HIGHWAY 104 TWINNING

Sutherlands River to Antigonish

Vegetation Assessment - Technical Report

CBCL LIMITED

Consulting Engineers

NOVA SCOTIA

Transportation and Infrastructure Renewal

151046.14 ● Report ● November 2018

Contents

APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ACCDC	Atlantic Canada Conservation Data Centre
BG	Bog
CEAA	*Canadian Environmental Assessment Act*
cm	centimetre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
FE	Fen
FEC	Forest Ecosystems Classification
GPS	Global Positioning System
IH	Intolerant Hardwood
m	metre
ME	Maine
MR	Marsh
mm	millimetre
MW	Mixedwood
NANH	Natural Areas of New Hampshire
NSDNR	Nova Scotia Department of Natural Resources
NSESA	*Nova Scotia Endangered Species Act*
NH	New Hampshire
NSTIR	Nova Scotia Department of Transportation and Infrastructure Renewal
SARA	*Species at Risk Act*
S-Rank	Subnational rarity ranks
SH	Spruce-Hemlock
SP	Spruce-Pine
USDA	United States Department of Agriculture
VEC	Valued Ecosystem Component
VT	Vegetation Type

CHAPTER 1 INTRODUCTION

1.1 Project Overview

CBCL Limited (CBCL) was contracted by the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) to prepare an Environmental Assessment (EA) Registration document for proposed highway twinning of Highway 104, Sutherlands River to Antigonish. In 2018, supplementary and additional field programs were completed for avifauna, wetlands, vegetation, lichen, aquatics, fish and fish habitat, noise, bats, and moose.

The present study is specific to the flora of Highway 104 (Sutherlands River to Antigonish). The study endeavours to document a suitable baseline of data within that Project area, as may be required for:

- Facilitating future regulatory requirements;
- Establishing conservation priorities for species (or communities) of conservation concern;
- Defining Project design constraints; and
- Implementing mitigation measures during construction and operational phases of the Project.

1.2 Previous Studies

Between 2015 and 2017, CBCL completed a Highway Twinning Feasibility Study on NSTIR's behalf for eight corridors. This Study, consisted of a number of components, which included environmental elements as indicated below:

- Preliminary Screening Assessment:
  - Desktop environmental constraints assessment;
  - Environmental regulatory review;
- Detailed Feasibility Study;
- 2016 Environmental Field Programs:
  - Site Reconnaissance, Breeding Birds, Moose, Owls, Aquatics, Wood Turtles, Wetlands, and Vegetation.

During the *Preliminary Screening Assessment*, CBCL performed a desktop constraints analysis and identified several Valued Ecosystem Components (VECs), including vegetation, that may interact with the proposed highway twinning Project. A number of field studies have since been initiated investigating these VECs; this report presents a summary of the findings of the flora programs for Highway 104.

1.3 Project Boundaries

The proposed highway corridor will link the twinned Highway 104 infrastructure east of Sutherlands River to the twinned Highway 104 infrastructure west of Antigonish (Figure 1.1). The proposed route will include twinning two segments of the existing alignment in addition to the construction of an all new four-lane highway. This new infrastructure will diverge from the present alignment at Barneys River Station and reconnect west of Exit 30 (James River Interchange).

Highway 104 (Sutherlands River to Antigonish) is divided into three subsections:

- Sutherlands River to Barneys River Station;
- Barneys River Station to James River; and
- James River to Antigonish.

Project Area: The 'Project Area' is defined as the Right-of-way for the new highway alignment which includes the daylighting extent or area of impact of the Project; this would include any areas of vegetation clearing, grubbing, cut and fill, etc.

Study Area: The 'Study Area' is defined as the area surveyed, which is the 'Project Area' plus a minimum additional distance of 20 m measured laterally from the 'Project Area'. Through the Barneys River Station to James River, the study area is up to 1 km in width. The study area boundary can be seen on Figure 1.1.

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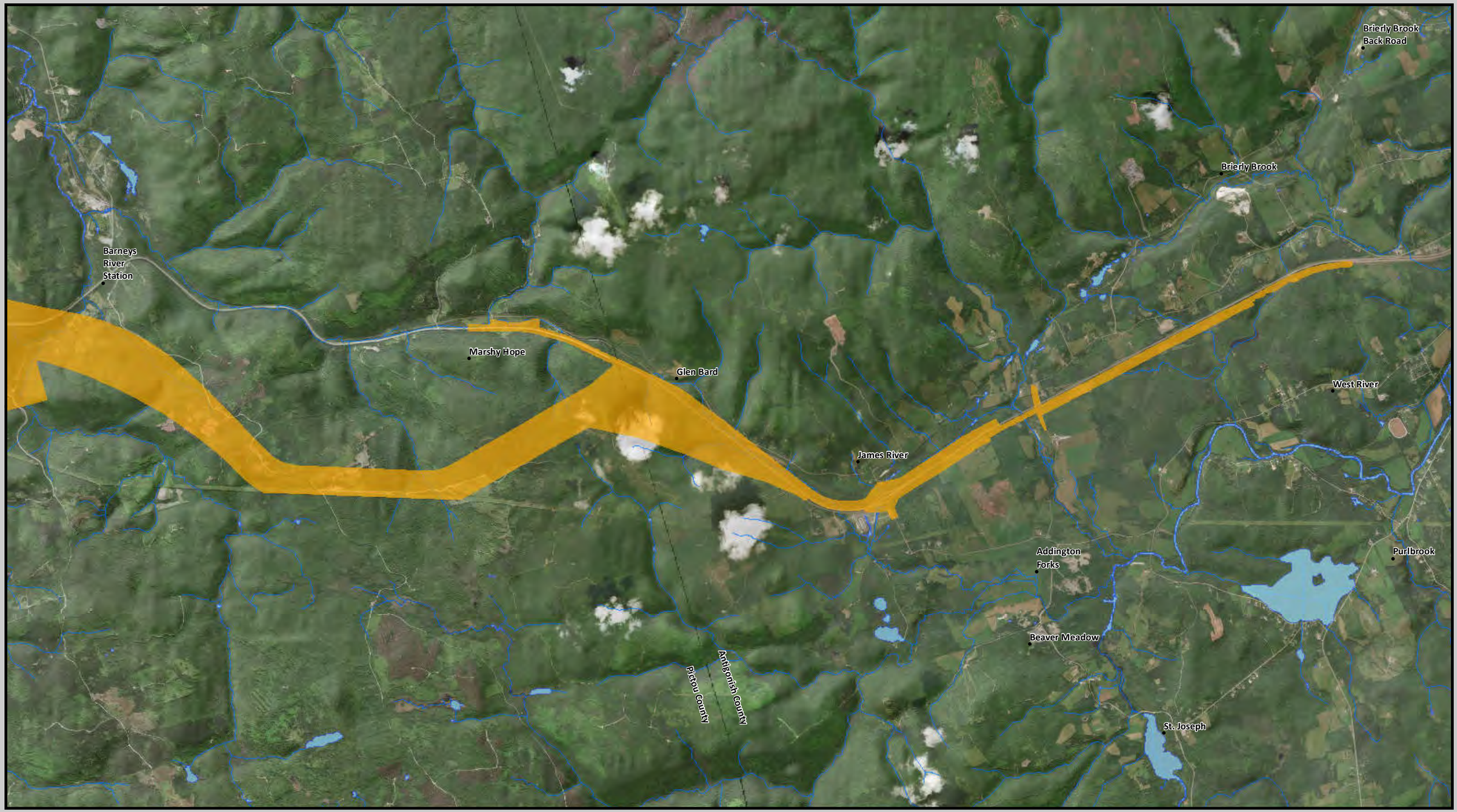
Highway 104
Figure 1.1
Sutherland's River to Antigonish,
Pictou & Antigonish Counties, NS
11/10/2018

0 630 1,260 1,890 2,520 m
1:50,000 Scale when printed at 11"x17"

Study Area
NSGC - 1: 10 000 Waterbodies
NSGC - 1: 10 000 Rivers/ Streams

Document Path: Z:\151046.14 - NSTIR CORRIDOR 4 EA\20 CAD\08 GIS\151046.14 - MXD-033- FIG 1-1 - GENERAL SETTING.mxd



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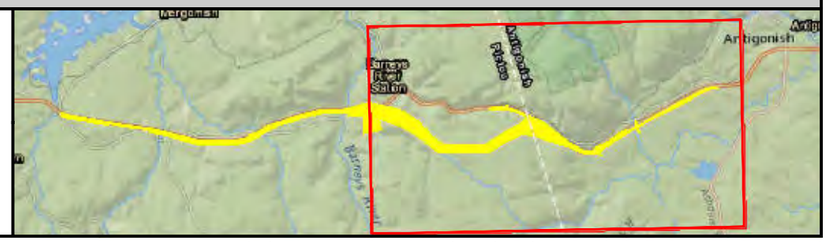


Document Path: Z:\151046.14 - NSTIR CORRIDOR 4 EA\20 CAD\08 GIS\151046.14 - MXD-033- FIG 1-1 - GENERAL SETTING.mxd

1.3.1 *Biophysical Setting*

This section of Highway 104 intersects with the Pictou Antigonish Highlands (west of Antigonish), St. George's Bay (surrounding Antigonish), and the Northumberland Lowlands (east of Sutherlands River) ecodistricts (Neily et al., 2005).

The Pictou Antigonish Highlands ecodistrict is defined by tolerant hardwood and mixedwood forests consisting of American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), red spruce (*Picea rubens*) and sporadic Eastern hemlock (*Tsuga canadensis*) and can be located along the crests and the upper and middle reaches of hills and larger hummocks. Eastern hemlock is often associated with steep slopes along the banks of watercourses. Red spruce and Eastern hemlock are predominantly located in the low-lying areas with black spruce (*Picea mariana*) occupying poorly drained sites. Coarser soils that were deposited during the melting of the glaciers, often found along stream banks, will support stands of white pine (*Pinus strobus*). Old fields that were once tolerant hardwood stands are reclaimed by white spruce (*Picea glauca*).

The St. George's Bay ecodistrict includes most of Antigonish County and extends towards the Cape Breton Hills. This low-lying area is characterised by cool springs, and warm, moist summers. These climatic conditions produce prime growing conditions as seen by the abundance of agricultural lands amongst the rolling hills. Soils are primarily imperfectly drained to moderately drained gravel to gravelly clay loams. Well drained gravelly sand loams are often associated with major tributaries. Gypsum outcrops and karst topography, areas that often support the growth for rare species, are found along the cliffs of St. George's Bay. Natural forest stand compositions are infrequent due to the extensive agricultural disturbance. Abandoned agricultural lands have been reclaimed primarily by white spruce. Under normal conditions, it is likely that tolerant hardwoods including beech, sugar maple, and yellow birch would be present along the upper hillslopes, while tolerant softwoods including red spruce, Eastern hemlock, and white pine would be found along the low-lying areas. Black spruce and tamarack (*Larix laricina*) could be common amongst imperfect to poorly drained soil types.

The Northumberland Lowlands ecodistrict extends along the Northumberland Strait into New Brunswick, seldom exceeding 50 m above sea level. This area is bounded and sheltered by the Cobequid Mountains, Pictou Antigonish Highlands, and the Cumberland Hills. This area consists primarily of black and red spruce. After a disturbance, either natural (i.e., fire) or anthropogenic (i.e., forest harvesting), early successional species including balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and largetooth aspen (*Populus grandidentata*) will likely become established. Tolerant hardwood stands are uncommon to rare in this ecodistrict but can occur along the upper hillslopes with better drained soils.

1.4 General Approach

The over-arching intent of the study was to generate vegetation-related data and produce documents that would support future regulatory submissions in support of the Project's eventual development; these primarily include (but are not limited to) Environmental Assessment applications to NS Environment, pursuant to the *Environment Act*.

CHAPTER 2 METHODOLOGY

2.1 Desktop Review

The Atlantic Canada Conservation Data Centre (ACCDC) maintains linked databases that document species occurring in the Maritimes, as well as the locations at which provincially-rare species are known to occur. A review of the ACCDC database was conducted and a list of flora species of conservation concern (vascular plants and lichens) that were previously identified within a 5 km buffer of the proposed Study area was obtained and evaluated prior to field surveys (ACCDC, 2018). Further details on the desktop vascular plant and lichen desktop studies are provided below.

2.1.1 *Vascular Plants*

Prior to field surveys, basic information on vascular plant communities and species occurring in the Study Area was obtained from a variety of sources, such as the *Natural History of Nova Scotia* (Davis & Browne, 1996), and *Nova Scotia Plants* (Munro, 2014). Information on potential rare or uncommon plant species was also obtained from the ACCDC. Additional specialized references used during the vegetation community and species assessments are listed in their relevant subsections below.

2.1.2 *Lichens*

The objectives of the desktop lichen review were to: 1) determine if uncommon to rare lichen species are present on (or in the vicinity of) the proposed Study Area; and 2) identify any potentially suitable habitat for uncommon or rare lichen species within the proposed Study Area. Information on macrolichen species potentially present within the Study Area, including uncommon and rare species, was derived from a number of sources, such as:

- *Lichens and allied fungi of the Atlantic Maritime Ecozone* (Clayden, 2010);
- *Macrolichens of Nova Scotia: a provisional checklist* (Anderson, 2014);
- *The Macrolichens of New England* (Hinds & Hinds, 2008);
- *Lichens of North America (Brodo et al., 2001);*
- *A Reconnaissance Level Survey of Calciphilous Lichens in Selected Karst Topography in Nova Scotia with Notes on Incidental Bryophytes* (Anderson & Neily, 2010);
- NSDNR's Significant Species and Habitats database;
- Atlantic Canada Conservation Data Centre database (ACCDC, 2018);
- Committee on the Status of Endangered Species in Canada (COSEWIC) reports on individual species;
- Nova Scotia Environment's Predictive habitat maps for rare species (i.e., boreal felt lichen);
- Personal communications with NSDNR biologists;
- Personal communications with local lichenologists; and

- Personal knowledge of CBCL ecologists.

2.2 Vegetation Inventory Surveys

Vegetation surveys focused both on, 1) examining habitats considered highly suitable for containing vascular plant and lichen species of conservation concern, and 2) examining general vascular plant diversity and community composition within the corridor as a whole. Habitats considered to be highest-priority areas for visitation generally include wetlands, floodplains, old-growth forests, and regions of calcareous geology (i.e., gypsum and limestone). The search pattern used in the field was a random meander, an accepted method for detecting presence or absence of plant species, including rare flora. In order to maximize the detection of vascular plants species in flower (which is optimal for proper species identification), the flora surveys were conducted during various seasons ranging from early spring to late summer.

2.2.1 *Definition of Rarity Rankings*

Species ranks are defined by the ACCDC in Sackville New Brunswick; these are described in Table 2.1 below. A more detailed explanation of species rankings can be found in Appendix A (ACCDC, 2017). Species rankings are not static; as more sightings are recorded, ranks can be changed through a process of evaluation by ACCDC.

Table 2.1 Interpretation of Subnational rarity ranks (S-Ranks) after ACCDC, 2017

S1	Extremely rare: May be especially vulnerable to extirpation (typically five or fewer occurrences or very few remaining individuals).
S2	Rare: May be vulnerable to extirpation due to rarity or other factors (six to 20 occurrences or few remaining individuals).
S3	Uncommon, or found only in a restricted range, even if abundant at some locations (21 to 100 occurrences).
S4	Usually widespread, fairly common, and apparently secure with many occurrences, but of longer-term concern (e.g., watch list) (100+ occurrences).
S5	Widespread, abundant, and secure, under present conditions.

For the purposes of the current assessment, all species ranked S3 (including those ranked S3S4) or higher (i.e., S2, S1, S2S3, S1S2, etc.) were considered to be Species of Conservation Concern, and were documented accordingly.

2.2.2 *Vascular Plant Inventory*

Targeted field surveys for vascular plant species were conducted in 2016 and 2018. The large size, linear nature, and varying geomorphological conditions of the Study Area resulted in a relatively large number of habitats and vegetative communities occurring within it.

The field surveys for vegetation focused on examining habitats considered suitable for vascular plant Species of Conservation Concern (SOCC); as well as examining general plant diversity and community composition within the corridor as a whole.

For each species sighting, the plant was identified and tabulated on an overall species inventory. Photos were taken for initial sightings where there was some doubt about identification. When necessary,

specimens were collected for immediate identification (assuming the plant in question appeared abundant); voucher specimens and herbarium samples were not collected. In addition to the prior knowledge of the surveyors, the study team used keys and descriptions from various print and electronic resources, including the following:

- Roland and Smith's *Flora of Nova Scotia* (Zinck, 1998);
- *Nova Scotia Plants* (Munro et al., 2014);
- *Flora of New Brunswick* (Hinds, 2000);
- *Flora Novae Angliae, A Manual of the Identification of Native and Naturalized Higher Vascular Plants of New England* (Haines, 2011);
- *Flora of the Northeast, A Manual of the Vascular Flora of New England and Adjacent New York* (Magee & Ahles, 1999);
- USDA PLANTS Database (USDA, 2017);
- GoBotany Digital Keys (GoBotany, 2017);
- *Sedges of Maine: A field guide to Cyperaceae* (Arsenault, 2013);
- *Newcombs Wildflower Guide* (Newcomb, 1989); and
- *Native orchids of Nova Scotia - A field guide* (Munden, 2001).

Habitats considered to be highest-priority areas for visitation generally include wetlands, floodplains, old-growth forests, and regions of calcareous geology (i.e., gypsum and limestone). The search pattern used in the field was a random meander, an accepted method for detecting presence or absence of plant species, including rare flora.

2.2.3 *Lichen Inventory /Incidental Observations*

Prior to initiation of the field surveys, information on habitat types potentially present within the Study Area was derived from a number of sources, such as:

- Topographical mapping;
- NSDNR's Wet Areas Mapping;
- Watercourse mapping;
- NSDNR wetland mapping;
- CBCL's field delineated wetlands mapping;
- NDSNR forest cover mapping; and
- Surficial geology mapping (for calciphilic species).

The ecological requirements (habitat preferences) of any lichen SOCC or SAR species with potential to occur within the Project area were then compared with the habitats identified within the Study Area. Areas identified as having elevated potential for any lichen SOCC were then identified on mapping of the Study Area. Such areas included:

- Mature forest areas;
- Treed wetlands;
- Riparian zones;
- Small cool watercourses;
- Areas of potential exposed gypsum;
- North-facing slopes; and
- Any other areas deemed to match the habitat requirements of lichen SOCC identified in the desktop species review.

Field surveys for macrolichens were conducted in suitable habitat areas within the Study Area during the 2018 field program. CBCL's team of ecologists, as well as lichenologist Tom Neily, recorded all macrolichen species identified in the target areas of the Study Area. Microlichen observations were also recorded when distinctive species were observed.

Transect surveys were conducted in areas identified in the desktop review as having elevated potential for uncommon or rare lichen species. This method involved a detailed search of the selected habitats within the study area. All accessible microhabitats such as tree trunks and bases, logs, moist sites such as on trees and rocks in wetlands or riparian zones, rock outcrops, areas of bare soil, and any other interesting niches were searched. Lichen specimens were identified in the field based on growth form, colour (both wet and dry) of the thallus, presence, form and/or colour of reproductive structures, presence and structure of rhizines, texture, and habitat. All lichens species noted while meandering through the area were recorded, and a GPS track of the survey was recorded. The survey in each habitat of interest continued until the surveyors felt the majority of species had been detected. Voucher samples were also taken in order to add to the general knowledge of the lichen flora of this region of NS, as well as to confirm species identifications, if necessary.

When a lichen SOCC was identified, information such as geographic coordinates and a detailed habitat description was recorded. This included information on the type of substrate the specimen(s) were growing on, size of thallus, aspect, co-occurring lichen and bryophyte species, and the approximate number of specimens present. Photographs showing details of the upper and lower thallus, including rhizines and any reproductive structures such as apothecia, as well as the general habitat were taken. If the specimen appeared common in the area, a voucher sample was sometimes also taken to aid in identification. This procedure was also followed whenever a species that could not be identified in the field was encountered.

The following documents were used to confirm identifications of lichen species:

- *The Macrolichens of New England* (Hinds and Hinds, 2007);
- *Lichens of North America* (Brodo et al., 2001); and
- *Common Lichens of northeastern North America* (McMullin and Anderson, 2014).

Incidental observations of lichen species were also recorded by CBCL ecologists during other wetland, vegetation, and bird surveys within the Study Area in 2018. In addition, incidental sightings of mosses and liverworts were also recorded during the lichen surveys.

2.3 Community Inventory and Classification

The intention of this study was to document and describe occurrences of distinct vegetation communities that occur within the Study Area.

During surveys, forested ecosystems within the Study Area were identified and classified in the field using the Nova Scotia Department of Natural Resources (NSDNR) Forest Ecosystems Classification (FEC) for Nova Scotia (Neily et al., 2010). For non-forested communities, a number of other regionally applicable vegetation classification systems were consulted; these included:

- Maine Natural Areas Program – Natural Communities and Ecosystems (Govt. of Maine, 2017);

- Natural Communities of New Hampshire – Factsheets and Photo Guide (Govt. of New Hampshire, 2017); and
- Natural Communities of New Hampshire - Technical Manual (Sperduto and Nichols, 2011).

Both the New Hampshire and Maine systems were chosen given their geographic proximity, similarities in climate, and similarities in overall vegetation composition, given that they are within the same temperate broadleaf and mixed-forest biome as Nova Scotia.

The vegetation communities identified within these systems were reviewed in terms of their overall applicability to our local condition. It was found that in many cases, clear parallels exist between the Maine and New Hampshire classifications, and the conditions documented here in Nova Scotia. Where applicable, the nomenclature of these systems was adapted for the present study, and this is indicated accordingly for the applicable community description. There are some cases where species presence differs notably between NH/ME classification and our local observations, but conditions were considered otherwise analogous (i.e., in terms of physical setting, landform affinity, physiognomy); in such cases, descriptions for the given communities were adjusted accordingly, with befitting species added to reflect our local condition.

Sample locations for community classifications were chosen in the field, and were situated (where possible) in areas considered highly representative of a particular community. Where possible, vegetation plot data collected during the separate wetland delineation program in the Study Area were used for community classification. Survey location data were recorded using handheld GPS units and hardcopy sheets. Survey location waypoints were entered into the project database on a regular basis and raw data from field notes transmitted to the Halifax-based project team.

In some cases, community classifications were considered to have characteristics intermediate to two communities, and were noted as such. In many locations, owing to disturbance or early successional development, sites were unable to be discretely classified per the systems noted above. Community classification points are depicted in Appendix B.

2.4 Project Ecological Land Classification (P-ELC)

2.4.1 *P-ELC Study Objectives*

A component of the vegetation studies for the Project was the development of a Project Ecological Land Classification (P-ELC). The purpose of the P-ELC was to provide a landscape-level analysis of major vegetation communities and habitat within the defined P-ELC study area. It is intended that the P-ELC serve as an over-arching component of the vegetation baseline information to be used in the Environmental Assessment (EA) process.

More specifically, the goals of the ELC are to:

- Conduct a rigorous field assessment of the terrestrial environment;
- Generate a remote-sensing-based mapped inventory of ELC Units, which represent umbrella categories for the major vegetation communities encountered during the field surveys (see ‘Community Classification’ in previous sections) and other non-vegetated areas; and the provision of Geographic Information System (GIS) map layers of same;

- Provide a product which serves as the basis for other studies reliant on habitat mapping, i.e., avifauna, mammals, wetlands and rare vegetation;
- Provide an effects assessment tool for quantifying interactions between the Project and the natural environment, as required for various taxa, including Species of Conservation Concern (SOCC) and Species at Risk (SAR); and
- Assessing availability of alternate habitat for SOCC and SAR beyond the footprint of the Project.

The actual execution of any such specific habitat studies using the P-ELC are excluded from the present study.

2.4.2 *National and Provincial Frameworks for ELC*

National and provincial frameworks for ELC were reviewed, and, where possible, equivalent terminology is employed in the present study. These frameworks include:

- The National Ecological Framework for Canada (Ecological Stratification Working Group, 1995); and
- Ecological Land Classification for Nova Scotia (Neily et al., 2003; Neily et al., 2010).

These frameworks reference a nested hierarchy of ecological subdivisions, as follows, with a scale of applicability and definitions per the Ecological Stratification Working Group (1995):

- **Ecozone** (1:7.5M scale): *"An area of the earth's surface representative of large and very generalized ecological units characterized by interactive and adjusting abiotic and biotic factors."*
- **Ecoregion** (1: 5M to 1:2M scale): *"a part of a province characterized by distinctive regional ecological factors, including climatic, physiography, vegetation, soil, water, fauna, and land use."*
- **Ecodistrict:** (1: 3M to 1:1M scale): "*a part of an ecoregion characterized by distinctive assemblages of relief, geology, landforms and soils, vegetation, water, fauna, and land use."*

More refined levels of ecological stratification exist in Nova Scotia, and include the following:

- **Ecosection** (1:50k to 1:100k scale): These are a subdivision of Ecodistricts that are described by unique combinations of enduring landscape features such as soil drainage, soil texture and topographic pattern (Neily et al., 2003); and
- **Ecosite** (1:10k to 1:50k scale): These are subdivisions of Ecosections that are described by site conditions such as elevation, aspect, slope, slope position, soil drainage and texture (Neily et al., 2003). Ecosites have a finite range of soil and site conditions which in turn give rise to a predictable cohort of vegetation types which grow naturally under those conditions (Keys et al., 2010).

2.4.3 *The P-ELC Within Existing Frameworks*

The ELC units generated in the present study represent a range of conditions which are equally identifiable both through field surveys and remote sensing. These conditions are:

1. Major vegetation associations;
2. Vegetation structure; and
3. Wetland status.

2.4.4 *Remote Sensing Image Classification*

General Concepts: The purpose of image classification is to iteratively organize imagery pixels into land-cover information classes, which in this instance are related directly to vegetation communities sampled on the ground. Imagery pixels are placed into these defined classes based on their spectral signature, which is derived from the multiple bands contained in the image. These spectral signatures are generated through the delineation of training areas within a GIS, which are polygons of known vegetation characteristics, as determined during field surveys (whether for vegetation inventory, wetland assessment, watercourse assessment, etc.) or other reference data. Using the spectral signature data, the image classification algorithm in turn performs a pixel-by-pixel analysis of the remaining portions of the imagery in order to assign these remaining pixels to the defined land-cover classes.

Data Sources and Image Processing: The primary source of land-cover imagery for this study was RapidEye multispectral satellite imagery (5 m spatial resolution), The RapidEye product consists of 5 bands of spectral data with ranges as follows:

- Blue (440-510 nm)
- Green (520-590 nm)
- Red (630-685 nm)
- Red Edge (690-730 nm)
- Near Infrared (760-850 nm)

Using the RapidEye data, a Normalized Differential Vegetation Index (NDVI) layer was generated using the Near Infrared (NIR) and Red bands, per the following equation: NDVI = (NIR – Red) / (NIR + Red).

The five RapidEye spectral bands, plus the NDVI were composited into a multiband raster for the purposes of a 'supervised' image classification. 'Training areas' for this classification were developed using the network ecosystem classification field sample locations, and visual interpretation of high resolution imagery. The ecosystem classification points assisted in identifying major vegetation groups such as coniferous, deciduous, and mixed forest, as well as vegetated and un-vegetated non-forest areas (e.g., low herbaceous vegetation, gravel, asphalt, water, etc.). These training areas were in turn used to generate class signatures for each of the defined land-cover classes in the training area dataset. These class signatures are statistical clusters based on the spectral attributes of the various input layers in the multiband raster being classified (ESRI, 2018a). Using the class signature files, a Maximum Likelihood image classification algorithm (ESRI, 2018b) was performed, wherein each cell in the multiband raster is placed into one of the land-cover classes defined in the signature file. Upon execution of the RapidEye land-cover classification, a focal majority filter (ESRI, 2018c) was applied to reduce noise within the classification and to generalize the habitat regions. During this process, each classified image pixel was assigned the majority value found in its immediate 3x3 pixel neighbourhood.

The RapidEye data was supplemented by Light Detecting and Ranging (LiDAR) topographic data (1 m spatial resolution), to introduce various topographic and structural (i.e., vegetation height) parameters to the analysis. LiDAR was acquired from a variety of sources including the Nova Scotia Geomatics Centre Elevation Explorer (NSGC, 2018), and directly from NSTIR. LiDAR data was imported into the GIS as point clouds from raw LAS files from the various data sources. Using these data, a series of seamless raster datasets were generated along the entire length and breadth of the Project corridor, including:

- Digital Surface Model (DSM): An elevation surface derived from interpolation of all ground, and above ground elevation features;
- Digital Elevation Model (DEM): An elevation surface derived from interpolation of ground elevation features only;
- Canopy Height Model (CHM): Defined as the arithmetic difference between the DSM and DEM, and representing the height of all above ground features (predominantly vegetation); and
- Height Above 'Modelled Water Table': Defined as surface describing a modelled height of the LiDAR DEM above a theoretical channel network (as defined by surface topography); for the purposes of this assessment, this output assists in the definition of potential wetland areas or drainage paths through the landscape.

The various component layers were reclassified into categories as described below, and stored as 16-bit raster images with a horizontal resolution of 1 m. These reclassified component layers were summed using ArcGIS 'Raster Calculator' to form the final 'Composite PELC'.

2.4.5 *P-ELC Outputs*

The 'Composite P-ELC' output layer comprise three digit codes describing the various permutations of the component layers as follows.

- *COMPONENT 1: Major Land-cover Class ('100' level codes)*
    - 100: Coniferous
    - 200: Deciduous
    - 300: Mixed Wood
    - 400: Herbaceous
    - 500: Herbaceous/Gravel-Soil
    - 600: Disturbed
    - 700: Water
- *COMPONENT 2: Height Class ('10' level codes)*
    - 10: <0.5 m (Ground Vegetation)
    - 20: 0.5–2 m (Low Shrub)
    - 30: 2-5 m (High Shrub)
    - 40: 5-10 m (Immature Forest)
    - 50: > 10 m (Mature Forest)
- *COMPONENT 3: Wetness Class ('1' level codes)*
  Expressed as height above modelled water table. Values higher than '6' are considered highly likely for wetland presence.
    - 0: >20 m (Very Well Drained)
    - 1: 10-20 m (Very Well Drained)
    - 2: 5-10 m (Well Drained)
    - 3: 2-5 m (Well Drained)
    - 4: 1-2 m (Moderate-Well Drained)
    - 5: 0.5-1 m (Moderate-Poorly Drained)
    - 6: 0.25-0.5 m (Poorly Drained)
    - 7: 0.1-0.25 m (Poorly Drained)
    - 8: 0.05-0.1 m (Very Poorly Drained)
    - 9: < 0.05 m (Very Poorly Drained)

As specific examples of P-ELC code interpretation based on the above:

- P-ELC code '250' represents potential for mature, well drained, deciduous forest;
- P-ELC code '139' represents potential for coniferous shrub wetland;
- P-ELC code '429' represents potential for tall herbaceous-dominated wetland, such as a cattail marsh; and
- P-ELC code '344' represents potential for a moderately well drained, immature mixed forest.

Due to the high number of permutations of 3 digit codes, discrete mapping of the individual P-ELC codes can be challenging to visually interpret. This P-ELC does, however, enable the extraction of very specific landscape parameters and is well suited to analytical mapping within a GIS environment. Using the P-ELC as a foundation, further derivative products and models are able to be generated in support of specific habitat studies, or effects assessments in the context of an Environmental Assessment.

The spatial extent of the P-ELC study area is irregular, and is based upon those areas where both RapidEye and LiDAR data was available. In areas where twinning of existing highway is proposed, the study area ranged from approximately 400-1,000 m wide; in between Barneys River Station and James River (where greenfield development is proposed), the study area is upwards of 13 km wide in its maximum dimension.

2.5 Survey Dates

In order to maximize species identification, the vascular flora surveys were conducted by CBCL Biologists and Technicians specializing in vegetation and ecosystems during various seasons ranging from early spring to late summer, in order to capture most of the species in flower.

- Between May 10 and June 30, 2016;
- Between August 15 and September 18, 2016; and
- Between May 15 and September 7, 2018.

Surveys for lichens, which are identifiable year-round, were conducted simultaneously with the vascular plant surveys in 2018, as an efficiency measure.

Community classification and P-ELC field data collection was ongoing for the duration of the program.

CHAPTER 3 RESULTS

3.1 Desktop Study

Results of the desktop studies for vascular plant and lichens occurring within the Study Area are discussed in the following subsections.

3.1.1 *Vascular Plants*

The ACCDC did not report any vascular or non-vascular plant Species at Risk (SAR) from within the Study Area or 5 km buffer (ACCDC, 2018). The ACCDC report did list a total of 17 vascular plant Species of Conservation Concern (SOCC) from within the Study Area or 5 km buffer (Table 3.1). Some of these are considered to have suitable habitat within the Study Area (Table 3.1). It should be noted that several of these species (*Cystopteris bulbifera, Carex eburnea, Erigeron hyssopifolius, Cypripedium parviflorum, Packera paupercula)* are calcareous species which occur in gypsum areas; no areas of exposed gypsum were observed during field studies.

Table 3.1 Vascular Plant SOCC Reported by ACCDC (2018) from Within 5 km of the Study Area

Common Name	Scientific Name	COSEWIC	ACCDC	Suitable Habitat Within Study Area?
Hyssop-leaved Fleabane	*Erigeron hyssopifolius*	-	S3	No
Marsh Bellflower	*Campanula aparinoides*	-	S3	Possible
Hayden's Sedge	*Carex haydenii*	-	S1	Possible
Canada Lily	*Lilium canadense*	-	S2	Yes
Fragrant Green Orchid	*Platanthera huronensis*	-	S1S2	Possible
Blunt-leaved Pondweed	*Potamogeton obtusifolius*	-	S3	Possible
White-stemmed Pondweed	*Potamogeton praelongus*	-	S3	Possible
Ground-Fir	*Lycopodium sabinifolium*	-	S3?	Possible
Dwarf Clearweed	*Pilea pumila*	-	S1	Possible
Shortawned Foxtail	*Alopecurus aequalis*	-	S3	Yes
Yellow Lady's-slipper	*Cypripedium parviflorum*	-	S2S3	No
Hop Sedge	*Carex lupulina*	-	S3	Yes
Gmelin's Water Buttercup	*Ranunculus gmelinii*	-	S3	Yes
Woodland Strawberry	*Fragaria vesca* ssp. *americana*	-	S3	Yes
Balsam Groundsel	*Packera paupercula*	-	S3S4	No
Bulblet Bladder Fern	*Cystopteris bulbifera*	-	S3	No
Bristle-leaved Sedge	*Carex eburnea*	-	S3S4	No

3.1.2 *Lichens*

The suite of macrolichen species occurring within the Study Area was expected to be similar to that encountered in similar habitats throughout much of the Nova Scotian mainland. No lichen SOCC have been reported to occur within 5 km of the Study Area (ACCDC, 2018), nor have any SAR been reported from Pictou or Antigonish Counties (Anderson, 2014). The desktop review concluded that as of 2014, a total of 119 macrolichen species have been reported from Antigonish and/or Pictou Counties, representing 41 genera (Anderson, 2014; Anderson & Neily, 2010).

Of the 119 species, 19 are considered to be SOCC, with a provincial S-rank of S1, S2, or S3 (Table 3.2). NSDNR also has a list of species is considers to be of conservation concern, which are listed in the Special Management Plan for Boreal Felt Lichen (NSDNR, 2018). These are also indicated in Table 3.2.

Table 3.2 Lichen Species of Conservation Concern (including Species at Risk (bold text)) Reported from within 100 km of the Highway 104 Study Area (ACCDC, 2018) or from Pictou and/or Antigonish Counties (Anderson, 2014), or listed in the latest Special Management Plan for Boreal Felt Lichen (NSDNR, 2018)

Scientific Name	Common Name	COSEWIC	SARA	NSESA	S-Rank	Source of Record(s)/ Reason for Inclusion
Anaptychia palmulata	Shaggy Fringed Lichen	–	–	–	S3S4	• Anderson, 2014 • ACCDC, 2018 (N=6, closest 51 km)
Anzia colpodes	Black-foam Lichen	–	Threatened	Threatened	S3	• ACCDC, 2018 (N=2, closest 84.9 km) • Included in SMP for BFL
Arctoparmelia incurva	Finger Ring Lichen	–	–	–	S3S4	• Anderson, 2014
Bryoria capillaris	Gray Horsehair Lichen	–	–	–	S3S4	• Anderson, 2014 • ACCDC, 2018 (N=8, closest 85 km (PEI))
Bryoria chalybeiformis	Resplendent Horsehair Lichen	–	–	–	SNA	• Anderson, 2014
Cladina stygia	Black-footed Reindeer Lichen	–	–	–	S3?	• ACCDC, 2018 (N=2, closest 87 km)
Cladonia phyllophora	Felt Lichen	–	–	–	S2S3	• Anderson, 2014
Coccocarpia palmicola	Salted Shell Lichen	–	–	–	S3S4	• ACCDC, 2018 (N=304, closest 44 km)
Collema nigrescens	Blistered Tarpaper Lichen	–	–	–	S3	• ACCDC, 2018 (N=4, closest 63 km)
*Collema tenax**	Soil Tarpaper Lichen	–	–	–	S3	• Anderson, 2014

Scientific Name	Common Name	COSEWIC	SARA	NSESA	S-Rank	Source of Record(s)/ Reason for Inclusion
Degelia plumbea	Blue Felt Lichen	SC	SC-2010	Vulnerable	S3	• (N=59, closest 49.1 km) • Included in SMP for BFL
Erioderma mollissimum	Graceful Felt Lichen	–	E	E	S1S2	• ACCDC, 2018 (N=10, closest=59.4 km) • Included in SMP for BFL
Erioderma pedicellatum (Atlantic pop.)	Boreal Felt Lichen - Atlantic pop.	E	E	E	S1	• ACCDC, 2018 (N=426, closest=40.6 km)
*Evernia prunastri**	Valley Oakmoss Lichen	–	–	–	S3S4	• Anderson, 2014; ACCDC, 2018 (N=2, closest 82 km)
Fuscopannaria ahlneri	Corrugated Shingles Lichen	–	–	–	S3	• ACCDC, 2018 (N=33, closest 39 km) • of Concern to NSDNR
Fuscopannaria leucosticta	Rimmed Shingles Lichen	–	–	–	S2S3	• ACCDC, 2018 (N=5, closest 60 km)
Heterodermia neglecta	Fringe Lichen	–	–	–	S3S4	• ACCDC, 2018 (N=9, closest 46 km)
Heterodermia speciosa	Powdered Fringe Lichen	–	–	–	S3	• Anderson, 2014 • ACCDC, 2018 (N=2, closest 42 km)
Heterodermia squamulosa	Scaly Fringe Lichen	–	–	**	S3	• Of Concern to NSDNR
Hypogymnia vittata	Slender Monk's Hood Lichen	–	–	–	S3S4	• ACCDC, 2018 (N=12, closest 65 km)
Leptogium corticola	Blistered Jellyskin Lichen	–	–	–	S3	• ACCDC, 2018 (N=13, closest 54 km)
Leptogium hibernicum	Hibernia Jellyskin Lichen	–	–	–	S1	• Included in SMP for BFL
*Leptogium intermedium**	Forty-five Jellyskin Lichen	–	–	–	S1S2	• Anderson, 2014
*Leptogium lichenoides**	Tattered Jellyskin Lichen	–	–	–	S3	• Anderson, 2014
Leptogium saturninum	Bearded Jellyskin Lichen	–	–	–	SNA	• ACCDC, 2018 (N=4, closest 94 km)
Leptogium subtile	Appressed Jellyskin Lichen	–	–	–	S3	• ACCDC, 2018 (N=2, closest 60 km)

Scientific Name	Common Name	COSEWIC	SARA	NSESA	S-Rank	Source of Record(s)/ Reason for Inclusion
Leptogium tenuissimum	Birdnest Jellyskin Lichen	–	–	–	S2S3	• ACCDC, 2018 (N=1 @ 60 km)
Leptogium teretiusculum	Beaded Jellyskin Lichen	–	–	–	S2?	• ACCDC, 2018 (N=2, closest 34 km)
Lichina confinis	Marine Seaweed Lichen	–	–	–	S1?	• ACCDC, 2018 (N=1 @ 90.6 ± 2.0)
Melanohalea olivacea	Spotted Camouflage Lichen	–	–	–	S3S4	• Anderson, 2014
Moelleropsis nebulosa	Blue-gray Moss Shingle Lichen	–	–	–	S3	• ACCDC, 2018 (N=29, closest 54 km), •
Nephroma bellum	Naked Kidney Lichen	–	–	–	S3	• Anderson, 2014; • ACCDC, 2018 (N=2, closest 56 km)
Pannaria lurida	Wrinkled Shingle Lichen	–	Threatened	Threatened (2016)	S1S2	• Included in SMP for BFL
Parmelia fertilis	Fertile Shield Lichen	–	–	–	S2S3	• Anderson, 2014
Parmeliella parvula	Poor-man's Shingles Lichen	–	–	–	S1?	• ACCDC, 2018 (N=1, 65 km), • included in SMP for BFL
Parmeliopsis hyperopta	Gray Starburst Lichen	–	–	–	S3S4	• Anderson, 2014
Parmeliopsis hyperopta	Gray Starburst Lichen	–	–	–	S3S4	• ACCDC, 2018 (N=2, closest 52.2 ± 1 km)
Peltigera collina	Tree Pelt Lichen	–	–	–	S2?	• ACCDC, 2018 (N=10, closest 54.8 ± 5 km)
Peltigera hydrothyria	Eastern Waterfan	–	Threatened	Threatened (2013)	S1	• ACCDC, 2018 (N=1, closest=50.6 ± 1.0), • included in SMP for BFL
Peltigera malacea	Veinless Pelt Lichen	–	–	–	S1S2	• Anderson, 2014
Physconia detersa	Bottlebrush Frost Lichen	–	–	–	S3S4	• ACCDC, 2018 (N=3, closest 85 km)
Platismatia norvegica	Oldgrowth Rag Lichen	–	–	–	S3	• Anderson, 2014
Ramalina thrausta	Angelhair Ramalina Lichen	–	–	–	S3	• ACCDC, 2018 (N=1, 88 km)

Scientific Name	Common Name	COSEWIC	SARA	NSESA	S-Rank	Source of Record(s)/ Reason for Inclusion
Sclerophora peronella (Nova Scotia pop.)	Frosted Glass-whiskers Lichen - Nova Scotia pop.	SC	SC	–	S1?	• ACCDC, 2018 (N=10, closest=56.7 km), • included in SMP for BFL
*Solorina saccata**	Woodland Owl Lichen	–	–	–	S2S3	• Anderson, 2014
Stereocaulon condensatum	Granular Soil Foam Lichen	–	–	–	S2S3	• Anderson, 2014
Stereocaulon intermedium	Pacific Brain Foam Lichen	–	–	–	S1S3	• Anderson, 2014
Sticta fuliginosa	Peppered Moon Lichen	–	–	–	S3	• ACCDC, 2018 (N=8, closest 44.4 ± 2 km)
Sticta limbata	# Powdered Moon Lichen (eastern population)	–	–	–	S1S2	• Included in SMP for BFL
Usnea diplotypus	Ragged Beard Lichen	–	–	–	SNA	• Anderson, 2014
Usnea hirta	Bristly Beard Lichen	–	–	–	S3	• Anderson(2014)
Usnea mutabilis	Bloody Beard Lichen	–	–	–	S2S3	• ACCDC, 2018 (N=1, 86 km)

*= Calciphilic lichen species reported in Anderson & Neily (2010).
**Likely to be reviewed soon, according to NSDNR

Several of the lichen SOCC reported from Antigonish County are species associated with calcareous soils (Anderson & Neily, 2010). No exposed karst areas or gypsum outcrops were encountered in the Study Area during the field surveys in 2016 or 2018.

Of the 6 lichen SAR reported within 100 km, three (blue felt lichen, graceful felt lichen, and boreal felt lichen) occur mostly in humid Atlantic coastal forests within NS, which do not occur within Pictou or Antigonish counties. Many of these species are likely records from the Atlantic coastal forests of neighbouring Guysborough County. With the exception of blue felt lichen, suitable habitat is not expected to be present for these species within the Study Area.

None of the other three SAR species have been reported from Antigonish or Pictou counties (Anderson, 2014). Frosted glass whiskers is a tiny cryptic microlichen which grows only on exposed heartwood of red maple trees in mature/old growth hardwood forest. This species is not expected to occur within the Study Area.

Eastern waterfan is an aquatic species which grows at or below water level in cool, clear, partially shaded streams, and occurs in a small number of watercourses scattered throughout NS (COSEWIC,

2013). Based on conversations with lichenologists familiar with this species, Eastern waterfan has some potential to occur in watercourses within the Study Area.

Black-foam lichen occurs on sites dominated by mature deciduous trees with high humidity and moderate light (COSEWIC, 2015). There is some potential for suitable habitat to occur within the Study Area, although this species has not been reported from Antigonish or Pictou Counties (Anderson, 2014; COSEWIC, 2015).

Two additional macrolichen species, resplendent horsehair lichen (*Bryoria chalybeiformis*) and ragged beard lichen (*Usnea diplotypus*) are reported from Pictou and Antigonish counties; however, they have not been assessed by ACCDC and their current status within NS is uncertain (Table 3.2).

3.2 Vegetation Inventory

3.2.1 *Vascular Plant Diversity and Species of Conservation Concern Detected in the Study Area*

During the field surveys, a total of 464 species representing 76 families of vascular flora were encountered within the Study Area. The complete inventory of vascular plant species encountered in the Study Area is presented in Appendix C.

A total of seven vascular plant SOCC, including one SAR, were detected in the Study Area during the 2016 and 2018 field surveys. These are listed in Table 3.3, along with their ACCDC ranks for NS. Distributions of these species are depicted in Appendix B, while species description are provided below.

Table 3.3 Vascular Plant Species of Conservation Concern Detected During Field Surveys

Common Name	Species	Rank	# of Occurrence Locations
Black ash	*Fraxinus nigra*	NSESA - Threatened ACCDC - S1S2	10
Large purple fringed orchid	*Platanthera grandiflora*	S3	8
Blue vervain	*Verbena hastata*	S3	2
Halberd-leaved tearthumb	*Polygonum arifolium*	S2	2
Lesser pyrola	*Pyrola minor*	S3	2
Meadow horsetail	*Equisetum pratense*	S3	2
Hop sedge	*Carex lupulina*	S3	4

Black Ash *(Fraxinus nigra):* Black ash trees have a yellowish bark and are typically rather small, rarely reaching the height or diameter of the more common white ash (*Fraxinus americana*). Black ash trees are characteristic of poorly drained soils and are found in lowlands, wooded swamps, wet woods and intervales (Magee and Ahles, 1999; Haines, 2011; Hinds, 2000; Roland and Zinck, 1998).

It can be distinguished from white ash by the number of leaflets present on its compound leaf; white ash typically have 5-9 stalked leaflets, whereas black ash typically have 7-11 sessile leaflets (Roland and Zinck, 1998). In Nova Scotia, black ash trees typically flower from May to June and lack a corolla entirely. The fruit is a single-seeded achene with a single distal wing (Roland and Zinck, 1998; Munro et al., 2014). The species distribution ranges from Manitoba to Newfoundland. Within Nova Scotia, it is observed

from Digby and central Lunenburg counties to northern Cape Breton. Scattered in the northern part of the province, it is rare elsewhere (Roland and Zinck, 1998; Munro et al., 2014). Black ash is a significant species to Mi'kmaq First Nations as it is an important cultural plant used in basket-weaving and other handcrafts (Munro et al., 2014).

Black ash is listed under the NSESA as 'Threatened', while the ACCDC lists it as S1S2 ('Critically Imperiled to Imperiled') within the province of Nova Scotia. A total of twelve specimens of Black ash were found at 10 locations within the surveyed area, generally in shrub or treed swamps, or floodplains (Figure 3.1, Appendix B).

Figure 3.1 Black ash (*Fraxinus nigra*) as noted at several locations within the Study Area. (L) The pinnately compound leaf, variably consisting of 7-11 sessile leaflets; and (R) the small-diameter growth habit, corky bark, and typical swamp habitat of this species.

Large purple-fringed orchid *(Platanthera grandiflora):* *Platanthera grandiflora* is one of the two purple-fringed orchids found in Nova Scotia. Both species bear lilac to purple flowers on a raceme with three-parted, coarsely fringed lips (Figure 3.2). However, *P. grandiflora* is larger of the two, ranging from 27-120 cm (FNA, 2017) but typically exceeding 60 cm in height (Munro et al., 2014). Its inflorescence and lip are both wider at 5-9 cm and 1.8-2.5 cm, respectively, than the small purple-fringed orchid (*Platanthera psycodes*); additionally, more than one-third of the deeply indented lip is fringed, and its leaves are wider and more elliptic in shape than its smaller variant (Roland and Zinck, 1998). Both species are found in similar habitats (e.g., wet meadows and riverine areas) in Canada east of Ontario. In Nova Scotia, these species may be further distinguished based on their range and flowering period. For example, *P. psycodes* is common throughout the province, while *P. grandiflora* is rare in south-western counties, and *P. grandiflora* blooms in July approximately two weeks prior to *P. psycodes* (Roland and Zinck, 1998; Munro et al., 2014), apparently with little or no overlap (Munden, 2001).

The ACCDC lists this species as S3 ('Vulnerable') in NS. Large purple fringed orchid was found at eight locations within the Study Area, primarily in wetland or ditch habitats (Appendix B).

Figure 3.2 Large purple-fringed orchid (*Platanthera grandiflora*) typical form, some flowers still unopened.

Figure 3.3 Blue vervain (*Verbena hastata*) specimen from the Study area.

Blue vervain *(Verbena hastata):* This tall, herbaceous plant is most noticeable when flowering (Figure 3.3), which occurs roughly from August to September in Nova Scotia (Roland and Zinck, 1998). It bears numerous erect spikes of small, tubular blue flowers composed of five lobes. The gray-green, doubly serrated, lance-shaped leaves are oppositely orientated on a quadrangular stem. The plant is limited to rich mucky soils along flood plains, river terraces, wet meadows and marshes, ranging from British Columbia to Nova Scotia and south to Florida (Magee and Ahles, 1999; Haines, 2011; Hinds, 2000; Roland and Zinck, 1998) Locally, it is considered rare (Pronych and Wilson, 1993) only found in scattered populations across Queens, Annapolis and Cumberland counties, and east to Cape Breton (Roland and Zinck, 1998).

The ACCDC lists blue vervain as S3 in NS, meaning its conservation status is 'Vulnerable' in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation. Blue vervain was found at two locations within the Study Area (Appendix B).

Halberd-leaved tearthumb (*Polygonum arifolium*): Halberd-leaved tearthumb is a rough, clinging, herbaceous plant (Figure 3.4) that prefers rich alluvial soils and is most commonly found in wooded swamps, alder thickets, marshy edges and other freshwater wetland-types (Magee and Ahles, 1999; Haines, 2011; Hinds, 2000; Roland and Zinck, 1998). It has a weakly erect, branching quadrangular stem armed with fine, recurved spikes and broadly arrow-shaped leaves with wide flaring lower lobes, from which it earns its common name (Roland and Zinck, 1998; Munro et al., 2014). Its leaves can be up to

0.15 m wide to 0.20 m long, bear fine stellate hairs underneath, as well as another row of fine, recurved spikes along the underside of the midrib (Roland and Zinck, 1998; Munro et al., 2014).

It bears small white or pink terminal flowers, typically blooming late summer and into the fall in Nova Scotia (Roland and Zinck, 1998; Munro et al., 2014). This species has been reported from observations in Kings, Annapolis, Colchester, Cumberland, and Pictou counties (Roland and Zinck, 1998; Munro et al., 2014).

The ACCDC ranks halberd-leaved tearthumb as S2 ('Imperiled') in NS, because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the province. Halberd-leaved tearthumb was found at two locations within the Study Area, in wetland habitats (Appendix B).

Figure 3.4 The conspicuously hastate leaves, and typical sprawling growth habit of halberd-leaf tearthumb (*Polygonum arifolium*).

Lesser pyrola (*Pyrola minor*) is a small perennial plant with oval-shaped basal leaves. In Nova Scotia it is considered to be characteristic of mature coniferous forests (Munro et al., 2014). It bears small white nodding flowers, typically blooming during July and August in Nova Scotia (Munro et al., 2014). This species has a scattered distribution from Digby Neck to Kentville and east to Cape Breton (Munro et al.,

2014). The ACCDC ranks this species as S3 ('Vulnerable') in the province of Nova Scotia. Lesser pyrola was found at two locations within the Study Area, in coniferous treed wetland habitats (Appendix B).

Meadow horsetail (*Equisetum pratense*) is a low-growing perennial plant which has jointed hollow stems and whorled branches covered in scale-like leaves. Munro et al. (2014) state it is uncommon in Nova Scotia, and limited to alluvial thickets, pastures and treed streamsides, including gravelly bars. It is known to occur in Hants, Colchester, Cumberland, Victoria, and Inverness counties.

The ACCDC ranks meadow horsetail as S3 ('Vulnerable') in the province of Nova Scotia. Meadow horsetail was found at two locations within the Study Area, in forested seeps adjacent to small watercourses (Appendix B).

Hop sedge (*Carex lupulina*) is a rather large and conspicuous sedge species, with a large (10+ cm typical) inflorescence typically comprising 2-5 pistillate (female) spikes, each 2.5-6.5 cm in length (Figure 3.5). This species flowers and fruits starting in June, and in our area is primarily found in mucky soils in forests, swamps, swales and intervales (Munro et al., 2014). Within Nova Scotia, distribution of this species is scattered and local from Shelburne to Cumberland counties.

The ACCDC ranks hop sedge as S3 ('Vulnerable') in the province of Nova Scotia. Hop sedge was found at four locations within the Study Area (Appendix B).

Figure 3.5 Hop sedge (*Carex lupulina*).

3.2.2 *Lichen Diversity and Species of Conservation Concern*

A total of 94 species of lichens, representing 27 families, were detected within or adjacent to the Study Area by CBCL ecologists in 2018. The full inventory is provided in Appendix C.

Of the 94 species, 14 are considered to be SOCC, while one is also a SAR. These are summarized in Table 3.4 and discussed below. Locations of lichen SOCC within the Study Area are depicted in Appendix B.

Table 3.4 Lichen Species of Conservation Concern Detected by CBCL in the Study Area

Common Name	Scientific Name	Rank
Blue felt lichen	***Degelia plumbea***	**S3, NSESA Threatened**
A jellyskin lichen	*Leptogium acadiense (*recently split from *L. saturninum)*	S3S4
Appressed jellyskin lichen	*Leptogium subtile*	S3
Beaded jellyskin lichen	*Leptogium teretiusculum*	S2?
Birdnest jellyskin lichen	*Leptogium tenuissimum*	S2S3
Brookside stippleback lichen	*Dermatocarpon luridum*	S3S4
Crumpled bat's wing lichen	*Collema leptaleum*	S2S3
Granular soil foam lichen	*Stereocaulon condensatum*	S2S3
Naked kidney lichen	*Nephroma bellum*	S3
Pompom-tipped shadow lichen	*Phaeophyscia pusilloides*	S3?
Scaly pelt lichen	*Peltigera lepidophora*	S1
Shaggy fringed lichen	*Anaptychia palmulata*	S3S4
Shelter shingle lichen	*Vahliella leucophaea*	S3S4
Scaly pelt lichen	*Peltigera lepidophora*	S1

Blue felt lichen (*Degelia plumbea*) is a large foliose lichen which grows on hardwoods in forested areas (Figure 3.6). It is sensitive to acid rain as well as to changes in humidity regimes. In Canada, it is found only in the Atlantic Provinces, and is most frequent in Nova Scotia (COSEWIC, 2010). This lichen is listed as 'Special Concern' under SARA, as 'Vulnerable' under the NSESA (2013) and as S3 (or 'Vulnerable') in Nova Scotia by the ACCDC. Blue felt lichen was found in one location within the Study Area but beyond the anticipated Project footprint, as well as at a second location outside of the Study Area (Appendix B).

Figure 3.6 Blue felt lichen (*Degelia plumbea*).

Beaded jellyskin lichen (*Leptogium teretiusculum*) is a small jelly lichen (Figure 3.7) which is usually found on basic bark or moist rocks, though occasionally it occurs among mosses on the ground (National Biodiversity Network Atlas, undated). This species has recently been renamed to ***Scytinium teretiusculum,* though this change in nomenclature is not currently adopted within the ACCDC ranks.** Hinds and Hinds (2007) state simply that *L. teretiusculum* occurs on trees. Although it is widely scattered in temperate regions of the Northern Hemisphere in Western Europe and North America, it is not often collected, likely due to its very small size and inconspicuous appearance. It is ranked as S2? or 'Imperiled' by the ACCDC in Nova Scotia. Within the Highway 104 Study Area, the beaded jellyskin lichen was detected at sixteen locations, growing on sugar maple and occasionally white ash (Appendix B).

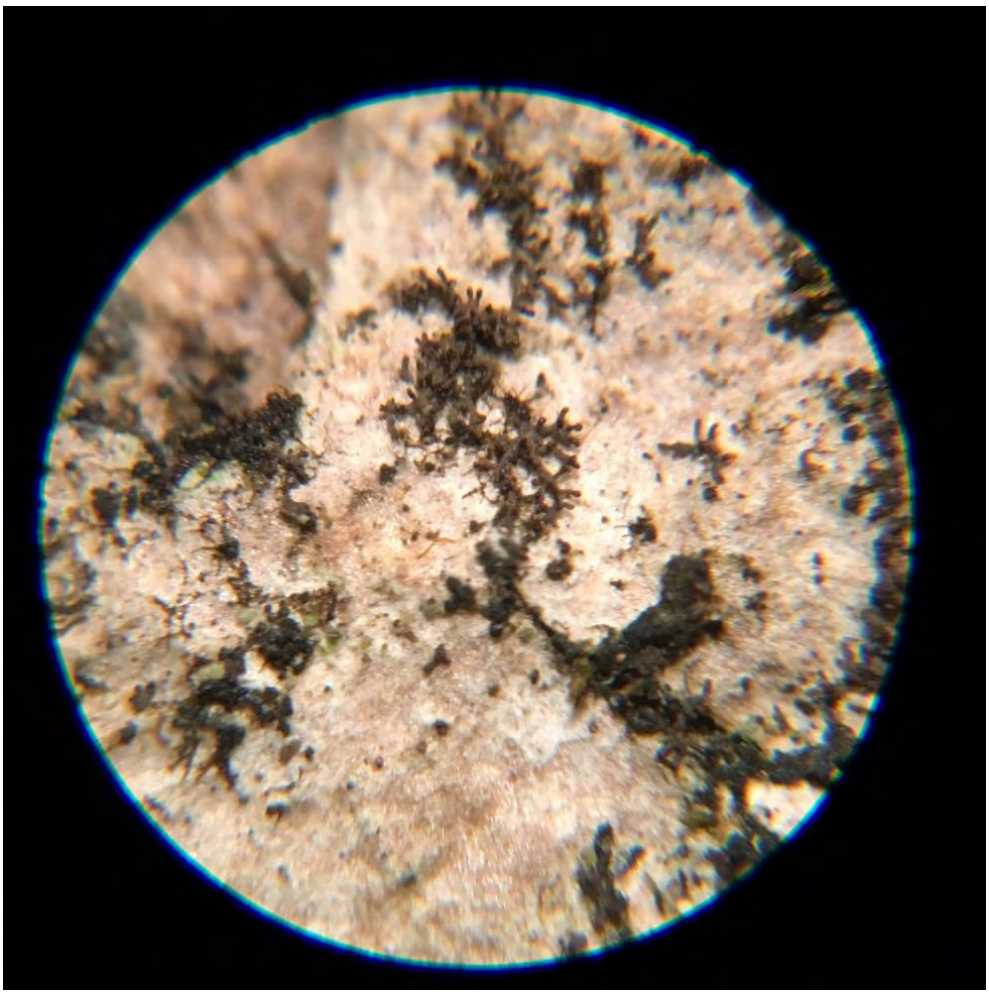


Figure 3.7 Beaded jellyskin lichen (*Leptogium teretiusculum*)

An **unnamed jellyskin lichen *(Leptogium acadiense)*** is a foliose jelly lichen which has only recently been recognized as a separate species from the bearded jellyskin lichen, *Leptogium saturninum* (Stone et al., 2016). It does not yet have a common name, and little published habitat information is available for this species, due to its recent recognition (Figure 3.8). The 'parent' species, *L. saturninum*, from which *L. acadiense* has been separated, is ranked as S3S4 (or 'Vulnerable' to 'Apparently Secure') in Nova Scotia by the ACCDC. *L. saturninum* grows on a variety of tree bark, especially poplar and willow, and sometime on mossy rocks (Brodo et al. 2001). Hinds and Hinds (2007) also state L*. saturninum* sometimes grows on calcareous rock. Within the Highway 104 Study Area, *Leptogium acadiense* was detected at four locations, growing on sugar maple in mixed wood forest habitat (Appendix B).

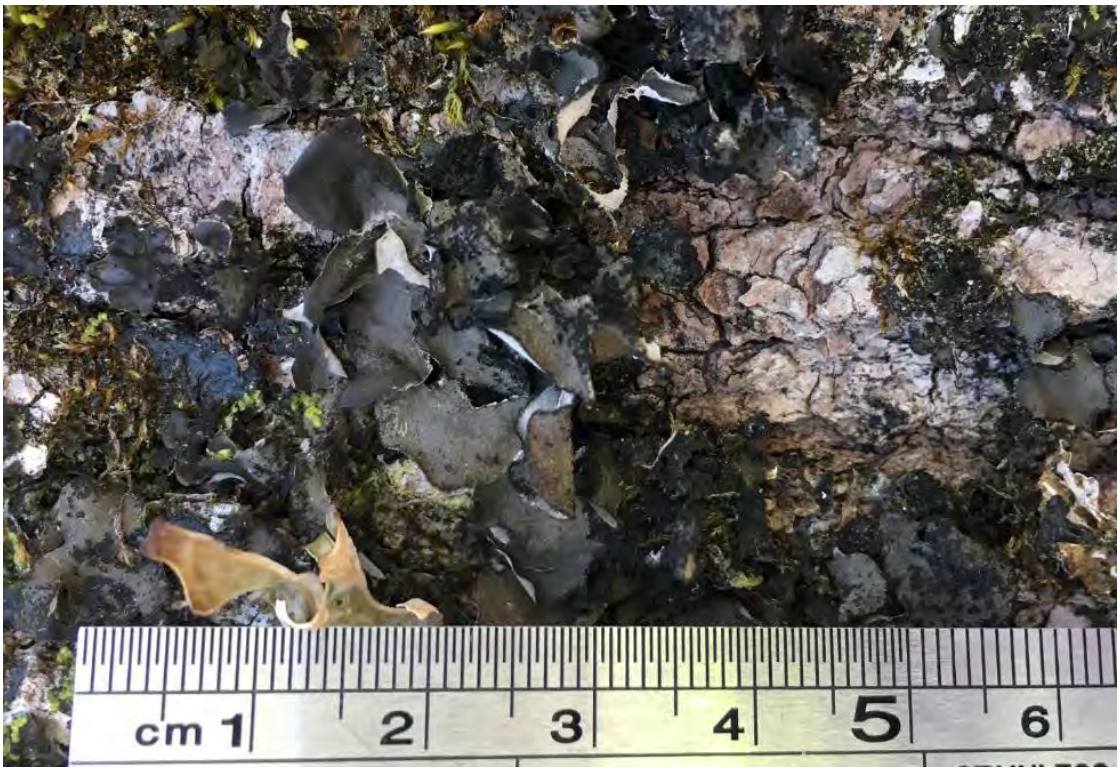


Figure 3.8 An unnamed jellyskin lichen (*Leptogium acadiense*).

Appressed jellyskin lichen (*Leptogium subtile*) is a small foliose jelly lichen which grows on rotting bark, wood or detritus at intermediate elevations. (Consortium of North American Lichen Herbaria, online). It is ranked as S3 (or 'Vulnerable') in Nova Scotia by the ACCDC. Within the Highway 104 Study Area, it was detected at 18 locations, growing on red maple or white ash trunks or bases, often growing amongst moss (Figure 3.9 and Appendix B).

Figure 3.9 Appressed jellyskin lichen (Leptogium subtile) in habitat (left) and closeup (right).

Shaggy fringe lichen (*Anaptychia palmulata*) is a foliose lichen which grows on the bark of hardwoods or white cedar or on shaded rocks (Brodo et al., 2001). It is ranked as S3S4 (or 'Vulnerable' to 'Apparently Secure') in Nova Scotia by the ACCDC. Within the Highway 104 Study Area, it was detected at six locations (Figure 3.10), growing mostly in deciduous or mixedwood forests (Figure 3.10 and Appendix B).

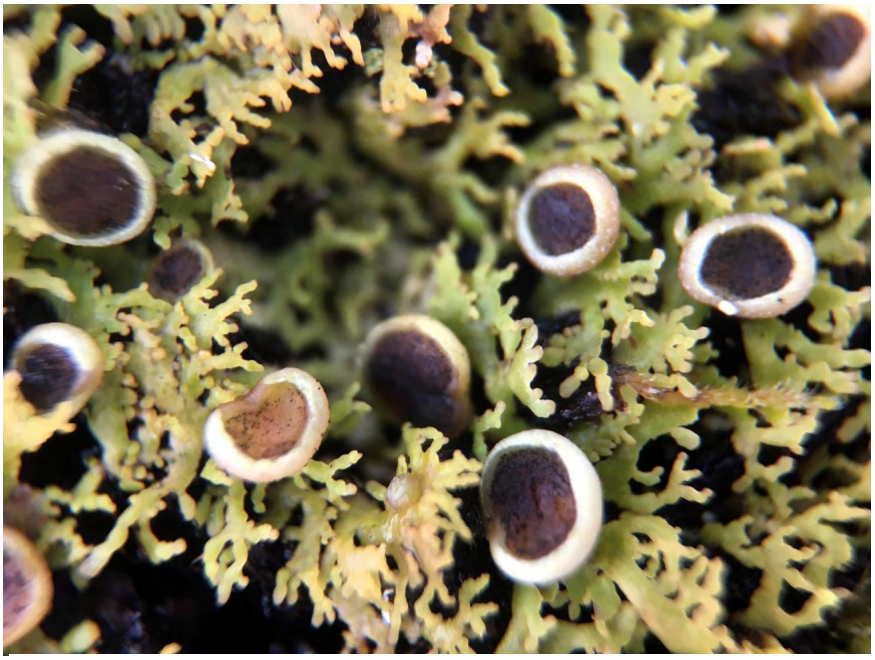


Figure 3.10 Shaggy fringe lichen (*Anaptychia palmulata*).

Rock shingle lichen (*Vahliella leucophaea*) was formerly known as *Fuscopannaria leucophaea* (Jørgensen, 2008). This species is a squamulose lichen which grows on various kinds of rock in shaded locations, particularly in seepy areas of wet rock (Brodo et al., 2001). It is ranked as S3S4 (or 'Vulnerable' to 'Apparently Secure') in Nova Scotia by the ACCDC. It was found at one location within the Study Area, growing on a rock in shaded upland forest habitat (Figure 3.11 and Appendix B).

Figure 3.11 Rock shingle lichen (*Vahliella leucophaea*).

Pompom-tipped shadow lichen *(Phaeophyscia pusilloides)* is a small foliose lichen which occurs on bark of all kinds, and sometimes calcareous rock (Brodo et al., 2001). It is ranked as S3? (or 'Vulnerable' with some uncertainty) in Nova Scotia by the ACCDC. Pompom-tipped shadow lichen was detected at four locations within the Study Area, growing in mature mixed wood and hardwood forest, primarily on sugar maple (Figure 3.12 and Appendix B).

Figure 3.12 Pompom-tipped shadow lichen (*Phaeophyscia pusilloides*).

Crumpled bat's wing lichen (*Collema leptaleum*) is a foliose lichen which grows on bark, especially on hardwoods (Hinds and Hinds, 2007). It is ranked as S2S3 (or 'Imperiled' to 'Vulnerable') by the ACCDC in Nova Scotia. Crumpled bat's wing lichen (Figure 3.13) was found in two wetland locations within the eastern twinning portion Study Area, growing on trunks of mature red maple (Figure 3.13 and Appendix B).

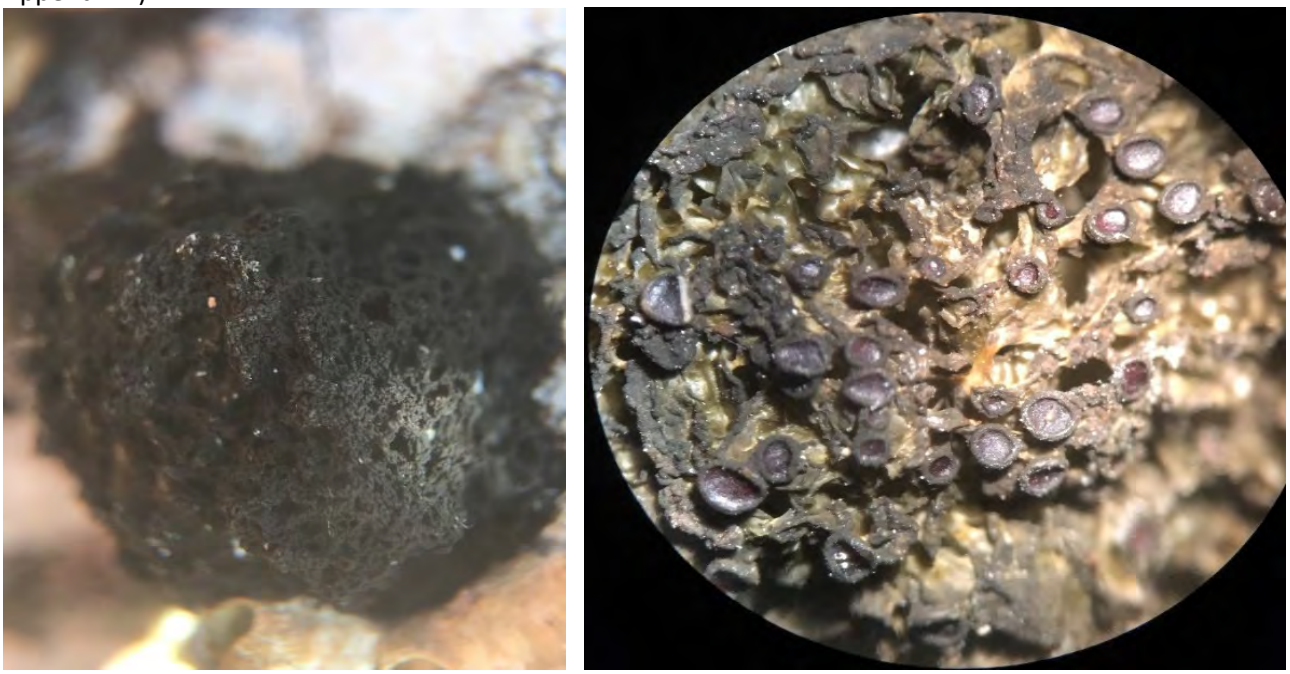


Figure 3.13 Crumpled bat's wing lichen (*Collema leptaleum*). Whole thallus (left) and detail (right).

Birdsnest jellyskin lichen (*Leptogium tenuissimum*) is a small jellyskin lichen which typically occurs on sandy soil, often among mosses, but sometimes also on bark or sandstone (Hinds and Hinds, 2007). This species has recently been renamed to *Scytinium tenuissimum,* though this change in nomenclature is not currently adopted within the ACCDC ranks. It is ranked as S2S3 (or 'Imperiled' to 'Vulnerable') in Nova Scotia by the ACCDC. This species was found at six locations within the Highway 104 Study Area (Figure 3.14), typically on the mossy bases of white ash, red maple and willow trees (Figure 3.14 and Appendix B).

Figure 3.14 Birdsnest jellyskin lichen *(Leptogium tenuissimum*)

Naked kidney lichen (*Nephroma bellum*) is a medium-sized brown foliose lichen with kidney-shaped reproductive structures (apothecia). It is said to grow on branches and twigs of trees, particularly conifers, and on mossy rocks in humid forests (Brodo et al., 2001), although Hinds and Hinds (2007) state it grows on mossy tree trunks as well. It is ranked as S3 (or 'Vulnerable') in Nova Scotia by the ACCDC. This species was found at seven locations within the Study Area (Figure 3.15 and Appendix B).

Figure 3.15 Naked kidney lichen (*Nephroma bellum*).

Brookside stippleback lichen (*Dermatocarpon luridum)* is an aquatic foliose lichen which grows on siliceous rocks in and along streams and at lake edges (Brodo et al., 2001) on wet rocks (Hinds and Hinds, 2007). It is ranked as S3S4 (or 'Vulnerable' to 'Apparently Secure') in Nova Scotia by the ACCDC. It was found at four locations within the Study Area (Figure 3.16 and Appendix B).

Figure 3.16 Brookside stippleback lichen *(Dermatocarpon luridum*).

Granular soil foam lichen (*Stereocaulon condensatum*) is a low-growing fruiticose lichen with a whitish thallus and black reproductive structures which grows on soil (Hinds and Hinds, 2007). It is ranked as S2S3 (or 'Imperiled' to 'Vulnerable') in Nova Scotia by the ACCDC. This species was found at least 18 locations within the Study Area (Figure 3.17), suggesting it is considerably more common than is currently realized (Appendix B.1). In several of the locations where this species was observed, it was noted to be the dominant ground lichen.

Figure 3.17 Granular soil foam lichen (*Stereocaulon condensatum*).

Scaly pelt lichen (*Peltigera lepidophora*) is a soil-dwelling species with a pale to dark brown thallus consisting of small round concave lobes. It is considered a circumpolar temperate to arctic species, often found on calcareous soil (Hinds and Hinds, 2007). Other sources state it occurs on exposed soils such as road cuts or trail banks, usually in open dry habitats (Brodo et al., 2001).

Scaly pelt lichen is ranked as S1 (or 'Critically Imperiled') in Nova Scotia by the ACCDC. This species was found at one location during the 2018 surveys, just outside the Study Area boundary (no picture available).

3.2.3 *Other Non-Vascular Plants Species Diversity and Species of Conservation Concern (Incidental Observations)*

Thirty-one moss and liverwort species representing 22 families were also detected incidentally during the lichen and vegetation surveys. Of these, five were Species of Conservation Concern, including one SAR. These are summarized in Table 3.5. Brief species descriptions are provided below, along with notes on where in the Study Area each species was detected. Occurrences are also depicted on Appendix B.

Table 3.5 Other Non-Vascular Plant Species of Conservation Concern Detected in the Study Area

Group	Species	Common Name	Rank
Mosses	***Fissidens exilis***	**Pygmy pocket moss**	COSEWIC Not at Risk, SARA Special Concern ACCDC S1S2
	Brachythecium acutum	Acute Brachythecium moss	SNR
	Fissidens taxifolius	Yew-leaved pocket moss	S2?
	Brachythecium albicans	Whitish ragged moss	SU
Liverworts	*Riccardia chamedryfolia*	Jagged germanderwort	SU

Bold species in table are SAR.

The full list of moss and liverwort species observed is provided in Appendix C.

Pygmy pocket moss (*Fissidens exilis*) is a small ephemeral moss species which was previously thought to be less abundant than is currently realized. Easily overlooked, it can only be identified when reproductive features are present. Its habitat requires localized soil disturbance, so may actually benefit from human disturbance (COSEWIC, 2016). Previously listed as 'Special Concern' by COSEWIC (COSEWIC, 2005) and consequently listed as such under Schedule 1 of SARA, this species' conservation rank has since been downgraded to 'Not at Risk' by COSEWIC (COSEWIC, 2016). As it remains listed as 'Special Concern' under SARA, it is a SAR and so is discussed in more detail in Section 5.7. This species occurs on several continents, and in North America is found typically on bare, moist, shaded clay-based soils in a variety of environments. There is currently no evidence to suggest that this species is at risk in Canada (COSEWIC, 2016). The ACCDC lists this species as S1S2 in NS, meaning it is considered 'Critically Imperiled to Imperiled' within the province. This species was found at five locations within the Study Area, growing on bare soils (Appendix B).

Acute Brachythecium moss (*Brachythecium acutum*) is a medium sized to large species of moss which tends to grow in mats. It occurs on wet soil or peat in fens and swamps as well as on rotten logs in swampy forests, at low to moderate elevations (Flora of North America, undated). The ACCDC lists this species as SNR in Nova Scotia, meaning its conservation status has not yet been assessed. This species was found at one location within the Study Area, growing on rotting wood (Appendix B).

Yew-leaved pocket moss (*Fissidens taxifolius*) is a medium-sized species of fork moss. It is said to grow on damp, shaded soil, humus, and rocks (Flora of North America, undated). The ACCDC ranks this species as S2? in NS, meaning it is currently considered possibly 'Imperiled' in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other

factors making it very vulnerable to extirpation from the province. This species was found at one location within the Study Area, growing on bare soil (Appendix B).

Whitish ragged moss (*Brachythecium albicans*) is a large moss species which tends to occur on soil in sandy, open and grassy places, as well as on rock. It occur from low to high elevations within North America. ACCDC ranks this species as SU in Nova Scotia, meaning its status is currently considered unrankable due to lack of information or substantially conflicting information about status or trends. This species was found at a single location (Appendix B).

Jagged germanderwort (*Riccardia chamaedryfolia*) is a species of terrestrial liverwort with conspicuously upturned lobe tips. It is often used as an ornamental species in freshwater planted aquaria. ACCDC ranks this species as SU in Nova Scotia, meaning its status is currently unrankable due to lack of information or substantially conflicting information about status or trends. This species was found at two locations within the Study Area (Appendix B).

3.3 Vegetation Community Classification – Upland Communities

A total of 12 vegetation community groups and 24 vegetation types (VTS) were identified within the Study Area in 2016 and 2018. These are listed in Table 3.6.

Table 3.6 Summary of Vegetation Groups and Vegetation Types Identified in the Highway 104 Study Area during the CBCL Vegetation Field Program in 2016 and 2018

Community Type	Vegetation Groups	Vegetation Types (VTs)	Source of Category
Upland Communities	Intolerant Hardwood Forest Group	• IH6 – White Birch - Red maple / Sarsaparilla / Bracken	Neily et al., 2010
	Old Field Forest Group	• OF1 – White spruce / Aster / Goldenrod / Shaggy moss • OF5 – Trembling aspen / Grey birch / Rough goldenrod / Strawberry	Neily et al., 2010
	Mixedwood Forest Group	• MW3 – Hemlock / Yellow birch / Evergreen wood fern	
	Spruce-Hemlock Forest Group	• SH1 – Hemlock / Pin cushion moss / Needle carpet • SH10 – White spruce / Balsam fir / Broom moss	Neily et al., 2010
	Tolerant Hardwood Forest Group	• TH1a – Sugar maple / Hay-scented fern • TH1b – Yellow Birch / Hay-scented fern • TH2 — Sugar maple / New York fern / Northern beech fern • TH3 – Sugar maples/White Ash / Christmas fern	Neily et al., 2010
Wetland Communities	Flood Plain Forest Group	• FP1 – Sugar maple / White ash / Ostrich fern / Wood goldenrod	Neily et al., 2010
	Wet Coniferous Forest Group	• WC1 – Black Spruce / Cinnamon Fern / Sphagnum • WC6 – Balsam Fir / Cinnamon Fern / Three-seeded Sedge / Sphagnum	Neily et al., 2010

Community Type	Vegetation Groups	Vegetation Types (VTs)	Source of Category
		• WC8 – Hemlock / Cinnamon fern / Sensitive fern / Sphagnum	
	Wet Deciduous Forest Group	• WD2 – Red Maple / Cinnamon fern / Sphagnum • WD3 – Red Maple / Sensitive fern / Lady fern / Sphagnum	Neily et al., 2010
	Floodplains and Riverbanks	• FR2 – Mesic Herbaceous River Channel • FR3 – Twisted Sedge Low Riverbank	Adapted from Sperduto & Nichols (2011)
	Marshes	• MR1 – Cattail Marshes • MR2 – Tall Graminoid Meadow Marshes • MR4 – Short Graminoid / Forb Meadow Marsh	Adapted from Sperduto & Nichols (2011)
	Forested Swamps	• FS3 – Northern Hardwood Seepage Forest	Adapted from Sperduto & Nichols (2011)
	Shrub Swamps	• SS1 – Alder Alluvial Shrubland • SS2 – Alder Seepage	Adapted from Sperduto & Nichols (2011)

Five upland forest groups per NSDNR FEC were identified within the Study Area; 'Intolerant Hardwood' (IH), 'Old Field' (OF), 'Spruce-Hemlock' (SH), 'Tolerant Hardwood' (TH) and 'Floodplain' (FP) (Table 3.6). The 'Wet Coniferous' and 'Wet Deciduous' groups were also identified as present within the study area, but are discussed in the context of the wetland communities (Section 3.4), where they are encountered primarily. Within these forest groups, a number of VTs were present, and are described below.

3.3.1 *'Intolerant Hardwood' Forest Group (NSDNR FEC)*

Intolerant hardwoods are an early to mid-successional group comprising predominantly even-aged, short lived species such as red maple, aspen (*Populus* spp.), gray birch (*Betula populifolia*) and white birch. The origin of these stands is primarily from stand-level disturbances over relatively large areas, such as forest fire or clearcut harvesting.

IH6 – White Birch - Red maple / Sarsaparilla - Bracken: White birch – Red maple / Sarsaparilla – Bracken (*Pteridium aquilinum*) VTs are typically associated with variable sites from dry to moist sites, with a variable nutrient content. In this VT, white birch and red maple are the most common overstory trees, with occasional balsam fir, red and white spruce, white pine and yellow birch. The typically well-developed shrub layer often comprises wild raisin (*Viburnum nudum*), serviceberry (*Amelanchier* spp.), lambkill (*Kalmia angustifolia*), blueberry (*Vaccinium* spp.), striped maple (*Acer pennsylvanicum*) and various species of tree regeneration. Herbaceous layer components commonly include bracken fern, woodferns (*Dryopteris* spp.), sarsaparilla (*Aralia* spp.), starflower (*Trientalis borealis)* and bunchberry (*Cornus canadensis*), and minor amounts of bryophytes such as Schreber's moss (*Pleurozium schreberi*) and *Hypnum*.

Figure 3.18 IH6 Typical vegetation, dominated by white birch (*Betula papyrifera*) and red maple (*Acer rubrum*). Understory vegetation is dominated by woodferns (*Dryopteris* spp.) at this location. French River, NS.

3.3.2 *'Old Field' Forest Group (NSDNR FEC)*

These vegetation types develop after the abandonment of old farmland, which is noted to be abundant throughout the corridor. The soils of such sites tend to be rich with organics with vegetation composed mostly of early successional softwood species. The structure usually consists of a dense overstory of species such as white spruce, tamarack, eastern white pine (though scarce in Corridor 4), balsam fir, and occasionally aspens (*Populus tremuloides* and *P. grandidentata*), and white ash, as well as a very patchy, but diverse, shrub and herb layer. Mosses, such as Schreber's moss, and mycorrhizal mushrooms are very common under the dense canopy cover of the overstory.

OF1 - White spruce / Aster – Goldenrod / Shaggy moss: This VT is often an early successional, even-aged forest, and is typically associated with fresh to fresh-moist sites, with a medium to rich nutrient content. White spruce is the dominant tree species in this vegetation type, with scattered occurrences of balsam fir, red maple, and tamarack. Although the ground floor is usually covered with dense needles or a carpet of mosses (primarily shaggy moss [*Rhytidiadelphus triquetris*]), there may be patchy shrub and herb layers present. Various grasses (e.g., *Agrostis* sp.), hawkweeds (*Hieracium spp.*), and goldenrods (*Solidago* spp., *Euthamia graminifolia*) are relict vegetation indicating these sites agricultural past. This vegetation type will progressively form into other VTs due to the lack of white spruce regeneration, and natural disturbances such as windthrow and insects. After several rotations of stand replacing disturbances, these stands will begin to look like pre-agricultural stands.

Figure 3.19 OF1 Typical vegetation, dominated by white spruce *(Picea glauca*) in the overstory. Ground vegetation is characteristically sparse owing to needle carpet, but includes shaggy moss (*Rhytidadelphus triquestris*) and goldenrod *(Solidago* sp.) at this location. James River, NS.

OF5 — Trembling aspen – Grey birch / Rough goldenrod – Strawberry: This early successional VT is mainly associated with fresh-moist to moist-wet, nutrient medium to rich soils of fine to medium texture. It is more common on wetter sites and previously cleared riparian forests. Trembling aspen and grey birch are the dominant overstory trees, with lesser white birch, red maple, balsam fir and/or black spruce. The well-developed shrub layer includes serviceberry, blackberry, wild raisin, beaked hazelnut and bush-honeysuckle accompanied by regenerating trees. Herb layer species are mainly those indicative of past agricultural land use, including strawberry, hawkweeds, goldenrods, asters, common peedwell, buttercups and several grasses and sedges. This VT can be found province-wide, but is most common in lowland ecoregions (Valley and Central Lowlands, Northumberland / Bras d'Or Lowlands).

Figure 3.20 OF5 - Typical vegetation, dominated by Trembling aspen – Grey birch / Rough goldenrod – Strawberry.

3.3.3 *Mixedwood Forest Group (NSDNR FEC):*

The Mixedwood Forest Group is an early to late successional group with the predominant tree species varying according to successional stages. Earlier successional stages are dominated by red maple, white birch and balsam fir, but they usually contain residuals from past stand-level disturbances. Late successional stages contain yellow birch along with red spruce or hemlock. Early and mid-successional stages are usually even-aged whereas late successional stages can develop uneven-aged characteristics due to the longevity of the dominant species.

MW3-Hemlock – Yellow birch / Evergreen wood fern: This late successional mixedwood Vegetation Type (VT) has an overstory co-dominated by hemlock and yellow birch. Several other shade-tolerant trees, such as sugar maple, beech, balsam fir, white pine and white ash, may also be present to varying degrees. This VT is mainly associated with fresh to fresh-moist, nutrient medium to rich soils of variable texture. The longevity and shade tolerance of the dominant overstory tree species aids in the development of old forest characteristics, maintained by gap disturbances. The moderate shrub layer consists mainly of regenerating trees as well as striped maple and fly-honeysuckle. The herb layer is represented by ferns, club-mosses, and various common flowering perennials such as bluebead lily, wild lily-of-the-valley, starflower, Indian cucumber root, partridge-berry and wood aster. Poorer sites can support pink lady's slipper, teaberry and bracken, while richer sites are represented by Christmas fern, oak fern and northern beech fern. Depending on disturbance history, this VT can be even-aged, but it will develop an uneven-aged structure as it matures. Between large-scale disturbance events this VT will maintain itself through gap replacement. This VT can be found throughout mainland Nova Scotia, with scattered occurrences in Cape Breton.

Figure 3.21 MW3 – Typical vegetation dominated by Hemlock /Yellow birch / Evergreen wood fern.

3.3.4 *'Spruce-Hemlock' Forest Group (NSDNR FEC)*

The Spruce-Hemlock Forest Group is a mid to late successional group comprising predominantly of red spruce, hemlock and white pine. Mid-successional stages are typically even-aged and develop into uneven-aged structure as they develops into late successional stages. Within the well-developed canopies, the mid-successional stages usually have a significant balsam fir along with hemlock, red spruce, and white pine in the overstory, changing to late successional stands of hemlock, red spruce due to species longevity.

SH1 – Hemlock / Pin cushion moss / Needle carpet: This VT is typically associated with dry to fresh/moist sites, with medium nutrient content. This late successional VT is dominated by hemlock with occasional red spruce, white pine, and yellow birch. The dense hemlock canopy remains persistent due to its ability to shade out other species. The shrub layer includes regenerating conifers such as hemlock, red spruce, and balsam fir. The herb layer is typically low in coverage because of high needle cover but can have a high diversity of species including evergreen wood fern (*Dryopteris intermedia),* rose twisted stalk (*Streptopus lanceolatus)* and starflower *(Trientalis borealis*). Bryophyte coverage is low, pin cushion moss can be found in this VT and *Bazzania* can be abundant where coarse woody debris has accumulated.

Figure 3.22 SH1 Typical vegetation, dominated by eastern hemlock (*Tsuga canadensis*). Understory is sparsely occupied by tree regeneration of balsam fir (*Abies balsamea*). Ground vegetation is notably sparse, containing various bryophytes and occasional woodferns (*Dryopteris* spp.). James River, NS.

SH10 – White spruce – Balsam fir / Broom moss: This VT is typically associated with fresh to fresh-moist sites, with medium nutrient content. This even-aged, mid successional VT is dominated by white spruce and balsam fir, with scattered white birch in the overstory. This vegetation type may also include red maple and yellow birch. White spruce does not hold a large component in the shrub layer (regeneration) which indicates that it will not be dominant during later successional stages. The shrub layer is dominated by balsam fir regeneration. There is minimal species and species coverage in the herb layer. Wild lily-of-the-valley (*Maianthemum canadense)*, bunchberry, Schreber's moss and wavy broom moss (*Dicranum scoparium*) are typical ground vegetation species in this stand type.

Figure 3.23 SH10 Typical vegetation, dominated by white spruce *(Picea glauca*) and balsam fir (*Abies balsamea*). Ground vegetation at this location is mainly composed of bunchberry (Cornus canadensis) and wild lily-of-the-valley (*Maianthemum canadense*). James River, NS.

3.3.5 *'Tolerant Hardwood' Forest Group (NSDNR FEC)*

This vegetation type consists of mid to late successional hardwood species like sugar maple, yellow birch, American beech, red maple, ironwood (*Ostrya virginiana*), and white ash. There is a variety of fern species in the understory along with a diverse shrub layer. Large scale disturbances are a rarity, and as a result these vegetation types can eventually transform into uneven-aged, old growth forests. The nutrient rich soils promote the growth of many rare plant species in Nova Scotia.

TH1a –Sugar maple / Hay-scented fern: This late successional VT has an overstory dominated by sugar maple, beech, and yellow birch, lesser red maple and scattered red spruce and white spruce. , Beech is abundant in both the overstory and understory. It occurs on dry sites with nutrient medium to rich soils of glacial origin. This VT is found throughout the province in the Cobequid Hills, North Mountain and Cape Breton Hills ecodistricts, and on the upper slopes of drumlins. However, TH1 is relatively uncommon in the lowland ecodistricts and does not occur in the Atlantic coastal ecoregion. Due to the long-lived and shade-tolerant nature of dominant overstory trees, this VT will develop old forest characteristics maintained by gap disturbance. Stand level disturbance events are rare, with gaps or small patches usually created by individual tree mortality, wind or ice damage. In this variant, he shrub layer contains regenerating tree species along with striped maple, fly-honeysuckle and mountain maple. Beech and/or striped maple coverage in this layer can sometimes be extensive, strongly out-competing other species. Herb coverage is diverse, but generally dominated by hay-scented fern (*Dennstaedtia punctilobula*), and evergreen wood fern. Other common species may include rose twisted stalk, Indian cucumber root (*Medeola virginiana*), wood sorrel (*Oxalis montana*), drooping wood sedge (*Carex*

arctata), and wood aster (*Oclemena acuminata)*. Spring ephemerals may include spring-beauty (*Claytonia caroliniana)*, Dutchman's-breeches (*Dicentra cucullaria)* and dog tooth violet (*Erythronium americanum).*

TH1b – Yellow Birch / Hay-scented Fern: This VT is dominated by sugar maple and yellow birch in the overstory and is characterized by relatively moist, well-drained soils with medium to rich nutrient content. Within Nova Scotia, this VT is found on the upper slopes of the Cobequid Hills, North Mountain and Cape Breton Hills ecodistricts, making it susceptible to blow down and crown breakage from strong winds. These disturbances, and subsequently gaps in canopy coverage, allow for increased light penetration which promotes the growth and spread of hay-scented fern (*Dennstaedtia punctilobula*), which dominates the herbaceous stratum along with evergreen wood fern. The remainder of the herb layer is comprised of a diversity of less abundant species, such as rose twisted stalk, Indian cucumber root (*Medeola virginiana*), wood sorrel (*Oxalis montana*), drooping wood sedge (*Carex arctata*) and wood aster (*Oclemena acuminata).* Common spring ephemerals include spring-beauty (*Claytonia caroliniana)*, Dutchman's-breeches (*Dicentra cucullaria)* and dog tooth violet (*Erythronium americanum).* The shrub layer for this VT contains regenerating tree species, primarily sugar maple and yellow birch, but also striped maple, balsam fir, red maple and fly-honeysuckle (*Lonicera canadensis)*.

Figure 3.24 TH1b Typical vegetation, dominated by yellow birch (*Betula alleghaniensis*) in the overstory, with lesser amounts of sugar maple (Acer saccharum). Ground vegetation at this location is mainly composed of woodferns (*Dryopteris* spp.). Weavers Mountain, NS.

TH2 -Sugar Maple / New York Fern – Northern Beech Fern: Sugar maple / New York fern – Northern beech fern is dominated by sugar maple and yellow birch in the overstory and is generally associated with fresh-moist, nutrient medium to rich soils of glacial origin. This VT occurs throughout the province in the Cobequid Hills, North Mountain and Cape Breton Hills ecodistricts and on the upper slopes of drumlins, but is relatively uncommon in lowland ecodistricts, and does not occur in the Atlantic coastal ecoregion. The long-lived and shade-tolerant nature of the dominant overstory trees results in this VT developing old forest characteristics that are maintained by gap disturbance. The ground vegetation community is diverse, but generally dominated by New York fern, evergreen wood fern and northern beech fern. Rose twisted stalk, Indian cucumber root, wood sorrel, drooping wood sedge and wood aster are also common. Spring ephemerals may include spring-beauty, Dutchman's-breeches and dog tooth violet. The shrub layer for this VT contains regenerating tree species along with striped maple, fly-honeysuckle, beaked hazelnut and mountain maple.

TH3 – Sugar maple – White ash / Christmas fern: Sugar maple – White ash / Christmas fern is typically associated with fresh-moist to moist sites, with a rich content. This VT is dominated by late successional species such as sugar maple, white ash, and yellow birch in addition to other shade tolerant species. This VT is one of the most species rich of all the hardwood vegetation types. The species are long-lived and will form old-growth forests in the absence of disturbances. Other species include red maple, beech, red spruce, and ironwood. Balsam fir and striped maple can be located in the shrub layer, along with alternate-leaved dogwood (*Cornus alternifolia)*, hobblebush (*Viburnum lantanoides)*, and beaked hazelnut (*Corylus cornuta)*. Christmas fern (*Polystichum acrostichoides)*, oak fern (*Gymnocarpium dryopteris)*, lady fern (*Athyrium filix–femina)*, shining clubmoss (*Huperzia lucidula)*, and northern beech fern (*Phegopteris connectilis)* are the most common species in the herbaceous layer. In the absence of any forestry practises, natural disturbances in the VT are quite uncommon which develop an uneven-aged stand structure.

Figure 3.25 TH3 Typical vegetation, dominated by sugar maple (*Acer saccharum*) in the overstory. Ground vegetation at this location is mainly composed of sarsaparilla (*Aralia nudicaulis*) and woodferns (*Dryopteris* spp.). Weavers Mountain, NS.

3.3.6 *'Flood Plain' Forest Group (NSDNR FEC)*

These forest types are associated with floodplains which are periodically or annually flooded. The VTs contain mainly mixed hardwoods and have a species rich understory. Bryophyte layers can be poorly developed or non-existent within these VTs. Elm (*Ulmus* spp.) trees used to be part of these VTs: however, Dutch elm disease has almost wiped out this species among the forests stands in Nova Scotia.

FP1 – Sugar maple – White ash / Ostrich fern – Wood goldenrod: This VT is typically associated with fresh to fresh-moist sites, with soils of very rich nutrient content. This closed canopy VT may have several layers through the canopy depending on successional history. Generally, this stable mature forest is the last successional stage in actively flooded, rich, and well-drained soil areas. The dominant overstory species include sugar maple and white ash. Other species in the canopy might include ironwood, white spruce, elm, yellow birch, and black cherry (*Prunus serotina)*. The herbaceous layer can be high in diversity, and can contain species ostrich fern (*Matteuccia struthiopteris)*, sensitive fern (*Onoclea sensibilis)*, meadow-rue (*Thalictrum pubescens)* and numerous other species including several rare vascular plants. The shrub layer is variable but often reduced, except in disturbed or younger stands.

Figure 3.26 FP1 Typical vegetation, dominated by sugar maple (*Acer saccharum*) in the overstory. Ground vegetation at this location is mainly composed of ostrich fern (*Matteuccia struthiopteris*) and wood goldenrod (*Solidago flexicaulis*). French River, NS.

3.4 Vegetation Community Classification – Wetland Communities

3.4.1 *'Wet Deciduous' Forest Group (NSDNR FEC)*

This wet forest is dominated by species such as red maple and white ash and may include mixed wood forest with balsam fir. VT is this groups are associated with moderate to high nutrient content Regenerating tree species are dominant in the shrub layer. The herb layer is well-developed herb layer includes many ferns and sedges species.

WD2 – Red Maple / Cinnamon Fern / Sphagnum: This VT is a widespread maple swamp-type found throughout the province. It is characterized by a relatively high percentage cover of deciduous tree species, most typically red maple. Shrub stratum is typically moderate cover, but species poor, and may include regeneration of overstory species as well as other shrubs such as speckled alder (*Alnus incana*), winterberry (*Ilex verticillata*), and wild raisin. Herbaceous layer diversity is also characteristically low, but may be of relatively high cover; cinnamon fern (*Osmunda cinnamomea*) frequently dominates. Occasional species may include New York fern (*Thelypteris noveboracensis)*, three-seeded sedge (*Carex trisperma*), sensitive fern, dwarf red raspberry (*Rubus pubescens*), violets (*Viola* spp.), sarsaparilla and numerous others.

Figure 3.27 WD2 typical vegetation at Wetland 4-97, dominated here by red maple (*Acer rubrum*), and sensitive fern (*Onoclea sensiblis*); presence of the exotic and somewhat weedy bittersweet nightshade (*Solanum dulcamara*) was noted at this location. Addington Forks, NS.

WD3 – Red Maple / Sensitive fern – Lady fern / Sphagnum: This VT is more nutrient rich than WD2, typically associated with very poorly drained soils, with a moderate to high nutrient content. The closed canopy is dominated by red maple with lesser abundance of black spruce, white birch and balsam fir. The shrub layer includes regenerating tree species and low levels of balsam fir and wild raisin. The herbaceous layer has moderate diversity including sensitive fern, lady fern, dwarf raspberry and pale fat-leaved sphagnum *(Sphagnum centrale)*.

3.4.2 *'Wet Coniferous' Forest Group (NSDNR FEC)*

The VT's associated with the 'Wet Coniferous' forest group develop in areas with very high water tables, or with surface water present. Black spruce, tamarack, and balsam fir are the most common tree species in these vegetation types. Vegetation in the shrub and herb layer is often ericaceous species with high tolerances with water and poor soils. These VT's may arise from various types of disturbances such as fluctuating water levels, windthrow, insects, and disease.

WC1 - Black Spruce / Cinnamon Fern / Sphagnum: This VT is typically associated with moist to wet sites that are nutrient poor. Within this study area, this VT is dominated in the tree stratum by black spruce, with lesser amounts of balsam fir. The understory supports high herbaceous cover with low to medium levels of woody species. Vascular plants within the understory include cinnamon fern, false holly (*Nemopanthus mucronata*), creeping snowberry (*Gaultheria hispidula*), goldthread (*Coptis trifolia*) and three seeded sedge. The underlying substrate for ground vegetation is dominated by *Sphagnum* moss in most locations.

Figure 3.28 WC1 Typical vegetation, dominated by black spruce (*Picea mariana*) and cinnamon fern (*Osmunda cinnamomea*).

WC6 – Balsam Fir / Cinnamon Fern / Three-seeded Sedge / Sphagnum: This VT is typically associated with wet sites with a low to moderate nutrient content. This early to mid-successional VT is characterized by a dominance of balsam fir and lesser amounts of white spruce, black spruce and red maple in the tree stratum. The shrub stratum is variably developed and is dominated by regrowth, false holly, wild raisin, with lesser amounts of lambkill. The moderate herbaceous cover includes common hydrophytic species such as cinnamon fern and three-seeded sedge, and upland coniferous species. The ground vegetation is dominated by *Sphagnum* moss, typically common green (*Sphagnum girgensohnii*) and ladies' tresses (*Sphagnum capillifolium*).

Figure 3.29 WC6 Typical vegetation, dominated by balsam fir (*Abies balsamea*) and cinnamon fern (*Osmunda cinnamomea*) at this location (Wetland 4-12).

***WC8 – Hemlock / Cinnamon fern – Sensitive fern / Sphagnum*:** This VT is typically associated with very poorly drained flats, with a moderate nutrient content. The canopy is dominated by hemlock, and on occasion can be co-dominant with red maple. Red spruce and yellow birch are sparsely scattered with the canopy. The understory is relatively open, and the herb layer has low density. Cinnamon fern, sensitive fern, wood aster, and common green sphagnum are commonly present.

Figure 3.30 Typical WC8 vegetation at wetland 4-73, comprising eastern hemlock (*Tsuga candensis*) in the overstory, and cinnamon fern (*Osmunda cinnamomea*), woodferns *(Dryopteris* spp.), wood sorrel (*Oxalis montana*) and various bryophytes in the ground vegetation stratum.

3.4.3 *Floodplains and Riverbanks (FR)*

FR2 - Mesic Herbaceous River Channel (NANH adapted): The mesic herbaceous river channel occurs in moderate- to high-energy conditions along flooding or ice scouring rivers and large streams of coarse, sandy to sand-cobble substrate. These herbaceous communities are observed on low riverbanks, channel shelves, and river bars. Often flooded early in the growing season, the soil moisture conditions are mesic to hydric through most or all of the growing season with mesic conditions occurring more prevalently on slightly higher ground.

The community is dominated by short to moderate height species, such as forbs, grasses, sedges, and ferns. Shrubs are mostly sparse or absent from this community. Common species observed include Graminoids such as blue-grasses (*Poa* spp.), panic grasses (*Panicum* spp.), manna-grasses. (*Glyceria* spp), rice cut-grasses (*Leersia oryzoides*), blue-joint (*Calamagrostis canadensis*), barnyard-grasses (*Echinochloa* spp), bent grasses (*Agrostis* spp.), reed canary-grass (*Phalaris arundinacea*), rushes (*Juncus* spp.), spike-rushes (*Eleocharis* spp.), sedges (*Carex* spp.), and bulrushes (*Scirpus* spp.); forbs such as bedstraws (*Galium* spp.), water-hemlocks (*Cicuta* spp.), spotted jewelweed (*Impatiens capensis*), several fern species, violets, St. John's-worts (*Hypericum* spp.), beggars ticks (*Bidens* spp), common water horehound (*Lycopus* uniflorus), northern blue flag (*Iris versicolor*), Joe-pye-weed (*Eupatorium maculatum*), and water parsnip (*Sium suave*). Hydrophilic species such as smartweeds (*Polygonum* spp.) and swamp candles (*Lysimachia terrestris*) can be present if favorable conditions exist. Higher portions of this community may dry out in late summer and may support stress-tolerant graminoids such as cut-grasses (*Leersia* spp.), rushes (*Juncus* spp.), and sedges such as bulrushes and spike-rushes.

FR3 - Twisted Sedge Low Riverbank (NANH adapted): This community occupies a narrow band peripheral the actual channel of moderate to high energy rivers and streams. As the name suggests, the community is dominated by twisted sedge (*Carex torta*), with subordinates including bluejoint, grass-leaved goldenrod (*Euthamia graminifolia*), swamp candles, spotted Joe-pye-weed, sensitive fern, tall meadow rue (*Thalictrum pubescens*), violets, and scattered speckled alder. Reed canary grass may become prevalent in areas of greater anthropogenic disturbance.

Figure 3.31 Typical vegetation of 'FR3 Twisted Sedge Low Riverbank' (center and left of river channel), French River, NS.

Figure 3.32 Detail of vegetation at FR3, comprised primarily of twisted sedge (Carex torta).

3.4.4 *Marshes (MR)*

MR1 - Cattail Marshes (NANH adapted): Cattail marshes are one of the most common types of emergent marsh in our region. Broadleaf cattail (*Typha latifolia*), and secondarily narrowleaf cattail (*T. angustifolia*) dominate these communities, often to the exclusion other species, by forming well-developed clonal stands. Cattail marshes are commonly found in topographic basins, in sheltered coves of lakes and ponds, and contiguous with watercourses. By definition, marshes are (at a minimum) seasonally flooded, with water levels often fluctuating throughout the growing season. Soils can be entirely organic, or mineral with a high organic content, both owing to contributions of thatch from previous years' growth.

Figure 3.33 Typical vegetation of cattail marsh (MR1) at wetland 4-8, with dominant broadleaf cattail *(Typha latifolia*).

MR2 - Tall Graminoid Meadow Marshes (NANH adapted): This meadow marsh resembles a meadow that is dominated primarily by tall, clonal grasses or sedges. Depending on hydrologic regime, dominant species typically have dense root mats, and may dominate individually or in combinations. This community can be seasonally flooded and can only sustain water at ground surface for short periods of time. Characteristic species that may become dominant include bluejoint reedgrass, tussock sedge (*Carex stricta*), wooly bulrush (*Scirpus cyperinus*) and reed canary grass. Other species that may be present include mannagrasses, rice cutgrass, rushes, Joe-pye-weed, sedges and various spike-rushes. Other herbs can also be present; however, cover and biomass is normally dominated by only a few species.

Figure 3.34 Tall graminoid meadow marsh (MR2) conditions at wetland 4-50. This location is strongly dominated by woolgrass bulrush (*Scirpus cyperinus*) with lesser amounts of various sedges, ferns, and forbs.

MR4 - Short Graminoid – Forb Meadow Marsh (NANH adapted): - Short-graminoid - forb meadow marsh/mudflats are typically found on frequently temporary, seasonally flooded stream shores or on exposed mudflats from recently abandoned beaver ponds. As the community develops, plants emerge from recently deposited or buried seeds from inundated areas. This community often transitions into tall graminoid meadow marsh. Dominated by short, herbaceous plants including annuals with perennials either clumped or spreading, typical herb species include rice cut grass, mannagrasses, beggarticks, St. John's-wort (*Hypericum* spp., and *Triadenum* spp.), various spikerushes, rushes, water horehounds (*Lycopus* spp.) and common water parsnip.

Figure 3.35 Short graminoid-forb meadow marsh (MR4) conditions at wetland 4-80.

3.4.5 *Forested Swamps (FS)*

FS3 - Northern Hardwood Seepage Forest (NANH adapted): This hardwood forest community is typically associated with poorly to very poorly drained soils that are semi-rich in nutrient content. Commonly occurring on lower mountain slopes with seep openings or seepage runs; the community is characterized by both upland and wetland plant species. Canopy species include tree species such has sugar maple, yellow birch, and to a lesser extent white spruce, and balsam fir. The shrub layer can include red raspberry (*Rubus idaeus*), red elderberry (*Sambucus racemosa*), hobblebush, striped maple, and speckled alder. The herb layer is often diverse, containing species such as slender manna-grass (*Glyceria melicaria*), spotted jewelweed, common lady fern, and dwarf red raspberry, nodding sedge (Carex gynandra), rough sedge (*Carex scabrata*) mountain wood fern (*Dryopteris campyloptera*), tall meadow-rue, sensitive fern, yellow bluebead lily (*Clintonia borealis*), zigzag goldenrod (*Solidago flexicaulis*), red baneberry (*Actaea rubra*), white baneberry (*Actaea pachypoda*), northern beech fern, evergreen wood fern, spotted Joe-pye-weed, grassleaf goldenrod (*Euthamia graminifolia*), bluejoint reed grass, and white turtlehead (*Chelone glabra*).

Figure 3.36 Northern hardwood seepage forest (FS3) typical conditions. This location is dominated by yellow birch *(Betula alleghaniensis*), jewelweed (*Impatiens capensis*), rough sedge (*Carex scabrata*), sensitive fern (*Onoclea sensiblis*) and cinnamon fern (*Osmunda cinnamomea*). Wetland 4-61.

3.4.6 *Shrub Swamps (SS)*

SS1 - Alder Alluvial Shrubland (NANH adapted): These shrublands are dominated primarily by speckled alder (*Alnus incana* ssp. *rugosa*). Abundance and composition of other woody species and herbs varies depending the energy of the riparian system, becoming progressively denser and diverse in the fine textured silt soils of lower-energy floodplains. Alders are highly competitive in these environments, given both their flood tolerance and their habit to bend (rather than to break or uproot) during peak flows. While often occurring as a relatively narrow band (frequently <10 m wide) along watercourses, these communities may also occupy broader areas lateral to their associated watercourse, where topography allows. These communities are often seen ranging hundreds of meters along their associated watercourse. Alders nitrogen-fixing ability, which provides nitrogen in the nutrient-poor, coarse substrate (typically gravel, cobble, sand and minor silt), affords additional competitive advantage of this species over other species. Red maple and American elm (*Ulmus americana*) may be sparsely manifest as trees. Common associates in the shrub stratum may include red osier dogwood (*Cornus sericea*) and various species of willow (*Salix* spp.). Herbaceous associates may include bluejoint reedgrass, goldenrods (*Solidago* spp.), tall white aster (*Doellingeria umbellata*), ostrich fern, swamp candles, virgin's bower (*Clematis virginiana*), sensitive fern, and tall meadow rue; two-leaved toothwort (*Cardamine diphylla)* may be present on richer sites. Depending on level of disturbance, exotic weeds like coltsfoot (*Tussilago farfara*) may be present. Bryophytes are typically absent from this community.

Figure 3.37 Alder alluvial shrubland (SS1) typical vegetation, dominated here by speckled alder (*Alnus incana*), and slender mannagrass (*Glyceria melicaria*). Wetland 4-51.

SS2 - Alder Seepage Thicket (NANH adapted): This is tall shrub swamp community that typically occurs in nutrient-enriched depressions and in areas of groundwater influence. Speckled alders are the dominant shrub species, with other species occasionally present including winterberry and meadowsweet (*Spiraea alba*). The herbaceous layer can be diverse, on account of the minerotrophic conditions. Characteristic herbaceous layer species include bluejoint, mannagrasses, spotted touch-me-not (*Impatiens capensis*), sensitive fern, cinnamon fern, crested shield fern (*Dryopteris cristata*), perfect-awned sedge (*Carex gynandra*), and fringed sedge (*Carex crinita*). Bryophytes are conspicuously absent in many sites. These sites are typically saturated at least seasonally, and may contain a variety of soils ranging from mineral to organic.

Figure 3.38 Alder seepage thicket (SS2) typical vegetation, dominated here by speckled alder (*Alnus incana*), cinnamon fern (*Osmunda cinnamomea*) and fowl mannagrass (*Glyceria striata*). (WL-5-56).

3.5 Distribution of Vegetation Communities

Mapping depicting the distribution of the identified vegetation communities (including occurrences of rare flora) is provided in Appendix B.

3.6 Project Ecological Land Classification

P-ELC mapping is provided in Appendix D. This Appendix contains the composite P-ELC as well as individual component mapping. A breakdown of the areas of the individual composite P-ELC codes contained in the P-ELC study area is provided in Appendix E.

CHAPTER 4 DISCUSSION

4.1 Summary of Key Findings

CBCL encountered a total of 465 vascular plant species, representing 76 families (Appendix B), during vegetation surveys in 2016 and 2018 within the Study Area. In 2018, CBCL also detected 91 lichen species representing 27 families during the targeted lichen survey (Appendix C). Incidental observations were also made of 108 moss and 2 liverwort species within the Study Area. The full species inventories are provided by taxonomic group, and, (in the case of vascular plants) year, in Appendix C. The distribution of rare flora within the Study Area is mapped and depicted in Appendix B.

A total of 26 flora SOCC (S1-S3 ranks), were encountered during the surveys; these are summarized in Table 4.1. Of these, 3 are also legally protected SAR.

Table 4.1 Summary of Flora SOCC Detected by CBCL within the Highway 104 Twinning Project Study Area in 2016 and 2018

Taxonomic Group	Common Name	Scientific Name	NSESA Status and/or NS S-Rank
Vascular Plants	Blue vervain	*Verbena hastata*	S3
	Halberd-leaved tearthumb	*Polygonum arifolium*	S2
	Black ash	*Fraxinus nigra*	NSESA Endangered, S1S2
	Lesser pyrola	*Pyrola minor*	S3
	Meadow horsetail	*Equisetum pratense*	S3
	Hop sedge	*Carex lupulina*	S3
	Large purple-fringed orchid	*Platanthera grandiflora*	S3
Lichens	Blue felt lichen	*Degelia plumbea*	NSESA Threatened, S3
	Acadian jellyskin lichen	*Leptogium acadiense*	S3S4
	Appressed jellyskin lichen	*Leptogium subtile*	S3
	Beaded jellyskin lichen	*Leptogium teretiusculum*	S2?
	Birdnest jellyskin lichen	*Leptogium tenuissimum*	S2S3
	Brookside stippleback lichen	*Dermatocarpon luridum*	S3S4
	Crumpled bat's wing lichen	*Collema leptaleum*	S2S3

Taxonomic Group	Common Name	Scientific Name	NSESA Status and/or NS S-Rank
	Granular soil foam lichen	*Stereocaulon condensatum*	S2S3
	Naked kidney lichen	*Nephroma bellum*	S3
	Pompom-tipped shadow lichen	*Phaeophyscia pusilloides*	S3?
	Scaly pelt lichen	*Peltigera lepidophora*	S1
	Shaggy fringed lichen	*Anaptychia palmulata*	S3S4
	Shelter shingle lichen	*Vahliella leucophaea*	S3S4
	Scaly pelt lichen	*Peligera lepidophora*	S1
Mosses	Pygmy pocket moss	*Fissidens exilis*	COSEWIC Not at Risk, SARA Special Concern ACCDC S1S2
	Acute Brachythecium moss	*Brachythecium acutum*	SNR
	Yew-leaved pocket moss	*Fissidens taxifolius*	S2?
	Whitish ragged moss	*Brachythecium albicans*	SU
Liverworts	Jagged germanderwort	*Riccardia chamedryfolia*	SU

A total of 12 vegetation community groups and 24 vegetation types (VTS) were identified within the Study Area in 2016 and 2018. Eight of these vegetation community groups were forested ecosystems, while four were non-forest vegetative communities.

4.2 Regulatory Considerations

Under current legislation, linear project activities that could interact with rare flora and other vegetation typically adhere to the following acts:

- Federal *Species at Risk Act*. S.C. 2002, c.29;
- Provincial *Environment Act*. 1994-1995, c.1, s.1; and
- Provincial *Endangered Species Act*. 1998, c.11, s.1.

Should the proposed twinning of Corridor 4 proceed, the project may be subject to environmental permits and approvals pursuant to federal and provincial legislation

4.3 Limitations of the Assessment

Completeness of Species and Community Inventory: Although the vegetation surveys were conducted over the entire corridor length, and during various seasons and stages of vegetative growth (early spring to late summer to maximize exposure to flowering), it cannot be guaranteed that all species or communities have been encountered and identified.

Climatic Conditions: The Canadian Drought Monitor reports annual precipitation assessments for the month of September. According to these reports, the western end of the Study area was classified as 'abnormally dry', while the eastern end of the Study area was classified as experiencing a 'moderate

drought' in September 2016; in September 2018, the Study area was classified as 'abnormally dry' (Government of Canada, 2018). Therefore, while a considerable effort was made to assess the study area for plant species presence, unusually low precipitation levels may have impacted the growth, vigour, phenology or overall presence of certain plant species, particular those that are hydrophytic.

Classification of Immature and Disturbed Sites: Many of the vegetative communities encountered throughout the Study Area were immature growth arising from disturbed conditions such as forestry or agriculture; as such, some of the locations surveyed proved inconclusive in terms of vegetation classification given the classification schemes used in this study. The NSDNR FEC guides are intended for stands which are a minimum of 40 years old (Neily et al., 2010), and many of the forested locations encountered did not comply with this criterion. Areas such as agricultural fields, recent clearcuts, roadsides, waste places and other vegetated anthropogenic sites were not classified at the community level.

Certainty of Community Classification: In some instances, the characteristics of some plant communities as noted in the field were considered to be intermediate (based on species presence/abundance) to a number of classes, based on the classification schemes being used for the study. Where this was found to be the case, professional best-judgement was used to assign the most fitting classification based on the observed characteristics.

P-ELC: The results of the current P-ELC analysis are intended as a mapping platform that may serve as a predictive and quantitative tool for:

- Assessing and quantifying Project effects on specific habitats, and by association their contained species (including SOCC and SAR); and
- Assessing availability of alternate habitat for SOCC and SAR beyond the footprint of the Project.

The actual execution of any such specific habitat studies using the P-ELC are excluded from the present study.

4.4 Closure

This report has been prepared for the sole benefit of Nova Scotia Transportation and Infrastructure Renewal. The report may not be relied upon by any other person or entity without the express written consent of CBCL Limited and Nova Scotia Department of Transportation and Infrastructure Renewal.

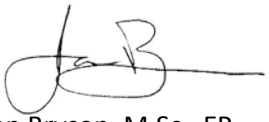
Any use which a third party makes of this report and any reliance on decisions made based on it, are the responsibility of such third parties. CBCL Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The conclusions presented represent the best judgement of the assessors based on the observed site conditions. Due to the nature of the investigation, the assessors cannot warrant against undiscovered environmental conditions or liabilities.

Should additional information become available, CBCL Limited requests that this information be brought to our attention so that we may re-assess the conclusions presented herein. Any changes to the Project alignment may result in a requirement to replicate the field program to capture any new information.

Respectfully submitted,

CBCL Limited



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