (OAA) helps resolve issues via effective negotiation, consultation, collaboration, and public education. NSTIR has been working with the OAA, nearby Aboriginal communities, and the Confederacy of Mainland Mi'kmaq (CMM) for over a decade on this project and its EA.

1.5 PROPERTY OWNERSHIP AND FUNDING

The majority of land required for the Project right-of-way (RoW) is currently being expropriated by NSTIR. As of January 2017, the Province has acquired approximately 30% of the land within the RoW for the Highway 101 Digby to Marshalltown Corridor Project.

The Government of Nova Scotia, Department of Transportation and Infrastructure Renewal has entered a cost-sharing agreement with the Federal Government of Canada. Under the New Building Canada Fund – Provincial-Territorial Infrastructure Component, the Government of Canada will consider an investment of up to 50% of the project's total eligible costs, to a maximum federal contribution of $7.558 million.

The Province of Nova Scotia will own and operate all highway infrastructure once constructed.

2.0 PROJECT DESCRIPTION

2.1 OVERVIEW OF THE PROJECT

Highway 101 is part of the National Highway System and extends from Bedford to Yarmouth. The proposed new 4 km of 101-series highway will be constructed between the existing Highway 101 from Exit 26 and Middle Cross Road in Marshalltown. The new corridor will be constructed initially as a two-lane controlled access corridor with a design speed of 110 km/hr with a posted speed of 100 km/hr. The highway design includes provisions for the future upgrade to a four-lane wide highway with median. There will be a new roundabout with ramp modifications to the existing Exit 26 at Digby, and construction of an at-grade intersection at Middle Cross Road (Marshalltown).

Once the Project has been released from the EA approval process, NSTIR will proceed with a detailed field survey, geometric design, and acquisition of the remaining portions of the RoW, and environmental permitting for watercourse and wetland crossings. Construction is planned to begin in 2017. It is anticipated that the highway will be maintained and remain in operation indefinitely.

2.2 PROJECT COMPONENTS

Project components include (as shown on Figure 1.1):

- new two-lane roadway
- modifications to two ramps at Exit 26 (Digby)
- new roundabout at Exit 26 eastbound off-ramp
- watercourse crossings, including an arch structure for Seely Brook
- access road on north side of new roadway
- bridge structure for the existing recreational trail west of Exit 26
- construction of an at-grade intersection at Middle Cross Road (Marshalltown)
- partial re-alignment of a major NSP transmission line that crosses the corridor near Digby
- realignment of existing highway at both ends of the Project
- future addition of twinned highway from Exit 26 to Seely Brook
- temporary ancillary elements.

These components are described in the following sections.

2.2.1 Roadway

The Project includes construction of 4 km of two-lane roadway, modifications for two Exit 26 ramps, the realignment of Acacia Valley Road, a bridge structure for the existing recreational trail west of Exit 26, and the realignment of the existing Highway 101 near both ends of the Project.

The new highway will be constructed initially as a two-lane, controlled access corridor with a design speed of 110 km/hr and posted speed of 100 km/hr. The highway will eventually be modified to a four-lane highway with median. Controlled access designation requires that access only be permitted at interchanges to minimize any effects on traffic using the freeway.

2.2.2 Interchanges

The existing interchange at Exit 26 along Highway 101 will be maintained however some changes are necessary to accommodate the new lanes. The Project includes a new roundabout with ramp modifications to the existing Exit 26 at Digby, and construction of an at-grade intersection at Middle Cross Road (Marshalltown).

2.2.3 Watercourse Crossings

Seely Brook will likely be crossed by an open bottom concrete arch structure. An elbow in the channel will be modified and the channel will be reconstructed within the span of the arch. The western end of the brook will be realigned to fit within the arch. As a result of installing the arch, a portion of the western section, as well as a side channel, of Seely Brook will be lost. The arch will be long enough to include the new two-lane highway and the access road. The preliminary structure alignment is shown on Figure 2.1. The detailed design is currently underway and will be included in future permitting requirements. The other watercourse crossings along the new alignment may require minor structures or culverts. Hydraulic design will be undertaken for new culverts considering both present day and future hydraulic conditions.

The tributary to Seely Brook will need to be realigned during the future construction of the four-lane highway with median. A new channel will be created near the proposed highway and will be naturalized with boulders, appropriate sediment and vegetation. Section 2.3.1.3 contains additional information on watercourse crossing detail.

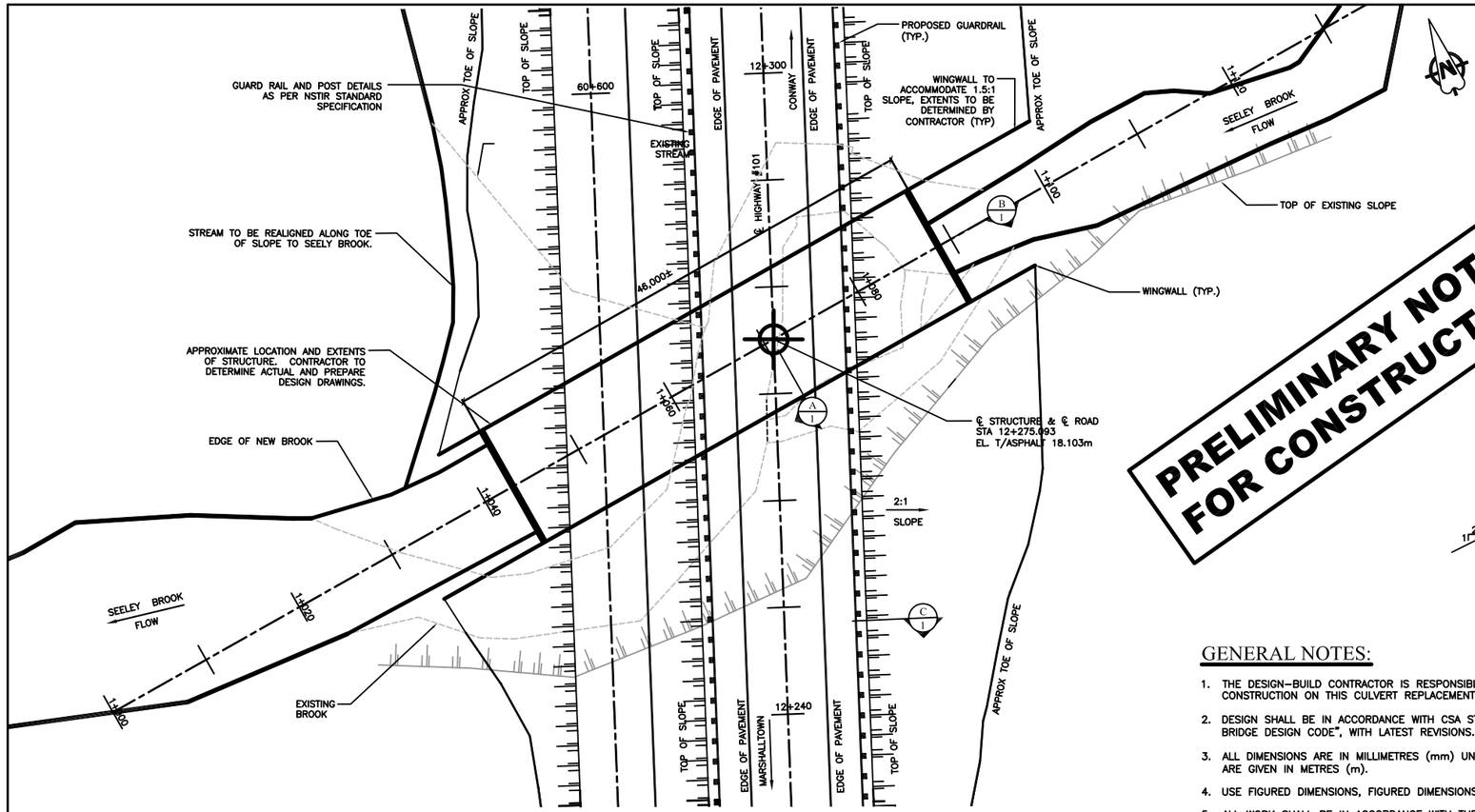
2.2.4 Access Roads

Temporary or permanent access roads may be required to maintain appropriate access to property during and following construction of the highway. Adjacent properties will be given access by parallel gravel access roads constructed at the edge of the RoW along the highway where necessary (Figure 1.1). Any temporary roads will follow relevant NSTIR standards. Final access road locations are yet to be determined but will be within the Assessment Area (as defined in Section 4.2.1) considered in this EA.

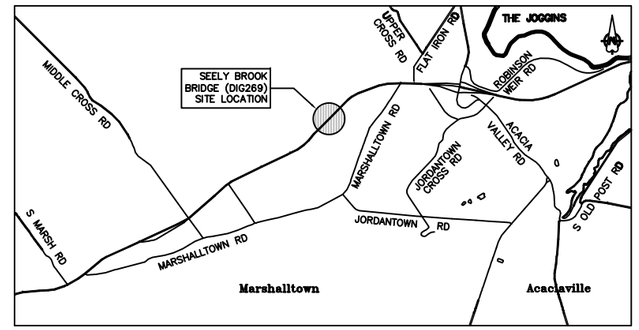
B-16-04

GENERAL ARRANGEMENT

SEELY BROOK BRIDGE (DIG 269)

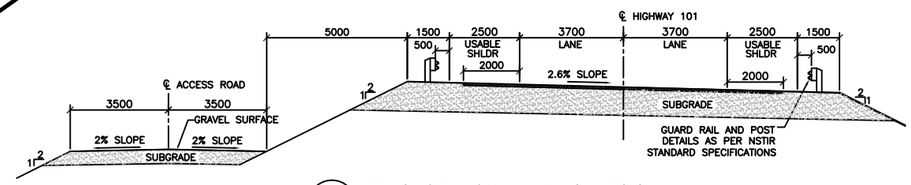


PLAN VIEW
SCALE: 1:250



LOCATION PLAN
SCALE: N.T.S.

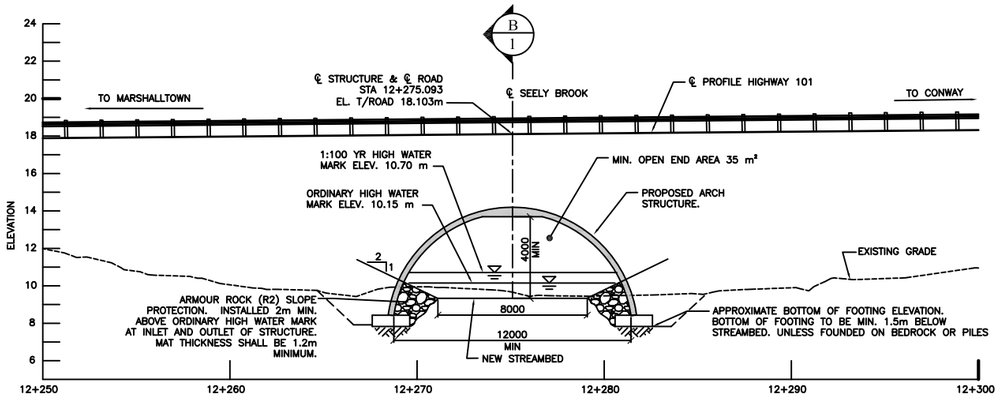
PRELIMINARY NOT FOR CONSTRUCTION



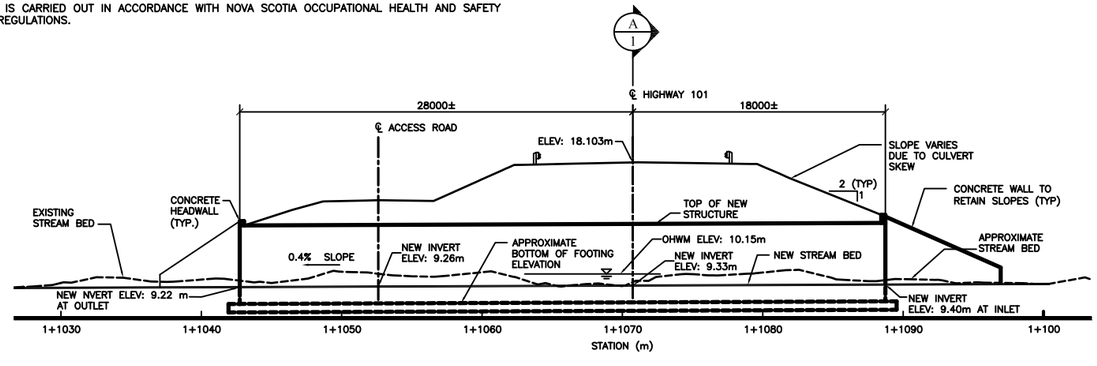
C/1 Typical Road Cross Section Highway #101
Scale 1:100

GENERAL NOTES:

1. THE DESIGN–BUILD CONTRACTOR IS RESPONSIBLE FOR ALL ASPECTS OF DESIGN AND CONSTRUCTION ON THIS CULVERT REPLACEMENT PROJECT.
2. DESIGN SHALL BE IN ACCORDANCE WITH CSA STANDARD CAN/CSA–S6–14, "CANADIAN HIGHWAY BRIDGE DESIGN CODE", WITH LATEST REVISIONS.
3. ALL DIMENSIONS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE. STATIONS AND ELEVATIONS ARE GIVEN IN METRES (m).
4. USE FIGURED DIMENSIONS, FIGURED DIMENSIONS TAKE PRECEDENCE OVER SCALING.
5. ALL WORK SHALL BE IN ACCORDANCE WITH THE NOVA SCOTIA DEPARTMENT OF TRANSPORTATION AND INFRASTRUCTURE RENEWAL "STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION AND MAINTENANCE" AND THE CONTRACT DOCUMENTS.
6. LIVE LOAD: CL–625 AS PER CAN/CSA–S6–14.
7. SURVEY INFORMATION IS ON THE NOVA SCOTIA COORDINATE SYSTEM AND ELEVATIONS ARE TO CANADIAN GEODETIC DATUM. PROJECT ENGINEER TO CONFIRM WORKING POINT STATIONING, COORDINATES, AND ELEVATION.
8. CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL EXISTING DIMENSIONS AND ELEVATIONS. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION.
9. CONTRACTOR SHALL DESIGN, INSTALL AND MAINTAIN TEMPORARY BRACING, SHORING AND FORMWORK.
10. ALL WORK IS CARRIED OUT IN ACCORDANCE WITH NOVA SCOTIA OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS.
11. REFER TO "STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION AND MAINTENANCE" FOR GUARDRAIL DETAIL.
12. BACKFILL TO BE "FILL AGAINST STRUCTURE" MATERIAL AS PER NSTIR STANDARD SPECIFICATIONS.
13. EACH PHASE OF WORK TO BE INSPECTED BY THE ENGINEER PRIOR TO PROCEEDING TO THE NEXT PHASE OF WORK.
14. CONCRETE SHALL BE 45MPa HPC CONFORMING TO NSTIR STANDARD SPECIFICATIONS FOR DIVISION 5, SECTION 7, 8, AND 18
15. REINFORCING STEEL SHALL BE GRADE 400W AND SHALL BE GALVANIZED IN ACCORDANCE WITH NSTIR STANDARD SPECIFICATIONS.
16. ALL OTHER STEEL ELEMENTS AND MISCELLANEOUS METAL FABRICATIONS AND HARDWARE SHALL BE HOT DIPPED GALVANIZED IN ACCORDANCE WITH CSA–G164–M, HOT GALVANIZING IRREGULARLY SHAPED OBJECTS.
17. REFER TO ALIGNMENT DRAWING TITLED SEELY BROOK BRIDGE (DIG 269). PLAN/PROFILE STA. 1+000 TO 1+700, FILE NO. H–2016–XXX–01.
18. FOR COMPLETE INFORMATION ON BOREHOLE DATA AND GEOTECHNICAL CONDITIONS, REFER TO HYDRAULIC INVESTIGATION FOR SEELY BROOK CROSSING, PROJECT NO. PS15–016, PREPARED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, NSTIR PROJECT FILE NO. PS15–016, DATED MAR 01,2016.



A/1 Elevation
Scale 1:150



B/1 Bridge Section
Scale 1:200

Designed by:	R Swinemar						Scale:	AS NOTED
Surveyed by:	TIR						Date:	Jan , 2017
Drawn by:	T. Meehan						File No. :	B-16-04
Checked by:	R. SWINEMAR						Sheet No. :	1 of 1
Approved by:	A.Memon							

Designer — Date

Manager, Structural Engineering — Date

0	XXX/XXX/XX	XXX
MK.	DATE	DESCRIPTION

NOVA SCOTIA
Transportation and Infrastructure Renewal

SEELY BROOK BRIDGE (DIG 269)
HIGHWAY #101 DIGBY COUNTY

GENERAL ARRANGEMENT
Figure 2.1

2.2.5 Recreational Trail Crossing

An abandoned railroad owned previously by Dominion Atlantic Railway runs through the Assessment Area (as defined in Section 4.2.1), southeast of the proposed highway, and is part of the Annapolis Valley Trail System that runs 200 km from Kentville to Norwood and on to the Town of Yarmouth (Tourism Nova Scotia n.d.). The section near the Project, called the Missing Link Trail, is a multi-use trail that runs 27 km from 262 Jordantown Road to Weymouth (Figure 1.1) (Tourism Nova Scotia n.d.). A bridge structure will be constructed for the existing recreational trail west of Exit 26 (Figure 1.1). The structure is being built to accommodate safe movement of ATVs across the highway and will have a 4 m wide travel lane.

2.2.6 Nova Scotia Power Transmission Line Crossing

A major Nova Scotia Power transmission line crosses the corridor near Digby (Figure 1.1). the project includes the partial re-alignment of a major NSP transmission line that crosses the corridor near Digby. NSTIR will coordinate with NSP to locate poles outside roadway clear zones, as specified by NSTIR policy.

2.2.7 Temporary Ancillary Elements

Temporary ancillary elements that may be required for the Project include material storage areas, temporary access roads, mobile asphalt plants, borrow areas, and disposal sites. The locations of these ancillary structures and sites will be identified as part of the contractors' bid proposals and have not yet been established. The locations and operations of these facilities will be subject to approval by NSTIR and any applicable regulators, and will be sited and operated in accordance with NSTIR standards.

Environmental effects, issues, and mitigation for ancillary elements are similar to those discussed under the construction and operation activities for the Project. Additional information is provided in Section 2.3.1.5.

2.3 PROJECT ACTIVITIES

This section provides a description of construction and operational activities typical for a 100-series highway.

2.3.1 Construction

Prior to initiating construction, clearing of trees and shrubs will be required to accommodate site preparation activities such as grubbing and grading. Following clearing, construction activities will include the following:

- site preparation activities to prepare the site for road and structure development (including access roads and interchanges) such as grubbing and installation of sediment control structures
- roadbed preparation (including access roads and structures) such as blasting, excavation, placement of fill material, and drainage culverts
- installation of watercourse crossing structures, including an arch structure for Seely Brook
- surfacing and finishing including activities such as paving, line painting, and installation of signs and guide rail
- development and removal of temporary ancillary structures and facilities.

Additional details of these activities are provided below.

2.3.1.1 Site Preparation

Site preparation includes activities associated with the preparation of the site in anticipation of roadbed construction such as:

- clearing and grubbing
- sediment and erosion control measures
- removal or modification of existing buildings.

Clearing and Grubbing

The first phase of major construction activity will be clearing of the proposed alignment. Construction of the initial two-lane highway will require clearing the RoW to a width of approximately 50 m (25 m each side of the centerline), except for a few areas where greater widths are required to accommodate the interchange and deep cuts and fills. Where access roads will be constructed, additional clearing may be required. Clearing width will vary depending on the toe of the slope (*i.e.*, 4 m from the toe of slope or top of cut). Limits of clearing will be clearly indicated on the contract drawings and in the field (*i.e.*, surveyed and marked with flagging tape).

The primary environmental concern associated with clearing of the RoW is to limit ground disturbance which may result in erosion and sedimentation of wetlands and watercourses. Harvesting will be conducted using conventional harvesting techniques and equipment and in accordance with the NSTIR Standard Specifications (1997 and latest revisions). Trees will be cut to within 0.3 m of the ground. Merchantable timber (minimum butt diameter of 100 mm and a length of 2.5 m) will be de-limbed and removed from the site, while non-salvageable material will be chipped within the RoW and left in place.

Isolated or ornamental trees, as designated by the Project Engineer, shall be removed, and relocated in accordance with NSTIR's Standard Specifications (1997 and latest revisions). Removal will be done by excavating the tree and removing the total tree including stump and roots, limiting damage to the surrounding property.

Clearing activities will be conducted outside of the breeding season for birds (*i.e.*, no clearing between mid-April and mid-August), where possible. Where it is not possible to avoid clearing during the bird breeding season, mitigation measures will be undertaken by NSTIR to facilitate compliance with the *Migratory Bird Convention Act*. Where possible, clearing operations will be conducted during winter months on frozen ground to protect the underlying vegetative mat and reduce erosion and sedimentation of watercourses and wetlands. Hand clearing will be conducted where ground conditions are not suitable for heavy equipment access (*e.g.*, within watercourse and wetland buffer zones).

Grubbing for roadway construction involves the removal of all organic material and unsuitable soil above the underlying soil. It also consists of the removal, disposal and/or salvage of all stumps, roots, downed timber, embedded logs, humus, root mat and topsoil from areas of excavations and embankments or other areas as directed by the Project Engineer. Grubbing is required for all areas where fills are less than 1.5 m or where excavation is planned. Grubbing is usually not required under fills greater than 1.5 m in depth, unless a structure (*e.g.*, bridge, culvert or retaining wall) is to be constructed, or where there is a significant layer of compressible soil that could cause a future settlement problem. To reduce environmental risks associated with erosion and sedimentation, grubbing within 30 m of a watercourse is conducted only after the installation of culverts and required erosion and sediment controls (*e.g.*, sediment fence, settlement ponds, *etc.*).

Bulldozers are typically used to scrape the organic material off the underlying soil and to pile the material. If the grubbed material is to be removed from the site, track-mounted excavators are sometimes used to load the material on to dump-trucks. Where grubbing involves the removal of extensive organic deposits (*i.e.*, peat), the material is usually removed by an excavator and loaded directly to dump-trucks. If the deposit of unsuitable material cannot be removed with a track mounted excavator, a drag-line excavator is often used.

The projected end use of the grubbed material and the method of disposal dictate whether incidental organic materials such as stumps, roots, *etc.* are removed prior to re-use or disposal. Some stumps may be removed from the grubbed material and chipped. Grubbed material may also be used in erosion and sediment control. Where feasible, grubbed soil may also be used to flatten the slopes of embankments along the roadway depending on soil quality and the need for fill at the site. Topsoil will be salvaged for use in the median and on side slopes as per NSTIR's Standard Specifications (1997 and latest revisions). Other grubbed material is disposed of as indicated in Section 2.3.1.5.

Erosion Prevention Measures

The primary environmental concern during site preparation is to manage ground disturbance to limit erosion and prevent sedimentation of wetlands and watercourses. Erodibility of soils and overburden material depends on terrain, cut slope, grain size and drainage characteristics of the material. Several generic measures that can be taken to minimize sedimentation and

erosion potential include: fitting the development to the terrain; construction sequencing to minimize soil exposure; retaining existing vegetation as long as possible; vegetation and mulching of grubbed areas; diverting runoff away from denuded (*i.e.*, bare) areas; reducing length and steepness of slopes; keeping runoff velocities low; properly sizing and protecting drainage ways and outlets; intercepting sediments on site; and inspecting and maintaining control measures. Erosion and consequent siltation due to direct runoff is a concern to dug wells in proximity to the alignment (*e.g.*, a few 10s of m) and where direct overland flow of silt occurs. It is important to prevent uncontrolled erosion to watercourses and wetlands.

A 30 m buffer of undisturbed vegetation will be maintained between the construction area and watercourses until required erosion and sediment controls are in place and watercourse crossing structures are installed. A 5 m buffer will be retained adjacent to wetlands.

Erosion and sediment control will be carried out according to:

- Nova Scotia's Watercourse Alterations Standard (NSE 2015);
- NSTIR's Standard Specifications (1997 and latest revisions);
- Generic Environmental Protection Plan (EPP) for the Construction of 100 Series Highways (Generic EPP) (NSTPW 2007; see also http://www.gov.ns.ca/tran/enviroservices/enviroErosion.asp);
- National Guide to Erosion and Sediment Control on Roadway Projects (TAC 2005); and
- Terms and conditions or government approvals, authorizations, and letter of advice.

NSTIR's work progression schedule will require construction in any work area to be carried out continuously from initiation to completion thereby reducing exposed soil on construction sites. Site-specific Water Control Plans, Erosion Control Plans, and Contingency Plans will be developed for the Project, where appropriate, and will specify the location of specific mitigation measures. These may require approval by NSE under Part V Water Approval process prior to culvert installation.

Removal or Modification of Existing Buildings

As of January 2017, approximately 30% of the land within the RoW has been acquired by NSTIR. The remaining land required for the Project RoW is currently being expropriated by NSTIR. There are nine buildings located within the PDA which will be purchased by NSTIR and removed prior to construction. Any required municipal or provincial permits associated with building removal will be obtained by the contractor performing the demolition. Waste from any such removals will be managed in accordance with the provincial Solid Waste-Resource Management Regulations.

2.3.1.2 Roadbed Preparation

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

- Excavation, blasting and ripping;
- Subgrade preparation;
- Sub-base and base construction;
- Grade separation structures;
- Ditching and drainage management;
- Work progression; and
- Contaminated sites.

Excavation, Blasting and Ripping

The removal of material for the construction of subgrade (bottom layer of material) may involve one or more methods of excavation including common excavation, rock excavation, and swamp excavation. Common excavation is the removal of overburden, including till, smaller boulders, and topsoil. Rock excavation is the excavation of rock which is bedrock or single pieces greater than one cubic metre in size. Cuts in "soft" rock can be accomplished using ripper blades attached to the back of larger bulldozers, breaking up the rock so that it can be loaded on to trucks with an excavator or loader.

Swamp excavation occurs where soil is unsuitable for use as a subgrade. The soil is either excavated and replaced with a competent fill, or floated over using geogrids or berm construction. This may occur when peat is encountered or when exposed soil has been saturated with water. Excavated soils unsuitable for use as fill or dressing slopes are disposed of at a site approved by the Project Engineer (or potentially salvaged for use in wetland restoration projects). An NSE Approval for wetland alteration will be obtained prior to any disturbance of wetland habitat.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment, and connectors. Conservative slopes for cuts and embankments will not exceed 3 horizontal:1vertical in sands and gravel as well as in cohesive soils (silts and clays). Flatter slopes will be used if necessary.

The use of blasting for rock excavation is dependent upon the competency of the rock. The contractor will determine whether blasting will be required for the construction of the proposed alignment. Wherever practical, rock excavation will be performed by ripping rather than blasting, due to the lower costs involved.

Based on overburden thickness and lithology (physical character of the rock), blasting is expected to be minor along the alignment (refer to Section 5.2). However, it may be required near the southeastern end of the alignment near the Marshalltown Road intersection with the existing Highway 101.

If blasting is necessary, blasting operations will be conducted in accordance with the applicable federal and provincial regulations and guidelines. Blasting in or near watercourses will require approval from DFO, and will be conducted in accordance with the "Guidelines for Use of

Explosives in or Near Canadian Fisheries Waters" (Wright and Hopky 1998). Blasting will also be conducted in accordance with the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act*. The contractor performing the blasting will have a valid Blaster's Licence and will confirm that a pre-blast survey has been conducted prior to blasting.

Subgrade Preparation

Several factors are considered in the design of the vertical alignment for the highway including subgrade and grade separation preparation. Major cut and fill sections are designed based on factors such as: slope stability; erosion control; silt and runoff control; location and rehabilitation of borrow pits; impacts on groundwater; and impacts on blowing snow. Specific cut and fill information is not available at this stage of the Project.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment. As per NSTIR's Standard Cross Section conservative slopes for cuts and embankments will not generally exceed three horizontal: one vertical; slopes may be steeper in rock, rock fill, and guardrail locations (*e.g.*, 2:1). Cut slopes in soils tend to undergo minor sloughing where high groundwater and freeze-thaw occurs. These are typically repaired using a layer of rockfill to facilitate drainage.

Borrow material, required for subgrade construction, will likely be derived from glacial till found near the alignment. Based on the surficial and bedrock geology, most of the materials used in subgrade construction will consist of glacial tills and bedrock of the Goldenville Group. The glacial tills are relatively fine grained and tend to be suitable as a subgrade fill material but are sensitive to moisture and are difficult to work with during wet periods of the year. They are also erodible, therefore erosion/sediment control measures will be necessary at borrow pits and along the alignment where these materials are used. Rock fill may be used as borrow material, but tends to be more expensive to obtain than glacial till. Borrow pits and existing quarries for rock will avoid the Halifax Formation bedrock to minimize the risk of encountering acid producing rock. The Halifax Group consists of the Acacia Brook Formation within the PDA (see Section 5.2)

All layered bedrock within the proposed alignment that may be disturbed or exposed will be tested for its potential to produce acid. Testing will comply with specifications outlined in the Sulphide Bearing Material Disposal Regulations under the Nova Scotia *Environment Act*. Exposure, removal, and disposal of potentially acid generating bedrock must be conducted in compliance with the Guidelines for Development on Slates in Nova Scotia (NSDOE and Environment Canada 1991), and the Sulphide Bearing Material Disposal Regulations. For further discussion on acid producing bedrock, refer to Section 2.4.14.

Subbase and Base Construction

Once the sub-grade or subbase has been brought to final lines, grade and cross sections as shown on plans or as approved by the Engineer, granular material consisting of crushed and screened rock or gravel are applied to the roadway. Normally on 100 Series Highway construction projects, once the subgrade is completed a 300 mm layer of Gravel Type 2 is applied. Then on the ensuing paving contracts, an additional layer of Gravel Type 2 (based on testing of bearing capacity) and additional layer of Gravel Type 2 (if required) and Gravel Type 1 is applied. The gravel provides a free draining layer under the asphalt concrete pavement.

Ditching and Drainage Management

Ditching, drainage channels and cross culverts will be designed and constructed to avoid erosion issues and divert stormwater away from active work areas. These will be constructed where natural drainage and surface runoff is intersected by new roadway construction. The outlets from ditches and drainage channels will be directed away from natural watercourses into areas of dense vegetative growth. Erosion control measures (*e.g.*, erosion control blankets, hydraulic mulches, turf reinforced mats and rip rap) will be used to line ditches, swales, and drainage channels to minimize erosion and siltation of down gradient watercourses and wetlands.

Work Progression

The progression of construction activities is described in Section 3.1 of the Generic EPP to facilitate the orderly progression of work and environmental protection. In any sensitive work area, the time between grubbing/cut/fill activities to stabilization will be no greater than 30 days. Stabilization refers to landscaping, hydroseeding and/or mulching, and includes completion of ditches and shaping of slopes as well as installation/maintenance of temporary and permanent sediment and erosion control structures.

2.3.1.3 Watercourse Crossing Construction

An authorization and compensation plan pursuant to Section 35 (2) of the *Fisheries Act* may be required from DFO to offset potential serious harm to commercial, recreational, and/or Aboriginal (CRA) fish and fish habitat. This is a result of the loss of fish habitat through the realignment of Seely Brook and the tributary to Seely Brook. The preliminary structure alignment is shown on Figure 2.1 (Section 2.2.3). The detailed design is currently underway and will be included in future permitting requirements.

Culverts will be constructed of either cast-in-place concrete or precast concrete and can be either three-sided (open bottom) or four sided. A typical box culvert would have a maximum inside clear span of 3.6 m. Two or more lines of box culverts may be placed side-by-side to create twin or multi-barrel box culvert installations for wider watercourses.

All crossings of watercourses are normally designed to accommodate the 1 in 100-year storm for the local region as defined by data from the Atmospheric Environment Service of ECCC. These estimates will incorporate anticipated changes in precipitation due to global warming.

Culvert sizing will be reviewed during highway design but will consider potential Project-related changes to local drainage patterns through blockage or alteration of existing drainage or creation of drainage patterns. Most small watercourses have limited drainage areas and may therefore be susceptible to effects of highway drainage. This assumes that normal standards are used in the design of hydraulic structures, including addressing the high risk for the initiation of an ice or debris jam and the accommodation of increased storm flows due to highway runoff and global warming. Estimates of runoff volumes and design of runoff control features will be made during the final highway design process using standard highway design criteria once the alignment and profile have been finalized.

2.3.1.4 Surfacing and Finishing

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

- paving
- hydroseeding and other permanent erosion control measures
- signage, lighting, guide rail installation
- highway marking/painting.

Paving

Most pavement used in Nova Scotia is the familiar black asphalt concrete. This material is made by mixing petroleum based liquid asphalt with sand and crushed stone (aggregates) in an asphalt plant. The hot mix is easily transported, spread, and rolled to provide a smooth surface that can be used almost immediately. Special care must be taken in the design and placement of granular and asphalt pavement layers to minimize wheel track rutting and frost action that may break the pavement and cause pot holes.

Concrete pavement is another type of road surfacing material. The material is made by mixing Portland cement, sand, gravel, and water at a concrete batch plant. The concrete mix material is transported by trucks and placed by a slip forming machine that automatically creates joints complete with steel joint dowels to retain alignment in adjacent slabs. Concrete must set or cure for several days before it can be opened to traffic. Although it has a higher initial cost than asphalt pavement, concrete pavement is rigid and provides a smooth riding surface which is not subject to rutting and generally resists frost action and pot holes.

Both pavement types require durable crushed stone that will meet NSTIR specifications. Provision of crushed stone will be the responsibility of road construction contractors, who will abide by

appropriate pit and quarry regulations. It is expected that stone for pavement mixes will be obtained from existing quarries near the Project area.

Hydroseeding and Other Permanent Erosion Control Measures

Stabilization of the finished soil surface is typically carried out by hydroseeding and covering with straw mulch, hydraulic mulches, erosion control blankets (*e.g.*, slope protection and channel protection) or turf reinforced mats (*e.g.*, permanent channel protection). Hydroseeding will be conducted as soon as possible after completion of the soil preparation, as per NSTIR's Standard Specifications (1997 and latest revisions; Division 7, Section 5). Final dressing of the slopes will be done as areas are completed to enable hydroseeding to be done in stages as work progresses, in accordance with the Work Progression Schedule.

Hydroseeding will not be permitted on hardened or crusted soil. Final dressing of slopes will include removal of materials such as sticks, roots or large rocks; loosening of the top 50 mm of soil; and scarification (or tracking) to minimize runoff velocities. Scarifications will be parallel to the contour of the slope with a minimum indentation (high to low) of 25 mm and at a maximum spacing of 150 mm. Scarifying can be made by means of dozer treads or any other mechanical means such that scarifications meet the above noted specifications.

Hydroseeding will not be performed under windy conditions, or during periods of rainfall or severe drought, on areas covered by standing water, on frozen surfaces or under other adverse conditions, as determined by the Project Engineer.

Signage, Lighting, and Guide Rail Installation

Signage, lighting, guide rail, and barriers will be installed once most construction activities have been completed. Signage and lighting installation involves localized disturbances within the finished Project, and will require small amounts of excavation and placement of concrete footings for the erection of the posts and signs. Guide rail installation involves posthole drilling, post installation and attachment of metal guide rail to the posts. Environmental protection procedures for signage and guide rail installation are included in Section 3.15 of the Generic EPP and include guidance for handling wood preservatives (*i.e.*, waste wood ends should be disposed of through a solid waste facility and not burned). Lighting and reflective devices will also be installed where necessary. Lighting is typically used near intersections and interchanges.

Highway Marking

The painting of pavement markings will also be performed after most construction activities have been completed. Marking, or striping, a highway consists of physically painting yellow and white longitudinal and transverse lines and other symbols and words as required on road surfaces to ensure the traveling public receives direction and guidance. The arrangement of these markings will be in accordance with Transportation Association of Canada's (TAC) Manual of Uniform Traffic Control Devices (TAC 2014) and NSTIR policies. The products that will be used

for highway marking will be approved products that meet NSTIR's Standard Specification (NSTIR 1997 and latest revisions).

2.3.1.5 Temporary Ancillary Elements

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

- temporary access roads
- borrow areas
- petroleum storage areas
- materials and equipment (transportation, storage, and handling)
- construction waste disposal
- mobile asphalt plants.

The exact locations of temporary ancillary elements have not been determined at this time. The following subsections provide information regarding the process for selection of suitable sites. The siting of temporary ancillary elements will avoid wetlands, watercourses, archaeological resources, species at risk (SAR), and species of conservation interest (SOCI), to the extent possible. Environmental investigations will be carried out in advance of development of temporary ancillary elements outside of the RoW to determine suitability of proposed locations.

Temporary Access Roads

Construction activities will require provision of access to the RoW and to maintain landowner access during construction activities. Existing access roads will be used to the extent possible; however, temporary access roads may be necessary. Temporary access roads will be constructed in accordance with landowner agreements and other construction practices as described in this section.

Borrow Areas

For this Project any new borrow sites located outside the RoW will require further environmental investigation (*e.g.*, archaeological and heritage resources, rare plants) and approval from the NSE as part of the approval for this Project. Mitigation, where required, will include avoidance of environmentally sensitive areas and will comply with guidelines for borrow areas described in the Generic EPP (Section 3.11) including the following: NSTIR will approve all borrow sites; pits will be operated in accordance with applicable guidelines, policies, acts, and regulations; an erosion and sediment control plan will be developed by the contractor for review and approval by the Project Engineer; and pits must be left in a neat and safe condition so as to comply with the Pit and Quarry Guidelines.

Petroleum Storage Areas

Specific mitigation measures in regard to storage of hazardous materials during construction are identified in the Generic EPP (Section 3.14) and include the following:

- Permanent storage areas for containers or drums will be clearly marked
- Storage areas will have appropriate secondary containment
- If drums are stored on their sides, the drums shall be stored so that the bungs are in the "9 and 3" position, on level ground and prevented from rolling
- Drum storage areas shall be marked or fenced with temporary fence to avoid impact
- Day-use quantities can be stored upright or on the side as required, drip pans lined with absorbent pads shall be used beneath taps
- Machinery will be checked regularly for leaks
- Storage of petroleum products is not allowed within boundaries for water supply watersheds or designated environmentally sensitive areas. Lubricants, hydraulic fluid, grease, gasoline, diesel, or other fuels will not be stored within 30 m of any watercourse
- Refuelling and equipment maintenance required in the field will not occur within 30 m of a watercourse, drainage ditch, areas with a high water table, private wells, or exposed and shallow bedrock.

These guidelines apply directly to watercourses, but are also considered to be relevant to the protection of groundwater resources, including private wells. The appropriate permits, as set out in the *Petroleum Management Regulations*, will be obtained for any onsite temporary fuel storage tanks.

Materials and Equipment

Vehicles used in construction typically include cranes, excavators, bulldozers, rollers, trucks, asphalt-concrete pavers, and graders. Most of these vehicles operate on diesel fuel and require some form of daily maintenance. Truck traffic generated by the Project during construction is closely related to the amount of imported fill material required. In general, highways are designed so that cut and fill volumes are balanced which minimizes the amount of fill that must be obtained or disposed outside the area of construction. If asphalt-concrete and concrete plants are not located onsite and/or aggregate must be obtained from offsite sources, the amount of truck traffic on the access roads will increase accordingly. Offsite truck traffic will also consist of hauling various unclassified excavated and other materials to approved disposal sites, and/or the movement of construction equipment to and from the Project site. Trucking operations during the subgrade construction phase will primarily include onsite transportation activities of materials for cut and fill operations. Specific borrow and disposal sites will not be known until they are identified by the construction contractor. All borrow areas and quarry operations will be conducted at approved sites in accordance with applicable laws and regulations.

Vehicles used in base and pavement construction include steel drum rollers, graders, trucks, and asphalt concrete pavers. If the asphalt concrete plant is located onsite and a suitable source of

aggregate used for the asphalt concrete and road base construction can be found onsite, truck traffic during this portion of construction will be limited to the delivery of primer, tack coat, asphalt cement and diesel fuel. If the asphalt concrete plant is not located onsite and/or aggregate must be obtained from offsite sources, the amount of truck traffic on the access roads will increase accordingly.

Use of local and collector highways for access to the Project will be subject to applicable Provincial gross vehicle weight maximums and spring weight restrictions.

Material will be stockpiled in such a way as to prevent their erosion and to prevent sedimentation to any adjacent watercourses or wetlands. The runoff from stockpiled material will be managed using standard sediment and erosion control practices and will be directed to a settling basin to be maintained in accordance with NSTIR Standard Specifications. Non-salvageable erosion control materials will also be properly disposed of when no longer needed or damaged (*e.g.*, silt fences).

Construction Waste Disposal

The most desirable use of material excavated from the RoW during construction is use within the RoW (*e.g.*, buried in the toe of the slope), assuming it conforms to NSTIR standards. Disposal of waste materials from the construction of the proposed undertaking will be in accordance with NSTIR's Standard Specifications (1997 and latest revisions) for highway construction and any provisions included in site-specific contracts. The current specifications for clearing and grubbing do not include any specific criteria for the selection of waste disposal sites. Disposal sites will be located by the contractor and must be approved by NSTIR. Existing approved construction and demolition debris disposal sites may be used for disposal outside the RoW.

Non-salvageable material from the clearing operations, such as limbs and non-merchantable timber, are typically chipped within the RoW and left in place except within buffer zones for watercourses and wetlands. Occasionally, large items which cannot be easily chipped (*i.e.*, stumps) are buried on adjacent land. Excavated organics overburden and rock must be disposed of where their use as fill material is impractical. Management and disposal of potential acid generating bedrock, if encountered, will be conducted in compliance with the Sulphide Bearing Material Disposal Regulations.

Mobile Asphalt Plants

A mobile asphalt plant may be required for the manufacture of hot mix paving asphalt. Nearby off-site quarries, may be used as temporary locations to reduce the haulage distance. Permits are required for the operation of the asphalt plant, specifically an Industrial Approval under the Activities Designation Regulations, and if required registration of petroleum storage tanks under the Petroleum Management Regulations. Asphalt plants will be operated in accordance with applicable regulations and appropriate mitigation will be applied (Section 3.17 of the Generic

EPP). The Canadian Construction Association's (CCA) Environmental Best Practices Guide for Hot-Mix Asphalt Plants (CCA 2004) will also be adhered to.

The location of an asphalt plant is chosen by the contractor prior to construction and must be approved by the Project Engineer. The plant and its components will be in compliance with the American Society for Testing and Materials (ASTM) D995-95b (Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures) (ASTM 2003) and the contract documents.

2.3.2 Operation and Maintenance

Operation and maintenance activities for the Project include:

- highway operation
- infrastructure maintenance
- winter maintenance
- vegetation management.

2.3.2.1 Highway Operation

The highway will initially operate as a two-lane freeway with a posted speed limit of 100 km/h. The highway will eventually be modified to a four-lane (twinned) freeway with median; however, the schedule for this construction has not been determined. Traffic volumes are not expected to increase because of the Project; however, the level of safety and performance of the transportation network will improve because of the Project.

2.3.2.2 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 repair of the asphalt concrete surface may include 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, bridge maintenance and line repainting. Disruption to the public from these repairs will be temporary and infrequent in nature.

2.3.2.3 Winter Maintenance

Winter highway operations activities generally include snow removal and ice control to reduce traffic disruptions and safety hazards. Snow removal includes plowing services provided by NSTIR or contracted out.

Road ice is controlled by the application of salt and sand. Salt is applied to roads to retain clear driving lanes within a reasonable time after a storm. Sand is applied to roads surfaces to provide traction on snow-packed or icy roads.

NSTIR has implemented several initiatives to help manage the use of road salts. These initiatives include:

- Installation of road weather information system (RWIS) sites
- New winter maintenance standards to provide a consistent and measurable level of service for ice and snow removal to all areas of Nova Scotia
- Upgrading of salt spread truck fleet through the installation of computerized salt controls, infrared pavement temperature sensors, and retrofitting of some trucks with pre-wetting capability.

Pre-wetting operations involve the application of a sodium chloride (NaCl) brine solution to the road salts just prior to application on the highway. Pre-wetting is carried out in an effort to reduce the loss of road salts applied to highways due to wind and traffic disturbance.

Further reductions in road salts can be realized if placed just prior to a storm event. This is usually referred to as "anti-icing" as opposed to "de-icing".

In accordance with ECCC's Code of Practice for the Environmental Management of Road Salt, NSTIR has developed a Salt Management Plan (SMP). The SMP provides a mechanism through which NSTIR can commit to implementing best management practices while fulfilling its obligation to providing safe, efficient, and cost effective roadway systems.

2.3.2.4 Vegetation Management

Regrowth of vegetation within the RoW may interfere with the lines of sight required for safe use of the highway. Clearing along the RoW is part of NSTIR's regular maintenance to maintain sight lines and may involve both manual and mechanized cutting. Vegetation management may also include use of species that require minimal management in the Project environment.

Vegetation management techniques will be employed where feasible to promote sustainable growth along the highway; however, if herbicide application is required for the control of noxious weeds, the application will be carried out by trained personnel who will apply the herbicide in accordance with an approval issued by the NSE pursuant to the Pesticide Regulations under the Nova Scotia *Environment Act*.

2.3.3 Decommissioning

The highway is planned to operate in perpetuity and will be maintained as necessary for an indefinite period. Decommissioning, if required in the future, will be undertaken in compliance with relevant laws, regulations, and guidelines current at that time.

2.4 ENVIRONMENTAL DESIGN CONSIDERATIONS

In addition to designing the Project with the intent to reduce effects on the biophysical environment (*e.g.*, reducing the Project Development Area or PDA, as defined in Section 4.2.1, to the extent feasible), there are other environmental factors that are being considering during Project design including:

- climate change considerations (*e.g.*, severe weather events)
- geological formations (*e.g.*, acid producing bedrock, Karst topography).

Climate Change Considerations

Projected severe weather events caused by climate change may hamper operational activity. Climate change is more likely to affect projects with much longer durations, however, properly planned engineering of storm water control and roadway design will assist in mitigating these changes. Nationally, Canada has been in a warming trend (1.1° C) since 1895, however, in Atlantic Canada, the warming peaked in the 1950s followed by a cooling trend to the 1990s with an overall trend increase of 0.4° C since 1895. The Atlantic Region does show an overall increase in precipitation since 1948, an increase in the number of daily precipitation events above 20 mm and a slight increase in the number of snowfall events above 15 cm (Lewis 1997).

NSTIR will be designing and installing erosion and sediment control structures to accommodate appropriate levels of precipitation, and considering weather conditions when scheduling activities, including scheduling of activities to accommodate weather interruptions. Heavy snowfalls and accumulation may force temporary closure of operations. Climate and meteorological conditions, including climate change, are not anticipated to significantly affect the operation of the road over its lifetime. Short period events, *e.g.* heavy rainfall, blizzards, or thunder storms, may temporarily close the road for safety reasons (NSTIR 2014).

Acid Producing Bedrock

Acid drainage problems have long been associated with mining related activities in Nova Scotia. In the past 20 years, such problems have also been identified with corridor-type developments such as highways. In Nova Scotia, excluding mining projects, acid drainage problems have been almost exclusively associated with developments in the Halifax Formation Slates.

As outlined in Section 5.2, the alignment is underlain by two geological formations, the Wolfville Formation, and the Bloomfield Formation and the Church Point Formation (Goldenville Group).

These formations are not typically associated with acid drainage problems and are considered as low potential for risk of acid production. The Halifax Group is in proximity to the eastern end of the alignment and, as noted, has a history of acid drainage problems in Nova Scotia. The Halifax Group consists of the Acacia Brook Formation within the PDA (see Section 5.2).

Based on the current highway alignment, acid producing bedrock is not expected to be encountered during construction. It is anticipated that geotechnical drilling will be carried out along the alignment prior to construction to determine the amount of rock excavation and for slope stability that will be necessary for tendering the Project. Rock to be moved during construction will be examined. Rock cores will be visually examined and will be tested if the visual examination reveals anything of a suspicious nature.

If the detailed acid rock testing program reveals sulphide concentrations in excess of 0.4 percent, specified by the Sulphide Bearing Material Disposal Regulations, NSE approval will be required for acid rock disposal. In general, excavated acid rock must be managed according to "Guidelines for Development on Slates in Nova Scotia" (NSDOE and Environment Canada 1991) which includes requirements for monitoring surface water runoff. Further discussion of acid drainage potential, including mitigation measures, is presented in Section 5.2.

Karst Topography

Karst is typically only encountered in areas with evaporite deposits (anhydrite, gypsum, halite, etc.), such as formations of the Windsor Group at Windsor located 135 km to the northeast from the alignment. Evaporite deposits are not associated with Wolfville Formation nor the Bloomfield Formation and the Church Point Formation (Goldenville Group) underlying the alignment.

2.5 ENVIRONMENTAL MANAGEMENT

NSTIR is committed to the construction and maintenance of highways in a manner that is protective of the environment and has prepared an environmental protection plan (EPP) to communicate this commitment to NSTIR staff, contractors, regulatory agencies and the public: the Generic EPP for the Construction of 100 Series Highways (NSTIR 2007). This Generic EPP provides an overview of items of special consideration in highway construction and provides detailed environmental protection measures, monitoring plans and contingency plans for general highway construction activities. This Generic EPP is publicly available on NSTIR's website: https://novascotia.ca/tran/works/enviroservices/EPP100series/Generic%20EPP_July%202007.pdf.

The Generic EPP is referred to throughout this EA document as it contains important best management practices (BMPs) for key environmental interactions which can occur during highway construction. The NSTIR SMP, as described in Section 2.3.2.2 will also apply to this Project.

Contractors hired by NSTIR for highway construction are expected to comply with requirements in the Generic EPP as well as the Terms and Conditions of government approvals/authorizations

and environmental control plans (ECPs) that they develop as part of construction tenders and contracts or during construction as the site conditions change or in response to unplanned events (*e.g.*, storms, accidents, and new technologies and equipment). The contractor's ECP will also include contingency plans and contractor awareness training to provide an overview of generic requirements and highlights of specific items of concern for the Project including identification and avoidance of SAR, critical habitat, and archaeological and heritage resources. Where considered appropriate, this EA document highlights specific items to be incorporated in contractor awareness training for the Project as well as contractor ECPs.

Machinery will be inspected regularly to properly maintain and minimize petroleum, oil, or lubricant (POL) leaks and drips. Employees and subcontractors will be required to implement appropriate control measures to prevent POL leaks during construction activities.

Emergency situations involving the accidental release of hazardous materials to the environment, discovery of historic or cultural resources, and other unplanned events, will follow the contingency and emergency response procedures provided in contractor ECPs, Section 5 of the Generic EPP, and Volume 4 of NSTIR's Health, Safety, and Environmental Program.

Environmental protection procedures and measures will be observed and employed throughout the life of the proposed Project, as outlined in NSTIR Standard Specifications. NSTIR will be responsible for installation, maintenance, and inspection and monitoring of environmental protection control measures during the operation and maintenance phase.

2.5.1 Inspection and Monitoring

To confirm compliance with environmental standards and regulations, the contractor will perform regular inspections and monitoring. NSTIR's Project Engineer also conduct periodic inspections of construction sites and environmental control measures. Improperly installed or damaged environmental controls will be corrected in accordance with the Generic EPP, Standard Specifications, contract requirements and/or manufacturers requirements.

NSTIR will establish an environmental compliance monitoring (ECM) program to monitor that regulatory requirements and commitments are being met. ECM can be divided into two elements: regulatory environmental surveillance; and self-regulatory ECM. Regulatory environmental surveillance is carried out by regulatory authorities. Self-regulatory ECM is that which NSTIR undertakes to monitor its own activities against internal and external environmental standards. Self-regulatory ECM overlaps with regulatory environmental surveillance where the external standards which are being monitored are regulatory in nature. However, self-regulatory ECM is a much broader concept and is an important tool for the implementation of mitigation, particularly where government regulations are vague or non-existent. Self-regulatory ECM can involve:

- monitoring of all environmentally-sensitive activities for compliance with internal and external non-regulatory environmental standards;

- coordination of communication with regulatory authorities; and
- provision of on-site environmental advice to project personnel.

The principal mechanism for ECM will be the Generic EPP, which provides the practical framework for the implementation of the environmental requirements of the Project. The EPP will also provide a common reference document against which compliance can be judged by both regulatory authorities and NSTIR.

Environmental effects monitoring (EEM) involves taking repetitive measurements of environmental variables over time to detect changes caused by external influences directly or indirectly attributable to a specific human activity or development. EEM is generally undertaken to:

- improve environmental understanding of cause and effect relationships;
- provide an early warning of undesirable change in the environment; and
- verify earlier predictions of impacts and effectiveness of mitigative measures.

The EEM recommendation program will be incorporated into the EPP and will be updated as required, as information regarding the predicted impacts and effectiveness of mitigative measures is collected.

Where habitat restoration is undertaken, monitoring programs will be implemented.

2.5.2 Compensation Programs

2.5.2.1 Compensation for Land Acquisition

NSTIR's land acquisition and compensation policy will generally follow the guidelines developed under the Nova Scotia *Expropriation Act*. Property expropriation under the Act, however, only occurs when negotiations between individual property owners and/or their legal representatives fail in reaching a fair and equitable settlement.

Once the location of the proposed undertaking has been determined, the process of land acquisition begins. Normal practice is to determine the local market value in accordance with recognized real estate appraisal practices for properties directly impacted and those which may be injuriously affected as appropriate. Acquisition and Disposal Officers contact property owners to negotiate a mutually acceptable settlement. If negotiations fail, the property is formally expropriated and the claim is scheduled to be heard by the provincial Expropriation Board.

The majority of the RoW for this Project is being acquired through expropriation.

2.5.2.2 Compensation for Lost Habitat

Under the federal *Fisheries Act* and Fisheries Protection Policy Statement (DFO 2013), serious harm to CRA fishery species requires authorization from DFO and an offsetting plan to compensate for lost habitat. It is anticipated that Project construction associated with the watercourse crossing construction at Seely Brook will potentially result in serious harm to CRA fishery species and therefore require an authorization from DFO and habitat compensation to offset this serious harm.

Construction activities will also result in loss of wetland habitat (refer to Section 5.5) which will require approvals from NSE and a habitat compensation program to achieve no net loss of wetland habitat.

In anticipation of fish habitat and wetland compensation requirements for Highway 101 twinning in various locations, NSTIR initially developed three large salt marsh compensation projects (habitat banks) that collectively restore more than 70 ha at Cheverie Creek, Walton River and St. Croix River. The St. Croix Project has been accepted by NSE as a "consolidated compensation project" for all the anticipated wetland compensation requirements of twinning between St. Croix and Coldbrook. To date, NSTIR have used the St. Croix bank for 13 wetland alterations and *Fisheries Act* authorizations around the Province. This bank still has approximately 10 ha of "habitat credits" available for future applications for wetland and fish habitat compensation. The other two banks, Cheverie and Walton, have since been closed with no available credits.

The St. Croix Project involved the restoration of high salt marsh and floodplain wetlands that were altered or lost by dyking in the 1950s by Agriculture Canada and NS Agriculture (under the former *Maritime Marshland Reclamation Act*). Removal of dyke segments from all four quadrants of the highway crossing and an obstructing culvert in the southeast quadrant restored natural tidal flow and fish passage to 18.1 ha of former and existing wetlands. The Project was completed in August 2009, and monitoring and adaptive management continued for five years after construction (i.e., to 2014 at St. Croix and a nearby Reference Marsh site).

2.6 PROJECT SCHEDULE

Detailed design is scheduled to be completed by early 2017. The proposed construction period is currently anticipated to begin with clearing in 2017, following detailed field survey and geometric design, acquisition of the remainder of right of way, and the provincial environmental approval process for watercourses and wetlands.

The construction of the Seely Brook watercourse structure and the recreational trail structure will proceed after the clearing. Earthworks and placement of sub-base material for the roadway sections will start in spring of 2017 and continue into summer of 2018. Paving is scheduled for

2018, with an anticipated completion and opening date of October 2018. Operation of the highway will occur indefinitely with no plans for decommissioning.

In general, construction activities will be scheduled to avoid potential interactions with Valued Components (VCs) during sensitive periods (*i.e.*, breeding periods) where recommended as specific mitigation measures; recommended as general protection practices; or to comply with specific required permits and conditions. For example, instream work at watercourses will generally be limited to the period from June 1 through September 30, as per Nova Scotia Water Approvals and DFO authorizations to avoid fish migration and periods of higher precipitation and runoff potential.

Although the functional design was based on a four lane highway, present traffic volumes do not warrant such construction; therefore, initial construction will be for a two-lane highway. However, corridor space required for the remaining two lanes will be preserved, and twinning will occur as future traffic volumes warrant.

3.0 STAKEHOLDER CONSULTATION AND ABORIGINAL ENGAGEMENT

3.1 OVERVIEW

While highway projects are typically undertaken to improve transportation infrastructure and public safety, it is important to consider the needs, concerns and benefits of the public to be served by the Project as well as area residents who may be affected by Project activities. Key issues identified by the public are subsequently considered during the EA and design processes and where possible, economically, and technically feasible approaches can be taken to address concerns.

This EA is based on the studies undertaken in 2001 and 2002, as well as additional 2016 field surveys, regulatory and stakeholder consultation, and Aboriginal engagement activities, and updated information as applicable where Project details and environmental conditions may have changed.

3.2 REGULATORY CONSULTATION

Several provincial and federal regulatory agencies have been engaged thus far during Project planning. NSTIR started planning work for the full 26 km corridor (Digby to Weymouth) in 1991. Open houses were conducted in 1992 and 1999. As discussed in Section 1, an EA for the Project was initiated in 2000 when the Project was subject to federal and provincial EA processes under the superseded *Canadian Environmental Assessment Act* and provincial *Environment Act*. The EA was submitted in 2002/2003 as a Class II EA, but withdrawn when the EA regulations changed to require only a Class I EA Registration. With changes in NSTIR priorities, the project was not re-registered. Field studies conducted in 2001 and 2002 were based on regulatory consultation at that time, while the 2016 field studies were based on current legislation.

Several provincial and federal regulatory agencies have been engaged over the planning cycle thus far for the Project. In the early 2000s when an EA was required under the former CEAA, NSTIR contacted representatives from regulatory agencies with a potential interest in the Project including NSE, NSDNR, Nova Scotia Community, Culture and Heritage (NSCCH), the Canadian Environmental Assessment (CEA) Agency, DFO and ECCC (formerly EC) to discuss the proposed scope of assessment and potential issues of concern. Although the federal EA process was not formally initiated, regulatory agencies agreed to participate in the EA process on an informal basis, providing technical and regulatory advice on scope of assessment, survey protocols and mitigation/compensation, until such time as they were formally engaged.

On May 10, 2016, NSTIR and Stantec met with NSE in Halifax to reintroduce the Project and EA process, with the understanding that only a provincial EA process would now be required under the regulatory regime. The purpose of the meeting was to: provide information about the Project; identify and discuss issues and concerns to inform the scope of the EA; discuss the proposed Project schedule and regulatory approvals process; and discuss the approach to public and Mi'kmaq engagement. At this meeting, government department representatives discussed expectations for new data and reuse of original draft 2003 EA data. In follow-up communication with NSDNR on May 11, 2016, NSDNR indicated that new field surveys should be undertaken. This input was used to develop the current scope of work reflected in this EA. Field surveys were conducted to meet current legislative standards and georeferenced data were collected for the EA. Field survey scope and methods are described in Section 5.

Municipal representatives have also been engaged, including:

- **Digby Town Council:** Consultant briefed Digby Town Council as part of initiating the EA process (2001).
- **Town of Digby:** NSTIR corresponds with Town re: location of proposed markers for Poor Farm (or Alms House) cemeteries (2007).
- **Highway 101 Task Force:** NSTIR met with municipal leaders from Town of Digby, Municipality of the District of Clare, Municipality of the District of Digby and Gordon Wilson, MLA Clare Digby to discuss proposed corridor (July 30, 2013, February 17, 2014, April 15, 2014, September 23, 2014, July 6, 2015 and March 10, 2016).

3.3 ABORIGINAL ENGAGEMENT

Engagement with the Mi'kmaq of Nova Scotia early in a project planning process is important to the success of a project. There are 13 First Nation communities with Chiefs in Council in Nova Scotia. The Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) represents the negotiations between the Mi'kmaq of Nova Scotia, the Province of Nova Scotia and the Government of Canada. The Sipekne'katik (Shubenacadie) First Nation and Millbrook First Nation, however, are not represented by the KMKNO. Mi'kmaq people living off-reserve are represented by the Native Council of Nova Scotia (NCNS).

Aboriginal engagement was initiated under the draft 2003 EA and was resumed in October 2014. This included letters to the KMKNO and the 13 First Nation bands in Nova Scotia. On December 2, 2014, NSTIR received a response from the KMKNO indicating their wish to proceed with consultation with regards to the proposed Project. An update letter was sent to the KMKNO in 2015, and update letters were sent to the KMKNO and Millbrook First Nation in 2016.

In 2016, NSTIR commissioned Mainland Mi'kmaq Development Inc. (or MMDI, a division of CMM) Environmental Services to conduct a Mi'kmaq Ecological Knowledge Study (MEKS) for the Highway 101 Digby to Marshalltown EA. The MEKS was completed in November 2016 and supersedes the previous report. The MEKS primarily includes archival research and interviews on current Mi'kmaq land and resource occurring within "living memory" and addresses current

Mi'kmaq land and resource use sites and plants of significance to Mi'kmaq communities. The MEKS is summarized in Section 5.7.4 and the full MEKS is provided in Appendix D. The MEKS was finalized in November 2016 and supersedes the previous report.

NSTIR will follow up with additional communication around any expressed issues of concern (if applicable) and share the steps that are taken to address any concerns. The EA Registration will be subject to a public review process, and in addition to being posted on the NSE website (http://www.novascotia.ca/nse/ea/), hard copies of the EA will also be shared with the KMKNO and Millbrook First Nation.

3.4 PUBLIC CONSULTATION

As part of the previous study for the Digby to Weymouth project, NSTIR hosted open house public meetings during the early planning stages of the project at the Brighton - Barton Fire Hall in the spring of 1992 to present local stakeholders and the general public with project information and obtain feedback. A single corridor north of the existing Highway 101 was proposed between the Route 303 interchange and a proposed Highway 101 crossing just west of South Marsh Road. Two broad corridor alignments were presented for discussion and comment between South Marsh Road and Weymouth North. The meeting was well attended and 72 questionnaires were completed.

There was a second public open house meeting for the Digby to Weymouth project, hosted by NSTIR at the same venue, in October 1999. Telephone calls and letters were sent to property owners where there was a potential for both land and building impacts, and letters were sent to property owners where impacts only involved land. Mail was distributed to 4,300 mailboxes between Weymouth North and Digby. Over 200 residents of the area attended and 73 completed questionnaires were submitted. There was positive support for the project and public input was used to redefine the project. The corridor was realigned to not cross the Poor Farm (or Alms House) cemeteries due to concerns of flooding on South Marsh Road. In 2005, NSTIR gave a Powerpoint presentation to the Digby and Area Board of Trade, outlining the project and a Route 303 Transportation Study, which was also well received.

In 2014, NSTIR resumed consultation for the Digby to Marshalltown Project. Based on public feedback received to date, including feedback from the previous 2003 study, the proposed highway alignment changed as a result of concerns that the highway could affect unmarked cemeteries. In March 2016, members of Marshalltown Alms House, Voices for Hope, met with representatives of NSTIR to discuss plans for a new stretch of Highway 101 between Digby (Exit 26) and Middle Cross Road in Marshalltown (Digby Courier 2016). During the meeting, NSTIR said that it is their priority to choose a corridor for the highway that avoids any graves and that they will continue public engagement.

In 2016, Davis MacIntyre & Associates Limited (Davis) was contracted by NSTIR to conduct two Archaeological Resource Impact Assessments: Marshalltown Highway 101 Realignment (Davis

2016a under Heritage Research Permit #A2016NS091) and Marshalltown Alms House Cemeteries (Davis 2016a under Heritage Research Permit #A2016NS012). The study area for Davis (2016a) and Davis (2016b) extended outside of the Project PDA (identified in Figure 1.1) to predict any future archaeological concerns when the next phase of construction approaches. Future extension of Highway 101 west of Seely Brook and a planned interchange at Marshalltown will be included in the scope of a future EA. Refer to Section 5.8 for the Archaeological and Heritage Resources VC.

NSTIR distributed a Project information letter to the adjacent property owners in June 2016. The letter contained project-specific information (including a map) and indicated field surveys would be conducted in the summer of 2016. The letter directed interested parties to contact NSTIR and/or Stantec if they had any questions or concerns.

Table 3.4.1 provides a summary of public and stakeholder consultation.

Table 3.4.1 Meetings with Public/Stakeholders

Public/Stakeholder Group	Purpose of Meeting and Concerns Raised	Timing
Adjacent land owners and local residents	NSTIR conducted first Open House for Highway 101, Digby to Weymouth North. A broad range of alignments for a new highway corridor from Digby to Weymouth North were presented to local stakeholders. Public input was requested on general alignment options, access locations, and any public concerns regarding both the project and the existing road. Several concerns and points of interest were expressed. Shortly after the Open House, NSTIR chose the alignment that best met the objectives and needs of both the local communities and the Province.	March 1992
Adjacent land owners and local residents	NSTIR conducted a second Open House for proposed highway corridor, Digby to Weymouth North. There was positive support for the project and public input was used to redefine the project. The corridor was realigned to not cross the Poor Farm (or Alms House) cemeteries due to concerns of flooding on South Marsh Road. Letters were mailed to people affected by the realignment. Each letter described the alignment change with an explanation. A map was included showing the proposed alignment before and after the Open House. See Figure 5.6, Map 1 of 3, Section 5.8, and Appendix F for information on the cemeteries (the cemeteries are outside of the PDA for this EA).	October 1999
Residents of Marshalltown	As a result of the mail-out following the Open House, NSTIR met with four residents of Marshalltown to discuss impact of project on their community. In response to comments about the Alms House cemeteries, NSTIR adjusted the alignment at Marshalltown Road.	December 9, 1999
Digby and Area Board of Trade	NSTIR gave a Powerpoint presentation outlining the project and a Route 303 Transportation Study.	February 10, 2005

Table 3.4.1 Meetings with Public/Stakeholders

Public/Stakeholder Group	Purpose of Meeting and Concerns Raised	Timing
Letters to adjacent property owners, from Digby to Marshalltown	NSTIR mailed approximately 162 letter to adjacent property owners for Phase 1 (Digby to Marshalltown). Letter requested access to property for land surveys.	November 2013
Rick Jacques, Trail Coordinator, Annapolis Valley Trails Coalition	NSTIR met on-site with Trail Coordinator to discuss proposed connecting of former rail corridor trail with bridge over Highway 101 and new highway corridor. See Section 2.2.5 and 5.7 for discussion on the 4 m wide travel lane bridge that will be constructed for the trail to accommodate safe movement across the highway.	March 25, 2014
Local interest group: Marshalltown Alms House - Voices for Hope	NSTIR staff met with representatives of the Facebook Group "Marshalltown Alms House - Voices for Hope" at the Admiral Digby Museum. Benda Small discussed the groups' intention to collect information about the site and commemorate cemetery near Trunk 1 with a monument. In 2016, two Archaeological Resource Impact Assessment reports were contracted to Davis MacIntyre & Associates Limited in 2016 to investigate the corridor and the Alms House cemeteries (see Section 5.8 and Appendices E and F).	March 10, 2016
Letters to adjacent property owners, from Digby	NSTIR distributed a Project information letter to the adjacent property owners. The letter contained project-specific information (including a map) and indicated field surveys would be conducted in the summer of 2016. NSTIR received responses from some landowners who did not give access permission for their properties, so those properties were not surveyed. The owner of a salvage yard was concerned that the presence of the highway would inhibit his use of his remaining property. NSTIR responded that there will be no restrictions to his property use.	June 2016

A dispute resolution policy will be established for addressing Project related complaints and concerns that may be received from nearby landowners or stakeholders. The intent of the dispute resolution policy is to establish a structured system to enable NSTIR to fulfil the goal of effective and responsible communication with landowners and stakeholders.

The EA Registration will be subject to a public review process. A copy of the EA will be posted on the NSE website (http://www.novascotia.ca/nse/ea/) and paper copies for public viewing will be at two locations in the Digby area. Publication dates and EA document locations will be advertised in one provincial newspaper and one local newspaper, as well as on the NSE website. Public comments will be solicited by NSE as part of this process.

4.0 ENVIRONMENTAL ASSESSMENT SCOPE AND METHODS

4.1 SCOPE OF THE ASSESSMENT

4.1.1 Scope

The scope of the Project includes those Project components described in Section 2 and summarized in Table 4.1.1 for construction and operations and maintenance activities. There are no plans for decommissioning within the planning horizon; therefore, decommissioning and abandonment was not considered to be applicable to the scope.

Table 4.1.1 Description of Project Activities and Physical Works

Activity Category	Project Activities and Physical Works
Project Phase	
Construction	
Site Preparation	Includes all Project-related activities associated with preparing the RoW for access and road construction. Activities include: • clearing and grubbing • relocation of power poles • sediment and erosion control measures
Roadbed Preparation	Includes all Project-related activities that are associated with roadbed preparation. Activities include: • blasting • excavation • placement of fill • grading • ditching and drainage management • grade separation structure construction
Watercourse Crossing Construction	Includes all Project-related activities required to install the watercourse crossings, including an arch structure for Seely Brook. Activities include: • site preparation • stream diversion (if applicable) • new channel creation • installation • site restoration
Surfacing and Finishing	Includes all Project-related activities that are associated with surfacing and finishing. Activities include: • paving • signage, lighting, and guide rail installation • highway marking

Table 4.1.1 Description of Project Activities and Physical Works

Activity Category	Project Activities and Physical Works
Operation and Maintenance	
Project Presence and Operation	Includes all Project-related aspects that will be present for the life of the Project, including: • presence of the highway • presence of vehicle traffic
Infrastructure Maintenance	Includes all Project-related activities that are required to maintain the Project infrastructure, including: • pavement maintenance • shoulder maintenance • watercourse crossing structure maintenance • highway marking • signage, lighting, and guide rail maintenance
Winter Maintenance	Includes all Project-related activities that are required for the safe operation of the Project during adverse winter weather conditions including; • salting • sanding • ploughing
Vegetation Management	Includes: • mowing, vegetation removal, and planting
Decommissioning and Abandonment	
No plans for decommissioning identified within the planning horizon (lifespan of the highway)	N/A

4.1.2 Valued Component (VC) Identification

An important part of the assessment process is the early identification of VCs upon which the assessment can be focused for a meaningful and effective evaluation. Table 4.1.2 provides a list of the selected VCs and associated factors to be considered in the assessment. The selection of VCs was carried out in consideration of:

- a previous Terms of Reference was prepared for the Project in 2000 in consultation with federal and provincial government departments for a federal Environmental Screening (no longer applicable) and Class II Nova Scotia Registration document;
- issues raised by regulatory agencies, key stakeholders, and the public (refer to Section 3);
- existing environmental conditions in the area and interconnections between the VCs and the biophysical and socio-economic environment;
- experience and lessons learned from other highway projects; and
- the professional judgment of the Study Team.

Table 4.1.2 Selected Valued Components

Valued Component	Factors to be Considered
Atmospheric Environment	• Air quality • Sound quality (noise and vibration) • Climate • Global climate change (GHG Emissions)
Groundwater Resources	• Bedrock, surficial geology, and soils • Groundwater quality and quantity • Water supply source
Fish and Fish Habitat	• Fish and fish habitat • Aquatic species of special conservation interest
Vegetation	• Terrestrial vascular plants • Dominant plant communities • Terrestrial plant species of special conservation interest
Wetlands	• Wetlands function and area • Use of wetlands by wildlife
Wildlife and Wildlife Habitat	• Wildlife (including migratory birds) presence/absence • Wildlife habitat • Wildlife species of special conservation interest
Land Use	• Agricultural, recreational, residential, or commercial use of land (existing and anticipated land use) • Identified current use of lands and resources for traditional purposes by Aboriginal persons
Archaeological and Heritage Resources	• Structures, sites, or things of historical, paleontological, archaeological, or architectural significance

4.2 ENVIRONMENTAL ASSESSMENT METHODS

The EA methods for the Project have been developed to meet the regulatory requirements of a Class I Registration under the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*.

This document focuses the assessment on environmental components of greatest concern to the public, other stakeholders, indigenous communities, regulators, and those identified through professional judgement. In general, the assessment:

- is focused on issues of greatest concern
- addresses regulatory requirements
- addresses issues raised by the public and stakeholders
- integrates engineering design and mitigation and monitoring programs into a comprehensive environmental management planning process
- concludes with an assessment of residual environmental effects.

The EA method for the Project includes an evaluation of the potential environmental effects of each phase (construction, operation and maintenance) as well as accidents and malfunctions, with regard to VCs. VCs are broad components of the biophysical and socio-economic environments that, if altered by the Project, may be of concern to regulatory agencies, the Mi'kmaq, scientists, and/or the general public. Project-related effects are assessed within the context of temporal and spatial boundaries established for the assessment.

The following sections describe the process used to evaluate each of the VCs. Environmental assessments of each VC are presented in Section 5.

4.2.1 Boundaries

Temporal and spatial boundaries include those periods during which, and areas within which, the VCs are likely to interact with, or be influenced by, the Project. Environmental effects are evaluated within spatial and temporal boundaries. The spatial and temporal boundaries may vary among VCs, depending on the nature of potential environmental effects.

Spatial and temporal boundaries are developed for each VC in consideration of:

- timing/scheduling of activities for Project phases of construction and operation
- known natural variations of each VC
- information gathered on current and traditional land and resource use
- the time required for recovery from an environmental effect.

The Project Development Area (PDA) is defined as the footprint of physical disturbance that will occur as a result of Project construction and operation activities (Figure 1.1). The PDA remains the same for all VCs. The Assessment Area, which extends beyond the PDA and is the area within which environmental effects may extend, may vary from VC to VC. The Assessment Area is specifically defined for each VC in Section 5. In some cases, the VC analysis also distinguishes a separate Field Survey Area which falls within the Assessment Area.

The Assessment Area (and/or Field Survey Area in some VCs) also extends beyond the western end of the planned construction of the project to include future interchange construction and the future initial extension of the twinned highway to the west of Marshalltown toward Weymouth North. This extension of the Assessment Area is so that non-mitigable effects could be identified and avoided. As previously noted, the future extension of Highway 101 west of Seely Brook and a planned grade-separated interchange at Marshalltown (Figure 1.2) will be included in the scope of a future EA.

Temporal boundaries identify when an environmental effect may occur. The temporal boundaries are based on the timing and duration of Project activities and the nature of the interactions with each individual VC.

The temporal boundaries considered for this assessment include the construction and operation of the Project. Decommissioning is not envisioned at this time and would be undertaken in consideration of requirements and regulations in place at that time; decommissioning is not being carried forward in the assessment. This EA assesses potential effects of the Project throughout the year. Temporal boundaries also address other temporal issues such as seasonal sensitivities (*e.g.*, bird migration). Spatial boundaries for the assessment vary according to the VC and are defined in Section 5.

4.2.2 Significance Determination

Each VC includes a threshold criteria or standard for determining the significance of the environmental effect, beyond which a residual environmental effect is considered significant (an unacceptable change). The threshold for significance is defined within each VC and is defined based on information obtained in issues scoping, available information on the state and characteristics of the VC, existing standard or regulations, and professional judgement. Regulatory standards are used, where appropriate, to determine thresholds. Where regulatory standards are not available, other key factors such as the sustainability of biological populations, and rarity of species and critical habitats, have been used as indicators of significance. Significance for environmental effects is predicted after application of mitigation (*i.e.*, residual effects).

4.2.3 Description of Existing Conditions

Existing (baseline) conditions are described for each VC to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context for the effects assessment. The description is restricted to a discussion of the status and characteristics of the VC within the boundaries established for the assessment. This section includes a summary of field surveys and additional data analysis, as applicable to the VC.

4.2.4 Assessment of Project-Related Environmental Effects

The assessment of Project-related environmental effects follows a sequence where potential interactions between each VC and the Project are first identified, and where such interactions may exist, a more detailed assessment of those effects is completed. Effects are analyzed qualitatively, and, where possible, quantitatively, using existing knowledge, professional judgment, and other analytical tools, where appropriate and applicable. Where existing knowledge indicates that an interaction is not likely to result in an effect, certain issues may not warrant further analysis.

The specific steps in the assessment of potential environmental effects include:

- identification of environmental effects pathways (*i.e.*, identification of how the Project could result in an environmental effect on the VC)

- description of the mitigation measures proposed to reduce or eliminate potential environmental effects, including industry standards, best management practices and environmental protection measures that NSTIR will implement
- identification of residual environmental effects (those that remain after mitigation and control measures are applied) as determined through several factors including magnitude, geographic extent, duration, frequency, reversibility and context
- determination of significance of the residual effects.

A determination of the significance of residual Project-related effects is included for each VC. Following the determination of significance, follow-up and monitoring measures are recommended, where required, to verify environmental effects predictions or to assess the effectiveness of proposed mitigation measures. Effects from accidents and malfunctions are assessed separately in Section 7.

5.0 ENVIRONMENTAL ASSESSMENT

5.1 ATMOSPHERIC ENVIRONMENT

The atmospheric environment is the component of the environment that comprises the layer of air near the earth's surface to a height of approximately 10 km. The atmospheric environment is characterized in three ways for this assessment:

- air quality, which is characterized by the chemical and physical properties of the air in the lower atmosphere, including gaseous and particulate air contaminants;
- sound quality, which is characterized by the type, character, frequency, intensity, and duration of sound pressure levels or noise (unwanted sound) in the outdoor environment; and
- climate, which is characterized by long-term trends in temperature, precipitation, sea level rise, and wind.

The atmospheric environment has been selected as a VC due to the nature of potential environmental effects of the Project on the local airshed, such as air contaminant releases and sound emissions, because of Project activities. The atmospheric environment has intrinsic importance to the health and well-being of humans, wildlife, vegetation, and other biota. The atmospheric environment is also an important pathway for the transport and eventual deposition of air contaminants to the freshwater, terrestrial and human environments.

In consideration of the scale of the Project, as defined in the Project Description (Section 2), the potential environmental effects of the Project on local climate are expected to be nominal. For example, microclimate issues such as cold air pooling along elevated sections of the Project and the potential for local crop damage are not expected to be a concern due to the relatively limited scale of the Project (*i.e.*, 4 km highway, and associated infrastructure) and because the Project is not expected to traverse any agricultural land use areas that would be sensitive to cold air pooling (*i.e.*, crops) (refer to Section 5.7 and 6.0). Microclimate issues therefore will not be considered further in this assessment. Global climate change will be addressed in the context of Project-related changes in greenhouse gas (GHG) emissions.

5.1.1 Regulatory and Policy Setting

Air Quality

For the purposes of this EA, the Project-related air contaminants of interest consist of total suspended particulate matter (TSP) (including dust), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxides (NO_2), and carbon monoxide (CO) and ozone (O_3).

The Government of Nova Scotia has established *Air Quality Regulations*, under the Nova Scotia *Environment Act* (Table 5.1.1). In addition to the provincial regulations, Canada has set an ambient air quality standard for fine particulate matter over two time averaging periods (Table 5.1.1).

Table 5.1.1 Summary of Regulations Pertaining to Ambient Air Quality in Nova Scotia

Contaminant	Averaging Period	Regulatory Threshold (µg/m³)	
		Federal[1]	Provincial[5]
Total Suspended Particulate (TSP)	24-hour	-	120
	Annual	-	70
Particulate Matter Less than 10 microns (PM_{10})	24-hour	-	-
Particulate Matter Less than 2.5 microns ($PM_{2.5}$)	24-hour[2]	28 (2015) 27 (2020)	-
	Annual[3]	10 (2015) 8.8 (2020)	-
Sulphur Dioxide (SO_2)	1-hour	-	900
	24-hour	-	300
	Annual	-	60
Nitrogen Dioxide (NO_2)	1-hour	-	400
	Annual	-	100
Carbon Monoxide (CO)	1-hour	-	34,600
	8-hour	-	12,700
Ozone (O_3)	1-hour	-	160
	8-hour[4]	135 (2015) 133 (2020)	-

Notes
1 Canadian Council of Ministers of the Environment Canada-Wide Standards for $PM_{2.5}$.
2 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
3 3-year average of the annual average concentrations.
4 3-year average of the annual 4th highest daily maximum 8-hour average concentrations.
5 *Nova Scotia Air Quality Regulations* (N.S. Reg. 179/2014).

Ground-level ozone is not emitted directly, but rather formed by secondary photochemical reaction between nitrogen oxides (NO_X) and VOCs in the atmosphere in the presence of strong sunlight. Although it is not expected that ground-level ozone levels in the Assessment Area will change substantially because of Project activities, it is useful to consider this contaminant in the assessment of existing conditions, since ozone is often considered an indicator of ambient air quality conditions in the environment. Therefore, ground-level ozone will be considered in this assessment solely as it pertains to the characterization of existing conditions in the Assessment Area.

Acoustic Environment

For sound levels, the NSE has published the noise guideline "Guideline for Environmental Noise Measurement and Assessment" (NSE 1990). This guideline includes noise criteria for different periods of the day (day, evening and night) and requires that the measurement duration be a minimum of two continuous hours of data in each time period for the data to be representative. The NSE noise guidelines are presented in Table 5.1.2. Although not explicitly stated, these values are interpreted to represent hourly averages measured at the property boundary of sensitive receptors (*e.g.*, residential properties, schools, retirement homes, medical facilities, places of spiritual significance). It is noted in the guidelines that "Transportation" is "excluded from the guideline". These limits are adopted in this assessment, as in previous highway environmental studies, in lieu of regulatory limits or a formal noise policy of NSTIR.

Table 5.1.2 Nova Scotia Noise Guidelines

Averaging Time Period	NSE Noise Guideline (dBA)
Day (7:00 to 19:00)	65
Evening (19:00 to 23:00)	60
Night (23:00 to 7:00)	55

GHG Emissions

There are currently neither air quality standards nor guidelines for GHG concentrations in ambient air (provincial or federal). Nova Scotia enacted the *Environmental Goals and Sustainable Prosperity Act* in 2007 that commits to supporting and enabling energy efficiency, sustainable transportation options, increased renewable energy and enhanced use of natural gas to displace oil and coal. The Act includes renewable energy targets, improved energy efficiency in building codes and GHG reduction targets. The GHG related targets include the following:

- Nova Scotia will work with other levels of government on national emissions standards for greenhouse gases and air pollutants from new motor vehicles; and
- greenhouse gas emissions are to be, by 2020, at least 10% below the levels that were emitted in 1990.

The Government of Nova Scotia has published two guidance documents for considering climate change during EA and project development: the "Guide to Considering Climate Change in Environmental Assessments in Nova Scotia" (NSE 2011a); and the "Guide to Considering Climate Change in Project Development in Nova Scotia" (NSE 2011b). The federal government has also developed a GHG assessment method which is based on guidance from the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, "Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners" (Federal-Provincial-Territorial Committee on Climate Change and

Environmental Assessment 2003) (the Climate Change General Guidance document). The GHG assessment presented here follows the general guidance specified in these documents.

5.1.2 Boundaries

The assessment of potential environmental effects on atmospheric environment encompasses the following spatial boundaries: the PDA and the Assessment Area. The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1. The potential environmental effects of Project-related activities on air quality and sound quality are generally not expected to extend beyond approximately 300 m of the centre of the PDA. This 300 m range generally provides for sufficient dispersion of emissions and dissipation of noise generated from Project-related activities, such as heavy equipment operation and vehicle traffic. The spatial boundaries for the characterization of potential environmental effects of Project activities on air quality and sound quality (the Assessment Area) are therefore identified as this zone extending to approximately 300 m of the centre of the PDA.

Potential effects related to GHG emissions on climate change are, by definition, global in nature.

The temporal boundaries for the assessment of potential environmental effects for each key aspect of the atmospheric environment include periods of construction and subsequent operation and maintenance phases of the Project in perpetuity. Residential areas are the most sensitive receptors for noise impacts at night. In residential areas, noise levels are usually dominated during the day by traffic, property maintenance and recreational activities. At night, local traffic is greatly reduced so that noise from the nearest arterial roads and industry may be the most dominant perceived source. Other temporal issues include seasonal considerations when residents may be engaged in a greater number of outdoor activities and potentially subject to a greater amount of noise and dust.

5.1.3 Significance Definition

A **significant residual adverse environmental effect of the Project on air quality** is one that, after mitigation has been considered, causes the maximum Project-related emissions of the air contaminants of interest (those described in Section 5.1.1) to exceed the Nova Scotia *Air Quality Regulations* for TSP, SO_2, NO_2 and CO, and the Canada Ambient Air Quality Standard for $PM_{2.5}$.

A **significant residual adverse environmental effect of the Project on the acoustic environment** is one that, after mitigation has been considered, causes either of the following to occur:

- a noticeable change in noise level (approximately 5 dBA) which results in exceedance of the NSE Noise Guidelines;
- a noticeable change in noise level (approximately 5 dBA) above existing noise levels in areas where the guideline levels are already exceeded; or

- a change in noise level of approximately 10 dBA above existing noise levels in areas where the guideline levels are not exceeded.

It is assumed that a noise level exceedance at a sensitive receiver would be frequent and persistent to result in a significant adverse change in sound quality.

Provincial guidance documents for assessing climate change (refer to Section 5.1.1) do not provide guidance on the determination of significance for GHG.; therefore this assessment is based on guidance from the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, "Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners" (Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment 2003) (the Guideline).

The Guideline does not provide guidance on determination of significance for GHGs; instead, it focuses on increasing attention to Project GHG emissions and consideration of less emission-intensive ways to develop projects. For this assessment, emitter levels are used to determine if a GHG Management Plan is required under the Guideline.

As identified in the Guideline, "…the contribution of an individual project to climate change cannot be measured". As the effect on climate change from the contribution of a single project cannot be accurately measured or attributed, it is not reasonable to conclude a significant adverse residual effect on atmospheric GHG concentrations or climate change from a single project's GHG emissions.

5.1.4 Description of Existing Conditions

The existing atmospheric environment is described in the following section in the context of air quality, climate, greenhouse gases and the acoustic environment. This discussion is focused on the Assessment Area.

5.1.4.1 Methods

Air Quality

The Assessment Area and Nova Scotia in general, have good air quality due to the combination of maritime climate, providing good dispersion of air contaminants, and relatively small population and industrial bases (NSDOE 1998). The ambient air quality also benefits from the infusion of relatively clean polar and arctic air masses. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transport contaminants into the area, causing poorer air quality.

A review of existing air emissions data and historical ambient air quality monitoring results at the nearest ambient air quality monitoring stations, was conducted to assist in the characterization of existing air quality conditions in the Assessment Area.

NSE monitors air quality in the province with a network of monitoring stations, in conjunction with Environment and Climate Change Canada's (ECCC) National Air Pollution Surveillance Network (NAPS). The air pollutants most commonly monitored are SO_2, TPM, $PM_{2.5}$, PM_{10}, CO, O_3, and NO_2. The closest monitoring site to the Assessment Area is the Keijimukuik National Park NAPS monitoring site, however this site only monitors for O_3. Therefore, to characterize the existing ambient air quality within and surrounding the Assessment Area data was also collected from the Aylesford Mountain and Halifax NAPS stations. Ambient concentrations of VOCs are not monitored in Nova Scotia.

Provincial air emissions data are reported to ECCC through the National Pollutant Release Inventory (NPRI) Reporting Program on an annual basis. Provincial air emissions data reported for the 2014 reporting year was also used to characterize existing air quality in the Assessment Area.

Acoustic Environment

A baseline noise monitoring survey was conducted to characterize the existing acoustic environment surrounding the Assessment Area.

Noise is measured as sound pressure levels (SPL) in decibels (dB). These measurements are conventionally expressed on the A weighted scale (denoted as dB_A), as it emphasizes the frequencies of highest sensitivity to the human ear. Humans are exposed to a broad range of sound pressure levels, which are represented on a logarithmic scale. A level of 0 dBA is the least perceptible sound by a human. A change in 3 dBA represents a physical doubling of the SPL but is barely perceptible as a change, whereas most people clearly notice a change of 5 dBA and perceive a change of 10 dBA as a doubling of the sound level. Typically, conversation occurs in the range of 50 to 60 dBA. Loud equipment and trucks passing on a busy road can create noise levels above 85 dBA. Very quiet environments, such as still rural or suburban nights, typically fall below 40 dBA.

Climate

Climate is the statistical average (*i.e.*, mean and variability) of meteorological and weather conditions of a region over a defined period of time. Climate is characterized by various weather elements such as precipitation, temperature, humidity, sunshine, cloudiness, wind and fog (ECCC 2014).

Current climatic conditions are typically represented by the most recent 30 year period, for which the Government of Canada has developed statistical summaries, referred to as climate normals. The closest Government of Canada weather station, with available historical temperature and precipitation data (1981-2010), is the Bear River station (44°34' N, 65°38' W). The closest weather station to the Assessment Area with available historical wind data is the Greenwood station (44°59' N, 64°55' W).

Data collected from these stations were used to describe existing climatic conditions in the Assessment Area.

Greenhouse Gases

An understanding of the existing provincial, national and global GHG emissions is required when placing Project-related GHG emissions into context. Provincial and national GHG emissions were obtained from the ECCC's National Inventory Report for 1990–2014 (ECCC 2016). An estimate of global GHG emissions is based on the Climate Analysis Indicators Tool (CAIT), developed by the World Resources Institute. CAIT has compiled estimates of global GHG emissions from sources such as the U.S. Energy Information Administration, US Environmental Protection Agency (US EPA) and the International Energy Agency (WRI 2016).

5.1.4.2 Summary of Existing Conditions

Air Quality

The major sources of criteria air contaminants (CAC) emissions in the Assessment Area would be from vehicles, home heating, small industrial activity, and long range transport. Based on the 2014 NAPS data (ECCC 2014), which represents the most recent available data, the following general observations can be made regarding the existing air quality in the Assessment Area:

- The monthly average 24-hour concentration of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) at the Halifax monitoring station ranged from 3 to 7 µg/m^3 and from 4 and 8 µg/m^3 at the Aylesford Mountain monitoring station. These values fall well below the current 24-hour Canada Wide Standard for $PM_{2.5}$ (28 µg/m^3).
- The monthly average 1-hour and 8-hour concentrations of carbon monoxide (CO) at the Halifax monitoring station ranged from 344 µg/m^3 to 460 µg/m^3. These values were below the 1-hour and 8-hour Nova Scotia Air Quality Regulations for CO (34,600 and 12,700 µg/m^3, respectively). CO is not monitored at the Aylesford monitoring station.
- The monthly average 1-hour and 24-hour concentrations of nitrogen dioxide (NO_2) at the Aylesford monitoring station were 1.88 µg/m^3, well below the 1-hour Nova Scotia Air Quality Regulation for NO_2 of 400 1.88 µg/m3. There is no Nova Scotia standard for the 24-hour time averaging period.
- The monthly average 1-hour and 24-hour concentrations of sulphur dioxide at the Halifax monitoring station ranged from 2.6 µg/m^3 to 7.86 µg/m^3, well below the 1-hour and 24-hour Nova Scotia Air Quality Regulations of 900 1.88 µg/m^3 and 300 1.88 µg/m^3, respectively. SO_2 is not monitored for at the Aylesforld monitoring site.
- The monthly average 1-hour concentration of ozone (O_3) at the Aylesford monitoring station ranged from 33 µg/m^3 to 46 µg/m^3, and 32µg/m^3 to 47 µg/m^3 at the Kejimkujik monitoring site. These values fall well below the 1-hour Nova Scotia Air Quality Regulations for Ozone (160 µg/m^3).

Given the rural nature of the Project, the relatively low concentration of heavy industry in the region and the results of recent ambient air monitoring, the existing ambient air quality in the Assessment Area is generally expected to be good.

Acoustic Environment

A description of land uses in the Assessment Area is provided in Section 5.7. Figure 5.1 shows the buildings near the Project. Note that the nine buildings within the PDA are being purchased by NSTIR and will be removed prior to construction. A noise monitoring survey was conducted to characterize the existing acoustic environment surrounding the Assessment Area. This baseline noise study was conducted in 2001 for the previous draft EA work (as noted in Section 1.2) and covered a larger area than currently under assessment. Of the ten baseline noise monitoring locations included in the 2001 study, four fall within the vicinity of the Project (refer to Figure 5.1).

Sound levels were taken using Larson Davis Model 824 and Bruel & Kjaer Model 2236 integrating sound level meters. These instruments average the energy level of sound over a selected period of time and express this as L_{eq} in dBA (A-weighted decibels). Each measurement session consisted of data logged as one minute L_{eq} readings over defined time periods. Measurements were then used to calculate hourly L_{eq} values. Pursuant to the NSE's Noise Guidelines, measurements were taken during portions of three daily periods: day (07:00 to 19:00), evening (19:00 to 23:00) and night (23:00 to 07:00).

The baseline noise monitoring results are presented in Table 5.1.3, and were taken between July 23 and 28, 2001. Conditions during which monitoring was performed were clear to partly cloudy, with calm to light winds (20 km/hr or less). Relative humidity ranged between 60 and 100% during the monitoring dates.

Table 5.1.3 Background Noise Levels - Hourly L_{eq} (dBA)

Station	Day Hour Starting	L_{eq} (dBA)	Evening Hour Starting	L_{eq} (dBA)	Night Hour Starting	L_{eq} (dBA)
N1[1]	8:30	58.3	21:00	44.5	23:00	45.7
	9:30	58.2	22:00	43.7	1:00	39.5
N2	11:00	40.8	19:00	52.3	23:00	38.6
	Not Available		20:00	37.1	1:00	36.3
N3[2]	12:30	53.3	21:00	52.5	23:00	47.6
	1:30	53.7	22:00	51.9	0:00	47.6
N4	11:30	46.0	19:00	56.9[3]	23:00	43.2
	12:30	42.4	20:00	62.0	0:00	38.7
NSDEL	7:00	65	19:00	60	23:00	55
Limit	19:00		20:00		7:00	

Notes
1 Background noise includes operation of a nearby temporary generator,
2 Noise from chainsaw on neighboring property omitted from results analysis.
3 Background noise recorded for the evening includes operation of nearby motorcycle.

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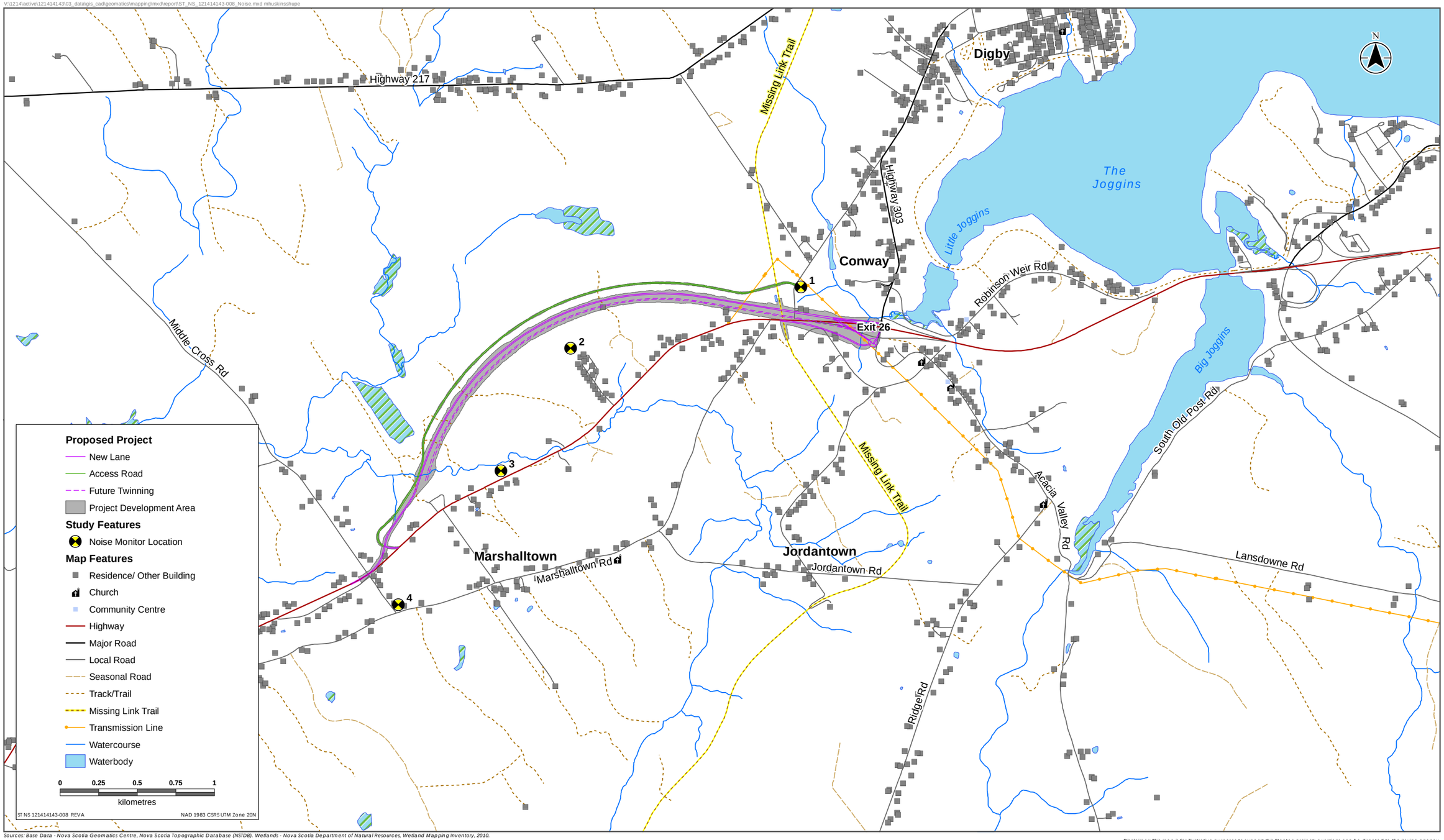

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Baseline Noise Monitoring Locations

Stantec

The values recorded at each monitoring location demonstrate typical levels expected in rural communities and outlying homes. The main sources of noise noted during the survey were traffic along the existing Highway 101 or local roadways, and normal residential outdoor activity. Location N4 exceeded the NSE Noise Guideline level for evening time period (Table 5.1.3), which the field observations show was likely due to local motorcycle traffic.

Climate

The Assessment Area is located in the western portion of Nova Scotia. A summary of the Climate Normals (1981 – 2010) for the Bear River weather station and the wind data for Greenwood weather station (Environment Canada 1982; Government of Canada 2016) are presented in Table 5.1.4 and discussed below.

Table 5.1.4 Summary of Climate Normals for the Assessment Area - Bear River and Greenwood

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature Normals for Weymouth Falls, NS (1981 - 2010)													
Daily Average (°C)	-3.8	-3.1	0.1	5.7	10.8	15.4	18.4	18.2	14.2	9.3	4.7	-0.5	7.4
Daily Maximum (°C)	0.4	1.2	4.5	10.5	16.3	21.1	23.9	23.7	19.4	14	8.5	3.2	12.2
Daily Minimum (°C)	-7.8	-7.5	-4.3	0.9	5.2	9.7	12.9	12.6	8.9	4.4	0.8	-4.3	2.6
Precipitation Normals for Bear River, NS (1981 - 2010)													
Rainfall (mm)	83.7	66.2	95.6	98.5	99	88.9	79.6	77.8	114.8	111.3	129.3	99.2	1143.9
Snowfall (cm)	63.7	42.1	32.7	9.1	0.3	0	0	0	0	0	7.7	43.3	198.9
Precipitation (mm)	147.4	108.3	128.3	107.1	99.4	88.9	79.6	77.8	114.8	111.3	137	142.1	1341.9
Wind Normals for Greenwood, NS (1981-2010)													
Most Frequent Direction	W	W	W	W	W	W	W	W	W	W	W	W	W
Maximum Gust Speed (km/h)	161	188	161	130	122	101	93	108	129	161	126	161	188
Direction of Maximum Gust	SE	SW	SE	S	W	W	NW	S	S	S	W	E	SW
Days with Winds >= 52 km/h	4.1	2.8	3.3	2.7	1.3	1	0.4	0.6	0.8	1.3	3.5	4.4	26.1
Days with Winds >= 63 km/h	1.5	1.1	1.4	0.7	0.3	0.2	0	0.1	0.2	0.3	1.3	1.8	9
Wind Speeds for Greenwood, NS (1981 - 2010) (km/hr)													
Average Speed (All Directions)	16.5	16.1	16.3	15.9	14	12.5	11.5	10.9	11.7	13.5	15.2	16.4	14.2

Based on the climate data presented in Table 5.1.4, January is the coldest month in the Assessment Area, recording a minimum of -7.8 °C, and July and August are the warmest with maximum temperatures of 23.9 °C and 23.7 °C, respectively. The average annual precipitation at the Bear River weather station is 1,342 mm, of which approximately 85% is in the form of rain.

The average annual wind speed reported at the Greenwood weather station was approximately 14.2 km/h. The maximum wind speeds occur in January with average speeds of

16.5 km/h and the minimum speeds occur in August at an average of 10.9 km/h. The average monthly wind speeds in the Assessment Area are higher in the winter than in the summer.

Greenhouse Gases

The provincial, national and global GHG emissions for 2005 through to 2014 (the most recent available) are presented in Table 5.1.6.

Table 5.1.5 Global, National and Provincial GHG Emissions (kt CO2e), 2005–2014

Region	2005	2009	2010	2011	2012	2013	2014
Global[1]	38,696,545	40,956,547	42,669,718	43,816,734	44,815,500	NA	NA
Canada	749,000	699,000	707,000	709,000	715,000	726,000	732,000
Nova Scotia	24,000	21,000	20,700	21,400	19,600	18,300	17,000

Notes
NA = not available.
Years 2005, 2009, 2010, 2011, 2012, 2013, 2014 are presented as these are the data provided in the most recent national inventory report (ECCC 2016).
[1]Includes countries that report GHG emissions.

Source: ECCC 2016, WRI 2016

In 2014, Canada's contribution to global GHG emissions (based on the most recent data available - 2012 data) was 1.6%. Nova Scotia's contribution to the national total was approximately 2.3% in 2014 and to the global total, approximately 0.04%.

In 2014, the Energy Sector (stationary combustion, transport and fugitive emission sources) represented the majority of Canada's GHG emissions at 81% (594,000 kt CO_{2e}) (excludes Land Use). The Industrial Process and Product Use, Agriculture, and Waste Sectors represented the remaining 7%, 8% and 4%, respectively. The Transport Sector represented approximately 34% (203 kt CO_{2e}) of the Energy Section, with Road Transportation making up 69% (140 kt CO_{2e}) of the Transport emissions (ECCC 2016).

5.1.5 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with the atmospheric environment to result in adverse effects on air quality and increased levels of greenhouse gas emissions and noise levels. In consideration of these potential interactions, the assessment of Project-related environmental effects on the atmospheric environment is therefore focused on the following potential environmental effects:

- change in air quality;
- change in acoustic environment; and
- change in greenhouse gases.

5.1.5.1 Change in Air Quality

Construction

During all construction activities, the operation of heavy equipment, such as earth movers, excavators, dump trucks and graders, affect air quality including dust generation from construction activities, particularly during site preparation and subgrade development. Grubbing generally creates few dust problems since the exposed soil is usually moist and the grubbed areas are seldom left exposed for extended periods. The removal of existing structures and roadways may create some particulate emissions. Blasting, handling of fill, dumping, grading and compaction are potential sources of airborne particulates which may affect any residences within sight of the activity. Until the roadbed is paved, the movement of construction vehicles over unconsolidated fill may generate suspended particulate matter, especially where these vehicles cross from the exposed area to a paved roadway. Dirt or mud clinging to the vehicles will be dispersed into the air as the vehicle accelerates or will fall onto the public roadway to be stirred up by other vehicles. In general, the dust is expected to disperse within 300 m of the generation point.

Equipment used in highway construction activities is typically powered by diesel engines. The combustion gases released from the operation of such equipment include sulphur dioxide (SO_2), carbon monoxide (CO) and nitrogen oxides (NO_x), as well as particulate matter (PM). The number and distribution of the equipment during typical construction practices will allow for sufficient dispersion of these emissions to prevent significant adverse environmental effects on local air quality during most atmospheric conditions.

Operation and Maintenance

Interactions between the Project and air quality during all phases of operation and maintenance will occur on a localized basis, primarily as a result of the emissions of combustion gases (including greenhouse gases) along the roadway. The Project is not intended to increase traffic in the area but rather to increase efficiency and mobility by reducing congestion, managing traffic volume, reducing travel time and improving productivity (NSTIR 2014). No additional interactions with air quality are therefore expected from the Project during operations, on an airshed basis.

During all maintenance activities, there will be operation of heavy equipment (possibly including paint striping equipment, vegetation control equipment, earthmovers, winter maintenance equipment and excavation and grading equipment). There is potential for environmental effects from dust generated due to some of the maintenance activities and from road salt application during winter, as well as the emissions of combustion gases, including selected air contaminants, from the equipment.

5.1.5.2 Change in Acoustic Environment

Construction

Sound quality will be affected by construction activities for the Project. Noise due to construction is usually louder than normal highway operation, but is of short duration and is also very localized. Noise from construction activities can affect land uses directly adjacent to the RoW. Highway construction will involve typical road building activities such as clearing and grubbing, roadbed preparation and grading, and construction of stream crossing structures and paving operation.

Operation and Maintenance

Interactions between the operation and maintenance of the Project and sound quality will occur due to increased sound pressure levels at the nearest sensitive receptors from vehicle traffic and maintenance equipment on the Project route. The sound emissions from vehicle engines and tires on the road may be perceptible to occupants of nearby residences and commercial developments.

Operational traffic noise from the Project may also result in a net positive effect. Sound levels will decrease for receptors adjacent to the existing Highway 101. The new alignment will remove some traffic noise from the existing Highway 101, and add a new roadway to an area that is currently less developed. The change in sound from vehicle traffic associated with operation of the new highway will persist in perpetuity.

With the locations of previous noise monitoring as examples, locations 1 and 4 will retain similar sound levels to current conditions. Location 3 will have generally lower sound levels with the reduction of traffic volumes on the existing highway. Residences at location 2 will likely receive increased sound levels.

Winter maintenance activities (such as snow plowing) and vegetation control activities will also create sound emissions. These maintenance activities are typically short-lived and infrequent in nature.

5.1.5.3 Change in GHG Emissions

Construction

Emissions of GHGs from heavy construction equipment (*e.g.*, trucks, front-end loaders, pavers, and other equipment) will occur from the operation of internal combustion engines, which are typically diesel-fueled. The removal of carbon sequestered in soil and vegetation within the Assessment Area as part of Project may lead to small changes in the net balance of GHG in the local area.

Operation and Maintenance

Project presence is not expected to result in increased vehicle traffic, but rather to increase efficiency and mobility by reducing congestion, managing traffic volume, reducing travel time and improving productivity (NSTIR 2014). No interactions with global climate change are therefore expected from road traffic during operation.

During Project maintenance, the operation of mowing and vegetation control equipment and heavy equipment (possibly including paint striping equipment, earthmovers, and excavation and grading equipment) will result in the release of GHG emissions as a result of the combustion of fossil fuels.

5.1.6 Mitigation

Mitigation measures to be implemented to reduce potential effects on existing ambient air quality, reduce sound emissions, and reduce emissions of GHGs during construction and operation and maintenance are presented in Table 5.1.6.

Table 5.1.6 Mitigation for Atmospheric Environment

Effect	Phase	Mitigation
Change in Air Quality	Construction	• Follow Generic EPP (Section 3.13; NSTPW 2007) including application of dust suppressants where feasible, follow equipment maintenance schedules, preserving natural vegetation where possible • Reduce activities that generate large quantities of dust during high winds
	Operation and Maintenance	
Change in Sound Quality	Construction	• Follow Generic EPP (Section 3.13; NSTPW 2007) including notification, muffling devices, machines in good working order, minimization of idling, and timing restrictions • Use noise controls where possible (*e.g.*, mufflers) • Retain wooded buffers along new highway to mitigate perceived noise levels
	Operation and Maintenance	
Change in GHG Emissions	Construction	• Environmental awareness session to reduce vehicle idling during construction • Follow equipment maintenance schedules
	Operation and Maintenance	

In addition to standard mitigation referenced above in Table 5.1.6, NSTIR will consider further site-specific mitigation measures to reduce noise from highway operation where receivers may be affected by significant increases in noise levels (refer to Section 5.1.7.2) based on monitoring during highway operations. Implementation of physical mitigation generally considers economic feasibility, effectiveness of the mitigation, and sensitivity of receptors.

5.1.7 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on atmospheric environment after the general mitigation measures, as provided above, have been implemented.

5.1.7.1 Change in Air Quality

Construction

Air quality may be affected during construction due to emissions associated with heavy equipment operation.

Dust will primarily be generated during construction from site preparation and sub-grade development activities, such as clearing, grubbing, grading and leveling. The grubbing operation as part of the Project should result in relatively few dust events since the exposed soil is expected to be moist, and the grubbed areas are not expected to be left exposed for extended periods. The handling of fill material, dumping, grading and compaction are potential sources of airborne dust that may affect nearby receptors. Until the roadway and watercourse crossing structure decks are paved, the movement of construction vehicles on unpaved roadway sections, access roads, and construction/laydown areas may generate airborne dust (suspended particulate matter), especially where these vehicles cross from the exposed area to a paved roadway.

All dust is expected to be generally confined to the immediate vicinity of the construction activity, and could be transported up to approximately 300 m or less from the point of origin. Dust emissions are expected to be short-lived, and will be reduced by following the Generic EPP (Section 3.12; NSTPW 2007). Among the mitigation suggested in the EPP (NSTPW 2007) are dust suppression measures, such as the application of water during periods of heavy activity and/or during dry or windy periods to reduce the generation and transport of airborne dust.

The emissions of combustion gases from heavy construction equipment (*e.g.*, trucks, front-end loaders, pavers, and other equipment) will occur from the operation of internal combustion engines, which are typically diesel-fueled.

Table 5.1.7 summarizes the emission estimates associated with the operation of typical construction equipment (*e.g.*, pavers, rollers, trucks) to be used during Project construction.

Table 5.1.7 Estimated Construction Emission Estimates for the Project

Emissions	Project Construction Emissions (tonnes)	2014 Emission Totals for NS (tonnes)
TPM	0.109	370,029
PM_{10}	0.098	101,500

Table 5.1.7 Estimated Construction Emission Estimates for the Project

Emissions	Project Construction Emissions (tonnes)	2014 Emission Totals for NS (tonnes)
$PM_{2.5}$	0.088	30,373
NO_x	2.33	75,486
CO	0.998	72,432
SO_2	0.192	172,631

Sources: ECCC 2016; US EPA 2002; US EPA 2004

Emission factors and methodologies published by the US EPA for non-road diesel vehicles (US EPA 2002) were used to estimate the emissions of selected air contaminants from the paving portion of the construction phase. Since most vehicles used during construction are powered with heavy-duty diesel engines with approximately similar engine displacements, it was assumed that the proportion of heavy-duty vehicles per km of highway construction would remain constant for all phases of construction. It was also assumed that heavy trucks would have to travel a distance of approximately 10 km to reach an asphalt plant and that they would complete one round trip per km of highway paved. Total emissions for Nova Scotia (in 2014) are included as a point of reference.

Air quality effects associated with asphalt plant operation have not been estimated here as NSTIR does not anticipate use of an on-site asphalt plant. It is anticipated that the asphalt will be made off site by local asphalt operators.

In consideration of the emissions estimates presented in Table 5.1.7, contaminant emissions during construction represent a very small fraction of comparable provincial emissions.

The number and distribution of heavy equipment during typical construction practices are not expected to result in substantive emissions to the local air shed and would not influence ambient air quality during most atmospheric conditions. The use of properly maintained vehicles and equipment during construction and adherence to the Generic EPP (Section 3.12; NSTPW 2007) will reduce Project-related construction air emissions. The magnitude, frequency and duration of the construction activities are such that the applicable ambient air quality standards and objectives are unlikely to be exceeded.

In consideration of the potential environmental effects of the Project-related activities during construction and the proposed mitigation, residual environmental effects of the construction of the Project on air quality are predicted to be not significant.

Operation and Maintenance

Air quality will be affected during operation due to air emissions from vehicle traffic and maintenance equipment including combustion gases and particulate matter. However, the Project will not cause an increase in vehicle traffic in the Assessment Area (and resulting air

emissions), but rather is intended to facilitate existing traffic volumes and improve overall traffic flows.

The magnitude, frequency and duration of the maintenance activities are such that related emissions are very unlikely to result in an exceedance of applicable ambient air quality standards or objectives within the Assessment Area. The use of properly maintained vehicles and equipment, and adherence to the EPP will help to mitigate any potential emissions from maintenance equipment during the operation and maintenance phase.

In consideration of the potential environmental effects of the Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the operation and maintenance of the Project on air quality are predicted to be not significant.

5.1.7.2 Change in Acoustic Environment

Construction

Construction equipment will cause sound pressure levels along the road, within approximately 50 m, to approach 85 dB_A as it passes, resulting in an average sound level of 60 to 70 dB_A within working hours. These levels will decrease with distance to approximately background levels within 1 to 2 km, and likely not perceptible at 5 km. Table 5.1.8 provides the sound pressure levels, at a distance of 15 m, of various typical pieces of construction equipment.

Table 5.1.8 Typical Construction Equipment Sound Pressure Levels

Equipment Powered by Internal Combustion Engines	Sound Pressure Level (dB_A at 15 m)
Roller	85
Front loader	80
Backhoe	80
Excavator	85
Bulldozer	85
Scraper, grader	85
Paver	85
Pick-up truck	55
Concrete mixer truck	85
Concrete pump truck	82
Crane	85
Pump	81
Generator	82
Generator (<25KVA, VMS signs)	70
Compressor (air)	80

Table 5.1.8 Typical Construction Equipment Sound Pressure Levels

Equipment Powered by Internal Combustion Engines	Sound Pressure Level (dB_A at 15 m)
Pneumatic Tools	85
Jackhammer	89
Blasting	94

Source: United States Department of Transportation, Federal Highway Administration (FHWA) 2006

As shown on Figure 5.1, nine structures/buildings located within or partially within the PDA will be removed. While construction noise in these areas may exceed the daytime noise guideline level of 65 dBA, the duration of these exceedances is expected to be relatively short (in the order of 1 to 2 hours at a time on any particular day).

To reduce the sound pressure levels at the nearest residents, a combination of mitigation measures will be employed, as described in the Generic EPP (Section 3.13; NSTPW 2007) including notification of construction activities to landowners; use of muffling devices on equipment; keeping machines in good working order (*i.e.*, regularly maintained); minimization of idling; and time of day working restrictions.

To reduce the potential environmental effect of the sound pressure levels on human receptors, NSTIR will notify nearby residents in advance of upcoming activities and will be provide contact information to use in the event that a resident wants to file a noise complaint. Any complaints received will be investigated promptly and addressed as required. After mitigation is applied the sound pressure levels during construction may still occasionally exceed 65 dBA; however, any exceedances are not likely to be frequent at any one residence (*e.g.*, less than 12 days per year).

Blasting may be required as part of the construction activities and could produce elevated sound pressure levels at the nearest residences, on a very short term and intermittent basis. Blasting, if required, will be conducted in accordance with the Generic EPP (5.4.2 in NSTPW 2007) and the Project-specific EMP, as well as other applicable guidelines.

Occasional noise sources such as the dumping of rock may be louder than the working machinery (>125 dBA at the source) (*e.g.*, tailgate slamming during dumping). However, these high sound levels attenuate quickly due to their impulsive nature (*i.e.*, short duration).

In general, mitigation measures may not bring levels to within the Guidelines at all times; however, actual levels are expected to be lower than the maximum predicted most of the time, as construction activities will be moving locations and will not always be at the nearest point to any particular sensitive receptor. Therefore, the sound pressure levels are not expected to exceed the NSE Noise Guidelines over a sustained period and on a frequent basis.

In consideration of the potential environmental effects of the Project-related activities during construction and the proposed mitigation, residual environmental effects of the construction of the Project on sound quality are predicted to be not significant.

Operation and Maintenance

Motor vehicle and maintenance equipment traffic on the Project route will result in some changes to sound quality at nearby receivers, as the sound from vehicle engines and tires on the road may be perceptible to some occupants of nearby residences.

During Project operation, the acoustic environment surrounding noise monitoring sites 1 and 2 is expected to increase, as the new highway alignment falls closer to these sites. The noise levels at noise monitoring sites 3 and 4 are expected to decrease as Highway 101 traffic will be diverted to the new alignment, which is located further away. Refer to Figure 5.1 for noise monitoring sites.

In general, increases in traffic noise are expected along the entire new alignment. These increases could be >10 dBA above baseline conditions at night, especially for those receptors who are in proximity to the new proposed alignment but were farther removed from the existing Highway 101. Increases in noise levels are due to the proximity of the alignment to residential properties, and the existing low background noise levels, particularly for those areas where no highway currently exists.

As shown on Figure 5.1, there are nine structures located within the PDA. These structures will be removed prior to construction and therefore do not represent receptors of potential operational noise from the new highway.

For those receptors outside the PDA that will remain in proximity to the new alignment and could potentially experience a significant increase in noise levels due to highway operations, NSTIR will consider acoustic modelling during detailed design prior to construction and/or acoustic monitoring during operations to determine if site-specific mitigation is required. Implementation of physical mitigation generally considers economic feasibility, effectiveness of the mitigation, and sensitivity of receptors.

Infrastructure maintenance activities will typically be restricted to daylight hours, and will be of relatively short duration. Events of elevated sound pressure due to maintenance activities are not expected to affect any one receiver for a prolonged period or during nighttime hours. Adherence to the Generic EPP (Section 3.13; NSTPW 2007), including the use of mufflers when appropriate on maintenance equipment and following regular maintenance schedules, will help to mitigate the effects of maintenance activities on the acoustic environment in the Assessment Area.

In consideration of the potential environmental effects of the Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the

operation and maintenance of the Project on the acoustic environment are predicted to be not significant, assuming that NSTIR undertakes additional site-specific mitigation measures to reduce noise from traffic along the new highway that might otherwise be considered significant for certain receivers. NSTIR will consider site-specific noise modelling during detailed engineering design to predict noise levels associated with highway operation, and develop site-specific mitigation strategies as feasible. NSTIR will also undertake monitoring, if requested, and corrective action will be taken if warranted.

5.1.7.3 Change in GHG Emissions

Construction

Emissions of GHGs will result from the operation of heavy construction equipment (*e.g.*, trucks, front-end loaders, pavers, and other equipment) during the construction phase of the Project. Table 5.1.9 summarizes the GHG emissions estimate associated with typical construction equipment (*e.g.*, pavers, rollers, trucks) to be used during Project construction and comparative provincial GHG emissions for 2014 (also refer to Table 5.1.5).

Table 5.1.9 Estimated GHG Emissions for Project Construction

Emissions	Project Construction Emissions (tonnes)	Nova Scotia 2014 Totals (tonnes)
GHGs (CO_2eq)	180.4	17,000,000

The estimated GHG emissions from Project construction represent 0.0015% of the provincial 2014 emissions and 0.00002% of the national emissions.

The removal of carbon sequestration sources such as forested areas during construction may also lead to changes in the net balance of stored carbon in the local area. Carbon sequestration is usually presented in terms of the tonnes of carbon stored per year in a given forested area. Carbon is incorporated into the physical structure of trees and plants through photosynthesis, which sequesters CO_2 from the air. An estimation of the removed carbon sequestration within the Assessment Area was completed based on the forested areas removed and their respective carbon sequestration potentials using methods developed by the United States Energy Information Administration (US EIA 2000) and Environment Canada (Gray 1995).

The estimated loss in carbon sequestration potential as a result of the Project is presented in Table 5.1.10.

Table 5.1.10 Estimated Loss of Carbon Sequestration due to the Project

Loss in Area of Carbon Sequestration Sources Resulting from Project (Hectares)[1]	Loss of Carbon Sequestration in Assessment Area (tonnes CO_2/year)	Estimated Provincial Greenhouse Gas Emissions for 2004 (reference) (tonnes CO_2-equivalent/year)
3.72	25	23,000,000
Notes [1]Assumes 55 m and 41 m corridor and one-third of RoW being forested.		

It should be noted that carbon sink calculations were limited to forested areas or areas with general tree cover, due to the lack of standardized procedures for determining carbon sequestration by other sinks, such as agricultural land and water bodies. The area of forest or tree cover removed was determined using habitat type classification based on NSDNR land cover data (refer to Figure 5.6 and Table 5.6.4) assuming that a 55 m corridor will be cleared for the wide median twinning and 41 m corridor will be cleared for the narrow median twinning, and that less than 10% of the area within the RoW is forested.

The carbon sequestration lost due to the deforestation required for Project construction is negligible when compared to GHG emissions in the province. In addition, this loss could be offset by GHG emission reductions from improvements in vehicle traffic flow as a result of operation.

GHG emissions during construction will be temporary, short in duration and small in magnitude and will be mitigated as described in the Generic EPP (Section 3.13; NSTPW 2007) and Table 5.1.6.

Operation and Maintenance

Project operation is not expected to result in increased vehicle traffic but rather increase efficiency and mobility by supporting efforts to reduce congestion, effectively manage traffic volume, reduce travel time and improve productivity (NSTIR 2014). Negligible interactions with global climate change are therefore expected during operation.

GHG emissions during maintenance will be temporary, short in duration, and small in magnitude. GHG considerations during maintenance will be managed as described for the construction phase in Section 5.1.7.3.

5.1.8 Monitoring and Follow-up

Should complaints of excessive noise or airborne dust be received, the root causes of these complaints will be determined by NSTIR, and corrective action will be taken if warranted. Should it be determined to be necessary to identify the source or extent of such problems, ambient monitoring of dust or noise will be conducted, as appropriate. NSTIR will undertake monitoring, if requested, and corrective action will be taken if warranted.

5.2 GROUNDWATER RESOURCES

Groundwater resources has been selected as a VC due to the nature of potential environmental effects of the Project on groundwater that could be used for potable purposes. Groundwater provides a potable water supply to approximately half of the total population of Nova Scotia, and to all the un-serviced residences adjacent to the proposed highway corridor. The potential for the disruption or contamination of the groundwater drinking supply for nearby residents therefore requires assessment.

5.2.1 Regulatory and Policy Setting

Provincial regulations and standards that relate to groundwater resources are described below.

- *Water Resources Protection Act*: This Act was developed to protect water resources in Nova Scotia.
- Well Construction Regulations, in accordance with Sections 66 and 110 of the Nova Scotia *Environment Act*: These regulations stipulate requirements for proper water supply well construction, testing and abandonment.
- Nova Scotia Groundwater under the Direct Influence (GUDI) Standards (NSE 2012): This standard applies to Municipal Groundwater Supplies and outlines the methods used to assess and remediate wells that interact directly or indirectly with surface water.
- Groundwater Withdrawal Approval Process pursuant to the Nova Scotia *Environment Act*: The Activities Designation Regulations (Division I) require a water withdrawal approval ("Water Approval") if a groundwater withdrawal exceeds 23,000 litres (L) per day for a period of more than two weeks.
- Nova Scotia Source Water Protection Planning, in accordance with section 106 of the Nova Scotia *Environment Act*: In areas that have been formally designated as a Protected Water Area, municipalities and/or utilities can develop regulations with the aim of protecting source water quality. This regulation can limit activities within designated watersheds, or well field protection areas, and can require monitoring of specific activities within these protected areas.

The following federal guidelines also apply to the protection of groundwater resources:

- Canadian Environmental Quality Guidelines (CCME 2007); and
- Guidelines for Canadian Drinking Water Quality (Health Canada 2014).

5.2.2 Boundaries

The assessment of potential environmental effects on groundwater resources encompasses the following spatial boundaries: the PDA and the Assessment Area. The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1. The Assessment Area for groundwater resources is the maximum area within which environmental effects related to the Project can be predicted or measured with a reasonable degree of accuracy and confidence, and encompasses the

likely zone of influence on groundwater resources. For groundwater resources the zone of influence is based on a combination of the type and locations of the known aquifers, aquifer hydraulic properties, expected groundwater flow directions, and the distance between the RoW and water supply wells that may be affected by Project activities. The Assessment Area for groundwater resources is therefore an area extending 500 m from the PDA, which conservatively accounts for the various zones of influence.

With respect to temporal boundaries, most physical and chemical effects on groundwater resources are likely to be temporary and to occur during the construction phase. However, if a deep road cut is necessary, a permanent drop in elevation of the local groundwater table in the vicinity of the road cut could occur. Residual effects from road de-icing materials could occur throughout the operation phase of the Project, and potential effects due to an accidental spill could occur in all phases of the Project.

5.2.3 Significance Definition

A **significant adverse residual environmental effect on groundwater resources** is defined as one in which the Project causes one or more of the following:

- yield from an otherwise adequate well supply decreases to the point where it is inadequate for intended use;
- the quality of groundwater from an otherwise adequate well supply that meet guidelines deteriorates to the point where it becomes non-potable or cannot meet the Guidelines for Canadian Drinking Water Quality (Health Canada 2014); and/or
- the aquifer is physically or chemically altered to the extent that interaction with local surface water results in stream flow or chemistry changes that adversely affect aquatic life or surface water supply.

5.2.4 Description of Existing Conditions

5.2.4.1 Methods

Background information on groundwater was obtained from published resource materials, maps and hydrogeological databases including:

- topographical and air photo mapping along the pipeline route
- Nova Scotia Groundwater Atlas (NSDNR 2016a) which includes:
    - NS Well Log Database (1960 to present)
    - NS Pumping Test Database (1975 to present)
- Surficial Geology Map (Stea *et al*. 1992)
- Bedrock Geology Map (Keppie 2000)
- Discussions with officials at the Water Commission Utility Clerk for Digby

No field reconnaissance was completed as part of this assessment and a well water inventory was not undertaken. Since this preliminary assessment identifies areas of potential concern (*i.e.*,

areas likely containing potable wells), a residential well water survey will be conducted within 500 m of the PDA prior to construction.

5.2.5 Summary of Existing Conditions

Surficial Geology

Based on the available maps (Stea *et al*. 1992), the surficial geology within the 500 m buffer of the PDA is predominantly comprised of 4 to 6 m of poorly to well-bedded silt, sand and gravel forming kame fields and esker systems of glaciofluvial origin (Figure 5.2). The southern extent of the proposed alignment is underlain by silty, compact glacial ground moraine till. The till thickness typically ranges from 3 to 30 m.

Bedrock Geology

Based on the geological mapping by Keppie (2000), the Assessment Area is underlain by Middle to Late Triassic sandstone of the Wolfville Formation (Figure 5.3), except at the ends of the alignment at Conway and Marshalltown. At these locations, the Assessment Area is underlain by lightly metamorphosed, folded and fractured crystalline bedrock of the Cambro-Ordovician aged Meguma terrain. Locally, the Halifax Group (referred to as the Halifax Slate, consisting of the Acacia Brook Formation) and the Goldenville Group (consisting of the Bloomfield Formation and the Church Point Formation) are present.

Formations of the Goldenville Group are not typically associated with acid drainage problems, and are therefore considered as low potential for acid drainage risk. Occasional mineralized zones are known to occur along the crests of anticline structures, and arsenic associated with arsenopyrite mineralization can occur naturally in the groundwater. The Halifax Group has a history of acid drainage problems in the Province due to the presence of sulphide mineralization.

Topography and Drainage

The Project alignment occurs at elevations ranging from near sea level at The Joggins (part of the Annapolis Basin) to approximately 50 m above sea level (mASL) near the middle of the alignment. Relief ranges from gently undulating to rolling, depending on the underlying surficial materials.

The proposed alignment is located within the Sissiboo/Bear watershed. The easternmost 1 km of proposed highway is in the 1DB-SD32 secondary watershed (see Figure 5.2) that drains to the northeast via streams and watercourses to the Joggins. The remaining portion is in the 1BD-SD13 secondary watershed that drains southwest via steams and watercourses to St. Mary's Bay (see Figure 5.2 and Section 5.3 Fish and Fish Habitat).

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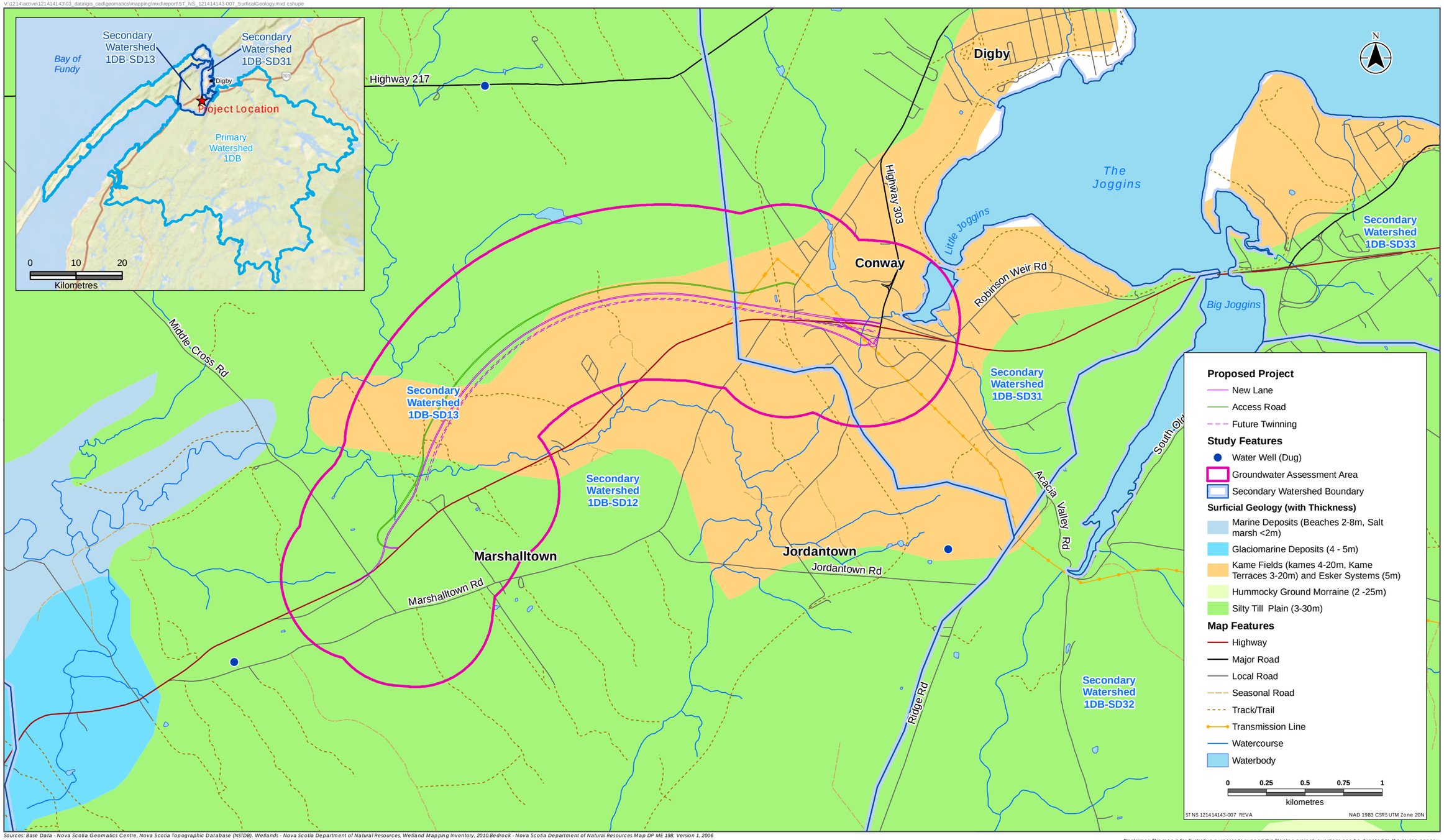

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.Bedrock - Nova Scotia Department of Natural Resources Map DP ME 198, Version 1, 2006
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Surficial Geology

Stantec

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Proposed Project
- New Lane
- Access Road
- Future Twinning

Study Features
- Water Well (Drilled)
- Groundwater Assessement Area
- anticline approximate
- syncline approximate
- geological contact assumed
- geological contact approximate
- geological contact defined

Bedrock Geologic Units

Blomidon Formation:
red-brown to locally grey-green siltstone and minor sandstone and shale; caliche

Wolfville Formation:
pink to red, coarse-grained sandstone and conglomerate with minor red to red-brown siltstone and shale pink to red, coarse-grained
sandstone and conglomerate with minor red to

Bear River Formation:
light to dark grey, well-laminated, cleaved metasiltstone with thin beds of slate; minor medium- bedded, fine-grained metasandstone;
trace fossils and bioturbated beds common;

Acacia Brook Formation:
grey to dark grey, laminated slate with minor, thin beds and lenses of light grey metasiltstone;
medium-bedded, crosslaminated, fine- to medium
-grained metasandstone; sulphide minerals

Bloomfield Formation:
maroon and green to grey, thin- to medium-bedded
metasiltstone to slate; rare thin-bedded, fine-grained

Church Point Formation:
grey, medium- to thick-bedded, very fine- to medium-grained metasandstone locally interlayered with green, cleaved metasiltstone,
and rare black slate; calc-silicate nodules common; minor mafic sills

Map Features
- Highway
- Major Road
- Local Road
- Seasonal Road
- Track/Trail
- Transmission Line
- Watercourse
- Waterbody

0 0.25 0.5 0.75 1
kilometres

121414143-006 NAD 1983 CSRS UTM Zone 20N

Digby
Conway
Marshalltown
Jordantown
The Joggins
Little Joggins
Big Joggins
Highway 303
Highway 101
Robinson Weir Rd
Marshalltown Rd
Jordantown Rd
South Old Post Rd
Back Rd
Lansdowne Rd
Ridge Rd
N

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.Bedrock - Nova Scotia Department of Natural Resources Map DP ME 127, Version 1, 2012

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Bedrock Geology

Stantec

HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 5.3

Hydrogeology

The hydrogeology and hydraulic properties of the various unconsolidated surficial materials and bedrock units underlying and within 500 m of the alignment are presented below in order of age and occurrence below ground surface. The capacity of each unit to store and transmit groundwater to wells is discussed.

Surficial Materials

As described above, the surficial materials along the alignment are reported to be between 3 and 30 m thick. Dug wells, typically 4.5 to 6 m in depth, may be located in the surficial materials within the Assessment Area. Depending on location, topography, and permeability of the overburden, some wells experience seasonal loss of water due to annual water table fluctuations in the order of 3 m or greater.

Glaciofluvial Sand and Gravel

Glaciofluvial sand and gravel has been identified by surficial geology mapping under approximately 80% of the proposed right of way. This type of deposit typically provides very productive aquifers. Kennedy (2014) identified a small portion of this deposit on the very eastern portion of the Assessment Area as a key surficial aquifer. The characteristics of this aquifer within Digby County were not available in the NSE Pumping Test Database (NSE 2016b); however, dug wells within this material is expected to provide sufficient water for single family needs.

Glacial Till

The ground moraine underlying the western 20% of the proposed alignment, from experience, typically has a low hydraulic conductivity in the order of 10^{-5} to 10^{-6} cm/sec. The characteristics of this aquifer within Digby County were not available in the NSE Pumping Test Database (NSE 2016b); however, dug wells within this material are expected to provide sufficient water for single family needs.

Bedrock Materials

Wolfville Formation

The Wolfville Formation sandstone is one of the better aquifers in Nova Scotia. Several high capacity wells are identified in Conway at the eastern end of the proposed alignment. Based on 13 pumping tests in Digby County, wells completed in the Wolfville sandstone have an average transmissivity of 24 m^2/day, and a typical well yield ranging from 16 to 2566 m^3/day, averaging 851 m^3/day (NSE 2016b).

Acacia Brook Formation (Halifax Group) Bedrock

The Halifax Group consists of the Acacia Brook Formation within the Assessment Area. The average transmissivity of the Halifax Group (all formations) is 46 m^2/day based on pumping tests conducted in four wells within Digby County. Safe yield is much lower than the Wolfville sandstone ranging between 0.7 to 222 m^3/day, averaging 103 m^3/day (NSE 2016b).

Church Point and Bloomfield Formations (Goldenville Group)

The Church Point and Bloomfield Formations of the Goldenville Group are present underlying the western portion of the alignment. The average transmissivity of the Goldenville Group (all formations) within Digby County is 3 m^2/day, based on 14 pumping tests (NSE 2016b). Safe yields are low ranging from 0.7 to 183.3 m^3/day, averaging 47.0 m^3/day (NSE 2016b). While generally a poor yield fractured bedrock aquifer, this unit is relied on by rural residents across Nova Scotia for potable water supply.

Existing Water Wells

The NSE Well Logs Database (NSE 2016a) contains records of all logs submitted to the Department. Although NSE has not received well logs for all wells installed in the province, the database provides a good indication of the distribution of wells in Nova Scotia. One of the known limitations of the database is the georeferencing (spatial coordinates) of these wells. Thus, the number, location, and construction of wells in use have not been verified.

Personal correspondence with the Utility Clerk (Joy Robins) for the Water Commission (September 27, 2016) indicate that municipal water services stop at Belair Drive off Highway 303 approximately 1.7 km north from Exit 26 on Highway 101.

Municipal Wells

No municipal water supply wells are known to be located within 500 m of the Assessment Area (Water Commission Utility Clerk pers comm 2016). Municipal wells for the Town of Digby are located approximately 4 km north in Mount Pleasant, with backup from a surface water connection at Vantasell Lake (partly within the 500 m buffer).

Drilled Domestic and Commercial Wells

The NSE well logs database (2016a) indicates there are 45 drilled wells within the 500 m buffer (Figure 5.3). Table 5.2.1 provides a summary of well construction. These wells have depths ranging from 18.3 to 99 m, and yields ranging from 0.5 to 681 L/min. Due to distance and expected well yields, drilled wells in Wolfville formation are not expected to be at risk from Project activities along the proposed alignment.

Table 5.2.1 Summary of Drilled Well Information

	Well Depth (m)	Casing Length (m)	Diameter (mm)	Est., Yield (L/min)	Static Water Level (m)
Maximum	99.0	69.7	203.2	681.0	32.6
Minimum	18.3	6.1	101.6	0.5	0.0
Mean	62.9	32.8	147.2	74.6	16.5
Median	62.4	36.5	152.4	22.7	18.3
Number	44	41	42	41	27

Source: NSE Well Logs Database 1920-2015

Water Quality

Water quality within the glacial till is expected to be good, although concentrations of iron, manganese and hardness may locally exceed the Guidelines for Canadian Drinking Water Quality (Health Canada 2014) aesthetic criteria of 0.3, 0.05 and 120 milligrams per litre (mg/L), respectively. Depending on age, location, and construction method, dug wells are highly prone to coliform bacteria impact.

The following evaluation of bedrock water quality is based on a review of the Nova Scotia Groundwater Chemistry Database (NSDNR 2016a). The Wolfville Formation is expected to have good quality water. Water quality in the Acacia Brook Formation (Halifax Group) can be expected to be of good chemical quality with moderate hardness, and some complaints of elevated iron and manganese concentrations, hydrogen sulfide odours in some wells with very deep overburden, and acidic water in areas of thin overburden cover. The Church Point and Bloomfield Formations (Goldenville Group) is expected to be good, with less iron and manganese than the Acacia Brook Formation (Halifax Group) wells, but possible elevated arsenic concentration along the crests of anticline structures, typically associated with gold bearing strata.

5.2.6 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with groundwater resources resulting in a change to groundwater quality and quantity. In consideration of these potential interactions, the assessment of Project-related environmental effects on groundwater resources is focused on the following potential environmental effects:

- change in groundwater quality and quantity.

5.2.7 Change in Groundwater Quality and Quantity

Construction

Construction activities that have the potential to affect groundwater quality and/or groundwater quantity include:

- clearing, and grubbing of vegetation during site preparation;
- blasting and major excavations associated with roadbed preparation and site preparation for watercourse crossing structures;
- excavations associated with roadbed preparation and site preparation for watercourse crossing structures (especially in areas with Karst/evaporate deposits);
- surfacing and finishing of paved surfaces which involve the application and mixing of asphalt; and
- ancillary elements, including temporary access roads and borrow areas.

The clearing, grubbing, and stripping of vegetation may lead to increased surface runoff, since there is no vegetation to intercept precipitation or impede the flow of water. Surface runoff from cleared and grubbed areas typically contains sediments. Shallow springs and wells, which are more susceptible to direct surface water influence, could increase in turbidity if exposed to runoff. Increasing the amount of surface runoff also reduces ground infiltration and groundwater recharge.

Blasting activities can affect well water quality including increased turbidity, dis-coloured water, and nitrate and/or coliform contamination due to damage of casing seals. Blasting can also result in changes in well water production capacity including loss of quantity of production, air in water and/or water lines, damage to pump, and damage to the well screen or borehole. However, it is anticipated that blasting would be minimal for this Project, if required.

Major excavations associated with cuts have the potential to affect groundwater quantity and/or quality in nearby or down-gradient shallow water wells and may cause localized changes in groundwater flow directions. Effects on wells from excavation could include temporary increases in turbidity and decreased yield or "dry" wells due to a lowering in the water table. Due to distance and expected well yields, drilled wells in the Wolfville Formation are not expected to be at risk from Project activities along the proposed alignment.

Runoff during paving operation may contain dissolved hydrocarbons. At least part of this runoff will infiltrate the ground, introducing dissolved contaminants into the groundwater flow system. Vibrations from equipment have also been reported to affect water wells in close proximity, generally resulting in temporary increases in turbidity. Accidental releases of hazardous materials (*e.g.*, hydrocarbons) during construction can degrade the chemical quality of downgradient water supplies.

Operation and Maintenance

Operation of the highway has the potential to affect groundwater quality and/or quantity by:

- reducing groundwater recharge due to the increase in impervious surface area;
- altering local groundwater quality due to dissolved contaminants in runoff from the highway or from accidental spills;
- lowering of the water table due to ditching, cutting, and grading; and
- altering shallow groundwater flow patterns due to changes in surface drainage patterns.

Impervious materials, such as asphalt, prevent the infiltration of precipitation into the ground, thereby reducing the amount of groundwater recharge. Similarly, ditching and cutting modify local drainage patterns, thereby reducing groundwater recharge and potentially resulting in a local lowering of the water table, as well as altering shallow groundwater flow patterns.

Runoff from roads and highways, as well as from paving operation during infrastructure maintenance may contain contaminants such as lubricants, coolants, vehicle deposits, and road salt. Some runoff may infiltrate into the ground, introducing dissolved contaminants into the groundwater system. Accidental releases of hazardous materials (e.g., hydrocarbons) from vehicular crashes or other unforeseen events can degrade the chemical quality of downgradient water supplies. The normally acidic runoff will dissolve underlying evaporate deposits and alter groundwater flow rates and pathways.

During winter, salt is used by NSTIR on road surfaces to aid in melting snow, and to provide clear road conditions. Road salt can enter into the environment (surface water, groundwater, and soil) through application of these salts. As road salt is applied directly to the road surface, its potential to affect the groundwater system is considered to be substantially higher than than vehicle-related contaminants.

Since NSTIR primarily uses mechanical means to maintain vegetation control, ongoing maintenance of vegetation is not expected to affect groundwater quality. However, the removal of vegetation will reduce the amount of precipitation that is intercepted, thereby increasing runoff. This could result in a local reduction in groundwater recharge and a lowering of the water table. In this case, this effect is likely to be negligible since much of the area is already cleared due to previous developments.

5.2.8 Mitigation

Mitigation measures to be implemented to reduce potential effects on groundwater quality and quantity are presented in Table 5.2.2.

Table 5.2.2 Mitigation for Groundwater Resources

Effect	Phase	Mitigation
Change in Groundwater Quality and Quantity	Construction	• Pre-construction well survey • Pre-blast surveys (if required) • Ripping instead of blasting where possible near residential areas • Erosion and sediment control measures to reduce surface runoff • Minimize extent of clearing to only what is required • Remedial action as necessary to restore damaged wells and provide temporary potable water as needed • Follow Generic EPP (including Spill Contingency Plan) (NSTPW 2007)
	Operation and Maintenance	• Follow Generic EPP (including Spill Contingency Plan) (NSTPW 2007) • Remedial action as necessary to restore damaged wells and provide temporary potable water as needed • Follow Salt Management Plan

5.2.9 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on the groundwater resources after the general mitigation measures, as provided above, have been implemented.

5.2.10 Change in Groundwater Quality and Quantity

Construction

During Project construction, several activities could result in a change in groundwater quality and quantity. These include grubbing and stripping of vegetation during site preparation; erosion and siltation; major excavations associated with roadbed preparation; site preparation for watercourse crossing structures; and surfacing and finishing of paved surfaces.

Clearing, grubbing, and stripping activities associated with site preparations will decrease interception of precipitation by vegetation and increase runoff in these areas, which would result in a reduction of groundwater recharge (*e.g.*, a decrease in groundwater quantity) and an increase in water turbidity within shallow wells and springs. Erosion from grubbed and stripped areas is generally only a concern to shallow dug wells and springs in proximity to the Project (*e.g.*, a few tens of metres) and where direct overland flow of silt occurs.

Erosion control systems will be in place to manage runoff from the construction areas, reducing the amount of runoff. Erosion and siltation control measures to be used for highway projects are described in Section 3.2 of the Generic EPP (NSTPW 2007).

Blasting, if required, can cause environmental effects in adjacent wells ranging from minor temporary turbidity to rare complete collapse of the well. The severity of the environmental effect is proportional to distance, physical and seismic properties of the bedrock being excavated, age and construction method of the well, well yield, and blast magnitude. It is expected that blasting, if required, would be minimal. Several properties with potential onsite wells have been identified within 500 m of the PDA. Pre-blast well surveys will be conducted on wells within 500 m of planned blast locations. Major excavations through tills could lead to a drop in groundwater table elevations in proximity to the cut. The degree of water level lowering will be proportional to the depth of the cut below the natural water level table, the distance between the well and the cut, and the hydraulic properties of the overburden materials (*i.e.*, larger and faster decline in higher permeability media). Dug wells near the edge of a cut could suffer sufficient water level decline to become dry, while drilled wells are not likely to be adversely affected. Ripping will be used preferentially over blasting, when possible, near residential areas (Section 5.4.2 in NSTPW 2007).

Borrow pits and existing quarries for rock will avoid the Halifax Formation bedrock to minimize the risk of encountering acid producing rock. All layered bedrock within the proposed alignment that may be disturbed or exposed will be tested for its potential to produce acid. Testing will comply with specifications outlined in the Sulphide Bearing Material Disposal Regulations under the Nova Scotia *Environment Act*. Exposure, removal, and disposal of potentially acid generating bedrock must be conducted in compliance with the Guidelines for Development on Slates in Nova Scotia (NSDOE and Environment Canada 1991), and the Sulphide Bearing Material Disposal Regulations. Additional mitigation measures to be used for blasting on highway projects are described in Section 4.2.3 and 5.4.2 of the Generic EPP (NSTPW 2007).

Runoff from paving areas may contain dissolved hydrocarbons, and vibration from equipment may cause temporary increases in turbidity in adjacent wells. However, the concentration of dissolved hydrocarbons in any runoff from these areas is expected to be at trace levels. Proper staging of the paving (*e.g.*, dry weather application, drainage controls as required, paving of the roadway in sections) and vibration controls will minimize any potential environmental effects.

A contingency plan will be developed to provide an interim water supply to consumers in areas that experience adverse effects in water quality or quantity during the various stages of construction, and operation and maintenance phases of the Project. Well repair and/or replacement, including deepening of existing wells and drilling new wells, which are permanently damaged or adversely affected by the Project may be undertaken in both the construction, and operation and maintenance phases of the Project. All wells drilled in relation to the Project will be drilled by a licensed water well contractor. The specifics of the contingency

plan will be decided on a case-by-case basis, pending the nature of the adverse environmental effect and its relation to the Project.

In consideration of the potential environmental effects of Project-related activities during construction, and the proposed mitigation, residual environmental effects of the construction of the Project on groundwater resources are predicted to be not significant.

Operation and Maintenance

Once the highway has been constructed, there will be a permanent decrease in the amount of infiltration to groundwater; however, as the surface extent of the highway within any one watershed is substantially less than the total watershed area, the magnitude of this effect will be imperceptible to groundwater users.

ECCC completed an assessment of road salt under CEPA. Recognizing that a total ban of road salt could potentially compromise human safety, the focus of road salt risk management is on implementation of measures that optimize winter road maintenance practices so as to not jeopardize road safety while minimizing the potential environmental effects (Environment Canada and Health Canada 2001). Therefore, ECCC has categorized road salt as a Track 2 substance, requiring Life-Cycle Management.

NSTIR has a Salt Management Plan (see Section 2.3.2.3) which specifies application rates and designates vulnerable areas to be used to maximize the efficiency of salting and sanding. The drainage of salt laden runoff away from residences and their wells along ditching will likely mitigate this potential environmental effect on any nearby residential wells. A change in groundwater quality may occur with the presence of the Project. However, adherence to the Salt Management Plan will reduce changes in groundwater quality to levels that are likely to be indiscernible from natural variation.

Dissolved contaminants such as lubricants, coolants, and vehicle deposits may also be present in runoff from the highways, and subsequently may infiltrate into the ground and reach the groundwater. However, the concentrations of these contaminants are expected to be very low relative to road salt. The effect of these other dissolved contaminants on the groundwater quality will be imperceptible to groundwater users.

Routine infrastructure maintenance may potentially interact with groundwater. Runoff from paving areas may contain dissolved hydrocarbons, and vibration from equipment may cause temporary increases in turbidity in adjacent wells. However, the concentration of dissolved hydrocarbons in any runoff from these areas is expected to be at trace levels. Proper staging of the paving (*e.g.*, dry weather application, drainage controls as required, paving of the roadway in sections) and vibration controls will reduce potential environmental effects. The likelihood of an environmental effect on groundwater resources from runoff and during resurfacing activities is considered to be very low.

Vegetation management techniques will be employed where feasible to promote sustainable growth along the highway; however, if herbicide application is required for the control of noxious weeds, the application will be carried out by trained personnel who will apply the herbicide in accordance with an approval issued by the NSE pursuant to the Pesticide Regulations under the Nova Scotia *Environment Act*.

If required, a contingency plan will be developed to provide temporary water to consumers in the area that experience adverse effects in water quality or quantity during the operation and maintenance of the Project. Repairs and replacement of any wells that are permanently damaged by the Project will be decided on a case-by-case basis, pending the nature of the adverse environmental effect and its relation to the Project.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the operation and maintenance of the Project on groundwater resources are predicted to be not significant.

5.2.11 Monitoring and Follow-up

Several domestic and commercial water supply wells are likely located within 500 m assessment boundary. As per Section 4.2.3 of the Generic EPP (NSTPW 2007), NSTIR will complete a detailed standardized survey of wells within 500 m of the centreline of the new alignment prior to construction. This would include the type of water supply and its age, conditions and known history based on property and survey information obtained during sample collections. Water samples will be collected by an independent contractor and analysed for pH, general chemistry and metals (Rapid Chemical Analysis Program (RCAp) plus metals), as well as fecal and total coliform counts as per NSE guidelines for sampling domestic wells. The number of wells to be inventoried and the monitoring boundary will be determined through consultation with NSE and the well-log database. Should samples indicate the presence of fecal coliform or concentrations of other parameters in excess of Canadian Drinking Water Standards, NSTIR's Project Engineer will immediately notify the landowner(s).

In the event that any residential wells are found within 500 m of any significant blasting excavation areas (*e.g.*, road cut or quarry), or if dug wells are located within 50 m of a major (> 5 m) overburden cut, these wells will be inspected (measuring depth, yield and water level in dug wells), and sampled for baseline water quality (RCAp-MS and bacteria) by the contractor. Where several drilled wells are present within the proposed 500 m blast monitoring radius, selected representative proximal wells will be inspected, baseline sampled, and closely monitored during the construction phase.

Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is recommended for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the

evaluation of effects. The suggested duration of any post-construction monitoring would be the lesser of two years of quarterly monitoring, or stabilization of water level and chemical indicators in wells of concern.

The extent and frequency of well monitoring post construction and during the operation phase will be determined once the preconstruction data has been assessed or following receipt of landowner complaints.

5.3 FISH AND FISH HABITAT

Fish and fish habitat were selected as a VC because of the importance of the freshwater environment as an ecosystem component and the associated regulatory protection afforded to it. Freshwater habitats are socially and culturally important to the people of Nova Scotia for the fisheries they support. In the context of the fish and fish habitat VC, the following definitions apply:

Fish, as defined by the *Fisheries Act,* includes: (a) parts of fish; (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals; and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fish habitat is defined by the *Fisheries Act* as spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes. Fish habitat includes physical (*e.g.*, substrate, temperature, flow velocity and volumes, water depth), chemical (*e.g.*, dissolved oxygen, pH, nutrients) and biological (*e.g.*, fish, benthic invertebrates, plankton, aquatic plants) attributes of the environment that are required by fish to carry out life cycle processes (*e.g.*, spawning, rearing, feeding, overwintering, migration).

The fish and fish habitat VC is inherently linked to the Vegetation and Wetlands VCs (Sections 5.4 and 5.5) through riparian vegetation and wetlands. The fish and fish habitat VC is also linked to the Land Use VC (Section 5.7) through the recreational fishery and traditional Aboriginal use.

5.3.1 Regulatory and Policy Setting

Fish and fish habitat are protected through federal and provincial legislation. Key federal and provincial acts and regulations that apply to fish and fish habitat in Nova Scotia are listed below, followed by brief descriptions:

- the *Fisheries Act* (R.S.C., 1985, c.F-14);
- the *Species at Risk Act*;
- the Nova Scotia *Endangered Species Act*; and
- *Nova Scotia Activities Designation Regulations.*

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

- the Fisheries Protection Policy Statement (DFO 2013);
- Watercourse Alterations Standard (NSE 2015); and
- Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME 1999).

Fish species of conservation interest (SOCI) are defined for this assessment as those species that are:

- listed under the NS ESA or the federal SARA as being either *endangered, threatened, vulnerable,* or of *special concern* (*i.e.*, Species at Risk or "SAR");
- not yet listed under provincial or federal legislations, but identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being either *endangered, threatened,* or of *special concern;*
- listed by the NSDNR to be *at risk, may be at risk,* or *sensitive* to human activities or natural events; and/or
- ranked as *S1, S2,* or *S3* by the Atlantic Canada Conservation Data Centre (AC CDC).

5.3.1.1 Fisheries Act

Fish habitat is protected under the federal *Fisheries Act*. On November 25, 2013, the *Jobs, Growth and Prosperity Act* came into force which resulted in changes to several sections of the *Fisheries Act*, most notably Section 35 that defines serious harm to fish and their habitat. An updated Fisheries Protection Policy Statement (DFO 2013) was released, replacing the previous Fish Habitat Policy. The amendments in Section 35 of the *Fisheries Act* adopt "serious harm to fish" replacing "harmful alteration, disruption or destruction (HADD), of fish habitat". The updated Fisheries Protection Policy Statement interprets "serious harm" to commercial, recreational and Aboriginal (CRA) fishery species 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; and*
- *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.*

With the recent amendments, the requirement under the Act to gain authorization applies 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.

Table 5.3.1 outlines the relevant requirements for NSTIR under the federal *Fisheries Act* and regulations.

Table 5.3.1 Relevant Directives under the *Fisheries Act*

Regulations	Nature of Directive	Relevance to NSTIR	Federal Authority
Section 20	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.	Watercourse crossing designs and provision of fish passage.	DFO
Section 35(1)	Provide protection of fish and fish habitat.	Watercourse crossing designs.	DFO
Section 35(2)	Permit authorizations for the alteration of fish habitat.	Permit *Fisheries Act* authorizations for habitat alterations, if required.	DFO
Section 36	Implement mitigation as per guidelines to prevent introduction of deleterious substances into fish bearing waters.	All heavy equipment work within watercourse buffers (30 m) and need to prevent erosion and sedimentation of watercourses, or fuel spills from reaching watercourses.	DFO/ Environment and Climate Change Canada

5.3.1.2 Species at Risk Act

Provincially, species listed as *extirpated*, *endangered*, *threatened* or of *special concern* are formally protected under the Nova Scotia *Endangered Species Act* (NS ESA). Federally, species listed on Schedule 1 as *extirpated*, *endangered* or *threatened* are formally protected under the Federal *Species at Risk Act* (SARA). Species at risk (SAR) are formally protected through prohibitions on killing, harassing, or capturing a listed species, unless otherwise approved through a ministerial order (*i.e.*, license or permit). Habitat critical to the survival of SAR is also protected, through prohibitions on destruction or alteration.

5.3.1.3 Nova Scotia *Activities Designation Regulations* – Watercourse Alteration

Provincial regulations applicable to fish habitat protection include the Nova Scotia *Activities Designation Regulations* made under section 66 of the *Environment Act*. The objective of the Watercourse Alteration Program is to protect aquatic habitat from unmitigated works in or near watercourses and wetlands. The *Activities Designation Regulations* enable NSE to issue either an approval (stipulating project-specific mitigation), or a notification to the department, indicating that the work is to be carried out in accordance with the Nova Scotia Watercourse Alterations Standard. A Watercourse Alteration Permit is required before:

- the physical modification of the bed or banks of a watercourse; or
- the modification of flow of water (*i.e.*, diversion or pumping).

5.3.2 Boundaries

The spatial boundaries for assessment of potential effects of the Project on fish and fish habitat includes all streams crossed by the proposed highway (Figure 5.4). Standard procedures include assessing fish habitat on either side of the proposed crossing which, coupled with stream site information, provides baseline information for subsequent habitat evaluations and monitoring.

The assessment of potential effects on fish and fish habitat encompasses the following spatial boundaries: the Project Development Area (PDA) and the Assessment Area. The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1. The Assessment Area includes sufficient upstream and downstream freshwater habitat at all crossings to evaluate anticipated measurable Project-related environmental effects to the Sissiboo/Bear Watershed (Watershed 1D6). This Assessment Area was selected to encompass all areas with the potential to have direct and indirect loss of fish habitat under normal conditions and where environmental effects are reasonably expected to occur and are measurable with a high degree of confidence.

The temporal boundaries for the assessment of Project's effects on the fish and fish habitat are the periods of construction, and operation and maintenance of the Project. Most potential Project-related environmental effects on the freshwater environment will begin and peak during construction, and diminish during operation and maintenance.

5.3.3 Significance Definition

A **significant adverse residual environmental effect on fish and fish habitat** is defined as a Project-related environmental effect that:

- results in the likelihood of fish mortality, after mitigation measures are implemented, that reduces the productivity and sustainability of a CRA fishery and cannot be offset, thereby indicating residual serious harm to fish;
- results in the likelihood of mortality of an aquatic Species at Risk, after mitigation measures are implemented, that jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed species; or
- results in the permanent alteration or destruction of fish habitat and is of a spatial scale, duration, or intensity that limits or diminishes the ability of CRA or SAR aquatic species to use or rely upon such habitats for spawning, nursery, rearing, food, migration, or to carry out one or more other life processes affecting the productivity and sustainability of a CRA fishery, if the results of this change in fish habitat cannot be mitigated or offset.

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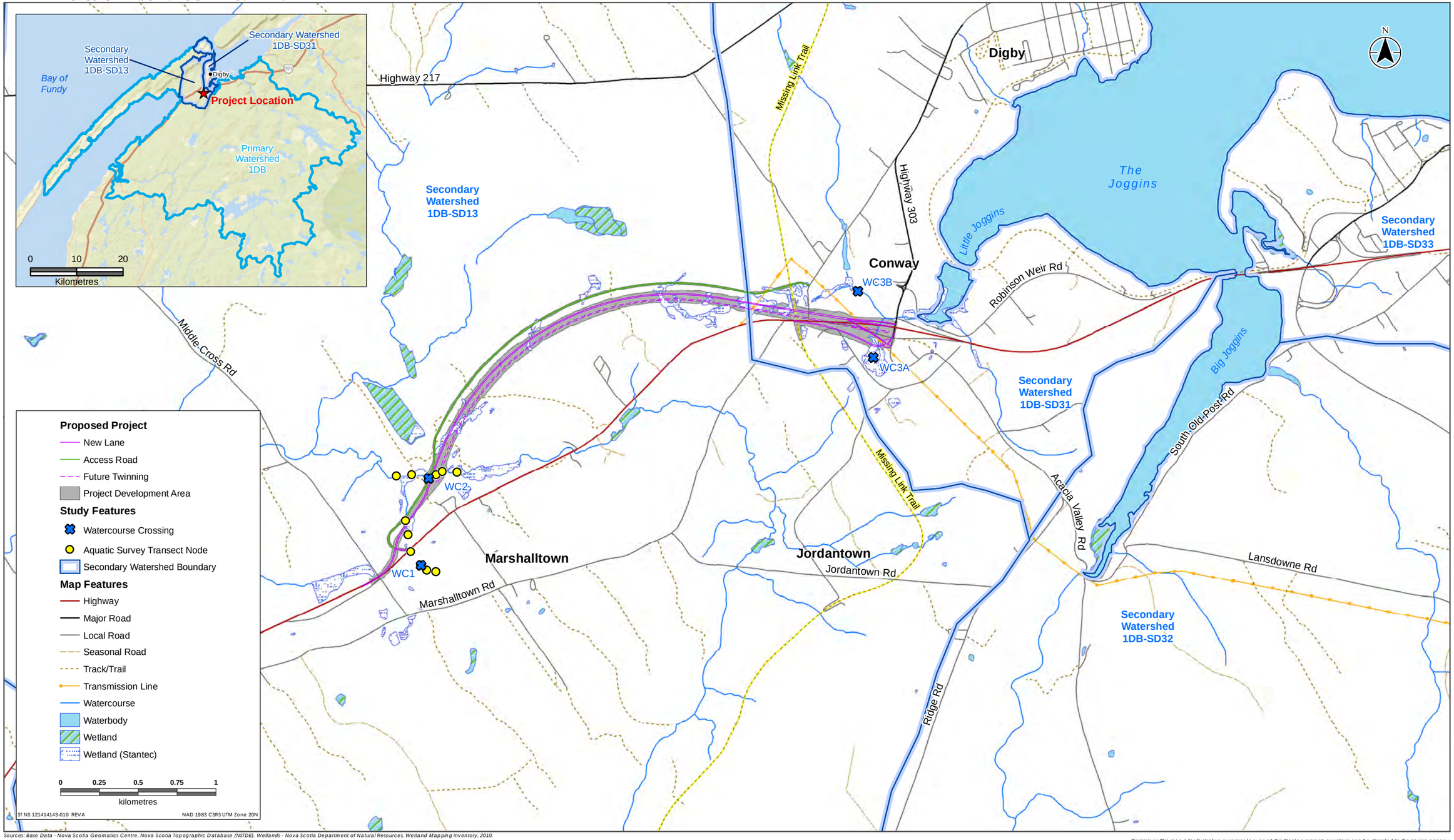

Sources: Base Data - Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB). Wetlands - Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010. Watersheds - Nova Scotia Department of Environment.

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Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Aquatic Features

Stantec

HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 5.4

5.3.4 Description of Existing Conditions

A fish and fish habitat study was conducted in 2001-2003 to support the original alignment of the Digby to Weymouth North corridor (refer to Section 1.1 for Project background). There were further studies in 2003 due to a slight realignment of the highway (referred to as the 'Marshalltown realignment').

Stantec conducted fish presence and habitat surveys in June 2016 to support the development of this EA. This description of existing conditions is primarily based on the data collected by Stantec in 2016, but data gathered in 2001/2003 were also referenced.

5.3.4.1 Methods

Based on existing 1:10,000 scale GIS mapping (and information from the 2001/2003 aquatic surveys), three watercourses intersecting the proposed highway were identified (Figure 5.4). While the exact route of the new highway had not been finalized at the time of field surveys, a temporary centerline through the right of way (RoW) was used to approximate an area of potential effects as to determine water crossing sampling locations (Figure 5.4).

Each watercourse (WC) was assigned a stream order using the method described by Strahler (1952). Water quality was assessed at the crossing location for WC1 and WC2. For WC3, water quality was assessed slightly downstream of the confluence of WC3a and WC3b.

At WC1 and WC2, crossing characteristics were collected using transects. The placement of transects on WC3 was not possible due to the highly altered nature of the stream and presence of existing infrastructure (Figure 5.4). Transects were placed as follows:

WC1 – Tributary to Seely Brook

- 100 m upstream of the centre line (Transect 1);
- 50 m upstream of the centre line (Transect 2*);
- the assessment corridor centre line (Transect 3*);
- 100 m downstream of the centre line (Transect 4*);
- 200 m downstream of the centre line (Transect 5*); and
- 300 m downstream of the centre line (Transect 6*).

*Transects 2-6 were used to summarize characteristics of WC1 as these transects fall within the PDA for the proposed highway.

WC2 – Seely Brook

- 200 m upstream of the centre line (Transect 1);
- 100 m upstream of the centre line (Transect 2*);
- 50 m upstream of the centre line (Transect 3*);
- the assessment corridor centre line (Transect 4*);
- 100 m downstream of the centre line (Transect 5); and

- 200 m downstream of the centre line (Transect 6).

*Transects 2-4 fall within the PDA for the proposed highway; these transects were used to summarize the characteristics of WC2.

WC3a – Tributary to Unnamed Stream and **WC3b** – Unnamed Stream

- No transect information was gathered along WC3a or WC3b. The placement of transects along WC3a was not possible due to roads, culverts, and wetlands while WC3b was outside the PDA.

Data collected from each transect included, but was not limited to, the following:

- channel width;
- wetted width;
- water depth at 0.25, 0.50 and 0.75 of wetted width;
- velocity at evenly spaced stations across one transect (corridor centre line);
- abiotic water column measures (temperature, conductivity, pH, total dissolved solids (TDS), dissolved oxygen);
- substrate composition;
- bank description, including height, slope and stability;
- functional in-water and riparian cover type and abundance; and
- photographs looking upstream, downstream, at left bank and at right bank.

A Stantec field crew assessed the four watercourse segments for fish presence and habitat. All four watercourse segments were accessible via Crown Lands and/or private lands for which access permission had been granted. Permission for land access had not been granted for the northern section of WC1 (*i.e.*, where it joins WC2) and so this section of the watercourse was not assessed. The watercourses were surveyed for fish populations to reconfirm the presence/absence of CRA fish species data from previous assessments. A qualitative determination of fish presence and community structure was completed at each watercourse using a Smith Root LR-24 backpack electrofishing unit. Fish habitat assessments were conducted at all four watercourse segments using Stantec's internal protocols along the surveyed reach. This habitat assessment procedure was based on differentiating habitat units (runs, riffles, pools), and recording channel characteristics, cover types and abundance and channel stability for each unit. Biotic features of interest (*e.g.* molluscs, algae, *etc.*) were also noted if encountered.

The watercourse summaries provided in Section 5.3.4.2.1 use both transect and habitat assessment information. To characterize Watercourses 1 and 2, only transects that fell within the PDA boundaries were used. Because the placement of transects was not possible on Watercourse 3, the habitat information was used to characterize this watercourse. WC3a crosses through the PDA, but WC3b does not. However, WC3b is still discussed in Section 5.3.4.2.1 because it is downstream of the proposed alignment.

5.3.4.2 Summary of Existing Conditions

The existing conditions of fish and fish habitat are summarized in this section including:

- freshwater habitats observed during the 2016 fish habitat assessments;
- fish species observed during the 2001 and 2016 electrofishing surveys;
- Species of Conservation Interest which inhabit the watercourses in the Project Area; and
- observed water quality.

5.3.4.2.1 Fish Habitat

Water Quality

Water quality measurements were collected between June 20 and June 22, 2016; results are summarized in Table 5.3.2. Water temperature ranged from 9.8°C to 15.6°C and the pH values ranged from 7.15 – 7.65. The CCME Guidelines for the protection of Freshwater Aquatic Life recommends pH values in the range of 6.5 to 9 as suitable for all life stages of aquatic life. Total dissolved solids (TDS) ranged from 29-105 ppm at the time measurements were taken.

Table 5.3.2 Water Quality Summary

Project Site ID	Watercourse Name	Sub-Watershed Information	Stream Order	Water Temp. (°C)	Conductivity (µS/cm)	pH	TDS (ppm)	Salinity (ppt)	Flow (m/s)
WC1	Tributary of Seely Brook (Starts at Marshalltown Road)	1DB – SD13 Flows into St. Mary's Bay (Bay of Fundy)	1	9.8	49	7.15	29	0	0.032
WC2	Seely Brook	1DB – SD13 Flows into St. Mary's Bay (Bay of Fundy)	3	15.5	66	7.65	40	0	0.056
WC3a	Tributary to Unnamed Stream (Starts at Beechwood Lane)	1DB – SD31 Flows into the Annapolis Basin (Bay of Fundy)	1	15.6	178	7.23	105	0.1	0.088
WC3b	Unnamed Stream (Starts at Highway 217)	1DB – SD31 Flows into the Annapolis Basin (Bay of Fundy)	2						
Note: water quality information for WC3 was taken slightly downstream of the confluence of WC3a and WC3b									

5.3.4.2.2 Habitat Assessment Results

WC1 – Tributary of Seely Brook

WC1 crosses the proposed RoW at its southern extent; the portion of the stream within the proposed RoW is roughly 500 m long. WC1 is a first order stream that meanders through deciduous forest, flows under highway 101, passes through more deciduous forest and eventually empties into Seely Brook (Photo 5.1; Figure 5.4). This watercourse had a mean channel width of 2.44 m and a max depth of 0.164 m (Table 5.3.3). Channel depth was calculated as 0.90 m using max water depth and average bank height.

The majority of the substrate was composed of large gravel (26%), gravel (25%) and cobble (22%). Fines made up 14% of the substrate, while organics made up 5%. Boulders (5%) and large boulders (3%) were also present. WC1 had low to high embeddedness throughout its assessed length. Stream banks tended to have roughly 18.5% bare ground, while riparian vegetation consisted of mostly shrubs (39.5%) and deciduous trees (36%) with some grasses (5.5%) and coniferous trees (0.5%). At the time of the assessment, the water temperature was 9.8°C, TDS was 29 ppm, conductivity was 49 µS/cm and the stream had a pH of 7.15 (Table 5.3.2). Flow was recorded as 0.032 m/s.

Photo 5.1 WC1 Upstream (left photo) and Downstream (right photo) Views at Transect 2 (50 m Upstream)

Table 5.3.3 Summary of Fish and Fish Habitat by Watercourse

Channel Characteristics						Substrate (%)									Water Depth (m)			
Project Site ID	**Stream Order**	**Channel Width (m)**	**Wetted Width (m)**	**Channel Depth (m)**	**Dominant Habitat Type**	**O**	**F**	**G**	**LG**	**C**	**B**	**LB**	**Br**	**E**	**1/4 Stream Width**	**1/2 Stream Width**	**3/4 Stream Width**	**Max Depth**
WC1	1	2.44	0.86	0.90	Riffle	5.0	14.0	25.0	26.0	22.0	5.0	3.0	0.0	L-H	0.056	0.072	0.042	0.164
WC2	3	6.10	4.10	0.91	Run	13.3	16.7	20.0	25.0	25.0	0.0	0.0	0.0	L-H	0.133	0.153	0.133	0.260
WC3a	1	1.88	1.40	-	Culvert	5.0	24.0	8.0	8.0	13.0	5.0	1.0	0.0	-	-	-	-	0.60
WC3b	2	3.64	2.00	-	-	6.4	29.3	20.0	20.0	14.3	7.1	2.1	0.0	-	-	-	-	0.30

Notes:
The data presented in the table are a representation of mean measurements assessed within the PDA.
WC3b is not in the PDA but is summarized here because of its proximity to the PDA boundary and its connection with WC3a.
Stream Order: The position of a watercourse in the hierarchy of tributaries that are a part of drainage system.
Substrate: O-organics, F-fines (<1mm), G-gravel (1-32 mm), LG-large gravel (32 -64mm), C-cobble (64-255mm), B-boulder (256-500 mm), LB-large boulder (>500mm), Br-bedrock, E-Embeddedness [L-low (<25%), M-moderate (25-50%), H-high (50-75%), VH-very high (>75%)].

WC2 – Seely Brook

Seely Brook (WC2) is a third order stream and the largest stream that crosses the PDA. In the assessment area, this watercourse flows through deciduous and mixed wood forest and is well shaded by trees and shrubs (Photo 5.2). The average channel width in Seely Brook was 6.1 m, while the average wetted width was 4.1 m (Table 5.3.3). The channel was, on average, 0.91 m deep. The substrate in this watercourse was comprised of mostly large gravel and cobble (both 25%), with roughly 20% gravel; fines (16.7%) and organics (13.3%) made up the remainder. Embeddedness ranged from low-high throughout the assessed length. The banks along Seely Brook were well vegetated. Riparian vegetation was comprised primarily of deciduous trees (38%) and shrubs (26%) as well as grasses (16%) and coniferous trees (7%) with 13% unvegetated. Water temperature at the time of the survey was 15.5°C. Conductivity was 66 µS/cm, and pH was 7.65. Flow was recorded as 0.056 m/s (Table 5.3.2).

Photo 5.2 WC2 Upstream (left photo) and Downstream (right photo) Views at Transect 3 (50 m Upstream)

WC3a – Tributary of an Unnamed Stream

This watercourse begins in a wetland near Beechwood Lane on the south side of the east bound exit ramp of Highway 101. The watercourse then flows north under this ramp (culvert 1), under Highway 101 (culvert 2), then under the westbound ramp (culvert 3) to the highway eventually flowing into WC3b (Figure 5.4). The majority of this stream within the assessment area flows through culverts (Photo 5.3).

WC3a is a first order stream that had a mean channel width of 1.88 m, a mean wetted width of 1.40 m, and a max depth of 0.60 m (Table 5.3.3). The substrate was mostly composed of fine material (24%) and cobble (13%). Gravel and large gravel each comprised 8%, while organics, boulders and large boulders were also present (5%, 5%, and 1%, respectively). WC3a passed through three culverts within the PDA, and this was the dominant habitat type in this

watercourse within the PDA. Water quality information was gathered slightly downstream of the confluence of WC3a and WC3b. At the time of the assessment, the water temperature was 15.6°C, TDS was 105 ppm, conductivity was 178 µS/cm and the stream had a pH of 7.23 (Table 5.3.2). Flow was recorded as 0.088 m/s.

Photo 5.3 WC3a concrete culvert

WC3b – Unnamed Stream

WC3b is outside the PDA boundaries, but is discussed due to its connection with WC3a. WC3b originates near Highway 217 and flows south toward the PDA. Before reaching the PDA, this watercourse turns to the east and runs along the north side of the existing highway, crossing through a culvert under Highway 303 before eventually emptying into Little Joggins Cove (Photo 5.4; Figure 5.4).

The assessed portion of WC3b is a second order stream. This watercourse had a mean channel width of 3.64 m, a mean wetted width of 2.00 m and a max depth of 0.30 m. The substrate was mostly composed of fine material (29.3%), gravel and large gravel (20% each). Cobble comprised 14.3%, while organics, boulders and large boulders were also present (6.4%, 7.1%, and 2.1%, respectively). Riparian vegetation consisted of grass, shrubs and deciduous trees. Water quality information was gathered slightly downstream of the confluence of WC3a and WC3b. At the time of the assessment, the water temperature was 15.6°C, TDS was 105 ppm, conductivity was 178 µS/cm and the stream had a pH of 7.23 (Table 5.3.2). Flow was recorded as 0.088 m/s.

Photo 5.4 WC3b fish passage under Highway 303

5.3.4.2.3 Fish Populations

The PDA falls within one primary watershed (Sissiboo, Bear River Watershed) and two secondary watersheds (Figure 5.4). Seely Brook (WC2) and its tributary (WC1) are part of secondary watershed 1DB-SD13, which flows into St. Mary's Bay. WC3a and WC3b are within secondary watershed 1DB-SD31, emptying into the Annapolis Basin at Little Joggins. During the 2016 field program, Stantec field crews conducted electrofishing surveys in all four watercourse segments in the PDA and fish were caught in all four watercourse segments. Electrofishing in 2016 identified two species: brook trout (*Salvelinus fontinalis*) and American eel (*Anguilla rostrata*). Both are SOCI species and are important to CRA fisheries. Juveniles and adults of each species were recorded. Table 5.3.4 summarizes electrofishing results for 2016.

Table 5.3.4 Species Caught and Observed During 2016 Field Surveys

Water Crossings Sampled	Species Caught	
	2016	Total Length (mm)
WC1 - Tributary of Seely Brook Fished for a total of 223 seconds	Brook Trout	55
	Brook Trout	103
	Brook Trout	126
	Brook Trout	162
	Brook Trout	185
WC2 - Seely Brook Fished for a total of 300 seconds	Brook Trout	35
	Brook Trout	39
	Brook Trout	45
	Brook Trout	50
	Brook Trout	50
	Brook Trout	101
	Brook Trout	143
	Brook Trout	169
	Brook Trout	175
	American Eel	120
	American Eel	134
	American Eel	135
	American Eel	200
	American Eel	-
WC3a - Tributary of an Unnamed Stream Fished for a total of 189 seconds	Brook Trout	165
	Brook Trout	169
	American Eel	175
WC3b - Unnamed Stream Fished for a total of 300 seconds	Brook Trout	154
	Brook Trout	172
	American Eel	152

Notes:
"-" means that a measurement was not obtained

Species of Conservation Interest

Legal protection for SOCI is limited to species listed under Schedule 1 of SARA and those species listed under the NS ESA. SOCI fish species found in the surveyed streams include American eel and brook trout (Table 5.3.5); neither are protected under SARA or NS ESA. While the Inner Bay of Fundy (iBoF) Atlantic salmon population is considered a Designatable Unit (DU) by COSEWIC, the Project Area falls outside this DU, and therefore the iBoF population will not be considered further in this document.

Table 5.3.5 Species of Conservation Interest that Inhabit the Assessment Area

Common Name	Scientific Name	SARA Rank[1]	NS ESA Rank[2]	COSEWIC Rank[3]	NSDNR General Species Rank[3]	AC CDC Rank[3]
American Eel[4]	*Anguilla rostrata*	No status (No Schedule)	-	Threatened	Secure	S5
Brook Trout[4]	*Salvelinus fontinalis*	-	-	-	Sensitive	S4

Notes:

1 Species At Risk Public Registry. 2016. Accessed August 19, 2016. Available online at: http://www.sararegistry.gc.ca/.

2 Nova Scotia *Endangered Species Act*. 1999. Accessed August 19, 2016. Available online at http://www.novascotia.ca/natr/wildlife/biodiversity/.

3 Atlantic Canada Conservation Data Centre, 2016b. Accessed August 19, 2016. Available online at http://www.accdc.com/en/ranks.html.

4 Legal protection for SOCI is limited to species listed under Schedule 1 of SARA and those species listed under the NS ESA.

``-`` = No rank.

Atlantic Canada Conservation Data Centre

S1 = Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences). May be especially vulnerable to extirpation.

S2 = Imperiled in the province because of rarity due to very restricted range, very few populations (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.

S3 = Vulnerable - Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer).

S4 = Uncommon but not rare; some cause for long-term concern due to declines or other factors (80+ occurrences).

S5 = Common, widespread, and abundant in the province.

American Eel

The American eel is listed as *threatened* under COSEWIC (2012) and is currently being considered for inclusion under SARA. The American eel occurs throughout fresh and salt waters of Eastern Canada and faces a number of threats, including barriers to upstream migration, turbine mortality in hydroelectric dams, fisheries and the swim-bladder parasite, *Anguillicola crassus* (COSEWIC 2012a). As noted above in Table 5.3.5, AC CDC ranks the species as secure as it is widespread throughout Nova Scotia.

American eels are catadromous; they move downstream to marine waters to spawn in the Sargasso Sea. As young eels grow, they drift toward the continental shelf and eventually move into inshore waters. Some eels migrate up rivers to freshwater habitats, while others remain in

brackish or salt waters. Some move between fresh and salt waters (COSEWIC 2012a). American eels spend the winter buried in mud (Scott and Crossman 1998). Following 8 to 23 years of growth, they mature into silver eels and migrate back to their spawning grounds. Spawning occurs only once in an eels lifetime. In Nova Scotia, the migration of American eels exiting freshwater systems occurs between August and November (COSWEIC 2012a). Eels are carnivores and consume a wide variety of prey that includes larval insects, crayfish, snails, earthworms and small fish (Scott and Crossman 1998). This species supports the CRA fishery.

American eels, ranging from 50 mm to 250 mm in length, were identified in watercourses WC2, WC3a and WC3b.

Brook Trout

The brook trout is listed as *sensitive* by NSDNR. It is not listed by SARA or the NS ESA. The brook trout is endemic to North America and is common throughout Nova Scotia, from Yarmouth to Cape Breton. Found in clear, well-oxygenated lakes and streams, brook trout require cool water habitats (*i.e.*, below 20°C) and are sensitive to warmer waters (Garside 1973, as cited in MacMillan *et al*. 2008). When water temperatures rise, brook trout move downstream to larger bodies of water, seeking cooler temperatures. Some populations include individuals that go out to sea to feed and grow. Brook trout spawn in the late summer or early fall, typically between September and November (Scott and Crossman 1998). Spawning occurs over gravel beds, usually located in shallow headwaters of streams, but occasionally in shallow lakes. Members of this species often travel long distances upstream to reach spawning grounds. Brook trout are carnivores and feed on a huge variety of insect larvae, insects, molluscs and fish. Large fish have also been known to eat frogs, salamanders and even small mammals. Brook trout are an important species to recreational fisheries in Nova Scotia.

During the 2016 electrofishing surveys, brook trout were caught in all four watercourse segments. The individuals caught varied in size, with total lengths ranging from 35 mm to 185 mm.

Watercourse Summary

WC1 – Tributary to Seely Brook

In 2001, electrofishing conducted in this watercourse resulted in the capture of American eel and brook trout in the vicinity of this crossing. During surveys in 2001/2003, this unnamed tributary to Seely Brook also contained six small brook trout trapped in an isolated pool 100 m upstream of the proposed crossing at the time. Electrofishing was not conducted to avoid additional stress on these fish. The fish were, however, removed by dipnets, identified, and released. The trout were small and still had prominent juvenile barring, so were assumed to be the current year's offspring. Even during times of high flow, the surveyed section of tributary would offer, at best, marginal spawning habitat. This suggested that there could be better spawning habitat further upstream or that the trout had travelled up the tributary from Seely Brook.

Five brook trout were caught during the 2016 electrofishing survey. These fish had total lengths ranging from 55 mm to 185 mm (Table 5.3.4). Six other brook trout were observed in the watercourse during the survey, but were not caught in nets. These individuals had total lengths between 40 mm to 160 mm, approximately. WC1 was fished for a total of 223 seconds.

During the 2016 survey, a secondary dry channel was noted at N 44° 34.934' and W 065° 48.525'. This channel was assessed in 2001/2003 but was not assessed in 2016, as it was dry at the time of the survey.

WC2 – Seely Brook

Nine brook trout and five American eels were caught in Seely Brook during the 2016 electrofishing survey (Table 5.3.4). The brook trout ranged from 35 mm to 175 mm total length. The eels were between 120 mm and 200 mm long. This watercourse was fished for a total time of 300 seconds.

During the 2001/2003 surveys, 15 brook trout were found in Seely Brook (WC2). Three were juveniles, with total lengths between 49 mm and 55 mm. The remaining fish measured between 95 mm and 180 mm. American eels were numerous. Nine were captured and at least 10 other individuals were observed. The captured eels measured between 114 mm and 322 mm. The results from the 2001/2003 survey indicated that Seely Brook could be considered good salmonid rearing habitat with limited spawning in small, isolated gravel pockets.

WC3a – Tributary to an Unnamed Stream

Two brook trout and one American eel were caught in WC3a during the 2016 electrofishing survey. The brook trout measured 165 mm and 169 mm, and the eel was 175 mm long. There were five other brook trout observed in this stream which ranged in length from 70 mm to 160 mm. At least 15 American eels were also observed, ranging in length from 50 mm to 250 mm. This watercourse was fished for a total of 189 seconds.

WC3b – Unnamed Stream

During the 2016 survey, two brook trout and one American eel were caught in WC3b. The brook trout measured 154 mm and 172 mm and the eel measured 152 mm. Another four brook trout and five American eels were observed. This watercourse was fished for a total of 300 seconds.

Historical Information

According to information gathered in 2001/2003, other fish species are thought to occur in watercourses in the Assessment Area (but not necessarily at the proposed crossings) and may be present for at least part of the year. Diadromous fish such as alewife (*Alosa pseudoharengus*; Gaspereau), blueback herring (*Alosa aestivalis*), and sea-run brook trout may be present in the larger watercourses (*i.e.*, Seely Brook). Rainbow smelt (*Osmerus mordax*) are known to occur in

large numbers in Seely Brook during their spawning runs in the spring. Local residents reported that the smelt do not, as a rule, swim as far upstream as the PDA. Smallmouth bass (*Micropterus dolomieu*) could also be present. Other fish species of minor commercial and/or societal value, such as sticklebacks and creek chub (*Semotilus atromaculatus*) may also occur in the PDA.

Soft-shell clams *(Mya arenaria*), scallops (*Placopecten magellanicus*) and limited populations of Blue mussels (*Mytilus edulis*) can be found within Annapolis Basin. The soft-shell clam inhabits the intertidal zone of the Annapolis Basin and the clam fishery was once a productive industry. However, during the 1970s an increasing number of clam harvesting areas were closed on the North and South shore of the Annapolis Basin, including in Joggins. In addition to the economic value of a local clam fishery in the Basin, the presence of this species is ecologically beneficial to the region as they filter microscopic algae out of suspension, thereby improving water clarity and by stabilizing sediments, which helps protect shorelines from erosion (Brumbaugh *et al.*, 2006).

In 2013 a cooperative management plan was created by the clam harvesting industry to move in the direction of a more adaptive management approach of the resource. At present, regulation of the soft-shell clam fishery in the Annapolis Basin is still being administered by the Canadian Food Inspection Agency (CFIA), Environment and Climate Change Canada (ECCC), and the Department of Fisheries and Oceans Canada (DFO) though the Canadian Shellfish Sanitation Program (CSSP) (Freeman 2013). Clam harvesting is restricted at all times in prohibited areas due to high levels of contamination or the possibility of a large contamination event (*i.e.*, radius around sewage treatment plants, marinas, *etc.*) (Sullivan 2007).

5.3.5 Potential Environmental Effects and Project-Related Interactions

The Project is expected to interact with fish and fish habitat during construction, and operation and maintenance. Key potential issues are identified using DFO's Pathway of Effects diagrams (DFO 2014). These diagrams describe mechanisms through which projects near water could have an effect on fish and fish habitat. In consideration of these potential interactions, the assessment of Project-related environmental effects on fish and fish habitat is focused on the following environmental effect:

- change in fish and fish habitat.

5.3.5.1 Change in Fish and Fish Habitat

Construction

The most substantive interaction between the Project and the VC is the loss (or change) of habitat from the installation of the watercourse crossings, culvert installation and extension, stream realignment, and erosion and sedimentation.

Site preparation, especially clearing, has potential to decrease the abundance of riparian vegetation along watercourses. Removing vegetation near streambanks removes shaded habitat, alters food supply and may increase bank erosion and increase suspended sediment concentrations and nutrient concentrations in the watercourse (DFO 2010a). The loss of stream shading may result in increased stream temperatures during the summer months (Teti 1998). With increased water temperature, there is also a potential for decreased dissolved oxygen for fish and other aquatic life. As a result of reduced riparian vegetation, the diversity and abundance of the aquatic food supply may change through the reduction of invertebrates and their food sources (DFO 2010a). Soil may be mobilized by equipment working near watercourses which may cause the sedimentation of 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 gill structures (DFO 2010b).

Watercourse crossings have the potential to alter fish habitat directly through changes in streambed material at the crossing location or downstream as a result of increased sediment loads. Depending upon the type of structure, watercourse beds and banks may be disturbed during the installation of culverts. Fish movement could be impaired or fish may be displaced during culvert installation as well as following installation if the culvert is not properly placed or measured (*i.e.*, sufficient depth and flow). In-stream work also contributes to sedimentation and the potential for damaging stream habitat. If altered, the stream must be remediated to natural conditions. Flow alterations must be kept short and be completely reversible.

The installation of watercourse crossings can also require the realignment of stream channels, which can potentially lead to the loss of fish habitat and increased sedimentation. Stream realignment has the potential to result in the loss of fish habitat, when realignment activities result in the loss of side channels or result in less stream channel area than was naturally in place. Once in place, newly created stream channels will experience a lag until they become naturalized. Furthermore, when first flushed with water, newly built stream channels will likely result in increased sedimentation as loose sediment is flushed downstream and sediments become embedded.

Erosion and sedimentation can occur whenever soil is exposed. Sedimentation (increased sediment load in stream water and deposition in downstream sediments) is perhaps the most common environmental effect of construction activities on fish and fish habitat. The environmental effects of sedimentation are well studied and understood. Fish eggs and larvae have been shown to be the most sensitive to increased sedimentation through the reduction of water flow and oxygen to eggs (DFO 2000; Baxter and Hauer 2000; Sedell *et al*. 1990).

The potential direct environmental effects of sedimentation on fish include the following:

- first-level behavioural responses, usually temporary, and not resulting in a change in health;
- minor physiological influences where the fish may avoid exposure but there may be environmental effects to health due to exposure or reduction in food supply;

- physiological changes due to long-term exposure affecting life stages or feeding; and
- environmental effects on eggs and larvae which cannot avoid areas of exposure.

Sedimentation and siltation of surface water can degrade surface water quality (*e.g.*, oxygen levels, light penetration, water temperature, water chemistry such as organics and metals) leading to changes in primary production and food availability (DFO 2010c) as well as aesthetics. Bacteria levels can also be affected by changes in sediment loading within a system. Other potential environmental effects on surface water quality that may occur during construction include increases in total suspended sediments (*i.e.*, increased turbidity), a change in hydrologic conditions, and changes in pH from runoff. These changes in surface water quality can lead to effects on the benthic invertebrate community, in addition to potential physical effects resulting from sedimentation and siltation.

The freshwater fish encountered during the 2016 surveys included brook trout (a salmonid) and American eel. American eel are known to spawn in the marine environment with the salmonid species spawning in spring or fall. Constructing the watercourse crossings outside the spawning periods and within DFO's lower biological risk period of June 1 to September 30, is anticipated to reduce effects on spawning salmonids and their offspring.

Changes in pH resulting from runoff can also have a direct effect on fish in watercourses already experiencing acidification. Salmonid species in particular (*e.g.*, brook trout and Atlantic salmon) are sensitive to pH changes throughout their life history, including during egg incubation and larval hatching. Over an evolutionary time scale, fish populations can adapt and survive within acidified systems, but abrupt changes (particularly decreases) in pH can be detrimental to their survival. Abrupt decreases in pH can be associated with spring runoff.

Excavation may occur in areas of bedrock with acid generating potential. Runoff from exposed sources of sulphide mineralization can drastically reduce water quality by acidification. Acidic waters liberate heavy metals which can reach toxic levels for fish and other aquatic life. Aquatic macroinvertebrates, fish eggs, and fry are most susceptible to acidic drainage.

Noise from construction activities may result in habitat avoidance by fish. The handling of asphalt, concrete, hydrocarbon and hazardous materials in the vicinity of watercourse crossings during the construction phase of the new highway could potentially affect fish and fish habitat through exposure to contaminating substances.

Blasting can have physical and chemical environmental effects on the aquatic environment. Shock waves and vibrations from blasting can damage fish swim bladders and rupture internal organs, and may kill or damage fish eggs or alevins. Blasting can cause re-suspension of sediments, bank failure and resultant sedimentation and habitat avoidance. Nitrogen-based explosives can affect aquatic life through direct toxicity of the compounds, reducing dissolved oxygen during nitrification and providing nutrients for aquatic plants.

Operation and Maintenance

Various operation and maintenance activities can result in increased sediment entry into watercourses, including ditching for improved runoff water flow, vegetation control and watercourse crossing repairs and maintenance. An increase in sediment entering the watercourses can affect fish and fish habitat. Accumulation of debris or erosion can lead to loss of fish passage within watercourse crossings. The sudden release of blockages can result in increased sediment levels and an associated decrease in water quality.

Freshwater aquatic species such as fish are cold-blooded and have preferred temperature ranges; if temperatures exceed these ranges (*e.g.*, from pavement runoff and removal of riparian vegetation), additional stress is put on that species (DFO 2013). Water warming also decreases the saturation of dissolved oxygen and increases algae growth (Ducharne 2008), both of which may increase stress on aquatic species. The first flush of spring runoff may also contain traces of various substances including automotive fluids, dust, metals, or polycyclic aromatic hydrocarbons (PAHs) that can result in contamination of surface water.

During operation, vegetation will be mechanically maintained within the RoW. The use of equipment within 30 m of watercourse crossings for vegetation control may result in increased suspended sediment concentrations and the physical alteration of watercourse habitats and adverse effects to fish (DFO 2010b). Direct conduits to the watercourse may be created from equipment rutting; these ruts may create a pathway for sediment or contaminants to enter the watercourse. The alteration of bed and banks may reduce fish habitat quality and the suitability for life processes (DFO 2010b).

Winter maintenance activities such as salting and/or sanding highways during winter months can lead to increased sedimentation in surface water in relation to sanding, and changes in salinity of surface water in relation to salting. The spring melt may present the greatest potential for environmental effects on surface water quality. Please refer to the Project Description (Section 2.3.2.3) for additional information concerning the NSTIR Salt Management Plan.

5.3.6 Mitigation

Table 5.3.6 outlines measures that will be implemented, where practical, to reduce the environmental effects of the Project on fish and fish habitat during construction and operation and maintenance.

Table 5.3.6 Mitigation for Fish and Fish Habitat

Effect	Phase	Mitigation
Change in Fish and Fish Habitat	Construction	• Follow Generic EPP for the Construction of 100 Series Highways (NSTPW 2007), NSE Watercourse Alteration Standards (2015), Guide to Altering Watercourse (2015), Guidelines for the design of fish passage for culverts in Nova Scotia (2015), and DFO

Table 5.3.6 Mitigation for Fish and Fish Habitat

Effect	Phase	Mitigation
		Guidelines for the Protection of Fish and Fish Habitat: The Placement and Design of Large Culverts (1998) • Erosion and sediment control measures (Section 2.3.1) will be implemented • Follow DFO's blasting guidelines (Wright and Hopky 1998) • A NS Watercourse Alteration Approval will be obtained for all watercourse crossings and; conditions of the Water Approval will be met • A Certified Watercourse Alteration Installer will carry out or directly supervise all watercourse crossings • A fish habitat offsetting plan will be developed and implemented if it is determined that there is serious harm to CRA fisheries • In-stream work and/or disturbance will be minimized, where possible • Stream crossings will be assessed for erosion, with areas of erosion stabilized • Work will be scheduled to avoid periods of heavy precipitation • No washing, fuelling or maintenance of vehicles or equipment in the vicinity of a watercourse or wetland without secondary containment • No storage of chemicals or Petroleum Oils Lubricants (POLs) within 30 m of a watercourse or wetland • Heavy machinery use during clearing will be kept a minimum of 10 m from the watercourse banks • All equipment to be used during construction activities will be free of leaks and coatings of hydrocarbon-based fluids and or lubricants harmful to the environment. Hoses and tanks are to be inspected on a regular basis to prevent fractures or breaks • A limited disturbance buffer zone of 30 m from watercourses will be maintained, where possible • The contractor will have a Spill Prevention and Response Plan established before commencing construction • There will be on-site appropriate emergency spill response equipment, specific to the types of spills likely to be encountered during operations. The required equipment will be specified in the Spill Prevention and Response Plan. • Instream construction will be limited to the lower biological risk period between June 1 – September 30, when feasible • Fish passage will be maintained for all species that use the watercourses for life-cycle purposes • Fish rescues will be carried out before in-water work occurs during watercourse crossings
	Operation and Maintenance	• Same mitigation for construction activities, as applicable for maintenance activities • Preferential use of mechanical vegetation control with limited use of herbicides (no pesticides). Herbicides are used only under the guidance of the department's Integrated Roadside Vegetation Maintenance (IRVM) • Follow NSTIR Salt Management Plan

5.3.7 Residual Environmental Effects and Significance Determination

Residual Project-related environmental effects on fish and fish habitat (*i.e.,* effects remaining after the application of mitigation measures) may occur during initial site preparation, construction of watercourse crossings and installation of watercourse structures, vegetation control during operation and ongoing maintenance. These environmental effects will occur once during construction and periodically during operation as needed for road maintenance and vegetation control.

5.3.7.1 Change in Fish and Fish Habitat

Construction

Prior to initiating construction of watercourse crossings, permitting applications for the construction in or around watercourses will be submitted. These applications will be made to the required authorities such as NSE and DFO. A Request for Review will be completed and submitted to DFO for the construction of watercourse crossings. If DFO determines that the Project results in 'Serious harm' to the CRA fisheries, a *Fisheries Act* Authorization and offsetting plan will be submitted for review and acceptance prior to construction.

All watercourse crossings will be sized and designed to allow watercourse flow and, in fish-bearing streams, to allow fish passage as per the criteria detailed in the DFO Guidelines for the design of fish passage for culverts in Nova Scotia (2015) and the DFO Practitioner's Guide to Fish Passage (2007). The final designs of the watercourse crossing structures will be submitted for review to NSE with the Water Approval application for watercourse alteration.

All watercourse crossing structures will be installed in compliance with the conditions set in the site-specific Water Approval and following mitigation specified outlined in the Project EPP (as updated from the Generic EPP). Specifically, NSTIR will work with NSE and DFO so that new culverts and culvert extensions or upgrades installed in fish-bearing streams will not obstruct fish passage, can handle peak flows, and maintain natural stream conditions (*e.g.,* width, habitat).

In-stream work will be conducted to avoid sensitive biological periods such as brook trout spawning and egg incubation times. In general, in-stream work will be conducted between June 1 and September 30, where possible. During the summer, low water flow makes in-stream work easier and erosion more manageable. Where possible, the installation of watercourse crossings will be done in the dry, using dam and pump procedures or channel diversion and following applicable guidelines. In either case, fish will be removed from the area of planned construction activities prior to construction. This will be accomplished by enclosing the construction area with fine-mesh nets and removing the fish using DFO approved methods (*e.g.,* seine nets). Direct mortality of some fish can be expected at low rates consistent with those typical for the use of seine nets. Water pump intakes, used during dam and pump procedure, will be screened in compliance with the DFO *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995).

Subject to regulatory approval, in-stream work may be conducted outside of the June 1 - September 30 period when seasonal weather conditions permit (where there is no anticipated environmental effect on sensitive life stages), when work must be completed prior to the onset of winter conditions, or where the advantages of completing the work (*e.g.*, sediment control structures) prior to winter conditions justifies late season work. In the event of in-stream work outside of the June 1 to September 30 season, a Division I approval will be required and DFO will be consulted and appropriate authorizations will be obtained. Any in-stream work completed after September 30 will require monitoring during the work period, and inspection of sediment control mitigation during periods of the visible overland flow of water (*e.g.*, heavy rain or thaw events). Alternative sediment control mitigation may be required during the winter period. Alternative sediment control techniques will be discussed with DFO prior to authorization of late season in-stream work.

In the event of late season work (*e.g.*, after September 30 and with regulatory approval) stabilization of exposed soils within the Work Area will be completed as follows:

- within 5 days of disturbance within 30 m of a watercourse (using mulch or another approved late season stabilization material), or prior to any forecasted storm event and/or the onset of frozen ground conditions; or
- within 30 days of disturbance beyond 30 m of a watercourse, or prior to any forecasted storm event and/or the onset of frozen ground conditions, when possible.

Specific preventative measures to mitigate the potential environmental effects from erosion and sedimentation are detailed below, under surface water quality.

Should blasting be required during construction in or near a watercourse, authorization will be required from DFO for the use of explosives. Blasting will be conducted in accordance with the Generic EPP (See Sections 4.2.3 and 5.4.2 in NSTPW 2007) and *Guidelines for the use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky 1998), and in compliance with the requirements of DFO's authorization, if required.

Habitat avoidance as a result of Project-related noise (from all construction activities) would be temporary. It is assumed that fish would begin re-populating the affected area immediately upon cessation of noise generating activities.

Watercourse crossings will be installed according to the conditions of the Water Approval to reduce potential for introduction to surface waters of contaminants or suspended sediments at levels that exceed the CCME Guidelines (25 mg/L) as described below. The potential for environmental effects to fish and fish habitat through direct disturbance at a site will be reduced by limiting the area accessed and situating temporary ancillary elements at least 30 m from the watercourse.

Throughout the period of highway construction, erosion and sediment control measures should be installed and maintained. To reduce erosion and sedimentation, clearing will be limited within

30 m of the watercourse, to the extent possible. Sufficient vegetation must be allowed to grow along the bank of the watercourse to maintain bank stability. Heavy machinery used during clearing will be kept a minimum of 10 m from the watercourse banks. Erosion and sedimentation controls employed during construction, and operation and maintenance phases will be designed and maintained in accordance with Section 3.2 of the Generic EPP (NSTPW 2007) and Standard Specifications, and the terms and conditions of Water Approvals and NSE Watercourse Alteration Standards.

Soil loss from slopes may occur even with erosion and runoff control measures. To prevent this soil from entering watercourses, further mitigation measures, including vegetated buffer strips, silt fences, filter berms and sediment traps will be implemented to intercept sediments. During construction, steep highway embankments could lead to sediment entering the watercourses, but the use of standard erosion and sediment control measures should adequately mitigate the effects of sediment laden runoff on nearby surface water sources of watercourses. Any watercourses having steep banks should have an augmented level of erosion and sediment control measures. Based on experience with erosion and sediment control measures in eastern Canada, it is recommended that these measures are designed to function to the applicable water quality limits during a 1 in 2 year return period storm event and designed to withstand a 1 in 10 year return period event without incurring significant damage.

Increases in watercourse nutrient levels from hydroseeding would be temporary as the applications are infrequent and these nutrient forms are readily flushed away (nitrates), absorbed by sediments (phosphates) or taken up by plants and microbial communities.

The potential for environmental effects on fish and fish habitat through direct disturbance will be minimized by limiting areas of disturbance and situating temporary ancillary elements at least 30 m from watercourses. Storage of hazardous materials will not occur within 30 m of watercourses. Permanent storage areas for containers or drums will be clearly marked, have appropriate secondary containment, and be located on an impermeable floor that slopes to a safe collection area. Fuel storage and designated fuelling areas will be located at least 30 m from watercourses and wetlands. Refuelling and equipment maintenance required in the field will not be undertaken within 30 m of a watercourse or wetland. Wastewater from washing equipment will not be released into the watercourse. Storage of all hazardous materials will comply with WHMIS requirements, and appropriate material safety data sheets will be located at the storage site.

Prior to initiating construction of watercourse crossings, permitting applications for the construction in or around watercourses will be submitted. These applications will be made to the required authorities such as Nova Scotia Environment and DFO. A Request for Review will be completed and submitted to DFO for the construction of watercourse crossings. If DFO determines that the Project results in 'Serious harm' to the CRA fisheries, a *Fisheries Act* Authorization and offsetting plan will be submitted for review and acceptance prior to construction so there is no net loss of productive capacity of CRA fisheries.

In consideration of the potential environmental effects of Project-related activities during construction, and the proposed mitigation, residual environmental effects of the construction of the Project on fish and fish habitat are predicted to be not significant.

Operation and Maintenance

The watercourse crossing structures will be inspected, cleaned and repaired on a regular basis, as required, to maintain normal water flows. Maintenance will be conducted according to requirements specified in Water Approvals including clearing of culverts and maintenance of erosion control measures.

Adherence to the NSTIR Salt Management Plan and winter maintenance guidelines will reduce the environmental effects to fish and fish habitat, as the guidelines specify application rates and designate vulnerable areas. Detailed protection measures outlined in Section 3 of the Generic EPP (NSTPW 2007) and Standard Specifications will help to reduce the potential environmental effects to fish and fish habitat resulting from maintenance activities. Ditching will end a minimum of 30 m from watercourses where possible, and will be directed into the surrounding vegetation to allow filtering of sediment prior to water entering the watercourse.

Mechanical clearing will primarily be used for vegetation control during highway operation on the RoW (*e.g.*, road shoulders). NSTIR does not use any pesticides other than herbicides. Herbicides are used only under the guidance of the department's Integrated Roadside Vegetation Maintenance (IRVM) program and NSE pesticide application approvals.

It is not anticipated that NSTIR will ever be engaged in widespread herbicide use. Herbicides will be considered as an option for undesirable species in selected locations and in compliance with all appropriate legislation. Specifically, there will be no herbicide applications under any of the following legislated conditions:

- within a 30 m buffer zone of any watercourse;
- within any distance of any watercourse prescribed on a product label; and
- within 60 m of a protected water supply.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance, the proposed mitigation, and the significance definition, residual environmental effects of the operation and maintenance of the Project on fish and fish habitat are predicted to be not significant.

5.3.8 Monitoring and Follow-up

Monitoring during construction will promote and confirm application of applicable environmental protection and permitting requirements for work in and adjacent to watercourses and successful implementation of remedial actions where necessary. Monitoring will consist of the following core elements at the watercourse, as applicable:

- regular inspection of all sediment and erosion control measures to confirm effectiveness;
- monitoring of total suspended solids (TSS) when precipitation events result in the visible overland flow of water; and
- inspection of hazardous materials storage areas (including possible sediment generating materials).

The location and frequency of observations, required sample sizes, and reporting frequency will be determined in consultation with NSE and DFO through their respective permitting and authorization processes where required.

Post-construction monitoring will occur following the construction phase. A monitoring program will be developed to assess fish habitat along the RoW and downstream. The program will evaluate the stability of the channel and the ability to provide fish passage at fish bearing crossings. If a habitat offsetting program is required, effectiveness monitoring will be undertaken according to approved offsetting plan.

5.4 VEGETATION

Vegetation was selected as a VC because of the potential for interactions between Project activities and vegetation, particularly plants that are considered as Species of Conservation Interest (SOCI) and their habitats. SOCI provide a gauge of the effects of a project on the vegetated environment due to the sensitivity of many of these plants to disturbance, and because of the intrinsic value of these plants and their habitats (vegetation communities) for biodiversity. SOCI are often associated with rare or unusual microsites and habitats. Rare or sensitive habitats develop in areas supporting unique combinations of soil, geology, topography, microclimate, and disturbance regimes. These include habitats such as old growth forest, karst topography, cliffs, rich intervales, and certain types of wetland conditions. These habitats often provide areas for rare species of plants and animals and contribute to the overall habitat diversity of a particular area. The rarity of the habitat type can result in the concentration of plants or animals dependent on them into a relatively small area. The vegetation VC is closely linked to other VCs, including Wetlands (Section 5.5), Wildlife and Wildlife Habitat (Section 5.6) and Land Use (Section 5.7).

5.4.1 Regulatory and Policy Setting

SOCI are defined in this document to refer to plant species that are:

- listed under the Nova Scotia *Endangered Species Act* (NS ESA) or the federal *Species at Risk Act* (SARA) as either *endangered*, *threatened*, *vulnerable*, or of *special concern* (*i.e.*, Species at Risk or "SAR");
- not yet listed under provincial or federal legislations, but identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as either *endangered*, *threatened*, or of *special concern*;
- listed by the Nova Scotia Department of Natural Resources (NSDNR 2014) as *at risk*, *may be at risk*, or *sensitive* to human activities or natural events; or

- ranked as *S1*, *S2*, or *S3* by the Atlantic Canada Conservation Data Center (AC CDC 2014).

There are regulations under the provincial *Forest Act*, the *Wilderness Areas Protection Act* and the *Wildlife Act* that provide protection for some vegetation communities, either directly or indirectly. The regulatory framework relevant to the potential effects on vegetation focuses specifically on SAR.

Plant species that are protected federally under SARA are listed in Schedule 1 of the Act. The purpose of SARA is to protect SAR and their critical habitat. SARA is administered by Environment Canada, Parks Canada and the DFO. Those species listed as *endangered* or *threatened* in Schedule 2 or 3 of SARA may also be considered as SAR, pending regulatory consultation.

Certain plant species are also protected under the NS ESA. Species identified as seriously at risk of extinction in Nova Scotia are identified by a provincial status assessment process through the Nova Scotia Endangered Species Working Group. Once identified, they are protected under the NS ESA. The conservation and recovery of species assessed and legally listed under the NS ESA is coordinated by the Wildlife Division of the NSDNR. There is also a provincial General Status assessment process that serves as a first alert tool for identifying species in the province that are potentially at risk. Under this process, species are assigned to one of four categories that designate their population status in Nova Scotia. These include *secure, sensitive*, *may be at risk*, and *at risk*. Although species assessed under this process are not granted legislative protection, the presence of species ranked as *sensitive, may be at risk*, and *at risk* is an indication of concern by provincial regulators, as are those ranked as *S1, S2*, or *S3* by the Atlantic Canada Conservation Data Centre (AC CDC). The occurrence of rare plant species within wetlands is also of concern with respect to provincial wetland policy and the permitting process.

5.4.2 Boundaries

The assessment of potential environmental effects on vegetation encompasses the following spatial boundaries: the Project Development Area (PDA) and the Assessment Area. The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1. The Assessment Area for vegetation is presented in Figure 5.5 as the Field Survey Area, and is defined as the area encompassed within a 30 m buffer of the PDA. The Assessment Area represents the area in which field surveys were conducted; although the significance of residual environmental effects is considered within a larger context.

The temporal boundaries for the assessment of the potential Project-related environmental effects on vegetation include the duration of construction, and operation and maintenance of the Project in perpetuity. Temporal boundaries consider that rare plants or habitats are non-mobile and are essentially present at a particular location on a continuous basis.

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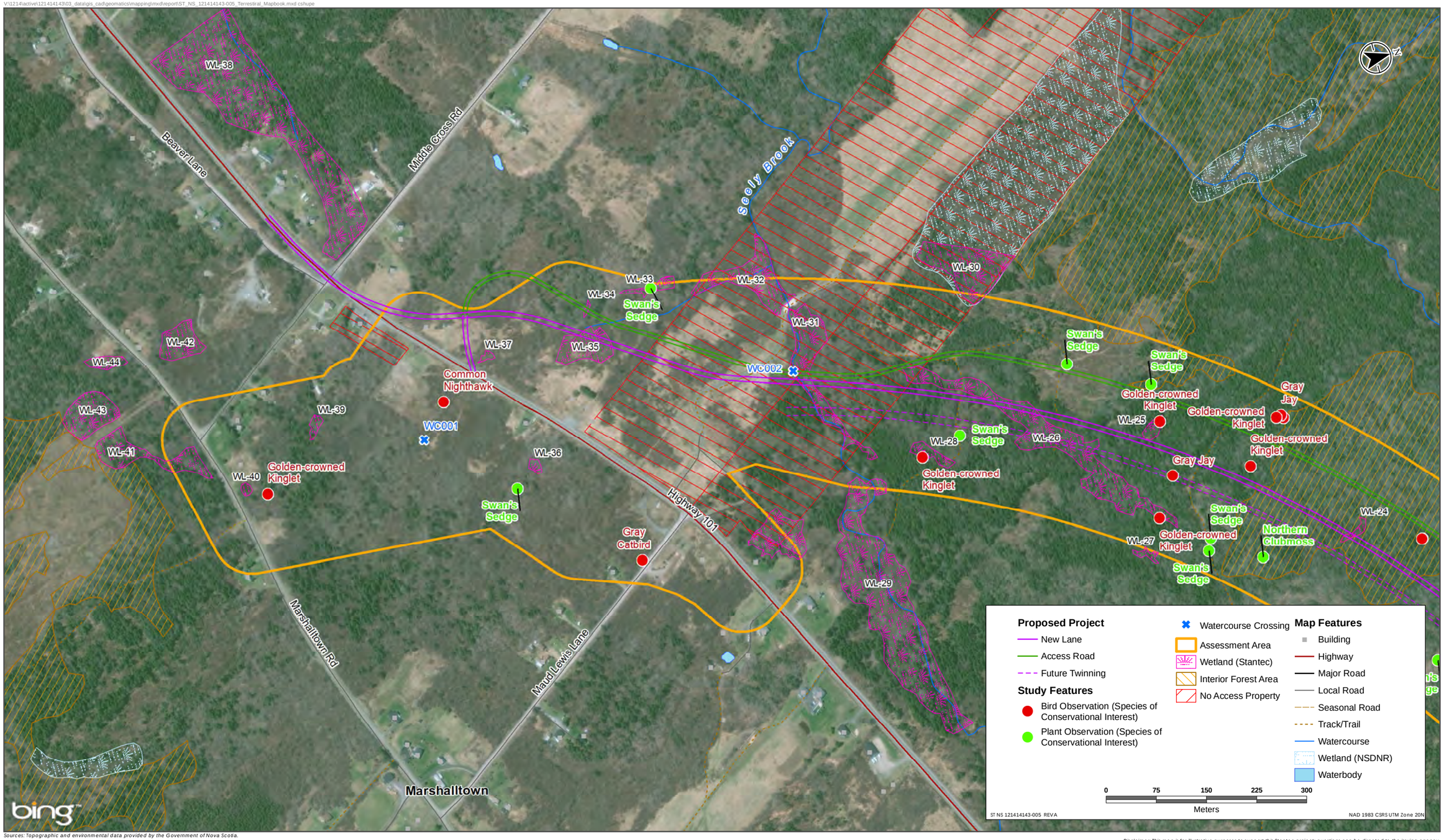

Sources: Topographic and environmental data provided by the Government of Nova Scotia.

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Biophysical Features within the Project Area

Stantec

Figure 5.5
Map 1 of 3

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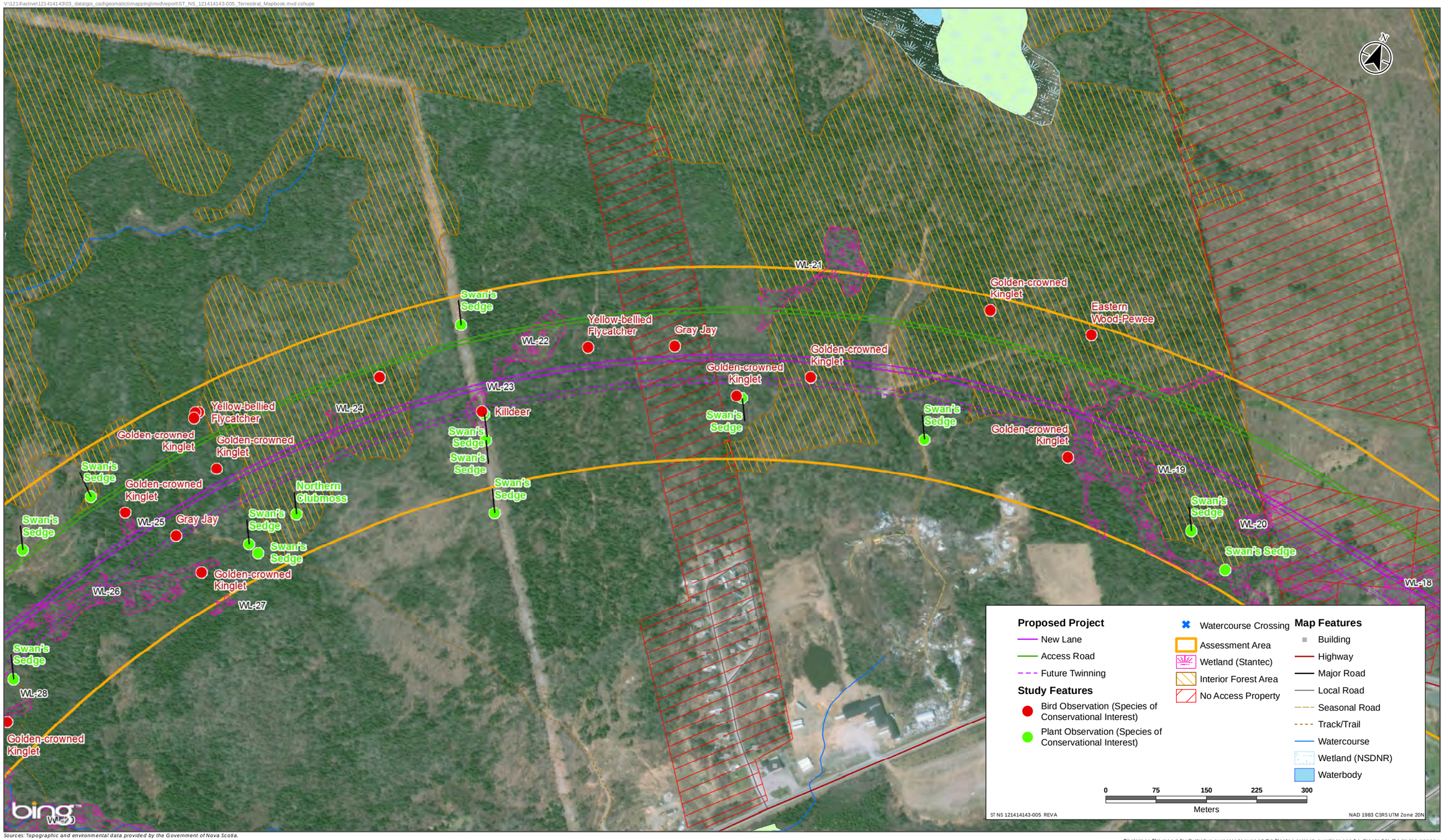

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Biophysical Features within the Project Area

Stantec

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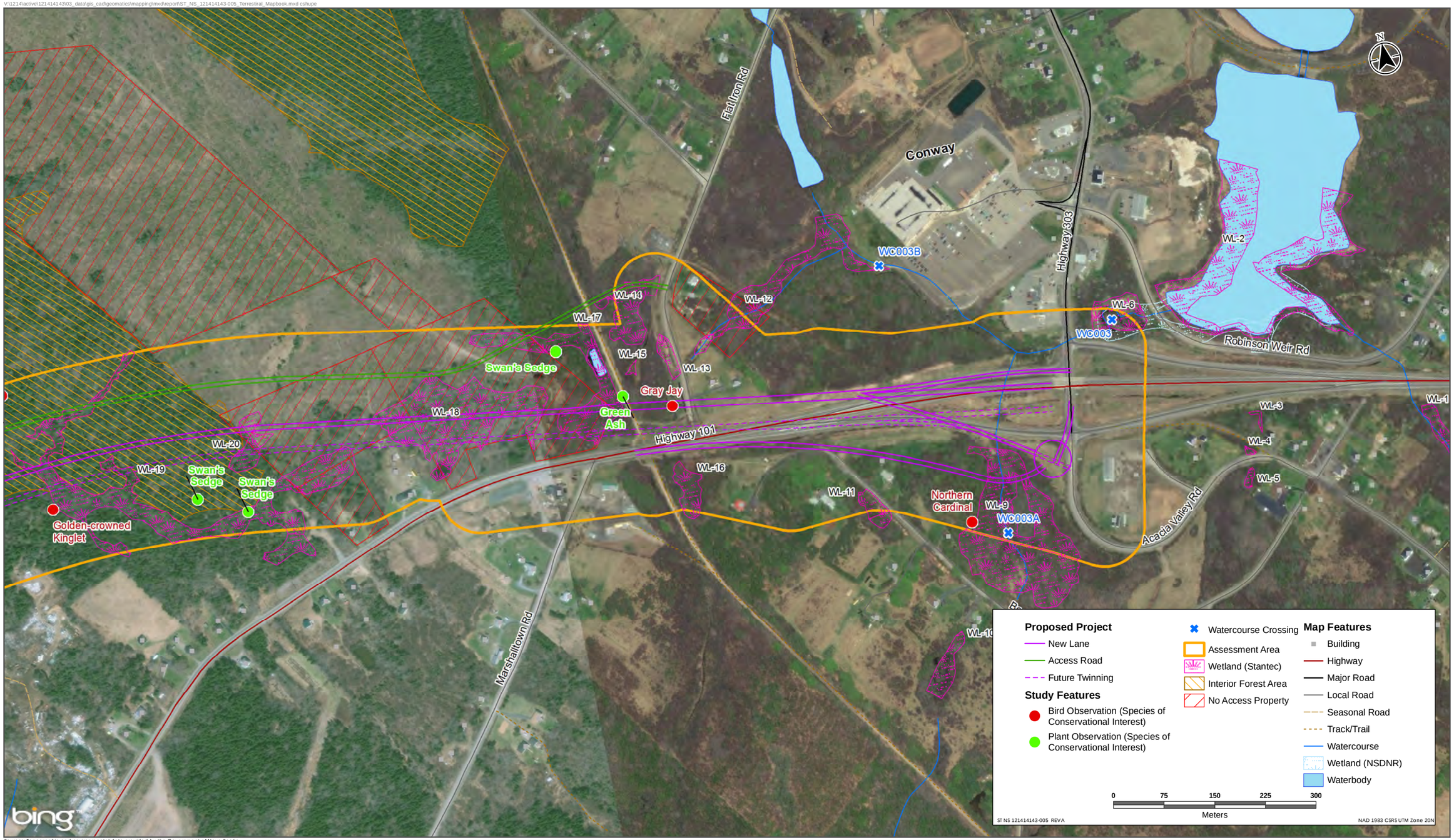

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Biophysical Features within the Project Area

Stantec

Figure 5.5
Map 3 of 3

5.4.3 Significance Definition

A **significant residual adverse environmental effect on vegetation** is one that, after mitigation has been considered, results in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA, or in contravention of any of the prohibitions stated in Section 3 of the NS ESA; or threatens the long-term sustainability of a plant species within the Annapolis Valley (610) or Valley Slope (710) Ecodistricts.

5.4.4 Description of Existing Conditions

5.4.4.1 Methods

Desktop Information Sources

Baseline vegetation data for the Assessment Area used to describe existing conditions include the following sources:

- AC CDC records of SOCI within 10 km of the Project (AC CDC 2016a);
- NSDNR forest inventory data (NSDNR 2016a);
- Provincial wetland inventory data (NSDNR 2016b);
- orthophotos and LiDAR (Light Detecting and Ranging) data from NSTIR; and
- previous field studies conducted between 2001-2003 to support the original alignment of the Digby to Weymouth North corridor project.

These data were used in planning field surveys, analyzing field-collected data, and determining the potential presence of SOCI.

Field Surveys

Information on vegetation conditions within the Assessment Area was primarily obtained during field surveys conducted in 2016. Field surveys were conducted to document the presence of plant SOCI, including vascular and non-vascular taxa, and their habitats. Additional information on the methods used during these surveys is provided below.

Surveys for vascular plants were conducted between June 20 and June 24, 2016 and July 12 to July 14, 2016 to document the presence of SOCI within the Assessment Area. Lands within accessible portions of the Assessment Area (*i.e.*, crown land or privately owned parcels with no landowner objections) were surveyed. A floristic habitat sampling approach (*i.e.*, as described in Newmaster *et al*. 2005) was completed by meandering, throughout vegetation communities. The location of the first encountered occurrence of all vascular plant species and all locations of SOCI were recorded. Details on the occurrence of any SOCI encountered, including population size and associated vegetation communities, were also recorded. Areas with a relatively high likelihood of supporting rare species in the Assessment Area were most intensively investigated during the field surveys; including wetlands, riparian habitats, and mature hardwood forest. However, all habitats were surveyed except for active residential and commercial properties

and a comprehensive inventory of highly disturbed or anthropogenic vegetation communities (*e.g.*, roadsides, ditches, brownfields) was not conducted. All species of vascular plant encountered during the surveys were identified and their population status in Nova Scotia was determined through a review of the designations provided by NSDNR (2014), AC CDC (AC CDC 2014), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2016), SARA, and the NS ESA.

A lichen survey was conducted for the Project on September 1, 2016. The focus of the survey was on epiphytic macrolichens, particularly cyanolichens which are a group of lichens with cyanobacteria as the photobiont and which are sensitive to acid rain, climate change, and habitat disturbance. Several species in this group are some of our rarest lichens in the province and are being heavily impacted by habitat loss through deforestation and development. Surveys focused on forested wetlands and areas of relatively mature hardwood or mixedwood upland forest.

Field surveys within the Assessment Area were also conducted in 2001 to support the original alignment of the Digby to Weymouth North highway. Vegetation surveys for that project were primarily performed June 26 to 29, 2001; with additional information being collected between September 11 and 14, 2001 and on October 10 and 1, 2001. During the first field survey, the PDA was walked by two botanists using the flagged center line as a transect. All species of vascular plants encountered during the survey were recorded. The locations of rare plants encountered during the survey were recorded using a Garmin GPS12 global positioning system and the number of plants or shoots of rare plants were counted, or estimated if large numbers were present. A follow up survey to identify the distribution of narrow-leaved evening primrose (*Oenothera fruticosa ssp. glauca*) was conducted on August 2, 2002.

5.4.4.2 Summary of Existing Conditions

5.4.4.2.1 Environmental Setting

The majority of the Assessment Area falls within the Annapolis Valley Ecodistrict (610) but the southern end of the project encroaches within the Valley Slope (710) Ecodistrict. The Annapolis Valley Ecodistrict occurs between the North Mountain and Valley Slope Ecodistricts and occurs within a lowland region that is sheltered from coastal climactic influences and has warmer summer temperatures and milder winters than elsewhere in the province (Neily *et al*. 2003). The Valley Slope Ecodistrict similarly occurs within a region with mild weather and it encompasses a series of hills and slopes, and has a warm climate because of its westerly exposure and distance from the Bay of Fundy (Neily *et al*. 2003). Much of the area within both these ecodistricts has been cleared for agriculture and the composition of the remaining forests varies considerably depending on drainage, aspect, and the influence of human disturbances (Neily *et al*. 2003).

Vegetation structure and composition within the Assessment Area has been highly influenced by human activities. The forests within the area are in various stages of regeneration because of past clearing and much of the Assessment Area is currently occupied by anthropogenic

environments; including residential and commercial developments, transportation infrastructure, abandoned pastures and brownfields. Non-native plants are abundant throughout much of the Assessment Area, and the invasive shrub glossy buckthorn (*Frangula alnus*) is abundant throughout much of the area, often comprising a dominant component of wetlands and early successional forest communities. The influence of human activities is particularly prominent at the eastern and western ends of the Assessment Area where residential, commercial and transportation infrastructure are concentrated and where evidence of past human activities (*e.g.*, land clearing) are prominent. In total, lands used to support agriculture, residential, commercial, and transportation infrastructure represent approximately 20% of the Assessment Area.

The majority of the Assessment Area (*i.e.*, approximately 71%) is forested, with provincial forest inventory data indicating that the most prominent stand types may be characterized as "forest other", "multi-aged softwood", "multi-aged mixedwood", "early mature mixedwood", and "early mature hardwood" (see Section 5.6 for land cover data). The majority of the forest stands were observed during field surveys to be in an immature to early mature seral state but patches of relatively mature mixedwood forest are present, as are areas of a younger successional stage. Forest composition varies depending on site moisture, aspect and seral stage, but red maple (*Acer rubrum*), white spruce (*Picea glauca*), and trembling aspen (*Populus tremuloides*) are prominent components of the overstory canopy, with American beech (*Fagus grandifolia*) also common in some areas; and gray birch (*Betula populifolia*) prominent in the early successional forest communities. A sparse to well-developed shrub layer is formed by regenerating trees, variable amounts of glossy buckthorn, and other shrubs such as northern bush honeysuckle (*Diervilla lonicera*). Understory vegetation is variable but generally comprised of scattered forbs characteristic of mesic forest communities within the region, such as wild sarsaparilla (*Aralia nudicaulis*), New York fern (*Thelypteris noveboracensis*), northern starflower (*Trientalis borealis*), bracken fern (*Pteridium aquilinum*); and a moderate cover of mosses including red-stemmed feather moss (*Pleurozium schreberi*), white pincushion moss (*Leucobryum glaucum*), and haircap moss (*Polytrichum sp.*). A mature mixedwood stand near the center of the Assessment Area had a relatively diverse overstory of red spruce (*Picea rubens*), yellow birch (*Betula alleghaniensis*), paper birch (*Betula papyrifera*), red maple, American beech, sugar maple (*Acer saccharum*), and striped maple (*Acer pensylvanicum*). The understory vegetation within this stand was comprised of a moderately-developed shrub layer dominated by balsam fir (*Abies balsamea*) and other regenerating tree species, along with scattered Canada yew (*Taxus canadensis*); and a herbaceous layer of evergreen wood fern (*Dryopteris intermedia*), Christmas fern (*Polystichum acrostichoides*), goldthread (*Coptis trifolia*), northern starflower, and other forbs.

Wetlands are abundant throughout much of the Assessment Area and account for approximately 8% of its area. Swamp, marsh, and shallow water classes are represented within the Assessment Area, but treed and / or tall shrub dominated swamps are most abundant. Tree cover within the swamps is typically dominated by either deciduous trees or a mixture of hardwoods and softwoods, with red maple particularly abundant within the majority of the

swamps; and various combinations of balsam fir, white spruce, black spruce (*Picea mariana*), tamarack (*Larix laricina*), and paper birch occurring in lesser amounts. Speckled alder (*Alnus incana*) typically dominates the shrub strata, with glossy buckthorn, common winterberry (Ilex verticillata), and regenerating tree species occurring as dominants or co-dominants. Peatmoss (*Sphagnum spp.*) cover is often prominent within the swamps and herbaceous vegetation is comprised of a mixture of forbs and graminoids that varies depending on moisture, nutrient levels, canopy shading, and the influence of past and current human activities. Common dominant herbaceous plants within swamps of the Assessment Area include cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), manna grass (*Glyceria spp.*), rough-stemmed goldenrod (*Solidago rugosa*), creeping buttercup (*Ranunculus repens*), purple-stemmed aster (*Symphyotrichum puniceum*), hairy flat-top white aster (*Doellingeria umbellata*), and various species of sedge (*e.g., Carex trisperma, C. gynandra, C. brunnescens, C. leptalea*). Several small areas of freshwater marsh are also present within the Assessment Area, and occur in association with disturbed areas. These areas are typically dominated by a variety of graminoids, including nodding sedge (*Carex gynandra*), rushes (*Juncus spp.*), creeping bent grass (*Agrostis stolonifera*), bulrushes (*Scirpus spp.*), manna grass; and a variety of forbs such as swamp yellow loosestrife (*Lysimachia terrestris*). A brackish marsh at the eastern end of the Assessment Area supports an assemblage of graminoid-dominated communities, with species composition varying across zones in relation to topographic position and the degree to which they are subject to tidal flooding. Dominant plants within this wetland include smooth cord grass (*Spartina alterniflora*), black-grass rush (*Juncus gerardii*), quack grass (*Elymus repens*), creeping bent grass, seaside goldenrod (*Solidago sempervirens*), and chaffy sedge (*Carex paleacea*). A single occurrence of shallow water wetland was encountered within the accessible portions of the Assessment Area and supported a vegetation community of floating leaved aquatics, particularly water-shield (*Brasenia schreberi*), variegated pond-lily (*Nuphar lutea*), and pondweed (*Potamogeton sp.*). Additional information on the ecological character of wetlands within the Assessment Area is provided in Section 5.5.

Large sections of the Assessment Area are also comprised of imperfectly-drained tall shrub thicket, particularly at the western end. Glossy buckthorn is particularly prominent within some of these areas, dominating both the canopy and occurring throughout the understory as dense mats of seedlings in some areas. Speckled alder and chokecherry (*Prunus virginiana*) are also prominent in this area, and scattered trees are found throughout, including white spruce and red maple. Rough-stemmed goldenrod and hairy flat-top white aster are dominant components of the understory, along with a mat of *Rhytidiadelphus* moss on the forest floor.

Several watercourses are present within the Assessment Area, the largest of which is Seely Brook. Although property access restrictions prevented the majority of the area in the vicinity of Seely Brook from being surveyed, it is known to support relatively rich riparian forest and shrub thickets. Riparian habitat also occurs in association with a stream in the eastern end of the Assessment Area, although the steep banks that occur along the side of this watercourse result in little interval habitat.

5.4.4.2.2 Plant Species of Conservation Interest

AC CDC records indicate that at least 17 vascular plant SOCI have been recorded near the Project. All these SOCI have potential to occur within the Assessment Area, except for knotted pearlwort (*Sagina nodosa ssp. borealis*) which is associated with relatively dry and exposed coastal features such as cliffs, sand flats, and dunes (Zinck 1998). AC CDC data indicate that vascular plant SOCI may be associated with a variety of habitat conditions within the Assessment Area, including wetlands, deciduous forests, riparian forests, and open and disturbed areas such as pastures or roadsides. The timing of the surveys conducted in June and July 2016 would have been sufficient to identify the majority of SOCI that have been historically recorded in the vicinity of the Project. Many of these SOCI would have been flowering or in fruit at the time of the surveys (*e.g.*, Dudley's rush (*Juncus dudleyi*) and others are identifiable throughout the growing season (eastern white cedar (*Thuja occidentalis*)). Although some of the SOCI would be most easily recognizable in spring (round-lobed hepatica (*Hepatica nobilis var. obtusa*)) or fall (Chinese hemlock-parsley (*Conioselinum chinense*)), most maintain aboveground vegetative features that would allow for their identification at other times of the growing season. However, the timing of the surveys was not ideal for identifying some of the vascular plant SOCI. For example, although purple-veined willowherb (*Epilobium coloratum*) flowers during summer months, its seeds are required for proper identification and thus are often not available until early fall. AC CDC data do not contain any records of non-vascular SOCI within 10 km from the center of the Project (AC CDC 2016a). A list of plant SOCI recorded within 10 km from the center of the Assessment Area, along with information on their habitat associations and phenology is provided in Appendix A, Table A1.

A total of 313 vascular plant taxa were recorded during the 2016 field surveys, a complete list of which is provided in Appendix A, Table A2. Three of the species encountered were considered to be of (potential) conservation interest (Table 5.4.1). Fifteen epiphytic macrolichens were observed during the survey, a list of which is provided in Appendix A, Table A3. No non-vascular plant SOCI were encountered during surveys and the Assessment Area was found to have very little suitable habitat for rare lichens as a result of a long history of farming, forestry and urban development which has resulted in a general lack of older tree. Although not a SOCI, mealy-rimmed shingle lichen (*Pannaria conoplea*) was of interest. This cyanolichen can be very common on older red maples in treed swamps in southwest Nova Scotia and along the Atlantic coast to Cape Breton but it is rarely observed in the Annapolis Valley probably because very little suitable habitat remains (Neily pers comm 2016).

Table 5.4.1 Plant Species of Conservation Interest Recorded during 2016 Field Surveys

Common Name	Scientific Name	AC CDC S-Rank	NSDNR General Status Rank
Swan's Sedge	*Carex swanii*	S2S3	Sensitive
Green Ash	*Fraxinus pennsylvanica var. subintegerrima*	na	na
Northern Clubmoss	*Lycopodium complanatum*	S3S4	Secure

Swan's sedge (*Carex swanii*) has been recorded in association with "boggy pastures, dry peaty barrens, forests, clearings and the edges of woods" within the province (Zinck 1998). The provincial population of this species is considered to be *sensitive* by NSDNR (2014) and is ranked as *S2S3* by the AC CDC (2014), indicating that it is considered to be imperiled to *vulnerable* in the province because of restricted range, few populations, population declines, or other factors making it vulnerable to extirpation (AC CDC 2016b). This species was found to be scattered throughout much of the Assessment Area during field surveys (Figure 5.5); with 16 records being recorded and approximately 127 clumps being counted. Swan's sedge was typically found growing in association with disturbed habitats, including old woods roads and skidder tracks (eight records), within the RoW of a distribution line (four records), clear-cuts (two records) and immature forest (two records). AC CDC data obtained for the Project indicate that swan's sedge has been recorded at least 12 other locations within 10 km of the Project center in association with old wood tracks, cut-over areas, and forest edges. This species is likely to occur elsewhere in the Assessment Area and surrounding landscape in association with similar habitats.

Northern clubmoss (*Lycopodium complanatum*) is scattered throughout the province in association with "deciduous forests, on hillsides under brush, and spreading into neglected fields" (Zinck 1998). A single record of this species was noted (Figure 5.5) within a mixedwood forest near the center of the route. Although the provincial population of this species is considered *secure* by NSDNR (2014), it has been ranked as *S3S4* by the AC CDC (2014), indicating that it may be *vulnerable* to apparently *secure* (AC CDC 2016b).

A cluster of four green ash (*Fraxinus pennsylvanica var. subintegerrima*) was encountered growing along the well-drained embankment of an abandoned rail bed near the eastern end of the route (Figure 5.5). Red ash (*F. pennsylvanica*) is rare in Nova Scotia (*S1, may be at risk*); with populations scattered throughout Lunenburg, Kings, and Hants counties in association lakes, ponds, ravines and other areas with poorly drained soils (Zinck 1998; Munroe *et al.* 2014). However, var. *subintegerrima* is an introduced tree occasionally found growing as a planting or along old habitations (Zinck 1998), and is commonly referred to as green ash. Although varieties of this taxa are sometimes not recognized because of hybridization, the habitat conditions and character of the specimens encountered (*i.e.*, hairless twigs and petioles) indicate that they are of the introduced variety.

Surveys conducted to support the original alignment of the Digby to Weymouth North corridor project did not identify any rare plants within the area that overlaps with the current Project. Although no rare species were identified during these surveys, the floodplain of Seely Brook was noted to be relatively rich and to have potential to provide habitat for SOCI. Although dedicated surveys for narrow-leaved evening primrose did not identify this species as occurring in the Marshalltown area, the abandoned pasture and ditches located between Seely Brook and the existing Highway 101 were considered to provide suitable habitat for this species, which was found to be relatively widely distributed in the vicinity of Weymouth. Apart from the Seely Brook flood plain and area between Seely Brook and Highway 101, the area encompassed by the Marshalltown realignment was considered to have low potential to support rare species.

Portions of the Assessment Area could not be surveyed during 2016 as a result of property access restrictions. Areas which could not be accessed included the floodplain of the Seely Brook and the area between Seely Brook and Highway 101; both of which have been identified to have relatively high potential to support vascular plant SOCI. Areas near the north end of the Marshalltown Road and off Flatiron Road could also not be accessed, but are likely to support an abundance of wetland habitat and may therefore be considered to have relatively high potential to support SOCI. A portion of the Assessment Area near the center of the Project that could not be accessed is composed of relatively mature mixedwood forest, but surveys in similar habitat on either side of this land parcel did not indicate a high potential for the area to support SOCI.

5.4.5 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with vegetation and result in changes to SOCI populations, and vegetation communities. The assessment of Project-related environmental effects on vegetation is therefore focused on the following potential effects:

- change in SOCI.

5.4.5.1 Change in SOCI

Construction

Construction activities could potentially interact with vegetation and result in changes to plant SOCI populations and their habitats through direct or indirect interactions. The measurable parameter for these effects would be changes to vascular plant or lichen SAR or SOCI (number of individuals or populations). Direct interactions with SOCI could occur as a result of physical disturbance whereas indirect effects may occur where there is potential for hydrological modifications to their habitat (*e.g.*, wetlands), or sedimentation and erosion occurs in areas with SOCI. The most substantive and likely interactions are a change in habitat quantity or quality and possible loss of SOCI as a result of site preparation activities and the construction of watercourse crossing structures.

Site preparation activities during Project construction have the highest potential to directly or indirectly interact with vegetation, including plant SOCI. Vegetation located within the PDA will be removed during the construction phase of the Project. In particular, clearing and grubbing during site preparation will directly remove vegetation and has potential to result in a permanent loss of SOCI individuals. A number of indirect effects can also result from these site preparation activities. Clearing of forested areas can change the quality of the habitat along the edge of the PDA as a result of increased side lighting or drying of what was previously forest interior habitat. This may enable more light-tolerant and disturbance-tolerant species to penetrate into adjacent forest habitat. Off-road and off PDA activity also have potential to disturb vegetation habitat and cause direct mortality of vascular plants. This may occur when vehicles are accessing the work site along tertiary roads, by the gradual widening of the

thoroughfare, as well as through non-motorized activity in undisturbed areas adjacent to the PDA.

The Project will require the installation of culverts and bridges. Improper installation of watercourse crossings can alter aquatic or wetland habitat on which some plant species are dependent. Improperly installed crossings can result in flooding or extensive erosion. Construction activities also have potential to introduce sediment or silt into wetlands, watercourses, and surface water in the Assessment Area; this has potential to cause adverse effects to SOCI.

Operation and Maintenance

Several activities related to the operation and maintenance of the Project could affect vegetation. In particular, maintenance of the Project infrastructure and vegetation management initiatives can adversely affect vegetation, SOCI.

During winter, salt is used by NSTIR on road surfaces to aid in melting snow, and to provide clear road conditions. Road salt can enter the environment (surface water, groundwater and soil) through storage and application of these salts. The highest concentrations are usually associated with winter and spring thaws. Environment Canada (2001) cites several studies attributing vegetation damage and changes in plant community composition to road salt application. Road salt applications can damage plants located immediately adjacent to highways and increase the salinity of soils. The effects of road salt are generally observed within 10 m of the edge of the road, although salt related injuries have been detected at distances of up to 80 m from the road. Damage to vegetation includes osmotic (*i.e.*, concentration induced dehydration) injuries as well as direct chloride ion toxicity. Salt deposited on soils can adversely affect plant growth by changing the structure of soil (development of salt crusts) or reducing soil fertility (replacement of calcium and potassium ions by sodium ions). In some areas between 5 and 10% of trees within 30 m of highways have salt damage (Transportation Research Board 1991).

Vegetation management will occur during the operation and maintenance phase of the Project and could affect SOCI populations if they become established in the RoW after construction. However, SOCI that would tend to populate the RoW during operation would typically be associated with disturbed or early-successional vegetation communities (*e.g.*, swan's sedge) and their presence may therefore benefit from periodic vegetation management initiatives. These plants therefore have potential to be adversely affected by herbicides, if used for vegetation maintenance.

As part of infrastructure maintenance, ditching may be required to improve water flow, reduce erosion and/or to deter excessive vegetative growth. The release of sediment into wetlands could have a detrimental effect on the survival of SOCI in these areas. Some rare species may

colonize ditches and could be lost when ditches are periodically cleaned out. The effects of infrastructure maintenance on wetlands are also discussed in Section 5.5.

5.4.6 Mitigation

Mitigation to reduce the environmental effects of the Project on vegetation are identified in Table 5.4.2. Standard mitigation and measures identified in Sections 5.3, 5.5, and 5.6 to reduce effects on aquatic resources, wetlands, and wildlife and wildlife habitat will also act to reduce effects on vegetation. The use of some mitigation will be determined on a site-by-site basis in consideration of local concerns and conditions to provide the most effective mitigation. Locations for site-specific mitigation will be outlined in the EPP following detailed design and in consultation with the appropriate regulatory authorities in consideration of the following criteria:

- rarity, status, or function of SOCI or wetland under consideration;
- ecology of SOCI under consideration;
- location of SOCI relative to the Assessment Area;
- alternatives to current design;
- temporary or permanent mitigation; and
- public or landowner support (*e.g.*, existing use/ownership).

Table 5.4.2 Mitigation for Vegetation

Effect	Phase	Mitigation
Change in SOCI and their Habitats	Construction	• Follow Generic EPP (NSTPW 2007) • Employee environmental awareness training during construction • Limit Project-related off road activity • Follow Watercourse and Wetland Alterations permit conditions • Erosion control measures • Proper installation of culverts to prevent flooding or draining of wetlands • Project design to reduce PDA and area to be cleared, where feasible • Flagging and avoidance of plant SOCI outside RoW • Develop mitigation plans for unavoidable effects on SOCI in consultation with regulators • Use snow fencing and signage in areas of SOCI to protect plant occurrences near construction activities • Follow NSTIR Integrated Roadside Vegetation Management (IRVM) Manual. Restrict the general application of herbicide near SOCI. Spot spraying, wicking, mowing, or hand-picking are acceptable measures for integrated vegetation management in these areas • Install cross ditches and berms on moderately steep and steep slopes in non-agricultural areas to prevent runoff along the RoW and subsequent erosion • All equipment must arrive at the site clean and free of soil or vegetative debris. • Limit Project-related off road activity

Table 5.4.2 Mitigation for Vegetation

Effect	Phase	Mitigation
	Operation and Maintenance	• Follow Generic EPP (NSTPW 2007) • Employee environmental awareness training • Apply drainage controls • Follow NSTIR Salt Management Plan • Follow NSTIR IRVM Manual

5.4.7 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on vegetation after the general mitigation measures, as provided above, have been implemented.

5.4.7.1 Change in SOCI

Construction

Field surveys have identified two vascular plant SOCI in the Assessment Area which may be adversely affected by construction activities: northern clubmoss and swan's sedge. The single record of northern clubmoss encountered during field surveys was at the edge of the PDA and direct disturbance to this location will be avoided during Project construction. Swan's sedge was distributed throughout the Assessment Area but only one of the records overlaps with the PDA; consisting of approximately 20 clumps (*i.e.*, representing approximately 16% of the total number of individuals observed) that were scattered within the disturbed RoW of a distribution line. Additional occurrences were recorded in close proximity to the PDA and have potential to be affected by Project construction, but survey data indicates that this species is relatively common throughout the Assessment Area and that it is associated with a variety of previously-disturbed habitats, including old woods roads, a distribution line RoW, and clear-cuts. In consideration of its apparent distribution, abundance, and habitat association, it is unlikely that Project construction will have an important influence on the local population of swan's sedge.

As noted in Section 5.4.4, several locations within the Assessment Area could not be surveyed because of property access restrictions, but have been identified to have relatively high potential to support vascular plant SOCI. The floodplain of the Seely Brook, the area between Seely Brook and Highway 101, and areas near the north end of the Marshalltown Road and off Flatiron Road are considered to have relatively high potential to support SOCI. Follow-up surveys will be undertaken to confirm presence/absence of plant SOCI at these locations, and additional mitigation measures may be identified pending survey results.

In consideration of the potential environmental effects of Project-related activities during construction, and the proposed mitigation, residual environmental effects of the construction of the Project on SOCI or their habitat are predicted to be not significant. Construction activities are unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in Section 3 of the NS ESA; or

threaten the long-term sustainability of a plant species within the Annapolis Valley or Valley Slope Ecodistricts.

Operation and Maintenance

Although winter maintenance (*i.e.*, road salt applications) and vegetation management have potential to adversely affect vegetation, Project operation and maintenance are not likely to have an important effect on plant SOCI.

Road salt applications can adversely affect salt sensitive plants growing near the edge of the RoW but the overall salt loading will be reduced by following the NSTIR Salt Management Plan, which specifies application rates. Techniques to reduce the amount of road salt used will be employed and will include the use of road weather information systems to monitor road surface conditions, pre-wetting of salt, and the use of anti-icing systems such as brine solutions to reduce the amount of salt required. These techniques would benefit other VCs in addition to the rare plants found along the proposed highway including groundwater and surface water quality and freshwater aquatic life. Areas where rare or uncommon plants are present may be considered as salt sensitive areas to be considered for pre-wetting and anti-icing agents.

Additional mitigation measures include following the Generic EPP (Section 3.18; NSTPW 2007), applying drainage controls, employee environmental awareness training prior to commencement of operation activities (*e.g.*, salt and sand application during winter), and increased vigilance and inspection of permanent erosion and sediment control structures, particularly in areas identified as sensitive.

Vegetation management will consist primarily of mechanical control of vegetation. Use of herbicides may be considered where undesirable species persist but these applications would be in accordance with applicable legislation and in consideration of sensitive areas. Regular mowing will occur on the shoulder of the road and occasional mowing of the RoW will occur on an as needed basis to control the growth of trees and tall shrubs. One SOCI, swan's sedge, has potential to colonize the cleared RoW and ditches. However, vegetation management is not likely to have an adverse effect on this species because it is low-lying and associated with open disturbed habitats.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the operation and maintenance of the Project on SOCI and their habitat are predicted to be not significant. Project operation and maintenance are unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; or threaten the long-term sustainability of a plant species within the Annapolis Valley or Valley Slope Ecodistricts.

5.4.8 Monitoring and Follow-up

Follow-up surveys for plant SOCI will be conducted within portions of the Assessment Area that could not be surveyed during 2016 because of property access restrictions. Areas which could not be accessed included the floodplain of the Seely Brook and the area between Seely Brook and Highway 101; both of these areas have been identified to have relatively high potential to support vascular plant SOCI. Areas near Flatiron Road could also not be accessed but may have potential to support SOCI because they support an abundance of wetland.

5.5 WETLANDS

Wetlands have been selected as a VC because of the potential for interactions between Project activities and wetlands. Wetlands have environmental, aesthetic, recreational, and socio-economic value to the people of Nova Scotia. They provide habitat for plant and animal species, many of which depend on wetland habitats for their survival. Hydrological functions of wetlands include erosion and flood control, contaminant reduction, and groundwater recharge and discharge. Wetlands support various forms of recreational activity, as well as subsistence production, such as harvesting of wildlife and plants, and commercial production, such as cranberry bogs, forestry, and peat extraction. They are also subject to federal and provincial legislation, regulations and policies that require delineation and conservation. Related VCs include Vegetation (Section 5.4) and Wildlife and Wildlife Habitat (Section 5.6).

5.5.1 Regulatory and Policy Setting

Wetlands in Nova Scotia are protected by the Nova Scotia *Environment Act*, where "wetland" is defined as:

> *"…land commonly referred to as a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly-drained soils, hydrophytic vegetation and biological activities adapted to wet conditions."*

The Nova Scotia Wetland Conservation Policy (NSE 2011a) provides context to legislation, regulations and operational policies designed to protect and guide management of wetlands in Nova Scotia. Most importantly, the policy establishes a specific goal of no loss of Wetlands of Special Significance (WSS) and no net loss in area and function for other wetlands. The government considers the following to be WSS:

- all salt marshes;
- wetlands that are within or partially within a designated Ramsar site per the Ramsar Convention; Provincial Wildlife Management Area (Crown and Provincial lands only), Provincial Park, Nature Reserve, Wilderness Area or lands owned or legally protected by non-government charitable conservation land trusts;

- intact or restored wetlands that are project sites under the North American Waterfowl Management Plan and secured for conservation through the Nova Scotia Eastern Habitat Joint Venture;
- wetlands known to support at-risk species as designated under SARA or the NS ESA; and
- wetlands in designated protected water areas as described within section 106 of the *Environment Act*.

Any project with the potential to alter a wetland (*e.g.,* filling, draining, flooding or excavating), including direct and indirect effects, requires a Water Approval (for wetland alteration) from NSE, pursuant to the *Activities Designation Regulations*, prior to starting the work. If alterations to a wetland exceed two hectares in area, a project is also subject to registration under the *Environmental Assessment Regulations*.

Applications for a Water Approval for wetland alteration must be supported with details of the unavoidable nature of the proposed wetland alterations, the measures to reduce or compensate for wetland alteration, and the character and function of wetlands to be affected. These applications are evaluated in the context of the mitigation sequence: avoidance, minimization and compensation. Loss of wetland habitat, either through direct or indirect project effects, requires compensation to replace the wetland functions lost as a result of the wetland alterations. In this respect, area lost is used as a surrogate for loss of function, and compensation is required as a ratio of the area lost.

Wetland conservation federally is directed by the Federal Policy on Wetland Conservation (Environment Canada 1991) which sets a conservation goal of no net loss of wetland function. This policy is applied to federal land or federal programs in areas where wetland loss has reached critical levels, but is not applicable to the Project as no federal lands will be crossed by the new highway.

5.5.2 Boundaries

The assessment of potential environmental effects on wetlands encompasses the following spatial boundaries: the PDA, the Field Survey Area and the Assessment Area. The PDA represents the footprint of physical disturbance and is defined in Section 4.2.1. The Assessment Area is the area within which LiDAR and aerial imagery has been obtained. The Assessment Area encompasses the "Field Survey Area" as described in Section 5.4.2 (*i.e.*, the area within a 60 m buffer of the PDA), and a buffer of variable width. The Assessment Area represents the extent within which known or potential wetlands were identified, although field surveys were limited to accessible portions of the Field Survey Area (*i.e.*, Crown Land or privately owned parcels with no landowner objections).

The temporal boundaries for the assessment of the potential Project-related environmental effects on wetlands include the duration of construction, and operation and maintenance of the Project in perpetuity. Temporal boundaries consider that wetlands are a semi-permanent landscape feature and may interact with the Project year-round.

5.5.3 Significance Definition

This assessment considers residual effects on wetlands (*i.e.*, after mitigation is implemented). A **significant residual adverse environmental effect on wetlands** is defined as:

- one that results in an unauthorized permanent net loss of wetland area; or
- one that results in a loss of WSS.

5.5.4 Description of Existing Conditions

5.5.4.1 Methods

Areas within accessible portions of the Field Survey Area that meet the definition of a wetland as outlined by Nova Scotia's *Environment Act* were delineated in the field following principles outlined by the US Army Corps of Engineers (1987). Delineations were conducted between June 20 to June 24, 2016 and July 12 to July 14, 2016. Orthophotos, LiDAR [Light Detecting and Ranging] data from NSTIR, provincial wetland mapping (NSDNR 2016b), and Wet Areas Mapping (Forest Watershed Research Centre 2012) were used to extrapolate partially delineated wetland boundaries and to identify other areas with potential to support wetlands within the larger Assessment Area.

Wetlands were classified according to the Canadian Wetland Classification System (NWWG 1997). This system classifies wetlands to three levels: class, form/subform, and type. The wetland class places a wetland into one of five categories based on the overall nature of the wetland environment, such as whether the wetland soils are primarily mineral or organic (*i.e.*, peat), their association with groundwater, and whether they are dominated by woody plants over 1 m in height. Wetland classes include bog, fen, swamp, marsh, and shallow water. Form and subform indicate the physical morphology and hydrological characteristics of the wetland. Wetland type distinguishes wetland communities based on one of eight groups of dominant vegetation (NWWG 1997). Only information on class and dominant vegetation type were obtained for wetlands identified through desktop assessment.

Information on the functional characteristics of wetlands in accessible portions of the Field Survey Area was obtained during field surveys following the NovaWET method (2011b). Although the NovaWET method consists of a field component and a desktop component, the approach focused on collecting information that is obtained through site visits, such as dominant species and the potential for the wetland to provide habitat for SAR or other SOCI. Functional assessments were conducted between July 12 and July 14, 2016. Results of the breeding bird surveys were also reviewed to obtain information on habitat functions for wildlife SAR and other SOCI. Data collected during the surveys were used to determine whether the wetlands provided key hydrogeological, water quality and wildlife-related functions, as well as their social value. Functional assessments were completed for 29 wetlands / wetland portions during field surveys.

5.5.4.2 Summary of Existing Conditions

5.5.4.2.1 Wetland Classification and Character

A total of 44 known or potential wetlands were identified through a combination of field surveys and desktop assessment within the Assessment Area, 32 of which intersected the Field Survey Area (Table 5.5.1, Figure 5.5). The boundaries of 17 of these wetlands were delineated in the field, 13 were identified through a combination of field delineation and desktop assessment, and 14 were identified through desktop review only. Swamps are the most common wetland class in the Assessment Area, but freshwater and brackish marsh are also present and an area of shallow water wetland was also identified (Table 5.5.1). Additional information on the classification, area, character, and functions of the wetlands within Assessment Area is provided below and in Appendix B.

Table 5.5.1 Area and Number of Occurrences of Wetland Class within the Assessment Area

Wetland Class (type)[1]	Field Survey Area[2]		Assessment Area	
	Number	Area (ha)	Number	Area (ha)
Marsh (graminoid)[3]	2	0.1	2	0.1
Salt Marsh (graminoid)[4]	1	0.2	2	2.8
Shallow water (floating-leaved aquatic)[5]	1	0.1	1	0.1
Swamp (treed / tall shrub / cut-over)[6]	30	11.4	41	22.3
Total	32	11.7	44	25.2

[1]Only wetlands within accessible portions of the Field Survey Area were field surveyed; wetland boundaries identified through desktop assessment have not been confirmed

[2]Two wetlands were comprised of multiple classes: WL-17 (swamp and shallow water) and WL-18 (swamp and marsh)

[3]Freshwater marshes includes wetlands 18 and 40

[4]Salt marshes include wetlands 2 and 6

[5]Wetland 17 is the only shallow water wetland

[6]Swamps include wetlands 1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, and 44

Swamps

Swamps are the most common wetland class in the Assessment Area, being represented within 41 of the wetlands identified within the Assessment Area (Table 5.5.1). Swamps are mineral wetlands or peatlands and their water table is generally at or near the surface of the swamp, with standing water or water flowing slowly through pools or channels often present (NWWG 1997). There is internal water movement from the margin of the swamp or from other sources of mineral enriched waters. If peat is present, it consists mainly of well-decomposed wood, underlain at times by sedge peat. The vegetation typically consists of a dense cover of trees or shrubs, herbs and some mosses (NWWG 1997). Swamp forms and subforms encountered during

the field surveys were flat, basin, slope, drainageway, and riverine (NWWG 1997), with some wetlands being comprised of multiple forms:

- Flat swamps have topographically flat or slightly concave surfaces where the water is derived by local surface runoff, groundwater, or precipitation, and occasionally by small watercourses (NWWG 1997). Basin swamps are a subform of flat swamp that occur in topographically defined basins with relatively well-defined edges (NWWG 1997). Basin swamps are a relatively common occurrence within the Field Survey Area, represented within 11 of the 29 wetlands for which field assessments were performed (*i.e.*, Wetlands 9, 12, 13, 16, 17, 18, 19, 20, 25, 36, and 37). Two other wetlands were encountered that were characterized as having a flat form but which did not occur in basins (*i.e.*, Wetland 26 and 28).

- Slope swamps occur on sloped surface, on mineral or peaty soils and surface channels may be either absent or present (NWWG 1997). Drainageway swamps are a subform that occur in confined drainageways or water tracks and were observed to be present in four of the field assessed wetlands, where they occurred by themselves (*e.g.*, Wetland 24 and 34) or as a feature of larger wetlands (*e.g.*, Wetland 19 and 31). Ten other wetlands were observed to occur in association with sloped surfaces during field assessments (*i.e.*, Wetlands 11, 14, 15, 16, 21, 22, 23, 32, 33, and 35).

- Riverine swamps occur on the banks of permanent or semi-permanent streams. Their water table is primarily maintained by the level of water in the stream and they are subject to flooding when water levels are high (NWWG 1997). The majority of riverine swamp within the Field Survey Area occurs in association with Seely Brook (*e.g.*, Wetland 29) but this wetland form was also observed along a small stream at the western end of the Field Survey Area (Wetland 39) during field surveys.

Vegetation types encountered within swamps during field surveys include mixed treed, hardwood treed, and tall shrub dominated communities (Table 5.5.1). Hardwood treed swamps are distinguished from mixed treed swamps by a greater dominance of broadleaf species in the overstory (*i.e.*, >75% canopy cover) but they are often similar, with red maple particularly abundant. Various combinations of balsam fir, white spruce, black spruce, tamarack, paper birch and other trees also occupy the overstory canopy. Many of the treed swamps have well-developed shrub strata and where tree cover is low and / or intermittent, tall shrub-dominated swamps occur. Speckled alder is typically the most abundant species within the shrub strata for both the treed and tall shrub-dominated swamps, with common winterberry, the invasive glossy buckthorn, and regenerating tree species also occurring as dominants or co-dominants. Peatmoss (*Sphagnum spp.*) cover is often prominent and herbaceous vegetation is comprised of a mixture of forbs and graminoids that varies depending on moisture, nutrient levels, canopy shading, and the influence of past and current human activities, Common dominant herbaceous plants within swamps of the Field Survey Area include cinnamon fern, sensitive fern, manna grass, rough-stemmed goldenrod, creeping buttercup, purple-stemmed aster, hairy flat-top white aster and various species of sedge (*e.g.*, *Carex trisperma, C. gynandra, C. brunnescens, C. leptalea*). Many of the swamps had been subject to recent tree harvesting activities, at least in part, and were in an early stage of

regeneration. Tree cover within these recently disturbed wetlands was generally lacking, but intermittent cover was sometimes provided by remnant trees. The shrub and ground vegetation stratums reflected those of more intact swamps but species typically associated with shaded environments were often less abundant and those typical of more open early seral stages, such as woolly bulrush (*Scirpus cyperinus*), more abundant. The vegetative composition of the swamps did not suggest that any were particularly nutrient-rich or nutrient-poor, as may be respectively observed in areas with calcareous or acidic substrates. However, areas along Seely Brook were not surveyed as a result of property access restrictions, but the riparian habitats (including potential wetlands) in this area may be relatively nutrient-rich.

Marshes

Marshes are wetlands that are periodically inundated by standing or slow flowing water that fluctuates daily, seasonally, or annually as a result of water level fluctuations such as tides or draw down (NWWG 1997). During drier periods declining water levels may expose areas of matted vegetation or mud flats. The surface waters are typically rich in nutrients and the substrate is usually mineral material although well-decomposed peat may occasionally be present (NWWG 1997). Marshes typically display zones or surface patterns consisting of pools or channels interspersed with patches of emergent vegetation, bordering wet meadows and peripheral bands of shrubs or trees. Both freshwater and brackish marshes are present within the Assessment Area (Table 5.5.1).

Two shallow freshwater basin marshes were observed during field surveys, both of which were anthropogenic in character. A small marsh was encountered on the edge of Wetland 18, which was otherwise dominated by forested swamp, and another small basin (*i.e.*, Wetland 40) was encountered at the western end of the Project (Table 5.5.1, Figure 5.5). These basin marshes occupy uniformly shallow depressions or swales, having a gradual gradient from the edge to the deepest portion. Both appear to have developed as a result of excavation activities, which have created low-lying areas where surface water accumulates. Both marshes are dominated by graminoids, but shrubs are scattered around their edges. Vegetation within the marsh component of Wetland 18 was dominated by broad-leaved cattail (*Typha latifolia*) and rush (*Juncus sp.*), with a scattered shrub layer along the edges formed by speckled alder, white meadowsweet (*Spiraea alba*), and willow (*Salix sp.*). Dominant species within Wetland 40 include reed canary grass (*Phalaris arundinacea*), nodding sedge, creeping bent grass, common woolly bulrush (*Scirpus cyperinus*), Canada manna grass (*Glyceria canadensis*), and lesser amounts of the forb swamp yellow loosestrife (*Lysimachia terrestris*) and the invasive shrub glossy buckthorn.

Field surveys and desktop review indicate two small brackish marshes within the Assessment Area but not in the PDA (Table 5.5.1, Figure 5.5). These wetlands may be classified as salt marshes, and would therefore be considered as WSS under the provincial wetland conservation policy (NSE 2011a). PDA Wetland 6 is an estuarine marsh located at the eastern end of the Field Survey Area. This supports an assemblage of graminoid-dominated

communities, with species composition varying across zones in relation to topographic position and the degree to which they are subject to tidal flooding. Dominant plants within this wetland include smooth cord grass, black-grass rush, quack grass, creeping bent grass, seaside goldenrod, and chaffy sedge. Aerial imagery indicates a larger salt marsh further to the east (*i.e.*, Wetland 2). The hydrological character of these coastal marshes varies throughout the day, being subject to inundation at high tide but with surface water being largely confined to channels associated with the outflow of a small stream at low tide.

Shallow Water

Shallow water wetlands have standing or flowing water that is <2 m deep during mid-summer but their hydrological character is quite varied. That is, water levels with shallow water wetlands may be seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows, or intertidal periods (NWWG 1997). Although they typically occupy the transitional areas between wetlands that are saturated or seasonal wet and permanent deep water bodies, the shallow water wetland encountered during field surveys occupied a flooded basin that occurred in association with a larger swamp (*i.e.*, Wetland 17). This wetland class was likely anthropogenic in character because it occurred along the bed of an abandoned road or rail line which appeared to act as a drainage impediment that support flooding. The vegetation community within this area was comprised of floating leaved aquatics, particularly water-shield, variegated pond-lily, and pondweed.

5.5.4.2.2 Wetland Functions and Values

A general overview of wetland functions and values that are known or suspected of being provided within the Assessment Area is provided in the following sections. A summary of wetland functions for each of the 29 wetlands / wetland portions assessed during field surveys is provided in Appendix B.

Wildlife-Related Functions

Wetlands with the Assessment Area provide habitat for a variety of wildlife, such as wetland-associated passerines and amphibians. However, with the exception of the coastal marshes located at the eastern end of the Assessment Area, they are not likely to provide important habitat for waterfowl or other waterbirds (*i.e.*, ducks, herons, geese, or shorebirds (excluding Killdeer)). The freshwater marshes and area of shallow water wetland identified during field surveys may also provide habitat for waterfowl and other waterbirds, but the value of these areas as such would be limited by their small size and isolation from larger permanent water bodies. Similarly, because the swamps generally lacked surface water, they are unlikely to provide important habitat for mammals that are highly dependent on aquatic environments (*e.g.*, muskrat, beaver).

None of the wetlands are known to support SAR but survey results indicate that several are associated with SOCI. Although not observed within wetland habitat, swan's sedge (*S2S3, sensitive*) was observed in disturbed areas along or near the border of Wetlands 17, 19, 23, and

33. Several bird SOCI were also observed within or in the immediate vicinity of wetlands. Golden-crowned Kinglets (*S4, sensitive*) were encountered within or in the immediate vicinities of mixed treed swamps associated with Wetlands 19, 25, 26, and 28. Northern Cardinal (*S3S4, secure)* was recorded near the edge of Wetland 9, and Killdeer (*S3S4B, sensitive*) was observed in association with a recently cut-over swamp (Wetland 23).

Few wetlands within the Assessment Area would provide fish habitat. The majority of wetland encountered during field surveys would not be sufficiently inundated to support fish, or is not connected to a permanent waterbody or watercourse where fish may be present. Of exception, the coastal marshes located at the eastern end of the Assessment Area (*i.e.*, Wetlands 2 and 6) may be considered relatively important for fish habitat. Swamps located along watercourses which are known or have potential to support fish, including Seely Brook (*e.g.*, Wetlands 29 and 31), may provide important functions related to the maintenance of fish habitat (*e.g.*, stream shading), regardless of whether they are regularly inundated and fish occur outside of the stream channel. Although the freshwater marsh or shallow water wetlands encountered during field surveys contained standing water, these wetlands were not accessible to fish.

None of the wetlands were considered to have a high diversity of plant communities or to support plant communities that are unique or rare within the province or region. For example, none were observed to support calcareous fen, black ash, cedar swamp, or wild rice marsh. The vegetative communities within the wetlands did not suggest that any were particularly nutrient-rich or nutrient-poor, as may be respectively observed in areas with calcareous or acidic substrates. However, areas along Seely Brook were not surveyed as a result of property access restrictions, but the riparian habitats (including potential wetlands) in this area may be relatively nutrient-rich. Although some of the wetlands were considered to have relatively high vegetative integrity (*e.g.*, Wetlands 6, 24, 28, and 29) the quality of the plant communities of most wetlands were compromised by a prevalence of non-native plants, particularly the invasive glossy buckthorn which often comprised a dominant component of the shrub strata.

Wetland Hydrology and Non-Wildlife Functions

An overview of the results of the wetland assessments as they relate to hydrological condition, water quality, groundwater interactions, shoreline stabilization and integrity, and community use is provided below. A summary of the results for individually assessed wetlands (or portions thereof) is provided in Appendix B.

Hydrological Condition and Integrity

- The hydrological condition of the majority of the assessed wetlands was considered to be in a relatively natural state, with water levels fluctuating in response to inputs from groundwater, surface water runoff, and precipitation. However, wetlands located adjacent to human infrastructure (*e.g.*, roadways) may receive elevated surface water runoff from surrounding developments following high precipitation events. The hydrological character of

the freshwater marshes and the shallow water wetland was anthropogenic in character, as these areas occurred as a result of excavation activities or drainage impediments caused by nearby human infrastructure. Both of the coastal marshes located within the Assessment Area are surrounded by roadways and the presence of these features may restrict the passage of tidal waters.

- Although several of the wetlands were located along watercourses, only one was identified in the field as being potentially important for maintaining stream flow. Wetland 9, located at the eastern end of the Assessment Area, was a source of a small watercourse that flowed to the north via a culvert under the road.

- Marshes and shallow water wetlands were considered to have a medium to high ability to detain surface water. The ability of swamps to detain surface water was more limited, although there was evidence in some of the swamps (*e.g.*, sparsely-vegetated concave surfaces, blackened leaves) that water does collect locally following high precipitation or surface water runoff events.

Water Quality

- Evidence of excess nutrient loading / contamination within wetlands was limited; but those located immediately adjacent to roadways or other human infrastructure may receive elevated inputs because of disturbances and activities in these areas.

- Although wetlands within the Assessment Area generally have potential to improve water quality (*e.g.*, by having capacity to filter excess sediments or nutrients), few were considered potentially important for contributing to water quality in downstream resources. Of exception, those within the floodplain of larger watercourse (*e.g.*, Wetland 31, located along Seely Brook), or those that are important for maintaining stream flow (*e.g.*, Wetland 9) have greater potential to provide this function.

Groundwater Interactions

- None of the wetlands were considered to likely serve as a groundwater recharge site; but the surrounding topography, land use, wetland soils, expected hydroperiod, and inlet/outlet configuration indicated that many are likely to serve as groundwater discharge sites.

Shoreline Stabilization and Integrity

- The majority of wetlands within the Assessment Area are not associated with open water bodies or watercourses and therefore do not have potential to contribute to the function of shoreline stabilization. Coastal marshes (*e.g.*, Wetland 6) and wetlands located along watercourses (*e.g.*, Wetland 29) may contribute to this function, although the shoreline erosion potential for these features was not considered high.

Community Use / Value

- None of the wetlands assessed during field surveys were considered important for community use. Many of the treed swamps have supported commercial tree harvesting

activities but wetlands within the Assessment Area generally have low potential to support other economic activities and would not be regularly visited for recreational, scientific, or educational purposes. Of exception, the coastal marsh and associated waters located at the eastern end of the Assessment Area (*i.e.*, Wetland 2) has potential to be relatively valuable for recreational (*e.g.*, boating or fishing) and educational purposes; and has relatively high aesthetic value because of its coastal nature and proximity to roadways.

5.5.5 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with wetlands and result in changes to wetland area and wetland function. The assessment of Project-related environmental effects on wetlands is therefore focused on the following potential effects:

- change in wetland area or function.

5.5.5.1 Change in Wetland Area or Function

Construction

The most substantive change in wetland area and function will result from site preparation activities. Clearing and grubbing during site preparation will directly remove wetland vegetation and soils and the construction of roadbeds will require that wetland habitats be infilled.

Indirect effects during site preparation activities may also result in a change in wetland area or function. The erosion of uplands as a result of vegetation removal and deposition of sediments in wetland habitat (unplanned event) may alter wetland habitat beyond the PDA. Similarly, construction activities have the potential to disturb wetland habitat through off-road and off RoW activity. This may occur when vehicles are accessing the work site along tertiary roads, by the gradual widening of the thoroughfare, as well as through non-motorized activity in undisturbed areas adjacent to the RoW.

Local and regional hydrological changes resulting from the impediment of the road bed, changes in surface cover type (forested to asphalt or grass), and surface drainage features (roadside swales) may alter wetland water supply and drainage, resulting in a change in wetland character, quality, and function.

There is a potential need for blasting for roadbed preparation, and this activity could have physical and chemical environmental effects on wetland habitat and associated wildlife. Blasting has potential to alter wetland hydrology by causing fractures in the underlying bedrock, thereby promoting the drainage of wetlands. Blasting may also have an adverse effect on wetland-associated wildlife – for example, by discouraging birds from establishing their nests during their breeding season.

The Project will require the installation of watercourse crossing infrastructure, such as culverts and bridges. Installation of such features can alter wetland habitat through drainage, flooding or

extensive erosion. Water crossing structures could also result in a potential loss of wetland function in wetlands supporting fish habitat (see Section 5.3).

Hydroseeding applications have the potential to alter the quality of wetland habitat. If applied in hydrological source areas for wetlands, hydroseeding applications have the potential to increase nutrient levels in wetlands, which could affect their biological processes (*e.g.*, nutrient uptake by plants, decomposition rates, *etc.*). Although hydroseeding efforts will use an approved seed mix, these can be comprised of non-native species and therefore have potential to influence the species composition of wetland communities. Construction activities also increase the susceptibility of wetland habitats to non-native and invasive plants through increased disturbances, proximity to anthropogenic infrastructure, and by promoting their dispersal.

Operation and Maintenance

Several activities related to the operation and maintenance of the Project could affect wetland habitat. In particular, maintenance of the Project infrastructure, winter maintenance activities, and vegetation management initiatives all have potential to adversely affect wetlands.

As part of infrastructure maintenance, the roadside shoulder will be periodically graded and ditched to improve water flow, reduce erosion and/or to deter excessive vegetative growth. These maintenance activities have potential to adversely affect the quality of wetland habitat through the direct disturbance of their vegetation and soils, as well as affects to their hydrology. Indirect impacts can result from the release of sediment into wetlands.

During winter, salt is used by NSTIR on road surfaces to aid in melting snow and to provide clear road conditions. Road salt can enter into the environment (surface water, groundwater, and soil) through storage and application of these salts. The highest concentrations are usually associated with winter and spring thaws. Road salt application has potential to result in damage to wetland habitat and/or loss of wetland function and quality.

Vegetation management will consist primarily of mechanical control of vegetation. Regular mowing will occur on the shoulder of the road to control the growth of trees and tall shrubs. Vegetation control on road shoulders will be conducted by both manual and mechanical clearing during operation (see Section 5.4) and could result in the direct disturbance of wetland habitat.

The use of herbicides for vegetation management will generally be avoided but may be considered where undesirable species persist. For example, they may be required in areas where physical vegetation management techniques are unsuccessful at controlling noxious weeds. The use of herbicides in source water areas for wetlands has the potential to affect the survival and composition of the botanical community and wetland fauna.

5.5.6 Mitigation

Mitigation to reduce the environmental effects of the Project on wetlands are identified in Table 5.5.2. Standard mitigation and measures identified in Sections 5.3, 5.4, and 5.6 to reduce effects on fish and fish habitat, vegetation, and wildlife and wildlife habitat will also act to reduce effects on wetlands. The use of some mitigation will be determined on a site-by-site basis in consideration of local concerns and conditions. Locations for site-specific mitigation will be outlined in the EPP following detailed routing and in consultation with the appropriate regulatory authorities in consideration of the following criteria:

- water flow pathways and hydrological character of wetlands;
- alternatives to current design;
- temporary or permanent mitigation; and
- public or landowner support (*e.g.*, existing use/ownership).

Mitigation measures to be implemented to reduce potential effects on wetland area and function during construction and operation are presented in Table 5.5.2, and include both generic and VC-specific measures.

Table 5.5.2 Mitigation for Wetlands

Effect	Phase	Mitigation
Change in Wetland Area or Function	Construction	• Avoid direct and indirect disturbance to wetlands, where feasible • Implement 30 m non-disturbance buffers for wetlands not scheduled for direct alteration, where possible • Follow Generic EPP (NSTPW 2007) and Project Specific Environmental Control Plan • Implement erosion control measures • Limit Project-related off road activity • Clean construction machinery prior to entering wetlands • In areas of high peat depths, use progressive installation to reduce potential for overfilling or over excavation • Use clean, pH neutral, non-leaching coarse fill in wetlands • Follow Watercourse and Wetland Alterations approval conditions • Compensate for loss of wetland area and function following provincial requirements • Employee environmental awareness training
	Operation and Maintenance	• Follow Generic EPP • Maintain culverts as required to maintain hydrological conditions • Operate vehicles outside wetland boundaries • Follow NSTIR Salt Management Plan • Avoid herbicide use in wetlands • Follow NSTIR IRVM Manual • Employee environmental awareness training

5.5.7 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on the wetland area and function after mitigation measures, as provided above, have been implemented.

5.5.7.1 Change in Wetland Area or Function

Construction

A mitigative sequence has been adopted as the approach to wetlands in the Assessment Area with the objective of no net loss of wetland habitat as a result of the Project. The mitigative sequence promotes wetland conservation through the application of a hierarchy of preferred alternatives: 1) avoidance of impacts; 2) minimization of unavoidable impacts; and 3) compensation for residual impacts that cannot be minimized. Within the context of the mitigative sequence, approvals will be sought for unavoidable wetland alterations.

Due to the abundance of wetlands in the Assessment Area and limitations of other technical and environmental constraints, avoidance of impacts to wetlands is not practical. Where practical, avoidance will be used as a means of wetland conservation. Wetlands within or adjacent to the PDA and that do not require direct infill for roadbed construction will be documented in a Project-specific EPP and avoided by construction-related activities, including 30 m non-disturbance buffers where practical. Although impacts to wetlands located outside of the RoW have potential to be affected by off-RoW vehicle traffic, these areas will also be documented in the EPP and mechanized activity will not be permitted within 30 m of their boundaries, where practical. The Project is expected to directly impact 17 wetlands, for a cumulative total of approximately 4.36 ha of wetland habitat (approximately 17% of the wetland area in the Assessment Area), during construction activities (Table 5.5.3).

Table 5.5.3 Summary of Wetland Alteration

Wetland Number	Source[1]	Class and Vegetation Type	Anticipated Area of Alteration (ha)	Percent of Wetland in Assessment Area
9	Field / Desktop	Mixed Treed / Tall Shrub Swamp	0.41	17.6%
14	Field / Desktop	Tall Shrub / Hardwood Treed Swamp	0.07	15.7%
15	Field	Tall Shrub Swamp	<0.01	5.4%
16	Field	Tall Shrub Swamp (with cut over components)	0.01	5.5%
17	Field / Desktop	Mixed Treed / Hardwood Treed / Tall Shrub Swamp and Aquatic Shallow Water (with cut over components)	0.52	54.3%

Table 5.5.3 Summary of Wetland Alteration

Wetland Number	Source[1]	Class and Vegetation Type	Anticipated Area of Alteration (ha)	Percent of Wetland in Assessment Area
18	Field / Desktop	Hardwood Treed / Mixed Treed Swamp and Graminoid Marsh	1.24	68.2%
19	Field / Desktop	Mixed Treed Swamp (with cut-over components)	0.42	17.9%
20	Field / Desktop	Mixed Treed Swamp (cut-over)	0.22	84.7%
21	Field / Desktop	Mixed Treed Swamp (with cut-over components)	0.03	4.6%
22	Field	Mixed Treed Swamp	0.09	21.6%
23	Field	Mixed Treed Swamp (cut-over)	0.11	94.7%
24	Field	Mixed Treed Swamp	0.04	91.1%
25	Field	Mixed Treed Swamp	0.04	63.6%
26	Field	Mixed Treed Swamp	0.76	59.0%
31	Field / Desktop	Mixed Treed / Hardwood Treed / Tall Shrub Swamp	0.25	40.2%
34	Field	Mixed Treed Swamp	<0.01	65.4%
35	Field	Tall Shrub Swamp	0.16	49.1%
Total			4.36	17.3%

[1]Only wetlands within accessible portions of the Assessment Area were field surveyed; wetland boundaries identified through desktop assessment have not been confirmed

Wetland habitat will not be disturbed without a Water Approval for Wetland Alteration from NSE. The Approval application will contain site-specific plans for minimization of wetland alteration. It is understood that Wetland Alteration Approvals may be contingent on the fulfillment of compensation obligations to promote "no net loss" of wetland habitat as a result of the Project. Compensation requires that the residual impacts on the wetland functions are compensated by the enhancement, restoration, or creation of a wetland ecosystem at an area ratio commensurate with the loss.

Two wetlands that would be classed as WSS were encountered within or adjacent to the Assessment Area including Wetland 2 and Wetland 6. Both wetlands are saltmarshes which are classed as WSS by the province. Neither of these tidal marshes is located within the PDA and adverse effects associated with highway construction and operational activities are not anticipated for these wetlands.

Site Preparation

Project effects to wetland habitat as a result of erosion and sedimentation are most likely to occur during site preparation activities, which include the clearing, grubbing, and infilling of upland and wetland habitat. However, erosion control systems will be in place to manage runoff from the construction areas Erosion control measures are identified in the Generic EPP (NSTPW 2007), and also include erosion control fencing, check dams, and use of mulch (possibly from shrubs and trees removed during clearing). Sediment and erosion control will be carried out according to all applicable standards, regulations, the EPP, and site-specific terms and conditions of government approvals, authorizations and letters of advice. Erosion and sedimentation control measures will remain following site (*i.e.*, roadbed) preparation, until stabilization of soils is complete (*i.e.*, surface dressing).

Project-related off-road activity will be limited during roadbed construction through employee environmental awareness training and field flagging of wetland avoidance areas and setbacks.

As discussed in the Wildlife and Wildlife Habitat VC (Section 7.5), a number of mitigation actions will be undertaken to minimize the effect of site preparation on wetland-related wildlife

Watercourse Crossing Structure Construction

Very few of the wetlands within the Assessment Area are connected directly with watercourses or are immediately adjacent to them. Most wetlands exist as basin or slope wetlands without well-defined channels. However, some wetlands in the Assessment Area are susceptible to adverse effects resulting from the construction of watercourse crossing structures, including drainage, flooding, or sedimentation from erosion events (*e.g.*, those along Seely Brook). In addition to the erosion and sedimentation control practices outlined in the Generic EPP (NSTPW 2007), additional mitigation measures regarding the installation of watercourse crossing infrastructure, such as culverts and bridges, will be followed and detailed through the Wetland Alteration Approval process, including:

- preparation of erosion and sedimentation control procedures for watercourse crossings;
- contractor environmental awareness training, focusing on avoidance and minimization of wetland impacts;
- control of runoff from construction to reduce potential turbidity and sedimentation; and
- use of clean, pH neutral, non-leaching, coarse fill materials within wetland areas.

In addition to the anticipated conditions of Wetland Alteration Approvals which are required for Projects that may affect wetland habitat, the following mitigation measures will be considered for wetlands:

- design culverts to accommodate water level equalization to allow peak and low flows;
- retain existing circulatory patterns;
- minimize channeling;

- consider permeability and compression to allow for the passage of substrate water wherever feasible;
- minimize the draining of surface water;
- restrict construction activities to designated roadways and access points of the Project; and
- limit the extent of clearing to the outside toe of slope.

Wetland Alteration Approvals are required from NSE before wetlands can be altered. Site works that may affect wetlands will not proceed until the requisite approvals are acquired. Approvals will be sought for wetlands that cannot be avoided and for wetlands that may be indirectly affected by the development despite the employment of appropriate mitigation measures. A description of mitigation measures to reduce adverse effects on wetlands during the construction and operation and maintenance of the Project will be included in the approval application, along with a wetland compensation plan.

To offset the loss of valued services provided by an affected wetland, compensation is required for any alteration of wetland habitat in Nova Scotia. Compensation requires that the residual impacts on the wetland functions are compensated by the enhancement, restoration, or creation of wetland habitat at an area ratio commensurate with the loss. The objective of the compensation plan will be to obtain no net loss of wetland area or wetland function for up to 4.56 ha of altered wetland.

In consideration of the potential environmental effects of Project-related activities during construction and the proposed mitigation (including habitat compensation), residual environmental effects of the construction of the Project on wetland area and function are predicted to be not significant. In particular, Project construction is not expected to result in an unauthorized permanent net loss of wetland area or a loss of WSS.

Operation and Maintenance

Infrastructure Maintenance

As part of infrastructure maintenance, ditching may be required to improve water flow, reduce erosion and/or to deter excessive vegetative growth. Small scale hydrological modifications, such as ditch maintenance, could adversely affect the functioning of adjacent wetlands. Additional unplanned maintenance required post-construction will be assessed for the potential to enhance or reduce drainage from wetlands or to discharge sediment to wetlands, and appropriate mitigation will be implemented.

Winter Maintenance

Effects to vegetation as a result of winter maintenance will be reduced through a number of mitigation measures including following the EPP, applying drainage controls, employee environmental awareness training prior to commencement of maintenance activities (*e.g.*, salt

and sand application during winter), and increased vigilance and inspection of permanent erosion and sediment control structures, particularly in areas identified as being sensitive.

Salt loading will be reduced by following the NSTIR Salt Management Plan, which specifies application rates and techniques. Techniques that reduce the amount of road salt used will be employed. These include the use of road weather information systems to monitor road surface conditions, pre-wetting of salt, and the use of anti-icing systems such as brine solutions to minimize the amount of salt required. These techniques would reduce salt-induced stressors to wetland habitats as well as other important environmental components. Wetlands known to provide habitat for plant SOCI may be considered salt sensitive areas for which pre-wetting and anti-icing agents will be employed. Salt storage and snow disposal areas will not be located in proximity to salt vulnerable areas along the RoW, including wetlands, as stated in the NSTIR Salt Management Plan.

Vegetation Management

Vegetation control on road shoulders will be conducted by both manual and mechanical clearing during operation. The use of herbicides for vegetation control may be required in areas where physical vegetation management techniques are unsuccessful at controlling noxious weeds. Physical vegetation control activities within 30 m of a wetland and the use of herbicides in drainage areas for wetlands have the potential to affect the survival and composition of the botanical community and wetland fauna. Vehicles will not operate from within the boundaries of wetlands for the purpose of controlling the growth of their trees and tall shrubs (*i.e.*, they will be operated from outside the edge of wetlands or hand tools will be used). Additional mitigation measures involving the flagging of setbacks and limits on the use of herbicides will be implemented to prevent disturbance to the remaining portions of partially affected wetlands and to avoid disturbance to nearby ones.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the operation and maintenance of the Project on wetland area and function are predicted to be not significant. In particular, operation and maintenance is not expected to result in an unauthorized permanent net loss of wetland area or a loss of WSS.

5.5.8 Monitoring and Follow-up

Follow-up wetland surveys will be conducted within portions of the Field Survey Area that could not be surveyed during 2016 as a result of property access restrictions. Areas which could not be accessed include the floodplain of the Seely Brook, the area between Seely Brook and Highway 101, as well as areas near the north end of the Marshalltown Road and off Flatiron Road. Field surveys will consist of performing wetland delineations and functional assessment of wetlands (including inventories of plant and animal SAR and other SOCI) with potential to be directly or indirectly altered by the Project.

Monitoring will be conducted to measure the extent of wetland alteration, the effectiveness of mitigation measures, and the successful completion of compensatory wetland restoration and creation. Efforts will be directed at a subset of remaining wetlands that are representative of the wetland types within the Field Survey Area, as well as those enhanced, restored, or created as a result of compensatory obligations. As in previous NSTIR wetland monitoring programs (*e.g.*, along Highways 101, 103, 104 and 125), wetlands will be monitored for at least three years and annual monitoring reports will be provided to NSE.

5.6 WILDLIFE AND WILDLIFE HABITAT

Wildlife and wildlife habitat is considered a VC because of potential Project interactions with wildlife (mammals, birds, herpetiles) and associated habitats, particularly with respect to species of conservation interest (SOCI), and due to concerns with protecting species diversity. Provincial and federal legislation addresses protection of many wildlife species, including species at risk (SAR) and migratory birds.

5.6.1 Regulatory and Policy Setting

Migratory birds are protected federally under the *Migratory Birds Convention Act* (MBCA), which states that "no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" without a permit. Section 5.1 of the MBCA describes prohibitions related to depositing substances harmful to migratory birds. Bird species not protected under the MBCA, such as raptors and cormorants, are protected under the provincial *Wildlife Act* along with other wildlife.

Wildlife species that are protected federally under the *Species at Risk Act* (SARA) are listed in Schedule 1 of the Act. The purpose of this Act is to protect wildlife species at risk and their critical habitat. SARA is administered by Environment and Climate Change Canada, Parks Canada Agency, and DFO.

Certain wildlife species are also protected under the Nova Scotia *Endangered Species Act* (NS ESA). Species recognized as being at risk of extinction in Nova Scotia are identified by a provincial status assessment process through the Nova Scotia Endangered Species Working Group. The conservation and recovery of species assessed and legally listed under the NS ESA is coordinated by the Wildlife Division of the Nova Scotia Department of Natural Resources (NSDNR). There is also a provincial general status assessment process that serves as a first alert tool for identifying species in the province that are potentially at risk. Under this process, species are assigned to categories that designate their population status in Nova Scotia, including *secure*, *sensitive*, *may be at risk*, and *at risk*. Although species assessed under this process are not granted legislative protection, the presence of species ranked as *sensitive*, *may be at risk* and *at risk* is an indication of concern by provincial regulators, as are those ranked as *S1*, *S2*, or *S3* by the AC CDC.

The wildlife and wildlife habitat VC focuses on wildlife SOCI, which are defined as those wildlife species that are:

- listed under the NS ESA or Schedule 1 of the federal SARA as being either *endangered*, *threatened*, *vulnerable*, or of *special concern* (*i.e.*, species at risk);
- listed in Schedule 2 or 3 of SARA;
- not yet listed under provincial or federal legislations but identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being either *endangered*, *threatened*, or of *special concern*;
- listed by the NSDNR (2014) to be *at risk*, *may be at risk*, or *sensitive* to human activities or natural events; and
- ranked as *S1*, *S2*, or *S3* by the AC CDC (2014).

5.6.2 Boundaries

The assessment of potential environmental effects on wildlife and wildlife habitat encompasses the following spatial boundaries: the Project Development Area (PDA), and the Assessment Area. The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1. The Assessment Area is presented in Figure 5.5 and represents a 60 m buffer of the PDA and is the area in which field wildlife surveys were focused.

The temporal boundaries for the assessment of the potential Project-related environmental effects on wildlife and wildlife habitat include the duration of construction, and operation and maintenance of the Project in perpetuity. Most mammals in Nova Scotia are non-migratory and are present in the Assessment Area year-round.

Most bird species in Nova Scotia are migratory, though some are considered resident. Temporal boundaries for the assessment are variable, as some species may be present year-round while others may occupy habitat near the Project only during a particular point in their life (*i.e.*, migration period). The assessment considers both construction and operation phases of the Project, on a year-round basis with an emphasis on sensitive periods for birds such as the breeding season.

The terrestrial and freshwater herpetiles of Nova Scotia are generally non-migratory, although they are capable of undertaking short seasonal movements to and from suitable breeding and hibernating sites. Resident species will remain in the Assessment Area year round except in cases where some key habitat component occurs just outside of the Assessment Area. Within the Assessment Area, certain species (*i.e.*, spring peeper (*Pseudacris crucifer*)) may not be present in specific habitats (*i.e.*, breeding pools) year round. During the late fall to winter period resident reptiles and amphibians will be in hibernation. Temporal boundaries consider the potential for herpetiles to be affected by Project construction and, within their active season, operation throughout the duration of Project activities.

5.6.3 Significance Definition

A **significant adverse residual environmental effect on wildlife and wildlife habitat** is defined as:

- one that results in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of SARA, or in contravention of any of the prohibitions stated in section 3 of the NS ESA;
- one that threatens the long-term sustainability of a wildlife species within the Annapolis Valley (610) or Valley Slope (710) Ecodistricts; or
- one that is inconsistent with the goals, objectives or activities of recovery strategies and action plans for any SOCI.

5.6.4 Description of Existing Conditions

5.6.4.1 Methods

5.6.4.1.1 Environmental Setting

Provincial forestry (NSDNR 2016b) and wetland inventory data (NSDNR 2016c) were obtained for describing existing conditions within the Assessment Area. Interior forest was defined as continuous stands of forest greater than 10 ha, with a maturity class of either "multi-aged" or "late mature", and free of edge effect (*i.e.*, more than 100 m from anthropogenic edges). The amount and distribution of mature forest habitat in the Assessment Area was determined using NSDNR forest inventory data by establishing 100 m buffers around anthropogenic edges, including existing distribution line RoWs, roadways, and other heavily disturbed non-forested habitat. The model was not able to capture the edge effects of recent clear-cuts because of the lack of recent data on their extent within the Assessment Area. Areas remaining after buffering these features were classed as forest interior habitat if they were 10 ha or greater in size.

5.6.4.1.2 Mammals

Information regarding the presence of mammal SOCI and sensitive mammal habitat within the Assessment Area was derived from existing data sources (*e.g.*, AC CDC data), field surveys conducted in 2001 to support the original alignment of the Digby to Weymouth North corridor. Additional field surveys were conducted in 2016. During designated field surveys for wetlands, aquatics and birds, field staff took incidental records of mammals observed in the Assessment Area. Knowledge of the distribution of small mammals in the Assessment Area is limited due to their secretive nature; however, many rare small mammals have specific habitat requirements, which can be used to predict areas where they are likely to be found.

5.6.4.1.3 Birds

Information on bird species within the Assessment Area was determined through a combination of desktop research and field surveys. The main source of existing data related to rare species records near the Assessment Area was the Atlantic Canada Conservation Data Center (AC CDC). AC CDC data was obtained for a 10 km buffer area surrounding the midpoint of the PDA. Data from the AC CDC comes from a variety of sources, including the Maritime Breeding

Bird Atlas (MBBA). The MBBA data consists of observations that are recorded in 10 km x 10 km census squares by citizen scientists. The AC CDC data provide an indication as to which species may be expected in the Assessment Area.

A breeding bird survey was conducted between June 20 and 24, 2016. These surveys were conducted in conjunction with wetland surveys, and all species observed or heard along the route were recorded. GPS points were taken for observations. While all species were recorded to obtain a complete list for the Assessment Area, particular attention was given to identifying and recording SOCI.

The breeding status of all observed species was determined. Species identified but not exhibiting signs of breeding were classed as non-breeders. Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were classed as probable breeders:

- courtship behaviour between a male and female;
- birds visiting a probable nesting site;
- birds displaying agitated behaviour; or
- male and female observed together in suitable nesting habitat.

Species were confirmed as breeding if any of the following items or activities were observed:

- nest building or adults carrying nesting material;
- distraction display or injury feigning;
- recently fledged young;
- occupied nest located; or
- adult observed carrying food or faecal sac for young.

Dedicated surveys for common nighthawks (*Chordeiles minor*) were conducted at sites that were identified as having potential breeding habitat. Common nighthawks nest in diverse habitats, such as clear-cuts, agricultural lands, barrens, disturbed areas, non-productive forest at other open environments. Three survey sites were identified in three different habitat types: a clear-cut, a pasture and disturbed sites. These sites were each surveyed four times between June 21 and 23, 2016.

Common nighthawk survey methodology followed that outlined by CWS (2016) but included the use of playback. The survey consists of a six-minute silent listening period at each station, followed by two minutes of playbacks, and two minutes of silent listening (*i.e.*, 10 minutes total). Surveyors recorded environmental conditions (temperature, cloud cover and wind) at the time of the survey.

5.6.4.1.4 Herpetiles

Information regarding herpetiles in the Assessment Area was obtained from existing information sources (*i.e.*, Gilhen 1984; Gilhen and Scott 1981; Scott 1994; NS Herpetofaunal Atlas

Project 2001) and field surveys. During vegetation, wetland and bird field surveys, observations of herpetiles were recorded.

5.6.4.2 Summary of Existing Conditions

5.6.4.2.1 Environmental Setting

Habitat in the Assessment Area is relatively diverse and somewhat fragmented by secondary roads, woods roads, an abandoned railroad and recent clear-cuts. Habitats present in the Assessment Area include: mixedwood, hardwood and softwood forest ranging in age from young to multi-aged, treed swamps, agriculture, highway, marshes and urban areas. The land cover class 'barrens' does not represent true barrens in the Assessment Area, but rather sparsely vegetation areas, generally associated with disturbance. In the Assessment Area, the most abundant land classes include forest other, urban and multi-aged softwood (Table 5.6.1, Figure 5.5). There are no lakes or other major sources of open water within the Assessment Area.

Forest cover makes up most of the Assessment Area, accounting for 71% of total land cover, or 101 ha. This forest cover is made up by a variety of stands of different age classes and types. The most abundant forest class is 'forest other', which accounts for 20% of the total land cover in the Assessment Area. The next most abundant forest category is multi-aged softwood, which accounts for 11% of the Assessment Area, followed by multi-aged mixedwood, at 9%. In total, multi-aged or late mature stands account for 27% of the Assessment Area. There are approximately 21 ha of interior forest in the Assessment Area. Most interior forest is multi-aged softwood, followed by late mature softwood. Interior forest also includes patches of multi-aged hardwood and mixedwood, and late mature hardwood and mixedwood. All interior forest in the Assessment Area is part of one large patch that extends north, which means that there is connectivity between the different sections of interior forest shown in Figure 5.5. Young, established, and early mature forest types account for 24% of the land cover. Softwood forest accounts for most of the forest cover (26% of Assessment Area), followed by mixedwood (17%) and hardwood (9%).

Wetlands account for 8% of the Assessment Area and cover approximately 12 ha. The vast majority of wetlands are swamps, which cover just under 8% of the Assessment Area. These swamps are generally either forested or tall shrub swamps. The remaining wetlands, in order of decreasing abundance, are comprised of salt marshes, shallow water, and freshwater marshes, each of which account for ≤0.1% of the Assessment Area. There is only one saltmarsh in the Assessment Area, located in the northeast. Wetlands were delineated in the field and are discussed in greater detail in Section 5.5.

Anthropogenic land use accounts for approximately 20% of land cover in the Assessment Area. This is made up primarily of urban areas (10%), which is most abundant at each end of the Assessment Area, near Highway 1. Highways are present at each end of the Assessment Area, and are particularly abundant at the eastern end at Exit 26. Agriculture accounts for 5% of the Assessment Area, and is concentrated at its western end, north of Highway 1.

Additional information on vegetation and wetland conditions within the Assessment Area including a discussion of dominant vegetation types) is provided in Section 5.4 (Vegetation) and Section 5.5 (Wetlands).

Table 5.6.1 Land Cover Within the Assessment Area

	Land Cover	Assessment Area	
		Area (ha)	Percent (%)
Forest	Multi-Aged Hardwood	1.41	0.98
	Multi-Aged Mixedwood	12.15	8.48
	Multi-Aged Softwood	15.54	10.84
	Late Mature Hardwood	3.00	2.10
	Late Mature Mixedwood	0.28	0.20
	Late Mature Softwood	6.66	4.64
	Early Mature Hardwood	8.00	5.58
	Early Mature Mixedwood	9.14	6.37
	Early Mature Softwood	6.69	4.66
	Young Hardwood	0.04	0.02
	Young Mixedwood	2.25	1.57
	Young Softwood	5.81	4.05
	Establishment- Softwood	2.40	1.67
	Forest Other	27.96	19.50
Wetland	Marsh	0.07	0.05
	Salt Marsh	0.17	0.12
	Shallow water	0.06	0.04
	Swamp	11.45	7.99
Other	Urban	13.99	9.75
	Agriculture	6.70	4.67
	Barren	2.14	1.49
	Highway	7.49	5.23
	Total	**143.40**	100.00

5.6.4.2.2 Mammals

No designated significant habitat, such as deer wintering areas, exist within the Assessment Area (NSDNR 2016d). The AC CDC data did not produce any records of rare mammals near the Assessment Area. The species recorded in the Assessment Area are characteristic of woodland and riparian habitats. Visual sightings and the presence of abundant spoor suggested that white-tailed deer (*Odocoileus virginianus*), red squirrel (*Tamiasciurus hudsonicus*), varying hare (snowshoe hare) (*Lepus americanus*), and raccoon (*Procyon lotor*) are relatively abundant in the Assessment Area. Several large mammal species not recorded during the field surveys may be expected to be found in habitats present in the Assessment Area; these include black bear

(*Ursus americanus),* bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), short-tailed weasel (*Mustela erminea*) and muskrat (*Ondatra zibethicus*).

Field surveys conducted between Digby and Weymouth in 2001 identified six small mammal species, including red squirrel (*Tamiasciurus hudsonicus*), eastern chipmunk (*Tamias striatus*), red-backed vole (*Clethrionomys gapperi*), common shrew (*Sorex cinereus*), short-tailed shrew (*Blarina brevicauda*), and star-nosed mole (*Condylura cristata*). Other small mammal species which have potential to occur in the Assessment Area include smoky shrew (*Sorex fumeus*), northern flying squirrel (*Glaucomys sabrinus*), deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), meadow jumping mouse (*Zapus hudsonius*), and woodland jumping mouse (*Napaeozapus insignis*). None of the species recorded in the Assessment Area are considered to be *rare* in Nova Scotia according to AC CDC s-ranks and NSDNR general status ranks.

There are four mammal species listed under the NS ESA that occur on mainland Nova Scotia: the mainland moose (*Alces alces americana*) and three species of bats. Mainland moose are not generally found in the Digby area and are not expected to occur in the Assessment Area. The three species of bats are all listed as *endangered* both provincially and federally (SARA Schedule 1). The little brown myotis (*Myotis lucifugus*), northern long-eared myotis (*Myotis septentrionalis*) and eastern pipistrelle (*Perimyotis subflavus*) all have potential to occur in the Assessment Area. All species are insectivorous bats that depend on forest environments for foraging opportunities and roosting during the spring, summer and fall. Both little brown and northern long-eared myotis roost in trees; although little brown myotis also often roost in man-made structures, such as roofs, attics or barns. Eastern pipistrelles are unique in their roosting strategies, and roost in clumps of *Usnea* lichen, often in spruce trees (Poissant *et al.* 2010). In all three species, females form maternity colonies where they birth and raise pups; whereas males tend to roost alone or in small groups. Bats enter underground sites in the fall, such as caves or abandoned mines, where they hibernate for the winter. All three species of hibernating bats have potential to occur in the Assessment Area during the spring summer and fall months. However, no known hibernation sites occur in or near the Assessment Area.

5.6.4.2.3 Birds

The AC CDC results identified 32 SOCI with the potential to occur in or near the Assessment Area (Table C1 in Appendix C). Eight SAR were identified, including common nighthawk (*Chordeiles minor*), olive-sided flycatcher (*Contopus cooperi*), eastern-wood pewee (*Contopus virens*), barn swallow (*Hirundo rustica*), bank swallow (*Riparia riparia*), Canada warbler (*Cardellina canadensis*), bobolink (*Dolichonyx oryzivorus*) and rusty blackbird (*Euphagus carolinus*). Bank swallows nest in erodible, unvegetated banks, which are not found within the Assessment Area; therefore, this species is unlikely to occur. Suitable habitat does exist for the remaining seven SAR in the Assessment Area, which indicates that they all have the potential to occur in this area. Of the additional bird SOCI recorded near the Project, four others are unlikely to be found in the Assessment Area due to a lack of suitable habitat (Appendix C).

A total of 46 bird species were observed in the 2016 field surveys. The list of all species, including status rankings and breeding status can be found in Table C2, Appendix C. A total of eight SOCI were observed: Gray catbird (*Dumetella carolinensis*), northern cardinal (*Cardinalis cardinalis*), gray jay (*Perisoreus canadensis*), killdeer (*Charadrius vociferous*), eastern wood-pewee, yellow-bellied flycatcher (*Empidonax flaviventris*), golden-crowned kinglet (*Regulus satrapa*) and common nighthawk (Table 5.6.2). Two of these species are designated SAR: eastern wood-pewee and common nighthawk. All SOCI identified in the Assessment Area breed in Nova Scotia.

Table 5.6.2 Bird SOCI Observed in the Assessment Area

Common Name	Scientific Name	SARA	COSEWIC	NS ESA	AC CDC S-Rank	NSDNR General Status Rank	Breeding Status
Gray Catbird	*Dumetella carolinensis*	-	-	-	S3B	May Be At Risk	Possible
Northern Cardinal	*Cardinalis cardinalis*	-	-	-	S3S4	Secure	Possible
Gray Jay	*Perisoreus canadensis*	-	-	-	S3S4	Sensitive	Possible
Killdeer	*Charadrius vociferus*	-	-	-	S3S4B	Sensitive	Observed
Eastern Wood-Pewee	*Contopus virens*	-	Special Concern	Vulnerable	S3S4B	Sensitive	Possible
Yellow-bellied Flycatcher	*Empidonax flaviventris*	-	-	-	S3S4B	Sensitive	Possible
Golden-crowned Kinglet	*Regulus satrapa*	-	-	-	S4	Sensitive	Possible
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened	S3B	At Risk	Observed

Gray Catbird

Gray catbirds have a NSDNR general status rank of *may be at risk* and an AC CDC ranking of *S3B*. Preferred habitat includes shrubby, dense vegetation. They are generally tolerant of human disturbance and are often found in edge habitats. Nests are generally built in deciduous shrubs and are usually less than 2 m from the ground (Smith *et al*. 2011). One male gray catbird was observed during field surveys. This bird was located just off Maud Lewis Lane in forested habitat (Figure 5.5).

Northern Cardinal

Northern cardinals have an AC CDC ranking of *S3S4*. This species is found in areas with shrubs or small trees, which include forest edges, logged and second growth forests and hedgerows or shrubs around agricultural areas or buildings (Halkin and Linville 1999). Nests are built in dense,

woody foliage, usually in shrubs or small trees. One northern cardinal was observed in the Assessment Area near the eastern extent of the RoW. This bird was located approximately 60 m east of Beachwood Lane (Figure 5.5) in multi-aged mixedwood forest.

Gray Jay

Gray jays have a NSDNR general status ranking of *sensitive* and an AC CDC ranking of *S3S4*. This is a boreal species that is found in coniferous and mixedwood forest, typically where spruce is present. Nests are generally built in spruce or balsam fir, and are often located north of the north edge of an open area, such as an open bog or road (Strickland and Ouellet 2011). Four gray jays were observed in the Assessment Area (Figure 5.5). Two of these birds were observed in early mature mixedwood, one was observed in early mature hardwood, and one was observed in the forest-other land class.

Killdeer

Killdeer have a NSDNR general status rank of *sensitive* and an AC CDC s-rank of *S3S4B*. This species is very tolerant of anthropogenic activities. They are generally found in open areas, such as cultivated fields, heavily grazed pastures, sandbars, airports and golf courses. Killdeer nest directly on the ground in areas with low or no vegetation, often on grass or rocks/pebbles (Jackson and Jackson 2000). One killdeer was observed as a fly-over at the western end of the Assessment Area (Figure 5.5).

Eastern Wood-Pewee

Eastern wood pewees are listed under the NS ESA as *vulnerable*, and by COSEWIC as *special concern*. This species uses a variety of types of wooded habitats, including intermediate aged and mature deciduous and mixedwood forests. They are often found near edges and are associated with the mid-canopy layer (COSEWIC 2012b). Nests are generally built in large, mature trees. One male eastern wood pewee was observed in the Assessment Area (Figure 5.5) in multi-aged softwood forest.

Yellow-bellied flycatcher

Yellow-bellied flycatchers have a NSDNR general status ranking of *sensitive* and an AC CDC ranking of *S3S4B*. This species is generally found in moist conifer or mixedwood forests, including bogs and swamps. Breeding habitat is often well stratified with an open canopy, with spruce and/or balsam fir as dominant species. Nests are built on or near the ground in shady, well-hidden spots, often concealed by moss or overhanging vegetation (Gross and Lowther 2011). Two yellow-bellied flycatchers were observed in the Assessment Area (Figure 5.5), both of which were singing males. Both birds were located near the center of the Assessment Area, one in young softwood forest and the other in early mature mixedwood forest.

Golden-crowned Kinglet

Golden-crowned kinglets have a NSDNR general status rank of *sensitive*. This small forest bird is most strongly associated with mature conifer forests, but can also be found in mixedwood or deciduous forests, or spruce and pine plantations. Golden-crowned kinglets often choose nesting sites at the edges of clearings or near water. Nests are built in conifer trees, such as balsam fir, white spruce or black spruce (Swanson *et al*. 2012). A total of 16 individuals were observed in the Assessment Area. These birds were distributed throughout the southwestern two-thirds of the Assessment Area (Figure 5.5), all of which were observed in forested areas. Seven of these birds were observed in multi-aged softwood and three were observed in early mature mixedwood.

Common Nighthawk

Common nighthawks are listed as *threatened* by SARA, COSEWIC and the NS ESA. This species will occupy a variety of open habitats for breeding, including barrens, burned-over areas, pastures, rocky outcrops forest clearings and peatbogs. Anthropogenic habitat may also be used for breeding, including flat gravel roofs or gravel lots (COSEWIC 2007). Eggs are laid directly on the ground. One common nighthawk was recorded as an incidental observation. This bird was observed as a flyover near the southwestern end of the Assessment Area, near WC1 (Figure 5.5). No other observations were made during the dedicated night hawk surveys.

5.6.4.2.4 Herpetiles

Almost the entire habitat found along the proposed route provides habitat for reptile and amphibian species. These habitats include coniferous, deciduous and mixed wood forests of various ages, abandoned pasture and a variety of wetlands. Various wetland habitats suitable to host breeding adult, resident and transitory adult, and larval amphibians are found within the Assessment Area. Aquatic breeding sites include wetland pool habitats, streams, roadside ditches and pools, fire ponds, and wheel rut pools on wood roads.

No species of herpetiles were identified in the AC CDC data search. Nova Scotia has four species of freshwater turtles and five species of snakes. No turtle species were recorded during the field surveys. Three freshwater turtle species have at-risk designations in Nova Scotia: Blanding's turtles (*Emydoiodea blandingi*), wood turtles (*Clemmys insculpta*), and snapping turtles (*Chelydra serpentina*). Blanding's turtles are listed by SARA, COSEWIC and the NS ESA as *endangered* in Nova Scotia. This species naturally occurs in the warmer central portions of the interior of the province, with populations centered in and around Kejimkujik National Park and are therefore not expected to occur in the Assessment Area. Wood turtles are listed as *threatened* by SARA, COSEWIC and the NS ESA. Snapping turtles are listed as *special concern* by both SARA and COSEWIC, and as *vulnerable* by the NS ESA. Some suitable habitat occurs for both wood turtles and snapping turtles in the Assessment Area. It is possible that either species could occur at Seely Brook. There are several ponds in the Assessment Area that could provide habitat for snapping turtles. For example, ponds associated with wetland 119 and wetland 4

could provide snapping turtle habitat (see Section 5.5 for description and locations of wetlands). However, no signs of turtles were observed in field surveys in either 2003 or 2016. The fourth species of turtle in Nova Scotia, eastern painted turtle (*Chrysemys picta picta*), is unlikely to occur in the Assessment Area.

Nova Scotia has eight species of frogs and toads, and five species of salamander. During the 2016 field surveys, bullfrogs (*Rana catesbeiana*), green frogs (*Rana clamitans*) and American toads (*Bufo americanus*) were observed. Suitable habitat exists in the Assessment Area for all other species of frogs, including northern spring peeper (*Pseudocaris c. crucifer*), pickerel frog (*Rana palustris*), northern leopard frog (*Rana pipiens*), wood frog (*Rana sylvatica*) and mink frog (*Lithobates septentrionalis*). All species, with the exception of American toads and wood frogs, are associated with wetlands and aquatic habitats. Toads are only associated with aquatic habitats during the breeding season and as larvae, and can be found in a variety of terrestrial habitats as adults. Wood frogs are often found in aquatic habitats, but also commonly occur in upland areas. No species of frogs in Nova Scotia are currently considered to be SOCI.

During 2001, herpetile surveys were conducted between Digby and Weymouth, during which two species of snake were recorded: maritime garter snake (*Thamnophis sirtalis pallidula*); and eastern smooth green snake (*Liochlorophis vernalis borealis*). Both these species are widespread through Nova Scotia. Habitat for northern redbelly snake (*Storeria o. occipitomaculata*) and northern ringneck snake (*Diadophis punctatus edwardsi*) are present along the proposed route, though northern ringneck snakes are generally found in southweastern and northeastern mainland Nova Scotia, and would not be expected to occur in the Assessment Area. One snake SAR exists in Nova Scotia: the northern ribbon snake (*Thamnophis sauritis septentrionalis*). However, this species is recorded only in the warmer south western interior of the province and would not be expected in the Assessment Area. No rare or sensitive snake SOCI were encountered during field surveys or have been identified within 10 km of the Project (AC CDC 2016b).

Three species of salamanders were observed in the general vicinity of the Assessment Area during the 2003 field surveys; including yellow-spotted salamander (*Ambystoma maculatum*), eastern redback salamander (*Plethodon cinereus,* n>20) and red- spotted newt (*Notophthalmus v. viridescens,* n=2). Larvae of the subterranean, spring breeding, yellow spotted salamanders were found during the surveys. These were noted from two fire ponds along wood roads and in wood road rut pools. All twelve *Ambystoma* larvae examined were yellow-spotted salamanders. No blue-spotted salamander (*Ambystoma laterale*) larvae were noted and this species is not recorded (Gilhen 1984) from the area. Leadback and redback phases of the eastern redback salamander (n=12) were noted in wooded habitats and woodland edges. The ubiquitous redback salamanders do not require aquatic breeding sites and are common in woodlands, even those that are distant from surface waters. The rare erythristic phase was not found. In Nova Scotia, the erythristic phase of the redback salamander is associated with higher altitude, sugar maple dominated, deciduous forests; which were not

present in the Assessment Area. Only two adult red-spotted newts were encountered, each located in wood road fire ponds.

Though the species was not located during surveys, suitable breeding habitat for four-toed salamanders (*Hemidactylium scutatum*) was encountered near the Assessment Area in association with swamps. The four-toed salamanders have a ranking of *S3* in Nova Scotia, and are not considered to be rare at the national level. The critical requirements for this species are the presence of sphagnum moss in which to lay eggs and a semi-permanent or permanent, soft bottomed pond or slow flowing stream adjacent to the sphagnum moss in which the hatched larvae can develop.

5.6.5 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with wildlife and wildlife habitat through direct loss or alteration of habitat, and direct mortality. In consideration of these potential interactions, the assessment of Project-related environmental effects on wildlife and wildlife habitat is focused on the following potential environmental effects:

- change in habitat quantity, quality or use; and
- change in risk of mortality or physical injury.

5.6.5.1 Change in Habitat Quantity, Quality or Use

Construction

Wildlife habitat within the PDA will be eliminated during construction. Clearing and grubbing for site preparation will remove vegetation, reducing the quantity of terrestrial habitat, and will affect the quality of habitat bordering the PDA. The Project will result in more edge area, which can increase predation on birds and small mammals but also has potential benefits related to habitat, and food availability.

During construction, wildlife may be affected by disturbance and noise related to construction activities. This is true for both terrestrial and aquatic species. Construction work at water crossings may affect aquatic habitat for herpetiles. Animals thus affected may temporarily move out of the range of disturbance.

Change in wildlife habitat quality includes habitat fragmentation and sensory disturbance. Small mammal and herpetile populations which have limited dispersal capabilities are particularly susceptible to habitat fragmentation. Populations isolated from other populations in small habitat fragments are more prone to local extirpation since these fragments may be too small to support a population. Fragments may be large enough to support a population, but may not be large enough to provide enough animals to rebuild the population should it be heavily impacted by disease or predators. Isolation of the fragment can also impair the immigration of new animals into an area where a local population has been extirpated. Impaired immigration

can also adversely affect populations by restricting gene flow between populations leading to inbreeding.

Habitat fragmentation can also affect highly mobile animals such as birds. During the breeding season some species may be reluctant to cross clearings causing populations to be isolated in resultant habitat fragments. Studies of bird use of forest patches in agricultural areas by the CWS in Quebec found that bird movement between patches decreased with increasing distance between patches (CWS Undated). The CWS determined that the influence of edge environmental effects extended as far as 300 m from the forest edge. It also observed that 98% of the movements between habitat patches were concentrated in gaps smaller than 200 m and some species traveled up to three times as far to avoid a gap. Physical isolation of a population combined with the deleterious environmental effects of edge may eliminate species in habitat fragments.

Construction of the proposed highway will result in the creation of habitat edge. Habitat edge has both positive and negative implications for birds. Habitat edges often support a large number and variety of bird species. Edges also tend to attract generalist predators such as raccoons, red fox, coyote, dogs, cats, crows, and jays. They may also attract brown-headed cowbirds (*Molothrus ater*) a nest parasite of passerine (perching) birds. The presence of high concentrations of predators and brown-headed cowbirds along habitat edges can result in these areas becoming reproductive sinks in which large numbers of birds attempt to breed but have poor breeding success.

Several activities (*i.e.*, clearing and grubbing) associated with road construction could interact with bird species. During construction, potential effects include habitat loss, noise and related disturbance and the creation of habitat edge. Clearing and grubbing will result in the removal of trees, shrubs, and other ground cover such as herbaceous plants, brush piles and dead falls that provide nesting habitat for various bird species. This will result in the displacement of birds nesting in these areas. The effects of clearing and grubbing are most severe when these activities are conducted during the period when most bird species are breeding (predominantly from mid-April and mid-August). Clearing and grubbing outside of the breeding season will destroy suitable habitat; however, birds have the option of establishing nests in adjacent areas. NSTIR plans to conduct clearing during the winter which should avoid many adverse effects on nesting birds. The width of RoW cleared will be as narrow as practical to reduce the amount of lost habitat.

Operation and Maintenance

Noise and several forms of pollution (light, sound, air) are capable of adversely affecting the quality of the surrounding habitat due to sensory disturbance. In particular, traffic could disturb birds and mammals nesting or foraging in habitats near the new road. The presence of traffic would enhance the efficacy of the road as a barrier to wildlife movement, thereby intensifying the effect of habitat fragmentation caused by construction of the road.

Populations isolated from other populations in small habitat fragments are more prone to local extirpation since these fragments may be too small to support a population. Fragments may be large enough to support a population but may not be large enough to provide enough animals to rebuild the population should it be heavily impacted by disease or predators. Isolation of the fragment can also impair the immigration of new animals into an area where a local population has been extirpated. Impaired immigration can also adversely affect populations by restricting gene flow between populations leading to inbreeding.

A bridge structure crossing will be constructed for the existing recreational trail (Section 2.2.5, Figure 1.1 and Figure 5.6, Map 3 of 3). This may help mitigate habitat fragmentation effects.

During operation, birds could be disturbed by traffic. Several studies have shown that disturbance associated with automobile traffic can have an adverse effect on bird abundance and breeding success. A study of terrestrial bird abundance, species composition and breeding success in forested habitats adjacent to a busy highway in New Brunswick (JWEL 1998) revealed a reduction in bird abundance of 18 to 25% in plots located 100 and 200 m away from the road relative to control plots 500 m from the road. Evidence of breeding activity was reduced by 34 to 39% relative to control plots. These reductions were not statistically significant. A similar study conducted in the Netherlands revealed a reduction in the number of singing males from 3.3/ha in control plots to 2.1/ha in areas within 200 m of a highway (Reijnen and Foppen 1994). These data indicate that disturbance associated with operation of the road will have a measurable adverse effect on local populations but is not expected to significantly adversely affect regional populations. Reijnen and Foppen (1994) noted that the degree of disturbance to birds by highway traffic was best correlated with noise levels. As such, the best means of mitigating the adverse effects of traffic on birds is to reduce noise levels. There is no practical or effective way in which to do this over a stretch of highway this long, although the new corridor will reduce traffic on other roads (e.g., the existing Highway 101 and Marshalltown Road). Noise barriers would be prohibitively expensive and a reduction in speed limits within practical limits would have only a minor effect on noise levels. By way of example, reduction of the speed limit from 80 km/h to 70 km/h would only reduce noise levels by an average of 2 dB at a distance of 100 m from the highway.

Periodic infrastructure maintenance on bridges or culverts has the potential to disrupt birds and mammals, especially during the breeding season and lower the habitat quality by the addition of noise, disturbance and possible vibrations of the equipment being used to carry out the maintenance.

5.6.5.2 Change in Risk of Mortality or Physical Injury

Construction

Construction activities such as clearing, grubbing, and blasting (if required) have potential to cause direct mortality or injury to birds and other wildlife within the PDA. For small mammals, such

as shrews, habitat loss is likely to result in direct mortality of individuals since they stay in close proximity to cover. Larger mammals are less likely to suffer direct mortality since they will tend to flee the area as soon as they detect humans. The Project-related increase in edge area also has potential to cause a change in risk of mortality or physical injury due to increased predation on birds and small mammals. Some wildlife within the PDA will be permanently displaced, potentially causing direct mortality of those wildlife species that are unable to relocate to suitable habitat.

Operation and Maintenance

The presence of traffic during operation of the highway poses a risk of mortality or physical injury for wildlife species that are not fast enough to cross the road and successfully avoid traffic. Road construction will result in increased access to the site, which can cause increased predation and hunting pressure.

Mechanical clearing of vegetation within the RoW during highway operation has potential to destroy the nests of breeding birds and cause mortality or injury to nestlings. Vegetation management will be conducted by mechanical clearing during highway operation (*e.g.*, road shoulders). It is possible, despite the disturbance from passing vehicles, that the open habitats in medians, ditches, and/or side slopes may be used as breeding habitat by species such as savannah sparrows (*Passerculus sandwichensis*) and song sparrows (*Melospiza melodia*). Mowing and brush cutting of the vegetated slopes and drainage ditches could destroy the nests of these birds, causing mortality or injury to nestlings. The maintenance branch of NSTIR mows the grassy edges and medians of the Province's highways, as required, usually once per year, for safety and partially for aesthetic reasons. Vegetation cutting will occur within the RoW in areas that had already been disturbed as a result of construction activities. Vegetation cutting (mowing) can result in fewer vehicle/animal interactions when viewing conditions for motorists are maximized.

Some bird species such as cliff swallows (*Petrochelidon pyrrhonota*), barn swallows and eastern phoebes (*Sayornis phoebe*) frequently nest on bridges, and may colonize the bridge arch in the future. Maintenance activities such as sandblasting, painting or structural repairs to the sides or underside of the bridge during the breeding season could result in the destruction of active nests, a violation of the MBCA. This could be prevented by inspecting bridges prior to maintenance work to determine if occupied nests of protected bird species are present. If active nests are present maintenance activities would be delayed until after young have fledged. Other bird species not protected under the MBCA also nest on bridge structures including rock dove (*Columba livia*), European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*). Maintenance work would not necessarily have to be delayed if these species were nesting on the structure.

5.6.6 Mitigation

Mitigation measures to be implemented to reduce potential effects on wildlife and wildlife habitat during construction and operation and maintenance are presented in Table 5.6.3.

Table 5.6.3 Mitigation for Wildlife and Wildlife Habitat

Effect	Phase	Mitigation
Change in Habitat Quantity, Quality or Use	Construction	• Follow Generic EPP (NSTPW 2007) • Reduce the extent of vegetation clearing for RoW preparation to only the amount required for Project construction • Clear RoW outside of breeding bird season (April 15 – August 15). Where this is not feasible, develop a Bird Nest Mitigation Plan (prior to construction) in consultation with ECCC and provincial regulators • Compensate for loss of wetland area and function following provincial requirements • Limit Project-related off road activity • Employee environmental awareness training • Use designated roadways and access to reduce unnecessary ground disturbance • Consideration of culvert design if necessary and feasible
	Operation and Maintenance	• Follow Generic EPP (NSTPW 2007) • Use existing access for maintenance activities • Conduct vegetation maintenance outside of breeding season (April 15 to August 15) where feasible • Keep activities within disturbed RoW where feasible • Employee environmental awareness training • Deactivate temporary roads to reduce access • Adhere to the NSTIR Salt Management Plan
Change in Risk of Mortality or Physical Injury	Construction	• Follow Generic EPP (NSTPW 2007) • Conduct vegetation maintenance outside of breeding bird season (from April 15 to August 15 where possible • Limit Project-related off road activity • Clear only the area required for the Project • Reduce the depth of road cuts where possible • Employee environmental awareness training during construction • Reduce area of disturbance • Use designated roadways and access
	Operation and Maintenance	• Where feasible, do not mow cleared RoW between April 15 and August 15 to avoid destruction of the nests of species which nest on the ground in grasslands • Inspect bridges prior to maintenance work to determine if occupied nests of protected birds are present. If nests are present, avoid maintenance work until chicks have fledged • Adhere to the NSTIR Salt Management Plan

5.6.7 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on wildlife and wildlife habitat after the general mitigation measures, as provided above, have been implemented.

5.6.7.1 Change in Habitat Quantity, Quality or Use

Construction

Construction will result in the permanent loss of habitat for some wildlife species, and the creation of edge habitat along the PDA. Clearing of mature forest for highway construction resembles clear-cutting of forest in which the existing forest becomes unavailable or reduced in the immediate area. A total of 12 ha of multi-aged or late mature will be altered because of the Project. Approximately 7 ha of this is interior forest, which will be lost. Overall, the PDA accounts for 29% of the Assessment Area. Many types of land cover will be lost in approximately this same proportion as they exist in the Assessment Area, which indicates that they are evenly distributed in the PDA as in the Assessment Area (Table 5.6.4). One exception is the barrens, category, which will decrease by 66% after road construction. However, it is important to note that in the Assessment Area, the 'barrens' category actually represents areas with low vegetation cover that are generally associated with disturbance; these are not true barrens. Several land classes will have relatively small proportions that are altered. These include young hardwood, multi-aged hardwood, and shallow water wetlands.

Table 5.6.4 Land Classification: Habitat Alteration

	Land Class	PDA		Percent of Habitat in Assessment Area to be Altered
		Area (ha)	Percent (%)	
Forest	Multi-Aged Hardwood	0.100403156	0.24	7.13
	Multi-Aged Mixedwood	4.148954639	10.11	34.13
	Multi-Aged Softwood	4.107251599	10.01	26.43
	Late Mature Hardwood	1.193644081	2.91	39.72
	Late Mature Mixedwood	0.042360215	0.10	15.10
	Late Mature Softwood	2.174110249	5.30	32.65
	Early Mature Hardwood	2.405584513	5.86	30.08
	Early Mature Mixedwood	2.952781243	7.20	32.32
	Early Mature Softwood	0.706350554	1.72	10.56
	Young Hardwood	0.001281582	0.00	3.62
	Young Mixedwood	0.845786492	2.06	37.58
	Young Softwood	1.892484568	4.61	32.55
	Establishment- Softwood	0.290781636	0.71	12.12
	Forest Other	6.583288465	16.05	23.54

Table 5.6.4 Land Classification: Habitat Alteration

	Land Class	PDA		Percent of Habitat in Assessment Area to be Altered
		Area (ha)	Percent (%)	
Wetland	Marsh		0.00	0.00
	Shallow water	0.004884694	0.01	7.90
	Swamp	4.360683747	10.63	38.08
Other	Urban	2.725311906	6.64	19.49
	Agriculture	1.223755347	2.98	18.27
	Barren	1.402457196	3.42	65.63
	Highway	3.857964829	9.41	51.48
Grand Total		**41.02**	100.00	**-**

Forest interior birds are particularly sensitive to habitat disturbance since they are affected both by direct habitat loss and through edge influences. One large patch of interior forest habitat is present that overlaps the Assessment Area in several locations. The Assessment Area is at the southern end of this patch of interior forest, and it continues north to cover a total of 201 ha. Connectivity is therefore provided between the various portions of interior forest within the Assessment Area, which allows for wildlife movement. The total area of interior forest habitat within the Assessment Area is 21 ha which represents 15% of its area. The highway construction will increase fragmentation, thereby reducing interior forest habitat. Approximately 7 ha of interior forest is located within the PDA, and will be lost during highway construction. Highway edge effects may be considered to extend approximately 100 m into the forest, which means that more interior forest will be lost than that which is in the direct footprint of the highway. However, because this is a small proportion of the interior forest in the region, and there are no known interior specialist SOCI occupying this area, the loss of interior forest is not expected to have a substantial effect on local wildlife populations. The Assessment Area has already been subjected to habitat fragmentation as a result of forest harvesting activity, agricultural activity, housing developments and linear developments including roads and an abandoned railroad.

Field surveys and a review of existing data sources did not identify any rare mammal SOCI and/or critical habitat in the Assessment Area. Three federally endangered species, the little brown myotis, northern long-eared myotis and eastern pipistrelles may be present in the Assessment Area during the spring, summer and early fall. Habitat for these species is abundant in the region during these seasons. There are no known hibernacula in or near the Assessment Area. Construction of the highway is therefore not expected to adversely affect rare or sensitive mammal SOCI. There will be habitat loss and sensory disturbance associated with noise during Project construction. However, these effects are not likely to substantially affect mammal populations or important mammal habitat. Mitigation measures are limited to reducing vegetation clearing as far as practical during RoW preparation to preserve habitat.

Due to the apparent habituation of birds to existing human activity, the effects of habitat fragmentation and sensory disturbance during Project construction is not likely to have a substantial effect on bird populations.

While road construction may have potential adverse effects on local herpetile populations within the Assessment Area, the species involved are widely distributed across the province and reasonably abundant locally. Beyond care to protect watercourses and wetlands affected by construction from excess sediment inflow, and care to avoid or neutralize the effects of acid drainage from acid generating rock exposures, no special mitigation is required for reptile and amphibian species found to be present, or possibly present in the PDA.

In consideration of the potential environmental effects of Project-related activities during construction, the proposed mitigation, and the significance definition, the residual environmental effects of the construction of the Project on wildlife habitat quantity, quality and use are predicted to be not significant. In particular, Project construction is unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; cause direct conflict with the goals, objectives or activities of recovery strategies of SOCI known to occur; or threaten the long-term sustainability of species within the Annapolis Valley or Valley Slope Ecodistricts.

Operation and Maintenance

Since no rare mammal SOCI were confirmed in the Assessment Area, operation and maintenance activities are not expected to adversely affect habitat quantity, quality or use for rare or sensitive mammal SOCI. Although bats may be present in the spring, summer and fall, there is ample roosting habitat in the surrounding area to which bats can move, and there are no known hibernacula in the vicinity of the Project. No species-specific mitigation has been identified for these particular species.

The presence and operation of the highway will unavoidably lead to further habitat fragmentation. The highway may act as a barrier preventing or limiting the dispersion of local small mammals and herpetiles into suitable habitats, as some species may be reluctant to cross the road. Species most reluctant to cross the road would be those particularly sensitive to anthropogenic activity and small mammals such as shrews, voles and mice.

Maintenance activities such as resurfacing and mowing of the RoW are not expected to have substantial effects on local bird populations. Disturbance associated with repairs to the road surface are not expected to be any more intense than that encountered during the construction or operational phases of the project.

Winter maintenance of the Project after completion may have a potential negative effect through degradation of wildlife habitat quality. Salt or other de-icing agents may affect water/habitat quality for wildlife adjacent to the RoW. Adherence to the NSTIR Salt

Management Plan, which specifies application rates and designates vulnerable areas, will reduce the environmental effects to wildlife habitat.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance, the proposed mitigation, and the significance definition, residual environmental effects of the operation and maintenance of the Project on wildlife habitat quantity, quality and use are predicted to be not significant. In particular, Project operation and maintenance is unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; cause direct conflict with the goals, objectives or activities of recovery strategies of SOCI known to occur; or threaten the long-term sustainability of species within the Annapolis Valley or Valley Slope Ecodistricts.

5.6.7.2 Change in Risk of Mortality or Physical Injury

Construction

There will be a change in risk of mortality or injury for bird and small mammal and herpetile species during Project construction due to potential destruction of nests, dens, and burrows as well as potential interactions with Project equipment and vehicles. The creation of habitat edge during construction has potential to cause increased predation of birds and small mammal and herpetile species, as habitat edges tend to attract generalist predators such as raccoons, red fox, coyote, dogs, cats, crows and jays. However, these effects are not likely to substantially affect wildlife populations.

Clearing and grubbing during the period when birds are breeding (predominantly from April to August for most species) could result in the direct mortality of eggs and unfledged nestlings. The intentional killing of migratory birds or the destruction of their eggs, or young is an offence under the MBCA. However, NSTIR plans to conduct clearing during the winter which should avoid many adverse effects on nesting birds. The width of RoW cleared will be as narrow as practical to reduce potential interactions between Project equipment and birds or other wildlife.

Although NSTIR plans to conduct clearing during the fall/winter, some minimal clearing of watercourse buffer zones (typically 30 m either side of the watercourse; approximately 5% of the total) may take place during the April to August timeframe. Due to construction timing restrictions as a result of other legislation (*e.g., Fisheries Act*), site preparation activities other than clearing (*e.g.,* grubbing and grading) will take place during the May to September period. This may result in the disturbance of some ground-nesting birds for a period of up to 30 days, which is the time in which grading activities must be completed (within a given work area) as specified by the Work Progression Schedule (Section 3.1 of the Generic EPP; NSTPW 2007). These disturbances will be reduced by adhering to the Bird Nest Mitigation Plan.

In consideration of the potential environmental effects of Project-related activities during construction, the proposed mitigation, and the significance definition, residual environmental

effects of the construction of the Project on the risk of mortality or physical injury to wildlife are predicted to be not significant. In particular, Project construction is unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; cause direct conflict with the goals, objectives or activities of recovery strategies of SOCI known to occur; or threaten the long-term sustainability of species within the Annapolis Valley or Valley Slope Ecodistricts.

Operation and Maintenance

Operation of the Project could result in an increased risk of mortality or physical injury for wildlife due to the potential for collisions with vehicles, as well as the potential for wildlife to be harmed during vegetation and winter maintenance activities.

Roadkill is generally not considered as a significant source of mortality for bird populations (Leedy and Adams 1982). This is supported by a study which demonstrated that the survival rates of male willow warblers (*Phylloscopus trochilus*) was equal in areas near and far from highways (Reijnen and Foppen 1994). Mammals are more susceptible to collisions with automobiles because they are less able to avoid traffic and are generally active at night. A study of road kill in Nova Scotia collected data on mammal road kills on various highway classes in Nova Scotia. The number of deer expected to be killed by collisions on a four lane 100 series highway was 0.14 kills/km/year. For small mammals, including raccoon, porcupine and skunk, the rate is 6 kills/km/year (Fudge *et al*. 2007). The section of the new highway corridor (which will be constructed initially as a two-lane highway) for this Project is 4 km. As such, less than one deer (0.6 kills/km/year, or one kill every 2 years) is expected to be killed, on average, along the proposed highway. The number of small mammals expected to be killed is 24. The species which can be expected to account for approximately most of the road kills are raccoon and striped skunk.

Vegetation management will be conducted by mechanical clearing during highway operation (*e.g.*, road shoulders). It is possible, despite the disturbance from passing vehicles, that the open habitats in medians, ditches, and/or side slopes may be used as breeding habitat by species such as savannah sparrows and song sparrows. Mowing and brush cutting of the vegetated slopes and drainage ditches could destroy the nests of these birds, causing mortality or injury to nestlings. The maintenance branch of NSTIR mows the grassy edges and medians of the Province's highways, as required, usually once per year, for safety and partially for aesthetic reasons. Vegetation cutting will occur within the highway RoW in areas that had already been disturbed as a result of construction activities. Vegetation cutting (mowing) can result in fewer vehicle/animal interactions when viewing conditions for motorists are maximized.

Given the mitigation to avoid maintenance activities such as mowing of the RoW during breeding season, these activities are not expected to have substantial effects on local bird populations.

During winter maintenance, consumption of de-icing brine by birds can cause narcosis that can result in increased rates of collision with automobiles. Adherence to the NSTIR Salt Management Plan, which specifies application rates and designates vulnerable areas, will reduce the environmental effects to wildlife habitat.

In consideration of the potential environmental effects of Project-related activities during operation and maintenance, the proposed mitigation, and the significance definition, residual environmental effects of the operation and maintenance of the Project on the risk of mortality or physical injury to wildlife are predicted to be not significant. In particular, Project operation and maintenance is unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; cause direct conflict with the goals, objectives or activities of recovery strategies of SOCI known to occur; or threaten the long-term sustainability of species within the Annapolis Valley or Valley Slope Ecodistricts.

5.6.8 Monitoring and Follow-up

No follow-up or monitoring is recommended.

5.7 LAND USE

Land use was selected as a VC in consideration of potential Project-related interactions with current and anticipated land uses near the proposed Project. The potential environmental effects of the Project are assessed for the immediate vicinity of the proposed Project and the surrounding areas, including Conway, Digby and Marshalltown.

The discussion of land use will also consider current use of lands and resources by Aboriginal persons, including lands and resources of specific social, cultural or spiritual value to the Mi'kmaq of Nova Scotia, with a focus on current use of land and resources (including terrestrial and freshwater resources) for traditional purposes.

The land use VC has linkages to the following other VCs: Archaeological and Heritage Resources (Section 5.8), Aquatic Environment (Section 5.3), Vegetation (Section 5.4), Wetlands (Section 5.5), and Wildlife and Wildlife Habitat (Section 5.6).

5.7.1 Regulatory and Policy Setting

In Nova Scotia, communities are enabled to create legally binding Municipal Planning Strategies (MPS) in compliance with the Province of Nova Scotia's *Municipal Government Act*. Among other things, MPSs outlines the overarching growth and development strategy for the area, presents the environmental constraints for potential development at various locations, and determines the permitted land uses of the area via zoning determinations. The Municipality of the District of Digby has developed a MPS and Land Use Bylaw for the Conway Area (2014). The community of Conway lies between Highway 101 and the Town of Digby with a southerly

extension south of Highway 101. The majority of the Assessment Area however, is outside the MPS and Land Use Bylaw scope and has no applicable bylaws or land use designations. The MPS recognizes the planned future extension of Highway 101 and a probable need to revisit the MPS and Land Use Bylaw as current traffic patterns are altered.

There are two key Mi'kmaq guidelines which have influenced the EA process for this Project: Proponent's Guide: *The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (NSOAA 2011); and the Mi'kmaq Ecological Knowledge Study Protocol (Assembly of Nova Scotia Mi'kmaq Chiefs 2014). A Project-specific MEKS was completed in 2016 by MMDI, a division of CMM, and supersedes the previous 2005 report. The purpose of the MEKS is to identify Mi'kmaq traditional use activities that have taken place or currently are taking place near the Project. The MEKS predominantly involves archival research and interviews on current Mi'kmaq land and resource occurring within "living memory" and addresses current Mi'kmaq land and resource use sites and plants of significance to Mi'kmaq communities. The MEKS is summarized in Section 5.7.4 and the full MEKS is provided in Appendix D.

5.7.2 Boundaries

The assessment of potential environmental effects on land use encompasses the following spatial boundaries: the PDA and the Assessment Area (Figure 5.6). The PDA (*i.e.*, footprint of physical disturbance) is defined in Section 4.2.1 and shown on Figure 1.1. The Assessment Area for land use includes the PDA and adjacent communities (*e.g.*, Conway, Digby, Marshalltown), where Project activities could potentially interact with current and anticipated land uses.

The temporal boundaries for the assessment of the potential Project-related environmental effects on land use include construction and operation and maintenance of the Project in perpetuity. Certain aspects of land use and community life (*i.e.*, recreational activities and economic activity related to tourism) are seasonal and will be affected to a greater or lesser extent according to the timing of the Project interaction.

5.7.3 Significance Definition

A **significant residual adverse environmental effect on land use** will occur if proposed activities are not compatible with adjacent land or resource use activities as designated through the municipal land use planning process, and/or the proposed use of the land will create a change or disruption that widely restricts or degrades the present land or resource use to a point where activities cannot continue at current levels and for which this change is not mitigated.

A **significant adverse residual environmental effect on current use of land and resources for traditional purposes by Aboriginal persons** is defined as a Project-related environmental effect that results in a long-term, unaccommodated loss of the availability or access to land and resources that are currently used by the Mi'kmaq for traditional purposes, such that these lands and resources cannot continue to be used by the Mi'kmaq at current levels for extended periods of time.

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Beaver Lane
Middle Cross Rd
Seely Brook
North Poor Farm Cemetary
South Poor Farm Cemetary
Highway 101
Marshalltown Rd
Mauld Lewis Lane
Marshalltown
N

Proposed Project
- New Lane
- Access Road
- Future Twinning
- Project Development Area

Study Features
- Cemetary Location (as per Davis 2016b)
- Building/Residence
- Church
- Community Centre

Land Classification
- Agriculture
- Forested
- Wetland/Wet area
- Barren
- Gravel Pit
- Industrial
- Transportation Corridor
- Rural Residential/Commercial

Map Features
- Trans Canada Highway
- Highway
- Major Road
- Local Road
- Seasonal Road
- Track/Trail
- Watercourse
- Waterbody

0 75 150 225 300
Meters

ST NS 121414143-011 REVA
NAD 1983 CSRS UTM Zone 20N

Sources: Topographic and environmental data provided by the Government of Nova Scotia.

Service Layer Credits:

Disclaimer: This map is for illustrative purposes to support ths Stantec project; questions can be directed to the issuing agency.

Land Use within the Project Area

Stantec

HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 5.6
Map 1 of 3

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Sources: Topographic and environmental data provided by the Government of Nova Scotia.

Service Layer Credits:

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Land Use within the Project Area

Stantec

HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 5.6
Map 2 of 3

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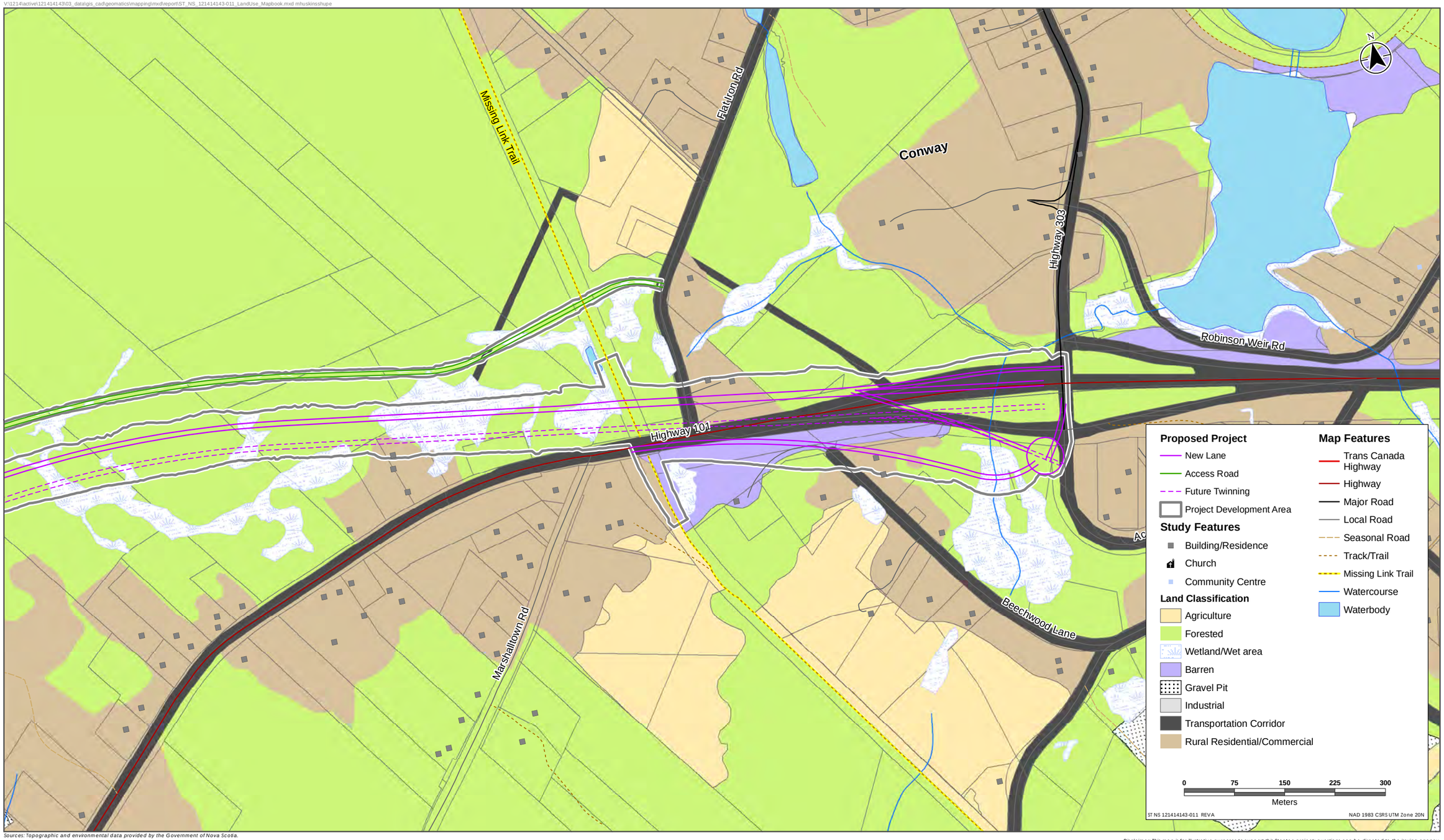

Sources: Topographic and environmental data provided by the Government of Nova Scotia.

Service Layer Credits:

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Land Use within the Project Area

Stantec

HIGHWAY 101 DIGBY TO MARSHALLTOWN ENVIRONMENTAL ASSESSMENT

Figure 5.6
Map 3 of 3

5.7.4 Description of Existing Conditions

5.7.4.1 Methods

A combination of spatial analysis and baseline research was used to characterize the types and extent of the land uses and resource use activity within the Assessment Area. Baseline research included a review of online sources, including:

- GIS databases;
- municipal websites;
- publicly available reports and information collected from the websites of government agencies and other sources; and
- incidental observations of land use by Stantec field crews during surveys completed for the proposed Project.

5.7.4.2 Summary of Existing Conditions

The Project is in the Municipality of the District of Digby, extending approximately 4 km, from Exit 26 in Digby to Middle Cross Road in Marshalltown. The proposed Project is located approximately 3 km south of the Town of Digby as well as nearby the communities of Conway and Marshalltown.

The existing Highway 101 between Digby and Marshalltown is intermittently developed, with a mixture of residences, tourist-related businesses, and commercial establishments catering primarily to local or regional clientele. As of January 2017, approximately 30% of land within RoW has been acquired by NSTIR. The remaining land required for the Project RoW is currently being expropriated by NSTIR. Nine buildings located within the PDA are being purchased by NSTIR and will be removed prior to construction.

Residential, Industrial and Commercial Use

The Conway area is in the Municipality of the District of Digby between Highway 101 and the Town of Digby, with a southerly extension south of Highway 101. The community has experienced considerable commercial development, almost exclusively focused on Highway 303, the main link between the Highway 101 and the Town of Digby. The area has changed from predominantly residential with some highway commercial to predominantly commercial with a decreasing residential component (Municipality of the District of Digby 2003). As noted in the Conway Area Municipal Planning Strategy (2003), there is relatively little large-scale acreage with Highway 303 frontage left undeveloped or uncommitted, and residential uses are being slowly eliminated. In the Conway area, residential uses are predominately located on the southern portion of Highway 101.

Residents are located mainly along Highway 101, and in the communities of Conway and Marshalltown and small mobile home park off Highway 101, near the proposed highway RoW.

Commercial development along the existing highway includes home-based services consisting primarily of small contractors, which are distributed throughout the area and represent an important component of the rural economy. Commercial land use in the area is mainly characterized by small businesses serving a local market, such as: Guy's Frenchy's, Acadian Wipers, barber shop, system care cleaning and restoration, Tri-county Truck and Marine Ltd., T&C Motors Kwik Way. Fundy Auto Salvage Ltd. is also located along Highway 101.

Along Exit 26 and Highway 303 there are several commercial businesses, including Irving gas station, Ultramar gas station, Superstore grocery, WalMart, Tim Hortons, Wine Kitz, and McDonald's.

There are nine structures/buildings located within or partially within the PDA and approximately 30 structures/buildings within the Assessment Area. Buildings are primarily residential dwellings and accessory structures such as garages or sheds. There are also a few commercial buildings, including a Kwik Way and Frenchy's located within the Assessment Area.

Recreational Use

Woods roads and trails are informal recreational areas within the Assessment Area used for hiking, cross-country skiing, snowmobiling, and ATV use. An abandoned railroad owned previously by Dominion Atlantic Railway runs through the Assessment Area, southeast of the proposed highway, and is part of the Annapolis Valley Trail System that runs 200 km from Kentville to Norwood and on to the Town of Yarmouth (Tourism Nova Scotia n.d.). The section that runs through the PDA is approximately 1 km west of Exit 26 is called the Missing Link Trail, is a multi-use trail that runs 27 km from 262 Jordantown Road to Weymouth (Tourism Nova Scotia n.d.) (Figure 1.1 and Figure 5.6, Map 3 of 3). The Assessment Area is located within Zone Three of the Snowmobilers Association of Nova Scotia (SANS) trail system; however, the trails appear to extend beyond Bridgetown (SANS n.d.).

Along the current Highway 101, about 3 minutes past Exit 26 (north of Maud Lewis Lane), there is a Maud Lewis Replica House as she lived most her life in Marshalltown (Valley Family Fun website n.d.). At the site there is a replica of her house, gardens and several information panels telling Maud Lewis' story.

Resource Use

Forestry remains the main resource industry within the Assessment Area. There are 35.5 ha of forested lands within the PDA and 101.3 ha within the Assessment Area. Much of the forested lands are identified as resource forest meaning a forest property totaling less that fifty thousand acres. There is one property identified as commercial forest (*i.e.*, greater than fifty thousand acres) owned by J.D. Irving Limited (Government of Nova Scotia 2016).

Agricultural activity in the Assessment Area consists of pastures and fur farms. Digby County is home to several farm production activities, reporting a total of $63.1 million farm receipts in 2010,

accounting for 10.6% of all farm receipts reported in Nova Scotia (Nova Scotia Federation of Agriculture n.d.). In 2011, there were a total of 150 farms with other animal production (such as mink farms) being the most common type of farm at 66.7% of the total farms (Nova Scotia Federation of Agriculture n.d.). There is 2.6 ha of agricultural lands within the PDA and 6.7 ha within the Assessment Area.

Current Use of Lands for Traditional Purposes Aboriginal Persons

The Bear River Reserve, belonging to the Bear River First Nation, is the closest Mi'kmaq community to the PDA and is 633.8 ha. A MEKS was undertaken in 2016 by MMDI, and is included as Appendix D and supersedes the previous Mi'kmaq Knowledge Study (MKS) conducted by CMM in 2005. The study included the historic (occurred before living memory) and current (occurred within living memory or is occurring at the present day) Mi'kmaq land and resource use. As reported in the MEKS, Mi'kmaq settlers could be found throughout Digby County, and Bear River acted as a kind of capital village for bands in southwestern Nova Scotia (McDonald 2016 in MMDI 2016). The St. Marys Bay area provided marine resources attractive to the Mi'kmaq. The small valley located between the head of St. Marys Bay and Digby provided an overland route sheltered from the effects of the wind and tide and is thought to have offered a safe passage route from inland Mi'kmaq communities to the marine resources. The Mi'kmaq in the area made use of both coastal and interior resources depending on their seasonal activities of hunting, fishing or gathering. On land, the moose was extremely important to the Mi'kmaq, as were caribou, white-tailed deer, black bear, wolf, raccoon, red fox, lynx, bobcat, fisher, marten, otter, skunk, porcupine, hare, beaver, and muskrat. Gathering played an integral role in traditional Mi'kmaq activities. MMDI (2016) also identified plants species of significance. These plants are typically used for medicinal, food/beverage, or craft/art purposes.

At present, *L'sitkuk* (Bear River) First Nation has a registered population of 336 people, with 110 living on reserve, and 226 living off reserve (as of Oct. 2016, INAC 2016). Mi'kmaq continue to use the land for hunting and gathering. The primary hunted species include smelt, rabbit and trout. Gathering activities occur for quills and specialty wood. A variety of plants of significance are present in the study area, which are used for medicinal, food/beverage and/or craft/art purposes (MMDI 2016).

5.7.5 Potential Environmental Effects and Project-Related Interactions

Activities and components could potentially interact with land use by disrupting existing uses. The assessment of Project-related environmental effects on land use is therefore focused on the following potential environmental effect:

- change in land use.

5.7.5.1 Change in Land use

Construction

Residential, Industrial and Commercial Use

During construction activities, potential Project-related effects on residential land use include loss of property within the PDA as well as potential loss of enjoyment of properties (as a result of noise, dust, and other air emissions) and a change to, or loss of, access to property. There are nine residential/commercial buildings located within the PDA which will be purchased by NSTIR and removed prior to construction, and 30 residential/commercial buildings within the Assessment Area which may be affected by construction activities.

Residential, commercial, and industrial use in the Conway area and surrounding areas may experience some traffic disruptions along the existing highway at various points along the PDA as a result of construction activities.

Recreational Use

During construction, the potential effects of the Project on recreational land use include noise, dust, and air emissions. Access to the immediate area of construction will be limited for safety reasons, which may cause disruption to normal recreation land use (*e.g.*, ATV use) as regular points of access thoroughfare may be inaccessible for periods of time.

Resource Use

Construction activities will result in the permanent loss of merchantable forest resource as a result of the clearance of the PDA. There is 35.5 ha of forested lands within the PDA that will be cleared during construction activity. This will result in permanent loss of potential merchantable resource.

The potential Project-related environmental effects of construction on agricultural activities include the loss of small portions of property intersected by the PDA and the loss of agricultural resources. Access to portions of agricultural lands adjacent to the Project footprint may be interrupted or changed for safety reasons during construction. There is 2.6 ha of agricultural land within the PDA.

Traditional Land Use

The construction of the proposed Project has the potential to remove areas historically or currently used by the Mi'kmaq for traditional purposes such as hunting, fishing or gathering. The MEKS identified plants species of significance (MMDI 2016). These plants are typically used for medicinal, food/beverage, or craft/art purposes.

Operation and Maintenance

There are several residential, commercial and industrial properties located along the existing Highway 101. During the operation of the Project, these properties may experience noise and air emissions that result from the operation and maintenance of the Project.

There is potential that existing commercial or industrial businesses located along Highway 101 may rely on "drop-in" clientele from travelers using Highway 101. Businesses, such as the convenience store, may see a decrease in sales with the operation of the proposed new Highway 101 corridor.

It is not expected that any recreational use will have to be permanently relocated during operation of the Project.

5.7.6 Mitigation

Mitigation measures to be implemented to reduce potential effects on land use during construction and operation are presented in Table 5.7.1.

Table 5.7.1 Mitigation for Land Use

Effect	Phase	Mitigation
Change in Land Use	Construction	• Temporary detours provided if necessary • Follow Generic EPP (NSTPW 2007) that includes guidelines for reducing noise and air emissions • Reduce dust through the application of water • Fair market value compensation for properties and buildings • Maintain access to lands where possible. • A bridge structure with a 4 m wide travel lane will be constructed for the existing recreational trail west of Exit 26 to accommodate safe movement of ATVs across the highway • Standard traffic control procedures • Reasonable accommodation to allow forestry / agricultural operations access to adjacent lands during construction (e.g., to harvest woodlots required to be cleared) • Communication throughout the construction phase of the Project to landowners, Mi'kmaq, and interested stakeholders regarding construction activities and progress • As noted in the MEKS, should M'kmaq archaeological deposits be encountered during construction activities, the procedures described in an Archaeological Contingency Plan will be implemented, including the cessation of construction activities in the area of the discovery and contacting NSCCH and the KMKNO

Table 5.7.1 Mitigation for Land Use

Effect	Phase	Mitigation
	Operation and Maintenance	• Follow Generic EPP (NSTPW 2007) that includes guidelines for reducing noise and air emissions • Maintain noise control devices

5.7.7 Residual Environmental Effects and Significance Determination

The assessment of residual environmental effects considers residual effects on land use after the general mitigation measures, as provided above, have been implemented.

5.7.7.1 Change in Land Use

Construction

Construction activities will affect the land use within the Assessment Area. Some of these environmental effects will continue in perpetuity (*e.g.*, property acquisition access and change in land use to transportation infrastructure); however, the effect is realized in the construction phase of the assessment through provision of access and compensation for properties not yet owned by NSTIR.

Residential, Industrial and Commercial Use

As of January 2017, approximately 30% of land within RoW has been acquired by NSTIR. The remaining land required for the Project RoW is currently being expropriated by NSTIR. There are approximately 30 buildings within the Assessment Area. There are nine buildings located within the PDA which will be purchased by NSTIR and removed prior to construction. Buildings are primarily residential dwellings and accessory structures such as garages or sheds. Any required municipal or provincial permits associated with building removal will be obtained by the contractor performing the demolition. Waste from any such removals will be managed in accordance with the provincial Solid Waste-Resource Management Regulations. Project-related environmental effects on the remaining adjacent residential land uses include the loss of enjoyment of their property from dust and noise during construction activities. Effects from Project construction are most likely to affect residential properties along Marshalltown Road and Flat Iron Road. To reduce the effects of construction activities on residences, noise and dust control measures will be adhered to during construction, and efficient scheduling will lead to the timely completion of the Project. As discussed in Section 5.1, air emissions will include dust and exhaust emissions during construction. Control measures, such as the use of dust suppression techniques, will be used in construction zones to reduce dust. Air emissions will be maintained within the limits specified by the Nova Scotia *Air Quality Regulations* (*Environment Act*). Noise emissions will not exceed provincial guidelines at the closest residences (Section 5.1), and are not expected to result in nuisance effects.

Residential, commercial, and industrial land use in the Conway area and surrounding areas may be potentially affected by some traffic disruptions along the existing highway at various points along the PDA as a result of construction activities. Disruptions in traffic flow may include change in access, delays and increased wait times. Standard traffic control procedures will be implemented to reduce traffic interruptions and maintain traffic continuity. Appropriate traffic management and realignment of access roads where necessary will be imperative in maintaining access for residential, commercial, and industrial purposes.

NSTIR or its contractors will provide information throughout the construction phase of the Project to all potentially affected landowners and interested stakeholders to keep them informed of construction activities and progress.

Recreational Use

Construction activities have the potential to interact with recreational land use. Undeveloped areas presently accessible by informal trails or woods roads will be bisected by the proposed Project. The limited access design will create obstacles for vehicular traffic in reaching those areas. Limited access to previously accessible areas may create difficulties for recreational opportunities (*i.e.*, hiking).

Effects to recreational use access are anticipated to occur only during construction (*i.e.*, temporary restriction to the Missing Link Trail in the PDA) and should cease during operation of the highway following reinstatement of access (*i.e.*, following the construction of the trail bridge structure described in Section 2.2.5) to recreational areas.

Resource Use

The environmental effects on forestry and agricultural land use are related to the removal of and/or access to the lands during construction. This could result in the loss of production for the landowner and loss of lands in general. Woodland property owned or leased within the RoW will be removed permanently as a resource use. Some of these woodlands may be actively or informally managed for forestry resource. Acquisition of forested land within the RoW will preclude future forestry resource use. The roadway may also limit access to current woods roads, thereby affecting harvesting of forestry resources on these lands. Mitigation to compensate for this effect may include outright purchase of land parcels or a land swap with the Province to trade ownership of property within the RoW for alternate parcels of property of equivalent value, which may be used for forestry activities. Fair and reasonable compensation for woodland within the RoW will be provided for any remaining lands required for the Project and not currently owned by NSTIR.

Forestry lands not contained within the RoW will also be affected as access to existing woods roads may be altered during Project construction. To the extent possible, existing access roads will be maintained during Project construction. If an existing access road can no longer be used

to access forested lands for logging activities, purchase of these lands will be negotiated or compensation will be provided by NSTIR.

Traditional Use

Changes in traditional land and resource use may result in direct and indirect disturbance to or loss of resources traditionally harvested on the lands in the Assessment Area. The MEKS identified plants species of significance (MMDI 2016). These plants are typically used for medicinal, food/beverage, or craft/art purposes. It was concluded, however, that the destruction of some specimens within the Assessment Area does not pose a threat to Mi'kmaq use of the species and the permanent loss of some specimens of plant species of significance to Mi'kmaq is considered not likely significant (MMDI 2016). Communication and engagement with the Mi'kmaq will be important prior to and during construction activities. As recommended in the MEKS, in the event Mi'kmaq archaeological deposit is encountered during construction, the procedures described in an Archaeological Contingency Plan will be implemented, including the cessation of construction activities in the area of the discovery and contacting the NSCCH and the KMKNO (MMDI 2016).

Summary

In consideration of the potential environmental effects of the Project-related activities during construction and the proposed mitigation, residual environmental effects of the construction of the Project on land use including traditional land use are predicted to be not significant.

Operation and Maintenance

A New Build Canada Fund Business Case for Highway 101 Digby to Marshalltown was completed by NSTIR in 2014 (NSTIR 2014). As noted in the report, the proposed Project is predicted to benefit the public and contribute to the long-term growth and prosperity of the area, including reducing congestion along the local road network, effectively managing traffic volume, reducing travel time, improving safety, and extending the life of existing roadways (NSTIR 2014). A controlled-access design is anticipated to reduce the likelihood of vehicle/vehicle and vehicle/pedestrian accidents, as there will be less traffic along the existing Highway 101 than at present, with few pedestrians and no intersections along the new highway. The decreased traffic will contribute to a quieter, safer living environment for residents along this roadway.

The Project may result in loss of enjoyment of residential and recreational land use near the proposed Project. However, based on the predicted noise levels (as described in Section 5.1) and the presence of the existing highway, these are not expected to exceed those of the existing highway. Infrastructure and vegetation maintenance will generate dust, noise, and air emissions similar to those during construction, only considerably less in magnitude, extent, and duration. Dust will be mitigated during operation though the application of water when required, and noise will be mitigated through noise controls on equipment (refer to Section 5.1).

It is difficult to predict the effect of Project operation on commercial and industrial land use. On the one hand, the proposed Project will essentially create a bypass of the commercial areas along the existing highway, which may result in a decrease in activity for those businesses, especially clientele who may simply "drop-in" on their travels. Alternatively, the Project may have a positive effect on commercial land use along the existing highway by decreasing the frequency of inappropriate traffic, thereby increasing the perceived level of driving and walking safety on this uncontrolled access road. Given most the business likely serves the local communities (*i.e.*, barber shop, salvage yard, garage) it is anticipated that the proposed Highway 101 corridor will result in a positive effect due to increased safety and traffic control.

Summary

In consideration of the potential environmental effects of the Project-related activities during operation and maintenance and the proposed mitigation, residual environmental effects of the operation and maintenance of the Project on land use are predicted to be not significant. The proposed Highway 101 corridor is anticipated to have positive effects from the overall improved safety along the existing highway for the local community.

5.7.8 Monitoring and Follow-up

No follow-up or monitoring is recommended for the land use VC (refer to Section 5.1.8 for potential follow-up and monitoring related to air quality and noise effects).

5.8 ARCHAEOLOGICAL AND HERITAGE RESOURCES

Archaeological and Heritage Resources is a VC in recognition of the potential interest of Aboriginal communities, the general public, and provincial and federal regulatory agencies in ensuring the effective management of these resources. For the purposes of this assessment, archaeological and heritage resources are defined as any physical remnants found on top of and/or below the surface of the ground that inform us of past human use of and interaction with the physical environment. These resources may be from the earliest time of human occupation in the study area up to the relatively recent past and include both built and depositional resources.

Heritage resources are generally considered to include historic period sites such as cemeteries, heritage buildings and sites, monuments, and areas of significance to Aboriginal groups. Also considered in this VC are paleontological (fossil) resources.

In October 2016, Davis MacIntyre & Associates Limited (Davis) was contracted by NSTIR to conduct two Archaeological Resource Impact Assessments: Marshalltown Highway 101 Realignment (Davis 2016a under Heritage Research Permit #A2016NS091) and Marshalltown Alms House Cemeteries (Davis 2016a under Heritage Research Permit #A2016NS012).

This VC provides a summary of the two Archaeological Resource Impact Assessments that were completed for this Project. The full reports with detailed assessments and mapping are included in Appendix E (Davis 2016a) and Appendix F (Davis 2016b).

5.8.1 Regulatory and Policy Setting

All archaeological, historical, paleontological, and ecological sites located within the Assessment Area fall under the jurisdiction of the *Special Places Protection Act*, which is administered by NSCCH.

5.8.2 Boundaries

Spatial boundaries for the assessment of archaeological and heritage resources include the areas assessed by Davis (2016a) and Davis (2016b) (Appendices E and F). The assessment of potential Project effects on archaeological and heritage resources is focused principally on those Project activities that cause ground disturbance within the PDA and to reflect potential adjustments to the PDA to avoid or mitigate adverse effects.

The study area for Davis (2016a) and Davis (2016b) extends outside the PDA and includes the western end of the planned construction of the Project allowing for future interchange construction and future extension of the twinned highway to the west of Marshalltown towards Weymouth North (Appendices E and F). Figure 1.1 identifies the PDA that is included within the scope of this EA. Figure 1.2 shows some of the planned future highway construction that is not within the scope of the proposed Project. The study area for Davis (2016a) and Davis (2016b) included the southward extension to predict any future archaeological concerns when the next phase of construction approaches. Future extension of Highway 101 west of Seely Brook and a planned interchange at Marshalltown will be included in the scope of a future EA.

Temporal boundaries for archaeological and heritage resources consider that these resources are relatively permanent features of the environment. Construction activities carried out at any time of year can therefore affect the integrity of any archaeological or heritage site encountered. Ground disturbance associated with construction will be short-term. However, any potential adverse effect on archaeological and heritage resources will be permanent, as no archaeological site can be returned to the ground in its original state once it has been disturbed or destroyed. Temporal boundaries also consider that archaeological and heritage sites may be affected in the long term by an increase in accessibility. The temporal boundaries for the assessment of the potential environmental effects of the Project on archaeological and heritage resources include the construction, and operation and maintenance of the Project in perpetuity.

5.8.3 Significance Definition

A **significant adverse residual environmental effect** on archaeological and heritage resources is defined as one which will disturb or destroy archaeological or heritage resources considered by affected Aboriginal groups, communities, or provincial heritage regulators to be of major

importance due to factors such as rarity, condition, spiritual importance, or research importance, and that cannot be mitigated.

5.8.4 Description of Existing Conditions

5.8.4.1 Methods

A background study was conducted, which involved consulting historical maps, manuscripts, published literature and previous archaeological assessments at the Nova Scotia Archives and online. The Maritime Archaeological Resource Inventory was reviewed in October 2016. This is a database that contains all known archaeological sites in the Maritime provinces. Field reconnaissance and archaeological testing was also undertaken to determine the presence of buried archaeological materials within the PDA. At the sites identified as potential burials, a geophysical (magnetometry) survey was conducted, as well as a ground penetrating radar (GPR) survey for the southern cemetery (Davis 2016b, Appendix F).

5.8.4.2 Summary of Existing Conditions

Two cemetery sites were previously identified in the Marshalltown area through oral history. The cemeteries are associated with a former farm house, known as Digby Poor House or Alms House (referred to as Alms House in this EA), located in Marshalltown and near the western end of the PDA (Figure 5.6 and Figure 2-3 in Appendix F). The Alms House was built in 1891 and remained in operation until 1963. The cemetery that is situated closest to the Alms House's former location (cemetery 1), is more firmly identified through oral history. Geophysical surveys done at the second, more northern potential cemetery (cemetery 2), were strongly suggestive but ultimately inconclusive in identifying grave shafts and burials (Davis 2016b in Appendix F).

The proposed alignment will pass close to the historic Alms House in Marshalltown (Davis 2016b) (shown as Poor House on Figure 2-1 in Appendix F). Since the initial investigation of possible burials in 2003, a revised highway alignment has been proposed that is intended to avoid disturbance of the two cemeteries of the former Alms House property known through oral history (Figure 2-1 in Appendix F). The known and potential area of burials near the Alms House will be within the lands purchased for the highway RoW. However, the sites are located outside the PDA for the highway section addressed by this EA and will not be disturbed by any stage of construction; therefore, mitigation is currently not required. Future highway work for the Marshalltown interchange and Weymouth extension will require a new EA and the area will be re-assessed prior to that time.

During field reconnaissance, five sites that were identified as having archaeological potential were subjected to archaeological testing (Davis 2016a). Approximate test unit locations are shown on Figures 3-12 and 3-13 in Appendix E, Davis 2016a). These sites included a large terrace along the southern bank of the proposed crossing of Seely Brook, two small terraces of

the northern side of Seely Brook, a possible mill site, and a rectangular depression. A series of test units were dug at each of these sites. Results indicated that all sites were negative for archaeological material (Davis 2016a).

A small cellar feature was located on the northwest side of Marshalltown Road, just outside the proposed toe-of-slope (see Appendix E). This feature can be easily avoided during construction (mitigation provided in Section 5.8.6).

No areas of significance to Mi'kmaq communities were identified (also refer to the MEKS summary in Section 5.7 and MEKS report in Appendix D).

5.8.5 Potential Environmental Effects and Project-Related Interactions

Construction activities could interact with archaeological and heritage resources through surficial or subsurface ground disturbance, potentially resulting in disturbance to archaeological and heritage resource sites, if such sites are present. In consideration of these potential interactions, the assessment of Project-related environmental effects on archaeological and heritage resources is therefore focused on the following potential environmental effect:

- change in archaeological and heritage resources.

5.8.5.1 Change in Archaeological and Heritage Resources

Construction

No disturbance of resources is anticipated from highway construction. The known area of burials near the Alms House will be within the lands purchased for the highway RoW, but will not be disturbed. There is a concern that Project-related movement of construction equipment and placement of laydown areas could affect nearby resources, including burials, if not carefully considered during Project planning.

Operation

There are no predicted interactions between the Project archaeological and heritage resources during the operation and maintenance phase of the Project.

5.8.6 Mitigation

Mitigation measures to be implemented to reduce potential effects on archaeological and heritage resources during construction are presented in Table 5.8.1.

Based on the assessment, the NSCCH recommended that further mitigation of either cemetery will not be required if both cemeteries are outside the proposed toe of slope and outside the range of any laydown areas for the Project. The known cemeteries are outside of the PDA for this

Project; however, the location of the cemeteries and related mitigation measures (including monitoring) and restrictions will be incorporated in the Archaeological Contingency Plan. If ground disturbing activity is planned near either cemetery area, an archaeologist will monitor construction and will remain on call should suspected human remains he encountered. Finally, if burials or other archaeological resources are encountered in the future, and an archaeologist is not already present, all activity will cease and the Coordinator of Special Places (902-424-6475) will be contacted immediately. Because findings in this region indicate historic activity, should the highway be realigned again, a reassessment is recommended to determine if more significant features are present (NSCCH 2017, Appendix F).

Table 5.8.1 Mitigation for Archaeological and Heritage Resources

Effect	Phase	Mitigation
Change in Archaeological and Heritage Resources	Construction	• An Archaeological Contingency Plan will be prepared. • Highway alignment has been revised to avoid burials. • Follow NSCCH recommendations (see Appendix E). • If ground disturbing activity is planned near either cemetery area, an archaeologist will monitor construction and will remain on call should suspected human remains be encountered. • A small cellar feature was located on the northwest side of Marshalltown Road. It is recommended that a 10 m buffer be flagged around the exposed stone of the cellar area so that this feature can be avoided during construction. • If archaeological resources are encountered in the future and an archaeologist is not already present, it is required that any ground-disturbing activity be halted immediately and the Coordinator of Special Places (902-424-6475) be contacted regarding a suitable method of mitigation. • Findings in this region indicate historic activity. Should the highway be realigned again, a reassessment is recommended to determine if more significant features are present.

5.8.7 Residual Environmental Effects and Significance Determination

5.8.7.1 Change in Archaeological and Heritage Resources

Construction

Two Archaeological Resource Impact Assessments were conducted for the proposed highway development to identify the risk for disturbance of archaeological or heritage resources. There special concern that the nearby burials associated with the Alms House identified through oral history could be disturbed. Earlier Project planning had realigned the highway resulting in avoidance of the known burial areas. Additional mitigation was recommended by NSCC to reduce the potential for disturbance of the burial and other identified resources. An Archaeological Contingency Plan will be developed and implemented during construction and will address contingency planning for any previously unknown resources discovered during ground disturbance. These mitigation measures will be included in a Project Archaeological Contingency Plan.

In summary, adverse residual environmental effects on archaeology and heritage resources during Project construction and operation are predicted to be not significant. No areas of archeological significance were identified within the PDA. The cemeteries associated with the Marshalltown Alms House will be avoided, and thus will not be disturbed by this Project. If recommended mitigation measures are implemented, no adverse environmental effects on archaeological and heritage resources are predicted.

5.8.8 Monitoring and Follow-up

Due to the potential for there to be unknown archaeological resources within the PDA, the following mitigation is required:

- If the construction or development of ancillary elements is planned for areas with potential for archaeological resources that have not been surveyed by a professional archaeologist, then a preconstruction archaeological assessment of these areas will be conducted, the results of which will be reported to NSCCH, prior to development of the ancillary elements.

6.0 OTHER UNDERTAKINGS IN THE AREA

Under Section 12 of the Nova Scotia *Environmental Assessment Regulations*, the Minister must consider other undertakings in the area of a proposed project registered as a Class 1 Undertaking. For this EA, other undertakings that may potentially act in combination with the environmental effects of the Project have been grouped into the following categories:

- existing and planned linear features (including existing Highway 101, secondary roads, and powerlines);
- land use (including existing and anticipated residential, commercial, industrial, and recreational land use); and
- resource use (including past, present, and future forestry use).

Potential environmental effects associated with these other undertakings is described below, as well as a description of the potential for these other undertaking to act in combination with the environmental effects of the proposed Project.

6.1 EXISTING AND PLANNED LINEAR FEATURES

Linear developments include roads, and power transmission near the Project. Existing linear features in the nearby area include the existing Highway 101, other local roads, and a power transmission line. Beside the proposed Project, there are no other road development planned in the nearby area. A major Nova Scotia Power transmission line crosses the corridor near Digby (Figure 1.1).

Linear features have the potential to result in environmental effects, including:

- air and noise emissions from operation of roadways;
- groundwater quality through the use of road salt, particularly downgradient to the existing highway RoW;
- winter maintenance activities and periodic repairs required during operation of existing roadways may increase sedimentation and salinity in nearby vegetated areas and watercourses;
- a reduction of wetland and other natural habitats through removal, and indirectly through changes to wetland quality and function and adjacent habitats; particularly where the existing highway has contributed to the creation of wetland habitat by acting as a hydrological barrier and impounding water long enough to promote aquatic processes; and
- increased fragmentation, potential barrier to wildlife movement and direct mortality of wildlife from collisions between vehicles and animals.

The proposed Project is anticipated to maintain or increase environmental effects that currently exist as a result of linear developments (and are described in Section 5 as baseline conditions for VCs); however, it is anticipated that the contribution of Project-related effects will be reduced through the implementation of mitigation measures identified in this assessment.

Potential Project-related environmental effects on groundwater quality includes changes from the application of, and runoff from, road salt, particularly on the downgradient side of the PDA. Mitigation measures such as the drainage of salt laden runoff away from residences and their wells along ditching will likely reduce this potential environmental effect on any nearby residential wells.

Potential environmental effects of the Project include increased habitat loss and reduction of habitat quality as a result of habitat fragmentation, production of adverse edge effects and disturbance of wildlife. The highway construction will increase fragmentation, thereby reducing interior forest habitat (approximately 7 ha lost). However, because this is a small proportion of the interior forest in the region, and there are no known interior specialist SOCI occupying this area, the loss of interior forest is not expected to have a substantial effect on local wildlife populations (see Section 5.6.7). Therefore, the Project is unlikely to contribute to these effects that may have been caused by other linear developments in the region. It is predicted that Project activities are unlikely to result in a non-permitted contravention of any of the prohibitions stated in sections 32-36 of the federal SARA or the prohibitions stated in section 3 of the NS ESA; or threaten the long-term sustainability of a species within the Annapolis Valley or Valley Slope Ecodistricts.

The clearing and grading of land required for the Project can alter flow regimes to downgradient areas, resulting in infilling of wetlands and the discharge of sediments and other harmful substances to wetlands both during and after construction. These activities may have historically resulted in an overall decrease in wetland habitat in the watersheds of the proposed Project. Mitigation and compensation will be required to offset these effects. Particularly, wetland offsetting will be undertaken so there is no net loss of wetland function. It is anticipated that any future linear developments will also be required to compensate for any loss of wetland function. It is therefore anticipated that no long term additional net loss of wetland function on wetlands is expected from Project construction and operation. The proposed Project is not expected to result in an unauthorized permanent net loss of wetland area or a loss of WSS.

6.2 LAND USE

Land use within the nearby area includes residential, commercial, industrial, and recreational land uses. Residents are located mainly along Highway 101, and in the communities of Conway and Marshalltown and small mobile home park off Highway 101. Commercial development occurs along the existing highway includes home-based services consisting primarily of small contractors, which are distributed throughout the area and represent an important component of the rural economy. There are also several commercial businesses along Exit 26 and Highway 303. There are no proposed residential, commercial, or industrial development in the nearby area. Recreational use includes the use of woods roads and trails for informal recreational uses such as hiking, cross-country skiing, snowmobiling, and ATV use. There is also an abandoned railroad that is now a multi-use trail that runs 27 km from 262 Jordantown Road to Weymouth

(Tourism Nova Scotia n.d.). A bridge structure will be built to accommodate safe movement of ATVs across the highway and will have a 4 m wide travel lane (see Section 2.2.5).

Residential, commercial, industrial, and recreational land uses have potential to result in environmental effects, including:

- air and noise emissions from existing land uses;
- reduced groundwater quality and quantity from residential, commercial, and industrial land uses including chemical use and spills and other discharges;
- reduced effects on fish habitat, and water quality from garbage, nutrient enriched runoff (*i.e.*, fertilizer), chemical use, spills stormwater runoff, and heavier traffic (foot and automobile);
- direct loss of plants and plant habitat as well as adverse habitat alterations associated with changes in local hydrology, pesticide use, eutrophication of wetlands and water bodies, introduction of non-native plants and animals, and contamination of plant habitats;
- effects to wetland quality, through sedimentation, erosion, removal of wetland area from hazardous materials storage and discharges of wastewater which can affect wetland quality and function;
- direct reduction of total wetland through removal, and indirectly through changes to wetland quality and function;
- damage to wetland and other natural habitats from recreational use through rutting, which causes direct damage to wetland vegetation and soils, and indirect damage by changing hydrological patterns and increasing sedimentation; and
- direct loss of habitat and alteration of the quality of remaining habitat as a result of edge effects and habitat fragmentation.

The proposed Project is anticipated to maintain or increase environmental effects to residential, commercial, industrial, and recreational land uses that currently exist (as described in Section 5 as baseline conditions for VCs); however, it is anticipated that the contribution of Project-related effects will be reduced through the implementation of mitigation measures identified in this assessment.

Removal of vegetation from Project construction activities, such as clearing and grubbing, can contribute to additional environmental effects currently realized from other land uses which also resulted in clearing and habitat alteration. The result of these environmental effects may include: changes in species diversity, introduction of invasive species and the loss of SOCI.

Similar to residential, commercial and industrial land uses, the proposed Project may result in a further loss of wildlife habitat quantity and/or reductions in habitat quality due to edge effects, habitat fragmentation, disturbance of wildlife, and contamination of terrestrial and aquatic habitats.

Project mitigation will reduce contribution of effects that may currently exist in the region from existing land uses. Certain effects from land uses will require permits such as effects on watercourses and wetlands. This permitting process will require land users to protect sensitive environmental features and habits. It is expected that the construction and operation of the

proposed highway Project will contribute social and economic benefits in the nearby area (Section 1.2).

6.3 RESOURCE USE

The limited agricultural activity within the nearby areas consist mainly of pastures. Forestry activities are currently occurring in nearby areas, have occurred in the past, and are likely to continue in the future after the Project is constructed and is in operation.

Resource use activity has potential to result in environmental effects, including:

- loss/alteration of adjacent riparian and wetland areas (*e.g.*, from water control structures), increased total suspended sediments, increased water temperature, elevated nutrient levels, decreased dissolved oxygen, sedimentation of benthic habitat and subsequent alteration of stream hydrology;
- Destabilization of terrain (erosion) from forestry activities;
- loss and/or change in terrestrial habitat including a direct effect on SOCI in the area through direct disturbance or by causing indirect changes to their habitat resulting in a loss of individuals or overall abundance;
- indirect changes from sedimentation and eutrophication of wetlands, introduction of exotic weeds, and insects as well as off-site effects of herbicide drift;
- clearing activities associated with resource activity affects wetland quality, through sedimentation, erosion, and changes to local hydrological patterns;
- direct reduction of total wetland through removal, and indirectly through changes to wetland quality and function; and
- direct mortality of wildlife as a result of plowing and mowing associated with agriculture activities as frequent and early mowing is a contributing factor to declines in Bobolink numbers in Nova Scotia, small mammals can also be killed as result of mowing and plowing, and predators such as American Crows and gulls are often attracted to newly mowed and plowed fields where they feed on birds, mammals and herpetiles that have been exposed by mowing or plowing.

The proposed Project is anticipated to maintain or increase environmental effects that currently exist as a result of resource use (and are described in Section 5 as baseline conditions for VCs); however, it is anticipated that the contribution of Project-related effects will be reduced through the implementation of mitigation measures identified in this assessment.

Construction activities for the proposed Project, particularly site preparation activities will result in the change in wildlife and wetland area and function. Clearing and grubbing during site preparation will directly remove wetland vegetation and soils and the construction of roadbeds will require that wildlife and wetland habitats be infilled. Mitigation measures identified in this document will reduce potential adverse environmental effects to Wildlife and Wildlife Habitat (Section 5.6.6) and Wetlands (Section 5.5.6) as well as satisfy the provincial requirement of no net loss of wetland habitat as a result of the Project.

The area has already been subjected to habitat fragmentation as a result of resources use activity. Mitigation measures proposed in this document will help to reduce potential adverse effects on VCs that may be currently affected by habitat fragmentation and sensory disturbance associated with forestry and off-road traffic activities (ATV use) as well as the abandoned railway line (*e.g.*, wetlands, rare herpetiles, rare and sensitive birds, rare mammals and critical habitat, and rare plants and plant communities).

6.4 SUMMARY

Since the proposed Project is not anticipated to result in an immediate increase in traffic, and assuming the effective application of mitigation measures proposed throughout this document, it is not anticipated that residual adverse effects from the proposed Project will substantially contribute to existing adverse effects from other undertakings. It is anticipated that other future undertakings will be required to implement similar mitigation measures and standards, further reducing potential for other undertakings to contribute additional adverse effects. It is expected that the construction and operation of the proposed highway Project will contribute social and economic benefits in the nearby area (see Section 1.2).

7.0 ACCIDENTS AND MALFUNCTIONS

Malfunctions and accidental events associated with the Project have potential to result in environmental effects. Potential malfunctions and accidental events associated with the Project include spills of hazardous materials, failure of erosion and sediment control structures, fires and vehicular collisions.

Precautions and preventative measures will be taken to reduce potential for the occurrence of malfunctions and accidental events that may occur during the life of the Project and to reduce the impacts of any associated environmental effects. It is difficult to predict the precise nature and severity of malfunctions and accidental events. However, the probability of serious accidental events or those causing significant adverse environmental effects is low, particularly when construction and operation procedures incorporate environmental protection and contingency and emergency response plans. Construction, and operation and maintenance procedures will be conducted in accordance with relevant regulations, guidelines and accepted industry practice.

7.1 SPILLS

Spills of petroleum, oils, or lubricants (POLs) may occur during construction during refuelling of machinery, maintenance activities or failure of hydraulic lines. These spills are usually highly localized and readily cleaned up by onsite crews using standard spill remediation equipment. However, even small spills can have very serious effects on migratory birds. In the unlikely event of a large spill, soil, groundwater, and surface water contamination may occur, thereby potentially adversely affecting the quality of groundwater, fish and fish habitat, and wetland habitat, and resulting in the ingestion/uptake of contaminants by wildlife. Depending on the nature of the spill, it could also potentially affect residential, commercial, agricultural, and other land uses.

The Generic EPP, Section 5 (NSTPW 1997 and latest revisions) and Volume 4 of NSTIR's Health, Safety and Environmental Program contains best management procedures to reduce the likelihood of spills and will contain instructions for crew training and orientation in spill prevention and management. POLs and other hazardous materials will be handled in accordance with applicable regulations and with the procedures noted in the Generic EPP and Standard Specifications. Construction equipment will be frequently inspected for possible fuel and hydraulic system leaks; detected leaks will be repaired immediately, where possible. If the repair cannot be completed immediately, drip pans or alternative containment will be put in place to prevent loss of POLs to the environment. Equipment refuelling and maintenance will be conducted at designated sites, away from residential and known cultural or heritage properties, and not within 30 m of a wetland or watercourse or other areas known to be frequented by migratory birds.

A large spill of contaminants (*i.e.*, tanker accidents during highway operation) could result in a significant effect on the terrestrial or aquatic environment. In this unlikely event, local and provincial emergency response procedures will be invoked to reduce impacts. Emergency response and contingency plans are accepted and effective means to limit the severity of accidental effects. These plans and procedures will be implemented through standard NSTIR and Emergency Management Office (EMO) practices and supported through training programs.

Significant adverse effects on any VC due to accidental spills are not likely to occur.

7.2 EROSION AND SEDIMENT CONTROL FAILURE

There is potential for failure of erosion and sediment control structures due to precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving watercourses with adverse effects on fish and fish habitat. Erosion and sediment control measures will be implemented according to NSTIR's Generic EPP and Standard Specifications (1997 and latest revisions), and the Nova Scotia Watercourse Alterations Standards (2015). Control measures will be monitored by an environmental inspector, particularly after a heavy precipitation event or snow melt. Remedial action including pumping, runoff diversion and additional control measures will be taken as necessary. In the event of a failure, Project construction will be shut down until controls are restored. Significant adverse environmental effects are unlikely to occur as a result of erosion and sediment control failure due to the implementation of best management practices.

7.3 FIRES

Project construction activities could result in fires due to activities such as equipment refuelling, brush burning, and careless smoking. Fires may result in habitat loss, sensory disturbance, direct mortality to wildlife, loss or damage of property and loss or damage to archaeological and heritage resources. Fire-fighting chemicals could enter surface water, affecting fish and fish habitat if allowed to disperse and persist.

Specific mitigation includes: proper supervision of brush fires; compliance with conditions of burning permits; regular work inspections; proper design and use of chemical storage areas and provision of fire-fighting equipment. Material management and operational procedures will further reduce the frequency and extent of accidental fires related to the Project. Burning on the RoW will not be permitted and hazardous materials storage areas will bear appropriate flammability warning signs where applicable.

In the unlikely event of a fire, local emergency response and fire-fighting capability will be able to reduce the severity and extent of damage. A fire prevention procedure will be included in the EPP contractor's environmental control plans to reduce the potential for fires along with training and orientation information for work crews. Adverse effects on air quality (*i.e.*, exceeding regulatory limits) could result due to fires, however, these accidents are unlikely to

occur and would be rapidly controlled by first responders. Any such effects on local air quality would be localized and temporary therefore no significant effects on air quality are predicted as a result of fires.

A significant adverse effect on any VC due to fires is considered unlikely.

7.4 VEHICULAR ACCIDENTS

Between 60 percent and 80 percent of the traffic on the existing Highway 101 will likely divert to the new highway. As noted in Section 1.2 and Section 2.3, the new Highway 101 is expected to result in a controlled access highway, with collision rates expected to be lower than those on the existing highway. Removal of through traffic from the existing road will improve the ease and safety of access for local traffic using road and driveway entrances throughout the study area. Since most of the heavy trucks will divert to the new highway, public concerns for safety and noise associated with truck traffic will also be reduced.

Any construction project that affects public highways has the potential for transportation-related malfunctions and collisions. However, the following features of the Project will reduce the potential for the number, severity of vehicular accidents along the new highway:

- There will be a new roundabout with ramp modifications to the existing Exit 26 at Digby, and construction of an at-grade intersection at Middle Cross Road (Marshalltown).
- The horizontal and vertical alignments will be designed and constructed in accordance with current freeway design guidelines.
- The new corridor will be a controlled access highway which will improve traffic flow and safety on the highway.

Malfunctions and vehicular collisions are not predicted to have a significant effect on any VC.

7.5 SUMMARY

In summary, with adherence to best management practices, including adherence to the Generic EPP (NSTPW 2007) and, if necessary, implementation of emergency response and contingency procedures, opportunities for malfunctions or accidental events as a result of this Project are minimized. In the event of occurrence, significant adverse environmental effects are not likely. Significant effects from fires on air quality and large spills on the terrestrial and/or aquatic environment are possible but not likely to occur. Positive effects of bypassing the existing uncontrolled access highway and constructing a controlled access highway include separating high speed through traffic from slower speed local traffic, and improving the overall safety of the highway with collision rates expected to be lower than those on the existing highway.

8.0 SUMMARY AND CONCLUSIONS

8.1 SUMMARY

NSTIR proposes the construction, operation, and maintenance of 4 km of new 100-series highway from Exit 26 in Digby to Middle Cross Road in Marshalltown. The Digby to Marshalltown corridor is the first phase of the Digby to Weymouth North Corridor Project, a multi-phased project with an overall total length of 26 km. The remaining sections of the corridor will be assessed in a subsequent EA(s) when the phases progress through the planning stage of the project. The new highway will be constructed initially as a two-lane, controlled access corridor with a design speed of 110 km/hr and posted speed of 100 km/hr. Construction for the initial two lanes is planned to begin in 2017. Sufficient right of way will be purchased initially so that a four-lane highway can be constructed; however, the schedule for this construction has not been determined. It is anticipated that the highway will be maintained and remain in operation indefinitely.

This EA was completed in accordance with the provincial *Environmental Assessment Regulations* made pursuant to the *Environment Act* as the Project is subject to the requirements associated with a Class I Registration.

The assessment included an evaluation of the potential Project-related environmental effects for construction, operation and maintenance, and accidents and malfunctions for the following VCs:

- atmospheric environment;
- groundwater resources;
- fish and fish habitat;
- vegetation;
- wetlands;
- wildlife and wildlife habitat;
- land use; and
- archaeological and heritage resources.

Potential Project-related effects were assessed within the context of temporal and spatial boundaries established for the assessment. Mitigation, compensation, and monitoring have been proposed to reduce or eliminate potentially adverse effects for each VC (refer to Table 8.1 for summary). The significance of residual environmental effects (*i.e.*, after mitigation has been applied), was also predicted for each VC.

Potential Project-related effects from Project construction include direct and indirect affects to the terrestrial and aquatic environments through loss or alteration of habitat and/or mortality of wildlife species including species of conservation interest. Construction activities may also restrict or change access to lands and resources used by community members and the general public.

In general, potential adverse effects on these VCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods recommended in this document. With respect to the mitigation of effects on fish and fish habitat and wetlands, compensation to offset predicted losses is proposed in accordance with the *Fisheries Act* and Nova Scotia Wetland Conservation Policy, respectively.

A summary of mitigation and monitoring proposed to reduce or eliminate potentially adverse effects for each VC is provided in Table 8.1.1.

Table 8.1.1 Summary of Mitigation, Monitoring and Follow-up

Valued Component	Proposed Mitigation	Proposed Monitoring and Follow-up
Atmospheric Environment	• Follow Generic EPP (Section 3.13) including application of dust suppressants where feasible, follow equipment maintenance schedules, preserving natural vegetation where possible • Reduce activities that generate large quantities of dust during high winds • Follow Generic EPP (Section 3.13; NSTPW 2007) including notification, muffling devices, machines in good working order, minimization of idling, and timing restrictions • Use noise controls where possible (*e.g.*, mufflers) • Environmental awareness session to reduce vehicle idling when possible during construction • Follow equipment maintenance schedules • Retain wooded buffers along new highway to mitigate perceived noise levels • NSTIR will determine noise levels from highway operation where receivers may be affected by increases in noise levels (refer to Section 5.1.7.2).	• Should complaints of excessive noise or airborne dust be received, the root causes of these complaints will be determined by NSTIR, and corrective action will be taken if warranted. Should it be determined to be necessary to identify the source or extent of such problems, ambient monitoring of dust or noise will be conducted, as appropriate.
Groundwater Resources	• Pre-construction well survey • Pre-blast surveys (if required) • Ripping instead of blasting where possible near residential areas • Erosion and sediment control measures to reduce surface runoff • Minimize extent of clearing to only what is required • Remedial action as necessary to restore damaged wells and provide temporary potable water as needed • Follow Generic EPP (including Spill Contingency Plan • Follow Salt Management Plan	• Preconstruction well survey • Preblast surveys (if required)
Fish and Fish Habitat	• Follow Generic EPP for the Construction of 100 Series Highways (NSTPW 2007), NSE Watercourse Alteration Standards (2015), Guide to Altering Watercourse (2015), Guidelines for the design of fish passage for culverts in Nova Scotia (2015), and DFO Guidelines for the Protection of Fish and Fish Habitat: The Placement and Design of Large Culverts (1998) • Erosion and sediment control measures (Section 2.3.1) will be implemented • Follow DFO's blasting guidelines (Wright and Hopky 1998) • A NS Watercourse Alteration Approval will be obtained for all watercourse crossings and; conditions of the Water Approval will be met • A Certified Watercourse Alteration Installer will carry out or directly supervise all watercourse crossings	• Monitoring during construction activities to promote and confirm application of applicable environmental protection and permitting requirements for work in and adjacent to watercourses and successful implementation of remedial actions where necessary. • Post-construction monitoring

Table 8.1.1 Summary of Mitigation, Monitoring and Follow-up

Valued Component	Proposed Mitigation	Proposed Monitoring and Follow-up
	• A fish habitat offsetting plan will be developed and implemented if it is determined that there is serious harm to CRA fisheries • In-stream work and/or disturbance will be minimized, where possible • Stream crossings will be assessed for erosion, with areas of erosion stabilized • No washing, fuelling or maintenance of vehicles or equipment in the vicinity of a watercourse or wetland without secondary containment • No storage of chemicals POLs within 30 m of a watercourse or wetland • Heavy machinery use during clearing will be kept a minimum of 10 m from the watercourse banks • All equipment to be used during construction activities will be free of leaks and coatings of hydrocarbon-based fluids and or lubricants harmful to the environment. Hoses and tanks will be inspected on a regular basis to prevent fractures or breaks • A limited disturbance buffer zone of 30 m from watercourses will be maintained, where possible • The contractor will have a Spill Prevention and Response Plan established before commencing construction • There will be on-site appropriate emergency spill response equipment, specific to the types of spills likely to be encountered during operations. The required equipment will be specified in the Spill Prevention and Response Plan. • Instream construction will be limited to the lower biological risk period between June 1 – September 30, when feasible • Fish passage will be maintained for all species that use the watercourses for life-cycle purposes • Fish rescues will be carried out before in-water work occurs during watercourse crossings • Preferential use of mechanical vegetation control with limited use of herbicides (no pesticides). Herbicides are used only under the guidance of the department's Integrated Roadside Vegetation Maintenance (IRVM) • Follow NSTIR Salt Management Plan	
Vegetation	• Follow Generic EPP (NSTPW 2007) • Employee environmental awareness training during construction • Follow Watercourse and Wetland Alterations permit conditions • Erosion control measures • Proper installation of culverts to prevent flooding or draining of wetlands • Project design to reduce PDA and area to be cleared, where feasible	• Follow-up surveys for plant SOCI will be conducted within portions of the Assessment Area that could not be surveyed during 2016 as a

Table 8.1.1 Summary of Mitigation, Monitoring and Follow-up

Valued Component	Proposed Mitigation	Proposed Monitoring and Follow-up
	• Flagging and avoidance of plant SOCI outside RoW • Develop mitigation plans for unavoidable effects on SOCI in consultation with regulators • Use snow fencing and signage in areas of SOCI to protect plant occurrences near construction activities • Follow NSTIR Integrated Roadside Vegetation Management (IRVM) Manual. Restrict the general application of herbicide near SOCI. Spot spraying, wicking, mowing, or hand-picking are acceptable measures for integrated vegetation management in these areas • Install cross ditches and berms on moderately steep and steep slopes in non-agricultural areas to prevent runoff along the RoW and subsequent erosion • All equipment must arrive at the site clean and free of soil or vegetative debris. Equipment will be inspected by the Environmental Inspector(s), or designate • Limit Project-related off road activity • Apply drainage controls • Follow NSTIR Salt Management Plan • Follow NSTIR IRVM Manual	result of property access restrictions.
Wetlands	• Avoid direct and indirect disturbance to wetlands, where feasible • Implement 30 m non-disturbance buffers for wetlands not scheduled for direct alteration, where possible • Follow Generic EPP and Project Specific Environmental Control Plan • Implement erosion control measures • Limit Project-related off road activity • Clean construction machinery prior to entering wetlands • In areas of high peat depths, use progressive installation to reduce potential for overfilling or over excavation • Use clean, pH neutral, non-leaching coarse fill in wetlands • Follow Watercourse and Wetland Alteration approval conditions • Compensate for loss of wetland area and function following provincial requirements • Employee environmental awareness training during construction • Maintain culverts as required to maintain hydrological conditions • Follow NSTIR Salt Management Plan • Operate vehicles outside wetland boundaries • Avoid herbicide use in wetlands • Follow NSTIR IRVM Manual	• Follow-up wetland surveys will be conducted within portions of the Field Survey Area that could not be surveyed during 2016 as a result of property access restrictions. • Monitoring will be conducted to measure the extent of wetland alteration, the effectiveness of mitigation measures, and the successful completion of compensatory wetland restoration and creation.

Table 8.1.1 Summary of Mitigation, Monitoring and Follow-up

Valued Component	Proposed Mitigation	Proposed Monitoring and Follow-up
Wildlife and Wildlife Habitat	• Follow Generic EPP • Reduce the extent of vegetation clearing for RoW preparation to only the amount required for Project construction • Clear RoW outside of breeding bird season (April 15 – August 15). Where this is not feasible, develop a Bird Nest Mitigation Plan (prior to construction) in consultation with ECCC and provincial regulators • Compensate for loss of wetland area and function following provincial requirements • Limit Project-related off road activity • Employee environmental awareness training during construction • Use designated roadways and access to reduce unnecessary ground disturbance • Consideration of culvert design if necessary and feasible • Use existing access for maintenance activities • Conduct vegetation maintenance outside of breeding season (April to August) where feasible • Keep activities within disturbed RoW where feasible • Deactivate temporary roads to reduce access • Adhere to the NSTIR Salt Management Plan • Reduce the depth of road cuts where possible • Reduce area of disturbance • Where feasible, do not mow cleared RoW between April 15 and August 15 to avoid destruction of the nests of species which nest on the ground in grasslands • Inspect bridges prior to maintenance work to determine if occupied nests of protected birds are present. If nests are present, avoid maintenance work until chicks have fledged	• No follow-up or monitoring is recommended.
Land Use	• Temporary detours provided if necessary • Follow Generic EPP that includes guidelines for reducing noise and air emissions • Reduce dust through the application of water • Fair market value compensation for properties and buildings • Maintain access to lands where possible • A bridge structure with a 4 m wide travel lane will be constructed for the existing recreational trail west of Exit 26 to accommodate safe movement of ATVs across the highway • Standard traffic control procedures	• No follow-up or monitoring is recommended.

Table 8.1.1 Summary of Mitigation, Monitoring and Follow-up

Valued Component	Proposed Mitigation	Proposed Monitoring and Follow-up
	• Reasonable accommodation to allow forestry / agricultural operations access to adjacent lands during construction (e.g., to harvest woodlots required to be cleared) • Communication throughout the construction phase of the Project to landowners, Mi'kmaq, and interested stakeholders regarding construction activities and progress • As noted in the MEKS, should M'kmaq archaeological deposits be encountered during construction activities, the procedures described in an Archaeological Contingency Plan will be implemented, including the cessation of construction activities in the area of the discovery and contacting NSCCH and the KMKNO • Maintain noise control devices	
Archaeological and Heritage Resources	• An Archaeological Contingency Plan will be prepared. • Highway alignment has been revised to avoid burials. • Follow NSCCH recommendations (see Appendix E). • If ground disturbing activity is planned near either cemetery area, an archaeologist will monitor construction and will remain on call should suspected human remains be encountered. • A small cellar feature was located on the northwest side of Marshalltown Road. It is recommended that a 10 m buffer be flagged around the exposed stone of the cellar area so that this feature can be avoided during construction. • If archaeological resources are encountered in the future and an archaeologist is not already present, it is required that any ground-disturbing activity be halted immediately and the Coordinator of Special Places (902-424-6475) be contacted regarding a suitable method of mitigation. • Findings in this region indicate historic activity. Should the highway be realigned again, a reassessment is recommended to determine if more significant features are present.	• Due to the potential for there to be unknown archaeological resources within the PDA, the following mitigation is required: If the construction or development of ancillary elements is planned for areas with potential for archaeological resources that have not been surveyed by a professional archaeologist, then a preconstruction archaeological assessment of these areas will be conducted, the results of which will be reported to NSCCH, prior to development of the ancillary elements.
Generic EPP is NSTWP (2007)		

8.2 CONCLUSION

With the implementation of the proposed mitigation (including compensation) and monitoring, no significant adverse residual environmental effects are predicted for most VCs due to routine Project construction or operation and maintenance activities. Residual environmental effects of the operation and maintenance of the Project on the acoustic environment are predicted to be not significant, assuming that NSTIR undertakes monitoring of traffic noise levels along the new highway that might be considered significant for certain receivers.

The main purpose of a 100 series highway network in Nova Scotia is the safe, convenient, and efficient movement of large volumes of people and goods over long distances at high speeds while reducing negative economic, social, and environmental impacts. This Project will provide benefit to the local region as well as the Province of Nova Scotia as it will improve the current safety performance and level of service along this stretch of Highway 101.

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10.0 APPENDICES

APPENDIX A Vegetation Field Survey Results

APPENDIX B Wetland Field Survey Results

APPENDIX C Wildlife Field Survey Results

APPENDIX D Mi'kmaq Ecological Knowledge Study (MMDI 2016)

APPENDIX E Archaeological Resource Impact Assessment: Marshalltown Highway 101 Realignment (Davis MacIntyre & Associates Limited 2016)

Appendix F Letter from Nova Scotia Communities, Culture and Heritage

Archaeological Resource Impact Assessment: Marshalltown Alms House Cemeteries (Davis MacIntyre & Associates Limited 2016)

APPENDIX A

VEGETATION FIELD SURVEY RESULTS

Table A1 Plant SOCI recorded within 10 km of the center of the Assessment Area (AC CDC 2016)

Common Name	Scientific Name	Habitat Association[1]	Season[1]	ACCDC S-Rank	NSDNR General Status Rank	Distance from Project (km)	# of Records
Wild Leek	*Allium tricoccum*	Rich deciduous forests and intervals.	Late July	S1	May Be At Risk	6.5 ± 0.0	3
Swan's Sedge	*Carex swanii*	Boggy pastures, dry peaty barrens, forests, clearings and the edges of woods.	Early Summer	S2S3	Sensitive	7.6 ± 0.0	12
Chinese Hemlock-parsley	*Conioselinum chinense*	Swamps, mossy coniferous woods or swales, and seepy slopes near the coast.	August to October	S2	Sensitive	9.4 ± 5.0	1
Matting Witchgrass	*Dichanthelium meridionale*	Dry open woods, fields, and sand barrens. Sometimes found in semi-moist sandy places.	Flowering and fruiting from June to September.	SH	Extirpated	7.7 ± 10.0	1
Purple-veined Willowherb	*Epilobium coloratum*	Low-lying ground, springy slopes and similar locations.	July and October. Seeds required for identification.	S2?	Sensitive	4.3 ± 1.0	2
Common Scouring-rush	*Equisetum hyemale var. affine*	Sandy, gravelly banks and low areas. Associated with calcareous areas.	Identifiable throughout the growing season	S3S4	Secure	4.5 ± 0.0	1
Dwarf Scouring-Rush	*Equisetum scirpoides*	Rich wooded banks, and mossy slopes. Typical of alkaline soils.	Identifiable throughout the growing season	S3S4	Secure	4.5 ± 1.0	1
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*	Dry, usually mixed deciduous forest.	Early May	S1S2	May Be At Risk	9.7 ± 0.0	1
Dudley's Rush	*Juncus dudleyi*	Marshy ground.	June to September	S3	Secure	9.6 ± 2.0	1
Narrow-leaved Evening Primrose	*Oenothera fruticosa ssp. glauca*	Old fields, the edges of thickets, and roadsides. In dry, open, sandy soil.	Flowers June to August	S2	Undetermined	7.7 ± 0.0	9
Large Purple Fringed Orchid	*Platanthera grandiflora*	Wet meadows and along streams.	Flowers in July	S3	Secure	4.8 ± 1.0	1

Table A1 Plant SOCI recorded within 10 km of the center of the Assessment Area (AC CDC 2016)

Common Name	Scientific Name	Habitat Association[1]	Season[1]	ACCDC S-Rank	NSDNR General Status Rank	Distance from Project (km)	# of Records
Pink Pyrola	*Pyrola asarifolia*	Rich, mainly calcareous, woods and thickets.	Flowers late June to early August	S3	Secure	10.0 ± 7.0	1
Alder-leaved Buckthorn	*Rhamnus alnifolia*	Calcareous bogs, swamps, swampy woods and meadows, marl bogs in rich alluvial soils.	Flowers mid -May to June. Identifiable from May to October and potentially year round.	S3	Secure	8.1 ± 0.0	1
Knotted Pearlwort	*Sagina nodosa ssp. borealis*	Sea cliffs, sand flats and dune slopes.	Flowers July to September	S2S3	Secure	9.4 ± 5.0	1
Coastal Plain Blue-eyed-grass	*Sisyrinchium fuscatum*	Sandy plains or banks	Flowers May to early June.	S1	May Be At Risk	3.3 ± 0.0	1
Eastern White Cedar	*Thuja occidentalis*	Lakesides and swamps or old pastures.	Can be identified throughout the year	S1	At Risk	4.3 ± 0.0	2
Arrow-Leaved Violet	*Viola sagittata var. ovata*	Dry sterile woods, clearings and fields.	April and May	S3S4	Secure	7.4 ± 0.0	5

[1] From Zinck (1998) and / or Munro *et al.* (2014)

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Balsam Fir	*Abies balsamea*	S5	Secure
Striped Maple	*Acer pensylvanicum*	S5	Secure
Red Maple	*Acer rubrum*	S5	Secure
Sugar Maple	*Acer saccharum*	S5	Secure
Mountain Maple	*Acer spicatum*	S5	Secure
Common Yarrow	*Achillea millefolium*	S5	Secure
Bishop's Goutweed	*Aegopodium podagraria*	SNA	Exotic
Colonial Bent Grass	*Agrostis capillaris*	SNA	Exotic
Redtop	*Agrostis gigantea*	SNA	Exotic
Upland Bent Grass	*Agrostis perennans*	S4S5	Secure
Creeping Bent Grass	*Agrostis stolonifera*	S5	Secure
Hairy Lady's-mantle	*Alchemilla monticola*	SNA	Exotic
Northern Water Plantain	*Alisma triviale*	S5	Secure
Speckled Alder	*Alnus incana*	S5	Secure
Green Alder	*Alnus viridis*	S5	Secure
Meadow Foxtail	*Alopecurus pratensis*	SNA	Exotic
Bartram's Serviceberry	*Amelanchier bartramiana*	S5	Secure
a Serviceberry	*Amelanchier sp.*	na	na
Pearly Everlasting	*Anaphalis margaritacea*	S5	Secure
Large Sweet Vernal Grass	*Anthoxanthum odoratum*	SNA	Exotic
Spreading Dogbane	*Apocynum androsaemifolium*	S5	Secure
European Columbine	*Aquilegia vulgaris*	SNA	Exotic
Bristly Sarsaparilla	*Aralia hispida*	S5	Secure
Wild Sarsaparilla	*Aralia nudicaulis*	S5	Secure
Swamp Jack-In-The-Pulpit	*Arisaema triphyllum ssp. stewardsonii*	S4S5	Secure
Common Lady Fern	*Athyrium filix-femina*	S5	Secure
an Orache	*Atriplex sp.*	na	na
Japanese Barberry	*Berberis thunbergii*	SNA	Exotic
Yellow Birch	*Betula alleghaniensis*	S5	Secure
Paper Birch	*Betula papyrifera*	S5	Secure
Gray Birch	*Betula populifolia*	S5	Secure
Devil's Beggarticks	*Bidens frondosa*	S5	Secure
a Beggartick	*Bidens sp.*	na	na
Northern Shorthusk	*Brachyelytrum septentrionale*	S5	Secure
Water-shield	*Brasenia schreberi*	S5	Secure
Smooth Brome	*Bromus inermis*	SNA	Exotic

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Bluejoint Reed Grass	*Calamagrostis canadensis*	S5	Secure
Hedge False Bindweed	*Calystegia sepium*	S5	Secure
Pennsylvania Bittercress	*Cardamine pensylvanica*	S5	Secure
White-tinged Sedge	*Carex albicans*	S4	Secure
Black Sedge	*Carex arctata*	S5	Secure
Brownish Sedge	*Carex brunnescens*	S5	Secure
Silvery Sedge	*Carex canescens*	S5	Secure
Fibrous-Root Sedge	*Carex communis*	S5	Secure
Fringed Sedge	*Carex crinita*	S5	Secure
White-edged Sedge	*Carex debilis*	S5	Secure
Northern Sedge	*Carex deflexa*	S4	Secure
Two-seeded Sedge	*Carex disperma*	S5	Secure
Star Sedge	*Carex echinata*	S5	Secure
Yellow Sedge	*Carex flava*	S5	Secure
Northern Long Sedge	*Carex folliculata*	S5	Secure
Graceful Sedge	*Carex gracillima*	S4S5	Secure
Nodding Sedge	*Carex gynandra*	S5	Secure
Bladder Sedge	*Carex intumescens*	S5	Secure
Bristly-stalked Sedge	*Carex leptalea*	S5	Secure
Finely-Nerved Sedge	*Carex leptonervia*	S5	Secure
Sallow Sedge	*Carex lurida*	S5	Secure
Boreal Bog Sedge	*Carex magellanica*	S5	Secure
New England Sedge	*Carex novae-angliae*	S5	Secure
Chaffy Sedge	*Carex paleacea*	S5	Secure
Pale Sedge	*Carex pallescens*	S5	Secure
Necklace Sedge	*Carex projecta*	S5	Secure
Eastern Star Sedge	*Carex radiata*	S4	Secure
Rough Sedge	*Carex scabrata*	S5	Secure
Broom Sedge	*Carex scoparia*	S5	Secure
Awl-fruited Sedge	*Carex stipata*	S5	Secure
Tussock Sedge	*Carex stricta*	S5	Secure
Swan's Sedge	*Carex swanii*	S2S3	Sensitive
Three-seeded Sedge	*Carex trisperma*	S5	Secure
Black Knapweed	*Centaurea nigra*	SNA	Exotic
Common Chickweed	*Cerastium fontanum*	SNA	Exotic
White Turtlehead	*Chelone glabra*	S5	Secure
a Goosefoot	*Chenopodium sp.*	na	na

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Canada Thistle	*Cirsium arvense*	SNA	Exotic
Virginia Clematis	*Clematis virginiana*	S5	Secure
Yellow Bluebead Lily	*Clintonia borealis*	S5	Secure
Field Bindweed	*Convolvulus arvensis*	SNA	Exotic
Goldthread	*Coptis trifolia*	S5	Secure
Early Coralroot	*Corallorhiza trifida*	S4	Secure
Bunchberry	*Cornus canadensis*	S5	Secure
Round-leaved Dogwood	*Cornus rugosa*	S4	Secure
Red Osier Dogwood	*Cornus sericea*	S5	Secure
English Hawthorn	*Crataegus monogyna*	SNA	Exotic
a Hawthorn	*Crataegus sp.*	na	na
Pink Lady's-Slipper	*Cypripedium acaule*	S5	Secure
Orchard Grass	*Dactylis glomerata*	SNA	Exotic
Dewdrop	*Dalibarda repens*	S5	Secure
Mountain Heath Grass	*Danthonia decumbens*	SNA	Exotic
Poverty Oat Grass	*Danthonia spicata*	S5	Secure
Queen Anne's Lace	*Daucus carota*	SNA	Exotic
Eastern Hay-Scented Fern	*Dennstaedtia punctilobula*	S5	Secure
Deptford Pink	*Dianthus armeria*	SNA	Exotic
Northern Panic Grass	*Dichanthelium boreale*	S5	Secure
White-Hair Witchgrass	*Dichanthelium villosissimum*	SNA	na
Northern Bush Honeysuckle	*Diervilla lonicera*	S5	Secure
Hairy Flat-top White Aster	*Doellingeria umbellata*	S5	Secure
Spinulose Wood Fern	*Dryopteris carthusiana*	S5	Secure
Crested Wood Fern	*Dryopteris cristata*	S5	Secure
Evergreen Wood Fern	*Dryopteris intermedia*	S5	Secure
Blunt Spikerush	*Eleocharis obtusa*	S5	Secure
a Spikerush	*Eleocharis sp.*	na	na
Slender Spikerush	*Eleocharis tenuis*	S5	Secure
Quack Grass	*Elymus repens*	SNA	Exotic
Beechdrops	*Epifagus virginiana*	S4	Secure
Trailing Arbutus	*Epigaea repens*	S5	Secure
Bog Willowherb	*Epilobium leptophyllum*	S5	Secure
Field Horsetail	*Equisetum arvense*	S5	Secure
Woodland Horsetail	*Equisetum sylvaticum*	S5	Secure
Rough Fleabane	*Erigeron strigosus*	S5	Secure
Common Boneset	*Eupatorium perfoliatum*	S5	Secure

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Common Eyebright	*Euphrasia nemorosa*	S5	Secure
Large-leaved Aster	*Eurybia macrophylla*	S5	Secure
Grass-leaved Goldenrod	*Euthamia graminifolia*	S5	Secure
American Beech	*Fagus grandifolia*	S5	Secure
Hair Fescue	*Festuca filiformis*	SNA	Exotic
Red Fescue	*Festuca rubra*	S5	Secure
Hard Fescue	*Festuca trachyphylla*	SNA	Exotic
Wild Strawberry	*Fragaria virginiana*	S5	Secure
Glossy Buckthorn	*Frangula alnus*	SNA	Exotic
White Ash	*Fraxinus americana*	S5	Secure
Green Ash	*Fraxinus pennsylvanica var. subintegerrima*	na	na
Common Hemp-nettle	*Galeopsis tetrahit*	SNA	Exotic
Rough Bedstraw	*Galium asprellum*	S5	Secure
Common Marsh Bedstraw	*Galium palustre*	S5	Secure
Dyer's Bedstraw	*Galium tinctorium*	S5	Secure
Three-flowered Bedstraw	*Galium triflorum*	S5	Secure
Creeping Snowberry	*Gaultheria hispidula*	S5	Secure
Eastern Teaberry	*Gaultheria procumbens*	S5	Secure
an Avens	*Geum sp.*	na	na
Canada Manna Grass	*Glyceria canadensis*	S5	Secure
Common Tall Manna Grass	*Glyceria grandis*	S4S5	Secure
Northern Mannagrass	*Glyceria laxa*	S4?	Secure
Fowl Manna Grass	*Glyceria striata*	S5	Secure
Common Oak Fern	*Gymnocarpium dryopteris*	S5	Secure
American Witch-Hazel	*Hamamelis virginiana*	S5	Secure
Wall Hawkweed	*Hieracium murorum*	SNA	Exotic
Mouse-ear Hawkweed	*Hieracium pilosella*	SNA	Exotic
Smoothish Hawkweed	*Hieracium x floribundum*	SNA	Exotic
Common Velvet Grass	*Holcus lanatus*	SNA	Exotic
Shining Firmoss	*Huperzia lucidula*	S5	Secure
American Marsh Pennywort	*Hydrocotyle americana*	S5	Secure
Garden Stonecrop	*Hylotelephium telephium ssp. telephium*	SNA	Exotic
Canada St John's-wort	*Hypericum canadense*	S5	Secure
Common St. John's-wort	*Hypericum perforatum*	SNA	Exotic
Common Winterberry	*Ilex verticillata*	S5	Secure
Spotted Jewelweed	*Impatiens capensis*	S5	Secure

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Yellow Iris	*Iris pseudacorus*	SNA	Exotic
Harlequin Blue Flag	*Iris versicolor*	S5	Secure
Jointed Rush	*Juncus articulatus*	S5	Secure
Narrow-Panicled Rush	*Juncus brevicaudatus*	S5	Secure
Canada Rush	*Juncus canadensis*	S5	Secure
Soft Rush	*Juncus effusus*	S5	Secure
Black-Grass Rush	*Juncus gerardii*	S5	Secure
a Rush	*Juncus sp.*	na	na
Slender Rush	*Juncus tenuis*	S5	Secure
Sheep Laurel	*Kalmia angustifolia*	S5	Secure
Tamarack	*Larix laricina*	S5	Secure
Fall Dandelion	*Leontodon autumnalis*	SNA	Exotic
Oxeye Daisy	*Leucanthemum vulgare*	SNA	Exotic
Twinflower	*Linnaea borealis*	S5	Secure
Canada Fly Honeysuckle	*Lonicera canadensis*	S5	Secure
Garden Bird's-foot Trefoil	*Lotus corniculatus*	SNA	Exotic
Marsh Seedbox	*Ludwigia palustris*	S5	Secure
Large-Leaved Lupine	*Lupinus polyphyllus*	SNA	Exotic
Common Woodrush	*Luzula multiflora*	S5	Secure
Stiff Clubmoss	*Lycopodium annotinum*	S5	Secure
Northern Clubmoss	*Lycopodium complanatum*	S3S4	Secure
Round-branched Tree-clubmoss	*Lycopodium dendroideum*	S5	Secure
Northern Water Horehound	*Lycopus uniflorus*	S5	Secure
Creeping Yellow Loosestrife	*Lysimachia nummularia*	SNA	Exotic
Swamp Yellow Loosestrife	*Lysimachia terrestris*	S5	Secure
Tufted Yellow Loosestrife	*Lysimachia thyrsiflora*	S4	Secure
Garden Yellow Loosestrife	*Lysimachia vulgaris*	SNA	Exotic
Purple Loosestrife	*Lythrum salicaria*	SNA	Exotic
Wild Lily-of-The-Valley	*Maianthemum canadense*	S5	Secure
Common Apple	*Malus pumila*	SNA	Exotic
Musk Mallow	*Malva moschata*	SNA	Exotic
Indian Cucumber Root	*Medeola virginiana*	S5	Secure
a Mint	*Mentha sp.*	na	na
Partridgeberry	*Mitchella repens*	S5	Secure
Naked Bishop's-Cap	*Mitella nuda*	S5	Secure
One-flowered Wintergreen	*Moneses uniflora*	S5	Secure
Pinesap	*Monotropa hypopithys*	S4	Secure

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Indian Pipe	*Monotropa uniflora*	S5	Secure
Northern Bayberry	*Morella pensylvanica*	S5	Secure
Mountain Holly	*Nemopanthus mucronatus*	S5	Secure
Fragrant Water-lily	*Nymphaea odorata*	S5	Secure
Whorled Wood Aster	*Oclemena acuminata*	S5	Secure
a hybrid White Panicled American-Aster	*Oclemena x blakei*	S5	Secure
Common Evening Primrose	*Oenothera biennis*	S5	Secure
Small-flowered Evening Primrose	*Oenothera parviflora*	S4?	Secure
Sensitive Fern	*Onoclea sensibilis*	S5	Secure
Wild Marjoram	*Origanum vulgare*	SNA	Exotic
Cinnamon Fern	*Osmunda cinnamomea*	S5	Secure
Interrupted Fern	*Osmunda claytoniana*	S5	Secure
Royal Fern	*Osmunda regalis*	S5	Secure
Slender Yellow Wood Sorrel	*Oxalis dillenii*	SNA	Exotic
Common Wood Sorrel	*Oxalis montana*	S5	Secure
European Wood Sorrel	*Oxalis stricta*	S5	Secure
Schweinitz's Groundsel	*Packera schweinitziana*	S4	Secure
Virginia Creeper	*Parthenocissus quinquefolia*	SNA	Exotic
Reed Canary Grass	*Phalaris arundinacea*	S5	Secure
Northern Beech Fern	*Phegopteris connectilis*	S5	Secure
a Mock-orange	*Philadelphus sp.*	na	na
Common Timothy	*Phleum pratense*	SNA	Exotic
Chokeberry	*Photinia sp.*	na	na
White Spruce	*Picea glauca*	S5	Secure
Black Spruce	*Picea mariana*	S5	Secure
Red Spruce	*Picea rubens*	S5	Secure
Red Pine	*Pinus resinosa*	S4S5	Secure
Eastern White Pine	*Pinus strobus*	S5	Secure
English Plantain	*Plantago lanceolata*	SNA	Exotic
Common Plantain	*Plantago major*	SNA	Exotic
Club Spur Orchid	*Platanthera clavellata*	S5	Secure
an Orchid	*Platanthera sp.*	na	na
Canada Blue Grass	*Poa compressa*	SNA	Exotic
Fowl Blue Grass	*Poa palustris*	S5	Secure
Kentucky Blue Grass	*Poa pratensis*	S5	Secure
Japanese Knotweed	*Polygonum cuspidatum*	SNA	Exotic

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Arrow-leaved Smartweed	*Polygonum sagittatum*	S5	Secure
a Smartweed	*Polygonum sp.*	na	na
Christmas Fern	*Polystichum acrostichoides*	S5	Secure
Large-toothed Aspen	*Populus grandidentata*	S5	Secure
Trembling Aspen	*Populus tremuloides*	S5	Secure
a Pondweed	*Potamogeton sp.*	na	na
Old Field Cinquefoil	*Potentilla simplex*	S5	Secure
Three-leaved Rattlesnakeroot	*Prenanthes trifoliolata*	S5	Secure
Common Self-heal	*Prunella vulgaris*	S5	Secure
Sweet Cherry	*Prunus avium*	SNA	Exotic
Canada Plum	*Prunus nigra*	SNA	Exotic
Pin Cherry	*Prunus pensylvanica*	S5	Secure
Black Cherry	*Prunus serotina*	S5	Secure
Chokecherry	*Prunus virginiana*	S5	Secure
Bracken Fern	*Pteridium aquilinum*	S5	Secure
Shinleaf	*Pyrola elliptica*	S5	Secure
Northern Red Oak	*Quercus rubra*	S5	Secure
Common Buttercup	*Ranunculus acris*	SNA	Exotic
Creeping Buttercup	*Ranunculus repens*	SNA	Exotic
European Buckthorn	*Rhamnus cathartica*	SNA	Exotic
Little Yellow Rattle	*Rhinanthus minor*	S5	Secure
Little Yellow Rattle	*Rhinanthus minor ssp. minor*	S5	Secure
Rhodora	*Rhododendron canadense*	S5	Secure
Staghorn Sumac	*Rhus typhina*	S4S5	Secure
Smooth Gooseberry	*Ribes hirtellum*	S5	Secure
Bristly Black Currant	*Ribes lacustre*	S5	Secure
Swamp Red Currant	*Ribes triste*	S4	Secure
Multiflora Rose	*Rosa multiflora*	SNA	Exotic
Shining Rose	*Rosa nitida*	S4	Secure
Virginia Rose	*Rosa virginiana*	S5	Secure
Alleghaney Blackberry	*Rubus allegheniensis*	S5	Secure
Smooth Blackberry	*Rubus canadensis*	S5	Secure
Bristly Dewberry	*Rubus hispidus*	S5	Secure
Red Raspberry	*Rubus idaeus*	S5	Secure
Dwarf Red Raspberry	*Rubus pubescens*	S5	Secure
a Blackberry	*Rubus sp.*	na	na
Sheep Sorrel	*Rumex acetosella*	SNA	Exotic

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Curled Dock	*Rumex crispus*	SNA	Exotic
Pussy Willow	*Salix discolor*	S5	Secure
Balsam Willow	*Salix pyrifolia*	S5	Secure
a Willow	*Salix sp.*	na	na
Red Elderberry	*Sambucus racemosa*	S5	Secure
Dark-green Bulrush	*Scirpus atrovirens*	SNA	na
Common Woolly Bulrush	*Scirpus cyperinus*	S5	Secure
Mosquito Bulrush	*Scirpus hattorianus*	S5	Secure
Small-fruited Bulrush	*Scirpus microcarpus*	S5	Secure
Mad-dog Skullcap	*Scutellaria lateriflora*	S5	Secure
Mountain Blue-eyed-grass	*Sisyrinchium montanum*	S5	Secure
Common Water Parsnip	*Sium suave*	S5	Secure
Bittersweet Nightshade	*Solanum dulcamara*	SNA	Exotic
Canada Goldenrod	*Solidago canadensis*	S5	Secure
Zigzag Goldenrod	*Solidago flexicaulis*	S5	Secure
Rough-stemmed Goldenrod	*Solidago rugosa*	S5	Secure
Seaside Goldenrod	*Solidago sempervirens*	S5	Secure
a Goldenrod	*Solidago sp.*	na	na
False Spiraea	*Sorbaria sorbifolia*	SNA	Exotic
American Mountain Ash	*Sorbus americana*	S5	Secure
American Burreed	*Sparganium americanum*	S5	Secure
Smooth Cord Grass	*Spartina alterniflora*	S5	Secure
Prairie Cord Grass	*Spartina pectinata*	S5	Secure
White Meadowsweet	*Spiraea alba*	S5	Secure
Steeplebush	*Spiraea tomentosa*	S5	Secure
Calico Aster	*Symphyotrichum lateriflorum*	S5	Secure
New York Aster	*Symphyotrichum novi-belgii*	S5	Secure
Purple-stemmed Aster	*Symphyotrichum puniceum*	S5	Secure
Common Tansy	*Tanacetum vulgare*	SNA	Exotic
Common Dandelion	*Taraxacum officinale*	SNA	Exotic
Canada Yew	*Taxus canadensis*	S5	Secure
Tall Meadow-Rue	*Thalictrum pubescens*	S5	Secure
New York Fern	*Thelypteris noveboracensis*	S5	Secure
Eastern Marsh Fern	*Thelypteris palustris*	S5	Secure
Bog Fern	*Thelypteris simulata*	S4	Secure
Poison Ivy	*Toxicodendron radicans*	S4	Secure
Fraser's Marsh St John's-wort	*Triadenum fraseri*	S5	Secure

Table A2 Vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
a St John's-wort	*Triadenum sp.*	na	na
Northern Starflower	*Trientalis borealis*	S5	Secure
Rabbit's-foot Clover	*Trifolium arvense*	SNA	Exotic
Low Hop Clover	*Trifolium campestre*	SNA	Exotic
Red Clover	*Trifolium pratense*	SNA	Exotic
White Clover	*Trifolium repens*	SNA	Exotic
Painted Trillium	*Trillium undulatum*	S5	Secure
Eastern Hemlock	*Tsuga canadensis*	S4S5	Secure
Coltsfoot	*Tussilago farfara*	SNA	Exotic
Broad-leaved Cattail	*Typha latifolia*	S5	Secure
Late Lowbush Blueberry	*Vaccinium angustifolium*	S5	Secure
Large Cranberry	*Vaccinium macrocarpon*	S5	Secure
Velvet-leaved Blueberry	*Vaccinium myrtilloides*	S5	Secure
American Speedwell	*Veronica americana*	S5	Secure
Common Speedwell	*Veronica officinalis*	S5	Exotic
Hobblebush	*Viburnum lantanoides*	S5	Secure
Northern Wild Raisin	*Viburnum nudum*	S5	Secure
Tufted Vetch	*Vicia cracca*	SNA	Exotic
Lance-leaved Violet	*Viola lanceolata*	S5	Secure
a Violet	*Viola sp.*	na	na

Table A3 Non-vascular Plants Recorded during 2016 Field Surveys

Common Name	Scientific Name	ACCDC S-Rank	NSDNR General Status Rank
Tree Tarpaper Lichen	*Collema subflaccidum*	S4S5	Secure
Monk's Hood Lichen	*Hypogymnia physodes*	S4S5	Secure
Blue Jellyskin Lichen	*Leptogium cyanescens*	S4S5	Secure
Lungwort Lichen	*Lobaria pulmonaria*	S4S5	Secure
Smooth Lung Lichen	*Lobaria quercizans*	S4S5	Secure
Textured Lungwort Lichen	*Lobaria scrobiculata*	S4S5	Secure
Tree Flute Lichen	*Menegazzia subsimilis*	S4S5	Secure
Mealy-rimmed Shingle Lichen	*Pannaria conoplea*	S4S5	Secure
Bottlebrush Shield Lichen	*Parmelia squarrosa*	S4S5	Secure
Black-bordered Shingles Lichen	*Parmeliella triptophylla*	S4S5	Secure
Salted Ruffle Lichen	*Parmotrema crinitum*	S4S5	Secure
Varied Rag Lichen	*Platismatia glauca*	S4S5	Secure
Gilded Specklebelly Lichen	*Pseudocyphellaria perpetua*	S4S5	Secure
Rough Speckleback Lichen	*Punctelia rudecta*	S4S5	Secure
Variable Wrinkle Lichen	*Tuckermannopsis orbata*	S4S5	Secure

APPENDIX B

WETLAND FIELD SURVEY RESULTS

Table B1 Wetlands Identified in the Assessment Area

Wetland Number	Class and Vegetation Type	Source[1]	Area (ha)		
			Assessment Area	Field Survey Area	PDA
1	Hardwood Treed Swamp	Desktop	0.20		
2	Graminoid Marsh (brackish)	Desktop	2.42		
3	Tall Shrub / Hardwood Treed Swamp	Desktop	0.02		
4	Mixed Treed Swamp	Desktop	0.01		
5	Tall Shrub / Hardwood Treed Swamp	Desktop	0.03		
6	Graminoid Marsh (brackish)	Field	0.35	0.17	
7	Mixed Treed Swamp	Desktop	0.32		
8	Hardwood Treed Swamp	Desktop	0.04		
9	Mixed Treed / Tall Shrub Swamp	Field / Desktop	2.32	1.15	0.41
10	Hardwood Treed Swamp	Desktop	0.21		
11	Mixed Treed / Tall Shrub Swamp	Field / Desktop	0.15	0.08	
12	Tall Shrub / Hardwood Treed Swamp and Wet Meadow	Field / Desktop	0.86	0.14	
13	Tall Shrub Swamp	Field	0.11	0.11	
14	Tall Shrub / Hardwood Treed Swamp	Field / Desktop	0.45	0.41	0.07
15	Tall Shrub Swamp	Field	0.02	0.02	0.00
16	Tall Shrub Swamp (with cut over components)	Field	0.22	0.20	0.01
17	Mixed Treed / Hardwood Treed / Tall Shrub Swamp and Aquatic Shallow Water (with cut over components)	Field / Desktop	0.95	0.95	0.52
18	Hardwood Treed / Mixed Treed Swamp and Graminoid Marsh	Field / Desktop	1.81	1.81	1.24
19	Mixed Treed Swamp (with cut-over components)	Field / Desktop	2.35	2.14	0.42
20	Mixed Treed Swamp (cut-over)	Field / Desktop	0.26	0.26	0.22

Table B1 Wetlands Identified in the Assessment Area

Wetland Number	Class and Vegetation Type	Source[1]	Area (ha)		
			Assessment Area	Field Survey Area	PDA
21	Mixed Treed Swamp (with cut-over components)	Field / Desktop	0.66	0.33	0.03
22	Mixed Treed Swamp	Field	0.42	0.42	0.09
23	Mixed Treed Swamp (cut-over)	Field	0.11	0.11	0.11
24	Mixed Treed Swamp	Field	0.04	0.04	0.04
25	Mixed Treed Swamp	Field	0.06	0.06	0.04
26	Mixed Treed Swamp	Field	1.29	1.29	0.76
27	Mixed Treed Swamp	Field	0.03	0.00	
28	Mixed Treed Swamp	Field	0.10	0.10	
29	Tall Shrub / Hardwood Treed Swamp	Field / Desktop	2.35	0.06	
30	Mixed Treed Swamp	Desktop	0.82	0.05	
31	Mixed Treed / Hardwood Treed / Tall Shrub Swamp	Field / Desktop	0.61	0.61	0.25
32	Hardwood / Mixed Treed / Tall Shrub Swamp	Field / Desktop	0.96	0.54	
33	Hardwood Treed Swamp	Field / Desktop	0.08	0.06	
34	Mixed Treed Swamp	Field	0.01	0.01	0.01
35	Tall Shrub Swamp	Field	0.32	0.32	0.16
36	Mixed Treed Swamp	Field	0.03	0.03	
37	Tall Shrub Swamp	Field	0.02	0.02	
38	Mixed Treed Swamp	Desktop	2.95		
39	Tall Shrub / Mixed Treed Swamp	Field	0.04	0.04	
40	Graminoid Marsh	Field	0.02	0.02	
41	Mixed Treed Swamp	Desktop	0.44	0.15	
42	Tall Shrub / Mixed Treed Swamp	Desktop	0.26		

Table B1 Wetlands Identified in the Assessment Area

Wetland Number	Class and Vegetation Type	Source[1]	Area (ha)		
			Assessment Area	Field Survey Area	PDA
43	Mixed Treed Swamp	Desktop	0.39		
44	Tall Shrub / Mixed Treed Swamp	Desktop	0.09		
Total		Field / Desktop	25.21	11.69	4.36

[1]Only wetlands within accessible portions of the Field Survey Area were field surveyed; wetlands identified through desktop assessment have not been confirmed

Table B2 Summary of Wetland Character (Field Assessment Results)

Wetland Number	Class	Form	Type	Landscape Position	Origin	Dominant Water Regime	Ave Water Depth (cm)	% Inundated	Inlet / Outlet	Stressors
6	Salt Marsh	Estuarine	Graminoid	Estuarine confined	Natural	Regularly flooded - tidal	30	na	Inlet and outlet (culverts)	Roads, culverts
9	Swamp	Basin	Tall Shrub / Mixedwood Treed	Terrene outflow	Natural	Permanently saturated	5	1	Outlet (stream)	Roads
11	Swamp	Slope	Tall Shrub	Terrene	Natural	Permanently saturated	na	na	No	Road and residential property in wetland buffer
12	Swamp	Basin	Tall Shrub / Wet Meadow	Terrene	Natural	Permanently saturated	na	na	Inlet (culvert)	Roads, culvert
13	Swamp	Basin	Tall Shrub	Terrene	Natural	Permanently saturated	5	na	no	Ditch, road
14	Swamp	Slope	Tall Shrub / Deciduous Treed	Terrene	Natural	Permanently saturated	na	na	No	Roads
15	Swamp	Slope	Tall Shrub	Terrene	Natural	Permanently saturated	na	na	No	Roads
16	Swamp	Basin, slope	Tall Shrub	Terrene	Natural	Permanently saturated	na	na	Inlet	Drainage ditch and infilling at edge of distribution line, forestry activity
17	Swamp	Basin	Mixedwood Treed / Tall Shrub	Terrene	Natural	Permanently saturated	na	na	Inlet (from culvert)	Culvert, flooding because of impoundment, tree harvesting
	Shallow water	Basin	Floating leaved		Natural / Created	Permanently flooded	>30	100		
18	Marsh	Basin	Graminoid	Lotic pond	Created (dug out pond) / Natural (swamp)	Permanently flooded	>30	>5	No	Roads, ditching at edge, infill
	Swamp	Basin	Deciduous Treed			Permanently saturated	na	na		
19	Swamp	Basin, Drainageway	Mixedwood Treed	Terrene	Natural	Permanently saturated	10	na	Inlet (ephemeral) , outlet	Roads, tree harvesting
20	Swamp	Basin	Mixedwood Treed (cut-over)	Terrene	Natural	Permanently saturated	5	na	No	Tree harvesting
21	Swamp	Slope	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	Inlet (ephemeral)	Tree harvesting
22	Swamp	Slope	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	Inlet (ephemeral)	None observed
23	Swamp	Slope	Mixedwood Treed (cut-over)	Terrene	Natural	Permanently saturated	na	na	No	Forest harvesting (in powerline RoW)
24	Swamp	Drainageway	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	No	Old woods road - soil compaction
25	Swamp	Basin	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	No	None observed
26	Swamp	Flat	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	Outlet (ephemeral channel)	Old woods road
28	Swamp	Flat	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	No	Old road
29	Swamp	Riverine (stream)	Deciduous Treed	Lotic stream	Natural	Permanently saturated	15 cm in stream	na	Inlet and outlet	None observed

Table B2 Summary of Wetland Character (Field Assessment Results)

Wetland Number	Class	Form	Type	Landscape Position	Origin	Dominant Water Regime	Ave Water Depth (cm)	% Inundated	Inlet / Outlet	Stressors
31	Swamp	Drainageway	Tall Shrub / Deciduous Treed	Lotic stream	Natural	Temporarily flooded, Permanently saturated	5	5	Outlet (stream)	None observed
32	Swamp	Slope	Deciduous Treed	Terrene	Natural	Permanently saturated	na	na	None observed but much of wetland outside Field Survey Area	Roads
33	Swamp	Slope	Deciduous Treed	Terrene	Natural	Permanently saturated	na	na	No	Old road
34	Swamp	Drainageway	Mixedwood Treed	Terrene	Natural	Permanently saturated	na	na	No	None observed
35	Swamp	Slope	Tall Shrub	Terrene	Natural	Permanently saturated	na	na	No	Abundant infill along eastern boundary; may be partly anthropogenic
36	Swamp	Basin	Mixedwood Treed	na	Natural	Temporarily flooded	na	na	No	None observed
37	Swamp	Basin	Tall Shrub	Terrene	Natural	Permanently saturated	na	na	No	None observed
39	Swamp	Riverine (stream)	Tall Shrub / Mixedwood Treed	Lotic stream	Natural	Temporarily flooded	na	?	Inlet and outlet	None observed
40	Marsh	Basin	Graminoid	Terrene	Created	Permanently flooded	na	na	Inlet and outlet	Roads, historical excavation

Table B3 Summary of Significant Wetland Functions (Field-Assessment Novawet Results)

Wetland Number	Significant Wetland Functions from NovaWET[1]																							
	SF3 (General condition / integrity)	SF4 (Adjacent Land condition / integrity)	SF5 (WSS?)	SF6 (Commercial/recreational fish / shellfish?)	SF8 (Conservation/ compensation agreements / activity?)	SF9 (Calcareous fen, black ash, cedar swamp, or wild rice marsh?)	SF11 (Floodplain upstream or within populated area?)	SF12 (Fed/Prov/Municipal area of interest?)	SF13 (WL hydrologic condition)	SF14 (WL important for maintaining stream flow?)	SF15 (WL ability to detain surface water)	SF16 (Wetland improves water quality?)	SF17 (Evidence of excess nutrient loading / contamination?)	SF18 (WL contributes to water quality in downstream resources)	SF19 (WL serves as a recharge site)	SF20 (WL serves as a discharge site)	SF21 (WL ability to stabilize shoreline)	SF22 (Unique or rare plant community?)	SF23 (Contains a diversity of plant communities?)	SF24 (Overall integrity / quality of plant community?)	SF25 (Rare or endangered plant species?)	SF26 (Does WEL support fish / fish habitat?)	SF27 (rare or endangered fish / wildlife species?)	SF28 (Overall fish and wildlife habitat quality)	SF29 (Community use / value)
6	M	L	Yes	Yes	No	No	No	No	Mod.	No	M	Yes	L	L	No	Yes	M	No	L	H	No	Yes?	No	M	L
9	H	M	No	No	No	No	No	No	Nat.	Yes	M	Yes	L	M	No	Yes	N/A	No	M	M	No	Yes?	NOCA	M-H	L
11	M	L-M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
12	L	M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	M	M	No	No	No	L	L
13	L	M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	L	No	No	No	L	L
14	M	M	No	No	No	No	No	No	Nat.	No	L	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
15	M	M	No	No	No	No	No	No	Nat.	No	L	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
16	M	M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
17	M	M	No	No	No	No	No	No	Nat.	No	H	Yes	L	L	No	Yes	N/A	No	L	M	*C. swanii*	No	No	L	L
18	M	M	No	No	No	No	No	No	Mod.	No	H	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	M	L
19	L	M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	L	No	No	GCKI	M	L
20	L	M	No	No	No	No	No	No	Nat.	No	M	Yes (only minimal)	L	L	No	Yes	N/A	No	L	L	No	No	No	L	L
21	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	L	No	No	No	L	L
22	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	M	M	No	No	No	L	L
23	M	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	*C. swanii*	No	KILL	L	L
24	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	H	No	No	No	L	L
25	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	GCKI	L	L
26	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	GCKI	L	L
28	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	H	No	No	GCKI	L	L

Table B3 Summary of Significant Wetland Functions (Field-Assessment Novawet Results)

Wetland Number	Significant Wetland Functions from NovaWET[1]																							
	SF3 (General condition / integrity)	SF4 (Adjacent Land condition / integrity)	SF5 (WSS?)	SF6 (Commercial/recreational fish / shellfish?)	SF8 (Conservation/ compensation agreements / activity?)	SF9 (Calcareous fen, black ash, cedar swamp, or wild rice marsh?)	SF11 (Floodplain upstream or within populated area?)	SF12 (Fed/Prov/Municipal area of interest?)	SF13 (WL hydrologic condition)	SF14 (WL important for maintaining stream flow?)	SF15 (WL ability to detain surface water)	SF16 (Wetland improves water quality?)	SF17 (Evidence of excess nutrient loading / contamination?)	SF18 (WL contributes to water quality in downstream resources)	SF19 (WL serves as a recharge site)	SF20 (WL serves as a discharge site)	SF21 (WL ability to stabilize shoreline)	SF22 (Unique or rare plant community?)	SF23 (Contains a diversity of plant communities?)	SF24 (Overall integrity / quality of plant community?)	SF25 (Rare or endangered plant species?)	SF26 (Does WEL support fish / fish habitat?)	SF27 (rare or endangered fish / wildlife species?)	SF28 (Overall fish and wildlife habitat quality)	SF29 (Community use / value)
29	H	H	No	No	No	No	No	No	Nat.	No	H	Yes	L	M	No	Yes	M	No	L	H	No	Yes	No	M	L
31	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	M	L
32	H	M	No	No	No	No	No	No	Nat.	No	L	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
33	H	H	No	No	No	No	No	No	Nat.	No	L	Yes	L	L	No	Yes	N/A	No	L	M	*C. swanii*	No	No	L	L
34	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
35	H	H	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
36	H	M	No	No	No	No	No	No	Nat.	No	L-M	Yes	L	L	No?	Yes?	N/A	No	L	M	No	No	No	L	L
37	H	M	No	No	No	No	No	No	Nat.	No	na	Yes	L	L	No	Yes	N/A	No	L	M	No	No	No	L	L
39	M	M	No	No	No	No	No	No	Nat.	No	M	Yes	L	L	No	Yes	L	No	M	M	No	No	No	L	L
40	L	M	No	No	No	No	No	No	Mod.	No	H	Yes	L	L	No	Yes	N/A	No	M	M	No	No	No	L	L

[1]L = Low, M = Moderate or Medium, H = High, N/A = Not Applicable. Nat. = Natural, Mod. = Modified, *C. swanii* = *Carex swanii*, GKCI = Golden-crowned Kinglet, NOCA = Northern Cardinal, KILL = Killdeer,

APPENDIX C

WILDLIFE FIELD SURVEY RESULTS

Table C1 Bird SOCI Identified in AC CDC Data Search

Common Name	Scientific Name	SARA	COSEWIC	Provincial Rank/Status of Taxon	Provincial Rarity Rank	Provincial GS Rank	Likely to Occur in Assessment Area?
Common Loon	*Gavia immer*	-	Not at Risk	-	S3B,S4N	2 May Be At Risk	No
Common Goldeneye	*Bucephala clangula*	-	-	-	S2B,S5N	4 Secure	No
Semipalmated Plover	*Charadrius semipalmatus*	-	-	-	S1S2B,S5M	4 Secure	Yes
Killdeer	*Charadrius vociferus*	-	-	-	S3S4B	3 Sensitive	Yes
Willet	*Tringa semipalmata*	-	-	-	S2S3B	2 May Be At Risk	Yes
Spotted Sandpiper	*Actitis macularius*	-	-	-	S3S4B	3 Sensitive	Yes
Semipalmated Sandpiper	*Calidris pusilla*	-	-	-	S3M	3 Sensitive	Yes
Wilson's Snipe	*Gallinago delicata*	-	-	-	S3S4B	3 Sensitive	Yes
Black Guillemot	*Cepphus grylle*	-	-	-	S3S4	4 Secure	No
Black-billed Cuckoo	*Coccyzus erythropthalmus*	-	-	-	S3?B	2 May Be At Risk	Yes
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened	S3B	1 At Risk	Yes
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	Threatened	S3B	1 At Risk	Yes
Eastern Wood-Pewee	*Contopus virens*		Special Concern	Vulnerable	S3S4B	3 Sensitive	Yes
Yellow-bellied Flycatcher	*Empidonax flaviventris*	-	-	-	S3S4B	3 Sensitive	Yes
Bank Swallow	*Riparia riparia*	-	Threatened	-	S3B	2 May Be At Risk	No
Cliff Swallow	*Petrochelidon pyrrhonota*	-	-	-	S3B	2 May Be At Risk	Yes
Barn Swallow	*Hirundo rustica*	-	Threatened	Endangered	S3B	1 At Risk	Yes
Gray Jay	*Perisoreus canadensis*	-	-	-	S3S4	3 Sensitive	Yes
Boreal Chickadee	*Poecile hudsonica*	-	-	-	S3	3 Sensitive	Yes

Table C1 Bird SOCI Identified in AC CDC Data Search

Common Name	Scientific Name	SARA	COSEWIC	Provincial Rank/Status of Taxon	Provincial Rarity Rank	Provincial GS Rank	Likely to Occur in Assessment Area?
Eastern Bluebird	*Sialia sialis*	-	Not at Risk	-	S3B	3 Sensitive	Yes
Gray Catbird	*Dumetella carolinensis*	-	-	-	S3B	2 May Be At Risk	Yes
Northern Mockingbird	*Mimus polyglottos*	-	-	-	S3B	4 Secure	Yes
Tennessee Warbler	*Vermivora peregrina*	-	-	-	S3S4B	3 Sensitive	Yes
Blackpoll Warbler	*Dendroica striata*	-	-	-	S3S4B	3 Sensitive	Yes
Canada Warbler	*Wilsonia canadensis*	Threatened	Threatened	Endangered	S3B	1 At Risk	Yes
Northern Cardinal	*Cardinalis cardinalis*	-	-	-	S3S4	4 Secure	Yes
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	-	-	-	S3S4B	3 Sensitive	Yes
Bobolink	*Dolichonyx oryzivorus*	-	Threatened	Vulnerable	S3S4B	3 Sensitive	Yes
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern	Endangered	S2S3B	2 May Be At Risk	Yes
Brown-headed Cowbird	*Molothrus ater*	-	-	-	S2S3B	4 Secure	Yes
Pine Grosbeak	*Pinicola enucleator*	-	-	-	S3?B,S5N	2 May Be At Risk	Yes
Pine Siskin	*Carduelis pinus*	-	-	-	S3S4B,S5N	3 Sensitive	Yes

Table C2 Bird Species Observed in 2016 Field Surveys

Common Name	Scientific Name	SARA	COSEWIC	NS ESA	ACCDC S-Rank	NSDNR General Status Rank	Breeding Status
Double-crested Cormorant	*Phalacrocorax auritus*	-	Not at Risk	-	S5B	Secure	Observed
Great Blue Heron	*Ardea herodias*	-	-	-	S4B	Secure	Observed
Osprey	*Pandion haliaetus*	-	-	-	S5B	Secure	Observed
Sharp-shinned Hawk	*Accipiter striatus*	-	Not at Risk	-	S4S5B	Secure	Observed
Ruffed Grouse	*Bonasa umbellus*	-	-	-	S4S5	Secure	Confirmed
Killdeer	*Charadrius vociferus*	-	-	-	S3S4B	Sensitive	Observed
Mourning Dove	*Zenaida macroura*	-	-	-	S5	Secure	Possible
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened	S3B	At Risk	Observed
Yellow-bellied Sapsucker	*Sphyrapicus varius*	-	-	-	S4S5B	Secure	Observed
Hairy Woodpecker	*Picoides villosus*	-	-	-	S5	Secure	Observed
Northern Flicker	*Colaptes auratus*	-	-	-	S5B	Secure	Possible
Eastern Wood-Pewee	*Contopus virens*	-	Special Concern	Vulnerable	S3S4B	Sensitive	Possible
Yellow-bellied Flycatcher	*Empidonax flaviventris*	-	-	-	S3S4B	Sensitive	Possible
Alder Flycatcher	*Empidonax alnorum*	-	-	-	S5B	Secure	Possible
Gray Jay	*Perisoreus canadensis*	-	-	-	S3S4	Sensitive	Possible
Blue Jay	*Cyanocitta cristata*	-	-	-	S5	Secure	Observed
American Crow	*Corvus brachyrhynchos*	-	-	-	S5	Secure	Observed
Common Raven	*Corvus corax*	-	-	-	S5	Secure	Observed
Black-capped Chickadee	*Poecile atricapilla*	-	-	-	S5	Secure	Possible
Red-breasted Nuthatch	*Sitta canadensis*	-	-	-	S4S5	Secure	Possible

Table C2 Bird Species Observed in 2016 Field Surveys

Common Name	Scientific Name	SARA	COSEWIC	NS ESA	ACCDC S-Rank	NSDNR General Status Rank	Breeding Status
Golden-crowned Kinglet	*Regulus satrapa*	-	-	-	S4	Sensitive	Possible
Veery	*Catharus fuscescens*	-	-	-	S4B	Secure	Possible
Hermit Thrush	*Catharus guttatus*	-	-	-	S5B	Secure	Possible
American Robin	*Turdus migratorius*	-	-	-	S5B	Secure	Possible
Gray Catbird	*Dumetella carolinensis*	-	-	-	S3B	May Be At Risk	Possible
Cedar Waxwing	*Bombycilla cedrorum*	-	-	-	S5B	Secure	Possible
European Starling	*Sturnus vulgaris*	-	-	-	SNA	Exotic	Observed
Blue-headed Vireo	*Vireo solitarius*	-	-	-	S5B	Secure	Possible
Red-eyed Vireo	*Vireo olivaceus*	-	-	-	S5B	Secure	Possible
Northern Parula	*Parula americana*	-	-	-	S5B	Secure	Possible
Yellow Warbler	*Dendroica petechia*	-	-	-	S5B	Secure	Possible
Chestnut-sided Warbler	*Dendroica pensylvanica*	-	-	-	S5B	Secure	Probable
Magnolia Warbler	*Dendroica magnolia*	-	-	-	S5B	Secure	Possible
Yellow-rumped Warbler	*Dendroica coronata*	-	-	-	S5B	Secure	Confirmed
Black-throated Green Warbler	*Dendroica virens*	-	-	-	S4S5B	Secure	Possible
Black-and-White Warbler	*Mniotilta varia*	-	-	-	S4S5B	Secure	Possible
American Redstart	*Setophaga ruticilla*	-	-	-	S5B	Secure	Possible
Ovenbird	*Seiurus aurocapilla*	-	-	-	S5B	Secure	Probable
Common Yellowthroat	*Geothlypis trichas*	-	-	-	S5B	Secure	Probable
Northern Cardinal	*Cardinalis cardinalis*	-	-	-	S3S4	Secure	Possible

Table C2 Bird Species Observed in 2016 Field Surveys

Common Name	Scientific Name	SARA	COSEWIC	NS ESA	ACCDC S-Rank	NSDNR General Status Rank	Breeding Status
Song Sparrow	*Melospiza melodia*	-	-	-	S5B	Secure	Probable
White-throated Sparrow	*Zonotrichia albicollis*	-	-	-	S5B	Secure	Possible
Dark-eyed Junco	*Junco hyemalis*	-	-	-	S4S5	Secure	Possible
Common Grackle	*Quiscalus quiscula*	-	-	-	S5B	Secure	Observed
Purple Finch	*Carpodacus purpureus*	-	-	-	S4S5	Secure	Possible
American Goldfinch	*Carduelis tristis*	-	-	-	S5	Secure	Probable