Environmental Assessment Registration

of a Class I Undertaking, Pursuant to Part IV of the Environment Act, N.S. Reg 52/2005

Final February 2020

Project

Spicer North Mountain Quarry Expansion

Proponent

B. Spicer Construction Ltd.

Environmental Assessment Prepared by:
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Executive Summary

B. Spicer Construction Ltd. (the Proponent) wishes to expand its aggregate quarry operations at Youngs Cove, Annapolis County, Nova Scotia that have existed for 11 years. The proponent proposes to maintain current production levels for a period of up to 30 years, or 2050. The current approved footprint is projected to last for two to four additional years. However, the current footprint can not be expanded without causing significant adverse effects to adjacent wetlands and watercourses within the proponent properties. Therefore, the proponent has proposed a future quarry footprint to be located on their properties, approximately 200m north of the existing site, where no significant adverse effects to wetlands and watercourses will occur. To continue uninterrupted production yet achieve the shift in quarry footprint location the proponent anticipates the operation will expand beyond four hectares. In proposing an aggregate quarry expansion in excess of four hectares, the Proponent is required to register this project as a Class I Undertaking pursuant to Part IV of the Environment Act, N.S. Reg. 52/2005, and the Environmental Assessment Regulations, N.S. Reg. 26/95 before commencing work on the project. As the requirement for an Environmental Assessment is triggered by the proposed quarry activity, the proponent has also chosen to also include the proposed expansion of the stockpile/crusher area to better separate on highway transport vehicles that are loading and scaling aggregate for transport from the crushing/stockpile activities where off highway vehicles operate as a means of improving site operational safety and function.

The project is situated on the south facing slope of the Annapolis Valley's North Mountain. The existing and proposed quarry sites exist at the crest of the mountain where the North Mountain Formation containing the desired basalt resource lies close to the surface. The existing stockpile/crusher area of the operation lies at the foot of the mountain in the lowlands of the Annapolis Valley. A highway vehicle accessible gravel access road connects the stockpile/crusher area to provincial Highway 1, while a steep off highway vehicle only gravel access road connects the stockpile/crusher area to the quarry. The majority of the Project Site is undeveloped forest cover of varying ages, while some fallow field habitat is found adjacent to the access road. The closest residential receptor is a proponent owned house on the subject properties while the nearest offsite neighboring residential receptor lies 1100 m from the existing quarry, 1300m from the proposed quarry, and 420 m from the stockpile/crusher area.

The proposed Undertaking consists of the blasting, excavation, crushing and screening, stockpiling and delivery of basalt aggregate. During development of the expansion areas, tree harvest, grubbing, and removal of overburden will occur. The existing and future quarry footprint areas will undergo progressive reclamation, limiting the area of open quarry that can exist at any one point in time. The annual aggregate production rate is anticipated to remain approximately constant at the current rate of ~100,000 metric tonnes/year. The stockpile/crusher area will undergo reclamation during decommissioning at the end of the projected project lifespan (30 years) in 2050.

The environmental assessment has evaluated the valued environmental components (VEC) of the project site and surrounding area; and, considered the spatial and temporal scope of the proposed Undertaking, the fact the operation has been long established, and the implications of an expanded footprint of the Spicer North Mountain Quarry with an unchanged rate of production. Based on this assessment a number of adverse effects of the proposed Undertaking will remain after mitigation and management strategies are employed. However, although adverse effects remain, they are not considered individually or together to be significant. This means that regulatory thresholds will not be exceeded at off site receptors, that important quality guidelines for components such as groundwater and aquatic life can be achieved within limitations of the natural systems present, and that no excessive burden will be borne by adjacent landowners or the community with the operation of the quarry. As such, it is concluded through the assessment within this document that the proposed Spicer North Mountain Quarry Expansion will not result in any significant adverse environmental effects.

1. General Information

General Project Information	B. Spicer Construction Ltd intends to continue operating the Spicer Quarry (NSE Approval #2007-056846-03)
Project Name	Spicer North Mountain Quarry Expansion
Proponent Name and Contact	B. Spicer Construction Ltd Jesse J. Spicer, President, 902 665 4302
Proponent Information	SPICER Construction B. Spicer Construction Ltd., 9777 HWY 1 RR#4, Bridgetown, NS B0S 1C0 902 665 4302 office@spicerconstruction.ca **Signature of Proponent Signing Officer:** [signature] Feb.28,2020 Jesse J. Spicer President, B. Spicer Construction Ltd. Date
Project Location	The civic address of the quarry is 7297 Highway 1, Upper Granville, Annapolis County, approximately 7 km west of Bridgetown in the Annapolis Valley. The project occurs across several property parcels (PID 05166004, 05166012, 05166020, 05166095). The existing quarry is located at UTM coordinates: 20T 311527 4967451.
Landowner	The project is situated on private lands, owned by B. Spicer Construction Ltd.
Closest distance from the quarry to a residence	The closest off-site residence is located approximately 500 m to the east of the aggregate storage area.
Federal Involvement, Permits and Authorizations	No federal funding is anticipated for the future development of the quarry. There are no triggers with respect to the Canadian Environmental Assessment Act (Section 5, CEAA). No federal permits or authorizations are anticipated.
Provincial Authorities issuing Approvals	Nova Scotia Environment (NSE)
Required Provincial Permits and Authorizations	The following authorizations and approvals are required for the continued operation of the quarry: 1. Environmental Assessment Approval (Section 40 of the Nova Scotia Environment Act and Section 13 (1)(b) of the Environment Assessment Regulations. 2. Revision of the Industrial Approval (Activities Designation Regulations, Division V, Section 13(f).

Provincial Regulatory Authorities Consulted during EA development	Bridget Tutty, NSE, EA Branch Adam D'Entrement, NSE Regional Engineer Mark Elderkin, NSDLF Randy Milton, NSDLF Sean Weseloh McKeane, NSDCCH
Municipal Authorities	Municipality of Annapolis County
Required Municipal Permits and Authorizations	None
Environmental Assessment review and report completed by	East Coast Aquatics East Coast Aquatics Inc. Mike Parker, Andy Sharpe, Stephanie White P.O. Box 129, Bridgetown, NS, B0S 1C0 902 665 4682 mike@eastcoastaquatics.ca www.eastcoastaquatics.ca **Signature of EA Preparer:** Feb 28, 2020 Michael A. Parker Date Senior Ecologist / President

2. Project Information

2.1 Proponent Profile

B. Spicer Construction Ltd., the project proponent, is a family-owned business that has been operating in the Bridgetown area since 1987. The proponent has operated the Spicer North Mountain Quarry, located on the North Mountain in Youngs Cove, Annapolis County, for the past 11 years. The quarry supplies basalt crushed aggregate and rock for construction projects throughout the western Annapolis Valley, operating under Nova Scotia Environment Industrial Approval #2007-056846-03, across several adjoined privately held properties totalling 150 ha. The existing quarry site is approaching 4 ha in size and, in accordance with the Nova Scotia Environment Act, requires the completion of a Class I Environment Assessment (EA) to allow for its continued operation in an area greater than 4ha.

The quarry currently provides direct seasonal employment for approximately 8 persons and indirectly supports an additional 35 jobs in trucking, construction and paving. Over its 11 years of operation, the Spicer Quarry has paid over $2.4 million in wages, fees and taxes. Products from the quarry have been used for construction and maintenance of local infrastructure. In 2018, for example, the quarry supplied material for the repaving of Highway 101 between Bridgetown and Lawrencetown, the construction of the north soccer field at the Bridgetown Regional Community School, and upgrades to Shore Road East, Port George. B. Spicer Construction Limited strives to be a good corporate citizen and has provided more than $55,000 over the past 11 years in cash donations, materials and equipment to local community groups ranging the Bridgetown Fire Department to the Clean Annapolis River Project.

East Coast Aquatics Inc. (ECA) was retained by B. Spicer Construction Ltd. to complete the Environmental Assessment. The ECA Project Team consists of:

- Mike Parker, East Coast Aquatics Inc.
- Andy Sharpe, EP, East Coast Aquatics Inc.
- Stephanie White, EPIT, East Coast Aquatics Inc.
- Jake Walker, Ornithologist
- Tom Neily, Botanist and Species at Risk specialist
- Davis McIntyre and Associates, Professional Archeologists

2.2 Location

The project site is situated on the south-facing slope of the Annapolis Valley's North Mountain (Figure 1), across several privately held properties (PID 05166004, 05166020, 05166095, 5289459, 5289467, 5289483, 5289475, 05166012,) owned by B. Spicer Construction Ltd. (Figure 2). The civic address of the quarry is 7297 Highway 1, Upper Granville, Annapolis County. The project site lies in the rural community of Youngs Cove, near the north-central boundary of Annapolis County. The majority of the site is undeveloped with intact mixed-age forest cover and recent timber harvesting. The site is accessed off Highway 1 by a private two-kilometer gravel road, owned and maintained by B. Spicer Construction Ltd.

Due to steep topography of the North Mountain and basalt resource’s location on the mountain, the quarry operation layout is such that the aggregate stockpiles, crushing, scales, and office are situated at the foot of the North Mountain on the valley floor where access by on highway transport vehicles is possible, while the quarry is located near the crest of the mountain where the basalt bedrock occurs. The two locations are connected by a private off highway vehicle (OHV) gravel road. As a result, the quarry has a significantly greater separation distance from the nearest offsite residences than the stockpile/crusher area.

Table 1: Spicer Mountain Quarry study area properties for the proposed expansion area.

PID	Owner	Property Size (ha)
05166004	B. Spicer Construction Ltd.	42.1
05166012	B. Spicer Construction Ltd.	36.4
05166020	B. Spicer Construction Ltd.	40.5
05289459	B. Spicer Construction Ltd.	14.1
05289467	B. Spicer Construction Ltd.	8.5
05289442	B. Spicer Construction Ltd.	16.6
05289483	B. Spicer Construction Ltd.	6.9
05289475	B. Spicer Construction Ltd.	13.7
05166095	B. Spicer Construction Ltd.	32.4

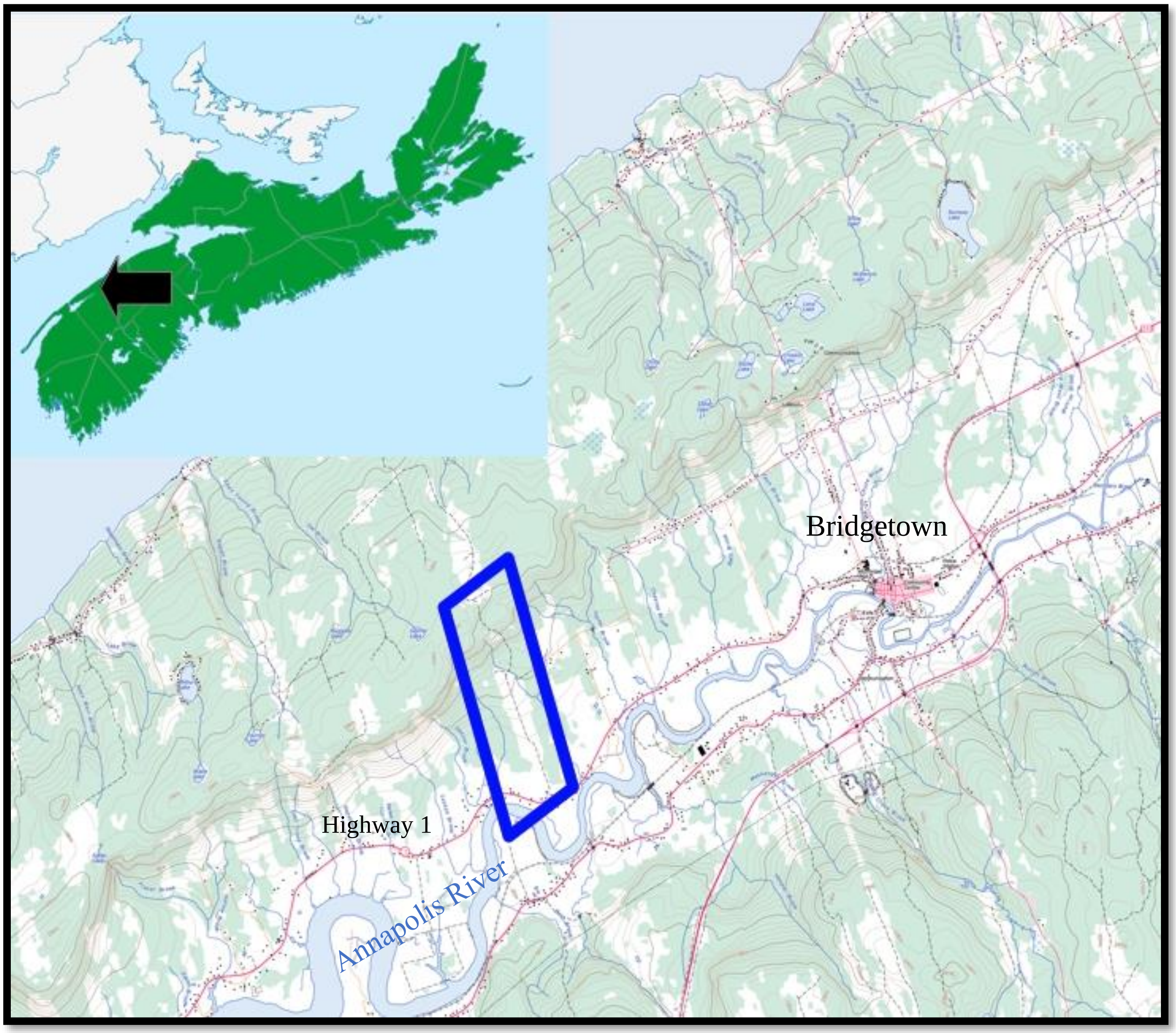

Figure 1: General location (blue box) of the B. Spicer Construction Ltd. North Mountain Quarry southwest of the community of Bridgetown in Nova Scotia's Annapolis Valley.

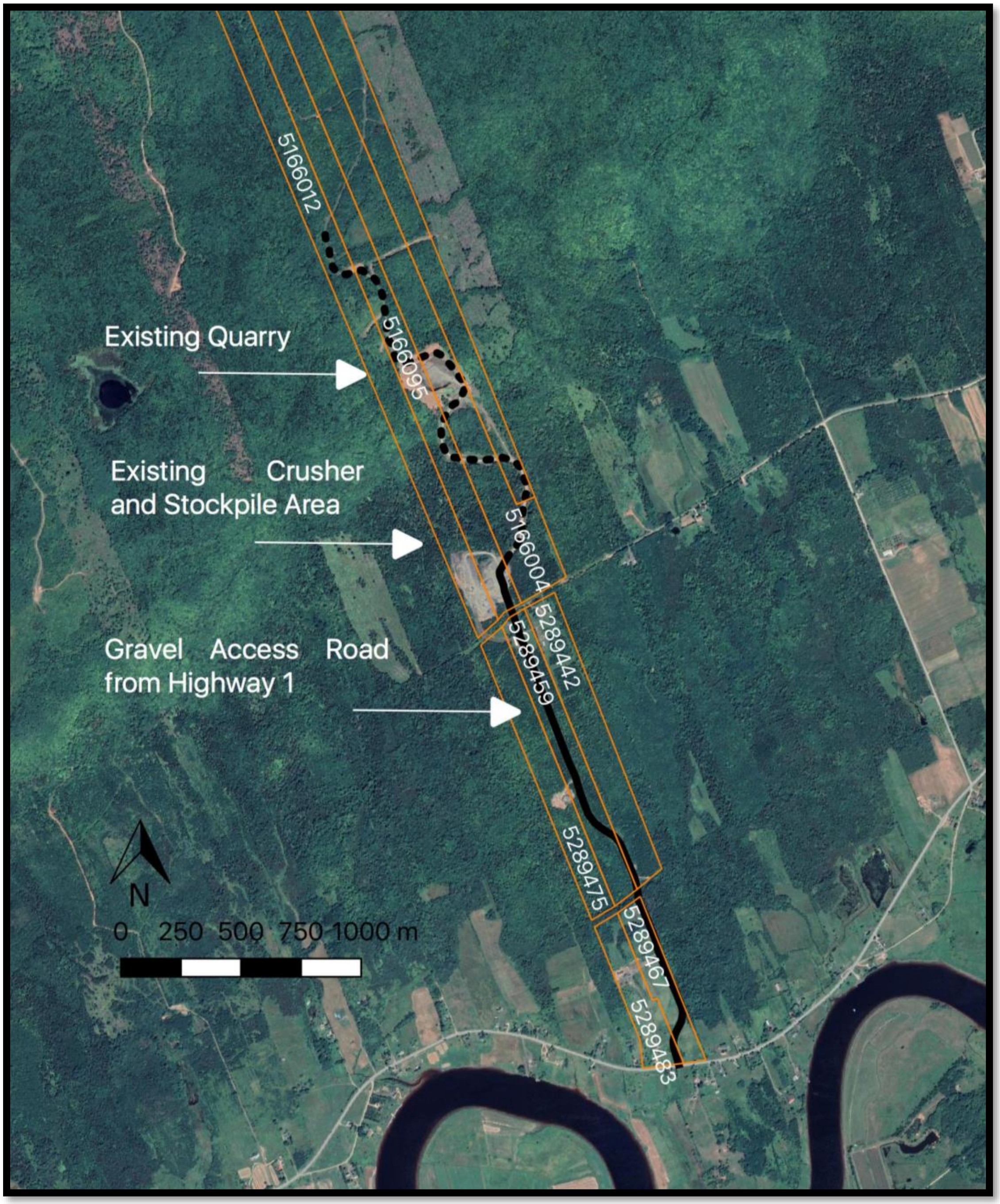

Figure 2: Project site properties and existing Spicer North Mountain Quarry features.

2.3 Existing and Planned Project Components

The existing Spicer Quarry components consist of an active quarry area, grubbing and overburden stockpiles, aggregate stockpiles and crushing area, scales and office. A gravel access road between provincial Highway 1 and the stockpile/crusher area is passable by highway vehicles while the active and proposed quarry footprints at the crest of the north mountain are accessed via an off highway vehicle (OHV) gravel road connecting the stockpile/crusher area at the foot of the north

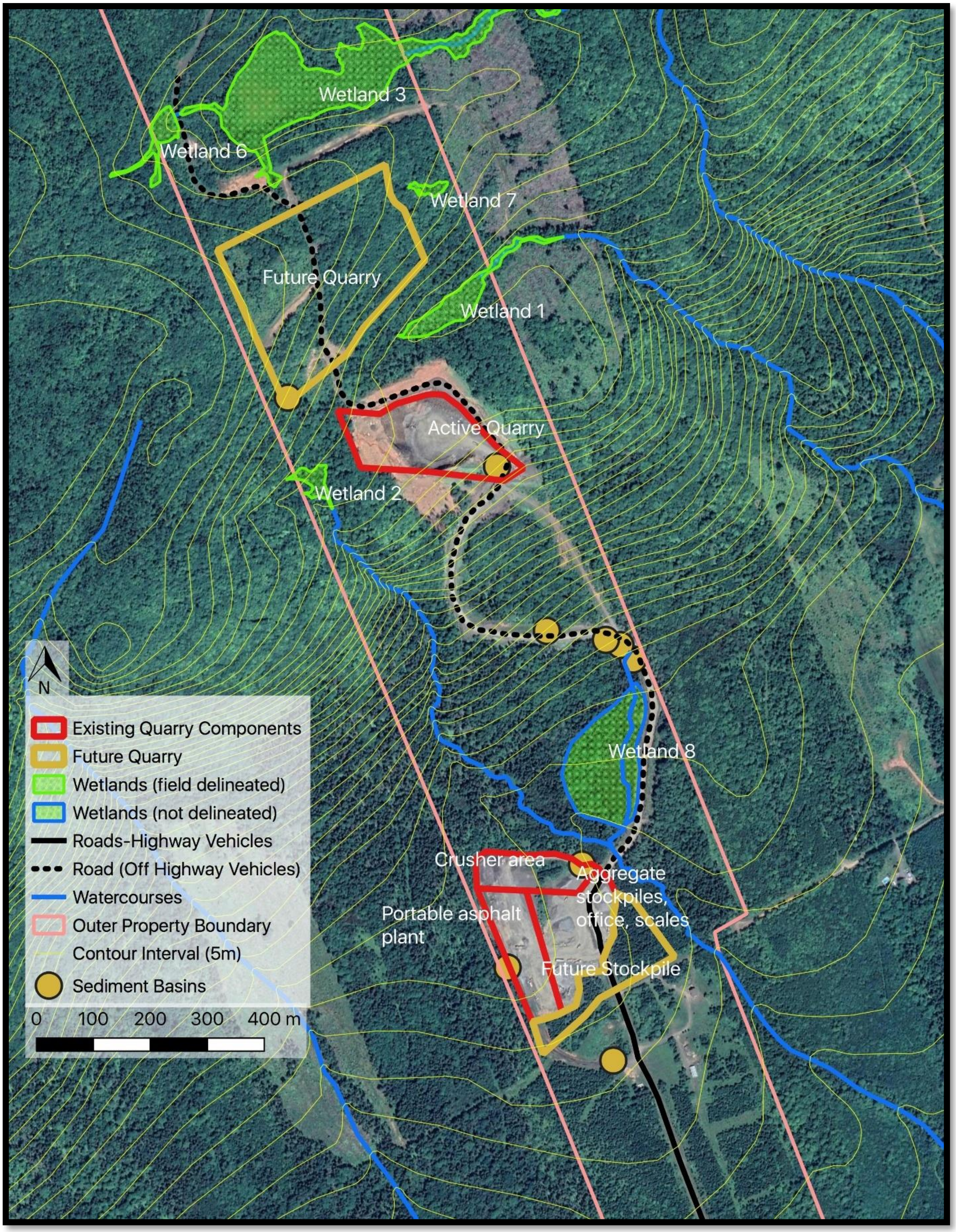

Figure 3: Existing and proposed quarry components at the B. Spicer Construction North Mountain Quarry.

mountain. The average slope of the OHV access road is 15% over the steepest 630 m with one section of the constructed switchback exceeding 24%; precluding the option for highway vehicles to load aggregate at the quarry footprint and safely transport product to Highway 1, or for large re-fueling vehicles to safely transport fuel to machinery stationed at the active quarry. A third party intermittently operates a seasonal mobile asphalt plant operates from a designated portion of the stockpile/crusher site and utilizes quarry produced aggregate, based on local demand. The existing and planned project footprint and boundaries for these project components are shown in Figure 3.

The proposed Undertaking consists of the extracting, preparation, stockpiling and delivery of basalt aggregates. The proposed activities to be undertaken at the site include:

- cutting, grubbing and piling of vegetation and topsoil,
- drilling, blasting and excavation of basalt,
- preparation of aggregates through screening and crushing,
- stockpiling of the prepared aggregates,
- intermittent operation of a mobile asphalt plant,
- delivery of aggregates and asphalt by truck through the principal quarry access road to Highway 1, and
- reclamation of areas following aggregate removal.

The proposed Undertaking is intended to allow for the continuation of the current operations at the Spicer Mountain Quarry and the improved function and safety of those operations. The annual aggregate production rate is anticipated to remain unchanged at the current rate of 100,000 to 150,000 metric tonnes/year. The extractable reserves within the existing and proposed project quarry footprints is estimated to be in excess of 10 million tonnes of aggregate. Based on the current extraction rate, the lifespan of the Undertaking is anticipated to be in excess of 30 years. For the purpose of this Registration, a project timeline of 30 years is proposed.

Future operation of the site will entail completing operation of the currently approved quarry footprint over a time frame of two to four years, opening a new quarry footprint area with its associated grubbing and overburden stockpile areas, and expanding the existing stockpile/crusher area to improve operational function and safety within that area. Access roads are expected to remain unchanged over the project lifespan. The proposed and existing operation footprint of each of the quarry features is summarized in Table 2. All existing and proposed quarry footprint areas have neighboring property setbacks of 30 m or more. Buffer zones to watercourses (including wetlands) from proposed and existing quarry footprints are a minimum of 30 m and generally extend to 100 m or more.

Following development of the quarry area through removal of overburden, the quarry face is periodically drilled and blasted to free aggregate. That material is then loaded in OHV rock trucks and transported to the stockpile/crusher area. All crushing activity takes place at the stockpile/crusher area located on the valley floor, as has occurred in the recent past. Although crushing has previously occurred at the mountain top quarry site, transport of fuel for the crusher on the steep gradient OHV access road (15-24%) was deemed an unacceptable safety risk and operationally time consumptive, and crushing has been shifted to the most current location at the stockpile/crusher area. The 1.5 km long OHV access road to the proposed quarry site exists as a forestry grade road, and no new installations of culverts or bridges are anticipated to extend operational use the short additional 0.15 km from the existing quarry to the proposed quarry footprint. Similarly, the existing 2.2 km long access road between the stockpile/crusher area and Highway 1, which is travelled by highway vehicles as they transport aggregate to various project locations around the region, will remain unchanged. No new road construction is anticipated to support the ongoing and proposed quarry operations at the site.

Table 2: Summary of Spicer Quarry existing and proposed (additional) operational footprints.

Feature	Existing	Proposed
Existing Quarry Area	Approved to 3.4585ha	No additional area
Future Quarry Area	None	7.04 ha
Stockpile/crusher area	4.5 ha	Additional 2.5 ha
Access Road Hwy 1 to Stockpile/Crusher Area (Hwy Vehicle accessible)	2.2km	un-changed (2.2 km)
Access Road Stockpile Area to Quarry (OHV Only)	1.5km	Additional 0.15km
Sediment Catch Basins	8	Additional 1+
Maximum Exposed Mineral Area	None	100 sq. m
Quarry Progressive Reclamation Trigger	None	4.45ha

As part of the proposed Undertaking the stockpile/crusher area is to be expanded by 2.5 ha as an operational safety measure and to improve function. The current area does not allow for clear separation of on highway vehicles loading and scaling aggregate from the off-highway vehicles and crushing equipment that operate in the stockpile/crusher area. The expanded area will allow a designated crushing and OHV operational area in the northern portion of the existing footprint, a designated area for temporary use by a third party portable asphalt plant, and for a separate safe loading and turning radius area for on highway transport trucks in and around the various aggregate size stockpiles. These areas are shown in Figure 3. The proposed stockpile/crusher area has a minimum setback from neighboring property boundary of 30m, a nearest off site residential receptor setback of 420 m, and a minimum buffer to any watercourse of 30m.

To allow the transition from the existing quarry to the new quarry area without creating a stoppage in production it is proposed that the maximum open quarry area be 1.25 times the existing approved quarry footprint, or a total of 4.45 ha. This would allow a 1.1 ha area to be established and set for production at the new location prior to initiating reclamation of the existing site. The existing quarry site has only one access point, located farthest from the active quarry face, a layout the precludes the opportunity for partial reclamation without limiting operational access that will be required until the approved quarry area has been exhausted. Furthermore, as proposed, reclamation will include creation of a wetland habitat within the existing quarry footprint, and land forming of this structure can not be completed while the quarry floor is active. These factors necessitate opening the new quarry footprint prior to initiating reclamation. It is likely that once the transition

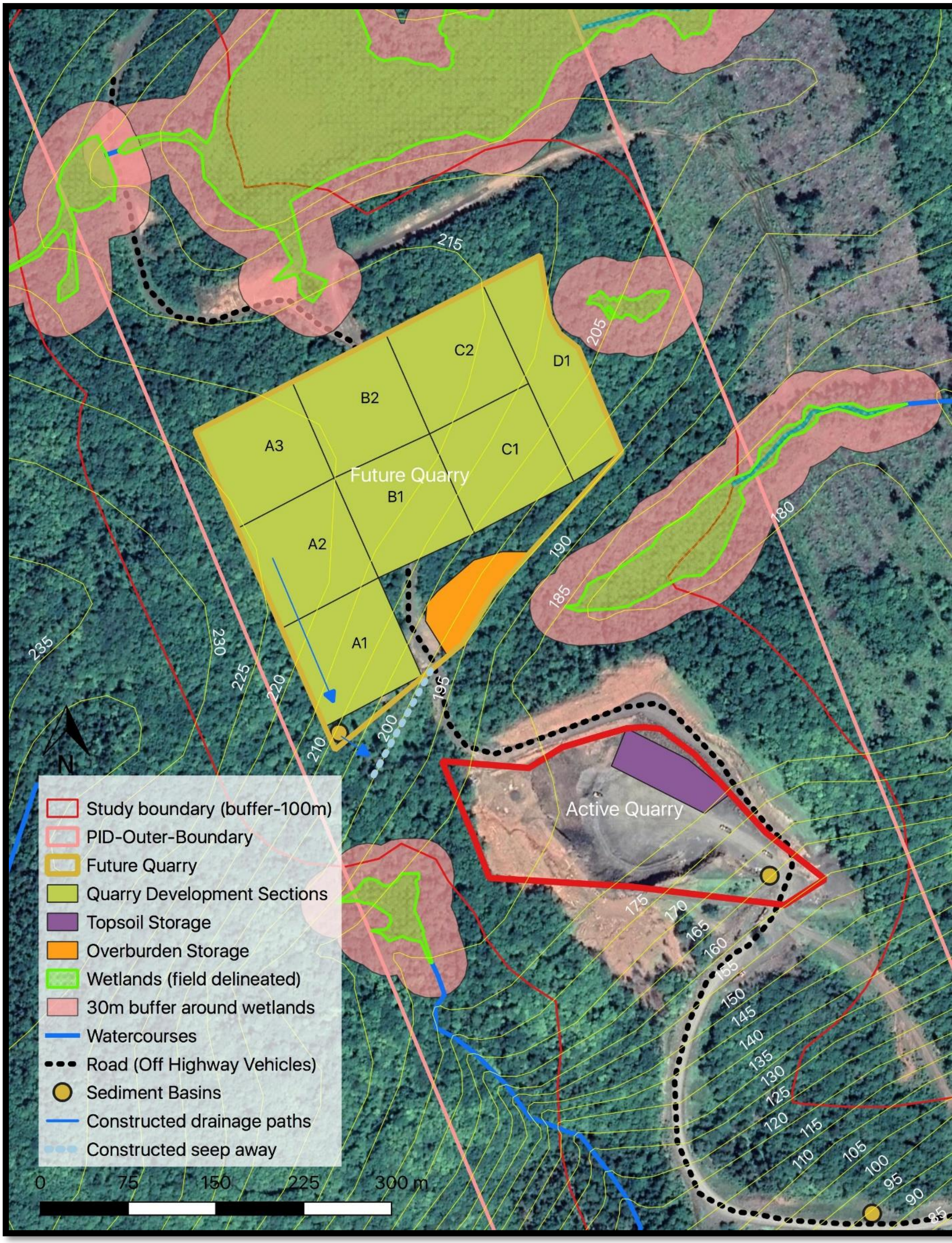

Figure 4: Existing and proposed quarry components, EA 100m buffered Study Area, and 30m buffer around wetlands.

has been complete and reclamation of the old site begins, open un-reclamated area of the quarry will drop well below the maximum proposed threshold of 4.45 ha of open quarry footprint.

Establishing a new quarry footprint will necessitate the clearing, grubbing and removal of overburden above the basalt resource. This material will be stockpiled in designated areas for reclamation of the existing and future quarry footprints as shown in Figure 4. It is proposed that to protect aquatic resources of the Study Area that any exposed mineral area exceeding 100 square meters will be mulched and seeded within a maximum of 3 months. Additionally, a series of 8 sediment catch basins exist around the current quarry and stockpile/crusher areas to help capture fine materials that may move from the working areas during heavy run off events. All of these sediment control structures are to be maintained. A new sediment catch basin has been proposed in association with the future quarry footprint development along with a "seep away" structure to allow surface flow originating in the new quarry to be returned to the adjacent forest as a diffuse surface sheet flow downslope of the sediment catch basin within its original sub-watershed area. These structures are discussed in further detail in Section 2.3.6. Additional sediment and erosion control measures at the new quarry footprint location will be required in future years and will be determined based on conditions encountered during development.

2.3.1 Drilling and Blasting

At the current, and planned future, production levels, blasting typically occurs between two and three times per year. An independent qualified blasting company will be contracted to undertake the drilling and blasting operations in accordance with the *General Blasting Regulations* contained in the *Nova Scotia Occupational Health and Safety Act* (1996). All blasting activities will be completed in accordance with the site's existing Industrial Approval (2007-056846-03) and NSEL Pit and Quarry Guidelines (NSDEL, 1999). Specifically:

i) A technical blast design prepared by a qualified person will ensure the following ground vibration and air concussion limits can be achieved.

Parameter	Maximum	Monitoring Frequency	Monitoring Station
Concussion (Air Blast)	128 dBL	Every Blast	Within 7 m of the nearest structure not located on the Site
Ground Vibration	0.5 in/sec (12.5 mm/sec)	Every Blast	Below grade or less than 1m above grade in any part of the nearest structure not located on the Site

ii) At the request of the Department, the proponent shall submit a copy of the blast design

iii) At the direction of the Department, the proponent shall modify or cease blasting

iv) The proponent shall conduct a pre-blast survey of all structures within 800 metres of the point of blast including a water quality analysis of any wells serving these structures. The survey shall be conducted in accordance with the Department's "Procedure for Conducting a Pre-Blast Survey" and the results of this survey sent to the Department prior to blasting on the Site. Additional water quality parameters may be required by the Department staff.

v) The proponent shall call the nearest weather office, to assess and record the climatic conditions prior to conducting any blasting. No blasting will be permitted if thermal inversion conditions are anticipated at the time of the proposed blast.

vi) No blasting shall occur on Sunday, on a statutory holiday prescribed by the Province, or on any day between 1800 and 0800 hours.

vii) The proponent shall ensure that all blasts are monitored for concussion and ground vibration to ensure that the limits in the Blasting Limits table are not exceeded.

viii) The monitoring station for blasting shall be as indicated in the Blasting Limits table. Additional monitoring stations for blasting may be specified as required by the Department. The Approval Holder(s) shall submit a record of individual blast results if so directed by the Department.

The separation distance between the working face of the existing quarry and the nearest off-site residence to the southeast is approximately 1100 m. As the operation transitions to the new quarry site, this separation distance will increase to approximately 1300 to 1500 m and include a further forested buffer that should increase sound attenuation (loss). Two residences owned by the proponents are located on the project properties. The closest of these is approximately 1150 m from the existing quarry face. These distances will similarly increase by 2-400m with the transition to the new quarry site.

Blasting and subsequent excavation of aggregates at the existing quarry is anticipated to occur from the existing surface elevation to an elevation of approximately 180masl as currently occurs. Blasting and subsequent excavation of aggregates at the future quarry location is anticipated to occur from the existing surface elevation to an elevation of approximately 190masl. Both elevations are to be a minimum of 1m above the groundwater table.

A phased approach to the quarry development in the proposed footprint area is to occur as depicted in Figure 4 beginning in the southwest corner (block A1) and moving toward the northwest corner (A3). To ensure the progressive reclamation area trigger (4.45 ha) is not exceeded each phased block of development that has been proposed and shown in Figure 4 is approximately 90m by 90m. The maximum open area will be triggered when more than the existing quarry and one future block, or five future blocks, are open at one time. Blasting in these development blocks will be done in lifts of approximately 45 ft (14m). Prior to moving from block A1 to A2 the reclamation at the existing quarry will have to occur as described in Section 2.4. As all “A” blocks are developed, operations will shift consecutively through “B” to “D” blocks.

2.3.2 Hazardous Materials Management

A single 3000 L double walled vacuum diesel fuel storage tank with lockable handle and power shut off is maintained at the stockpile/crusher site for the purpose of re-fueling off-road heavy equipment and rock crushers as shown in Figure 5. It is signed and protected with a barrier of $1m^3$ boulders painted in safety orange. A supply of machine lubricants (e.g. grease) is maintained at the site in a lockable steel shipping container for immediate and short-term use in servicing heavy equipment. A spill kit is maintained at the site for immediate use in the event of a fuel or oil spill. Heavy off-road equipment is serviced on site, with waste products (e.g. waste engine oil, used fuel filters) returned for the B. Spicer Construction Ltd. machine shop in Bridgetown East for safe storage and eventual disposal. A safety muster point has been designated and indicated by signage at the weigh scales.

Figure 5: Fuel storage unit and maintenance supply building at the Spicer Quarry stockpile/crusher area.

B. Spicer Construction Ltd. maintains a written Quarry Contingency Plan that outlines spill response procedures for the existing quarry operation. There are no current or future plans to store any additional hazardous materials or chemicals at the quarry site. During periods of operation of the third-party temporary asphalt plant, bitumen additives are brought in daily by the operators and none are stored on site.

2.3.3 Transportation and Production

Within the quarry operation, blasted stone is excavated and placed in 30-40 tonne off highway only rock trucks via a 30 – 50 tonne excavators at the quarry face. The blasted stone is moved 1.5 km from the quarry footprint area at the top of the north mountain to the stockpile/crushing area at the foot of the mountain with the off-highway rock trucks. These vehicles are capable of safely traveling the 15-25% gradient gravel road under load, where on highway capable vehicles could not. The blasted stone is dumped near a crusher in the northern portion of the stockpile/crusher area as shown in Figure 3. Based on demand the blasted stone is crushed by one of four company owned crushers into a variety of size classed materials, including crusher dust, ¾" minus, 3" minus, 4-8 inch stone, 6" minus, 24" minus, and armour stone (24"+). Smaller size classes are also produced as a clear stone product. A large front-end loader capable of moving 4 to 6 yards of material work along side 30 – 50 tonne excavators to load the crusher and remove the crushed material to appropriate stockpiles. No washed materials are produced as part of the quarry operations and no washing is proposed as part of this Undertaking.

Figure 6: A crusher at the stockpile/crusher area of the Spicer Quarry.

Vehicles hauling aggregate from the Spicer North Mountain Quarry to off site project locations include both trucks owned and operated by B. Spicer Construction Ltd. as well as those operated by private third-party construction contractors. All vehicles enter and leave the site via the 2.2 km private gravel access road linking Highway 1 to the stockpile area. With the proposed increase in size of the stockpile area, on site transport and crushing activities will be kept physically separated from on highway trucks. Trucks are loaded with required aggregate and scaled in the stockpile area before leaving to Highway 1 where they will travel either east or west to markets. Majority of production is used within a 50 km radius of the quarry, with occasional trips 70 km in length. At current production levels, during peak production periods, approximately 50 trucks leave the site per day (3% of Highway 1 volume), with approximately 10 truck departures per day during off-peak periods.

The quarry currently produces in the range of 100,000 to 150,000 tonnes of aggregate and rock each year. Production levels and materials produced are anticipated to remain the same in the future. With future operations, no change is anticipated in the trucking and delivery patterns.

Quarrying and processing of rock (excavation, crushing, stockpiling) occurs from 06:00 to 19:00, Monday to Friday, for approximately nine months per year (April to December). Hauling of gravel and aggregate from the site occurs on the same daily and weekly hours, for approximately ten months per year. The operation of the asphalt plant at the site is intermittent and in response to projects demands, with some years having no asphalt production. Designated space on the west side of the stockpile/crusher area is rented to third parties who own and operate the asphalt plant, utilizing quarry produced rock in the production of paving material. Asphalt plant operation is typically for a 1-2 month period. When in place, the mobile asphalt plant maintains the same daily and weekly operation pattern as the quarry. Fuel and bitumen used in the asphalt production are trucked in by the third party daily. No hazardous materials associated with the asphalt plant are stored on site. No change in the hours of operation are anticipated with future activities at the Spicer North Mountain Quarry.

2.3.4 Air Quality Management

Various aspects of the existing and proposed quarry produce dust, and several strategies are employed to mitigate excessive dust production and movement. All trucks leaving the site with aggregate are tarped, which helps to minimize dust lost from loaded aggregate. Water is applied to gravel access roads, as necessary, to control dust levels, with water from an on-site water supply pond. The gravel access road to Highway 1 is typically sprayed once a year with magnesium chloride to suppress dust through an agreement with a third party. During crushing operations, a mist of water is applied within the crusher to suppress dust, with water supplied from an established on-site water supply pond. The supply water for the dust suppression is replenished using a 3/4" gravity water line running from a spring north of the stockpile area and part way up the mountain. Water is pumped out of the pond to feed a manifold on the crusher where it then gets sent out to various spray bars to suppress dust. Capture of this water is discussed in Section 2.3.6.

In accordance with the Spicer Quarry's existing Industrial Approval (2007-056846-03) and NSEL Pit and Quarry Guidelines (NSDEL, 1999), particulate emissions shall not contribute to an ambient concentration of total suspended matter which exceeds the following limits (in micrograms per cubic metre of air) at or beyond the Site property boundaries:

i) Daily Average (24 hour) 120 $\mu g/m^3$
ii) Annual Geometric Mean 70 $\mu g/m^3$

The monitoring of ambient total suspended particulate matter will be conducted at the request of the Department of Environment. The location of the monitoring station(s) will be established by a qualified person retained by the proponent and submitted to the Department for approval, which may include point(s) beyond the property boundary of the site. Upon request, ambient total suspended particular matter will be measured in accordance with EPA standard: EPA/625/R-96/010a. Sampling of ambient air for Total Suspended Particulate Matter (SPM) and PM_{10} will be done using a High-Volume sampler.

2.3.5 Noise Management

Crushing, excavation, trucking, and blasting are all activities associated with quarrying that produce noise. In accordance with the site's existing Industrial Approval (2007-056846-03) and NSEL Pit and Quarry Guidelines (NSDEL, 1999), sounds levels measured at the site property boundaries will not exceed the following equivalent sound levels (Leq):

i) 65 dBA: 07:00 to 19:00 hours
ii) 60 dBA: 19:00 to 23:00 hours
iii) 55 dBA: 23:00 to 07:00 hours

The monitoring of sound levels will be conducted at the request of the Department of Environment. The location of the monitoring station(s) will be established by a qualified person retained by the proponent and submitted to the Department for approval, which may include point(s) beyond the property boundary of the site.

B. Spicer Construction has established a berm at the southern edge of the existing quarry to mitigate visual and noise effects. Dense forest cover is maintained around the stockpile/crusher area to attenuate noise, and an additional forested buffer between receptors and the proposed quarry footprint should further attenuate future quarry related noise. Noise levels have been measured during crushing operations at the current and future stockpile/crushing area at the base of the north mountain. NSE Inspector Specialist Jacquelyn Burneau conducted a sound test near the closest residential receptor and found acceptable sound levels (K. Spicer pers. comm. 2020). The receptor was a Spicer owned resident on the subject properties immediately south of Beaconsfield Road, approximately 175m from the existing stockpile/crusher area footprint.

2.3.6 Sediment Control and Management

The Spicer Quarry has been in operation since for 11 years under a Provincial Industrial Approval. As such, a number of measures to manage erosion and sedimentation have been implemented as discussed below. Several of these constructed features were implemented following the development of a Site Drainage Plan in 2008 (ECA 2009), completed as a condition of the quarries' Industrial Approval. These measures will continue into the future. With the proposed new quarry footprint additional measures will be implemented as proposed below. No washed materials are produced as part of the quarry operations and no washing is proposed as part of this Undertaking, helping to mitigate some risk associated with sediment control.

Figure 7: A sediment catch basin collects ditch drainage and any potential sediment along the OHV access road.

As shown in Figure 3, eight sediment catch basins are located in areas from the existing quarry, to the steep OHV access road, to the perimeter of the stockpile/crusher. These have been established for the existing operation, Figure 7. Over the years, drainage has been dispersed into natural low areas to avoid significantly concentrating flows in ditch lines or on working surfaces, minimizing the primary means of sediment transport; excessive water. Periodically hydroseeding has been used to stabilize exposed mineral surfaces. As evidenced through required total suspended solids monitoring (See Section 5.5.1), these measures have generally prevented excessive sedimentation of natural watercourses within the study area. As part of the proposed Undertaking it is proposed that each of these sediment catch basins be monitored once annually in the fall for maintenance prior to the onset of the rainy season and that all of the existing structures will continue to exist and to be maintained.

As described in Section 2.2.4 water is pumped out of a supply pond adjacent to the crushing area to suppress dust during the crushing portion of production. The dry crushed rock absorbs almost all the water that is being applied, producing minimal operational runoff. Residual water drains to the ground at the porous crusher area that is topped with crushed stone. Any excess water is captured in a ditch line and supply pond located at the southwest edge of the stockpile area. There, and suspended sediments can settle into the catch basin and the water returns to groundwater or diffuse surface flow to the forest floor based on environmental conditions.

As the Spicer Quarry continues to operate and shifts to the proposed quarry location north of the existing quarry footprint, a number of additional sediment and erosion control measures are proposed. These measures specifically address runoff from the proposed quarry floor, and stabilization of mineral/organic overburden stores as they are removed and stockpiled for future use in the progressive reclamation of the quarry.

As a new phase of quarry development is initiated the ground above the basalt resource is stripped of organic and mineral overburden. For the existing operation this material is stockpiled around the perimeter of the existing quarry footprint. For the proposed quarry footprint, initial organic topsoil will be moved to the existing quarry in the area to the east as indicated in Figure 4. This material will be used in the progressive reclamation of the existing quarry as described further in Section 2.4. The mineral overburden that is removed from the first phase (Block A1) area will be stockpiled first at the location indicated in Figure 4 immediately east of the access road at the new quarry footprint, and will provide a staging area for equipment as the site development is initiated. This overburden pile will extend approximately 100m east of the access road. The sides of this berm will be immediately covered with topsoil, seeded and mulched to stabilize the structure. It is anticipated that this berm will then facilitate management of water and sediments at the proposed quarry site for at least the first half of its anticipated lifespan, providing long term protection to the downslope Wetland 1 and associated ephemeral watercourse. As required, mineral overburden from the newly developed quarry will secondly be transported to the existing quarry for use in the progressive reclamation of that site to ensure appropriate slopes and contours are established during the reclamation.

Throughout the life of both the existing quarry operation and the proposed operations, mineral areas will become exposed and stockpiles of both topsoils and mineral soils will be shifted to facilitate operations and reclamation. This usually occurs once a year as working quarry area for the upcoming season is exposed in preparation for blasting. Stabilizing these materials to limit the risk of erosion and sediment transport has been periodically undertaken at the Spicer Quarry during the previous 11 years of operation. It is proposed that going forward a threshold of 100 meters square of exposed soils be established, whereby such areas will be stabilized within 3 months or less through mulching and seeding, hydroseeding, or placing a blanket of cover rock as appropriate based on slopes, exposure, and operational considerations. The maximum three-month timeline is suggested as it reflects a period over which an overburden stockpile area may be continually added to and initiating stabilization prior to completing seasonal overburden stockpiling would negate the stabilization efforts. As required by Federal and Provincial legislation current exposed areas must be adequately stable so as not to contribute sedimentation to a watercourse, and this is achieved through water management, slope management, and terracing of stockpiles. The proposed cover stabilization for areas greater than 100m square is an additional measure to further mitigate risk during expansion and operation. It is proposed that the operation be monitored twice annually, in spring and fall, for areas requiring stabilization.

Figure 8: An example of a recently constructed "seep away" structure used to restore a concentrated ditch flow to a more diffuse surface sheet flow at a wetland restoration project on Brier Island, Nova Scotia.

An additional proposed measure for surface water management to prevent erosion and sedimentation from arising at the new quarry footprint is the establishment of a defined drainage path from the quarry floor to a sediment catch basin. As shown in Figure 4, surface drainage from the working quarry floor will be collected on the western boundary and directed to a catch basin in the southwest corner where heavier particulate matter can settle. This direction of discharge also helps maintain the original sub-catchment watershed size. The sediment catch basin can be periodically maintained as necessary to ensure proper ongoing function and will be monitored once annually in the fall for maintenance requirements. It is further proposed that discharge from the catch basin then be directed into a ~70m long armoured "seep away" structure constructed along the contour immediately downslope of the catch basin. This structure will restore any ditch concentrated flow collected off the future quarry floor to a more natural diffuse surface sheet flow (as currently exists) through the adjacent forested. An example of a small 12 m long seep away structure employed by East Coast Aquatics in a wetland restoration project on Brier Island is shown in Figure 8. This structure will allow surface drainage from the quarry floor an opportunity to recharge to groundwater and minimize the risks of erosion that can be associated with concentrating flows through ditch lines. This is an important consideration in light of climate change predictions for the region of greater intensity rain events (discussed further in Section 5.2.2).

2.4 Decommissioning and Reclamation

Decommissioning of the quarry site will see the removal of all infrastructure and structures associated with the Spicer North Mountain Quarry operation and is intended to occur at the end of the anticipated life of the proposed undertaking in 2050. Reclamation, which will return the site to stable and naturalized habitats, encompasses slope stabilization and establishment of native plants through seeding and planting. Reclamation is proposed to occur progressively throughout the life of the quarry within the existing and proposed quarry footprints. A detailed decommissioning and reclamation plan will be prepared, at the request of NSE, for implementation at the site. However, the following activities are planned for progressive reclamation and decommissioning.

It is proposed that progressive reclamation of the existing and proposed quarry footprints occur based on maintaining a maximum open (un-reclamated) area at any one point in time. This trigger area is proposed to be 1.25 times the existing quarry footprint, or approximately 4.45 hectares of quarry area open at any one time. Functionally, reclamation of the existing quarry can not significantly begin until extraction operations at the existing site are completed (as described in further detail in Section 2.3.1) as initiating reclamation sooner would limit access to the active quarry floor. Similarly, the proposed new footprint area to the north must get cleared to allow production to be initiated as soon as the existing quarry production ends so that a stoppage in production does not occur. Finally, it is proposed that a portion of the existing quarry floor be reclamated to wetland habitat and shaping of that reclamation feature can not begin while the existing quarry remains active.

Spicer Construction has been stockpiling mineral and organic overburden along the north and east edges of the existing quarry footprint in anticipation of future site reclamation. As production transitions to the new quarry in approximately two to four years, the new site will need to be cleared of soils and mineral overburden. It is proposed that the topsoil from the first new cell of operation (~92m x 92m) in the southwest corner of the proposed new quarry site will be taken to the east side of the existing quarry to facilitate reclamation of the existing quarry. It is likely that mineral overburden from the new quarry site will also be taken to the east side of the existing quarry to facilitate re-sloping and reclamation of the existing quarry site.

As noted, it is proposed that a moderate area of the existing quarry footprint be remediated to wetland. It is anticipated that by shaping the quarry floor and surrounding catchment area, lining the area with clay mineral overburden soil from the local Blomidon Formation, and providing an organic top layer, adequate water could be captured to establish a 0.5-0.75ha or greater wetland on the site. The surrounding height of the quarry walls will be reduced with the placement of mineral soils and an organic topcoat at a low angle slope (<3:1). The salvaged surficial organic layer from the new quarry area will form the basis of a natural growing medium and facilitate the revegetation/colonization of the remediated areas, providing a place to seed and replant appropriate forest tree species. At minimum of 15cm of topsoil will be established across the reclamation area. To add further diversity of habitat, it may be appropriate to leave some exposed vertical rock face to provide nesting opportunities to bird and other species that favour such habitat, and stone piles for snakes and small mammals such as mice and porcupine to establish dens. Some tree seedlings will be transplanted to initiate forest cover habitat, and to promote establishment of an uneven age stand on the reclamated areas.

As the new quarry site development progresses, the existing quarry site will be progressively remediated at a rate that ensures that less than 4.5 hectares of quarry footprint remains open at any one time. When the existing quarry footprint is fully remediated, progressive reclamation will shift to the new quarry footprint area, again ensuring that 4.5 hectares remain open at any one time.

The location of the aggregate stockpile/crushing area at the foot of the north mountain will be required for the life of the proposed undertaking, and therefore is expected to remain unchanged and un-reclamated over that period of time. No progressive reclamation will occur in this area. Instead, the aggregate stockpile area will be decommissioned and reclaimed at the end of operations, anticipated to be in 2050.

2.5 EA Schedule

The executed and planned schedule for completion of the EA, permitting and operations of the quarry include:

Baseline studies for Environmental Assessment	Spring to Autumn 2019
Public Consultation	Open House May 13, 2019 and ongoing through the EA to inform the project design
Environmental Assessment Registration	Early March 2020
Public Review of EA	March 2020
Expected EA Decision	Mid-April 2020
NSE Permitting (Industrial Approval)	April to June 2020
Quarry Operations	2020 to 2050
Progressive Site Reclamation	2023 to 2050
Decommissioning	2049 to 2050

3. Environmental Assessment Scope

3.1 Spatial and Temporal Boundaries of EA

The investigation and description of effects on biophysical Valued Environmental Components (VECs) (e.g. vegetation, wetlands, species at risk, noise) has occurred within the EA Study Area shown in Figure 9 that encompasses a minimum 100 m buffer from all project components. For important habitat features identified within the Study Area (i.e. Wetlands 1 and 3), they were studied in their entirety at distances up to 350 m from the nearest project component. Effects on groundwater have been discussed in the context of geological strata, well logs, and groundwater studies out to between 1 and 2 km from the Project Site. Surface water resources in Ray Brook have examined primarily within the context of the 100 m buffer around all project components that constitutes the Study Area, but with consideration of the ecosystem linkages to the Annapolis River and the larger watershed, and specifically the importance of Ray Brook to the larger watershed. Socio-economic effects of the project have been evaluated at the scale of Annapolis County.

The temporal boundaries for the EA have been both forward and backward looking. It encompasses the current and planned operations (2020 to 2049) at the site as described in Section 2.3 (including excavation, crushing, screening and stockpiling of aggregate, progressive reclamation, and leading to the eventual decommissioning and of the site). Temporal boundaries of the EA assessment also include the past use of the site as a quarry since it began in 2008 and the various surface water, habitat, wetland, drainage plan, groundwater monitoring, and vegetation inventories that have been completed sine that time as part of the Industrial Approval requirements for the Spicer Quarry.

3.2 Assessment Scope

The scope of the environmental assessment has been determined by the proponent and their consultants, East Coast Aquatics Inc. (ECA). Factors considered in the development of the scope include the components of the proposed Undertaking, the professional judgement and knowledge of the study team, consultations with regulatory officials and the public, and the findings of the field studies conducted as part of this environmental assessment. The ECA study team met with representatives of the Nova Scotia Environment on February 9, 2019 to discuss the proposed assessment and project scoping. The Guide to Preparing an EA Registration Document for Pit and Quarry Developments in Nova Scotia (NSEL 2009) was also used to determine the focus and scope of the assessment.

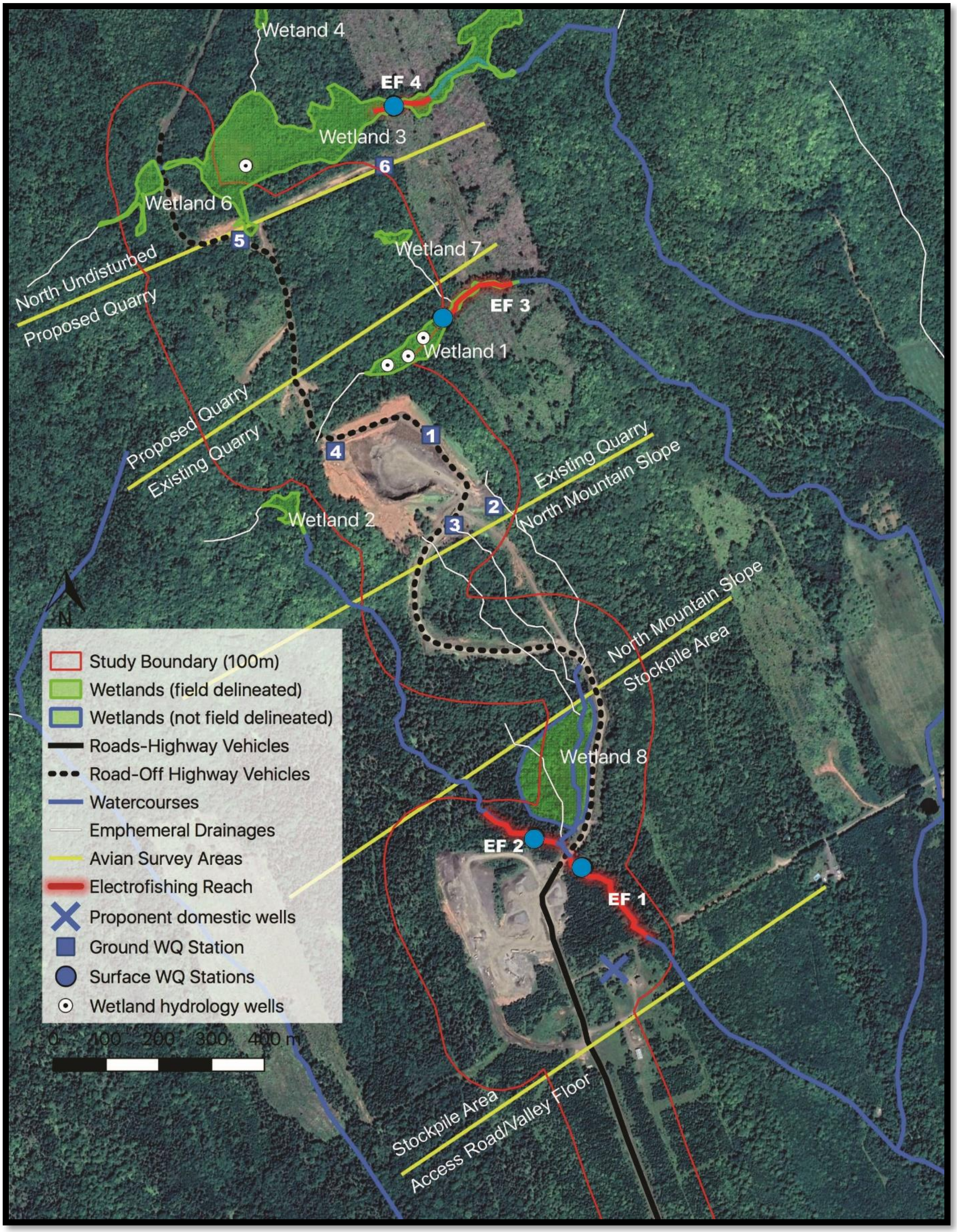

Figure 9: Field survey zones and site locations for both EA assessment and long-term monitoring of the Spicer North Mountain Quarry.

3.3 Purpose and Need for the Undertaking

The purpose of the Project is to allow B. Spicer Construction Ltd to continue to excavate, process and market basalt aggregate from the existing Spicer North Mountain Quarry. The site is currently operating under an Industrial Approval (No. 2007-056846-02), issued by NSE on January 26, 2018 and effective until January 26, 2028. A copy of the NSE Approval permit is included in Appendix 1. This approval allows for operations under 4 ha in size. Although the existing quarry has a predicted 2 to 4-year lifespan remaining, demand is anticipated to continue beyond this time frame. In order to meet this longer-term demand, Spicer Construction has initiated this EA Registration. The proponent understands the operational footprint has not and will not remain under the 4ha size currently approved if it continues to operate uninterrupted into the future. Expansion of the operational area beyond 4ha is predominantly related to the need to open a new quarry footprint, although the proponent will take the opportunity to carry out the expansion of the stockpile/crusher area a safety and operational functional improvement as described previously in Section 2.3.3 during the approval process.

The shift to the new adjacent quarry location is to allow access to additional basalt resource for uninterrupted operations while avoiding a wetland and watercourse at the site, which restrict access to basalt immediately adjacent to the existing quarry footprint. The proposed new quarry footprint lies north of both the existing quarry and Wetland 1 and will provide a forested buffer on all sides of the wetland. Shifting operations to the new quarry location in a manner that will not interrupt operations requires establishing the new quarry before the existing permitted quarry can be fully reclaimed, and in the process exceeding the 4-ha threshold that necessitates a full Environmental Assessment. The rate of aggregate production is expected to remain unchanged from current levels. No new operational activities are proposed as part of the Undertaking that have not been carried out as part of the current quarry operations.

The need for the undertaking is driven by past and project demand for aggregate which B. Spicer Construction Ltd. seeks to supply. The aggregates produced at the Spicer Mountain Quarry have been and will be an important supply requirement for both local and regional construction projects. The aggregates are of suitable quality for highway construction, infrastructure, and maintenance projects. Locally produced aggregate is desired for such projects not only because of the quality of the product, but also for the cost efficiency and smaller carbon emission footprint associated with shorter trucking distances to the end use location. The quarry currently provides both direct and indirect employment, in a region of the province with higher than average unemployment. The proposed project will allow these jobs to be secured for a generation of workers.

3.4 Consideration of Alternatives

Alternatives for a quarry at a location further removed from the current proponent properties were not considered given a variety of reasons, including the following:

- The current properties provide proven quality aggregate.
- Considerable investment has been made in infrastructure at the existing site and duplicating that effort elsewhere would significantly increase environmental and financial costs to aggregate production.
- There is a limited number of sites in the region with comparable aggregate resources, which

provides reliable demand for the quarry outputs.
- The site is favourably located in a rural area, and generally removed from nearby residential development.
- The existing site has good community support achieved through responsible operation and response to concerns that would need to be re-established at an alternative location with a new community.

In the consideration of alternatives, alternatives within the proponent owned project properties were considered. The possibility of an alternate quarry site at the top of the north mountain within the existing proponent properties was examined. This alternative was to continue to expand from the existing quarry footprint. This approach could initially be considered favourable to shifting to the nearby adjacent location for the quarry that has been proposed. However, in examining this alternative it was determined that it would require the encroachment on and alteration of valued wetland and watercourse habitats. A shift of the footprint to the south is not possible as the underlying geology changes and the basalt resource could not be accessed. Property ownership does to the east does not lie with the proponent constraining any expansion in that direction. Property ownership and surface water resources limits expansion to the east of the approved quarry footprint. To the north a limited area of additional resource exists before encroaching on a wetland. A thicker lens of soils over the desired basalt in this area would also produce an excessive amount of overburden material that would need to be moved and stabilized to minimize risk of sedimentation and erosion if the quarry were to shift immediately north from its existing footprint. Given these constraints on all sides of the existing quarry, a complete shift of the quarry footprint northward approximately 200 m allows access to good resource with minimal overburden and avoids the alteration of wetland and watercourse resources.

As previously noted, the existing operation has an active quarry site at the top of the north mountain where drilling, blasting, excavation of aggregate occurs. The operation has a second operational location as the base of the north mountain that is connected to the quarry site by a 1.5 km OHV access road and where crushing, screening, and stockpiling of aggregate occurs before highway bound trucks are loaded and weighed. This location is referred to in this document as the stockpile/crusher area, and it is proposed within this EA to undergo a moderate expansion of area to improve safety and operational flow reasons described in Section 2.3.3. Consideration of alternatives for expansion of the stockpile/crusher area included both another location within the proponent properties or a directional expansion from the existing stockpile/crusher area footprint. An alternative location was quickly dismissed as movement of the area northward is constrained by the steep topography of the north mountain and significant movement east or west is constrained by proponent property ownership. Although the site could be shifted southward toward Highway 1 it would bring operational activities closer to residential receptors, which would not be desirable for those residents or the proponent. A full-scale shift in the stockpile/crusher area would also incur a greater environmental effect and operational cost that would not be warranted given the stability and functionality of the existing site.

Based on 2019 field assessments, the established stockpile/crusher location has satisfied operational requirements (crushing, screening, scale house, temporary asphalt plant) in a manner that is not providing significant stress to the natural environment. Therefore, any required expansion from the existing footprint to address safety and operational concerns could be expected to have less adverse effect on VEC's than a complete shift in that footprint to a new location. Alternatives of direction for moderate expansion of the stockpile/crusher area from the existing footprint were considered. An expansion westward for the stockpile/crusher area is considered undesirable as it would encroach <30 m from a neighboring property boundary. Southward a small area of expansion is possible, and proposed, but constrained by a land right of way boundary associated with the undeveloped continuation of the Beaconsfield Road, a Provincial public road. Further shifting stockpile/crushing area southward of the ROW encroaches closer to a number of residential receptors and is considered undesirable for both the residents and the proponents. A northward expansion of the stockpile/crusher area was considered undesirable as surface water seeps associated with the geology in that area (see Section 5.3.3) would create potential water management challenges that are unwarranted given available alternatives for area expansion. Expanding the stockpile/crusher area eastward, as proposed as the best option, is still constrained by the Ray Brook watercourse. To maintain an appropriate 30m buffer (NSE 2003), further expansion eastward beyond that which as been proposed was not considered.

Finally, the Undertaking proposes for the delivery of aggregates by truck via the main access road south to the Highway 1 to be continued. The bulk of local construction activities and hence requirements for aggregate materials is located in the western Annapolis Valley. The main access road south to Highway 1 provides the most direct access to these locations, with the fewest road miles required. Although an alternate route to the north could be considered, the potential impact to VEC's, operational costs, and limited demand for use has negated its further consideration. No new watercourse crossings or structures are proposed in association with the ongoing use of the current access road.

4. Environmental Assessment Methodologies

This environmental assessment registration seeks to evaluate the potential environmental effects of the proposed Undertaking, through all Project phases and for each of the Valued Environmental Components (VECs). The evaluation of each of these VECs, within the spatial and temporal project boundaries, is utilized to provide a valid assessment of project effects. Government guidance, consultation and professional judgement was utilized in the development of the follow VEC list.

4.1 Rare and Sensitive Species at Risk

Published guidance was utilized to compile and examine data on SAR within the project footprint (Nova Scotia Environment, 2009). Species information from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Species at Risk Act (SARA), Nova Scotia Endangered Species Act (NSESA) was compiled. This information was combined with the results of a data search by the Atlantic Canada Conservation Data Centre (ACCDC) of flora and fauna occurrences within a 100 km radius of the project site (ACCDC, 2019) (Appendix 2) and additional data sources (Nova Scotia Significant Species and Habitats database and Sean Weseloh-McKeane, Coordinator, Special Places, NS Communities, Culture and Heritage (pers. comm.)). This process allowed the development of a short list of SAR that may occur within the project footprint (Table 23 Section 5.6). This short list was then used to guide the development and implementation of the field surveys and communicated to all project staff to aid in the refinement of their respective field survey methods which are described in the following sections. The general findings of the biological field surveys are contained in Sections 5.4 and 5.5 for terrestrial and aquatic species respectively, while further discussion on specific species at risk (SAR) and species of conservation interest (SOCI) are discussed in Section 5.6.

Within the context of this report, a species at risk (SAR) is one which is protected by either Federal of Provincial legislation (Species at Risk Act (SARA) and NS Endanger Species Act (NSESA), respectively) due to their rarity. Species of conservation interest (SOCI) are those that are known or believed to be rare or uncommon at a Provincial scale, and therefore ranked as S1-S3 by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) but that have not been given regulatory protections under SARA and NSEA.

Section 5.6 summarizes information on SAR and SOCI encountered, numbers of individuals observed, and the habitats with which they were associated. Section 5.6 further examines SAR from the desktop short list that were considered potentially present at the Study Area based on their documented presence within 20 km of the site, and provides discussion on the appropriateness of habitats present in the Study Area in supporting those short listed SAR that were not observed during field surveys.

4.2 Flora

Field surveys were conducted by botanist Tom Neily on June 18 and August 8th, 2019 aimed to capture the flowering times of vascular plant species present. Incidental observations of macrolichen species were also recorded during the vascular plant surveys. A separate macrolichen survey was conducted on January 13th, 2020. Increased light resulting from lack of leaf cover and vegetation creates ideal conditions for surveying epiphytic macrolichens during winter months. Mr. Neily is an experienced field botanist, who has worked extensively throughout Atlantic Canada. His experience includes wetland delineation, vascular plant surveys, lichen surveys, evaluation of rare and endangered flora, and collection and identification of bryophytes.

A desktop review compiled a potential list of plant SAR/SOCI that were provided to the project botanist prior to field surveys in order to increase awareness of important species that may be encountered during the surveys. Following a desktop review and preliminary field surveys, the Study Area vegetation was assessed by the botanist within six broad habitat ecotypes that had been identified: disturbed areas and ditches, mature upland hardwoods, upland regeneration, valley floor regeneration, valley floor alder thicket and wetlands. The habitat areas are mapped in Figure 9. A GPS track and an inventory of the plant species within each of the six habitat ecotypes was maintained during the surveys. Inventories were maintained for each vegetation strata with dominant species noted. Specific locational data was recorded for any SAR or SOCI encountered, as well as for invasive/exotic species. Alien invasive species present were identified using a list compiled from several sources: Hill and Blaney (2009), CARP (2007), Nova Scotia Weed Control Act (Revised 1989), Brazner (2011) and MTRI (2012).

Based on the results collected by Mr. Neily, ECA compiled a summary of the results presented Section 5.4.1 Vegetation Communities and Habitats and Section 5.6 Species at Risk and Species of Conservation Concern. The summary was reviewed by Mr. Neily for accuracy. Section 5.4.1 provides the dominant species by strata in each plant community., Section 5.6 provides observed

SAR and SOCI and their associated habitats, and includes SAR from the desktop short list that were considered potentially present at the Study Area based on their documented presence within 20 km of the site. A discussion on the appropriateness of habitats present in the Study Area to support short listed species that were not observed during field surveys is given.

4.3 Terrestrial Fauna

Observations for terrestrial fauna and herpetofauna were made incidentally during periods associated with all other field surveys. Fauna and sign were noted and photographed as appropriate to provide a list of confirmed species use. If SAR or SOCI observations made, GPS locations were also collected. All six primary forest types within the Study Area were traversed on a number of occasions for various surveys and mapping of operational features. Terrestrial fauna observations were noted during all seasons of the year, including track observations in winter snow. A preliminary desktop review of potential SAR based on confirmed observations within 20 km of the project site was considered in final evaluation based on the habitats present within the Study Area.

4.4 Avian Fauna

Further detail of avian survey methods is presented in the ornithologist Jake Walker's survey report attached in Appendix 3. A desktop review compiled a potential list of avian SAR/SOCI that were provided to the project ornithologist prior to field surveys in order to increase awareness of important species that may be encountered during the surveys. As well the spatial location of six broad habitat ecotypes utilized in the botanical surveys and proposed future quarry footprint areas were also identified to the ornithologist to ensure search effort was spent in each area.

Based on previous consultation with the Nova Scotia Department of Lands and Forestry (Elderkin pers comm. 2010) regarding avian studies for EA in the area, six general survey dates were used to assess bird use of the property. Surveys were designed to detect breeding raptors (March), breeding owls (April), early spring migrants and breeders (April), late spring migrants and breeders (early June), early fall migrants (early September), and late fall migrants (late September). Field methods varied for these different surveys as described in the following paragraphs. Exact dates for the surveys were selected to ensure favorable weather for migration and bird detection, and to maximize chances of detecting Species at Risk. The ornithologist's avian surveys report is presented in Appendix 3.

The breeding raptor survey was conducted to coincide with peak breeding display activity of Northern Goshawks. Appropriate habitats were surveyed on foot, with periodic scans of the sky for soaring raptors. Playback of Northern Goshawk was broadcast periodically throughout the survey. The survey date selected for breeding raptors was March 14^{th}, 2019. A list of all bird species identified during the raptor survey was compiled.

The nocturnal owl survey followed a protocol modified from the protocol used by the Nocturnal Owl Survey (Takats et al. 2001) and American Woodcock Singing Ground Survey (USFWS 2018). For Woodcock, 7 brief evening stops (<2 minutes) were made just after sunset within appropriate habitat of the valley floor to maximize the number of territories that could be surveyed since woodcocks typically call or perform flight displays without pause for the duration of their evening display (Duke 1966).

On the same date, and following the Woodcock survey, owl stop listening and playback protocols were used. Stops started with 2 minutes of silent listening, followed by a series of broadcasted three species' calls interspersed with 1-minute listening periods. A total of ten stops were conducted in and adjacent to the existing quarry and proposed quarry area, focusing on a combination of forest habitats that would be altered by the proposed undertaking and those that will remain physically unaltered by the undertaking, and along the access road between Highway 1 and the stockpile area at the foot of the north mountain. The nocturnal owl survey was conducted on April 18th, 2019. A list of all bird species identified during the nocturnal owl survey was compiled.

Migration and breeding bird surveys followed an area search methodology to cover as much territory as possible in the early hours of the morning when migrant and breeding birds are most detectable. Since the entire site was to be visited only twice and was small enough to be covered on foot in one morning, this method was believed desirable over point counts. The overall objective was to obtain an inventory of the birds within each of the following habitats: the open and mixed wood habitat future quarry site, the open and forest edge of the existing quarry, the open and forest edge of the stockpile area, the mature woods and Wetland 3 north of the proposed future quarry site, the south facing slope of the north mountain, and the forest and field habitat of the valley floor within 100 m of the access road. These habitat zones are indicated on Figure 9. The walking surveys were initiated at sunrise and endured until the focal areas had been covered. Spring surveys were conducted on April 26th and June 01st while fall surveys were conducted on September 6th and 30th, 2019. A list of all bird species identified during the migration and breeding bird survey was compiled.

During each of the six days avian species searches were completed, a full inventory of all avian species observed was compiled; not just those species targeted by the search timing and methodology. A GPS track was recorded for each search date. Specific locational data was recorded for any SAR encountered while SOCI were identified within one of the six habitat areas surveyed.

Based on the results collected by Mr. Walker, ECA completed the summary of results presented in Section 5.4.2 Avian Community and Section 5.6.1 Avian SAR/SOCI of this document and as reviewed by Mr. Walker. Results on taxonomic richness and effort was compiled, with a description of the habitats within which each avian community was found. Observed SAR and SOCI are presented in context of their associated habitats. SAR from the desktop short list that were considered potentially present at the Study Area based on their documented presence within 20 km of the site, but that were not observed during the 2019 surveys, are discussed in the context of the appropriateness of habitats present in the Study Area in supporting those species.

4.5 Surface Water Resources

ECA completed a desktop-based review of available mapping resources, prior to the commencement of surface water resources field surveys. Mapping resources accessed included NS

Landscape Viewer (Wet Areas Mapping and Flow Accumulation layers), surficial and bedrock geology, current and historic air photography and 1:10,000 provincial topographic maps. Field surveys sought to verify and, where necessary, map the alignment of watercourses, with their revised track recorded using a handheld GPS.

The proponent has conducted annual water quality monitoring, in accordance with Industrial Approval #2007-056846-03 for the past 11 years, with these results are reported annually to NSE. This monitoring has been completed at two surface water locations on Ray Brook (75 m upstream of the access road crossing on the West Branch ((UTM 0311853 4966675) (Zone 20T, NAD83)), and 15 m downstream of the access road crossing (UTM 031760 4966721). The annual reports documented water quality as it relates to a limited number of parameters (pH, dissolved oxygen, specific conductivity, temperature, turbidity, total suspended solids) at these locations, and the results were reviewed as part of the desk-top analysis (ECA, 2011 to 2018) to provide a sense of temporal variability and range for the measured parameters.

As part of this EA, three locations were selected for broad spectrum surface water chemistry analysis:

- Ray Brook 15 m downstream of the access road cross (so as to maintain consistency and compliment past monitoring efforts) (UTM 031760 4966721);
- Outflow channel from Wetland 1 at property boundary (given its proximity to the existing and future quarry footprint and so as to maintain consistency and compliment past monitoring efforts) (UTM 311 585 4967714); and
- Outflow channel from Wetland 3 at property boundary (given its proximity to the future quarry footprint) (UTM 311493 4968123).

Water samples were collected from the three locations on two occasions (May 8 and October 24th, 2019) to provide a seasonal range for the site. The spring and fall timing were chosen as summer flows from two of the locations (Wetland 1 and 3 outflows) are typically insufficient to allow for satisfactory sampling. As a means of QA/QC, in situ water quality observations were recorded at each sampling event using a YSI ProPlus multi-probe meter and a LaMotte 2020i turbidity meter (pH, temperature, dissolved oxygen, specific conductivity, total dissolved solids, turbidity). Water chemistry samples (standard water analysis, metal scan) were collected, placed on ice and transported to AGAT Laboratories in Dartmouth for analysis. The lab analyzed the samples for 56 different parameters through the Standard Water Analysis and Total Metals scan, and these results were assessed relative to natural levels within Nova Scotia and the CCME Environmental Quality Guidelines for the Protection of Aquatic Life. Surface Water Resources and Water Quality results and discussion are presented in Section 5.5.1, while all water chemistry results are presented in Appendix 8.

Additional surface water assessment was conducted as part of the evaluation of wetlands in the Study Area, and those methodologies are presented in Environmental Assessment methodologies sub-Section 4.7 Wetlands and corresponding results in the Aquatic Environment sub-Section 5.5.2. As part of the fish and fish habitat surveys, stream channel dimensions of wetted and bank full widths and depths were taken at multiple cross sectional locations of each watercourse assessed, including Ray Brook and the un-named tributaries flowing from Wetlands 1 and 3 as reported in the Aquatic Environment sub-Section 5.5.3 Fish and Fish Habitat.

The location of regular surface water monitoring sites and the three additional sites selected for this EA are shown in Figure 9.

4.6 Fish and Fish Habitat

Fish presence and habitat utilization was assessed at four locations on June 18, 2019 through a single pass electrofishing survey, using a Halltech HT2000 backpack electrofisher, operating under DFO scientific licence #700016387. The four stream segments surveyed with the intent of providing an inventory of species were the most likely within the Study Area, based on stream dimensions and available habitat, to support fish. The segments included (as shown in Figure 9):

- Ray Brook – 484m from Beaconsfield Road upstream to the quarry access road.
- Ray Brook – 314m from the quarry access road upstream to the base of the north mountain.
- Un-named tributary from Wetland 1- from the outlet to a point 235m downstream.
- Un-named tributary from Wetland 3 - from the outlet to a point 210m downstream

The location of these surveyed reaches is shown in Figure 9. Water quality measures were collected at each location using a YSI ProPlus multiprobe meter. The results ensured that water temperature was within an acceptable range for electrofisher sampling, and allowed the electrofisher settings, specifically the voltage and frequency settings, to be optimized for the observed water conductivity and target species/size. Channel morphology measurements were recorded at each location to allow for subsequent analysis and comparison of catch per unit area. Barrier nets were not used to isolate the stream segments. All segments were fished in an upstream direction. Experienced and certified electrofisher operators (M. Parker and A. Sharpe of East Coast Aquatics Inc.) conducted the surveys documenting electrofisher settings and active time fishing. All captured fish were immediately placed in a bucket of cool water, followed by processing (species identification and measurement) and live release onsite.

Fishing effort and results were recorded for each stream reach evaluated. A discussion of results is presented in sub-Section 5.5.3 of the Aquatic Environment section, and 5.6.7 Aquatic SAR/SOCI.

4.7 Wetlands

ECA completed a desktop-based review of available mapping resources prior to the commencement of field surveys to identify wetlands within the Study Area in order to predict where wetlands may be encountered. Mapping resources accessed included NS Landscape Viewer (Wetlands, Significant Habitats, Wet Areas Mapping and Flow Accumulation layers), NS Wetlands of Special Significance (2019 revised list), surficial geology, current and historic air photography. The Study Area was then traversed in the field, and any drainage or watercourse followed within the boundaries of the Study Area. Wetlands (and watercourses) encountered were mapped using a handheld GPS. Field surveys were completed by Andy Sharpe, Stephanie White and Michael Parker, all of whom have completed NS Environment-approved wetland delineation and assessment training (Fern Hill Institute, Maritime College of Forestry Technology) and Functional Assessment training, using the Wetland Ecosystem Services Protocol, delivered by Dr. Paul Adamus, in Fredericton and Halifax (Adamus, 2013 & 2016). The ECA team has completed dozens of wetland assessments and delineations for public and private sector clients across Nova

Scotia.

The wetlands encountered were then evaluated on field survey methods based on U.S. Corps of Army Engineers (2009), Fern Hill Institute (2011) and Maritime College of Forestry Technology (MCFT, 2008 and 2009), including the identification and documentation of wetland hydrology, hydrophytic vegetation and hydric soil properties. Assignment of vegetation indicator status was based on the Nova Scotia Wetland Indicator Plan List (Nova Scotia Environment, 2011). A functional assessment of four wetlands that fell within 200m of the active and proposed quarry footprints was completed following the Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC) (Version 2 – 2018), developed by Dr. Paul Adamus and adapted for use Nova Scotia. WESP-AC examines 17 functions and 19 benefits of wetlands.

As a condition of the existing quarry operations' Industrial Approval, previously identified Wetland 1 is annually monitored for potential effects from the quarry operation. This monitoring has occurred since 2008 and includes three primary components: shallow water table monitoring, wetland indicator plant species monitoring, and outflow turbidity monitoring.

Shallow groundwater monitoring wells (3) were constructed in 2008 along the centerline of Wetland 1; installed as described by the Wetlands Regulatory Assistance Program (2000). The holes for the monitoring wells were dug using a manual 2" Dutch Auger to a sufficient depth to allow the insertion of the monitoring pipes, leaving a minimum of 0.2 m extending above ground. Surface water levels are recorded at the east, central, and west wells (see locations in Figure 9). The annual surface water level measurement is recorded in September. A manual measure from the top of the well is compared to the ground level at the well head. The wells are periodically surveyed to local benchmark to quantify any movement that may occur with the well casing over time. Each well is located immediately adjacent to one of the three indicator species monitoring plots within Wetland 1.

As part of the EA process, two additional wetland shallow water table wells were established in 2019. One in each of the largest wetlands (Wetland 1 and Wetland 3) near the existing and proposed quarry footprint areas as shown in Figure 9. To allow comparison of groundwater elevations between these wells, all well casings were surveyed using an RTK GPS unit. Solinst Level Logger Junior (M5/F15) units were deployed in the wells on April 24th, 2019 and installed in accordance with the manufacturer's directions (Solinst, 2011). A Solinst Barologger Gold was deployed in a vented above-ground pipe to record barometric pressure fluctuations and in accordance with the manufacturer's instructions. Water level observations were set to record hourly in order to create a baseline annual hydrograph for each wetland. Wells were examined periodically during which time manual measures of water levels were collected as a QA/QC measure to verify datalogger results, and loggers were removed from the wells prior to freeze up on December 8th, 2019.

Turbidity has been monitored since 2008 at the outlet of previously identified Wetland 1, located at the wetland's most easterly extent, twice a year during a storm event. This typically occurs in April and October annually depending on conditions. Field conditions are noted, and Environment Canada weather data is documented for the nearest station during reporting of results to demonstrate storm conditions. Turbidity is measured with a handheld LaMotte 2020i turbidity meter.

Vegetation monitoring in Wetland 1 was established in 2008 to document any changes in the abundance of three specific wetland plants relative to the previously completed baseline assessment of Wetland #1 (ECA 2008) that might result from unintended alterations associated with the existing quarries operation. The indicator species are Cinnamon Fern (*Osmunda cinnamomea*), Dwarf Red Raspberry (*Rubus pubescens*), and Sensitive Fern (*Onoclea sensibilis*). All three of these plants are hydrophytic vegetation with wetland indicator statuses of facultative wetland plants (FACW). This status as a wetland plant means that they are found within a wetland 67-99% of the time and are only occasionally found outside of a wetland (NSE 2012). Furthermore, they are present in all three wetland monitoring plots and have relatively low spatial variation across the entire Wetland 1, unlike other taxa encountered.

One vegetation monitoring plot is located adjacent to each of the three surface water monitoring wells in the east, central and western portion of Wetland 1, which allows some evaluation of any plant community changes with consideration of any water level fluctuations that may be observed. Each plot is 5m by 5m as shown in Figure 10. The percent cover of the three target species was estimated within each of four 1m x 1m quadrats within each plot. Percent cover measurements are made independent of other species or substrates and, as a result, may exceed 100 % when combined. In addition, a number of environmental and biological parameters are also estimated within each quadrat to assist in any interpretation of changes in the plant community that may be observed. These parameters include such things as percent of exposed rock, water, muck, and moss. Wetland 1 vegetation monitoring was completed annually until 2013 and has been completed every two years since. It was last completed in the summer of 2018.

As part of the EA process, these data have been reviewed and incorporated into the evaluation of valued ecosystem components.

Results and discussion of the wetland assessment methodologies described here are presented in the Wetlands sub-Section 5.5.2 describing the Aquatic Environment of the Study Area. Further details on the wetland vegetation community and vascular SAR/SOCI as documented by the project botanist are presented in Section 5.4.1 and 5.6.6 respectively.

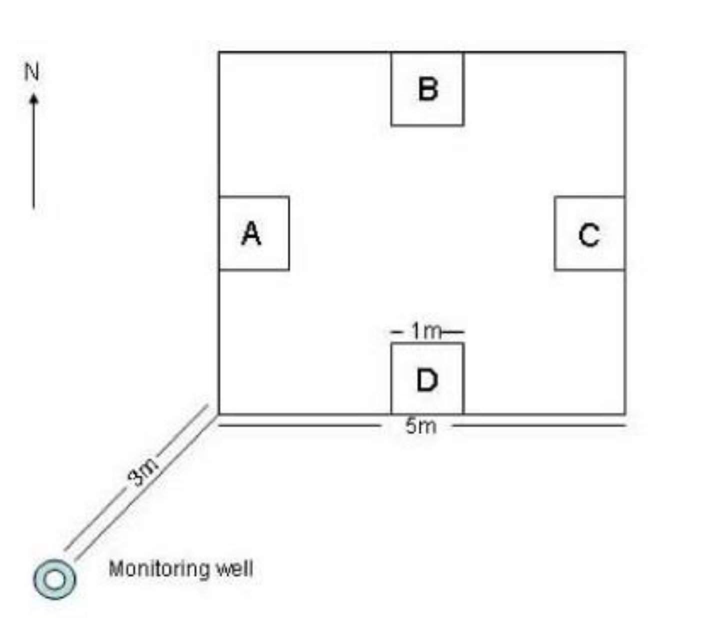

Figure 10: Layout of vegetation monitoring plot, adapted from Ecological Monitoring and Assessment Network's (EMAN) Terrestrial Vegetation Biodiversity Monitoring Protocols (Roberts-Pichette and Gillespie 1999).

4.8 Groundwater Resources

The proponent has conducted annual groundwater quality monitoring at the site, in accordance with Industrial Approval #2007-056846-03, with these results reported annually to NSE. This monitoring has been completed at three monitoring wells located adjacent to the existing quarry (Table 3) as shown in Figure 9. The groundwater monitoring was conducted by E&Q Consulting and Associated Limited, on behalf of B. Spicer Construction, with the annual reports (E&Q Consulting, 2013 to 2018) documenting the water elevation within the well casing and water chemistry. Annual groundwater monitoring reports have been reviewed and summarized as part of the Environmental Assessment registration.

Additionally, a residential well drilled on the south west of proponent properties' in 2018 was tested against drinking water standards and those results were also evaluated. That well is located at 20 T 312280 4964935. A second residential well was drilled on the proponent properties in 2009 at 20T 311911 4966480, located southeast of the stockpile/crushing area. Both of these proponents owned residential wells are indicated in Figure 9.

Table 3: Location of recent groundwater monitoring wells at Spicer North Mountain Quarry.

Well #	UTM Coordinates (NAD83, Zone 20T)	Depth (m)
2	311684 4967357	65.8
3	311607 4967323	51.6
4	311381 4967462	27.9

A desktop evaluation of groundwater resources involved a literature search and review of appropriate groundwater reports and studies for the Annapolis Valley. As well, the Nova Scotia Well Logs Database DP ME 430, Version 3, 2018 (Kennedy and B. E. Fisher, 2018) was reviewed for all wells in and adjacent to the study area to identify the depth to water carrying strata and general depth to the groundwater table. This resource also helped quantify the number of wells within a radius of the proposed Undertaking and spatially where wells were located relative to the anticipated direction of groundwater movement.

The results and discussion of these groundwater assessment methodologies are summarized in Section 5.3.3. Additional shallow groundwater monitoring in wetlands is discussed in the Aquatic Environment sub-Section 5.5.2.

4.9 Archaeological and Heritage Resources

Davis MacIntyre and Associates Limited completed a Phase 1 Archaeological Resource Impact Assessment for the Spicer North Mountain Quarry Expansion in 2019. This work was completed under Heritage Research Permit A2019NS020.

Several desktop activities were undertaken as part of the initial historic background study, completed in April 2019. The desktop component included review of historic maps, manuscripts, aerial photos and published documents. It further included a search of the Maritime Archaeological Resources Inventory in order to determine if archaeological resources have been reported in or near the study area. Predictive modeling for First Nations resources was conducted to determine the potential for precontact period archaeological resources and contact was made with the Archeology Research Division of the Kwilmu'kw Maw-klusuaqn (KMKNO-ARD) to inquire whether historic or precontact Mi'kmaq activity is known within or near the study area.

A field reconnaissance component of work was also completed at the project site on May 8, 2019 by Davis MacIntyre and Associates Limited staff members Vanessa McKillop and Courtney Glen. This reconnaissance was conducted to determine the extent of any previous disturbance as well as to establish if any in situ archaeological resources exist in or near the proposed footprint areas. The field work would be used to help establish the potential for any buried archaeological resources. GPS tracklogs were recorded by the surveyors for records, with photographs and handwritten notes used to document findings.

The full Archaeological Resource Impact Assessment report is presented in Appendix 7. This report has also been submitted to the NS Department of Communities, Culture and Heritage (CCH), as per the requirements of the Heritage Research Permit. A summary of key findings for the EA is presented in Section 7 Archeology and Historic Resources.

5. Biophysical Environment

5.1 Spatial Setting for Project

Due to the unique layout of the Spicer North Mountain Quarry, with the scales and aggregate storage on the valley floor and the active quarry area near the top of the North Mountain, the site occurs across two EcoRegions. The access road, crushing site, scales, aggregate storage and intermittent asphalt plant pad are located in the Valley and Central Lowlands EcoRegion (6), the Annapolis Valley EcoDistrict (610) and the IMHO and WMSM EcoSections. The Annapolis Valley EcoDistrict is well defined by the North Mountain and Valley slope, providing shelter from coastal influences and conditions which allow for early springs and hot summers (Neily *et al*, 2005) (Neily *et al*, 2017). The ground elevation of this region rarely exceeds 50 m above sea level. Due to the fertile soils and favourable climate, the Annapolis Valley has seen active agricultural cultivation since at least the 1600's. The access road to the site from Highway 1 traverses the WMSM EcoSection, characterized as well drained, medium textured soils with smooth to flat topography. The scales and aggregate stockpile/crusher area are located within the IMHO EcoSection, characterized as imperfectly drained, medium textured soils with hummocky topography.

The land use across the lower portion of the project site consists of second and third growth mixed Acadian forest, with fallowed agricultural fields at various stages of natural regeneration. These early successional forests consist of aspen, red maple, white ash, grey and white birch. Fire and windthrow are the most important natural disturbance features associated with the various forest communities (Neily *et al*, 2017).

Both the existing and future planned quarry, located near the crest of the North Mountain, occur within the Fundy Shore (9) EcoRegion, the North Mountain EcoDistrict (920) and the WMDS and WMHO EcoSections. The Fundy EcoRegion occurs in a narrow strip around the Bay of Fundy, with the North Mountain bearing the brunt of harsh weather originating in the cold waters of the Bay. As a result, summer temperatures in this region are cooler and winters somewhat milder than the interior of the province. The coastal influence also tends to prolong the arrival of spring. The WMDS EcoSection is characterized as having well drained, medium textured soils with steep slopes or canyons. The WMHO EcoSection is characterized as having well drained, medium textured soils across a hummocky topography.

Land use across the upper portion of the project site consists of commercial forestry harvest and resources extraction, in the form of quarrying rock. Much of the EcoDistrict has been harvested, with the existing forests consisting of mixed intolerant hardwood species, white spruce and balsam fir (with scattered occurrences of red spruce and hemlock). The North Mountain escarpment represents a narrow band hardwood forest at the mountain's crest, with visible rock outcrops. Soils are shallow over bedrock, with the fertility enhanced by the underlying basalt, allowing rich-site loving plants such as white ash, ironwood beech, sugar maple and yellow birch to occur (Neily *et al*, 2017).

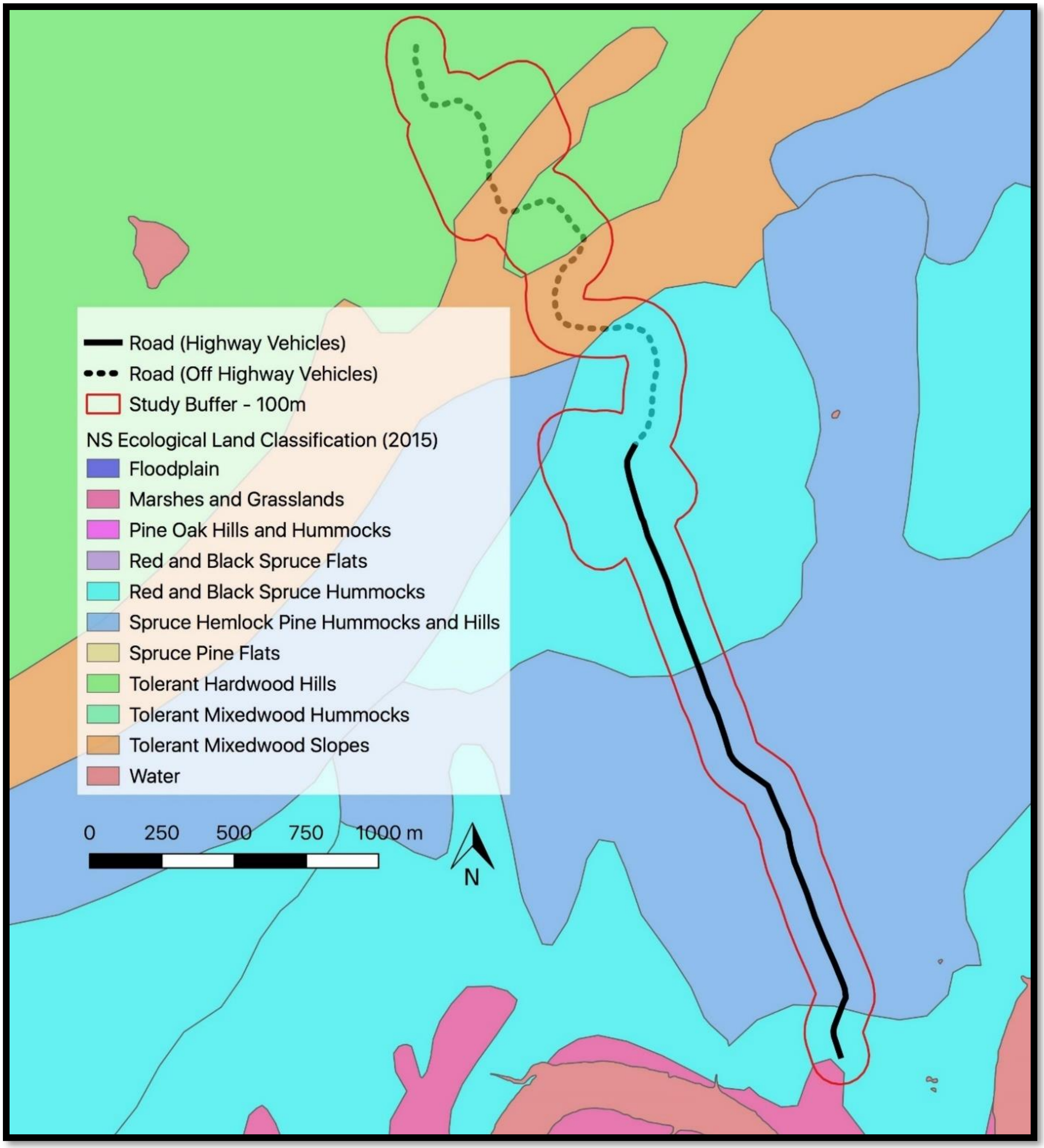

Figure 11: Landscape setting for the Spicer North Mountain quarry.

As part of the ACCDC (2019) data search for the project site, three Special Areas were identified as occurring within a five-kilometer radius of the site (Table 4). From the Nova Scotia Parks and Protected Areas interactive mapping, Valley View Provincial Park is the closest NS protected area to the Spicer Quarry and lies approximately 6.5 km to the northeast of the quarry site, also at the crest of the north mountain. The 164-ha property encompasses two lakes and has 30 seasonal camping sites. The next closest protected areas are the Mickey Hill Pocket Wilderness, immediately adjacent Lambs Lake Nature Reserve some 18 km away off Highway 8 southwest of the Study Area. The Proposed Roxbury Provincial Park lies a similar distance to the east.

Table 4: Known Managed and Significant Areas within a five-kilometer radius of project site.

Name	Administering Organizations	Size	Approximate Distance from Site (km)
Belleisle Marsh	Eastern Habitat Joint Ventures	262 ha	4.8
Belleisle DU Impoundment	Ducks Unlimited	95	4.8
Bloody Creek National Historic Site	Parks Canada	5.1	4.4

The Nova Scotia Significant Species and Habitats databased maps the Belleisle Marsh as the nearest feature of concern to the Spicer Quarry. The 354-ha area of marshland, identified as a significant habitat (AP122) and a feature of concern for several species of waterfowl, lies approximately 3km to the southwest of the stockpile/crushing area along the Annapolis River. The Annapolis River itself is identified as significant habitat (AP99) for a number of avian species and one turtle SAR. The closes portion of the Annapolis River lies about 2km south of the stockpile/crusher area. 6.5km to the north of the proposed quarry footprint significant habitat (AP179) has been identified for waterfowl wintering and Harlequin Duck, a species at risk, along the Bay of Fundy coastline.

5.2 Atmospheric Environment

5.2.1 Weather, Climate and Air Quality

The Annapolis Valley is a sheltered lowland with the warmest temperatures and lowest precipitation totals on the mainland of Nova Scotia (Davis and Browne 1996). Evaluation of climate normals for Greenwood (see Figure 12), the nearest station to the Spicer Quarry Study Area, shows that air temperatures reach an annual maximum daily average in July of 19.7^{o}C and minimum in January (-5.5^{o}C). Monthly low average precipitation occurs in August annually (78.4mm), but does not exceed 84.8mm for each of the months of April through August. This “dry” season corresponds with a good portion of the annual growing season. Monthly precipitation is highest from September through December, with a maximum average typically occurring in November (116.5mm).

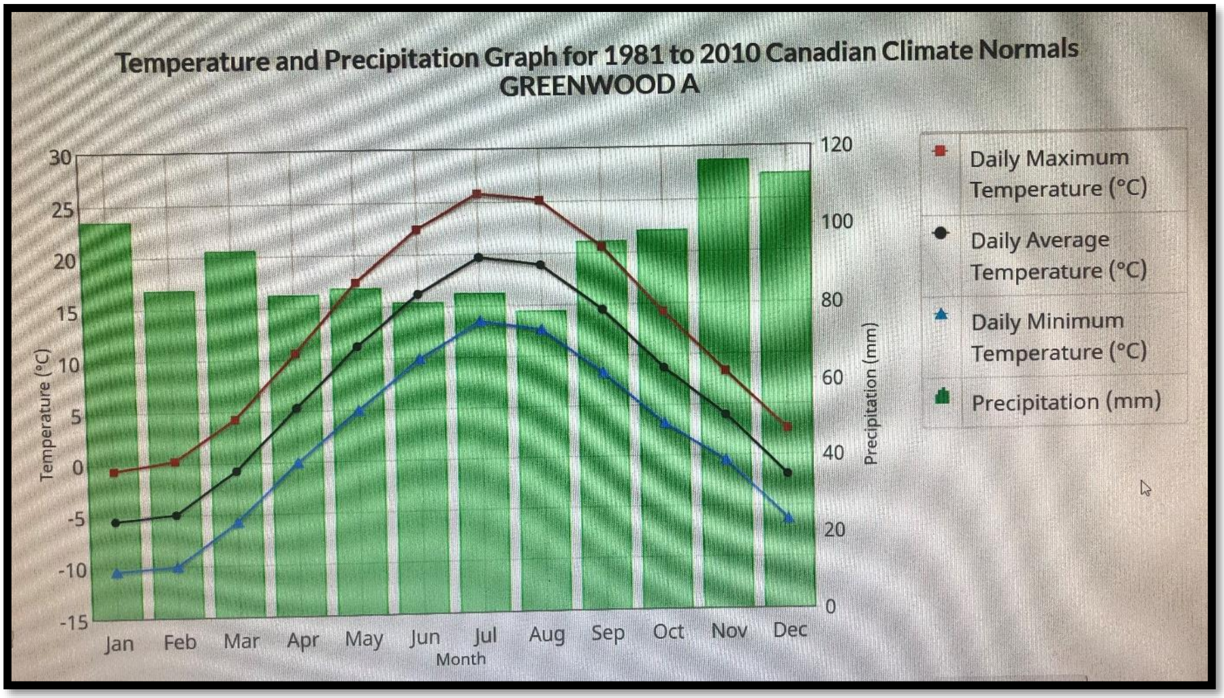

Figure 12: Daily temperature norms and monthly precipitation norms (1981-2010) as recorded in Greenwood, approximately 40km northeast of the Study Area (Source: Environment Canada 2020).

The National Air Pollution Surveillance (NAPS) program is the main source of ambient air quality data in Canada. Air pollutants monitored continuously include the following chemical species: carbon monoxide (CO), nitrogen dioxide (NO2), nitric oxide (NO), nitrogen oxides (NOX), ozone (O3), sulphur dioxide (SO2), and particulate matter less than or equal to 2.5 (PM2.5) and 10 micrometres (PM10). Historic data was not available for download at the time of this EA registration due to technical difficulties at the database.

The closest Provincial ambient air quality monitoring stations to the Study Area is located at Aylesford Mountain. During the period of 2000-2007, ground-level ozone levels at that station were some of the highest in the Province. Since there are few local sources of air pollutants in the region and the sites are upwind of other sources within Nova Scotia, the pollutants measured at these stations mostly come from areas outside the province. Peaks in ozone generally occur during the summer months, when sunlight and heat convert other pollutants to ozone (NSE200?). The higher ozone levels at Aylesford Mountain are partially attributed to its higher elevation on the north mountain, which would be similar to the Spicer Quarry elevations approximately 60 km to the southwest.

Provincially, the Study Area is considered part o the Western Air Zone (WAZ). The WAZ is Nova Scotia's largest air zone and is mostly rural. The climate features warm summers and mild winters and is one of the most humid in Nova Scotia. The most recent 2017 reporting year for the WAZ (NSE 2019) indicates particulate matter (PM2.5) measurements of 12ug/m^3, which requires management actions for preventing Canadian Ambient Air Quality Standards (CAAQS) exceedances. The western air zone's ground level ozone (GLO) measurements are the highest in Nova Scotia. In addition, the ground level ozone CAAQS metric in 2017 increased significantly from the previous year, with 61ppb (8hour) being reported. Various factors for this result are being investigated (including increased emissions of precursors from forest fires, and/or shifting meteorological conditions that contribute to transboundary flows), but the cause of the increase is not yet fully explained (NSE 2019). Analysis of the long-term ground level ozone monitoring data from the WAZ show that NO_2 emission reductions from coal-fired power plants in the Ohio River Valley, beginning in 1999, are correlated with reduced summertime GLO concentrations in Nova Scotia's Western Air Zone, including the Spicer Quarry Study Area.

5.2.2 Climate Change

There is overwhelming evidence that the Earth has warmed during the Industrial Era and that the main cause of this warming is human influence. This evidence includes increases in near-surface and lower-atmosphere air temperature, sea surface temperature, and ocean heat. Widespread warming is consistent with the observed increase in atmospheric water vapour, declines in snow and ice cover, and global sea level rise. The observed warming and other climate changes cannot be explained by natural factors. Environment Canada notes that only when human influences on climate are accounted for can the observed changes in climate be explained. Of these human factors, the build-up of atmospheric greenhouse gases, principally carbon dioxide, has been dominant cause of the observed global warming since the mid-20th century (ECCC 2020).

Regionally and locally, climate change impacts may vary significantly. The predicted changes need to be considered in the future management of industrial sites, like the Spicer Quarry, as they may affect the way we need to manage in order to protect the Valued Environmental Components (VEC's) associated with a Project Site and proposed Undertaking. The following text examines some of the predicted climate change impacts locally and regionally that may affect operations and management decisions at the Spicer Quarry. A summary of select climate change data for Nova Scotia's Annapolis Valley that is most likely to have an impact on operations and management at the Spicer Quarry is presented in Table 5. These climate change factors are associated with temperature and precipitation. Sea level rise, although a significant concern locally, is not anticipated to have a direct impact on the proposed Undertaking given the topographic character of the Project Site.

It is important to note that climate change does not affect all areas in a similar manner. Although most people understand that temperatures are predicted to rise globally, it is important to note that in Atlantic Canada this change is much smaller than in other parts of the country and world (Zhang et al. 2019). So, although locally we may not notice the temperature change in our day to day lives here in Nova Scotia, globally it is very important. Northern Canada, in comparison to Atlantic Canada, has warmed and will continue to warm at more than double the global rate (ECCC 2020). However, some temperature measures will impact the Atlantic Region. Following with the temperature comparison, even though Atlantic Canada will have the smallest increase in overall temperatures and in daily maximum temperatures within Canada, our daily minimum (typically night time temperature) temperature increase is predicted to be one of the greatest in the country (Zhang et al. 2019). Although the predicted climate change temperature increases are unlikely to directly affect the Spicer Quarry Operations in a significant way, the way in which the operations effect Valued Environmental Components (VEC's) can be magnified by the anticipated temperature changes and thereby make mitigations strategies more important to limit those effects.

One of the most apparent examples is related to water temperatures and aquatic habitats within the Study Area.

Table 5: Annapolis Valley climate change scenario data (source NSE 2020c).

Parameter		Historical 1980s	Projected 2020s	Projected 2050s	Projected 2080s
Temperature (°C)	Annual	6.8	7.9	9.1	10.4
	Winter	-4.4	-3.2	-1.7	-0.3
	Spring	5.0	6.1	7.2	8.4
	Summer	17.9	19.0	20.2	21.4
	Autumn	8.5	9.6	10.8	12.1
Precipitation (mm)	Annual	1126.7	1157.6	1167.2	1201.8
	Winter	310.3	325.3	333.1	351.3
	Spring	259.8	268.4	272.3	282.9
	Summer	250.4	254.6	253.8	254.1
	Autumn	306.3	310.0	309.6	316.5
Heating Degree Days		4215.6	3874.9	3513.7	3164.4
Cooling Degree Days		138.6	202.4	293.0	401.6
Hot Days (Tmax > 30)		6.0	11.3	19.0	32.7
Very Hot Days (Tmax > 35)		0.0	0.2	0.7	2.2
Cold Days (Tmax < -10)		4.3	2.9	1.5	0.5
Very Cold Days (Tmax < -20)		0.0	0.0	0.0	0.0
Growing Degree Days > 5		1859.9	2075.4	2338.6	2716.2
Growing Degree Days > 10		967.2	1122.4	1314.3	1592.8
Growing Season Length (days)		173.6	186.8	208.4	224.1
Corn Heat Units (CHU)		2619.1	2919.7	3294.0	3621.4
Corn Season Length (days)		140.6	151.3	167.0	177.3
Freeze Free Season (days)		204.9	224.8	246.3	265.1
Days With Rain		132.9	144.7	150.7	155.9
Days With Snow		65.6	59.9	51.1	44.3
Freeze-Thaw Cycles - Annual		106.8	98.8	86.1	75.6
Winter		41.3	42.8	43.3	44.4
Spring		38.6	33.9	26.9	20.5
Summer		0.1	0.0	0.0	0.0
Autumn		26.9	22.2	15.9	10.8
Water Surplus (mm)		684.3	643.5	630.0	620.9
Water Deficit (mm)		54.2	60.3	73.6	87.6
Δ Intensity Short Period Rainfall (%)		0	5	9	16

MacMillan and Crandlemere (200?) classed 312 streams in Nova Scotia based on mean summer water temperatures. Those that were <16.5°C were classed as cool streams. They then electrofished 100 streams to determine if salmonids appeared influenced by thermal conditions in summer. The results of the survey clearly indicated that cool water streams are vital to Brook trout during warm summer conditions in Nova Scotia. Brook trout population densities appeared to be strongly influenced (greatest) by summer water temperature (lowest), and fewer competitors were found in cool water streams. As shown during ongoing surveys of Ray Brook within the Study Area, temperatures have not been documented above 16.5°C, and Brook trout are present in the system. Therefore, it can be expected that the importance of Ray Brook to Brook trout will only increase in the future with climate change predictions. Ensuring that appropriate riparian buffers are maintained are critical to maintaining linkages between aquatic and terrestrial ecosystems, and maintaining thermal refugia for wildlife; characteristics that can contribute to ecological adaptation to climate change (Seavy et al. 2009). Protecting aquatic systems and within the Study Area around

Ray brook and the wetlands that headwater both Ray Brook and Foster Brook are a critical to maintaining cool water refuge and associated habitat in the face of climate change. The proposed Undertaking ensures that a minimum 30 m forested buffer is maintained to all aquatic habitats, and in the majority of areas this buffer extends to 100 m or more.

Along with air temperature changes, changing precipitation levels and patterns are an important climate change consideration for the proposed Spicer Quarry operations. Public concern regarding groundwater impacts and potential operational effects to wetlands and watercourses in terms of water volume and water quality need to consider and managed with an understanding of climate change predictions for precipitation and the implications for surface and groundwater resources.

Base groundwater flow projections for the Annapolis Valley suggest that groundwater baseflow is likely to decrease ~33% (~50mm/year) from current levels by 2050 based on various models (Rivard et al. 2008). This means that both private wells and those at the Spicer North Mountain Quarry are likely to have lower water levels relative to todays levels. This result is primarily driven by range and variability in the forecasted precipitation. The climate change precipitation and streamflow scenarios generated using various models during one study of the Annapolis Valley showed a significant decrease in baseflow over the next century (Rivard et al. 2008). The monitoring of groundwater levels is thus crucial in future years, as is the understanding that a decrease is anticipated locally when interpreting those future results. Ground water levels have been monitored at the Spicer Quarry through a series of wells since 2013 as discussed in Section 5.3.3. It is further proposed that additional groundwater wells be installed around the future proposed quarry footprint to evaluate not only potential effects that could result from the quarry, but to also track changes that may be related to climate change.

Climate models project further precipitation increases in Atlantic Canada, with annual mean precipitation projected to increase by about 7% to 24% by the late 21st century. As temperatures increase, there will continue to be a shift from snow to rain in the spring and fall seasons (Zhang et al. 2019). Although we expect to see more precipitation as a result of climate change, there may be an even higher rate of evaporation due to warmer temperatures resulting in an overall decline in water table levels (CCNS 2020). As outlined in Section 5.5.2, it has been proposed that shallow groundwater wells be established in Wetlands 1 and 3 at the Spicer Quarry; the two most significant wetland features near to the existing and proposed quarry footprints. These shallow wells will allow the continued tracking of any changes to wetland water levels that may be related to quarry operations or regional climate change.

Precipitation has increased in many parts of Canada, and there has been an overall shift toward less snowfall and more rainfall. This additional projected rain will see annual and winter precipitation levels increase everywhere in Canada over the 21st century. However, annual precipitation is only one part of the understanding and in Atlantic Canada a situation exists where there is expected to be a reduction in summer rainfall but an increase in extreme precipitation events where amounts accumulated over a day or shorter are projected to increase. This would likely lead to a higher incidence of rain-generated local flooding (ECCC 2020). For an operation like the Spicer Quarry, whose OHV access road is on the steep gradients of the north mountain and where areas of exposed mineral soils associated with the operation exist, it will be increasingly important to manage runoff through dispersing rather than concentrating flows, and to stabilize exposed areas and progressively remediate open areas. Atlantic Canada has seen the second greatest increase in precipitation between 1948 and 2012 of any regions in the country yet going forward to 2100 Atlantic Canada is projected to have the smallest change nationally in annual precipitation. However, the projected changes in annual maximum 24-hour precipitation for Atlantic Canada is the greatest in the country for 10, 20, and 50-year return events (Zhang et al. 2019). This means our rainstorms are expected to be more intense than any other part of the country, and this has real implications for managing runoff at the Spicer Quarry and other sites around Nova Scotia.

As has been discussed in Section 2.3.6, a number of sediment and erosion control measures exist within the current and proposed operations. It will be increasingly important to ensure existing and new sediment catch basins area appropriately sized and maintained in order to capture any changes in sediment laden flow that may originate from the operational footprint and roadways. The proposed and existing sediment catch basins around all operational areas of the existing and proposed quarry will need to be monitored for maintenance cleaning and changes in size as climate change occurs, and schedules have been proposed as part of this EA registration. The proposed "seep away" structure for the southwest corner of the future quarry footprint is an example of how flows at the site will be dispersed as sheet flows rather than concentrated as ditch flows leaving the quarry area; an important consideration in light of anticipated increased summer rain storm intensity through climate change.

Within Section 2.4 of this EA registration document, it has been proposed that a maximum open quarry footprint exists at any one point in time, that progressive reclamation that re-establishes soils and vegetation over areas where rock extraction has been completed takes place, and that part of the reclamation area be designed as a wetland that will enhance capture and slow release of surface sheet and shallow groundwater flows. These approaches to operational management are proposed in part due to the recognition of needing to address predicted Atlantic Canada precipitation changes associated with climate change.

Predicted warmer winters and earlier snowmelt will combine to produce higher winter flows in streams and rivers, while smaller snowpacks will produce lower summer flows. Warmer summers will increase evaporation of surface water and contribute to reduced summer water availability (ECCC 2020). The implications of these changes for an operation like the Spicer Quarry may be important. Winter conditions of lower snowpack and warmer temperatures may allow extended quarry operations into winter months (although seasonal demand would likely negate the need to operate), yet managing risks at that time of year associated with a predicted greater number of rain on snow events and increased winter precipitation could become substantial. Conversely, the current busy summer season may face reduced total precipitation. Therefore, dust effects from operations (access road traffic and aggregate excavation) can be expected to increase as conditions overall become drier through the summer months, and the risk associated with fire would also be expected to increase. The Spicer Quarry currently uses water as a dust suppressant during crushing operations and on driving surfaces of the access road. Seasonally, a single application of calcium chloride is applied to the access road between Highway 1 and the stockpile/crusher area as an additional dry season dust suppressant. It is anticipated that these approaches will continue with the proposed Undertaking and be modified with any direction provided by Nova Scotia Environment as required in the terms of the Spicer Quarry's Industrial Approval.

5.3 Geophysical Environment

5.3.1 Surficial and Bedrock Geology

The Annapolis Valley lies within the Mesozoic Fundy Basin and is predominantly underlain by Triassic sedimentary rocks of the Blomidon and Wolfville formations as shown in Figure 13. The Valley is bounded on the northern side by the scarp of North Mountain, where the existing and proposed Spicer quarry sites can be found, essentially composed of Triassic basalts. The Annapolis Valley has been eroded through friable Triassic sandstones, conglomerates, shales and siltstones of variable proportions (Rivard et al. 2008).

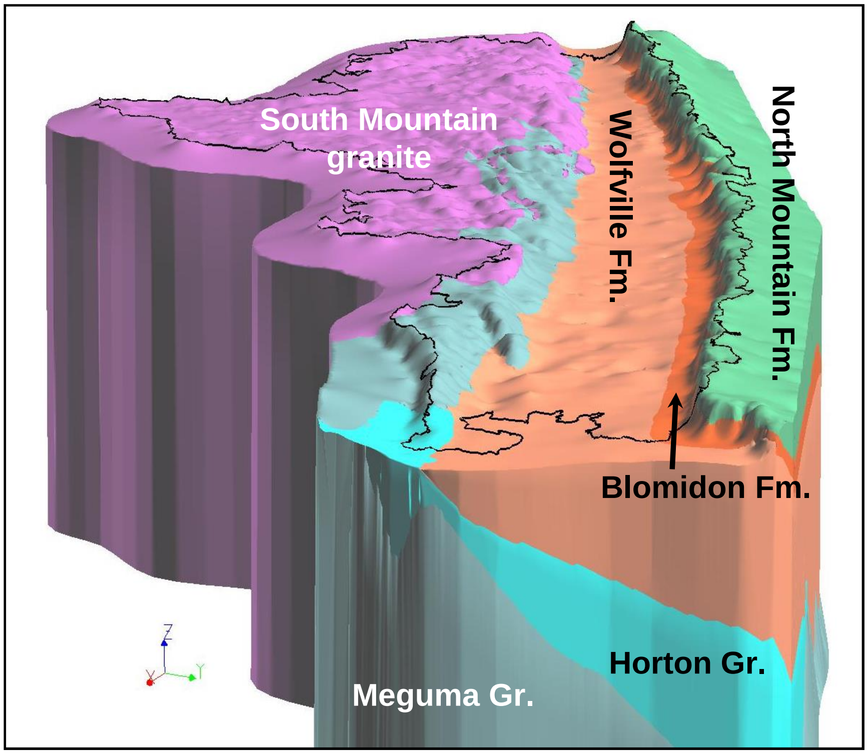

Figure 13:A 3-D geological model of the bedrock formation as viewed southwestward along the Annapolis Valley. Spicer Quarry would be at the south edge of the North Mountain Formation and the stockpile area would be near the boundary of the Blomidon and Wolfville Formations. Vertical exaggeration is 10X (Source: Rivard et. al. 2008).

As shown in Figure 14 the Study Area is intersected by three primary bedrock geological formations. The southern portion of the Project Site (access road) closest to Highway 1 occurs over the Wolfville Formation. The scales, aggregate crushing/storage and intermittent asphalt plant pad area as well as the lower portions of the north mountain slope are underlain by the Late Triassic to Early Jurassic Blomidon Formation. And the portion of the site where the existing and proposed quarry footprints are found at the top of the North Mountain are underlain by the Early Jurassic North Mountain Formation, composed of tholeiitic plateau basalt. This formation houses the target resource of the Spicer Quarry operation. The surficial geology of these three areas is varied.

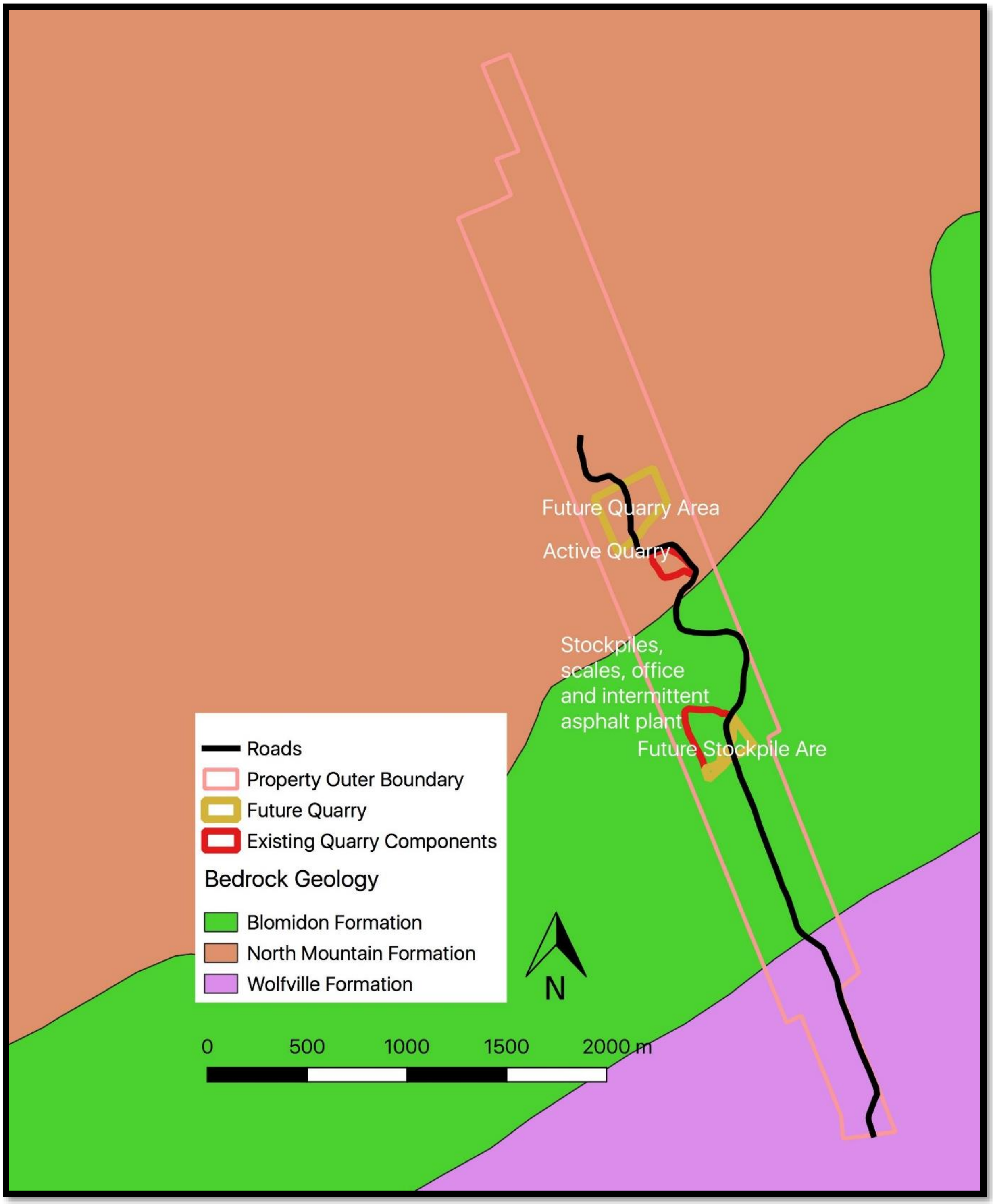

Figure 14: Bedrock geology relative to the primary components of the Spicer North Mountain Quarry project site.

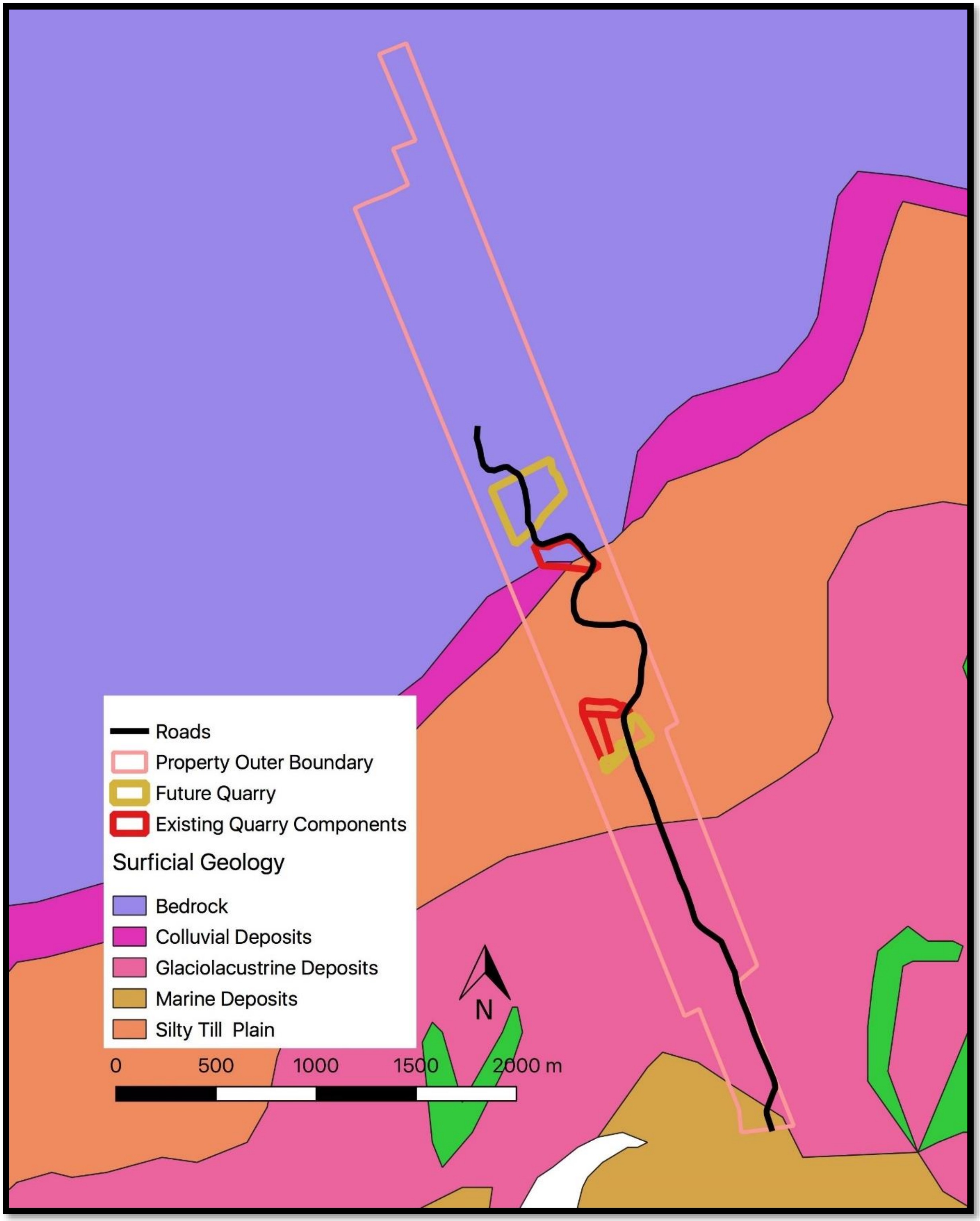

Figure 15: Surficial geology relative to the primary components of the Spicer North Mountain Quarry project site.

The North Mountain Formation is overlain by a thin veneer of discontinuous veneer of till (NS GeoScience Atlas, 2019). Soils across the upper portion of the Study Area have been classified as belonging to the Rossway series, characterized as dark-brown friable sandy loam over yellowish-brown sandy loam, originating from a parent material of yellowish-brown cobbly sandy loam till derived from basalt MacDougall *et al* (1969). The topography of the Rossway soils in this area are undulating to gently rolling, very stony and well drained.

The surficial geology of south facing slope of the north mountain, over which the OHV access road up the mountain slope to the quarry exists, is a complex mixture of glacial deposits, weathered and frost shattered rock and soils. It is shown as "colluvial deposits" in Figure 15. It is noted that this area can be subject to rapid and destructive slides and that deforestation can cause severe erosion, facilitated by a zone of springs and seeps (NS GeoScience Atlas, 2019). These characteristics require appropriate stabilization and water management along roadside ditches of the Spicer North Mountain Quarry operation in this area. These soils have also been characterized by MacDougall et al (1969) as belonging to the Glenmont series, characterized as very dark grayish brown sand loam over reddish-brown sandy loam. The parent material for this series is reddish-brown sandy loam till derived from a mixture of Triassic sandstone and basalt. The Glenmont soils well drained, and gently undulating to gently rolling with slight to very stoniness. This soil group, which occurs along the base of the North Mountain, benefits from seepage off the mountain face, maintaining moisture for longer periods.

The surficial geology around the stockpile/crusher area and a distance southward is typically 3-30 m thick silty, compact material deposited by glacial activity that provide some of the best agricultural land in the province and moderate to good buffering for acid rain due to the presence of calcareous bedrock components (NS GeoScience Atlas, 2019). They are shown as "Silty Till Plain" on Figure 15. Part of the Kentville Formation, these dark reddish brown friable sandy loam soils are imperfectly drained and considered stony (MacDougall et al 1969). In the most southerly extent of the Project Area adjacent to Highway 1 the sandy loam soils are part of the Avonport series and similarly imperfectly drained.

5.3.2 Acid Rock Drainage

There are many different types of chemical and physical geohazards in Nova Scotia that have the potential to place the public and infrastructure at risk. One of those is acid rock drainage (ARD) which can occur in association with disturbance of some types of bedrock. Typically, in Nova Scotia, ARD occurs when pyrite and other sulphide minerals are exposed to water and oxygen and react in a chemical oxidation process that releases sulphuric acid and metal oxides into watercourses downstream (NSDLF 2019). The Goldenville and Halifax Formation Groups containing these minerals tend to be slates which are most common surficially along the South Shore and Southwestern Nova Scotia. These geological formations do not extend to the top of the North Mountain or any of the surficial geology of the Study Area. No slates have been encountered as part of the ongoing quarry operations at the Study Area.

Given the potential for ARD at the quarry site, no testing of rock for its potential contribution to acid rock drainage was conducted as part of the EA. Staff at Dalhousie Minerals Engineering Centre were contacted by ECA staff to discuss the appropriateness of such sampling given the proposed undertaking location on the North Mountain of the Annapolis Valley. Staff suggested that given the geology of the site, sulphur content of the quarried rock would likely be at or below test detection limits, and therefore testing would be un-necessary (D. Chevalier pers com. 2019).

5.3.3 Groundwater

Groundwater Overview

The Project site overlies two primary groundwater regions. The existing and proposed quarry footprints lie within a volcanic groundwater region, while most of the access road to Highway 1 and the stockpile/crusher area overly a sedimentary groundwater region (Kennedy and Drage 2008). As shown in Figure 16, these two groundwater regions correlate to three bedrock formations, where the volcanic groundwater region corresponds to the North Mountain Formation and the sedimentary groundwater region corresponds to both the Blomidon and Wolfville bedrock formations.

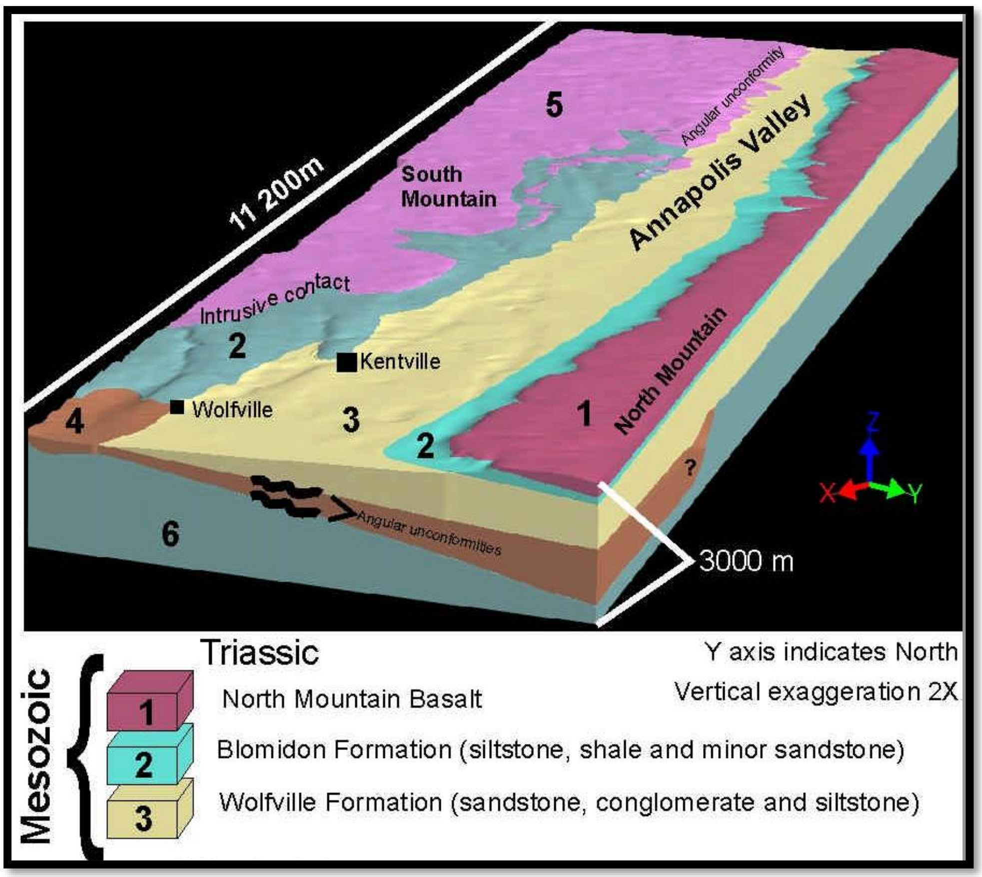

Figure 16: Preliminary 3D geological model (Source: Rivard et al. 2008) indicates the three Mesozoic bedrock formations influencing groundwater at the Spicer Quarry Study Area.

Groundwater is the primary source of drinking water for municipal and rural residents with 99% of the Valley residents obtaining their drinking water from groundwater (KCEDA, 2000 cited in Rivard et al. 2008). Although surface water is understood to flow from high ground toward low ground, groundwater flows does not always follow such an obvious path as it gets influenced by such characteristics as the tilt, porosity, and fractures of underlying geological formations. Rain falling on the ground at the top of the proposed study site on the North Mountain can be expected for flow into either Ray Brook or Foster Brook and eventually flow into the Annapolis Valley and the Annapolis River. However, the bedrock North Mountain Formation that is quarried at the top of the north mountain corresponds to a series of tholeiitic basalt flows up to 427 m thick that dip 3-5^{o} toward the northwest and the Bay of Fundy (Crosby, 1962 cited in Rivard et al. 2008).

The main regional aquifer that supports groundwater and wells in the valley resides in the Wolfville Formation, which underlies most of the Valley floor including the southern portion of the Spicer Quarry North Mountain Study Area. Water can readily move horizontally through good water bearing sandstones and/or conglomerates found in this layer (horizontal transmissivity of 10^{-5} to 10^{-2} m^2/s) (Rivard et al. 2008). In contrast the Blomidon Formation that underlies the lower slope of the north mountain and the stockpile/crusher area on the valley floor is composed predominantly of fine grained rocks (siltstone and claystone) that can usually only yield small amounts of water, primarily through joints (Trescott, 1968 cited in Rivard et al. 2008). Occasionally, thin, interbedded sandstones and/or more frequent fractures are encountered in this bedrock, which will yield more water to drilled wells. However, this formation can act, regionally, as a thick sealing aquitard (Rivard et al 2008).

Of significant importance is the ground water character associated with the existing and proposed quarry footprint areas at the south facing crest of the north mountain of the Annapolis Valley, as this will be the area where blasting and excavation of basalt bedrock will occur. Although the general tilt of all bedrock layers in the Study Area are towards the Bay of Fundy, groundwater flows from the topographic highs of the South and North Mountains to the Annapolis River located in the centre (lower part) of the Valley floor (Rivard et al. 2008).

In the area of the existing and proposed quarries, on the south side of the crest of the north mountain, permeable fractures dip steeply (~ 65°) to the SSE and into the Valley. These properties would probably only apply to the southern side of the North Mountain Formation where the Spicer Quarry exists. According to local drillers, vertical fracturing in the basalts at this edge is so “severe” in some areas that wells may collapse during drilling or a couple of days after drilling. This extensively fractured basalt is nevertheless rarely very permeable since sub-horizontal fracture interconnectivity is not well developed, and therefore water bearing fractures are very rare. The steeply dipping fracture planes close to the southern edge of the North Mountain Formation (cuesta) and parallel to the Valley axis would be more likely to provide larger quantities of water than elsewhere in the basalt cap, but on a local basis only (Rivard et al. 2008).

Water flowing in the flanks of North Mountain through these fractures in the basalt can discharge as springs, usually when groundwater encounters the low permeability layer of the Blomidon Formation. Such springs exist within the Study Area, generally feeding into Ray Brook slightly upslope of the quarry access road.

The North Mountain does not seem to contribute significantly to Annapolis Valley aquifer recharge. Instead, it seems that water from precipitation infiltrates preferentially through thick sandy tills, exposed fractured bedrock, and sandy and gravely units on the Valley floor, where slopes are the smallest. In addition, some of the water infiltrated into North Mountain discharges, as noted in the Spicer Quarry Study Area, as springs at the foot of the mountain, and a large percentage is probably unable to re-enter the bedrock once on the Valley floor, instead drained in colluvial deposits to streams (Rivard et al. 2008) like Foster and Ray Brooks, and eventually the Annapolis River. Rivard et al. (2008) suggest that the well developed hydrographic (drainage) network, modelling, and comparisons of water elevations between groundwater and the nearby streams, all suggest that a large portion (close to 50%) of the infiltrated water would in fact circulate as hypodermic flow into sediments (and often in the first few metres of bedrock) and would reach the surface network and feeds streams before entering the deeper bedrock aquifers from which residents with drilled wells adjacent to the Spicer North Mountain Quarry would draw their water.

The pumping test database reports values for Wolfville Formation wells across the valley indicate hydraulic conductivities varying from 10^{-9} to 10^{-3} m/s, with a median Long term yield (Q_{20}) of 5.7 L/s. These high capacity wells have a mean depth of 74 m (with minimum and maximum values of 9 and 198 m) (Rivard et al. 2008). Overlying the Wolfville Formation on the north side of the valley is the Blomidon Formation, which is considered a "variable" aquifer, as its hydraulic potential varies widely from one area of the Annapolis Valley to another. Well results depend mainly on the fracturing, porosity and sandstone content at a specific site. Few high capacity wells tapping the Blomidon Formation are reported in the pump test database (as compared to the Wolfville Formation). The estimated median long-term yield for these wells is 3.8 L/s and a median depth of 70 m (Rivard et al. 2008). The North Mountain Formation that lies on top of the Blomidon Formation at the height of the North Mountain, and in the area of the existing and proposed Spicer Quarry, has groundwater flow that moves primarily through joints, fractures and along weathered zones. However, in most areas as one moves further northward to the Bay of Fundy horizontal fracture connectivity is limited, often resulting in poor aquifer potential. Values reported for a limited number of wells drilled in the North Mountain Formation in the pump test database have a median of hydraulic conductivity of $5x10^{-7}$ m/s, mean long-term yield of 0.77 L/s (13.5% of Wolfville Formation yield observed in the Annapolis Valley), and median well depth of 88.7 m (Rivard et al. 2008).

Within a 1km radius of the south edge of the stockpile/crushing area, the closest portion of the Spicer Quarry operating area other than the access road to neighbouring residences, only one drilled residential well exists according to Nova Scotia well logs database (NSE 2020). However, it is known that at least three residences exist within that radius, meaning that other wells are likely either dug or not included in the well log. At 2 km radius 14 wells are shown in the well log. The closest edge of the existing quarry footprint is a further 1 km away from these wells (total 2 to 3 kms) and the closest edge of the proposed quarry footprint will be 1.2 km further away from these wells (between 2.2 to 3.2 km) in the Nova Scotia database (NSE 2020). Groundwater levels in the Annapolis Valley often appear to be significantly different for wells at different depths, even if they are very close to one another (or even within the same well, at different stages of drilling) in all three Triassic formations of the Spicer Quarry Study Area (Rivard et al. 2008). This assessment indicates that landowners adjacent to the Spicer Quarry may have varied well characteristics reflecting the natural groundwater zones, and that groundwater from the proposed quarry site is unlikely to enter groundwater in the Annapolis Valley where residential wells exists. Instead groundwater from the quarry area that enters the valley is likely to move toward the surface at the foot of the mountain and the intersection of the Blomidon Formation where it is discharged to surface water courses and the Annapolis River.

Local to the project site a few water chemistry parameters (arsenic and uranium) that can have an adverse human health effect are known by the public to potentially be high in groundwater wells. Therefore, the nature of these parameters in groundwater are discussed in a local context with consideration for activities associated with the proposed Undertaking.

Arsenic (As) is a natural element found in the Earth's crust that is likely to be found in well water throughout Nova Scotia. Some areas of Nova Scotia have a greater potential for elevated arsenic levels in drinking water. The most common source of arsenic in groundwater is through erosion and weathering of soils, minerals, and ores. The CCME guideline for arsenic in drinking water is 0.01 mg/L (NSE 202b). Exceedance rates for drilled wells across the province are around 12% (overall exceedance rate for bedrock aquifers) (Kennedy and Drage 2017).

Arsenic in well water in Nova Scotia is principally attributed to geogenic sources, including arsenopyrite and arsenian pyrite, which is hosted in various bedrock types. Bedrock geology is therefore the most important provincial-scale control on the distribution of arsenic concentrations in well water, and it is mainly drilled wells that are associated with elevated levels of arsenic (Kennedy and Drage 2017). A water risk map was produced dividing the province into low- (<5% exceeding), medium- (5 to <15% exceeding) and high- (≥15% exceeding) risk zones. Well water samples collected from Goldenville Group and South Mountain Batholith bedrock aquifers in southern Nova Scotia were associated with the highest frequency of arsenic exceeding the safe limits for drinking water (>40%), and as shown in Figure 17 not the sedimentary and volcanic bedrock that underlies the Spicer North Mountain Quarry.

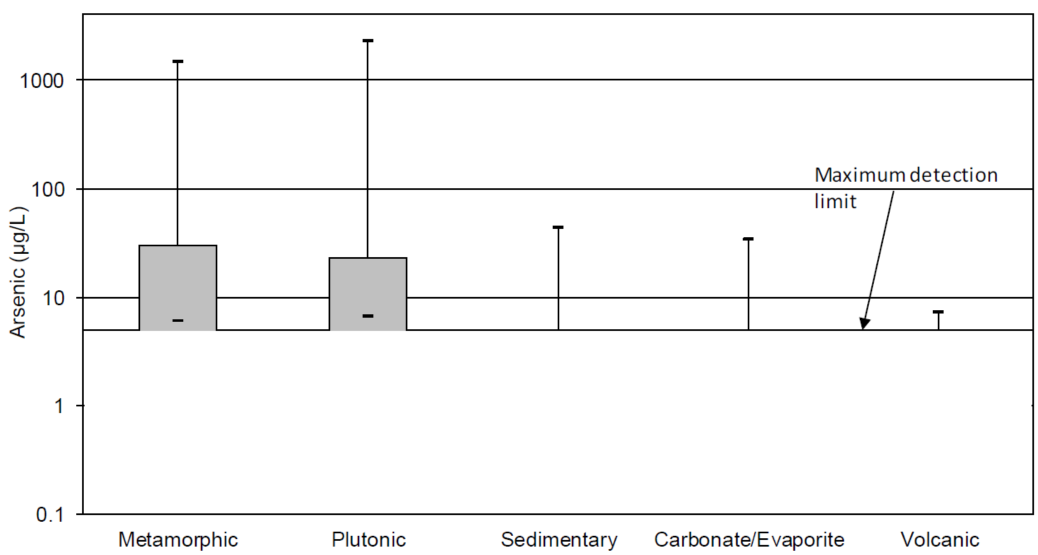

Figure 17: Censored box and whisker plot summarizing the minimum, 25%, median, 75% and maximum arsenic concentrations for the province's five groundwater regions. The portion of the plot below the maximum detection limit (e.g. 5 µg/L) is not shown (Source Kennedy and Drage 2017). Spicer Quarry falls within the Sedimentary and Volcanic groundwater regions.

As such, it is unlikely that any operational associated increase in arsenic in local wells around the Project Site would occur, and that existing levels of arsenic in local wells is likely attributable to geologic formations of the south mountain and ground water that have moved into the area through the Wolfville Formation from south mountain region (Kennedy and Drage 2017). Arsenic has been regularly monitored in the groundwater monitoring wells around the existing quarry since 2013, and no elevated levels have been observed.

Natural concentrations of uranium vary in Nova Scotia, depending on the type of minerals in the soil or bedrock. The Canadian drinking water quality guideline for uranium is 0.02mg/L. Wells most likely to have high levels of uranium are those in areas with granite, sandstone, and shale bedrock (NSE 2020b). Approximately 99% of the exceedances for uranium in the province are associated with drilled wells. Locally to the Annapolis Valley, the most likely areas to have high uranium are associated with either the granitic terranes of the south mountain or the sedimentary rocks that underlie the Annapolis Valley and serve as the primary groundwater source for wells (O'Reilly et al. 2009). Most residential wells within 2 km of the proposed undertaking would fall within this latter group. However, as noted previously, the location of undertaking activities occurs predominantly within the North Mountain and Blomidon Formations, which lie northward of potential uranium producing geologies, so uranium levels are not related to geology from the Project Site or any activities occurring at the quarry. Furthermore, Rivard et al. (2008) have shown it is unlikely that surface water that interacts with activities at the quarry areas or the stockpile/crushing area would enter the groundwater table from which locally drilled wells draw water.

<u>2013 to 2018 Groundwater Monitoring</u>

Annual groundwater monitoring has been conducted at the Spicer North Mountain Quarry by E&Q Consulting, on behalf of the proponent, for the period of 2013 to 2018. Annual summaries of this monitoring have been regularly reported to NSE (E&Q Consulting, 2013 to 2018) as condition of the existing Industrial Approval for the existing quarry operation.

Table 6: Construction details for the Spicer Quarry monitoring wells, as derived from W & R Drilling Co. well logs.

Well ID	Total Well Depth		Depth to Static Water Level		Well Recharge Rate		Wetted Bore Volume
	(ft)	(m)	(ft)	(m)	(igpm)	(m^3/min)	(L)
MW 01	280	85.3	243	74.1	3	0.0136	203
MW 02	195	59.4	160	48.8	3	0.0136	192
MW 03	95	29	30	9.1	5	0.0227	364
MW 04	90	27.4	16*	4.9*	0.5	0.0023	408*

*Derived from annual monitoring as well log data was NA.

Spicer's' have monitored four groundwater wells periodically around the existing quarry footprint at the locations indicated previously in Figure 9. As shown in Table 6, the depth to static groundwater in the wells is significantly deeper in some wells (MW01 ,02) than others (MW03, 04), yet this depth to water table is not related to where the wells are relative to the gradient break at the southern edge of the North Mountain Formation. This irregular groundwater depth likely reflects the predicted movement of groundwater along fractures at the southern edge of the North Mountain Formation and the low permeability layer of the Blomidon Formation underlying the basalt of the North Mountain Formation (Rivard et al. 2008).

Typically, 45 chemical parameters are measured in samples collected four times a year from each well, including a number of total metals and volatile organics. Samples are collected by E&Q Consulting and analyzed at the accredited laboratory, AGAT Laboratories of Dartmouth, Nova Scotia. The most recent annual report is presented in Appendix 11. Generally, groundwater chemistry is controlled by the composition of the rocks or sediments it circulates through, and contact time with these units. Water circulating in the North Mountain basalts, which are associated with the existing and proposed quarry footprint areas, tend to be low in total dissolved solids and very soft as a result of the low mineral dissolution of the basalts and the rapid infiltration through the sub-vertical fractures (Rivard et al 2008). The basic chemistry signature of this groundwater is shown in Table 7.

Table 7: Median parameter values according to the geological formation as sampled from Annapolis Valley wells (Source: Rivard et al. 2008).

Formation or group	**No of wells**	**Alkalinity** (mg/L CaCO3)	**Hardness** (mg/L)	**pH**	**TDS** (mg/L)
North Mountain	53	50	57.1	7.0	96.7
Blomidon	44	76	174.8	7.5	202
Wolfville	176	74	83.8	7.4	144

The 2012-2018 trendlines for the parameters of water depth, conductivity, pH and alkalinity from the Spicer North Mountain Quarry monitoring wells are presented in Figures 18 to 21. Well 3 has shown a moderate increasing trend in pH, with a weak decreasing trend observed for this parameter in Wells 2 and 4. A slight increasing trend in groundwater alkalinity has been observed between 2013 and 2018. Conductivity values have increased slightly for Wells 2 and 3, with a slight decrease observed for Well 4. Water levels in the three wells have been quite steady over the monitoring period, with minimal year to year change noted (E&Q Consulting 2019).

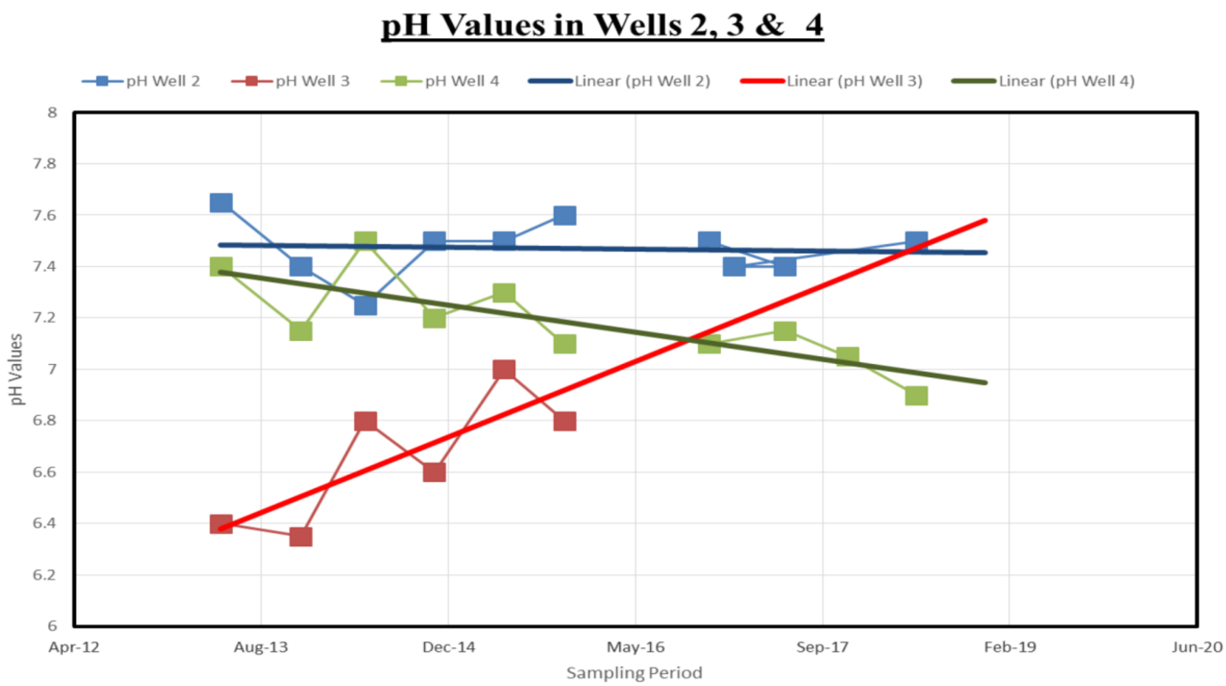

Figure 18: 2012-2018 Groundwater pH for monitoring wells #2, 3 and 4 (Source E&Q 2019).

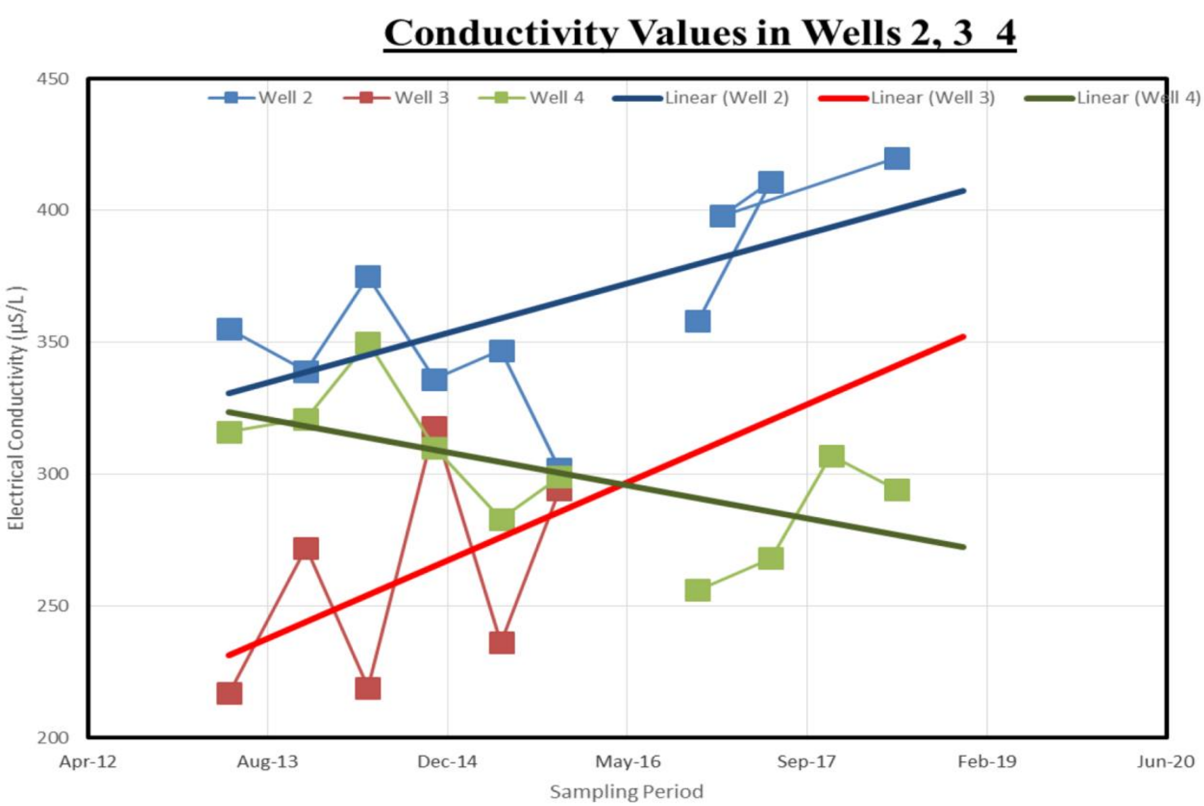

Figure 19: 2012-2018 Groundwater conductivity values for Wells #2, 3 and 4 (Source E&Q 2019).

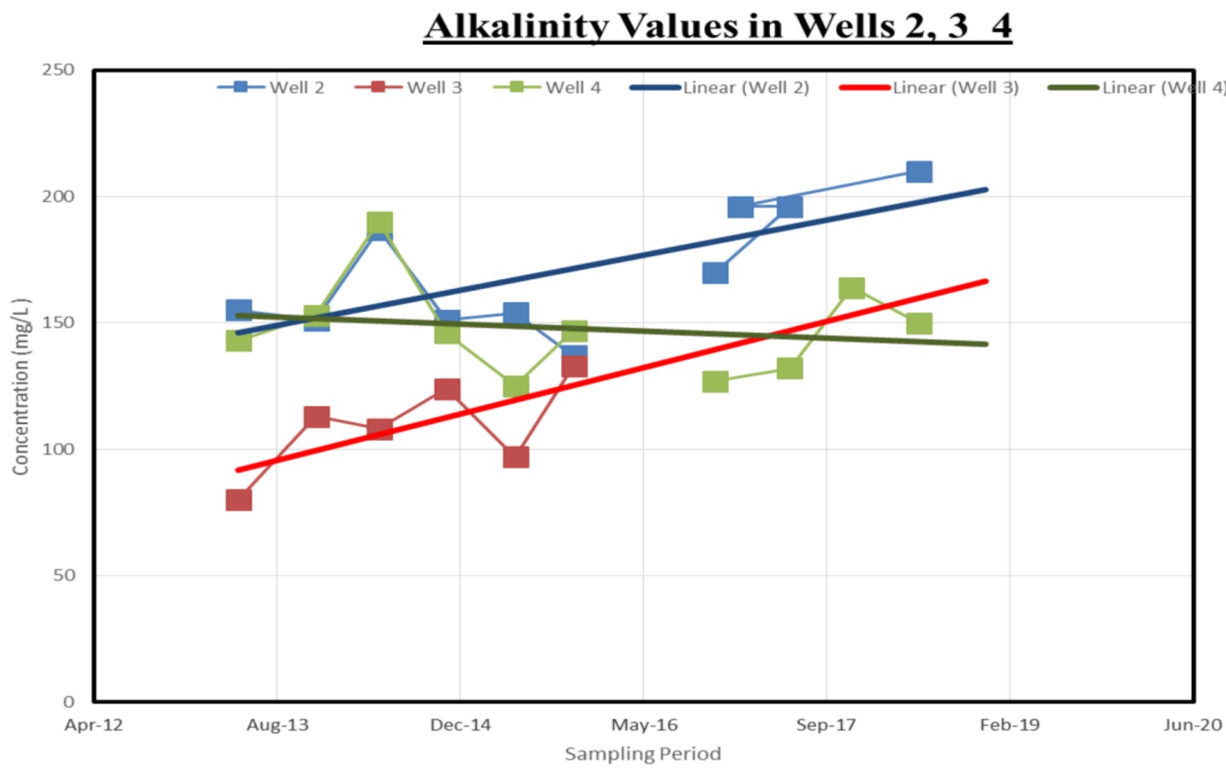

Figure 20: 2012-2018 Groundwater alkalinity values for Wells #2, 3 and 4 (Source E&Q 2019).

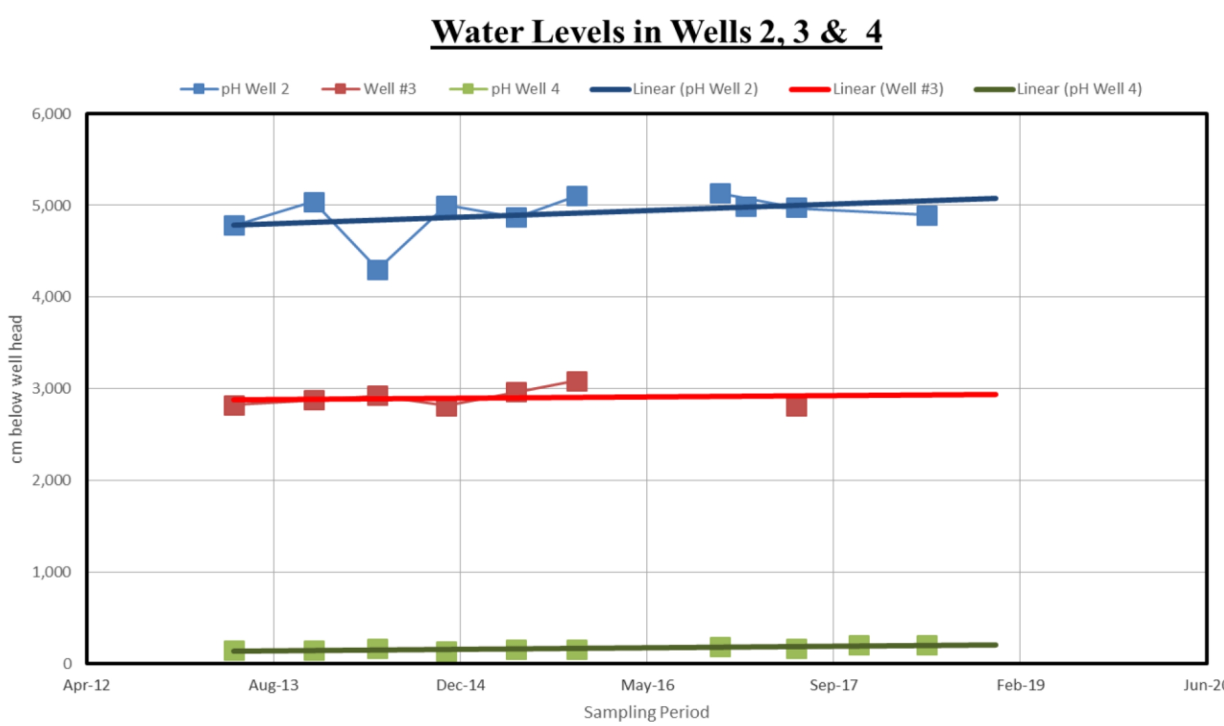

Figure 21: 2012-2018 Groundwater level values for Wells #2, 3 and 4 (Source E&Q 2019).

Based on the most recent (2018) monitoring well report, water in the wells have only moderate mineral levels as indicated by the conductivities (E&Q 2019), and as predicted by Rivard et al. (2008). No *E. Coli* bacteria have been found within the sampled wells. Total iron and total manganese have been periodically above aesthetic Guidelines for Canadian Drinking Water Quality (Health Canada 2020) of <0.3mg/L and <0.05mg/L at all well sites since 2013. Manganese also has a maximum allowable concentration of 0.12mg/L, which has also been exceeded, but less frequently. Both are commonly found in rock and soil and the levels observed are expected to be characteristic of the region. Toluene, an additive to gasoline, has been noted in Well 2 samples in 2017 and 2018 at 0.03mg/L slightly above the drinking water quality guideline of 0.024 but below the maximum allowable concentration (MAC) of 0.06mg/L as specified for Canadian Drinking Water Quality Guidelines. Low level Toluene was noted in the first ever groundwater samples collected from Wells 1 and 2 (0.032 and 0.08 mg/L respectively) in November 2010 and reported to NSE (ECA 2011). The result was addressed by NSE staff with a more frequent sampling schedule (MacLeod 2011) and this sampling frequency continues current day as quarterly. The source of this irregular low level contamination has not been identified but could be associated with a non-reported operational spill, contamination pre-dating quarry operations from operations along the historic forestry road that passed between the well locations decades prior to the quarry establishment, or unintended contamination at the time of well drilling.

Shortly after installation, Well 1 was found to have partially collapsed in 2011, making it functionally unreliable for monitoring. As noted previously, well drillers have reported wells collapsing along the “cuesta” of the North Mountain Formation (Rivard et al. 2008) were Well 1 was located. Well 2 at the southwest corner of the existing quarry and southern crest of the north mountain has been monitored throughout the life of the existing quarry operations and is proposed to be monitored throughout the life of the proposed Undertaking. Well 3 was partially collapsed in the fall of 2016, so has not been sampled since that date, but was replaced with Well 4 that was drilled to the northwest of the existing quarry footprint at that point in time. With the recent 2018 amendment to the Industrial Approval (Approval No: 2007-056846-03) for the existing quarry permitting a shift in layout of the existing quarry, it was necessary to destroy groundwater Well 4 in late 2019 to allow quarry development in that area. Pending the current EA that well has not been replaced. Well 2, located to the southeast of the quarry, remains fully functional and it is proposed that it be used along with the installation of two new wells to monitor groundwater around the existing and proposed quarry operations. As shown in Figure 9, the two new wells (#5 and #6) will be located to the north east and northwest of the proposed future quarry footprint. Surface flows are generally toward the east of the quarry area, and groundwater is expected to move south south east from the quarry areas along natural fractures in the bedrock (Rivard et al 2008).

In addition to the established groundwater monitoring wells around the active quarry, the proponent has drilled two residential wells associated with proponent owned homes on the project properties. It is proposed that a full chemical analysis be conducted at each well to provide a baseline for any future required comparisons. These wells lie upgradient from any other residential wells along the Highway 1 corridor in the vicinity of the Undertaking.

5.4 Terrestrial Environment

5.4.1 Vegetation Communities and Habitats

Following a desktop review and preliminary field surveys, the Study Area vegetation was assessed by the botanist within five broad habitat terrestrial ecotypes that had been identified as: disturbed areas and ditches, mature upland hardwoods, North Mountain Slope, valley floor regeneration, valley floor alder thicket, and wetlands. Visually dominant species are discussed for each of these habitats below. In total, 161 species were inventoried in the Study Area as listed by habitat in Appendix 4. Although wetland vegetation is mentioned here, sensitive wetland habitats are described in further detail in Section 5.5.2 Wetlands. The remaining upland communities are discussed in this section. Each community was assessed by the botanist to create a community plant inventory, and to survey for species at risk and species of conservation interest.

Disturbed and Ditched Habitats

Disturbed areas include those resulting from anthropogenic activity including roads, road ditches, cleared areas for machinery operation, parking etc. Ditches holding water that can provide suitable habitat for aquatic species such as Carex spp, grasses and other vascular plants. Common species observed include Cottongrass Bulrush (*Scirpus cyperinus*), Hoary Sedge (*Carex cannescens*), and Speckled Alder (*Alnus incana*). Weedy introduced species such as Poverty Oat-Grass (*Danthonia spicata*), St. John's-Wort (*Hypericum perfoliatum*), and Colt's Foot (*Tussalago farfara*) are prominent in areas were the soil has been disturbed. No species of interest were observed in this habitat. The invasive *Rosa multiflora* Rambler Rose was observed in this habitat, and coordinates recorded. This species is discussed in the Invasive Species Section.

Figure 22: Small purple fringe orchid (*Platanthera psycodes*).

Mature Upland Hardwoods

The south facing slope of the north mountain on either side of the existing quarry and northward around the proposed quarry site consists of mature hardwood forests. (See Figure 23). Tree species including Sugar Maple (*Acer saccharum)*, Red Maple (*Acer rubrum),* Red Spruce *(Picea rubens)*, American Beech *(Fagus grandifolia)* and Eastern Hemlock *(Tsuga canadensis)* dominate the tree stratum. Herbaceous species include Indian Cucumber-Root *(Medeola virginiana),* Christmas Fern *(Polystichum acrostichoides),* Rosy Twisted stalk (*Streptopus lanceolatus*), Downy Solomon's-Seal *(Polygonatum pubescens),* Rattlesnake Fern *(Botrychium virginianum)* and Ill-Scent Trillium *(Trillium erectum)* suggesting a rich forest.

Figure 23: Mature hardwood uplands have a relatively open understory as shown (left) where species such as Rattlesnake Fern *(Botrychium virginianum)* can be found.

North Mountain Slope

Figure 24: Exposed rock drainage of Ray Brook near the top of the North Mountain west of the existing quarry footprint.

Within the Study Area on the south facing slope of the North Mountain and west of the OHV access road switchback is a hemlock ravine through which portions of Ray Brook flows. The brook follows the ravine creating exposed rock faces in the upper North Mountain Formation and eroded banks somewhat downslope in the Blomidon Formation. Fragile Fern *(Cystopteris fragilis)* can be found growing on the exposed rock. Kidney-Leaved Buttercup *(Ranunculus abortivus)*, and Herb-Robert *(Geranium robertianum)* are frequent in the ravine. Mature Eastern Hemlock *(Tsuga canadensis)* and Red Spruce *(Picea rubens)* and Sugar Maple *(Acer saccharum)* dominate the ravine slopes. The rare cyanolichen *Leptogium dactylinium* is known to occur on rock in nearby brooks. This species is only known from Annapolis and Kings Counties in Atlantic Canada. As well, the diminutive bryophyte, Pygmy Pocket Moss *(Fissidens exilis)* could be expected on bare soil along the brook. Neither of these species was observed during the surveys. The hemlock woolly adelgid *Adelges tsugae* has been recently found in southwestern Nova Scotia including nearby Kejimkujik National Park. HWA, as it is abbreviated, is an aphid-like insect that attacks and kills hemlock trees. In the eastern United States, infestations of the HWA have resulted in significant levels of tree death, even destroying whole forests within 4-15 years. All sizes and ages of trees are susceptible to attack by the adelgid (CFIA 2020). HWA was not observed on hemlock of the study area during 2019 field surveys but could be a future impact to the Study Area hemlocks that is not directly related to the proposed undertaking. The invasive tall shrub *Rhamnus cathartica* Common Buckthorn was observed toward the valley floor of this mountain slope habitat. Coordinates for the observation were documented.

Valley Floor Regen

The access road corridor leading to the stockpile/crusher area of the proposed project from Highway 1 crosses a large swath of regenerating forest and abandoned farmland fields as suggested by the remnant apple trees, White spruce *(Picea glauca)*, and short lived tree species such as Wire birch *(Betula populifolia)*, and Large toothed aspen *(Populus grandidentata*). Approaching the stockpile/crusher area of the existing quarry operation, Balsam fir *(Abies balsamea)* and White spruce form dense woods where tree harvesting has occurred in the past. Weedy species are common. These include several exotic farm weeds such as Wild carrot *(Daucus carota)*, meadow timothy *(Phleum pretense)*, Birds foot trefoil *(Lotus corniculatus,)* and clover *(Trifolium)* species.

Figure 25: Example of fallow field habitat (right) and regenerating poplar stand (left) along the access road between Highway 1 and the stockpile/crushing area.

Valley Floor Alder Thicket

Figure 26: Alder thicket wetland habitat at the foot of the north mountain west of the OHV access road.

A small alder thicket at the base of the mountain exists where water seeps occur and become consolidated into flow of Ray Brook and its small headwater tributaries. This area is found north and east of the existing stockpile/crusher area and west of the OHV access road that approaches the foot of the mountain. It is dominated by tall shrubs including Speckled alder *Alnus incana*. Frequent herbaceous species include Tall Buttercup *(Ranunculus acris)*, Raspberry *(Rubus sp)*, Sensitive fern *(Onoclea sensibilis)*, Spotted jewel weed *(Impatiens capensis)* and lady fern *(Athyrium filix-femina)*. No SOCI or SAR were observed in this habitat.

Wetlands
As mapped in Figure 9, seven wetlands underwent a preliminary delineation to identify their boundaries relative to the proposed area of the future quarry footprint during the 2019 EA field surveys. No field delineated boundary has been mapped for an alder thicket (described in the preceding paragraph) that exists at the foot of the mountain, as it will not be encroached by the boundary of working areas of the existing quarry or access road. However, it is indicated on project mapping as shown in Figure 9. All wetlands are further discussed in Section 5.5.2 Wetlands.

Two treed swamps (Wetlands 1 and 2) of the Study Area were previously inventoried by the botanist in 2008 (ECA 2009) with 111 vascular plant species identified. No Provincially or Federally designated SAR were identified.

Treed swamps in Nova Scotia are well known to lichenologists as habitats supporting a diverse lichen community. Swamps provide an undisturbed forest with mature trees in a humid microclimate where lichens can thrive and in particular, epiphytic cyanolichens. Wetland 3, Figure 27, located in the study area north of the future proposed quarry footprint (in an area where quarry development activities are not proposed), is such a mature treed swamp. For this reason a focused lichen survey was conducted on January 13, 2020. A particular group of lichens known as cyanolichens containing a number of rare species can be found in treed swamps. The well known boreal felt lichen (*Erioderma pedicellatum*) that is typically found along the Atlantic coast of Nova Scotia is an example of a cyanolichen. No predictive mapping of habitat (Cameron and Neily 2008) exists within the Study Area for Boreal Felt lichen, and no suitable habitat for this species was encountered.

Figure 27: The treed eastern portion of Wetland 3, located north of the proposed quarry footprint during the winter lichen survey.

The lichen community in Wetland 3, which is likely the most robust within the Study Area, contained 26 species of lichen identified during the winter survey. Four of those are considered SOCI and are discussed further in Section 5.6.4. A complete inventory of the 28 lichen species identified during the 2019/20 field surveys of the Spicer Quarry Study Area are presented in Appendix 4.

Proposed Quarry Footprint

Within the area of the proposed future quarry footprint, vegetation and topsoil would be removed to facilitate construction of the quarry at a total loss of the plant community there. The area is a mix of mature hardwood areas and recently cleared and regenerating forest and no species at risk were observed here. Introduction of weedy and invasive species from equipment and vehicles that move off site, or that work in areas of the property where Invasives occur, is a possibility and will need to be managed. It is proposed that an invasive plant survey of working areas of the quarry occur once every three years so that an appropriate response can be developed should such species be found. Dust from the blasting, access road traffic, and rock excavation operations at the quarry sites could adversely affect adjacent plant and lichen species if not managed. Several dust mitigation measures are proposed as discussed in Section 2.3.4 Air Quality Management. Herbaceous vegetation and lichen communities could be expected as most susceptible to dust effects. It has been proposed that air quality monitoring using lichen a lichen ladder protocol occur every three years to track potential effects on these plants.

Invasive Plant Species

Two invasive species were identified within the Study Area during the 2019 field surveys. Coordinates for the observations were documented. *Rosa multiflora* Rambler Rose was observed in disturbed habitat at the crest of the mountain at locations shown in Figure 39, so may have been introduced by machinery contaminated with the invasive plant material, although other vectors such as animals can also spread the species. It is commonly found throughout old fields and disturbed habitats of the Annapolis Valley between Windsor and Annapolis Royal (MTRI 2012). Also commonly known as Multiflora rose, the species is extremely prolific and can form impenetrable thickets that exclude native plant species. This exotic rose readily invades open woodlands, forest edges, successional fields ((PCA 2005). The tall shrub *Rhamnus cathartica* Common Buckthorn was observed toward the valley floor of the mountain slope habitat. Given its presence in well forested habitat away from recent human activities is has likely been introduced by animals. It is not native to North America but was deliberately introduced before and during the early 1800s by colonists from Europe, primarily as an ornamental hedge plant and has since escaped cultivation.

The presence of both species within the Study Area is not likely attributable to the existing quarry operations. Neither of these species was found within areas of current or proposed quarry operations, so the risk of spreading these species during operations is considered minimal. However, the open disturbed ground associated with development of the quarry operations may provide appropriate opportunity for these or other invasive species to become established, and periodic monitoring for invasive plant species is considered important.

5.4.2 Avian Community

The following discussion on the avian community of the Study Area presents overall inventory results for six relatively distinct habitats that exist. Discussion on the avian community that was observed within the proposed future quarry footprint has been highlighted as the habitat in this area is that which will be most significantly changed with the Undertaking, and therefore where the greatest adverse effects to the avian community may be expected.

Avian searches of the property occurred on six dates between March 14th and September 30th, 2019 with timing to target breeding raptors, nocturnal owls, early and late spring breeding/migrants, and early and late fall migrants. Area searches covered six habitat areas as shown in Figure 9 and summarized in Table 8. A total of 1098 avian individuals representing 78 species were documented. The ornithologists report is presented in Appendix 3 along with a species list.

Table 8: Description of avian habitat units assessed during the 2019 field surveys.

Avian Habitat Unit Assessed	Description
Valley Access Road	Old fields and young conifer-dominated forest stands with small patches of hardwoods and birch/alder thickets. Regular vehicle traffic.
Crushing/Stockpile Area	Open bare substrate surrounded by conifer dominated forest from young to mature. Regular operational activities.
North Mountain Slope	Mature mixed forest, consisting of primarily of hemlock, spruce, maple, and birch. Regular off highway vehicle traffic.
Active Quarry	Open and steep rock and soil faces surrounded by mature mixed wood forests. Regular operational activities.
Future Quarry	Matrix of Mature Hardwood, young hardwood, regenerating forest (5yrs). Limited human activity
North Mountain Top	Large wetland complex surrounded by young to mature mixed wood forests. Very limited human activity.

On March 14th, 2019 a breeding raptor survey was conducted. A Red-tailed Hawk and a Turkey Vulture were seen soaring over the entrance road of the property from a vantage point at the edge of the quarry on top of North Mountain. Neither species landed on the property, and there was no evidence that they were nesting on the property. Two Bald Eagles were seen soaring along the edge of North Mountain but did not land or show any evidence of nesting on the property. There was no indication of raptors nesting in the future quarry area or active quarry areas. As the area around the proposed quarry footprint was surveyed by foot and Goshawk playback used, it is likely that no raptors of any species were nesting in this area or they would likely have responded to the playback. Two Sharp-shinned Hawks and a Red-tailed Hawk were seen migrating along the face of North Mountain during the September 30th survey of the Study Area.

During the April 18th, 2019 nocturnal owl survey a single Great Horned Owl (*Bubo virginianus*) was observed perched on top of a dead tree in a small wetland along the entrance road before the formal owl points were conducted. Three Barred Owls (*Strix nebula*) were detected during the timed callback surveys. One was calling from the base of the north mountain slope, the same general area as where one was heard calling during the raptor survey. The other two were dueting (presumably mates) northwest of the active quarry and into the area west of the future quarry. Since none of the owls detected were found in response to playback, the approximate locations of the birds should reflect the locations of their territories. All are presumed to be nesting on or near the property, but apparently not within the future quarry area. Eleven American Woodcocks

(*Scolopax minor*) were heard displaying along the access road along the valley floor during the owl surveys.

Two spring migrant/breeding and two fall migrant surveys were conducted across the Study Area as summarized in Table 9. During the first spring survey on April 26th the most active habitats in the Study Area for migrants were the entrance road and rock-crushing/stockpile area, where there were flocks of Yellow-rumped and Palm Warblers. Northern Flickers were also migrating, as individuals were seen moving over the site in long flights. Two Tree Swallows were seen heading north high over the future quarry area were presumed to be migrants. In the future quarry site, the birds documented were mostly resident breeding species, with a few migratory breeders that included one Hermit Thrush, two Winter Wrens, and one Yellow-rumped Warbler. A Ruffed Grouse, Song and White-throated Sparrows, and Dark-eyed Juncos were found in the regenerating clearcut on the west side of the access road at the proposed quarry area, while an additional 11 species were in the forested part of the future quarry site. All of the species detected, with the exception of a Tree Swallow, were presumed to be breeding birds rather than migrants, as they were singing and were not observed in flocks. During the peak spring migration and breeding survey conducted on June 01, 322 individuals of 52 species were observed in the Study Area. Although many birds were likely breeding at the site, there was some evidence that migrants were moving through the area, as Blackpoll and Tennessee Warblers (which breed in habitats not present) were observed, as were large numbers of American Redstarts and Red-eyed Vireos that could represent a combination of both breeding and migratory individuals. Canada Warblers were using the edge of Wetland 3 north of the proposed quarry footprint, and Eastern Wood-Pewees were noted through the entire Study area. In the proposed quarry area, 66 individuals of 26 species were found during the June survey. These were a mix of resident breeding and migratory breeding species, and all birds observed were presumed to be on territory, since none were observed in flocks or flying over. The most abundant species were Red-eyed Vireos, Ovenbirds, and American Redstarts. Two somewhat uncommon species using the habitat were Pileated Woodpecker and Black-throated Blue Warbler while the others were typical breeding species of medium-aged mixed-wood forest and small clearcut habitats.

During the spring migration surveys a relatively consistent taxonomic diversity was documented across all of the habitat areas surveyed, with 28-37 species being identified in each habitat. The greatest taxonomic richness (37) was observed in the area north of the proposed quarry footprint that included a combination of young/mature mixed wood forest and Wetland 3. As shown in Figure 28, seven species accounted for approximately 36% of the 536 total individuals from 61 species that were observed during the two spring migrant/breeding surveys.

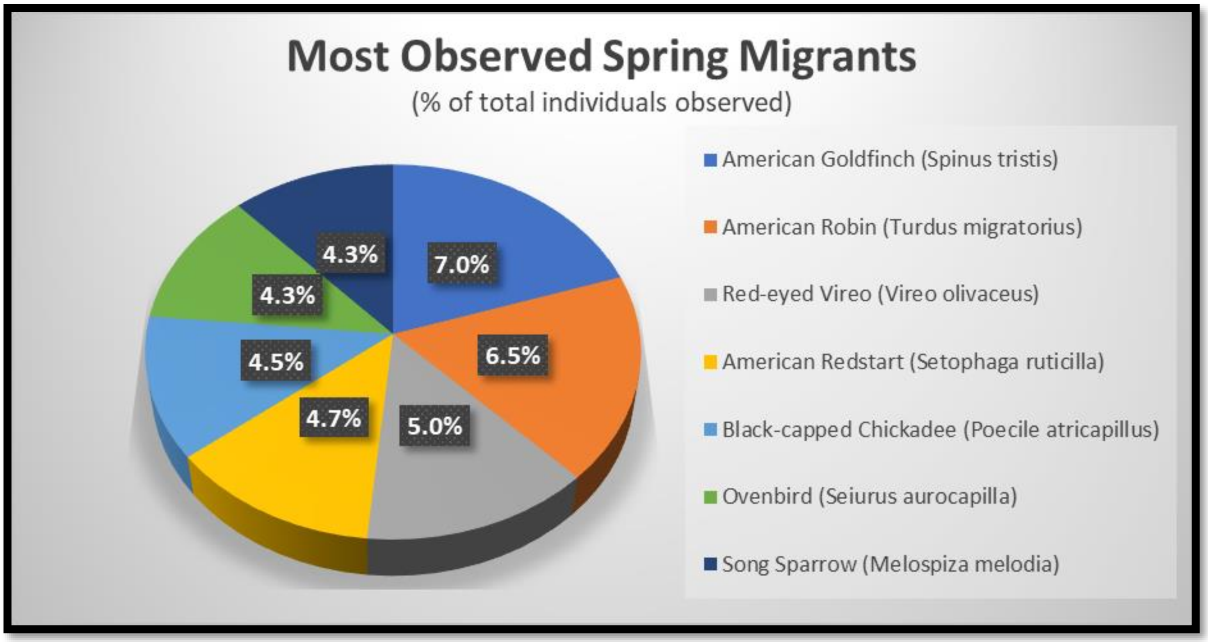

Figure 28: The seven most observed species during the combined April 26th and June 01st 2019 spring migrant/breeding bird surveys within the Spicer Quarry Study Area.

Table 9: Summary of avian migration/breeding observations by date, effort and habitat within the Study Area during 2019.

	Number of birds observed							
Survey Date	**Valley Access Road**	**Crush Stockpile Area**	**North Mountain Slope**	**Active Quarry**	**Future Quarry**	**North Mountain Top**	**Total**	**Species Obs.**
April 26	51	46	17	40	35	23	212	34
June 1	32	65	45	23	66	91	322	52
Sept. 6	22	130	NA	6	139	75	372	47
Sept. 30	9	10	15	7	64	38	143	28
Migration Totals	114	251	77	76	304	227	1049	-
Avg. Obs./min	2.8	2.6	2.5	1.2	0.8	0.8	1.2	-
Avg. Obs./km	25.1	72.8	80.6	31.8	46.9	27.5	38.7	-
Taxonomic Richness	31	46	31	34	46	48		70

Fall migrant surveys were conducted on September 6th and 30th 2019. The early fall migration survey coincided with a large migratory flight, based on numbers of migrants seen at the site. Three large flocks of warblers and vireos were found, one along the edge of the rock-crushing/stockpile area, a large ~110 bird flock at the edge of a recent cutting in the proposed quarry area, and one north of the proposed quarry area near the western edge of Wetland 3. In all, 372 individuals and 47 species were noted. These flocks were clearly migratory considering that a number of the species present do not breed locally, such as Bay-breasted Warblers, Cape May Warbler, Tennessee Warblers, and Wilson's Warbler. The large flock observed at the proposed quarry area included 15 species of warbler dominated by Magnolia, Black-and-white, Bay-breasted, and Black-throated Green Warblers. At the base of the north mountain near the stockpile area the composition of migrants was different from that on top of North Mountain including such species as Ovenbirds, Cape May Warbler, a flock of 70 Red-winged Blackbirds, and far fewer Magnolia Warblers. The second fall migrant survey date coincided with a period of heavy movement by sparrows and thrushes, yet no large flocks of migrants were found on the site. One flock of warblers, vireos, kinglets, chickadees, juncos, and goldfinches was found in the proposed quarry area that included two Blackpoll Warblers. A far fewer 143 individuals of 28 species were found during this later September survey. The most abundant species were American Goldfinch, Dark-eyed Junco, Blue Jay, Golden-crowned Kinglet, Ruby-crowned Kinglet, and Black-capped Chickadee.

Unlike the spring, during the fall migration surveys the taxonomic diversity varied by habitat from a low of 7 species observed in both the existing quarry and the slope of the north mountain to highs of 34 observed in the area north of the proposed quarry footprint that was also high in the spring and 37 species observed within the future quarry footprint area. As shown in Figure 29, seven species accounted for approximately 48% of the 515 total individuals from 53 species that were observed during the two fall migrant surveys.

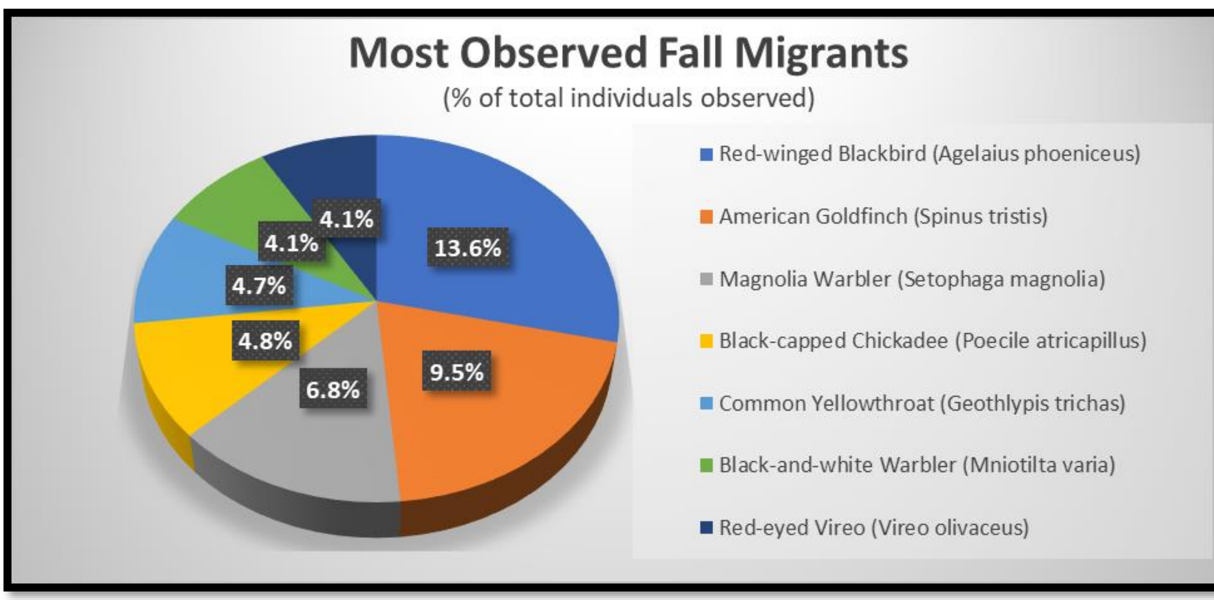

Figure 29: The seven most observed species during the combined September 6th and 30th, 2019 fall migrant/breeding bird surveys within the Spicer Quarry Study Area.

Of particular consideration is the proposed quarry footprint as this habitat will be modified from the current matrix of mature hardwood-dominated forest, younger hardwood-dominated forest, and recently cleared (~2016) regenerating forest to an open quarry that is to be progressively reclamated over the life of the Undertaking. As observed in the existing quarry footprint, such quarry habitat tends to be very poorly used by virtually all species of birds, while the regenerating forest hosts a variety of species. A total of 304 individuals of 46 species were documented in the proposed quarry expansion area, although ~110 individuals were detected in a single migratory flock on September 6, 2019. No raptors or owls were detected within the expansion area; however, suitable nearby nest sites are present in the mature trees on the east side of the access road in the expansion area near Wetland 1. Since playback was used for raptor and owl species, it is unlikely that raptors or owls were nesting in the expansion area and went undetected. Barred Owls were heard in the forest immediately to the west of the expansion area and may use the expansion area as part of their hunting territory. Breeding species in the proposed quarry footprint area were typical of mixed woods in the Study Area. One Eastern Wood-Pewee, a Species at Risk, was singing from within the expansion area, but the mature hardwood habitat immediately west of the expansion area appears to be better nesting habitat than what was observed in the expansion area, so it is expected the individual was taking advantage of foraging opportunities at the edge of the regenerating area of the proposed expansion. Specific discussion of avian SAR and SOCI is presented in Section 5.6.1.

5.4.3 Terrestrial Wildlife/Mammals

Incidental observations of terrestrial wildlife and sign were made throughout the seasons of 2019 during various field surveys. Table 10 outlines species that were confirmed within the Study Area. No mammalian Species at Risk or Species of Conservation Interest were observed, although the appropriateness of habitats within the Study Area for such species is discussed in Section 5.6.5.

Table 10: Summary of mammal species confirmed within the Study Area during 2019 field surveys by either direct sighting or observation of sign (scat, markings, tracks etc.).

Scientific Name	Common Name	National Advisory COSEWIC	Federal Legislated SARA	Provincial Legislated NSESA	NS Provincial Rarity Ranking
Odocoileus virginianus	White tailed deer	NA	NA	NA	S5
Canis latrans	Eastern Coyote	NA	NA	NA	S5
Tamiasciurus hudsonicus	Red Squirrel	NA	NA	NA	S5
Lynx rufus	Bobcat	NA	NA	NA	S5
Marmota monax	Groundhog	NA	NA	NA	S5
Tamias striatus	Eastern chipmunk	NA	NA	NA	S5
Erethizon dorsatum	Porcupine	NA	NA	NA	S5
Procyon lotor	Raccoon	NA	NA	NA	S5

Based on the available habitat it could be expected that many other mammal species periodically or frequently use the habitats available within the Study Area. These would include Black bear

Ursus americanus that forage on the valley floor in corn fields and orchards, and that are periodically observed in forested habitats on the North Mountain. Red Fox *Vulpes* and Striped skunk *Mephitis* are commonly observed within the Annapolis Valley and could be expected to make particular use of the fallow field habitats along the access road. Snowshoe hare *Lepus americanus* might be observed in many of the habitats present, and Short tailed weasel *Mustela erminea* has been observed at several locations outside of the Study area along the south facing slope of the North Mountain where habitat similar to that of the Study Area occurs (M. Parker pers com. 2020).

5.4.4 Herpetofauna

Incidental observation of herpetofauna were made during 2019 field surveys as summarized in Table 11. However, no comprehensive search was made for reptiles and amphibians. No significant open water habitat exists within the Study Area, although a number of small stream channels and wetlands with small pockets of water occur that provide appropriate quality habitat for a number of herpetofauna species. As well, the quarry area and natural basalt rock outcrops could provide habitat for some snake species. The diversity of habitats available would likely support most if not all common herpetofauna species in the Annapolis Valley region of Nova Scotia. The appropriateness of these habitats for herpetofauna SAR and SOCI is discussed further in Section 5.6.2, although no such species were observed during 2019 field surveys.

Table 11: Herpetofauna species incidentally confirmed within the Spicer Quarry Study Area during 2019 field surveys.

Scientific Name	Common Name	National Advisory COSEWIC	Federal Legislated SARA	Provincial Legislated NSESA	NS Provincial Rarity Ranking
Lithobates clamitans	Green Frog	NA	NA	NA	S5
Lithobates sylvaticus	Wood Frog	NA	NA	NA	S5
Anaxyrus americanus	American Toad	NA	NA	NA	S5
Pseudacris crucifer	Spring Peeper	NA	NA	NA	S5

During June 2019 electrofishing surveys a number of frogs were observed. Of note is that no frogs were observed in Ray Brook at the valley floor survey sites where fish were captured. However, at the mossy and slow-moving outlet channels for Wetland 1 and Wetland 3 at the top of the North Mountain and where no fish were captured, significant numbers of Wood frogs and Green Frogs were observed. This may reflect the predation on herpetofauna by fish, and the success of production by herpetofauna in and around wetland habitats where fish are not found.

Figure 30: One of six adult Green Frog observed in a small excavated hole next to a woods road north of the proposed quarry footprint. Dozens of tadpoles were also observed in the small body of water on June 18th, 2019.

As shown in Figure 30, 4-6 adult Green Frog and dozens of tadpoles were observed in a small 3m x 3m excavation adjacent to a woods road that had filled with water.

Yellow Spotted Salamander *Ambystoma maculatum*, Eastern Newt *Notophthalmus viridescens* Maritime Garter Snake *Thamnophis sirtalis pallidulus* and Ring-Necked Snake *Diadophis punctatus*, Northern Redbelly Snake *Storeria occipitomaculata* have all been regularly observed nearby on the North Mountain outside of the Study Area by ECA staff (M.Parker Pers comm. 2020) in habitats similar to those found within the Study Area, and it is expected that these species occupy habitats in the Study Area despite not being observed in 2019.

Spicer Quarry staff were queried regarding any observations of turtles in and around the stockpile storage area and access road along the valley floor. No such observations have been made. Although appropriate nesting and basking habitat may exist in this area, the lack of significant water features that would support overwintering and other life cycle requirements for various Nova Scotia freshwater turtle species makes it unlikely they are present at within the Study Area.

5.5 Aquatic Environment

5.5.1 Surface Water Resources and Quality

Surface Water Resources

This section outlines the known water quantity and quality characteristics of the surface water resources of the Study Area and how those may be affected by the proposed Undertaking. Current conditions reflect the existing quarry operation that has operated on site for the past 11 years. There are three small headwater streams associated with the Study Area that are discussed in this section. Wetlands are discussed separately in the following Section 5.5.2.

The hydrological divide of the north mountain, which defines whether surface waters flow to the Bay of Fundy or the Annapolis Valley, lies approximately 750 m northward of the most northerly edge of the proposed Spicer North Mountain Quarry footprint. As such, all surface water in the Study Area is on the south side of the crest of the North Mountain, and therefore flows to the Annapolis River. As shown in Figure 9, there are three small headwater stream channels in the area around the existing and proposed quarry footprint, none of which flow through either the existing or proposed quarry footprints. A minimum of a 30 m forested buffer will be maintained between the quarry footprints and these headwater watercourses and the associated wetlands, and in most areas this buffer extends to 100 m. As shown previously in Figure 4, the proposed phased development of the new quarry footprint will include maintaining drainage southward toward the un-named ephemeral tributary to Wetland 1 and the Ray Brook catchment, as currently occurs for virtually all surface sheet flows from this upland region. This will be achieved by directing sheet flows to the west side of the future quarry and along a constructed drainage path to the south. It is proposed that the ephemeral watercourse and Wetland 1 water quality will be protected from the potential of sedimentation associated with the proposed quarry activities by first directing any surface flows into a sediment catch basin, which can be periodically maintained as necessary for ongoing function, and then into a constructed ~70m long armoured "seep away" structure that will restore any concentrated ditch flow to a more natural diffuse surface sheet flow (as currently exists) through the adjacent forested. These structures are discussed previously in Section 2.3.6.

Of significant importance is the surface water character associated with the existing and proposed quarry footprint areas at the south facing crest of the north mountain of the Annapolis Valley, as this will be the area where blasting and excavation of basalt bedrock will occur and the greatest potential for alteration to surface water flows occurs. The two watercourses within this portion of the Study Area are west to east flowing across the Study Area. They both eventually turn south and flow down the north mountain toward the Annapolis Valley and into the Annapolis River. One water course is associated with the outflow of Wetland 1 within the Study Area and is a Tributary to Ray Brook. It flows in between the existing and proposed quarry footprint areas as mapped in Figure 9. The second watercourse is north of the proposed quarry footprint and is associated with the outflow of Wetland 3. It is a tributary to Foster Brook. The channel dimensions as measured in 2019 are shown in Table 12 for both of these watercourses.

Table 12: Annual flood return (bank full) stream channel dimensions for the three primary watercourses within the project Study Area.

Watercourse	Bank full Width (m)	Bank full Depth (m)
Wetland 3 outflow – Trib to Foster Brook	1.48	0.46
Wetland 1 outflow – Trib to Ray Brook	1.43	0.35
Ray Brook @ access Road	1.43	0.49

The third watercourse associated with the Study Area is a headwater of Ray Brook. This channel originates in a small wetland (Wetland 2) west of the active quarry footprint. The channel does not extend northward to be adjacent to the future proposed quarry footprint. Unlike the previous two watercourses associated with Wetlands 1 and 3, Ray Brook flows southward down the face of the mountain onto the valley floor where it crosses under the access road east of the existing stockpile/crusher area of the operation. As shown in Table 12, the channel dimensions of Ray Brook at the access road are similar to those of the outlet channels from Wetlands 1 and 3. Ray Brook at the access road is a productive Brook trout habitat, while the channels associated with the outlets of Wetlands 1 and 3 are believed to be non-fish bearing. The fish habitat value of all three watercourses is discussed further in Section 5.5.3.

The northwestern corner of the proposed quarry footprint does extend into the catchment of Wetland 3 and the headwater to Foster Brook, and approximately 0.5 ha of surface sheet flow from this portion of the proposed quarry footprint would currently flow northward through the upland forest toward Wetland 3. With the proposed undertaking, this area will eventually be lowered as part of the quarry development, and the associated sheet flow will become redirected southward into the catchment above Wetland 1. Based on the area of 0.5 ha and an annual average precipitation as observed at Greenwood Nova Scotia of 1117mm (EC 2020) this change in watershed catchment water volume would amount to an average of 15.3 m^3/day or 0.177 liter/sec (0.000177 m^3/sec). A discharge estimate for Ray Brook collected on December 2nd, 2008 indicated stream flow on the valley floor near the access road was well below the annual flood level at 0.13 m^3/sec (ECA 2009). At this coarse level of estimate, the change in watershed area associated with the proposed new quarry footprint would be expected to have increased the discharge level on December 2nd, 2008 by 0.13%. Given that loses to evapotranspiration and groundwater have not been considered in this calculation, the effect of the altered watershed area is considered insignificant to maintaining baseflow within the headwater drainages.

The access road from Highway 1 to both the existing and proposed quarry areas is to remain unchanged in its alignment and drainage with no new watercourse crossings or culvert installations being proposed as part of the Undertaking. A minimal proposed expansion of the footprint in the stockpile/crusher area (See Figure 3) to improve safety and operational flow of on-site vehicles will not alter the existing drainage paths of existing ditches and sheet flows.

Surface Water Quality

As part of the existing Industrial Approval requirements, water quality has been monitored at the Spicer North Mountain Quarry since 2011 where the quarry access road crosses Ray Brook. The confluence of two of Ray Brook's branches occurs immediately upstream of the access road crossing, with the western branch considered background and the eastern branch the potential recipient of runoff from the quarry and portions of the OHV access road. The 2011 to present monitoring has examined water quality on the western branch upstream of the access road and in the merged watercourse downstream of the road at the locations shown in Figure 9. Total Suspended Solids (TSS) samples are collected during a spring freshet event annually, and then analyzed by a certified laboratory (Envirosphere Consulting). This sample timing is intended to capture results from a potential "worst case" scenario of heavy rains on late snowpack that could result in a sudden high runoff period when erosion and sedimentation may be expected to occur in areas not well managed.

Table 13 presents the current upstream background average TSS during spring freshet for Ray Brook collected as part of the Industrial Approval monitoring between 2011 and 2019. The spring freshet high flow average is 15.2 mg/L. There has only been two TSS measures collected over the past ten years of sampling that are greater than 25 mg/L (35, 64.5 mg/L) upon which to define an upstream high flow background. High flow (spring freshet) TSS measures collected between 2011 and 2019 in the upstream (background) location have typically fallen within the Clear flow state defined in the Industrial Approval, being less than 25mg/L (average 15.2mg/L). No high flow measures have exceeded 250 mg/L to provide background in the >250 mg/L TSS range. The difference in TSS between the upstream and downstream sample sites on March 22nd, 2019 was 136.5 mg/L and exceeded the maximum increase of 25 mg/L. The result was presented immediately to the NSE Engineer for the project site and detailed in the annual 2019 monitoring report submitted to NSE (ECA 2019). The maximum increase has been exceeded 3 times over the past eight years and the average increase in TSS from the upstream background sample location to the downstream operation sample location has been 20.7mg/L.

Table 13: Summary of total suspended solids (TSS) upstream background average conditions based on 2011-2019 field collected data at Ray Brook monitoring sites relative to the Spicer Quarry Industrial Approval Terms and Conditions for these parameters.

	Industrial Approval Condition	Upstream Background Avg.
2011-2019 High Flow at background 25 - 250 mg/l	Max increase of 25 mg/L TSS	49.7 mg/L (n=2)
2011-2019 Average High Flow at background location	Max increase of 25 mg/L TSS	15.2 mg/L (n=12)
2011-2019 High Flow at background >250 mg/l	<10% increase over background	NA (n=0)

In addition to the regular IA monitoring requirements for surface water, detailed surface water chemistry was examined as part of the EA process at three locations within the Study Area. As shown in Figure 9, they are:

- Ray Brook 15 m downstream of the access road cross (so as to maintain consistency and compliment past monitoring efforts);
- Outflow channel from Wetland 1 at property boundary (given its proximity to the existing and future quarry footprint and so as to maintain consistency and compliment past monitoring efforts); and
- Outflow channel from Wetland 3 at property boundary (given its proximity to the future quarry footprint).

Full spectrum water chemistry samples were collected as part of the EA field evaluation on two occasions (May 8 and October 24th, 2019) to characterize these three watercourses and establish a baseline. Each sample was analyzed for 56 chemical parameters. The complete laboratory water chemistry results are shown at Appendix 8. Water quality results were compared against the

Canadian Council of Ministers of the Environment (CCME) Water Quality Objectives for the Protection of Freshwater Aquatic Life (CCME 2020), and Table 14 summarizes the three parameters that exceeded the guidelines at the time of sampling.

Table 14: 2019 Surface water sites were sampled on two dates and 56 chemical parameters analyzed. This table summarizes all results that exceeded (yellow shading) the CCME Guidelines for Protection of Aquatic Life.

Sampled Parameter	Unit	CCME Guideline FWAL	Ray Brook May 08	Ray Brook Oct. 24	Wetland #1 Outflow May 08	Wetland #1 Outflow Oct. 24	Wetland #3 Outflow May 08	Wetland #3 Outflow Oct. 24
pH		6.5-9.0	7.75	7.76	6.38	6.38	6.01	5.85
Total Aluminum	ug/L	5 µg/L pH < 6.5, >100 µg/L pH ≥ 6.5	104	400	142	208	195	246
Total Iron	ug/L	300	177	665	<50	103	83	75

The three parameters that periodically exceeded CCME Guidelines for the Protection of Aquatic life (aluminum, pH, iron) at the Spicer Quarry in 2019 reflect typical water chemistry in southwestern Nova Scotia (Rosseland et al. 1990; Dennis and Clair, 2011; Environment Canada 2017). pH of many water bodies within the province frequently fails to meet the guideline of 6.5 for protection of aquatic life (CCME 2005). The observed surface water concentrations of iron, and pH are similar to regional surface waters (Watt et al. 1979, 2000).

Elevated aluminum is reflective of regional concentrations of this element. However, having an element be elevated in natural waters does not mean it is not toxic. Metal toxicity based on total concentrations can vary by several orders of magnitude as a function of different water chemistries. Existing science on chronic toxicity of metals in water to fish and plants is not as well understood as it is for acute toxicity. However, it is known that the nature of dissolved organic carbon in the tested water, and competition between other metals within the tested water factor significantly in toxicity of a particular metal (MEND 2009). Dissolved organic carbon in water can bind to metals and make them unavailable for uptake by living organisms (Heijerick et al 2003, Winter et al. 2005, Clair et al. 2007), however, it is typical that small headwater streams like those of the Study Site to have low organic carbon. Moderate levels of total organic carbon (6-14 mg/L) were observed at the outlets of Wetland 1 and 3, likely originating from these wetland habitats, while Ray Brook was consistently lower (≤5mg/L). Dissolved organic carbon would be an equal or lesser sub-measure of total organic carbon. Dennis and Clair (2011) have noted that ionic aluminum (Ali) is an important determinant in identifying toxic effect of aluminum to fish, and that Ali toxic effect is generally reduced with increasing pH and thought to be negligible above pH 6. This is partly because of its solubility is reduced at that acidity level. At the Spicer Quarry, the naturally occurring levels of aluminum is not likely an impacting fish given that pH levels are above 6 in the trout supporting waters of Ray Brook and, based on electrofishing surveys, the lower pH systems of Wetlands 1 and 3 do not appear to support trout.

In situ water chemistry measures (see Table 15) collected at the time of the broad spectrum chemistry samples provide both a quality control measure for some parameters and capture conditions at the time of sampling for some critical parameters (temperature, dissolved oxygen) for aquatic life that can not be accurately captured by a laboratory analysis many hours later.

Table 15: 2020 *In situ* water chemistry results, Spicer Quarry, collected in association with the full spectrum water chemistry sampling and analysis.

		Ray Br. downstream of quarry access road		**Wetland #1 outflow**		**Wetland #3 outflow**	
Parameter	**Units**	**May 08th**	**Oct. 24th**	**May 08th**	**Oct. 24th**	**May 08th**	**Oct. 24th**
Water Temperature	(ºC)	10.1	10.1	8.1	9.9	9.9	9.7
Dissolved Oxygen	(%)	89	109	51	54	43	52
Dissolved Oxygen	(mg/L)	10.0	12.3	5.9	5.9	4.8	5.8
Specific Conductivity	(µS/cm)	114	222.8	36	104.3	31	85.8
Total Dissolved Solids	(mg/L)	74	144.4	23	67.6	20.2	55.9
pH		7.8	7.31	6.3	6.32	6.0	5.7
Turbidity	(NTU)	1.9	11.6	0.2	0.48	0.2	0.17

In summary, Ray Brook, downstream of the quarry access road crossing, was found to be cool, well oxygenated with low turbidity and a pH favourable for freshwater water aquatic life. Metal concentrations were low, and reflective of regional chemistry. The near neutral water pH was observed to be markedly higher at Ray Brook, when compared to the two sample locations situated at the outflows of the wetlands atop of the North Mountain. Ray Brook also had increased hardness relative to the other sites. Based on Trescott (1969), this would suggest that baseflow to Ray Brook is at least partially provided by the Blomidon formation, which is characterized by increased dissolved solids, hardness and alkalinity.

Surface water quality in the outflows from Wetland 1 and 3 were found to be similar; being cool, poorly oxygenated with very low turbidity, low pH and low total dissolved solids. Metal concentrations were low, and with aluminum exceeding the CCME water quality metal guidelines, as is not atypical of the region. Both pH and dissolved oxygen values (as Shown in Table 15), fell outside the CCME Guidelines for the Protection of freshwater Aquatic Life; although this is not unusual for surficial waters draining treed swamps. Flows at these two headwater locations is likely surficial in nature, although there may be a contribution from the North Mountain Basalt formation, which is characterized by low total dissolved solids, hardness and iron (Trescott, 1969).

5.5.2 Wetlands

As shown in Figure 9, eight wetlands have been identified on the proponent properties during the EA process. No Wetlands of Special Significance (WSS), as defined by Nova Scotia Environment, are found within the Study Area. Belleisle Marsh located 3 km southwest of the Study Site and Milbury Lake Marsh located 5.3 km west are the nearest WSS. Neither is connected through surface hydrology to any of the wetlands or watercourses at the Study Area. Seven of the wetlands have undergone preliminary delineation in the field based on observations of hydrology, soils and vegetation, and one has been desktop delineated after field visitation. Vegetation inventories were completed in several wetlands (1, 2, 3, 4, 6, and 8) that fall within the Study Area to provide a plant community description of each. These plant inventories are presented in Appendix 4. Four wetlands located in closer proximity (<200m) to the current and future quarry footprint areas have undergone a more comprehensive evaluation including hydrology, soil profiles, plant inventories, and WESP-AC functional assessments than those further away from m operations. These four wetlands are the primary focus of discussion here. As can be seen in Figure 4, all wetlands have a minimum 30 m vegetated buffer from the existing and proposed quarry operations (excluding the long-established access road), and in most cases this buffer extends around 100+m from the wetland features. No wetland is to be altered as part of the proposed undertaking.

Table 16: Summary evaluations of the eight wetlands within the EA study boundary and distance to the nearest existing or proposed quarry footprints.

Wetland #	**Delineated Wetland Area** (ha)	**Nearest Dist. To Quarry Footprint** (m)	**Type**	**2019 hydrology monitoring**	**Long term monitoring** (2008 to present)	**Vegetation Inventory**	**WESP assessment completed**
1	0.72	57	Treed Swamp	Yes	Yes	Yes	Yes
2	0.21	100	Treed Swamp	No	No	Yes	Yes
3	4.99	120	Complex (Bog, Fen, Treed Swamp)	Yes	No	Yes	Yes
4	2.19	435	Treed Swamp	No	No	Yes	No
5	3.11	780	Treed Swamp	No	No	No	No
6	0.33	200	Treed Swamp	Yes	No	Yes	Yes
7	0.96	30	Treed Swamp	No	No	No	No
8	2.39*	475	Alder Thicket	No	No	Yes	No

*Desktop estimated.

Shallow groundwater monitoring wells were established in Wetlands 1 and 3 and fitted with a Solnist level data recorder for the 2019 field season to examine the fine scale hydrographs. A barologger was also installed to allow barometric correction of logged shallow water table levels within the wetlands. Technical difficulties prevented either water level logger from recording data during the 2019 season. Periodic manual measures were collected during the 2019 season at both locations to verify electronic measurements, and these provide a basic characterization of the water tables. However, establishing baseline shallow water table hydrographs for Wetlands 1 and 3 should be completed prior to any move of operations to the future proposed quarry footprint location. This monitoring is proposed in Section 9.3 Monitoring.

Wetland 1 is a 0.72 ha treed swamp, with Red maple as the dominant tree species and Cinnamon fern the dominant herbaceous species. Wetland 1 is located approximately 100 m to the north of the active quarry and has been the subject of vegetation, hydrology, and water quality monitoring since 2008 as part of the quarry's existing Industrial Approval terms and conditions. Details of this monitoring are presented later in this section. The wetland is at the head of an un-named watercourse which flows down the face of the North Mountain and forms the eastern branch of Ray Brook. Based on 2019 surveys, the watercourse appears to be non-fish bearing. Water quality is of moderate pH, cool temperature, and low oxygen. A full chemical analysis on this watercourse was conducted on two dates in 2019 as presented in Section 5.5.1 and Appendix 8. Soils in the wetland consist of very well decomposed Humic organic sediments over silty loam and sandy clay, with patches of standing water present throughout the hummocky wetland but no continuous open watercourse. Because Wetland 1 sits at a slightly lower elevation (~180masl) than the proposed quarry floor (~190masl), and the buffer between the quarry footprint and Wetland 1 is 50-60+m, it is anticipated that groundwater hydrology of Wetland 1 will not be impacted by the future quarry. However, future monitoring should continue to track any potential changes in the Wetland 1 water table to allow appropriate resource management decisions to be made. As described in Section 5.5.1, surface water from the proposed quarry footprint will be directed toward the inflow of Wetland 1 as a surface sheet flow, as currently naturally exists from the adjacent upland basalt ridge.

Wetland 2 is a relatively small (0.21 ha) treed swamp, with White spruce and Red maple as the dominant tree species and Sensitive fern and Cinnamon fern as the dominant herbaceous species. Wetland 2 is located approximately 150 m to the west of the active quarry. The wetland is at the head of an ephemeral drainage, which flows down the face of the North Mountain, eventually

Table 17: Wetland characteristics of the four largest wetlands adjacent to the current and proposed Spicer quarry footprint.

Wetland #	Water flow path	Classification	Hydrological Conditions	Dominant Vegetation	Soils
1	Throughflow derived from surface runoff	Basin Swamp	Standing water (30% of WL, depth 0.1m). Permanent saturated conditions.	**Herbs**: *Osmunda cinnamomea, Osmunda sensibilis, Equisetum arvense, Rubus pubescens* **Trees**: *Acer rubrum, Fraxinus americana, Abies balsamea, Picea mariana*	0 to 26cm: Oh10 (7.5YR3/1) 26 to 80cm: silty loam (2.5YR4/1) +80cm: sandy clay (7.5YR4/4) Standing water to ground surface
2	Throughflow derived from surface runoff	Slope Swamp	Standing water (40% of WL, depth 0.1m). Permanent saturated conditions.	**Herbs**: *Osmunda cinnamomea, Osmunda sensibilis*, Graminoid spp, *Equisetum arvense, Carex spp, Rubus pubescens* **Shrubs**: *Acer pensylvanicum, Betula populifolia, Abies balsamea* **Trees**: *Picea glauca, Acer rubrum, Betula papyrifera*	0 to 14cm: Of3 (10YR2/1) 14 to 31cm: loam (10YR3/2) +31cm: rock Thin veneer of hydric soil over rock across much of wetland
3	Throughflow derived from surface runoff	Complex: Basin Bog, Basin Swamp, Stream Fen	Standing water (20% of WL, depths 0.1 to 0.2m). Permanent saturated conditions.	**Herbs**: *Glyceria striata, Osmunda cinnamomea, Osmunda sensibilis, Sarracenia purpurea, Osmunda regalis* **Shrubs**: *Myrica gale, Hamamelis virginiana* **Trees**: *Prunus spp, Larix laricina, Acer rubrum, Picea mariana*	0 to 30cm: Of4 (7.5YR3/3) 30 to +160cm: Oh9 (7.5YR3/1) Standing water to ground surface
6	Throughflow derived from surface runoff, outlet via culvert to wetland #3	Basin Swamp	Standing water (40% of WL, depths 0.1 to 0.3m). Permanent saturated conditions.	**Herbs**: *Osmunda cinnamomea, Osmunda sensibili, Rubus pubescens, Carex spp* **Shrubs**: *Betula populifolia, Acer rubrum* **Trees**: *Acer rubrum*	0 to 32cm: Oh8 (7.5YR2.5/2) +32cm: Oh9 (7.5YR2.5/2) Standing water to ground surface

forming a western branch of Ray Brook. Soils within the wetland consist of a 0.10 to 0.20 m veneer of Fibric organic sediments over rock. Persistent saturation to the ground surface was present, with occasional small patches of shallow (<0.1 m depth) water present.

Wetland 3 is a 4.99 ha complex composed of a basin bog, basin swamp and stream fen. The bog and fen characteristics predominate at western end near the inflow, with the treed swamp occurring at the eastern end. The wetland is at the head of a watercourse which flows down the face of the North Mountain to form the western branch of Foster Brook. Based on 2019 surveys, this watercourse appears to be non-fish bearing from the foot of the mountain upstream to Wetland 3. Water quality is of moderate pH, cool temperature, and low oxygen. A full chemical analysis on this watercourse was conducted on two dates in 2019 as presented in Section 5.5.1 and Appendix 8. Trees, though sparse at the western end, consist of stunted Larch and Red Maple, with a mature tree canopy of Red maple present at the eastern end of the wetland. Dominant herbaceous species include Cinnamon fern, Sensitive fern, Royal fern and Pitcher plant. Soils at the wetland consist of Fibric and Humic organic sediments to a depth of at least 1.6 m. Standing water is present around the perimeter of the wetland, particularly along the southern margin. As noted in Section 5.6, Wetland 3 supports a number of avian and plant SAR/SOCI. During 2019 four lichen SOCI, one vascular plant SOCI, and three avian SAR and seven avian SOCI were found in and adjacent to Wetland 3. This wetland lies approximately 120 m north of the proposed quarry footprint in an area that will remain undeveloped as part of the proposed Undertaking. Because Wetland 3 sits at a slightly higher elevation (~200 masl) than the proposed quarry floor (~190masl), future monitoring should track any potential changes in the Wetland 3 water table to allow appropriate resource management decisions to be made, and establishing a baseline hydrograph and shallow water table monitoring wells is proposed for Wetland 3 in Section 9.3 Monitoring. It is anticipated that the extended setback will negate any risks associated with altering hydrology or impacting the SAR/SOCI observed within Wetland 3.

Wetland 6 is a small (0.33 ha) tree swamp, with Red maple as the dominant tree species and Sensitive fern and Cinnamon fern as the dominant herbaceous species. The wetland is located upslope and to the west of the long established north-south logging road traversing the property. The outflow from Wetland 6 forms the inflow to Wetland 3. The inlet placement elevation of a corrugated metal culvert beneath the logging road between the two wetlands has likely caused some degree of back flooding at this location, increasing the size of Wetland 6 from what would have been its natural boundary. Soils at the wetland consist of Humic organic sediments to a depth of at least 30 cm. Standing and flowing water was present across ~50% of the wetland surface, with water depths of 0.1 to 0.3 m observed. This wetland lies approximately 200 m north of the proposed quarry footprint in an area that will remain undeveloped as part of the proposed Undertaking.

Wetland Ecosystem Services (WESP) Analysis

Wetlands provide a range of ecosystem services including groundwater recharge, shoreline and erosion protection, water flow moderation, climate regulation, water quality treatment, carbon sequestration and support for biodiversity. In cases where wetlands are adversely impacted by development, functional analysis provides a mechanism to assess the type and magnitude of impact on the various ecosystem services. Functional analysis recognizes that while all wetlands are important, they are not all equal in terms of their ecosystem services. Functional analysis provides a decision-making tool for proponents and regulators to compare and examine wetlands through the project planning and alteration application stages.

Wetland ecosystem services are a combination of functions and the benefits of those functions, judged individually. Functions are what a wetland potentially does, such as store water, regardless of whether humans care about it. Benefits are the degree to which a function interacts with human welfare or intrinsic human values. This linkage can be direct (e.g. mitigation of downstream flood damage) or indirect (wetland plant diversity supporting off-site consumptive human uses). Assessment of wetland benefits is linked to the wetland's opportunity to perform a particular function, the level of that function in the wetland, and the demand for the function at local, regional and wider scales (Adamus, 2013a, 2013b). In summary:

Ecosystem Services = ***Functions*** *+* ***Benefits*** *of those services*

The Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC) (Version 2 – 2018), developed by Dr. Paul Adamus and adapted for use Nova Scotia, was used to assess the functional state of wetlands at the project site. The Wetland Ecosystem Services Protocol has been used as a rapid, field-based assessment tool in multiple jurisdictions, including Oregon, Alaska, New Brunswick and Alberta. NS Environment has indicated that WESP-AC can also be used with other tools and measurements to monitor wetlands for loss of specific functions and benefits. Therefore, by completing WESP-AC for the wetlands nearest the active and proposed quarry footprints (1, 2, 3, and 6) a baseline of wetland functions and benefits have been documented pre-development. Future replication of this functional assessment could be used to help track any changes that may occur in wetland functions and benefits at the Project Site over time.

WESP-AC examines 17 functions and 19 benefits of wetlands using a standardized, science-based model (Adamus, 2013a, 2013b) (Table 18). Based on the completion of standardized question forms at the desk-top and in the field, each function and benefit is assigned a score ranging from 0 to 10. Within this model, a score of 0 indicates that the function or benefit is absent or occurs at the lowest possible level of performance. A score of 10 indicates the highest naturally achievable performance of the associated function or benefit. These scores are shown in Appendix 6 for each of the four wetlands assessed (1, 2, 3, and 6). The relative rankings of the various scores have been summarized as presented in Table 19.

Table 18: Definitions of wetland functions and benefits assessed by WESP-AC (Adamus, 2016)

Function	Definition	Potential Benefits
Hydrologic Functions:		
Water Storage and Delay	The effectiveness for storing runoff or delaying the downslope movement of surface water for long or short periods.	Flood control; Maintain ecological systems
Stream Flow Support	The effectiveness for contributing water to streams especially during the driest part of a growing season.	Support fish and other aquatic life
Water Quality Maintenance Functions:		
Water Cooling	The effectiveness for maintaining or reducing temperature of downslope waters.	Support cold-water fish and other aquatic life

Sediment Retention & Stabilization	The effectiveness for intercepting and filtering suspended inorganic sediments thus allowing their deposition, as well as reducing energy of waves and currents, resisting excessive erosion, and stabilizing underlying sediments or soil.	Maintain quality of receiving waters; Protect shoreline structures from erosion
Phosphorus Retention	The effectiveness for retaining phosphorus for long periods (>1 growing season)	Maintain quality of receiving waters
Nitrate Removal & Retention	The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonium to nitrogen gas while generating little or no nitrous oxide (a potent greenhouse gas)	Maintain the quality of receiving waters
Organic Nutrient Export, Carbon Sequestration	The effectiveness for producing and subsequently exporting organic nutrients (mainly carbon), either particular or dissolved.	Support food chains in receiving waters
Ecological (Habitat) Functions:		
Anadromous & Resident Fish Habitat	The capacity to support an abundance and diversity of native fish (both anadromous and resident species)	Support recreational and ecological values
Aquatic Invertebrate Habitat	The capacity to support or contribute to an abundance or diversity of invertebrate animals which spend all or part of their life cycle underwater or in moist soil. Includes dragonflies, midges, clams, snails, water beetles shrimp, aquatic worms and others.	Support salmon and other aquatic life; Maintain regional biodiversity
Amphibian & Turtle Habitat	The capacity to support or contribute to an abundance or diversity of native frogs, toads, salamanders and turtles	Maintain regional biodiversity
Waterbird Feeding Habitat	The capacity to support or contribute to an abundance or diversity of waterbirds that migrate or winter but do not breed in the region.	Support hunting and ecological values; Maintain regional biodiversity
Waterbird Nesting Habitat	The capacity to support or contribute to an abundance or diversity of waterbirds that nest in the region.	Maintain regional biodiversity
Songbird, Raptor & Mammal Habitat	The capacity to support or contribute to a diversity of native songbird, raptor and mammal species and functional groups, especially those that are most dependent on wetlands or water	Maintain regional biodiversity
Native Plant Habitat, Pollinator Habitat	The capacity to support or contribute to a diversity of native, hydrophytic, vascular plant species, communities, and/or functional groups, as well as the pollinating insects linked to them.	Maintain regional biodiversity and food chains
Public Use & Recognition*	Prior designation of the wetland, by a natural resource or environmental agency, as some type of special protected area. Also, the potential and actual use of a wetland for low-intensity outdoor recreation, education or research.	Commercial and social benefits of recreation; Protection of prior public investments

*a benefit rather than a function of wetlands

Table 19: WESP rankings for Spicer Quarry EA key wetlands.

Group	Specific Functions or Values	Wetland #1		Wetland #2		Wetland #3		Wetland #6	
		Function Ranking	Benefit Ranking	Function Ranking	Benefit Ranking	Function Ranking	Benefit Ranking	Function Ranking	Benefit Ranking
Hydrologic	Water Storage & Delay	L	H	L	H	L	H	L	H
	Stream Flow Support	H	H	M	H	M	H	M	H
	Water Cooling	H	H	H	H	H	H	H	H
Water Quality	Sediment Retention & Stabilization	M	H	L	H	L	H	L	H
	Phosphorus Retention	L	H	L	H	L	H	L	H
	Nitrate Removal & Retention	H	H	H	H	H	H	H	H
Carbon	Carbon Sequestration	M		M		M		M	
	Organic Nutrient Export	H		M		H		H	
Fish	Anadromous Fish Habitat	L	L	L	L	L	L	L	L
	Resident Fish Habitat	L	L	L	L	L	L	L	L
Aquatic Support	Aquatic Invertebrate Habitat	H	M	M	M	H	M	H	M
	Amphibian & Turtle Habitat	M	H	L	H	L	H	L	H
	Waterbird Feeding Habitat	M	H	M	H	M	H	M	H
	Waterbird Nesting Habitat	M	M	M	M	M	M	M	M
Terrestrial Support	Songbird, Raptor, & Mammal Habitat	H	H	H	H	H	H	H	H
	Pollinator Habitat	H	M	H	M	H	M	H	M
	Native Plant Habitat	H	M	M	M	H	M	H	M
	Public Use & Recognition		M		M		M		M
	Wetland Sensitivity		H		H		H		H
	Wetland Ecological Condition		H		H		H		H
	Wetland Stressors		H		M		M		M

Notes: H = Higher; M = Moderate; L = Lower

The principal outputs of the WESP model are the function scores. The benefit scores describe the setting within which an associated function is being currently performed but are largely influenced by current land uses and other factors not intrinsic to the particular wetland under consideration (Adamus, 2016). To aid in the interpretation of the results, a three-level (Lower, Moderate, Higher) rating system is used for the Function and Benefit scores. The thresholds used to separate the categories are based on the natural breaks in the statistical distribution of the scores among the calibration wetlands used for each function or benefit. The following is an explanation of the results presented in Table 19 above.

Hydrologic Group

The WESP rankings across the four wetlands exhibited a high degree of similarity, which is to be expected given their relatively undisturbed state, comparable size and similarity in type. Wetlands that do not have a surface outlet are better able to store or delay the downslope movement of water. The four wetlands examined were contiguous with a watercourse or drainage, resulting in a Low score for this function. The four wetlands were ranked High and Medium for two Hydrologic functions: Stream Flow Support and Water Cooling, in part due to their position near the headwaters of the watershed.

Water Purification Group

The functions within this grouping include: Sediment Retention and Stabilization, Phosphorus Retention, Nitrate Removal and Carbon Sequestration, with the potential for the wetland to intercept, retain and filter sediments, particulates and organic matter evaluated. Similar to the Hydrologic group, the wetlands that do not have a surface outlet generally score higher. The wetlands ranked High for Nitrate Removal and Retention, with High and Medium rankings for Carbon Sequestration and Organic Nutrient Export.

Aquatic Support Group

The Aquatic Support group comprises four functions: Stream Flow Support, Aquatic Invertebrate Habitat, Organic Nutrient Export and Water Cooling. The functions within this group evaluate a wetlands ability to support ecological stream functions that promote habitat health. Wetlands that are adjacent or contiguous with watercourses generally score higher. Also, wetlands located in the headwaters of a catchment are important for maintaining stream flow during dry periods via groundwater inputs and storage capacity. Within the Aquatic Support group, the wetlands ranked High and Medium across the four functions.

Aquatic Habitat Group

The Aquatic Habitat group is made up of five functions: Anadromous Fish Habitat, Resident Fish Habitat, Amphibian and Turtle Habitat, Waterbird Feeding Habitat and Waterbird Nesting habitat. Wetlands which directly provide fish habitat and are adjacent or contiguous with fish-passable watercourses generally score higher within this group. The four wetlands ranked Low for Anadromous and Resident Fish Habitat, given the absence of ponded water of sufficient depth to support overwintering fish. The wetlands scored Medium and High for Amphibian and Turtle Habitat.

Terrestrial Support Group

The Terrestrial Support group is composed of three functions: Songbird, Raptor and Mammal Habitat; Native Plant Habitat; and Pollinator Habitat. This group of functions evaluate a wetlands ability to support healthy habitats for birds, mammals, pollinators and native plants. Within this group, the four wetlands ranked High and Medium. These rankings were due to the abundance of downed wood, prevalent ground cover, microtopography, tree and shrub cover and naturally vegetated buffer zones around the wetlands.

Wetland Condition

Wetland Condition is based on the integrity or health of a wetland, derived from its vegetation composition and native species richness. The scores for this metric are derived from similarity of the wetland under evaluation to reference wetlands of similar type and landscape setting (Adamus, 1996). The four wetlands had High scores for this benefit, suggesting that at present, the wetlands have healthy plant communities.

Wetland Risk

Wetland Risk considers both the sensitivity of the wetland and any stressors impinging upon it. In this context, sensitivity is the absence of the wetland to withstand human or naturally caused stress. The WESP-AC model uses five metrics to assess sensitivity: abiotic resistance, biotic resistance, site fertility, availability of colonizers and growth rate. Stress considers the degree to which the wetland has been altered in a way that degrades its ecological function. The WESP-AC model applies four stress groups: Hydrologic stress, Water quality stress, Fragmentation stress, and General disturbance stress. The four wetlands ranked Medium to High across the Stressor and Sensitivity functions, in part due to their small size, close proximity to roads and developments and their high locations within the catchments.

Wetland 1 Annual Monitoring: 2008 to present

As part of the existing Industrial Approval requirements to monitor for potential hydrological effects to Wetland 1 from the existing quarry operation three monitoring program components have been implemented; shallow water table monitoring, wetland community indicators species monitoring, and outflow turbidity monitoring. The methodologies used to complete this monitoring are presented in Section 4.7. A report of the monitoring results is submitted to Nova Scotia Environment annually and is used in part to guide operations and future monitoring requirements. The results of the 2008-2019 monitoring are summarized below.

The percent cover of three key herbaceous wetland plant species has been monitored since 2008, and currently occurs every other year making 2018 the most current year with available data. Wetland 1 is monitored as the closest wetland to the existing quarry footprint. It lies approximately 90 m north of the quarry face and 60m north of the cleared quarry boundary. This vegetative cover analysis is currently completed every other year, with the most recent survey occurring in 2018. The three indicator species were Cinnamon Fern (*Osmunda cinnamomea)*, Dwarf Raspberry (*Rubus pubescens)*, and Sensitive Fern (*Onoclea sensibilis)*, all of which are considered Facultative Wetland plant species (FACW), meaning that they are found within a wetland 67-99% of the time and are only occasionally found outside of a wetland (NSE 2012). These species were selected for monitoring as they originally (2008) had low levels of spatial variation across the wetland and were predicted to be sensitive to changes in wetland hydrology, particularly if a shift toward a drier environment were to occur.

Cinnamon fern has the highest average photosynthetic cover at of the established plot locations, with a mean coverage ranging from 67 to 79 % between 2008 and 2018. This is a tall species (~1.5 m) that fans broadly from a common clump. Much closer to the ground, Dwarf Red Raspberry is present, but covers a small aerial portion of the plots. The summary histogram for the 2008 to 2018 period, showing the mean percent cover for all species, is shown in Figure 31. Overall there appears to be little to no change in vegetative cover of the three-indicator species being monitored in Wetland 1 at the Spicer Quarry between 2008 and 2018. While year to year fluctuations in the annual abundance of individual species has been observed no overall trends were observed, and observations fall within a range of natural variability and are an indication that the existing quarry operation has not had an adverse effect on the plant community of Wetland 1.

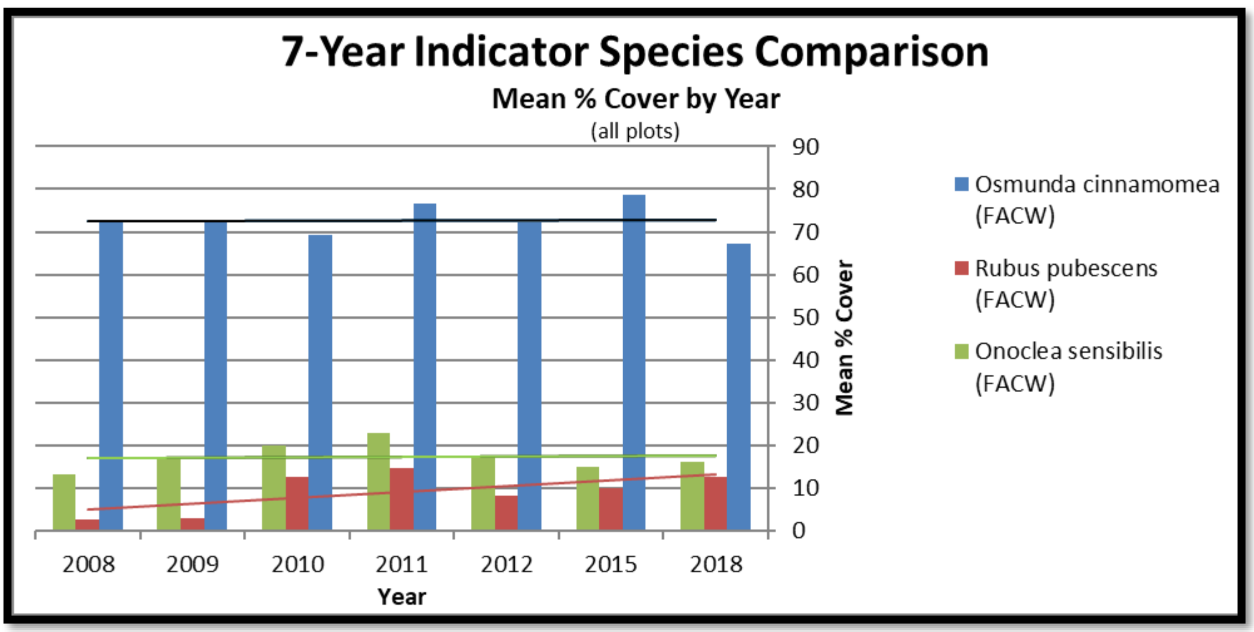

Figure 31: Summary histogram of mean % cover in all surveyed plots of Wetland 1 for each of the three monitored wetland species. Linear regression of each species does not indicate any significant trends in coverage over the time series 2008 to 2018.

Shallow groundwater hydrology in Wetland 1 has also be monitoring since 2008 as part of the quarry's existing Industrial Approval, through three shallow wells installed in the west, centre and east of the wetland (See Figure 32). In combination with the vegetation monitoring described above, a corresponding change in both shallow ground water levels and vegetation can be used to document any shift in the hydrological regime that has an effect at the plant community level. For year to year consistency, water levels in these three wells have been recorded once annually in September, with a manual measure made of the water table relative to the local ground level in a benchmark surveyed well. The September timing is expected to coincide with late season low water levels.

Figure 32: Installation of 2” diameter surface water monitoring wells (l), and a completed and capped monitoring well (r) at Wetland 1.

Over the 11-year period of 2008 to 2019, water levels within Wetland 1 have fluctuated between 6 cm above (wetland in flood) to 9 cm below the ground surface. These fluctuations are very likely due to inter-annual changes in local precipitation. Examination of Wetland 1 shallow water wells in 2019 revealed the lowest water table (average -9cm) documented for the site in September. To aid in placing these values in perspective, it is important to recognize that water levels must occur within 30 cm of the ground surface during a significant portion of the dry season for a site to be considered a wetland (U.S. Army Corps of Engineers. 2012). Therefore, a water table within 9 cm of the surface as observed in 2019 is still considered strongly reflective of wetland hydrology. The 2019 result is expected to reflect heavy rain events on dry ground that occurred in both August and September 2019. Although Environment Canada (2020) precipitation records show slightly above average precipitation for both months in 2019, >75% of both monthly totals came in single day events that would be prone to rapid runoff rather than infiltration and storage within the wetland.

Collectively, the results of shallow water table monitoring at Wetland 1, see Figure 33, do not indicate any significant change over the life of the monitoring program. It is proposed in Section 9.3 Monitoring that Wetland 1 hydrology continue to be monitored and that a seasonal hydrograph be developed to track changes that may occur over the lifespan of the proposed Undertaking.

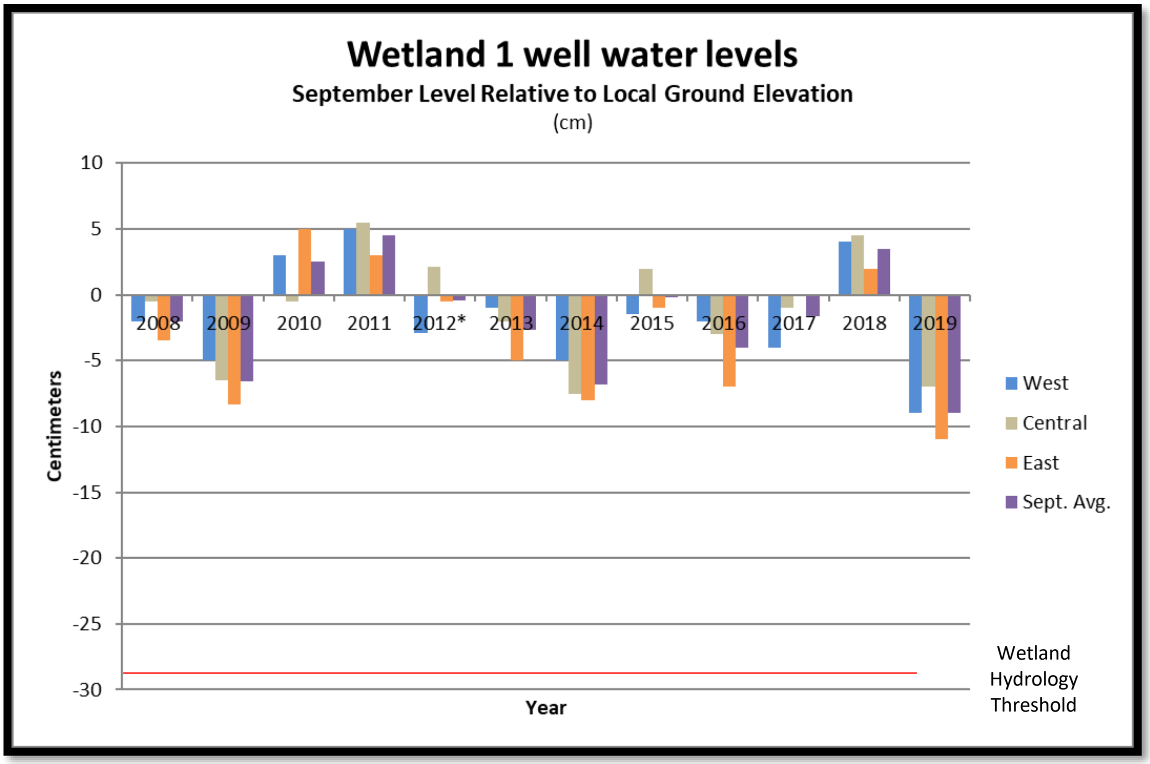

Figure 33: Comparison of September monthly water levels between 2019 and the baseline year of 2008 relative to local ground elevations at the three monitoring wells (west, central, and east) in Wetland 1. Note that zero on the y-axis denotes ground elevation.

As part of the annual Wetland 1 monitoring program, turbidity was assessed at the outlet on October 24th, 2019. The mean turbidity measure was 0.48 NTU. This measure provides some means of tracking whether suspended sediments that may be derived from quarry dusts, drainage, or sedimentation are affecting the wetland. Wetland 1 outlet typically has very low turbidity (1.5 NTU as shown in Table 20), likely due to the clean source water, mature forest surrounding the site, and the filtering capability of the wetland. There is no indication through the turbidity monitoring or visual observation for sedimentation across the various Wetland 1 monitoring stations that dust, erosion, or sedimentation is affecting Wetland 1 over the monitoring period. As Wetland 1 lies between the existing and proposed quarry footprints it is proposed that turbidity monitoring continue at the outlet over the lifespan of the quarry operation.

Table 20: Average in situ water chemistry measures at Wetland 1 between 2011-2019 (n=15 to 23).

Mean Turb. (NTU)	**Water Temp.** (C)	**DO** (% sat)	**DO** (mg/L)	**Spec. Cond.** (uS/cm)	**pH**	**TDS** (mg/L)
1.5	9.0	59.7	14.8	48.5	6.8	36.2

During the annual turbidity monitoring of Wetland 1, a number of additional chemical parameters are also incidentally collected. These measures, averaged in Table 20, provide a chemical fingerprint of Wetland 1 that support its identification as a quality treed wetland habitat. Overall, the 2008 to present monitoring of hydrology, turbidity, and vegetation in Wetland 1 at the Spicer Quarry has indicated no change in Wetland 1, with no adverse effects from the adjacent quarrying activity.

5.5.3 Fish and Fish Habitat

This section of the EA summarizes the evaluation of fish and fish habitat within the Spicer Quarry Study Area. The evaluation consists of both fish and habitat surveys. Methods are outlined in Section 4.6. Fish SAR/SOCI are discussed in Section 5.6.7.

An electrofishing survey of four watercourse reaches was completed on June 18, 2019 to determine fish presence, species composition, and habitat utilization. The locations of the four reaches is shown at Figure 9. The results of the surveys are summarized at Table 21. For additional details, see the individual field data sheets at Appendix 5. Total and fork lengths were recorded, and all fish released on site unharmed (Figure 34).

Table 21: Results of June 2019 single pass electrofishing survey within the Spicer Quarry Study Area.

Survey Reach	**Location**	**First Pass Effort** (s)	**Linear survey distance** (m)	**Fish captured**	**Total Fish/100m²**	**Total CPUE** (fish/100sec)
EF1	Ray Brook-Beaconsfield Rd to Quarry Access Rd	803	484	30 Brook trout; 2 American eels	5.9	4.0
EF2	Ray Brook-Upstream of Quarry Access Rd	371	314	30 Brook trout	8.3	8.1
EF3	Wetland 1 outflow	254	235	Nil	0	0
EF4	Wetland 3 outflow	254	210	Nil	0	0

Thirty Brook trout (*Salvelinus fontinalis*) and two American eel (*Anguilla rostrata*) were captured in Ray Brook between the Beaconsfield Road and the quarry access road (site EF1), with an additional 30 Brook trout captured on Ray Brook upstream of the quarry access road (site EF2). Ray Brook is a small channel with a bank full width of approximately 2 m and depth of 42 cm. As described in Section 5.5.1, the system is of near neutral pH (7.71), and cool temperature (10.5 ^{o}C) with high dissolved oxygen (>100 %). It does have naturally elevated aluminum. There is near 100% canopy closure and in-stream large woody debris. The watercourse at this location exhibited a typical riffle-pool sequence for the size of the system. Both of these sites are within a short distance east of the aggregate stockpile/crusher area at the foot of the North Mountain, separated by a forested buffer of 30-70m. The upstream end of survey reach EF2 on Ray Brook occurred where the slope increased at the base of the North Mountain and the system became increasingly small, wood-choked and braided (Figure 35). It is highly probable that upslope of this location the watercourse is seasonally dry and of limited value for fish habitat due to the steepness of the gradient that exceeds 30%.

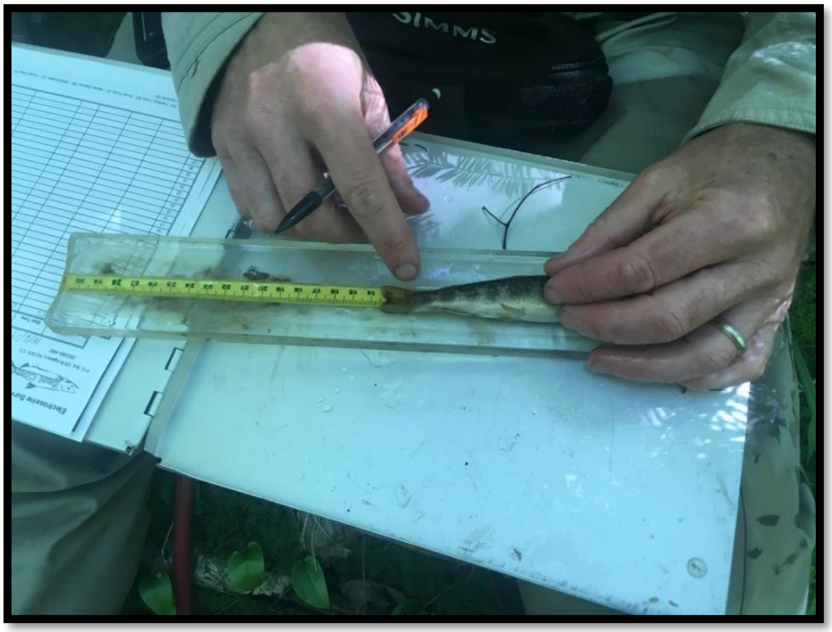

Figure 34: Recording total and fork lengths of Brook trout captured at Ray Brook.

The only other watercourses within the Study Area, and being of similar dimensions, are the outflow channels from Wetlands 1 and 3. These electrofishing survey sections (EF3 and EF4) are located at the top of the North Mountain and are a short distance of the existing and future proposed quarry foot print areas respectively. Both drainages have only short distances of moderate slope before draining at higher gradients down the slope of the North Mountain toward the Annapolis River. As described in Section 5.5.1, these systems have slightly lower pH (6-6.4) than Ray Brook, and although cool they tend to have a low (<50%) dissolved oxygen concentration coming out of the upstream wetland habitats. Both have naturally elevated aluminum. Furthermore, and perhaps most significantly, both of these watercourses quickly flow downslope approximately 1km into the Annapolis Valley at mapped slopes of around 15% and segments in excess of 30%. It is possible that these stream reaches form complete fish barriers and without headwater lake systems supporting these two watercourses it could be expected that they are non-fish bearing at the top of the north mountain near the wetlands. Despite covering approximately 450 linear meters and 500 seconds of active electrofishing effort at EF3 and 4 no fish were capture nor observed. It is likely therefore that these systems are non-fish bearing until they reach more moderate gradients of the valley floor well out of the Study Area to the east, and off the proponents' properties.

Figure 35: Upslope end of survey reach EF2 on Ray Brook, as the watercourse approaches the foot of the North Mountain and becomes increasingly braided, with steep gradient, and seasonally ephemeral flow.

Evaluation of the surveyed fish captured during EF1 and EF2 in Ray Brook near the proposed Undertaking reveals that total lengths of the Brook trout captured are similar in the two reaches, as would be expected given they are on the same watercourse and separated by a fish-passable culvert (Table 22). The two data sets were compared using Minitab (Version 18.1) with the Two-sample t-test. The mean total fish lengths for the two sections of Ray Brook (EF1 and EF2) were found not to be significantly different (t-value = 0.77; p-value = 0.445).

Table 22: Comparison of Brook trout Total Length for fish captured on sample reaches EF1 and EF2, Ray Brook.

Survey Reach	Location	N	Mean (Total Length) (mm)	Standard Deviation	Standard Error of the Mean
EF1	Ray Brook-Beaconsfield Rd to Quarry Access Rd	30	73.3	43.3	7.9
EF2	Ray Brook-Upstream of Quarry Access Rd	30	65.0	40.4	7.4

The single pass electrofishing surveys of reaches EF1 and EF2 found a total fish density of 5.9 and 8.3 fish / 100m^2 of wetted habitat, respectively. In a survey of 100 watercourses across Nova Scotia, MacMillian *et al* (2008) found a mean population density for Brook trout of 24 fish / 100 m^2, with a range of 0 to 332 fish / 100 m^2. The productivity of Ray Brook, based on the 2019 survey effort, thus falls into the lower range of what might be expected in the province. MacMillian *et al* (2008) has found that a single pass electrofishing survey for Brook trout in Nova Scotia, where no barrier nets were used, had a detection rate of close to 50%. Based on this, the population estimate of Brook trout in Ray Brook over the survey area may be in the order of 2 x 60 = 120 trout.

The Brook trout total length data from sample reaches EF1 and EF2 were combined and examined as a frequency distribution, indicating a distinct size classification within the population. Size classes appeared centred at 30 mm, 90 mm, 140 mm and 180 mm, in decreasing frequency with increasing length as shown in Figure 36. Around mainland Nova Scotia, length at age data for Brook trout indicate that the mean length at age (yrs.) is 88mm for Y0 (young of the year) fish (Halfyard et al. 2008a), 154 mm for Year 1+, and 216 mm for Year 2+ for stream-dwelling brook trout (Halfyard et al. 2008b). Based on this comparison to the field collected data at Spicer Quarry Study Area it appears that most captured fish were likely young of the year or one-year old fish. In Nova Scotian streams, the length at which 50% probability of sexual maturity is achieved for Brook trout is about 188mm (Halfyard et al. 2008b). Based on this and there being no fish of 188mm captured, it is unlikely that the fish sampled in Ray Brook near the Spicer Quarry operations were reproducing. Instead it is expected that Ray Brook provide a good cold-water rearing habitat for young trout. However, it can also be assumed given the presence of young of the year fish in the surveyed reaches that mature trout spawn either in or very near to the surveyed reaches. The absence of larger size class trout during the survey period may indicated that base flows do not provide adequate cover depth and forage areas for larger fish in the surveyed reaches.

In 2008, stream habitat channel surveys of the physical habitat in two reaches of Ray Brook, above and below the access road, was completed as required by a condition of the quarries' Industrial Approval (ECA 2009). In total 490 m of detail quantitative habitat survey was completed from a point 217 m upstream of the intersection of the access road and Ray Brook to a point downstream at the intersection of the old Beaconsfield Road and Ray Brook which corresponds to EF1 and 2, the 2019 electrofishing sites. Characteristics of twenty-four primary habitat units were documented, as were overview riparian and stream discharge characteristics. Detail stream channel measurements are presented in Appendix 13.

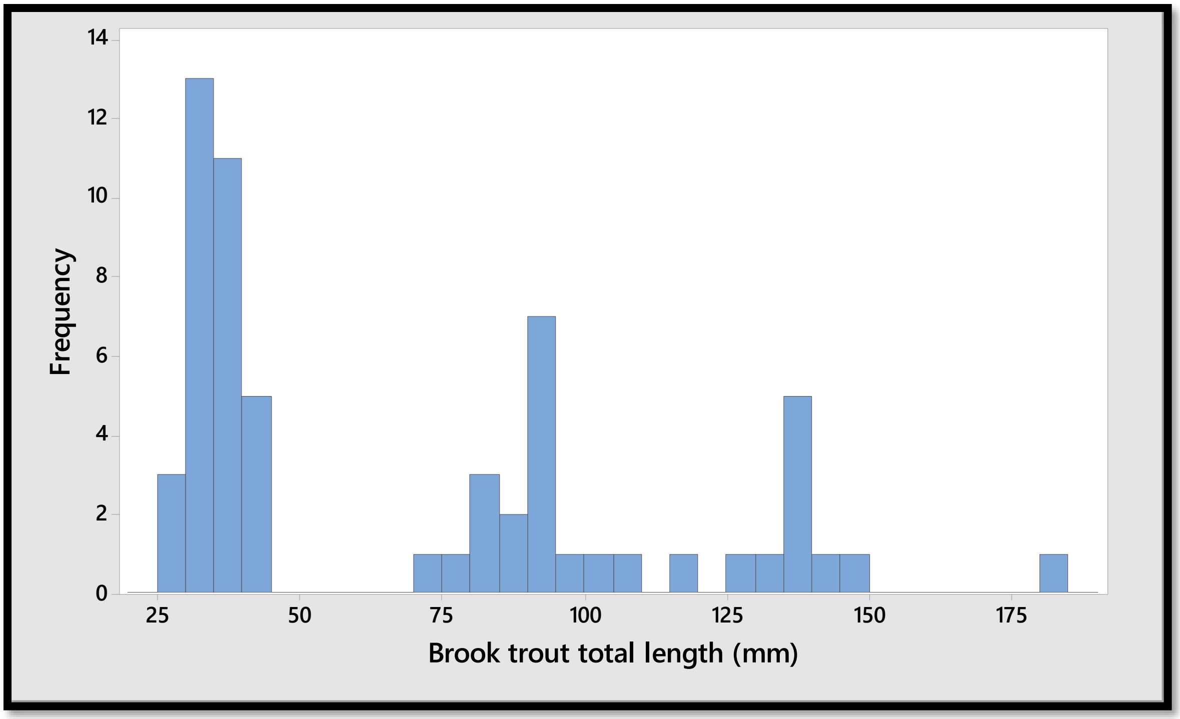

Figure 36: Length distribution of Brook trout in Ray Brook (n=60), based on a single pass electrofishing survey, surveyed on June 2019.

Figure 37: Glide at habitat (left) and riffle habitat (right) downstream of the quarry access road crossing of Ray Brook as observed during the 2008 quantitative fish habitat surveys.

The Ray Brook channel between the quarry access road and the old Beaconsfield Road crossing can be characterized as having an average bank full channel width of 2.0 m and bank full depth of 42 cm. These are the annual flood return channel dimensions. Approximately 63 % of the 273 m long stream reach below the access road crossing is riffle habitat. There is a 2:1 riffle to pool ratio, and the three primary pools found in the reach had an average residual depth of 26 cm and were located an average of 91 m apart (or 44 bank full channel widths). Substrates were dominated by sand in virtually all habitat units during the detailed 2008 stream habitat surveys (ECA 2009), a condition that was observed again during electrofishing surveys in 2019. This sand appears to move throughout the system actively as evidenced by the presence of algae and moss growth on the larger substrate below the line of the surrounding sand substrate. The riparian forest cover downstream of the access road crossing was predominantly mixed pole sapling and young forest. This offered the narrow stream channel an estimated 94 % overhead cover. A moderate amount of large woody debris (LWD) is found in the channel. Large woody debris is a significant contributor to channel morphology in small alluvial systems where it helps initiate scour, assists in retaining gravels, and sorts and stabilizes substrates in the channel. LWD counts averaged 0.75 pieces / bank full channel width (Wbf) in Ray Brook (ECA 2009). This frequency is considerably less than the 2.0 pieces / Wbf that has been documented for old growth unlogged reaches in western Canada (Chesney 2000, Slaney and Martin 1997) and the 2.2 pieces /Wbf found in low impacted streams of Nova Scotia (East Coast Aquatics 2006), but is reflective of the logging history of the Annapolis Valley. In western Canada, counts of less than 1 are considered poor and equivalent to a logged stream, in channels less than 15 m wide and 5 % gradient (Chesney 2000, Slaney and Martin 1997). This appears to be characteristic of Ray Brook below the access road crossing.

Of concern is the presence of a significant sand load moving in Ray Brook should this be related to quarry operations. Field investigations have identified both natural (see Figure 38) and anthropogenic sediment have been documented along Ray Brook on the Spicer property, and it would be difficult to quantify the relative significance of these sediment sources. The natural sources are sizeable and contribute to a level of TSS and turbidity in the Ray Brook upstream reference area that is higher than other monitored watercourses both on the properties and nearby (Refer to Section 5.5.1 for further details ono these measures). The downstream Ray Brook monitoring location indicates a slight increase in TSS and turbidity over the upstream location typically occurs during the spring freshet as can be expected within an operational area like the quarry and associated active OHV roads. Conditions of the Spicer Quarries' Industrial Approval require monitoring of this increase and sets maximum allowable limits, and further requires that exceeded limits must be immediately reported to Nova Scotia Environment and that all monitoring results get annually reported. As discussed in Section 2.3.6 many sediment control structures and progressive stabilization of quarry working areas have been undertaken by the proponent over the years. Ensuring continued diligence in managing operational erosion and sedimentation is important to protecting what appears to be a valuable Brook trout rearing habitat within the Study Area. Both mitigation measures and monitoring have been proposed as part of the proposed Undertaking to address sediment control and to evaluate potential effects of sedimentation.

Figure 38: An example of natural stream bank failure and sedimentation located upstream of the Ray Brook fish survey, habitat survey, and water quality monitoring stations. These fine textured sands and clays are observed in the downstream sample locations that exist both upstream and downstream of the quarry access road.

5.6 Species at Risk and Species of Conservation Interest

Within the context of this report, a species at risk (SAR) is one which is protected by either Federal of Provincial legislation (Species at Risk Act (SARA) and NS Endanger Species Act (NSESA), respectively) due to their rarity. Species of conservation interest (SOCI) are those that are known or believed to be rare or uncommon at a Provincial scale, and therefore ranked as S1-S3 by Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A data report for the project area was obtained from the Atlantic Canada Conservation Data Center (ACCDC) and is presented in full in Appendix 2. Making use of the DNR (2009) recommended prioritization process, a short list of SAR which may occur within 20 km of the project site was developed (Table 23), with a total of 27 species listed. This short list of prioritized species includes:

- 13 birds
- 3 reptiles
- 4 invertebrates
- 1 non-vascular plant (lichen)
- 1 mammal
- 5 vascular plants

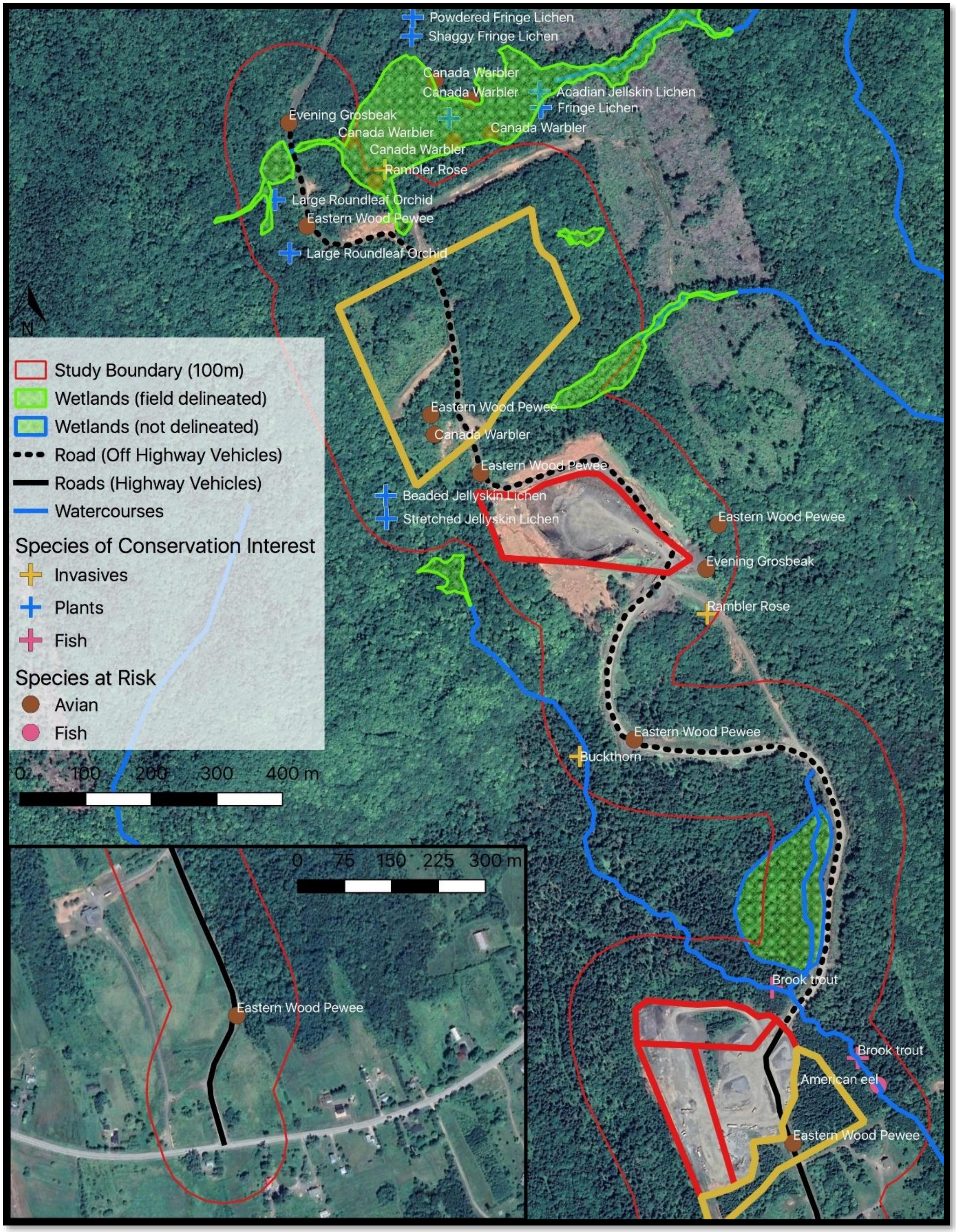

Figure 39: General location of SAR/SOCI within the Study Area of the Spicer North Mountain Quarry.

Table 23: Species at Risk documented by ACCDC within 20km of the project site provided a list to guide field searches and to consider during the assessment of habitats at the Spicer Quarry Study Area.

Taxa Group	Scientific Name	Common Name	COSEWIC*	SARA*	NSESA*	Provincial Rarity Ranking	Provincial General Status Rank	Observation Distance from site (km)
Birds	*Riparia*	Bank Swallow	T	T	E	S2S3B	2 May Be At Risk	4.1 ± 0.0
	Hirundo rustica	Barn Swallow	T	T	E	S2S3B	1 At Risk	3.4 ± 0.0
	Dolichonyx oryzivorus	Bobolink	T	T	V	S3S4B	3 Sensitive	3.9 ± 0.0
	Cardellina canadensis	Canada Warbler	T	T	E	S3B	1 At Risk	8.1 ± 7.0
	Chaetura pelagica	Chimney Swift	T	T	E	S2B, S1M	1 At Risk	4.6 ± 7.0
	Chordeiles minor	Common Nighthawk	SC	T	T	S2B	1 At Risk	4.6 ± 7.0
	Sturnella magna	Eastern Meadowlark	T	T	-	SHB	3 Sensitive	4.6 ± 7.0
	Contopus virens	Eastern Wood-Pewee	SC	SC	V	S3S4B	3 Sensitive	2.7 ± 0.0
	Coccothraustes vespertinus	Evening Grosbeak	SC	-	V	S3S4B, S3N	4 Secure	4.6 ± 7.0
	Colinus virginianus	Northern Bobwhite	E	E	-			4.6 ± 7.0
	Contopus cooperi	Olive-sided Flycatcher	SC	T	T	S2B	1 At Risk	4.6 ± 7.0
	Euphagus carolinus	Rusty Blackbird	SC	SC	E	S2B	2 May Be At Risk	4.6 ± 7.0
	Falco pereginus	Peregrine falcon	SC	SC	V	S1B, SNAM	3 Sensitive	8.1 ± 7.0
Herps	*Chrysemys picta picta*	Eastern Painted Turtle	SC	-	-	S4S5	4 Secure	4.6 ± 10.0
	Chelydra serpentina	Snapping Turtle	SC	SC	V	S3	3 Sensitive	7.7 ± 0.0
	Glyptemys insculpta	Wood Turtle	T	T	T	S2	3 Sensitive	12.1 ± 1.0
Inverts	Bombus bohemicus	Gypsy Cuckoo Bumble Bee	E	E	-	S1	-	-

	Epeoloides pilosulus	Macropis Cuckoo Bee	E	E	-	-	-	-
	Danaus plexippus	Monarch	E	SC	E	S2B	3 Sensitive	8.7 ± 0.0
	Coccinella transversoguttata	Transverse Lady Beetle	SC	-	-	-	-	-
Lichen	Erioderma mollissimum	Vole Ears Lichen	E	E	-	-	-	-
Mammal	*Martes americana*	American Marten			E	S1	1 At Risk	10.5 ± 0.0
Plants	*Fraxinus nigra*	Black Ash	T	-	T	S1S2	1 At Risk	20.0 ± 0.0
	Thuja occidentalis	Eastern White Cedar	-	-	V	S1	1 At Risk	6.0 ± 0.0
	Isoetes prototypus	Prototype Quillwort	SC	SC	V	S2	3 Sensitive	11.2 ± 0.0
	Salix candida	Sage Willow	-	-	E	S1	2 May Be At Risk	18.4 ± 1.0
	Potamogeton pulcher	Spotted Pondweed	-	-	V	S2S3	3 Sensitive	20.0 ± 0.0

*E=Endangered, T=Threatened, SC=Special Concern, V=Vulnerable

Each of these SAR species is discussed in the respective following sections, outlining whether the species was confirmed at the site, or the likelihood of it being found in the habitats present if it was not observed during field surveys. SOCI that were confirmed on the property during the 2019 surveys are also discussed in each relevant following section. In total 3 SAR (all avian), and 20 SOCI (4 plant, 14 bird, 2 fish) were confirmed within the Study Area during the 2019 field surveys. Figure 39 presents the approximate location of all SAR/SOCI that were identified during EA associated field surveys with the exception of avian SOCI as only general habitat sections and not specific coordinates were documented for avian SOCI.

5.6.1 Avian SAR/SOCI

A total of 13 avian SAR were short-listed as potentially occurring within 20 km of the project site, and each are discussed below. Three avian SAR were documented on the property during the 2019 surveys, and all were on the desktop shortlist. Only one individual of one species (Eastern Wood Peewee) was found within the proposed quarry footprint area. All other SAR were found in habitats adjacent to or removed from the existing operations and that are not proposed to be altered during the proposed undertaking. An additional 14 SOCI were documented during the surveys. Confirmed avian SAR/SOCI at the property during 2019 surveys are listed in Table 24.

The Canada Warbler (*Cardellina canadensis*) is a small, migrant SAR songbird that nests in Nova Scotia mixed wood forests. Nesting is typically associated within moist forests with dense, deciduous shrub layers, complex understory and available perch trees. The species is often found near standing water, streams and wetlands. Habitat loss, through intensive deforestation, removal of shrub layer and land conversion, has been identified as a significant threat to the species (Environment Canada, 2015). The species is listed as Threatened by COSEWIC, Threatened by SARA and Endangered by NSESA. Following habitat ecotype surveys, it was concluded there was a moderate to high probability that suitable Canada Warbler nesting habitat in or near the Project Site. During the 2019 field surveys ten individuals were observed, nine of which were around the edge of Wetland 3. Eight of the observations occurred during the spring migration surveys. Five male Canada Warbler were observed around the edge of Wetland 3 within the study area. This area is to remain undisturbed by the proposed development and lies north of the proposed future quarry footprint at the top of the north mountain. Three of these males were seen paired with a female. The only Canada Warbler not observed in association with Wetland 3 was observed during the early fall migration survey low in the saplings of a regenerating cut area with a large flock of other birds.

The Eastern Wood-pewee is a small forest bird, approximately the same size as a House Sparrow. The species utilizes the mid-canopy layer of forest clearings, as well as the edges of deciduous and mixed forests. In the Maritimes, the Eastern Wood-pewee is strongly associated with mature poplar and hardwood forests, with weaker associations to pine, hemlock and other forest types. A negative associate exists with harvested forest, human-occupied areas and roads. The population of this SAR has decreased, on average, 2.9% per year between 1970 and 2011, for an overall *decline* of 70% over the past 42 years. While threats to the population have not been fully identified, they are suspected to include loss and degradation of habitat and reduction in numbers of flying insect prey species (COSEWIC 2012). The Eastern Wood-peewee is listed as Special Concern by COSEWIC and Special Concern by SARA and Vulnerable by the NSESA. Based on the habitats present at the Study Area of the Spicer Quarry it was believed there was a moderate to low probability

Table 24: Avian Species at Risk and Species of Conservation Interest that were confirmed as present in the Study Area of the Spicer Quarry during 2019 field surveys.

Scientific Name	Common Name	National Advisory COSEWIC	Federal Legislated SARA	Provincial Legislated NSESA	NS Provincial Rarity Ranking	No: Obs
Cardellina canadensis	Canada Warbler	T	T	E	S3B	10
Contopus virens	Eastern Wood-Pewee	SC	SC	V	S3S4B	9
Coccothraustes vespertinus	Evening Grosbeak	SC	-	V	S3S4B, S3N	17
Setophaga tigrina	Cape May Warbler				S2B	1
Spinus pinus	Pine Siskin				S2S3	1
Pheucticus ludovicianus	Rose-breasted Grosbeak				S2S3B	2
Cathartes aura	Turkey Vulture				S2S3B	3
Sitta canadensis	Red-breasted Nuthatch				S3	8
Dumetella carolinensis	Gray Catbird				S3B	2
Cardellina pusilla	Wilson's Warbler				S3B	1
Setophaga castanea	Bay-breasted Warbler				S3S4B	15
Setophaga striata	Blackpoll Warbler				S3S4B	3
Regulus calendula	Ruby-crowned Kinglet				S3S4B	13
Catharus ustulatus	Swainson's Thrush				S3S4B	5
Oreothlypis peregrina	Tennessee Warbler				S3S4B	4
Catharus fuscescens	Veery				S3S4B	4
Empidonax flaviventris	Yellow-bellied Flycatcher				S3S4B	3

E=Endangered, T=Threatened, SC=Special Concern, V=Vulnerable

Eastern Wood-pewee would actively be using habitat within the Study Area. A total of nine Eastern Wood-pewee were documented during 2019 avian surveys. Only one individual was found during the breeding season in the proposed expansion area of the quarry at the top of the north mountain. The forest to be cleared for the expansion does not appear to be particularly good habitat for pewees at this time, as there were no stands of mature hardwoods. Spatially, observations were made relatively equally across the entire Study Area, with one or two individuals of this species observed in each of the six habitats sections surveyed.

The Evening Grosbeak (*Coccothraustes vespertinus*) is a stocky, boldly coloured songbird, resident in Nova Scotia throughout the year. Optimal habitat for this SAR includes open, mature mixed wood forests, with Balsam Fir and White Spruce abundant to dominant. The Spruce Budworm has been an important food species, together with seed crops from firs and spruce within the boreal forest. Principal threats identified to the Evening Grosbeak include window strikes at home feeders, reductions in mature and old-growth forests due to forest harvesting, and road collisions. The Evening Grosbeak is listed as Special Concern by COSEWIC and Vulnerable by the NSESA. During desktop and initial habitat surveys of the Study Site at Spicer Quarry it was determined there was moderate probability that suitable existed for the Eastern Wood-pewee. During the early spring migrant survey, two flocks of Evening Grosbeak were observed flying over the property but did not land. Seventeen individuals were observed within the habitats of the Study Area, all during the spring migration surveys, including 13 along the forested edge around the existing quarry operation. This species is highly nomadic and may use the property at times for feeding and/nesting, however there was no indication of breeding in 2019.

In addition to the three avian SAR observed in 2019 as discussed above, nine additional SAR had been identified in the desktop survey as having been observed within 20km of the Study Area and potentially within the habitats there. Although none were observed, the following paragraphs highlight the appropriateness of the habitat around the Spicer Quarry in supporting these species.

Bank Swallow (*Riparia riparia)* is a small aerial insectivore songbird, which nests in colonial breeding sites, on eroding vertical banks, such as sand stockpiles, aggregate pits and riverbanks. Breeding sites tend to be located near open terrestrial habitat that support aerial foraging, including grasslands, meadows, pastures and agricultural cropland. The species has suffered a severe decline, with a 98% loss of the Canadian population over the past 40 years (COSEWIC, 2014). The species is listed as Threatened by COSEWIC, Threatened by SARA and Endangered by NSESA. There are few, if any suitable nesting sites within the project area. While stockpiles are present within the processing area at the Spicer Quarry, the composition is gravel and stone, whereas the Bank swallow prefer sand to silt for nesting substrate. No Bank Swallow were observed during 2019 field surveys of the Study Area. During avian surveys it was noted that the steep muddy/clay banks of overburden adjacent to the active quarry site could provide potential nesting habitat for Bank Swallow, but these temporarily stored materials are not particularly steep and perhaps too muddy. The fallow field habitat near Highway 1 could provide forage area for the species.

The Barn Swallow (*Hirundo rustico*) is another small aerial insectivore songbird that have seen significant recent population declines, beginning in the 1980s. Barn swallows establish colonial nest sites on a variety of human structures, including open barns, garages, sheds and under house eaves. Nest sites are usually near open habitats for aerial feedings, such as farmland, wetlands and large forest clearings (COSEWIC, 2011). The species is listed as Threatened by COSEWIC, Threatened by SARA and Endangered by NSESA. There are few, if any suitable nesting sites within the project area, given the absence of buildings at the quarry. No Barn Swallow were observed during 2019 field surveys of the Study Area and no appropriate habitats were identified by the ornithologist.

The Bobolink (*Dolichonyx oryzivorus*) is found predominantly in open grasslands, pastures and hayfields. The species has seen severe population declines since the 1960s, with the principal threats being agricultural operations, habitat loss and fragmentation (COSEWIC, 2010). The species is listed as Threatened by COSEWIC, Threatened by SARA and Vulnerable by NSESA. There is no open grassland habitat in the vicinity of the quarry and adjacent processing area, as both occur in mixed forest. Limited old field habitat exists at the extreme south edge of the Study Area, where the property abuts Highway 1. No Bobolink were observed during 2019 avian field surveys of the Study Area. During the avian surveys it was noted that fields along the entrance road could harbour Bobolinks if managed for the species, although spatially it would be small relative to the used and managed areas of Belleisle Marsh and other fallow fields along the Annapolis River.

The Chimney Swift (*Chaetura pelagica*) is an aerial insectivore which roosts and nests primarily in abandoned chimneys. Prior to the arrival of Europeans in Nova America, the species very likely made use of large hollow trees. Principal threats to the species are dwindling numbers of breeding and roosting sites, with forestry activities and the destruction of old abandoned buildings. The chimney of the former Bridgetown High School (located eight kilometers to the east of the Project Site) was used as an active roosting site in 2018 (Kings County News, 2018). As the structure was slated for demolition, an alternate roosting chimney was constructed approximately 100 m to the north in March 2019. Early monitoring in 2019 indicated that the replacement Bridgetown chimney, located approximately 8.2 km west of the Study Area, was being used as a communal roost by up to 300+ individuals (CARP 2019). The Chimney Swift is listed as Threatened by COSEWIC, Threatened by SARA and Endangered by NSESA. There are no known roosting or breeding sites within the project Study Area. No Chimney Swift were observed during 2019 field surveys of the Study Area and no appropriate habitats were identified by the ornithologist.

The Common Nighthawk (*Chordeiles minor*) is an aerial insectivore which forages most actively near dusk and dawn, feeding on beetles, moths, grasshoppers, flying ants and other flying insects. Population numbers have decreased by 50 % over the past 40 years. The species nests on the ground on bare open soil, including sand dunes, beaches, logged or burned-over areas, forest clearings, rocky barrens and pastures. The eggs are laid on the flat ground surface with no nest structure built. The principal threats to the species include habitat degradation and fragmentation, depletion of insect food sources, and reductions in habitat availability, due to fire suppression and intensive agriculture practices. The Common Nighthawk is listed as Special Concern by COSEWIC, Threatened by SARA and Threatened by NSESA. There is a moderate probability that suitable Common Nighthawk nesting and forage habitat exists in or near the Project Site. No Common Nighthawk were observed during 2019 field surveys of the Study Area. The ornithologist assessing the site predicts that the habitat within the proposed expansion area is not suitable for the species given the varied age and structure of the patchwork forested habitat there. However, the ornithologist did consider the presence of Common Nighthawk a reasonable possibility considering the amount of bare rock and gravel within the Study Area, and the clearcut on property east of the study area and proposed expansion area.

The Eastern Meadowlark (*Sturnella magna*) is found predominantly in open grasslands, pastures, meadows and hayfields. There has been a significant decrease in the population of the species, with overall declines of ~29 % over the past several decades. The main causes for the decline in numbers have been attributed to loss of breeding habitat, resulting from agricultural intensification, overgrazing by livestock and mortality due to pesticide use. The Common Eastern Meadowlark is listed as Threatened by COSEWIC and Threatened by SARA. Limited old field habitat exists at the extreme south edge of the Study Area, where the property abuts Highway 1. No Eastern Meadowlark were observed during 2019 field surveys of the Study Area and no quality habitats for the species were identified by the ornithologist.

The Northern Bobwhite (*Colinus virginianus*) is as ground-nesting tallgrass prairie-savanna bird. The species also utilizes early to mid-successional forest habitats and open areas such as agricultural fields (ECCC, 2018). Although the species has been observed at Belleisle Marsh, it is a generally considered a non-migratory species that spends its entire lifetime close to its natal area. In Canada, Ontario has the only known population thought to be native. The species is listed as Endangered by COSEWIC and SARA. No Bobwhite were observed during 2019 field surveys of the Study Area and no appropriate habitats were identified by the ornithologist.

The Olive-sided Flycatcher (*Contopus cooperi*) is a moderate sized forest songbird, commonly found in coniferous forest edge habitats. The Nova Scotia breeding population typically arrives from the South American wintering grounds in May, to form monogamous pairs and nest in early June. The species is typically associated with forested areas adjacent to openings which contain tall live trees or snags which are used for perching. The forest openings may take the form of clearings, wetlands or man-made openings resulting from forest harvesting (COSEWIC, 2018). The species is listed as Special Concern by COSEWIC, Threatened by SARA and Threatened by the NSESA. While the specific causes of recent declines are not well understood, habitat loss and alteration in both Canadian breeding grounds and the South American wintering grounds are suspected. There is a moderate probability that suitable Olive-sided Flycatcher nesting and forage habitat exists in or near the Project Site. Despite conducting avian field surveys with timing considerations for Olive sided flycatcher, none were observed during 2019 field surveys. The avian surveyor assessed the habitat observed within the proposed expansion area as not appropriate for this species. He also noted that although Wetland 3 is the largest bog in the Study Area it may still be too small for Olive-sided Flycatchers.

The Rusty Blackbird (*Euphagus carolinus*) is a medium sized songbird, with breeding distributions across boreal regions of Canada in coniferous-dominated forests adjacent to wetlands, including swamps, marshes, bogs and riparian areas. The species has suffered one of the greatest declines of birds in Canada, with an annual rate of 5.5 to 6.3 % and a total reduction of 85 to 90 % since 1970. The principal threats to the Rusty Blackbird are thought to occur on the wintering grounds in the southern US, with the loss and degradation of habitats (COSEWIC, 2017). The species is listed as Special Concern by COSEWIC, Special Concern by SARA and Endangered by the NSESA. There is a moderate probability that suitable Rusty Blackbird nesting and forage habitat exists in or near the Project Site. No Rusty Blackbird were observed during avian studies of 2019. Wetland 3, located north of the proposed future quarry footprint, would be the most suitable location on the property for the species and the wet forested area on the east side of the wetland seems ideal for this species. This area was searched during four of the field visits and approached during an additional two field visits.

The Peregrine Falcon *Falco peregrinus anatum,* numbers dramatically declined in the mid 20th century, this species has rebounded significantly over the past few decades. This recovery is believed to be the result of reintroductions in most of southern Canada and the natural growth in productivity following the ban on organochlorine pesticides such as DDT. It usually nests alone on cliff ledges or crevices, preferably 50 to 200 m in height, but sometimes on the ledges of tall buildings or bridges, always near good foraging areas (COSEWIC 2017b). NSDLF staff have previously highlighted the potential of a Peregrine Falcon flyway between Belle Isle Marsh forage grounds and St. Croix Cove area on the Bay of Fundy, and the unknown routing of such relative to the Study Site (Elderkin pers comm 2010), and ECA staff have observed Peregrine flying east of the Study Area during other unrelated project investigations (Parker pers comm. 2020). The species is listed as Special Concern by SARA and Vulnerable in Nova Scotia by NSESA. No observations were made of Peregrine falcon during the 2019 avian surveys of the Study Area.

As shown in Table 24, fourteen SOCI were observed during the 2019 inventories of the Spicer Quarry properties. Ten of the avian SOCI species are considered "Sensitive", and three others are considered "Secure". The Gray Catbird (*Dumetella carolinensis*) has a NS General Status Rank of "May be At Risk" and is perhaps the most significant of the SOCI observed. Two individuals were observed during the fall migration surveys, one at the stockpile/crusher area and the other in the adjacent slope habitat of the north mountain. The ornithologist noted that in addition to Canada Warblers, a number of locally uncommon species were seen in the vicinity of Wetland 3 to the north of the future quarry site. These include the SOCI Yellow-bellied Flycatcher (three) as well as two Northern Waterthrushes, one Nashville Warbler, and six Black-throated Blue Warblers.

Table 25: Summary of SAR/SOCI taxonomic richness and total individuals observed by habitat during 2019 surveys of the Study Area.

	Crusher /Stockpile Area	Existing Quarry	Proposed Quarry	North of Proposed Quarry	North Mtn. Slope	Valley Floor Access Road	Total
Taxonomic Richness	9	3	8	10	5	4	17
Total observations	16	15	27	29	8	6	101

In terms of distribution of 2019 observations of the avian SAR/SOCI within the Study Area, Table 25 highlights that the greatest taxonomic richness (10) and individuals observed (29) of these species was in the area that will not be physically altered by the undertaking, north of the proposed quarry footprint at the top of the north mountain. This includes Wetland 3 and both the mature and regenerating upland forest habitats around the wetland. Clear cutting to the east on a neighboring property provides additional diversity of habitat available in that area. A similar number of SAR/SOCI species was documented around the current crusher/stockpile area at the base of the north mountain, an indication that current operations do not likely preclude the use of adjacent habitat types by avian species. The greatest number of avian SAR/SOCI individuals were observed at the top of the north mountain both within the proposed quarry footprint area (27) and the area north of the proposed quarry (29) that will remain physically unaltered by the undertaking.

5.6.2 Herpetofauna SAR/SOCI

No herpetofauna SAR/SOCI were observed during 2019 field studies of the project properties, and queried site staff did not report ever having observed any turtles on the property. During the desktop assessment of SAR, three species of turtle were identified as having been observed within 20 km of the Spicer Quarry. Each of these is discussed below in relation to the habitats observed within the Study Area and the likelihood of them existing within the Study Area despite not being observed during the field surveys.

The Eastern Painted Turtle (*Chrysemys picta picta*) is a small to medium sized freshwater turtle, with a distribution including New Brunswick, Nova Scotia and the Atlantic coastal states east of the Appalachian Mountains. The Painted turtle is typically found in slow moving, shallow and well vegetated wetlands and water bodies with abundant basking sites and organic substrates. Nesting occurs on open, south-facing and slope areas with sandy-loam to gravel substrates, typically within 1200m of aquatic habitats. Threats to the species include road mortality, habitat loss, subsidized predators (such as raccoons and skunks), introduced plant and animal species and climate change (COSEWIC, 2018). The species is listed as Special Concern by COSEWIC. Given the significant gradients found across much of the project site, there are very few, if any, occurrences of ponds and flood wetlands available for this predominantly aquatic species. While wetlands due occur on the site, they are typically forested swamps with water levels at or near the ground surface. For this reason, there is a low to moderate likelihood of Eastern Painted Turtle occurring within the project site. No turtles were observed in any habitats of study area.

The Snapping Turtle (*Chelydra serpentine*) is a large and distinctive freshwater turtle, with a Canadian range extending from southeastern Saskatchewan to Nova Scotia. While the turtle occupies a wide range of habitats, it prefers aquatic locations characterized by slow-moving water with soft muddy bottom and dense aquatic vegetation. The principal threats to Snapping Turtles in Nova Scotia included conversion of aquatic and riparian habitats for agriculture and/or urban development, road mortality, legal and illegal harvesting, and predators (such as raccoons and skunks) (ECCC, 2016). The species is listed as Special Concern by COSEWIC, Special Concern by SARA and Vulnerable by the NSESA. There is no slow moving watercourses with aquatic vegetation in the study area, with all streams being small and of moderate to steep gradient. There are very few occurrences of ponded water associated with man made structure (sediment catch basins) or wetlands, and all are small in surface area and depth. While wetlands do occur on the site, they are typically forested swamps with water levels at or near the ground surface. Road prisms and crushed material stockpiles within the Study Area could provide appropriate nesting for Snapping turtle were they to be present. However, given the lack of appropriate aquatic habitat there is a low to moderate likelihood of Snapping Turtle occurring within the project site. No turtles were observed in any habitats of study area.

The Wood Turtle (*Glyptemys insculpta*) is a medium sized freshwater turtle, with a patchy Canadian range extending from Nova Scotia west through New Brunswick, Quebec and Ontario. The species has been found in moderate numbers within the Annapolis River Watershed (CARP

201X), and portions of the watershed have been identified as Critical Habitat (EC 2016) for this species. All assigned habitat and observations in the Annapolis Watershed have been made well up river of the Study Site. The Wood Turtle is one of the most terrestrial of Canada's freshwater turtles, utilizing adjacent riparian, forest, wetland and field habitats for foraging. The species is reliant on aquatic habitats (rivers and streams) with sand or gravel bottoms for hibernation and protection. Sand and gravel-sand beaches adjacent to watercourses services as natural nesting habitats, although anthropogenic sites such as a gravel pits and road edges are also used (COSEWIC, 2007). Threats to the Wood Turtle include road mortality to adults, removal of turtles for the pet trade, construction of forest roads, destruction/alteration of riparian habitat and predators (such as raccoons and skunks). The species is listed as Threatened by COSEWIC, SARA and NSESA. Given the significant gradients found across much of the project site, it is unlikely that the species would ever be found beyond the Valley floor. Although some appropriate alder, field and forest type habitat exists within the Study Area, there are no nearby occurrences of suitable watercourses with sufficient depth for winter hibernation. The tidal nature of the Annapolis River adjacent to the Study Area is a potential barrier to their presence from upstream area in which they are known. No suitable natural sand bar nesting habitats occur within the Study Area, and road prisms and stockpiles present would be unlikely to provide a favoured nesting alternative for Wood turtle as they do not exist near to pools or slow moving streams. There is a low likelihood of Wood Turtle occurring within the project site. No turtles were observed in any habitats of study area.

5.6.3 Invertebrate SAR/SOCI

No invertebrate surveys were undertaken during the 2019 field surveys as part of the EA process. Therefore, discussion of SAR is based on appropriateness of habitats present in the study area. For a few of the potential invertebrate SAR identified during the desktop survey, particular plant species are a key part of their lifecycle. Therefore, the vascular plant species inventory compiled during the 2019 field surveys and project botanist were consulted to determine if these supporting plant species were present or likely to be present on the property.

The Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) is a medium-sized obligate social parasite of bumble bees within the subgenus *Bombus*, observed in three provinces: Ontario, Quebec and Nova Scotia (COSEWIC, 2014). The Gypsy Cuckoo Bumble Bee occurs across a diversity of habitats, including urban areas, mixed farmland, open meadows and boreal forests. The species' is a generalist forager, primarily for nectar associated with food plants flowering close to wooded areas. The species does not produce workers, but rather seeks out and kills host queens, laying eggs in the nest which are then tended by the host colony workers. While Nova Scotia has been thoroughly surveyed for bumble bees, the most recent provincial Gypsy Cuckoo Bumble Bee records are from 2002 near Middleton, approximately 27 km north east of the Study Area. The species is listed as Endangered by COSEWIC and Endangered by SARA. The mixed habitats across the southern portion of the project area represents potential habitat for the species.

The Macropis Cuckoo Bee (*Epeoloides pilosulus*) is a cleptoparasite, where the females sneak into the host nests and lay eggs, with the eggs and larva of the host bee then killed by the cleptoparasite (COSEWIC, 2011). The habitat utilization of the species is guided by that of its host *Macropis* bees and their food plant, Yellow Loosestrife (*Lysimachia*), which is known to grow in swampy, riparian and moist habitats. The most recent provincial Macropis Cuckoo Bee records are from 2002 near Middleton, north east of the Study Area. The species is listed as Endangered by COSEWIC and Endangered by SARA. The mixed habitats across the southern portion of the project area represents potential habitat for the species. However, no yellow loosestrife *(Lysimachia vulgaris)* was observed during the survey and is considered by the project botanist unlikely to occur in the project site as it is an introduced garden plant.

The Monarch butterfly (*Danaus plexippus*) is a distinctive and charismatic conservation icon, with the adult widely recognized due to its predominantly orange wings outlined with broad black borders. The Monarch is one of the few butterflies that migrate, with their migration from southern Canada to wintering sites in Mexico well documented (COSEWIC, 2016). Milkweed (numerous species) represent the sole food plant for Monarch caterpillars, are sometimes found growing on roadsides, fields, wetlands and open forests. The species is listed as Endangered by COSEWIC, Special Concern by SAR and Endangered by the NSESA. ACCDC records for the species exist within ~9 km of the project site. The mixed habitats across the southern portion of the project area represents potential habitat for the host milkweed. However, no milkweed was observed during the survey and is unlikely to occur at the Project Site given the limited amount of suitable habitat observed by the project botanist.

The Transverse Lady Beetle (*Coccinella transversoguttata*) is a small, round beetle. The adults have orange to red winder covers with red markings, consisting of a black band and four elongate spots (COSEWIC, 2016). The species is fairly general in its habitat preferences, primarily feeding on aphids and known to inhabit agricultural areas, suburban gardens, parks, coniferous and deciduous forests, meadows and riparian areas. The species is listed by COSEWIC as Special Concern. The specific causes for the range-wide decline of the Transverse Lady Beetle is unknown but may be related to negative interactions with recently arrived non-native species, such as the Seven-spotted Lady Beetle and the Multicolored Asian Lady Beetle.

5.6.4 Lichen SAR/SOCI

During the desktop study for the Spicer Quarry EA, one lichen SAR was identified as occurring within 20 km of the Study Area. The Vole Ears Lichen (*Erioderma mollissium*) is a foliose microlichen with a felty, grey-brown upper surface, occurring in cool, humid coastal coniferous forests dominated by Balsam fir (*Abies balsamea*) (COSEWIC, 2009). In Canada, the species has been found on the island of Newfoundland, New Brunswick and Nova Scotia, with only 133 documented adult and 50 juvenile occurrences. There is strong evidence to suggest significant declines in these populations, with at least 80 % of the sites in Nova Scotia known from the early 1980s no longer supporting the species. Occupancy rates of habitat patches have also appeared to have declined in Nova Scotia (COSEWIC, 2009). Threats to the species include air pollution, air pollution and habitat loss through commercial forestry. The species is listed as Endangered by COSEWIC and Endangered by SARA. No appropriate habitat was identified within the Study Area for the species by the project botanist, and the species was not encountered during vegetation nor lichen specific surveys of the project properties in 2019.

No lichen SAR were encountered during surveys however six SOCI were identified during 2019 and 2020 surveys as shown in Table 26. Acadian Jellyskin lichen (*Leptogium acadiense)* (see

Figure 40) was found in the treed portion of Wetland 3. It was observed once on Red maple (*Acer rubrum)*. *L. acadiense* is found throughout Nova Scotia but is primarily limited to Acer species and is usually found in treed swamps. It is part of the rich cyanolichen community that occurs in mature treed swamps in the province. Cyanolichens are a group of lichens that contain a cyanobacteria as the primary photobiont. Two additional cyanolichens, Stretched Jellyskin Lichen *Leptogium milligranum* and Beaded Jellyskin Lichen *Leptogium teretiusculum* were both found west of the proposed quarry footprint during the summer surveys. Both species are found in a variety of habitats but on mature hardwood tree species. Beaded Jellyskin Lichen is a minute cyanolichen and may be overlooked in the province. Shaggy Fringe lichen *Anaptychia palmulata* (S3S4), Fringe Lichen (*Heterodermia neglecta)* and Powdered Fringe Lichen (*H. speciosa)* were also found within the treed portion of Wetland 3. All lichen species found in Wetland 3 are >150m away from the closest portion of the future quarry footprint and in an area where not development activities area proposed. Lichen species can be sensitive to dust and activities, primarily forest clearing, that result in microclimate changes that alter light, heat, and moisture patterns. It has been proposed in Section 9.3 Monitoring that these potential impacts from the Proposed Undertaking on lichen SAR/ SOCI be monitored.

Figure 40: Lichen species of conservation interest found in the treed portion of Wetland 3 included *Leptogium acadiense (left photo),* while three more common species (*Menegazzia terrebrata*, *Lobaria scrobiculata* and *Pannaria conoplea)* are shown on a Red Maple.

Table 26: Summary of lichen species of conservation interest identified during 2019 surveys of the Spicer Quarry Study Area.

Scientific Name	Common Name	NS Provincial Rarity Ranking
Anaptychia palmulata	Shaggy Fringe lichen	S3S4
Heterodermia neglecta	Fringe lichen	S3S4
Heterodermia speciosa	Powdered Fringe lichen	S3
Leptogium acadiense	Acadian Jellyskin lichen	S3S4
Leptogium teretiusculum	Bearded Jellyskin Lichen	S3
Leptogium milligranum	Stretched Jellyskin Lichen	S3

5.6.5 Mammal SAR/SOCI

Only one mammalian SAR was identified within 20 km of the Study Area during the desktop surveys. The American Marten (*Martes americana*) is a member of the weasel family, with a slender body, a small sharp-pointed heart, round ears and a bushy tail. The species is found in mature coniferous forests, with foods including mice, chipmunks, rabbits, shrews, insects, reptiles, fruits and berries. Nova Scotia has two isolated populations of American Marten, one in the Cape Breton and the second in southwest of the province, centered around Kejimkujik National Park SAR Guide, 2015). The ACCDC data search indicates a record for the species 10.5 km from the Project site. The American Marten is listed as Endangered by the NSESA. The present threats to the species including habitat loss and small isolated populations. Given the expanse of forested habitat along the North Mountain crest, there is a moderate possibility of the species occurring within the project area. No marten or sign of the species was noted during the 2019 field surveys.

Although no bat species are noted in the desktop survey as having been documented within 20 km of the site, it is undeniable that several of these mammal species would have used the habitats of the Study Area. In particular, the Tri colored bat *Perimyotis Subflavus* Northern long -eared bat *Myotis Septentrionalis* and Little Brown bat *Myotis lucifugus* had significant populations in Nova Scotia prior to the outbreak of White-nosed Syndrome (WNS), which has caused has caused a 94% overall decline in known numbers of hibernating *Myotis* bats in Nova Scotia. Given these declines, no surveys were conducted for bats during the EA process, and no bats were incidentally observed in the field. The three species were emergency listed as Endangered in the federal Species at Risk Act (SARA) in 2014 because of sudden and dramatic declines that have been a direct result (WNS) (ECC 2018b). A 2010 echolocation survey approximately 7.5km north east of the Spicer Quarry, and in similar habitat as those around the existing and proposed quarry footprints, produced 3008 sound files at an average of 75/nite. Most of the recorded sequences (>99%) were attributable to the two common *Myotis* species (Broders and Burns, 2010).

No mammalian SOCI were noted during the 2019 field surveys of the Study Area.

5.6.6 Vascular Plant SAR/SOCI

No vascular plant SAR were observed during the three field survey dates conducted in 2019, nor a previous survey conducted in 2008. Several SAR were identified as occurring within 20 km of the site by ACCDC records and are presented in Table 23 Section 5.6. The potential for each of those species being present within the Study areais discussed below.

The Black Ash (*Fraxinus nigra*) is a broad-leafed hardwood tree, generally 2.5 to 15 m tall with large spreading or ascending branches. The species has a widespread distribution across Nova Scotia but with rare occurrence, with few seed-bearing individuals and a small number of individuals overall (n~1000 trees) (NSDNR, 2015). Historically, Black ash numbers have been reduced through timber harvesting as well as through the clearing and draining of wet forested habitats and riparian zones. The recent (~2018) arrival of the invasive alien Emerald Ash Borer represents a new and potentially very serious threat to the species, leading to its re-assessment and upgrading to Threatened status by COSEWIC in November 2018 (SAR Registry, 2019). The species is also listed as Threatened by NSESA. The ACCDC data search indicates a record for the species 20 km from the project site. The project botanist encountered appropriate habitat for the species within the Study Area, but no trees were observed.

The Eastern White Cedar (*Thuja occidentalis*) evergreen tree belong to the Cypress Family, generally 10 to 20 m tall and flattened branchlets. Cedar has been found at 32 sites in five counties in the province, of which two are believed to have originated from planted stock (Newell, 2005). The total number of mature individuals within the province is estimated to be ~12,000. Threats to the species include selective cutting, highway construction and land development. Regeneration levels have been observed to be low, possibly due to browsing by deer and snowshoes hare, drought-related seedling mortality and unfavourable soil pH conditions. The species is listed as Vulnerable by the NSESA, with the ACCDC search indicating the existence of a data record 6 km from the project site. Given the presence of several wetlands within the project zone, a moderate likelihood of Eastern White Cedar occurring in the project area exists. Although the species is known to occur on the North Mountain, no trees were observed by the project botanist. White cedar has a very limited distribution in the province and native stands are not expected on the North Mountain.

The Prototype Quillwort (*Isoetes prototypus*) is a perennial aquatic fern ally, know to occur in thirteen lakes worldwide, nine in Nova Scotia, three in New Brunswick and one in Maine. The species in found along the shallow margins of lakes, forming dense mats in nutrient-poor, spring-fed conditions (COSEWIC, 2005). While there are no specific threats to the species, the very limited number of lakes harbouring individuals presents a conservation concern. The species is listed by COSEWIC as Special Concern, SARA as Special Concern and NSESA as Vulnerable. The ACCDC data search indicates a record for the species 11 km from the project site. Given the specificity of the species' habitat requirements (shallow lake margins) and the absence of any lakes in the vicinity of the proposed project, there is a very low likelihood of species occurring in the project zone. It was not unexpected that no individuals were observed during the 2019 surveys.

The Sage Willow (*Salix candida*) is a low, deciduous, dioecious shrub with narrowly elliptic or oblanceolate leaves and slightly to strongly rolled under leaf margins. The species is extremely rare in Nova Scotia, being confined to calcareous fens and marshes (Newell, 2010). Threats to the species include hydrological alteration, grazing, browsing, peat mining, recreational use and timber harvesting. The species is listed as Endangered by the NSESA, with the ACCDC data search indicating a record 18 km from the project site. Given the specificity of the species' habitat requirements (calcareous wetlands) and the absence of this habitat within the vicinity of the proposed projects, there is a very low likelihood of the species occurring in the project zone, and none were observed during the 2019 field surveys.

The Spotted Pondweed (*Potamogeton pulcher*) is an aquatic herbaceous plant arising from a slender, often dark-spotted perennial rhizome with broadly rounded, cordate-based (heart-shaped) floating leaves. Spotted pondweed occurs principally in southwestern Nova Scotia in highly acidic nutrient-poor environments such as ponds and lakes (Mazerolle and Blaney, 2010) and is a member of the Atlantic Coastal Plain Flora suite of plants. The species is list as Vulnerable by the NSESA with the ACCDC data search indicating a record 20 km from the project site. Given the specificity of the species' habitat requirements (acidic ponds and lakes) and the absence of these habitat within the vicinity of the proposed projects, there is a very low likelihood of the species occurring in the Study Area and none were observed by the project botanist.

Table 27: Summary of vascular plant SOCI observed during 2019 field surveys of the Study Area. No federal of provincial SAR were documented.

Scientific Name	Common Name	National Advisory COSEWIC	Federal Legislated SARA	Provincial Legislated NSESA	NS Provincial Rarity Ranking	Individuals Observed
Platanthera orbiculata	Large Roundleaf Orchid				S3	3

Figure 41: Large Roundleaf Orchid *(Platanthera orbiculata),* shown here not in bloom, is a SOCI observed within the Spicer Quarry Study Area.

Table 27 shows only one vascular SOCI and no SAR was identified within the Spicer Quarry Study Area after three site visits by the project botanist covering approximately 14 linear km through the various available habitats.

Large Roundleaf Orchid *(Platanthera orbiculata)* (shown in Figure 41) was observed at three locations on the site. This orchid species has a Provincial rarity ranking of S3, making it a species of conservation interest. It was found in mature hardwood forests in moist shaded sites. They were found in isolated patches of two to three plants in close (~50m) proximity to Wetland 3. None of these locations will be modified as part of the proposed undertaking and all lie north of the proposed quarry footprint.

5.6.7 Aquatic SAR/SOCI

During the desktop evaluation of potential SAR within the Study Area, no aquatic fauna was identified, in part due to the limited aquatic habitats present and in part because freshwater species are not generally well documented within the ACCDC dataset. One SAR and one SOCI were observed during 2019 sampling within the project Study Area as summarized in Table 28.

Table 28: Summary of aquatic SAR/SOCI observed during 2019 surveys of the Spicer Quarry project properties.

Scientific Name	Common Name	National Advisory COSEWIC	Federal Legislated SARA	Provincial Legislated NSESA	NS Provincial Rarity Ranking	Individuals Observed
Anguilla rostrate	American Eel	T	T	-	S2	5
Salvelinus fontinalis	Brook Trout	-	-	-	S3	30

*E=Endangered, T=Threatened, SC=Special Concern, V=Vulnerable

During the electrofishing surveys of Ray Brook one SAR was observed. American eel (*Anguilla rostrate*) is a listed nationally as a Threatened species and has a provincial ranking of S2. The species General Status in Nova Scotia is considered secure. The American eel plays an important role as a top aquatic predator and is of great importance to Aboriginal peoples. It is also considered as an excellent indicator of habitat integrity (COSEWIC 2010b). Although considered secure in Nova Scotia, the distribution and abundance of American Eel has diminished over the past century in freshwater habitats, having been impacted by human development. Southwest Nova Scotia is an area where the population trend has declined between the 1980 and the 2000s. The most relevant freshwater impact is the construction of barriers (dams) to upstream movement, hydroelectric dams causing downstream mortality, and fisheries (COSWEIC 2012b). A significant natural source and potential operational sources of erosion occur a short distance upstream of the 2019 survey location within the Study Area. Infilling of interstitial spaces in the streambed of Ray Brook from such sources would likely be the greatest threat if erosion and sedimentation are not properly managed. Two individual eel that were 23 and 28cm in length were captured between the quarry access road crossing and Beaconsfield Road, and another three were observed during the survey but not captured.

Brook trout (*Salvelinus fontinalis*) were also observed during the 2019 aquatic surveys. This cool water species is not protected by legislation at either the federal or provincial levels but has a provincial ranking of S3 and is considered sensitive within Nova Scotia making it a SOCI. Good numbers of early year class trout were sampled in Ray Brook, as discussed in Section 5.5.3, between Beaconsfield Road north toward the base of the north mountain where stream gradients would become impassable to the species. High levels of dissolved oxygen, near neutral pH, and regular surface water temperatures of 15°C that have been measured at the site over a number of years would provide good water chemistry for the species despite naturally elevated aluminium. Stream morphology is diverse with pools, riffles, glides, and cover features of boulders, undercut banks and large woody debris. The channel is small and may be limiting for adult age groups as only fish aged 0-2 years appeared present during surveys of the habitat. It is likely the Ray Brook habitat within the Study Area provides important cold water refuge and rearing habitat for Brook trout locally. Significant natural sources of erosion and potential operational sources of sedimentation occur a short distance upstream of the 2019 survey location, and infilling of interstitial spaces and shallow pools in the streambed of Ray Brook would likely be the greatest threat to Brook trout from the proposed undertaking if erosion and sedimentation are not properly managed. Several management strategies for sedimentation have been proposed for the Undertaking as outlined in Section 2.3.6, and ongoing monitoring of TSS at Ray Brook is proposed in Section 9.3 to evaluate for potential adverse effects.

6. Socio-Economic Environment

6.1 Mi’kmaq

Upper Granville, where the Spicer Quarry is located, is part of the traditional Mi'kmaw territory known Kespukwitk meaning “end of flow”, which covers the counties of Queens, Shelburne, Yarmouth, Digby and Annapolis. Nearby Bridgetown is known as Likalie’katik meaning “at the church area” referring to the church frequented by the Mi’kmaw. Mi’kmaq presence and usage were largely confined to coastal areas and river valleys due to the abundance of food sources and water transportation routes (David MacIntyre, 2019). The Archaeological Resource Impact Assessment, presented in full in Appendix 7, found that the study area, which is concentrated at the base and top of the north mountain, had low potential for historical First Nations archaeological resources. However, the Archaeology Research Division at Kwilmu’kw Maw-klusuaqn (KMKNO-ARD) note that one traditional use site occurs within a one-kilometre radius of the Spicer Quarry study area. This is an unspecified hunting site. Bear River reserve is the nearest present day First Nations community to the study area and lies approximately 34.5 km to the southwest.

6.2 Population and demographics

The Spicer North Mountain Quarry is located within rural Annapolis County, approximately 7.6 km to the west of the community of Bridgetown and 13.8 km to the northeast of the Town of Annapolis Royal. Statistics Canada (2019) Census Profile data was accessed for Annapolis County and the province of Nova Scotia, based on the 2016 Census as summarized in Table 29. The population of Annapolis County represents approximately 2.2 % of the province’s total but saw a 0.8% decrease between the 2011 and 2016 censuses. The county is sparsely populated, when compared with the provincial value, with an older population, lower median income, and higher unemployment rate.

Table 29: Population and Demographics for Annapolis County and Nova Scotia (Source: Statistics Canada 2019).

Parameter	Annapolis County	Nova Scotia
Population 2016	20,591	923,598
Population 2011	20,756	921,727
2011 to 2016 Population Change	-0.8%	+0.2%
Total private dwellings (2016)	11,391	458,568
Population density per km^2 (2016)	6.5	17.4
Land area (km^2) (2016)	3,189	52,942
Median age of population (2016)	52.7	45.5
Median total income (2015)	$25,799	$31,813
Percentage with employment income	59.3%	67.5%
Unemployment rate	13.1	10.0

6.3 Spicer Quarry Direct and Indirect Employment

B. Spicer Construction Ltd., the project proponent, is a family-owned business that has been operating in the Bridgetown area since 1987. Quarry and crushing operations at the North Mountain Quarry employ 16 individuals, all of whom live in within Annapolis County (J. Spicer, pers. comm.). The seasonal operation of the asphalt plant at the site further employs an additional 24 individuals, manufacturing the asphalt and as members of the paving crews. As the asphalt plant is mobile and is setup at the quarry on as as-needed basis, the 24 individuals typically stay in local motels and eat at local restaurants while working in the area. Approximately 25 to 30 local trucking companies haul rock and gravel from the North Mountain Quarry on a regular basis for residential and commercial construction projects. Operations at the quarry are further supported by at least an additional 10 indirect positions provided by sub-contractors, with services ranging from rock testing, blasting and environmental monitoring. Over its 11 years of operation, the Spicer Quarry has paid over $2,400,000 in wages, fees and taxes.

Table 30: Spicer Quarry Direct and Indirect Employment

Employment Type	Activity	Number of Persons Employed	Notes
Direct	Quarry & Crushing Basal	8	Crusher operators, truck drivers, scale operators, Supervisor, Account/Payroll, Mechanics
Direct	Asphalt Plant & Paving	24	Approx. 6 months per year.
Indirect	Local trucking companies	25 to 30	Independent locally based operators
Indirect	Road construction	10	Seasonal; Construction crews and flaggers
Indirect	Sub-contractors and suppliers	10	Blasting, Rock Testing, Equipment Sales, Environmental Monitoring

6.4 Infrastructure

B. Spicer Construction and the North Mountain Quarry is an important provider of rock, gravel and asphalt for the construction and maintenance of private and public infrastructure in Annapolis County. Table 31 provides an excerpt of the types of projects supported with material from the North Mountain Quarry (J. Spicer, pers. comm.). Over the past decade, the Spicer North Mountain Quarry has provided aggregate and asphalt for bridge replacements, road construction, dam stabilizations, re-paving, and the construction of wharf breakwaters, playing fields and schools. Notable projects during this period include the construction of the new Bridgetown Community School and essential repaving to Highway 101. Much of the quarry output has been to support the construction and maintenance of public infrastructure.

Table 31: Public and Private Instructure Projects supported with material from the Spicer North Mountain Quarry since 2013.

Project Type	Project Name	Project Location	Project Size / Scope
Road/Infrastructure	Church Street Reconstruction	Bridgetown	Aggregate/asphalt
Road/Infrastructure	Clements Park Upgrades	Greenwood	Aggregate/asphalt
Bridge replacement	Sawmill Creek Bridge	Moschelle	Aggregate
Infrastructure	Brooklyn & Junction Road Water and Sewer	Middleton	Aggregate
Bridge replacement	Leonard Bridge	Parkers Cover	Aggregate
Site Work	Bridgetown School Site Development	Bridgetown	Aggregate
Road/Infrastructure	Faye Road Extension and Pump Station	Bridgetown	Aggregate/asphalt
Breakwater	Parkers Cover Breakwater	Parkers Cove	Aggregate
Slope Repair	Scragg Lake Dam	Squirrel Town	Aggregate
Road/Instructure	Centennial Drive Reconstruction	Bridgetown	Aggregate/asphalt
Soccer Field	Bridgetown School Soccer Field	Bridgetown	Aggregate
Paving	Various Roads, Annapolis County	Annapolis County	24 km
Paving	Clementsvale Road	Clementsvale	19 km
Paving	Morse Road	Bridgetown	9 km
Paving	Culloden Road	Digby	7 km
Paving	Granville Road	Port Royal	17 km
Paving	Highway 101	Bridgetown to Lawrencetown	11 km
Paving	Shore Road	Parkers Cover to Delaps Cove	10 km
Paving	Shore Road	Port George to Margaretsville	10 km
Paving	AWEC School Parking Lot	Annapolis Royal	Aggregate/asphalt
Paving	Bridgetown RCMP Parking Lot	Bridgetown	Aggregate/asphalt
Paving	Cornwallis Foodland Parking Log	Cornwallis	Aggregate/asphalt

6.5 B. Spicer Construction and the Community

As a local family owned and operated business, B. Spicer Construction Ltd. recognizes the importance of active support of community activities. The company is a regular supporter of local charities, community groups and amateur sports teams. Over the past 10 years, B. Spicer Construction Ltd. has provided cash, materials (aggregate and asphalt) and services (heavy equipment usage) to support local community activities, such as the construction of the Jubilee Park Floating Dock System, the Bridgetown Triathlon, the new Bridgetown Fire Hall, and the Western Valley Hockey Association. The company has been a key participant in the annual RiverFest event since its inception five years ago, an important fundraising event for the community-based watershed management charity, Clean Annapolis River Project (Figure 42). Over the past seven years, the company has contributed more than $55,000 to local community activities, as well as volunteer time and assistance (J. Spicer, pers. comm. 2019).

Figure 42: B. Spicer Construction Dragon Boat Team at RiverFest, a fundraiser for the Clean Annapolis River Project (CARP), a community-based watershed management charity.

6.6 Transportation

Aggregate and asphalt from the Spicer Quarry are transported via a two-kilometer private gravel road to Nova Scotia Trunk Highway 1 and then either east or west to its destination. Highway 1, at this location, has an average of 1670 vehicles passing daily (Table 32). During peak production, approximately 50 vehicle per day exit the property onto Highway 1, representing about 3% of the daily traffic at this location. Approximately 10 vehicles per day exit the property during off-peak periods.

Table 32: Traffic Volume for Highway 1, Section 220 (Bridgetown/Upper Granville Line to Young's Mountain Road (Belleisle) (NSTIR, 2017)

Date	Annual Average Daily Traffic*
22/6/2009	1560
11/06/2012	1690
07/07/2015	1780
14/09/2017	1650
Average	**1670**

* Average number of vehicles passing the count location in a 24-hour period, averaged on the basis of one year.

6.7 Recreation and Tourism

Valley View Provincial Park, open June to October, is located to the east of the project site (~6.3 km straight line, ~13.4 km by road). The park provides a day use area, hiking trails and approximately 30 campsites, many overlooking the Annapolis Valley.

Jubilee Park, located approximately seven kilometers to the east of the quarry, hosts a natural playground, washrooms, kayak rentals and Visitor Information Centre. The park is an important component of the county's tourism infrastructure, providing recreational access to the Annapolis River and hosting events such as the Bridgetown Triathlon and the CARP RiverFest. Facilities at the park were expanded in 2016/17 through the addition of a boat launch and floating dock (Figure 43), These upgrades were made possible through the support from all levels of government, the hard work of community volunteers, and a contribution of cash and materials from B. Spicer Construction Ltd.

Figure 43: Jubilee Park Boat Launch and Floating Wharf, Bridgetown

7. Archeology and Historic Resources

An Archaeological Resource Impact Assessment was completed for the site by Davis MacIntyre and Associates Ltd. and subject to Heritage Resources Permit A2019NS020. The full report is contained at Appendix 7. The assessment found that it has been well established through oral tradition, historical documentation and the archaeological record that First Nations people have been present in the general area of the Annapolis River and its tributaries since time immemorial. They continued to settle and frequent the area in the historic period and allied themselves with the French and Acadians that settled this region in the 17th and 18th centuries. The French established the first permanent settlement in North America at Port Royal and the Acadians dyked marshlands all along the Annapolis River and its estuary, establishing small villages in the upland regions around the marshes. Though most of the early Acadian settlers were deported in the mid-18th century, their farms continued to be settled and worked into the latter half of the 18th century by New England Planters and by later immigrants in the 19th century.

A field reconnaissance of the study area has revealed a landscape largely untouched by cultural activity until early 20th century forestry operations. The forest has recovered within the last 40-70 years in much of the study area, however, the landscape is still heavily scared from ground disturbance. The nearest three recorded archaeological sites are located within a 5 kilometers radius of the study area. The first is representative of a historic Acadian habitation dated to the early 18th century. The second is representative of several Acadian domestic structures located on the Belleisle Marsh. The third, is representative of an aboiteau located at Bloody Creek believed to be from the 17th century. Within a 10-kilometer radius of the study area, two First Nations sites are recorded. The first is an encampment site representing the Kejikawe'k L’nu’k (the Recent People) or the Woodland/Ceramic Period (3,000 –500 BP) located on a farm near Round Hill. The second is an isolated find representing a possible Protohistoric Copper Kettle burial near Bridgetown. It is noted that the relative absence of reported sites within the vicinity of the study area is likely due to a lack of previous archaeological research being conducted and is not necessarily reflective of an absence of archaeological sites. The Kwilmu’kw Maw-klusuaqn (KMKNO-ARD) Archaeology Research Division’s research database recorded one traditional use hunting site within a one-kilometre radius of the proposed study area.

An 1858 Admiralty chart of the Annapolis Basin and River depicts cultural activity focused around the post road in the Upper Granville area, but no roads or structures are depicted within the study area or the immediate vicinity. In 1876, Ambrose Church mapped the area recording a similar lack of activity on North Mountain. By the time the 1930 Geological Survey of Canada Map was published, more roads and structures are depicted on North Mountain, yet again, no activity is recorded within the immediate vicinity of the study area.

The Recommendations and Conclusions of the assessment include:

- The Spicer Quarry Study Area is of low potential for archaeological resources of pre-contact or historic First Nations or Euro-Canadian archaeological resources and therefore, no further active mitigation is recommended.
- In the unlikely event that archaeological resources are encountered in the future during grubbing, soil removal, or other ground disturbance activities, it is required that any ground-disturbing activity be halted immediately and the Coordinator of Special Places

(902-424-6475) be contacted immediately regarding a suitable method of mitigation. Should the impact area be modified to expand beyond the currently understood range, a qualified archaeologist should be consulted to evaluate whether further archaeological assessment may be required.

8. Public Engagement Summary

The Proponent sought to undertake a proactive public involvement program, to engage government offices and adjacent communities throughout the environmental assessment process. These activities were guided by documentation prepared by NSE (2009a) and Nova Scotia Office of Aboriginal Affairs (2009). The engagement process commenced early in the EA screening and scoping phase and continued through to the drafting of the EA report with its subsequent revisions.

Between December 2017 and January 2020, ECA initiated contact with a number of provincial government departments to gain input on the terms of reference and scope of the planned environmental assessment. Comments from the following individuals was used develop and refine the EA methodologies and in preparation of the list of Valued Environmental Components to be addressed:

- Brent Jackson, Nova Scotia Environment, Kentville Regional office
- Bridget Tutty, Nova Scotia Environment, EA Branch
- Mark Elderkin, Nova Scotia Lands and Forestry, Wildlife Division
- Randy Milton, Nova Scotia Lands and Forestry, Wildlife Division
- Sean Weseloh McKeane, Nova Scotia Communities, Culture and Heritage
- Adam D'Entremont, Nova Scotia Environment, Yarmouth Regional office
- John Drage, Nova Scotia Energy and Mines
- Gordon Check, Nova Scotia Environment

8.1 Public Consultation

Members of the public were invited early in the EA process to an information meeting, held on May 13, 2019 at the Bridgetown Fire Hall. In advance of the information session, flyers were distributed to 115 household mailboxes along Highway 1 between Youngs Mountain Road and Bridgetown, in the communities Belleisle and Upper Granville that lie adjacent to the Spicer North Mountain Quarry. The flyers announced the date and location of the information session and provided contact details for the ECA team for follow-up queries. A notice advertising the upcoming information meeting was placed in the May 3rd edition of the Bridgetown Annapolis County Reader as well as on posters placed on five public notice boards in the community of Bridgetown.

Project Description letters, along with an invitation to the project information session, were also sent to a number of local government representatives, including:

- Chief Carol Thompson, Bear River First Nation
- Chief Janette Peterson, Annapolis Valley First Nation

- Chief Gloade, Millbrook First Nation
- Chief Michael Sack, Sipekne'katik First Nation
- Chie Lorraine Augustine, Native Council of Nova Scotia
- Councillor Wayne Fowler, Municipality of Annapolis County
- Councillor Gregory Heming, Municipality of Annapolis County
- Councillor Burt McNeil, Municipality of Annapolis County
- Warden Tim Habinski, Municipality of Annapolis County
- Stephen McNeil, MLA
- Colin Fraser, MP

On May 13, 2019, from 4:30 to 7:30 pm, the proponent hosted an Information Session for the Spicer North Mountain Quarry at the Bridgetown Fire Hall. The session provided local residents, community members and other interested stakeholders the opportunity to gain information on the project and the proponent as well as ask questions. Poster boards, describing the existing quarry operations and the plans for the future, were placed around the hall, as shown in Appendix 9. The Information Session was moderated by East Coast Aquatics, on behalf of the proponent, with three consultants on hand (Sharon Parker, Administration Support, Andy Sharpe, Project Manager, and Michael Parker, Senior Ecologist). A total of seven individuals attended the Information Session (according to the signatures on the attendance sheet). Attendees were encouraged to fill out comment cards, although none were completed. One comment letter was hand delivered at the session.

Comments provided to and recorded by ECA staff during the Information Session included:

- A neighbour living the east of the project identified three issues with the existing operations: noise from trucking and crushing, odours from the asphalt plant and dust from the trucking and crushing. It was noted that the noise and dust issues were reduced when the crushing operations occurred within the quarry at the top of the mountain, as opposed to the stockpile area at the base of the North Mountain. It was also noted that the noise and dust issues were directly tied to the timing of operations (start and finish times each day) and days of operation each week.
- A neighbour, living to the west of the project, attended the Information Session on behalf of herself, her husband and several neighbours. Several comments and suggestions were provided:
    - The question was asked as to where individuals could get well water samples tested as they had noticed a film on standing water in and around their property. They wished to know if Spicer's might cover the cost of testing.
    - The neighbour indicated that they feel their land is now wetter over a period of the last 4-5 years. This observation is in field areas of the property, not just forested areas.
    - Individuals living near the junction of the quarry access road and Highway 1 feel that there is more dust in and around their house. They can feel vibration of trucks and noted the concern of noise from air brakes as trucks approach. It was suggested that air brakes should not be used as trucks approach the quarry road. When significant movement of material is occurring with numerous trucks it can be quite disturbing.
    - Concern was noted regarding gravel on Highway 1 from the quarry road being a

danger for cyclists and motorbikes. It was suggested that perhaps it could be swept at the end of a busy day of trucking. It was noted that signage along the road is good when trucking is occurring and helps notify non-local public of slow-moving vehicles.
    - It was noted that at times there is noise associated with the quarry as early as 6 am.
    - Concern was expressed with fumes from the asphalt plant by neighbours.
    - A concern that noise and dust is greater when crushing occurs at the base of the mountain than when it had previously at the quarry at the top of the mountain.
- One written submission was received by a participant at the Information Session (Appendix 9) where the individual expressed their support for the continued operation of the Spicer North Mountain Quarry.

The proponents have heard a number of concerns over the eleven years that the quarry has been operating. The following documents those concerns, and operationally how the proponent has modified activities or reasons why they have not modified activies.

Table 33: Summary of public comments and issues presented to B. Spicer Construction since its inception, and corporate response to the same.

Comment / Issue (Complainant)	Proponent Response
Noise and dust are greater when crushing occurs at the bottom of the hill in the aggregate stockpile area (resident).	Crushing has been moved over the last number of years to occur strictly at the base of the mountain, which is generally closer to residential receptors. The need for this shift has been to reduce the risks associated with transporting large volumes of fuel along the steep OHV access road to the quarry area at the top of the mountain. This trip had to be carried out frequently as only a small fuel transport vehicle could negotiate the steep gravel road when filled, and the volume of fuel would then limit crusher operating time. Shifting the screening and crushing operation to the stockpile area at the valley floor does move this activity closer to residential receptors. However, the reduction in risk from an accident and associated fuel spill necessitate the change. NSE staff have assessed sound levels at the nearest residential receptor during crushing at the current stockpile location and deemed them acceptable (K. Spicer pers comm. 2020). A dense forested perimeter at the crusher area and placement as far north within the stockpile footprint area and away from receptors mitigate noise effects.
Apparent changes in well water quality for neighbours living along Hwy 1 (resident)	During the open house a resident inquired whether B. Spicer Construction would pay to have their well water tested. As groundwater testing carried out as part of the Industrial Approval for the operation and submitted annually to NSE has not indicated potential water quality issues, Spicer Construction declined to cover costs. However, they did have ECA provide information to the resident on water testing options and costs available through NS Health Authority and Envirosphere Consulting of Windsor.
Vibrations felt by neighbours living along Hwy 1 (resident)	A resident noted that vibration and noise associated with trucks approaching the Highway 1/Quarry Access Road junction was disturbing, particularly noise associated with the use of engine brakes. As shown in

	Figure 44, B. Spicer Construction has installed a sign at the approach to highway 1 from the quarry access road that requests drivers be considerate of pedestrians and operate quietly at the intersection. A significant number of transport vehicles that use the quarry are owned by third parties and are beyond the control of B. Spicer Construction. Highway regulations allow the use of exhaust brakes in the speed zone associated with the intersection. Exhaust brake use is a safety measure for drivers carrying heavy loads to reduce the risk of accident by providing maximum braking opportunity at the speeds associated with Highway 1 traffic.
View planes on the approach to the quarry access road/Highway 1 junction were poor (3rd party truck driver)	B. Spicer Construction responded to this issue by cutting all shrub and sapling vegetation on either side of the access road and along proponent owned properties adjacent to Highway 1 to allow improved visibility for drivers approaching the intersection. Additional "Trucks Entering Highway" signage was placed along Highway 1 to alert motorists.
Dust observed by neighbours living along Hwy 1. Gravel and dirt on Hwy 1 (resident).	Spicer Construction acknowledges this is a factor of vehicles moving from a dirt road to a paved road and periodically changes based on vehicle traffic. To minimize potential of tracking dirt and mud onto the road, the access road approach to Highway 1 has been topped with crushed class A stone a number of times over the 11 years that the Spicer Quarry has been in operation. Most recently it was topped in summer 2019 2.2km to the stockpile/crusher area. If calls are received at the office regarding dirt, staff evaluate and respond as appropriate. This may include making NSTIR aware, or if feasible manually sweeping dirt from the road surface. In most cases, highway traffic movement clears gravel in a short time frame after significant transport from the quarry ceases.

Figure 44: Sign to all drivers leaving the Spicer Quarry requesting consideration of local residents and users.

8.2 First Nations Engagement

A Project Description and invitation to the May 13, 2019 Information Session was sent on April 13th to First Nations' communities which may have an interest in the project (Bear River FN, Annapolis Valley FN, Millbrook FN, Sipekne'katik FN and the Native Council of Nova Scotia. Project Descriptions and letters were also sent to the NS Office of Aboriginal Affairs (NS OAA) and the Kwilmu'kw Maw-klusuaqn (KMKNO) (the Mi'kmaq Rights Initiative). No responses were received by the time of producing this report.

9. Environmental Effects Assessment

9.1 Potential Environmental Effects and Mitigation Measures

This section presents the potential environmental effects (positive and negative) of the proposed Undertaking, Spicer North Mountain Quarry Expansion, on the environment and the effects of the environment (namely climate change) on the Undertaking. The activities proposed for the Spicer North Mountain Quarry will be conducted in accordance with the terms and conditions of the current Industrial Approval, any subsequent amendments to the Approval, and the Nova Scotia Department of Environment Pit and Quarry Guidelines. Each of the following subheadings addresses the valued environmental components as evaluated in Section 5 and the as well as the Socio-Economic and Historic Resources evaluated in Sections 6 and 7 respectively. For a complete understanding of these project environmental components, those previous sections should be reviewed.

This Section also outlines the proposed or existing mitigation measures to limit or eliminate any adverse effects to each project components.

9.1.1 Atmospheric Environment

The assessed atmospheric environment components include:

- Weather climate and air quality
- Noise
- Climate change

The following table identifies the predicted effects on those components and mitigation of adverse effects that may occur.

Table 34: Potential effects on the atmospheric environment and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
There could be adverse effects to Air Quality locally to the site from vehicle emissions and dust associated with crushing, excavation and transport.	• No increase in production or vehicle transport, activities that produce dust, over existing levels is proposed. • Dust will be suppressed through application of water to access roadways. • Access roadways are regularly maintained with new topping of crushed stone rather than a fine mineral surfacing that would be more prone to becoming air born. • In periods of significant roadway dust generation, application of calcium chloride may be made to the access road surface. • During crusher operation a mist of water is applied to suppress dust generation from crushing. • All company vehicles used in the Undertaking are maintained in good working order to achieve typical emissions for the class of vehicle.
There could be adverse effects to Noise by ongoing operations. As the quarry footprint moves northward away from residential receptors some noise levels that are associated with blasting, excavation, and loading of rock trucks may be reduced at those receptors due to the greater separation distance. However, adverse effects could result from the crusher operation being permanently	• No increase in production rates, that may equate with increased noise levels over existing, are proposed. • Existing noise levels at the nearest residential receptor during crusher operation at the proposed location have been measured by NSE staff and deemed acceptable, and setback distances exceed the minimum requirements. • All equipment used on site have mufflers to mitigate noise levels, and these equipment features are maintained. • Typical hours of operation will be from 06:00 to 19:00 for 9 months of the year, limiting the duration of potential noise effects.

relocated to the stockpile/crusher area, vehicular traffic, and site development associated with proposed expansion areas.	• A berm has been established between the existing quarry and closest residential receptors to provide some sound attenuation from quarry operations. • A further forested buffer will be maintained between the proposed future quarry footprint and the nearest residential receptor to facilitate sound attenuation from future quarry operations. • The proposed quarry footprint will be established approximately 200m further away from residential receptors, facilitating sound attenuation from quarry operations. • The screening crushing activity will be located at the northern extent of the stockpile/crusher area, the maximum available distance away from residential receptors at that location, facilitating potential sound attenuation. • Establishment of stockpiles between crushing activities and the nearest residential receptors are expected to facilitate sound attenuation. • The crushing activity occurs in a forested setting that facilitates sound attenuation, and no clearing of this forest beyond the stockpile/crusher footprint is proposed.
Climate Change could provide a positive effect on the Undertaking by allowing extended winter operation in warmer and reduced snow conditions. It could provide an adverse effect through increased intensity of rain events the facilitate erosion and sedimentation, or increased risk of fire associated with drought conditions. The Undertaking will contribute an adverse effect to Climate Change through greenhouse gas emissions and loss of carbon sink through removal of forest cover in proposed areas of expansion.	• Active and planned erosion control, water dissipation, and overburden storage stabilization measures are designed to address the potential increase in rainstorm intensity associated with climate change. • Water supply and pumps are kept on site in the stockpile crusher area and could be used as first response to a fire. • Fire extinguishers are kept on site and in most vehicles in case of fire. • Progressive remediation of the project footprint will provide for some carbon capture within a moderate timeline (10-20 years). • Proposed incorporation of wetland habitat in the site reclamation will provide for higher levels of carbon capture than standard brownfield remediation approaches.

9.1.2 Geophysical Environment

The assessed geophysical environment components include:

- Surficial and bedrock geology
- Acid Rock drainage
- Groundwater

The following table identifies the predicted effects on those components and mitigation of adverse effects that may occur.

Table 35: Potential effects on the geophysical environment and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
Surficial and bedrock geology will be adversely affected through excavation and removal.	• Surficial materials will be stockpiled on site and used in progressive reclamation of quarry footprints and eventually the stockpile/crusher area. • This material will be stabilized as outlined within this document to limit losses to erosion transport. • Any exposed mineral area greater than 100 meters square in area will be stabilized with seeding and mulching, or stone cover within 3 months to limit the potential for adverse effects. • Corresponding to the operation season, mineral areas will be evaluated twice annually, in spring and fall, for stabilization requirements.
Acid Rock Drainage is not considered a potential effect from proposed operations given local geological formations, so acid rock drainage effects from the Undertaking are not anticipated.	• Surface water monitoring of pH will capture any changes in local surface water resources that may be associated with acid rock drainage.
Adverse effects to Groundwater could occur through accidental draw down associated with blasting and/or excavation or through contamination associated with an accidental spill, vehicle accident, fire, or vandalism.	• No significant adverse effects have been documented to groundwater over the past 11 years of quarry operation, and existing operational management approaches will continue or be further enhanced as required. • B. Spicer Construction conducts an orientation session for all new employees to the quarry in order to mitigate occurrence of accidental adverse effects, providing appropriate training, direction, and safety equipment to site staff. • B. Spicer Construction has a Quarry Contingency Plan that outlines spill response actions.

- Groundwater monitoring of chemistry and levels will continue to occur regularly, allowing a timely response should water quality/quantity issues be observed.
- It is proposed that a full chemical analysis be conducted at two drilled residential wells associated with proponent owned homes on the project properties to provide a baseline for any future required comparisons. These wells lie upgradient from any other residential wells along the Highway 1 corridor in the vicinity of the Undertaking
- Two groundwater monitoring wells will be added to the existing array to ensure adequate capture of potential groundwater pathways around the proposed Undertaking and the future quarry footprint area.
- Shallow groundwater monitoring proposed for Wetlands 1 and 3 will provide additional early indication of potential groundwater level impacts associated with unintended bedrock fracture and drawdown of the local water table.
- The proposed future quarry footprint will shift a further 200m+ away from the nearest neighbouring residential groundwater receptors.
- No quarry operations at the proposed new footprint will occur at elevations lower than Wetland 1 and adjacent watercourses.
- An extended buffer of 100+m to Wetland 3 will be maintained to limit the potential of impacts to the that supports the wetland.
- Large volumes of hydrocarbon fuels will no longer be transported to the quarry area to supply crushing equipment given the crushers' proposed permanent relocation to the stockpile/crusher area on the valley floor, reducing the risk of an accidental spill during transport or refueling at the highest elevations of the project area.
- A hydrocarbon spill response kit is maintained on-site during operations.
- A double wall lockable fuel storage tank with power shut off is used for on site fuel storage and is protected from accidental collision by a barrier of boulders. These measures limit accidental release and inhibit opportunities for vandalism.
- Vehicle maintenance materials (oil and grease) that are kept on site are locked in a metal shipping container for protection from accidental release or vandalism, and waste oils from onsite equipment maintenance is removed to the off-site Spicer maintenance compound for proper storage and disposal.
- Bitumen used in pavement production at the third-party temporary asphalt plant facility is brought to the site daily. No hazardous material is stored on site long term for asphalt production.

9.1.3 Terrestrial Environment

The assessed terrestrial environment components include:

- vegetation communities and their associated habitats
- avian community
- terrestrial wildlife/mammals
- herpetofauna

The following table identifies the predicted effects on those components and mitigation of adverse effects that may occur.

Table 36: Potential effects on the terrestrial environment and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
Terrestrial Vegetation Communities face adverse effects from dust associated with traffic, crushing and, excavation activities. Lichens are particularly sensitive to dust effects. Plant communities may incur adverse effects through introduction and spread of invasive species. Vegetation communities will be adversely affected by partial to complete removal in the areas of proposed expansion.	• Dust mitigation strategies include spraying water on access road driving surfaces and within crushers during rock processing will be employed. • Native soils from grubbed piles with the operation will be used in site reclamation. Wherever possible, seed mixes containing native plants will be used in site reclamation, and only seed mixes free of noxious weeds will be used during site reclamation and stabilization activities. If not available, seed mixes containing naturalized species which are well established in Nova Scotia and that are not aggressive weeds in wetland and forest communities will be utilized. • Following any off-site use of equipment, machinery will be thoroughly cleaned at the designated temporary asphalt plant location of the stockpile/crusher area prior to its use at the Spicer North Mountain Quarry to limit the potential introduction of invasive species from other project areas. • Quarry footprints and the stockpile/crusher areas will eventually undergo reclamation to re-establish vegetation cover and promote forest re-establishment following use. • Reclamation of quarry footprints will be progressive to limit the total area of un-reclaimed operations to 1.25 times the current approved quarry footprint, allowing short timelines to recovery of vegetation communities.
Terrestrial wildlife/ mammal face potential adverse effects from loss of physical habitat and disturbance	• The proponent will adhere to a limited daily schedule, maximum noise levels, and air quality maximum through operations to limit effect on terrestrial fauna and other receptors.

associated with operational noise and activity.	• Forested habitats outside of the proposed operational footprints will be maintained, preventing significant fragmentation, attenuating noise, and maintaining plentiful forested cover and habitat. • The proponent will undertake progressive reclamation to help return open quarry and operational areas to productive terrestrial wildlife habitat.
Potential adverse effects Avian Fauna may result from land clearing activities and disturbance associated with operational noise and activity. Positive effects may result from creation of edge habitat favoured by some species and the proposed establishment of additional wetland habitat during reclamation that would be favoured by some species.	• Site clearing in areas of operational expansion will only occur during the September 01 to April 14th period (or as recommended by NSDLF) to avoid the breeding and nesting period for birds. • Significant forest resource surrounds the proposed undertaking, and forest habitat types do not appear limiting on bird species present. • The proponent will undertake progressive reclamation to help return open quarry and operational areas to productive avian habitat. • Reclaimed areas will be seeded with native mixes to provide fall migration forage opportunities for birds, and breeding opportunities for grassland species until woody vegetation can re-establish additional habitats. • Proposed partial site reclamation with wetland habitat will provide eventual enhanced diversity of avian habitat within and around the existing quarry footprint. • As evidenced by current avian studies, numerous bird species, including SAR/SOCI, are utilizing habitats in and associated with all aspects of the existing quarry and quarry activities are proposed to continue to operate in a similar manner for the duration of the Undertaking lifespan. • Baseline avian inventories have been collected with which to make comparison should any change in avian communities within the Study Area be expected.
Herpetofauna face potential adverse effects associated with unintended surface water effects to wetlands or sedimentation of aquatic habitats, and the loss of upland habitats through operational footprint expansion. Adverse	• Exposed mineral areas exceeding 100 meters square will be stabilized within a maximum of 3 months to reduce the risk of erosion and sedimentation that may adversely effect herpetofauna habitat. • Significant forested buffers are proposed for around all wetland areas to mitigate the potential of adverse effects.

effects to snakes may be realized if basking snakes on the access road are injured or killed by vehicles. Snakes may realize beneficial effects from operations as open basking areas increase and residual rock outcrops provide nesting/denning habitat for several local species.	• Progressively remediate the existing quarry footprint; in part through the establishment of wetland habitat that is likely to support future herpetofauna production. • Monitor surface water chemistry and levels at known herpetofauna habitats Wetlands 1 and 3 to ensure adverse effects do not occur. • Upland habitats associated with existing and proposed operational footprints will eventually be reclamated to provide a diversity of habitats, including rock piles that can provide hibernacula and nesting for some species.

9.1.4 Aquatic Environment

The assessed aquatic environment components include:

- Surface water resources and quality
- Wetlands
- Fish and fish habitat

The following table identifies the predicted effects on those components and mitigation of adverse effects that may occur.

Table 37: Potential effects on the aquatic environment and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
Adverse effects to Surface Water Resources may occur by unintended sedimentation, chemical contamination through accidental spills, vehicle accidents, or vandalism, or through unintended water quantity changes associated with landscape topographic change associated with quarry development.	• No significant adverse effects have been documented to surface water resources over the past 11 years of quarry operation, and existing operational management approaches will continue or be further enhanced as required. • The proposed Spicer North Mountain Quarry footprint has been selected specifically to avoid the need to undertake any watercourse alteration, and to further maintain minimum (30m) and typically extended (>100m) forested buffers to both wetlands and watercourses. • Several established and proposed sediment catch basins are designed to capture flow from the footprint areas of the Undertaking and intercept any unintended sediment prior to discharge to sheet flows or watercourses. • Catch basins will be monitored once annually in the spring for maintenance requirements. • A proposed “seep away” structure will restore drainage from the proposed quarry floor to diffuse surface sheet flow across the forest floor, minimizing the potential for erosion that could be associated with concentrated ditch flows. • Through site selection for the Undertaking, no sub-catchment drainage areas will change with the proposed stockpile/crusher area and existing quarry area, and a very small (0.5 ha) change associated with the proposed quarry footprint is expected to have a negligible effect on water quantity within associated catchments. • Existing drainage paths promote diffusion of surface flow from developed quarry areas rather than concentration of flows within long continuous ditch lines. This

	limits the potential effect of water quantity changes and minimizes erosion potential associated with higher volume and velocity drainage paths. • The proponent will undertake progressive reclamation of the quarry footprint, including a proposed wetland component. These measures will help reduce the rate and volumes of surface runoff during rain events within the sub-catchments of the Project Area. • The proponent will implement industry-standard erosion and sediment control measures during expansion operations to limit the risk of sedimentation events. • B. Spicer Construction conducts a site orientation with any new employees to mitigate occurrence of accidental adverse effects, and provide appropriate training, direction, and safety equipment to site staff. • A hydrocarbon spill response kit is maintained on-site during operations. • A double walled, lockable fuel storage tank with power shutoff is used to safely store fuel on site. It is further protected from accidental damage by a barrier of boulders. • Vehicle maintenance materials (oil and grease) that are kept on site is locked in a metal shipping container for protection from accidental release or vandalism, and waste oils from onsite equipment maintenance is removed to the off-site Spicer maintenance compound for proper storage and disposal.
Wetlands are a form of surface water resource and as such all of the potential adverse effects outlined in the previous section apply. Additional potential adverse effects specific to wetlands include loss of water quantity through the accidental fracture of bedrock resources during blasting providing a pathway for water loss from a wetland.	• As wetlands are a form of surface water resource, all of the mitigating measures mentioned in the previous section apply. • Although the floor of the proposed quarry footprint is below the surface of Wetland 3, an extended buffer of 100+m to Wetland 3 will be maintained to limit the potential of water table effects supporting that wetland. • The existing approved quarry floor lies below the surface of and <100m from Wetland 1 with no adverse effects having been documented over 11 years of monitoring. • Shallow groundwater monitoring proposed for Wetlands 1 and 3 will provide additional early indication of potential groundwater level effects associated with unintended bedrock fracture and drawdown of the local water table.

A positive effect on wetland resources will be the proposed construction of wetland habitat in the existing quarry footprint as part of the progressive site reclamation	• The floor of the proposed quarry footprint north of Wetland 1 will be at an elevation higher than the surface of Wetland 1, and as such water from Wetland 1 can not be drawn into the future quarry. • Proposed reclamation of the existing quarry footprint will establish new wetland habitat at that location, potentially offsetting any unforeseen wetland adverse effects.
Fish and fish habitat are a form of surface water resource and as such all of the potential adverse effects outlined in that previous section apply. No additional adverse effects to the fish and fish habitat resource are anticipated.	• As fish and fish habitat are a form of surface water resource, all of the mitigating measures mentioned in the previous section apply. • A series of existing and proposed sediment catch basins will be established and maintained to ensure surface water resources that support fish and fish habitat are not adversely affected by sediment. • A minimum 30m forested buffer will be maintained from the proposed stockpile/quarry footprint expansion to Ray Brook to assist in water temperature regulation and stream channel stability. In most areas of the proponent properties this will extend to near 100m. • A groundwater monitoring array has been proposed to ensure groundwater resources that may support fish habitats will not be adversely affected. • Continued surface water monitoring of Ray Brook, Wetland 1 and Wetland 3 has been proposed to ensure surface water resources that support fish and fish habitat are not being adversely affected.

9.1.5 Species At Risk and Species of Conservation Interest.

The assessed Species at Risk and Species of Conservation Interest components include:

- Avian SAR/SOCI
- Herpetofauna SAR/SOCI
- Invertebrate SAR/SOCI
- Lichen SAR/SOCI
- Mammal SAR/SOCI
- Vascular plant SAR/SOCI
- Aquatic SAR/SOCI

No invertebrate, mammal, or herpetofauna SAR/SOCI were identified on the property and no adverse effects to such species is anticipated from the proposed undertaking as discussed in Section 5.6. The following table identifies the predicted effects on the avian, lichen, vascular plant, and aquatic SAR/SOCI components and mitigation approaches for adverse effects that may occur.

Table 38: Potential effects on SAR/SOCI and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
Avian SAR/SOCI may face adverse effects from forest removal in new footprint areas and dust, noise, activity disturbance associated with ongoing operations. A positive effect may occur for some species that utilize edge habitats and open areas for foraging and following reclamation for those that prefer wetland habitat.	• A number of avian SAR and SOCI were observed during EA studies in and around operational activities that have occurred for 11 years, indicating limited adverse effects and or behavior modification to those effects by species present. • A progressive reclamation plan will minimize the period of time for which forest habitat at the site is lost to avian species and will add important wetland habitat to the landscape. • An extended buffer of ~100+m has been proposed around Wetland 3, a habitat supporting several avian SAR/SOCI to minimize noise, dust microclimate change, and other potential operational associated adverse effects. • It is proposed that any forest clearing associated with operational development of new footprint areas occur between Sept. 01 and April 15th in order to avoid effects to breeding, nesting, and migratory species. • Baseline seasonal avian inventories have been collected with which to make comparison should any change in avian SAR/SOCI presence within the Study Area be expected.

Lichen SAR/SOCI are often sensitive to adjacent activities that change microclimate such as light, moisture, wind, air quality. Therefore, adverse effects to lichen SOCI observed outside of the proposed undertaking could occur.	• No existing or future operational footprint areas support known lichen SAR/SOCI. No lichen SAR have been identified within the study area. • Forest cover in habitats outside of the operational footprint and where know lichen SOCI exist will not be directly altered. • The proponent will undertake dust suppression activities along access roads and in association with crushing activities to limit the potential adverse effect of dust on lichen species. • An extended buffer of ~100+m has been proposed around Wetland 3, a habitat supporting a diverse community of lichen, including SOCI to minimize dust, microclimate change, and other potential operational associated adverse effects. • Baseline lichen inventories have been collected with which to make comparison should any change in lichen SAR/SOCI presence within the Study Area be expected.
Vascular plant SAR/SOCI could face adverse effects if they were not identified during surveys and exist within the areas proposed for alteration, or if forest habitat within which they exist is significantly altered.	• No existing or future operational footprint areas support known vascular plant SAR/SOCI despite significant search effort. • An extended buffer of ~100+m has been proposed around Wetland 3, the only location where a vascular SOCI have been observed, to minimize dust microclimate change, and other potential operational associated adverse effects. • Operational boundaries to be cleared will be flagged prior to grubbing to eliminate risk of accidental clearing in area of vascular plant SOCI. • Baseline vascular plant inventories have been collected with which to make comparison should any change in plant SAR/SOCI presence within the Study Area be expected.
Aquatic SAR/SOCI face the same adverse effects as fish and fish habitat as presented in section 9.1.4. Please refer to that section for adverse or positive effects on this component.	• See mitigation for fish and fish habitat and surface water resources as presented in Section 9.1.4. • Baseline fish inventories have been collected with which to make comparison should any change in aquatic SAR/SOCI presence within Ray Brook be expected.

9.1.6 Socio-Economic Environment

The assessed socio-economic environment components include:

- Mi'kmaq
- Local population
- Direct and indirect employment
- Infrastructure
- Community
- Transportation
- Recreation and Tourism

As outlined in section 6.0 no current or historic Mi'kmaq use of the quarry area is thought likely to have occurred, and local population dynamics is unaffected by the operation other than through employment, and community as separately assessed. The following table therefore presents the predicted effects on employment, infrastructure, community, transportation, and recreation/tourism and mitigation of adverse effects that may occur.

Table 39: Potential effects on the socio-economic environment and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
The quarry has a positive effect on direct and indirect employment supporting 16+ jobs directly and 45+ indirectly. A potential adverse effect on employment would be the slowdown in production or closure of the quarry driven by regulatory, market, or management conditions.	• B. Spicer Construction Ltd. is adhering to the legislated requirements of owning and operating a quarry in Nova Scotian and thereby supporting direct and indirect jobs. • The Spicer North Mountain Quarry markets are expected to support existing production levels, which should secure similar direct and indirect employment levels as currently exist. • B. Spicer Constructions Ltd.'s past management approach has supported current employment levels and is expected to remain unchanged for the foreseeable future.
A positive effect on local infrastructure results from the presence of the quarry as it provides high quality local aggregate that allows various infrastructure projects to occur. A potential adverse effect to	• No significant change in current production levels is anticipated, and therefore no significant increase in heavy traffic that could impact local road conditions is likely to occur. • As a Corporate entity B. Spicer Construction contributes to a variety of Federal, Provincial and Municipal taxes that support maintenance and development of public infrastructure, including highway maintenance and repairs. Should

highway infrastructure could result from a significant increase in heavy traffic from the quarry.	increased production produce additional highway traffic, taxes paid by the quarry corporation will increase and support additional maintenance and repairs that may be necessary.
The community receives predominantly positive effects from the quarry as supported by employment, access to aggregate materials for infrastructure works and private projects, and financial contributions to events and organizations. Possible adverse effects are interpersonal conflict between individuals supporting and opposing the presence of the quarry, and a real or perceived adverse effect from any of the quarry operations within a sector of the community regardless of the magnitude of that effect.	• B. Spicer Construction is adhering to the legislated requirements of owning and operating a quarry in Nova Scotian, and in doing so helps keep the public informed regarding its operations, and helps minimize misinformation regarding quarry operations, limiting the possibility of conflict. • B. Spicer Construction has contracted appropriate specialists to produce this Environmental Assessment document and provide an evaluation if adverse effects and their significance. Additionally, specialists from various levels of government will review the assessment and determine whether the operation is to be approved and terms and conditions of any such approval. • As a positive community member, B. Spicer Construction supports a variety of community events and organizations with financial, volunteer time, and in-kind support.
Adverse effects to transportation would be associated with increased traffic levels and accident potential associated with quarry operations. These are unlikely as production rates at the quarry are to remain unchanged over current levels.	• No significant adverse effects on transportation have been reported previously or as part of this EA process relating to traffic and infrastructure. • Proposed transportation effects are expected to remain unchanged given no proposed change in production rates at the quarry.
Adverse effects to recreation and tourism from the proposed Undertaking are unlikely given its location and lack of past adverse effects during existing tenure within	• No adverse effects to tourism or recreation resulting from the Spicer Quarry have been noted over its 11-year existence. • The proposed Undertaking is located fully on privately owned lands and as such the area does not directly support recreation or tourism.

the area. Positive effects have occurred and are likely to continue give the corporate financial, in kind, and volunteer support of Spicer Construction to local events and organizations.	• Spicer Construction Limited has contributed financially, with volunteer time, with in kind support to a variety of local recreation events and structures, as well as local events that support tourism participation.

9.1.7 Archaeological and Historic Resources

The following table identifies the predicted effects on the assessed archaeological and historic resource components, and mitigation of adverse effects that may occur.

Table 40: Potential effects on archaeological and historic resources and proposed mitigation measures for adverse effects.

VEC Potential Effect	Mitigation Measures for Adverse Effects
Archaeological and historic resources could be adversely affected by site development that alters forest cover, surficial geology, and local topography and resources are not identified prior or during these disturbances. No historic buildings exist within the existing and proposed operational footprint.	• An archaeological resource investigation was conducted around the existing and proposed quarry footprint where significant forest and topographic alteration will occur, and no resources were encountered. • Quarry staff will be requested to stop all operations if archaeological resources are encountered during site development until the Coordinator of Special Places is contacted regarding a suitable method of mitigation.

9.2 Residual Environmental Effects

Whereas Section 9.1 summarized all positive and adverse effects on VEC's, this section presents only residual adverse effects of the proposed Undertaking. Following implementation of all mitigation measures and management strategies, many of potential adverse effects will no longer exist or are predicted not to exist. However, not all adverse effects of the proposed Undertaking that were outlined in the various tables of Section 9 can be mitigated, and those are considered residual adverse environmental effects on valued environmental components. The residual effects summarized in Table 42 are those that the proponent expects will exist with the approval of the Spicer North Mountain Quarry as proposed. The table also indicates the relative significance of those residual effects on individual environmental components in terms of temporal and spatial scope, and adversity. Adversity is as defined in table 41.

Table 41: Categories of adverse biophysical and socio-economic effects (Source: NSE2011)

Adversity Category	Biophysical	Socio-economic
Negligible	Effect on the population or a specific group of individuals at a local Project area and/or over a short period in such as way as to be similar to small random changes in the population but having no measurable effect on the population as a whole.	Effect of either very short duration or affects a small group of people or which occurs in the local Project area in a manner similar to small random changes but having no measurable effect on the population as a whole.
Low	Effect on a specific group of individuals in a population in the Project area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself.	Effect either of short-term duration or affects a specific group of people in the local Project area but not necessarily affecting the integrity of the entire group itself.
Moderate	Effect on a portion of a population that results in a change in abundance and/or distribution over one or more generations of that portion of the population or any population dependent upon it but does not change the integrity of any population as a whole. The effect may be localized.	Effect either of medium-term duration (which affects one or two generations and/or the portion of the population dependent upon it) or affects a moderate portion of the population without affecting the integrity of the population as a whole.
High	Effect on a whole stock or population of a species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return that population or species dependent upon it, to its former level within several generations.	Effect either of long duration (lasting several generations) or affecting an entire definable group of people in sufficient magnitude to cause severe change in economic, physical or psychological well-being or long-established activity patterns that would not return to pre-Project levels or patterns within several generations.

Table 42: Summary of residual adverse effects, after mitigation measures, to Valued Environmental Components for the proposed 30-year lifespan of the proposed Spicer North Mountain Quarry Expansion. Note positive effects are not presented, nor are fully mitigated adverse effects (See section 9.1 for a full list of effects on VEC's).

Valued Environmental Component	Anticipated Residual Adverse Effect	Temporal Scope of Effect	Predicted Spatial Scope of Effect	Adversity Category*
Air Quality	(-) Dust above pit and quarry guideline	Dry periods during summer months	Local, <50 m from active operation	Low
	(-) Exhaust gas emissions	9 months of the year while machinery is operated	Site Specific, <2m from active exhaust	Negligible
Noise	(-) Crusher equipment/vehicle noise above pit and quarry guideline	9 months of year, daily during operational hours	Local, <150 m from active equipment	Low
	(-) Blasting noise above pit and quarry guideline	Seasonal periodic during operational hours	Local, <250 m from active equipment	Negligible

Valued Environmental Component	Anticipated Residual Adverse Effect	Temporal Scope of Effect	Predicted Spatial Scope of Effect	Adversity Category
Climate Change	(-) Greenhouse gas emissions	9 months of the year while machinery is operated	Regional to global	Moderate
	(-) loss of carbon capture	During site clearing 2-20 years, intermittent	Site Specific 9.54 ha	Moderate
Geological Resources	(-) Removal of geological resources existing and proposed quarry footprints	Permanent	Site Specific 10.5 ha	High
Terrestrial Vegetation	(-) Loss of upland forest habitat to new quarry footprint and expanded stockpile/crusher area.	During site clearing 2-50 years, intermittent	Site Specific 9.54 ha	Moderate
Terrestrial Fauna	(-) Partial displacement from lost forest habitats at new quarry footprint and expanded stockpile/crusher area until remediated.	During site clearing 2-50 years, intermittent	Site Specific 9.54 ha	Negligible
	(-) Behavioural disturbance from operational activities.	30 years, seasonal intermittent	Study Area	Negligible

Valued Environmental Component	Anticipated Residual Adverse Effect	Temporal Scope of Effect	Predicted Spatial Scope of Effect	Adversity Category
Avian Fauna including SAR/SOCI	(-) Loss of forest habitat for forest birds at new quarry footprint and expanded stockpile/crusher area until regenerated.	During site clearing 2-50 years, intermittent	Site Specific 9.54 ha	Low
	(-) Behavioural disturbance from operational activities.	30 years, seasonal intermittent	Study Area	Negligible
Herpetofauna	(-) Loss of upland forest habitat for forest species at new quarry footprint and expanded stockpile/crusher area until regenerated.	During site clearing 2-50 years, intermittent	Site Specific 9.54 ha	Low

*As defined in NSE. 2011. *Guide to considering Climate Change in Environmental Assessments in Nova Scotia.* Table 2-2.

This document has presented baseline conditions for VECs within the Study Area and has considered the spatial and temporal scope of the proposed Undertaking, the fact the operation has been long established, and the implications of an expanded footprint of the Spicer North Mountain Quarry with an unchanged rate of production. Based on this assessment a number of adverse effects of the proposed Undertaking will remain after mitigation and management strategies are employed. However, although adverse effects remain, they are not considered individually or together to be significant. This means that regulatory thresholds will not be exceeded at off site receptors, that important quality guidelines for components such as groundwater and aquatic life can be achieved within limitations of the natural systems present, and that no excessive burden will be borne by adjacent landowners or the community with the operation of the quarry. As such, it is concluded through the assessment within this document that the Spicer North Mountain Quarry Expansino will not result in any significant adverse environmental effects.

9.3 Monitoring

Although the assessment of the proposed Spicer North Mountain Quarry Expansion predicts that it will not result in any significant adverse environmental effects, this prediction must be verified over time. Monitoring is intended to verify the predicted effects and to determine the effectiveness of mitigation that has been proposed for adverse effects. In conjunction with the mitigation measures noted in this document, it is recognized that monitoring will be required to ensure no unpredicted significant adverse effects actually arise from the project, and that the magnitude of any adverse effects is as predicted. To this end it is proposed that several monitoring activities either be continued or added to the annual operations at the Spicer Quarry. These include:

- Continued groundwater monitoring program as outlined in the existing Industrial Approval, including at the two new proposed wells.
- One-time full chemical analysis of two drilled residential wells associated with proponent owned homes on the project properties to provide a baseline for any future required comparisons. These wells lie upgradient from any other residential wells along the Highway 1 corridor in the vicinity of the Undertaking.
- Continued/new shallow groundwater table monitoring within Wetlands 1 and 3 to establish a seasonal hydrograph for each, and continued vegetation and turbidity monitoring within Wetland 1.
- Periodic (every 3 years) search of quarry operating areas for invasive plant species, and the development of response plan should such be encountered.
- Periodic (every 3 years) evaluation of potential air quality impacts on lichen using a lichen ladder protocol within areas as identified during the 2019 EA field surveys.
- Corresponding to the operation season, mineral areas will be monitored twice annually, in spring and fall, for stabilization requirements of areas >100 meters square.

- Sediment catch basins will be monitored no less than annually for maintenance requirements.

- Adherence to the Pit and Quarry Guidelines.

- Adherence to the existing and future terms and conditions of the Industrial Approval for the operation.

- Implementation of additional monitoring requested by NSE as outlined in an amended Industrial Approval.

10. Funding

The proposed undertaking will not be financed in any way with public funds but will be financed 100% by the proponent.

11. Other Approvals Required

The Proponent is required to register this Project as a Class I Undertaking pursuant to the Nova Scotia Environment Act and Environmental Assessment Regulations and obtain Environmental Assessment Approval.

The continued operation of the basalt quarry will require an amendment to the existing Industrial Approval No:2007-056846-03 from NSE, pursuant to the Activities Designation Regulations.

No other approvals are anticipated.

12. Other Undertakings in the Area

The proponent is aware of several other undertakings in the area that have fallen under Industrial Approval with the Province. Table 43 lists undertakings with Industrial Approval located within a 15km radius of the Spicer North Mountain Quarry, covering all communities between Annapolis Royal and Paradise that are indicated as active by Nova Scotia Department of Environment (NSE 2020d). Additional undertakings or unregulated activities may also occur in the area.

Table 43: Summary of other Undertakings in the Area (Source: Nova Scotia Environment 2020d).

Name	Activity	Proximity to Spicer Quarry (km)
Bruce Family Farm	Farming	5
VJ Rice Concrete Limited	Concrete production and sand pit	6.7
VJ Rice Concrete Limited	Sand pit	6.3
VJ Rice Concrete Limited	Sand pit	6.7
VJ Rice Concrete Limited	Sand pit	6.8
Rice's Contracting Company Limited	Basalt quarry	7.4
Parker Mountain Aggregates Limited	Basalt quarry	11
VJ Rice Concrete Limited	Sand pit	11.8
Arlington Heights C&D Limited	C&D, asbestos disposal	12
Lafarge Canada	Sand pit	15

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APPENDICES