Appendix 8 Rare Plant, Wetland and Watercourse Surveys

Biological Assessment for the proposed Harrietsfield Williamswood Wind Farm

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Introduction

East Coast Aquatics Inc. (ECA) was retained by Eon Wind Electric to conduct a biological assessment of the proposed Harrietsfield Williamswood Wind Farm. The wind farm, consisting of three turbines, is located near the community of Harrietsfield, Halifax Regional Municipality, being bounded in the west by Highway 306 (Old Sambro Road) and in the east by Highway 349 (Herring Cove Road) (Figure 1).

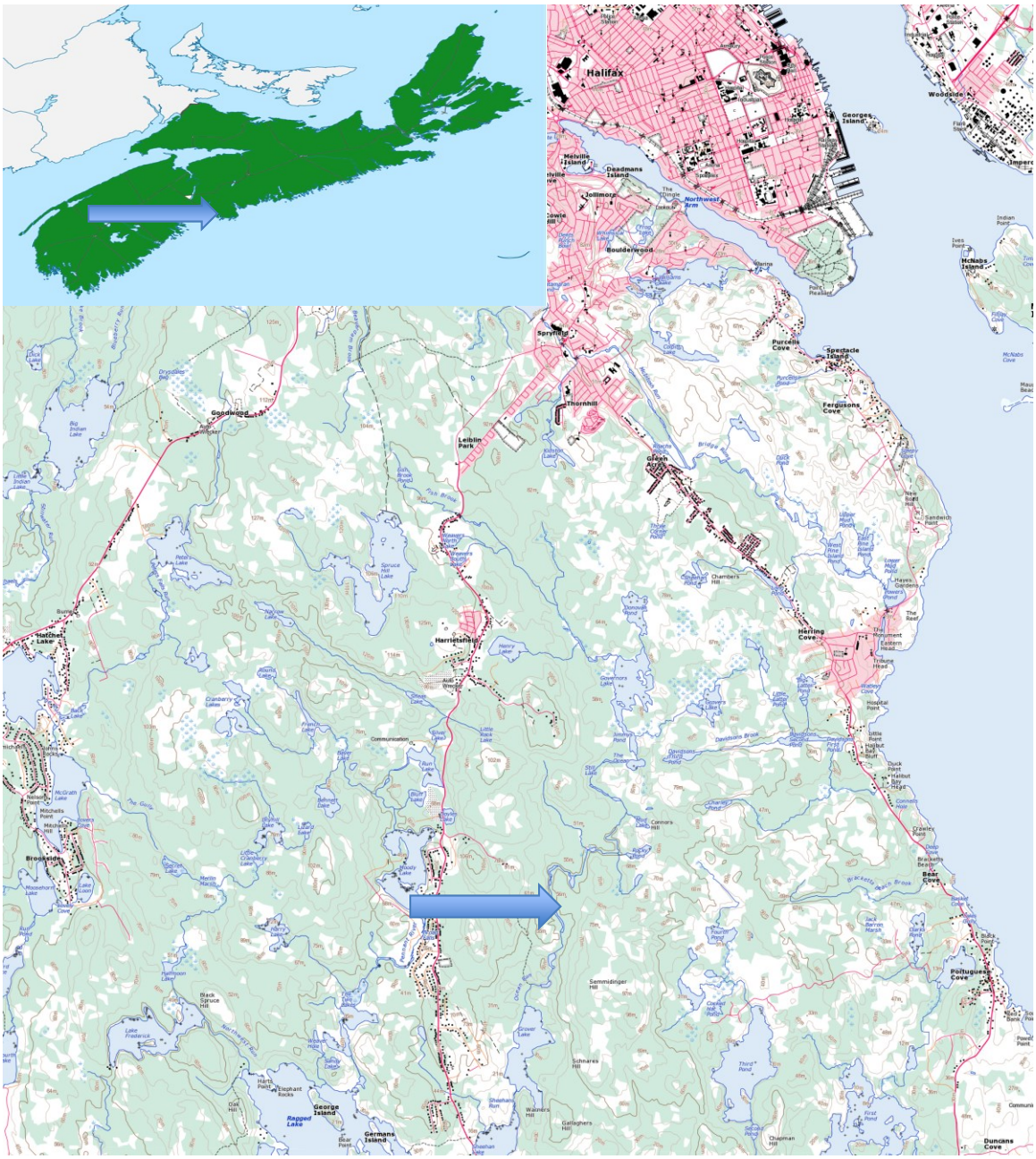

Figure 1*: Locator map for Harrietsfield Williamswood Wind Farm, situated near Harrietsfield, Halifax Regional Municipality.*

ECA's assessment of the site encompassed landscape features, forest ecotypes, wetlands, fish and fish habitat, water quality, and floral species at risk and species of conservation concern. The field studies for vascular plants, wetlands, fish and water quality were conducted during the period of July to September 2014, over multiple visits. A field search for boreal felt lichen is pending, and will be completed by early March 2015.

Project components will include access roads, three turbines and electric transmission lines. Centered on each turbine will be a 100 m x 100 m laydown area to provide for the assembly and erection of the turbines. The site will be accessed via Fraser Road, off Highway 306. It is anticipated that a gravel all-season road extending from Fraser Road will be constructed to provide access to the turbine locations (Figure 2), including a watercourse crossing of Ocean Run. The study boundaries for the biological assessment included the access track from Fraser Road and encompassed all project components including roads and turbine locations.

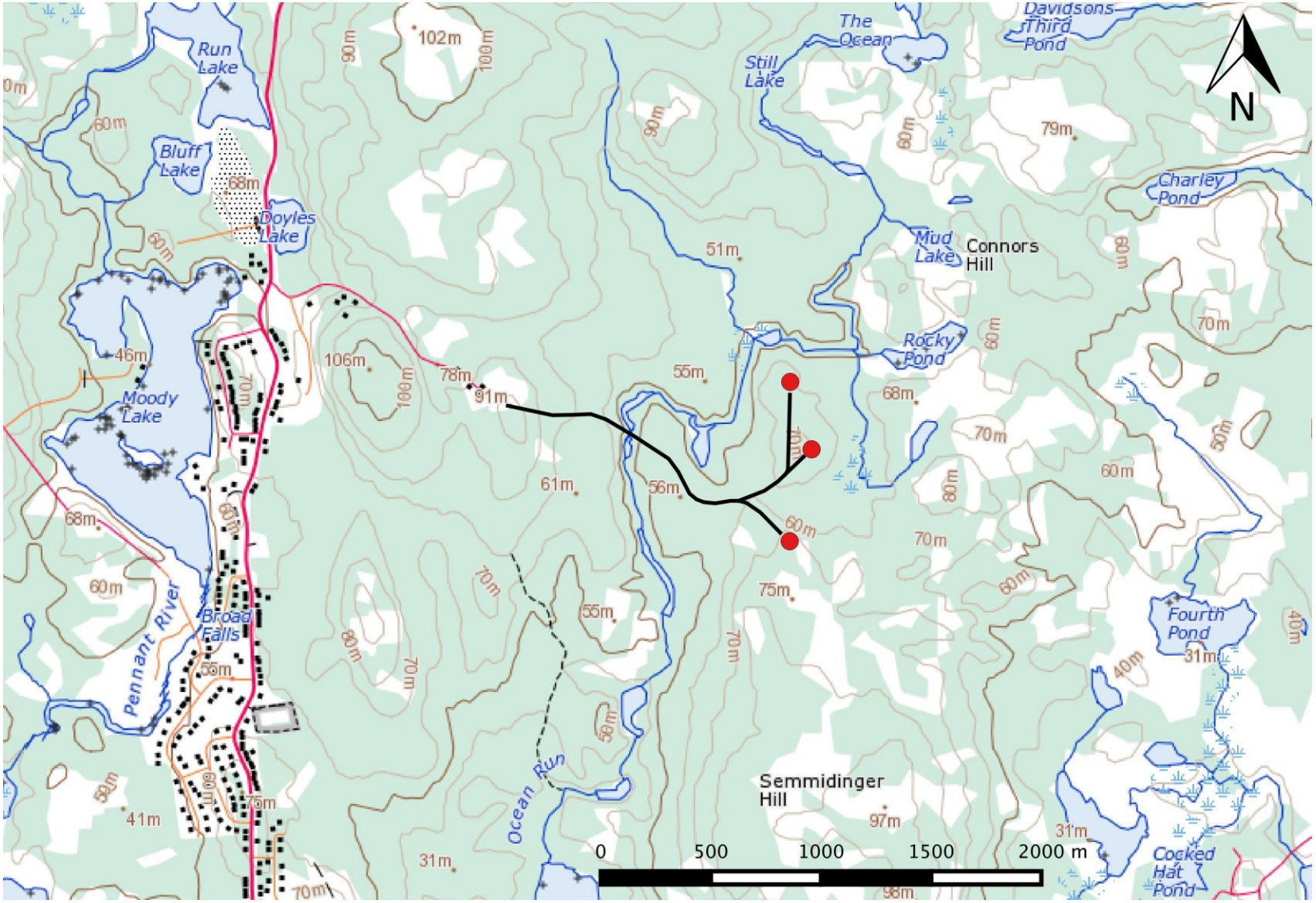

***Figure 2**: Harrietsfield Williamswood Wind Farm site map, showing access track extending from Fraser Road and turbine locations.*

Landscape Scale Characterization

Methodology

A desktop preliminary review of the project site and surrounding areas was undertaken in order to characterize key habitats, landscape-scale features and site-specific issues. Data sources for the desktop review included the Ecological Land Classification Map and Database of Nova Scotia (NSDNR, 2006) and associated report (NSDNR, 2003), Forest Cover Type Mapping (NSDNR, 2009), Soil Survey of Halifax County (MacDougall *et al*, 1963) as well as other sources noted below.

Two vegetation surveys were conducted at the proposed Harrietsfield Williamswood Wind Farm site. An early season survey occurred on July 3, 2014 and a late season survey on August 26, 2014. Field surveys were untaken by an experienced botanist. The area surveyed included a 30 m right-of-way along all planned road alignments, watercourse crossings and turbine laydown areas, encompassing all planned project features.

Findings

Landscape Scale Features

The project site occurs within Nova Scotia's Western Ecoregion (700), which extends from Yarmouth to Windsor and includes the Halifax peninsula. The Ecoregion is distinguished by upland tilting towards the Atlantic Ocean and milder weather conditions than experienced in the eastern portion of the province. Winters are generally mild (average -3.5) with warm summers, with total annual precipitation ranging from 1300 to 1500 mm per year. Given the proximity of the region to both the Atlantic Ocean and Bay of Fundy, significant temperature variations occur (NSDNR, 2003, 2006).

The project site is situated in the St. Margaret's Bay Ecodistrict (780), almost entirely within the ICHO Ecosection, with the initial 350 m of the access track from the Fraser Road being within the WFDM Ecosection. The ICHO Ecosection is characterized as being imperfectly drained, coarse textured soils on hummocky terrain. The WFDM Ecosection is well drained, fine textured soil on drumlins or flutes (NSDNR, 2003, 2006).

The bedrock geology for the site consists of Middle to Late Devonian muscovite biotite monzogranite (Keppie, 2000, as reported at NSDNR, 2004a). The generation of acidic run-off when sulphide-bearing slates of the Halifax Formation are excavated and exposed to air occurs widely throughout Nova Scotia. Based exclusively on geological mapping from the NSDNR Mineral Resource Land-Use Map (NSDNR, 2004b), sulphide-bearing slates do not occur within the project area. No field based investigations of site geology was conducted by East Coast Aquatics. A band of sulphide bearing slates does occur within the Halifax peninsula, approximately 10 km north of the project site (NSDNR, 2004b).

Soils over much of the project site belong to the Gibraltar soil series, being brown sandy loam over strong brown sandy loam, derived from till of granitic origin. These soils are recorded as being gently undulating to gently rolling, with good to excessive drainage. Gibraltar soils are reported as being generally shallow, seldom more than 20 inches thick (MacDougall *et al*, 1963). This is consistent with the 2014 soil survey results, discussed

below. The planned access road beyond the end of the Fraser Road passes through a short section of Wisconsinian silty drumlin, ranging in depth from 4 to 30 m. This material, released from the base of ice sheets by melting, have moderate drainage and stoniness and moderate to good buffering capacity for acid rain due to the transported calcareous bedrock components (NSDNR, 2004b).

Forests

Mapping of forest stands in the vicinity of the project site, current to 2004, identified a majority of mature softwood stands, with a limited number of hardwood stands located in the southeastern corner of the project site. Dominant species within the softwood stands include Black spruce and Balsam fir (NSDNR, 2009). Forest heights ranged from 11 to 15 m, with crown closures from 55 to 80%. Within the hardwood stands, dominant species include Red maple and Balsam fir.

There are no restricted or limited use lands within the footprint of the anticipated Harrietsfield Williamswood Wind Farm (NSDNR, 2007). The Terence Bay Wilderness Area is >2 km to the west of the project site, and occurs on the western side of Highway 306 (Old Sambro Road).

Field surveys of the project site occurred between July and September 2014. During the field surveys, patches of wind throw were documented, with individual patches ranging in diameter from 10 to >100 m. Given the degree of decay of the horizontal tree stems and vigorous Balsam fir regeneration across these sites, the wind throw was possibly the result of Hurricane June, which passed close to the site in September 2003 (NSDNR, 2004c). There is no evidence of recent commercial forestry operations on the eastern site of Ocean Run.

Figure 3: *Exposed bedrock ridge and fire-charred coniferous tree trunks. Photo taken July 2, 2014.*

Upland tree species include red spruce *(Picea rubens)*, red maple (*Acer rubrum*), balsam fir *(Abies balsamea)* and yellow birch *(Betula allegheniensis).* Ground layer species consist of common plants such as Wild Sarsaparilla *(Aralia nudicaulis),* low bush blueberry *(Vaccinium angustifolia),* Gold thread *(Coptis trifolia),* Bunchberry *(Cornus canadensis)* and Wild Lily-of-the-valley *(Maianthemum canadenses).*

Figure 4: Predominantly deciduous upland forest near the proposed location for Turbine 3. Photo taken August 65, 2014.

Wetlands

Methodology

A preliminary desktop review of the project site and surrounding areas was undertaken to identify key wetland features, site topography and soils, and likely vegetation communities. Data sources for the desktop review included aerial photography (both current and historic), the Provincial Significant Species and Habitats database (NSDNR, 2004d), Wet Areas Mapping and Flow Accumulation Channels (NSDNR, 2013), Soil Survey of Halifax County (MacDougall *et al*, 1963), the Nova Scotia database of Wetlands of Special Significance, as well as other sources noted below.

Field surveys of wetlands at the project site occurred on July 2, July 26 and August 28, 2014, with the surveys undertaken by qualified wetland delineators. Field survey methods were based on U.S. Corps of Army Engineers (2009), Fern Hill Institute (2011) and Maritime College of Forest Technology (MCFT, 2008 and 2009). Assignment of vegetation indicator status was based on the Nova Scotia Wetland Indicator Plan List (Nova Scotia Environment, 2011).

The area surveyed included a 30 m right-of-way along all planned road alignments, watercourse crossings and turbine laydown areas, encompassing all planned project features. The objectives of the field surveys were to (a) provide a general characterization of the vegetation communities within the wetlands, (b) identify and delineate wetlands which intersect with proposed project infrastructure, and (c) collect vegetation, soils and site details to facilitate subsequent wetland alteration applications for the project.

Findings

Characterization of Wetlands

The Nova Scotia Department of Natural Resources Provincial Significant Species and Habitats database (NSDNR, 2004d) indicates a number of fresh water wetlands within 1 km of the project site (Figure 5). The access track, extending beyond the end of the Fraser Road, will pass just to the north of a 1.5 ha treed swamp. The Ocean Run watercourse, which bisects the site north to south, is bordered by a number of mapped wetland features including marshes, fens and swamps. A 5.4 ha treed swamp is recorded as occurring immediately to the east of the Turbine 1 and 2 locations (NSDNR, 2004d).

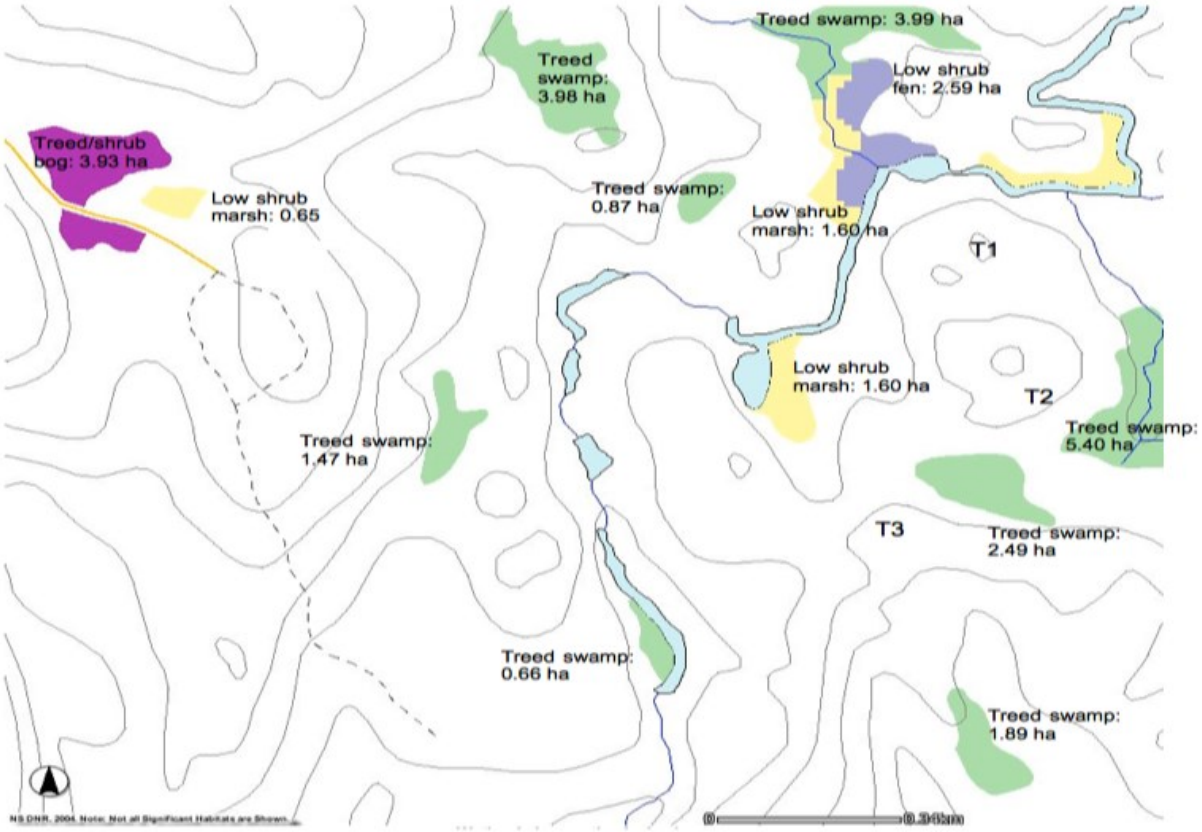

Figure 5: Nova Scotia Department of Natural Resource wetlands database mapping, indicating wetlands adjacent to the project site. Approximate turbine locations shown by "T". (Source: modified from NSDNR, 2004b).

There are no provincial Wetlands of Special Significance in the vicinity of the project site. The closest Wetlands of Special Significance occur in separate and distinct catchments approximately 2.7 km to the southeast of the site, on the west site of Highway 306 (Old Sambro Road). Several Wetlands of Special Significance occur near the headwaters of the Ocean Run watercourse, >5.5km upstream of the project site.

Numerous treed swamps were documented through the field survey on both the east and west sides of the Ocean Run watercourse. Dominant tree species at these sites included Red maple (*Acer rubrum*), Balsam fir (*Abies balsamea*) and Black spruce (*Picea mariana*). The understory shrub layer consisted of False mountain holly (*Nemopanthus mucronata)*, Cinnamon fern *(Osmunda cinnamomea)*, Huckleberry *(Gaylusaccia baccata)*, sedges (Carex *trisperma)* and peat mosses (Figure 6). Blue Felt Lichen *Degelia plumbea* was observed on Red maple and the presence of this species suggests a rich lichen diversity may exist.

Riparian habitats along the Ocean Run watercourse (Figure 7)included small meadows dominated by graminoid species including *Carex bullata, C. echinata, C. folliculata,* Blue joint *(Calamagrostis canadensis)* and Three way sedge *(Dilichium arundinaceum)*. Shrub species are Canada holly *(Ilex verticillata)*, False mountain holly *(Nemopanthus mucronata)* and Leather-leaf *(Chamaedaphne calyculatta)*. Other species include Swamp candles *(Lysimachia terrestris)*, Pickerel weed *(Pontederia cordata)*, and Bog aster *(Oclemena nemoralis).*

Figure 6: Typical treed/shrub swamp conditions encountered the HWWF site, with abundant Black spruce (*Picea mariana*), Cinnamon fern (*Osmunda cinnamomea*), Pitcher plant (*Sarracenia purpurea*), with *Sphagnum* moss ground cover.

Figure 7: Riparian wetlands along the borders of the Ocean Run watercourse, composed of *Carex* grasses, and the shrub species Canada holly (*Ilex verticillata*), False mountain holly (*Nemopanthus mucronata*) and Leather-leaf (*Chamaedaphne calyculatta*).

Field surveys of the project site in July and August 2014 identified numerous additional wetlands not recorded in the Provincial Significant Species and Habitats database. This result is not unusual, as it is generally recognized that the provincial wetlands mapping database is limited in its identification of physically small wetlands as well as shrub and treed swamps. The additional mapped wetlands occurred in a range of settings including mature forest stands in slight topographic depressions. These wetlands were generally linked by intermittent surface drainage channels, although subsurface flows were suspected a several cases. The typical species composition by strata for these wetlands is shown in Table 1.

Table 1: *Common vegetation species within the herbaceous, shrub, sapling and tree strata of mapped wetlands at the Harrietsfield Williamswood Wind Farm project site.*

Herbaceous Species	Shrub / Sampling Species	Tree Species
Huckleberry (*Gaylussacia baccata*) Cinnamon Fern *(Osmunda cinnamomea)* Three-Seed Sedge *(Carex trisperma)* Blue joint *(Calamagrostis canadensis)* Three way sedge *(Dulichium arundinaceum)* Leather-leaf *(Chamaedaphne calyculata)* Swamp Candles *(Lysimachia terrestris)* Pickerel Weed *(Pontederia cordata)* Bog Aster *(Oclemena nemoralis)*	False Mountain Holly *(Nemopanthus mucronatus)* Canada Berry *(Ilex verticillata)*	Red maple (*Acer rubrum*) Balsam fir (*Abies balsamea*) Black Spruce *(Picea mariana)*

Wetland delineations were carried out by experienced wetland delineators. Delineations focused on wetlands occurring within the footprint of the project infrastructure or where alternative routing of access roads may be required. In a number of cases, wetlands extending beyond the project footprint were not completely delineated (Figure 8).

The ground substrate in the mapped wetlands consisted predominantly of *Sphagnum* mosses (Figure 9). Organic soils were widely encountered in the wetlands, occurring at thicknesses of 37 to 71 cm and underlain by rock. The organic soils consisted of medium to dark brown fibric to humic soils (Of_4 to Oh_8), based on the Von Post Scale (Soil Classification Working Group, 1998)(Figure 10).

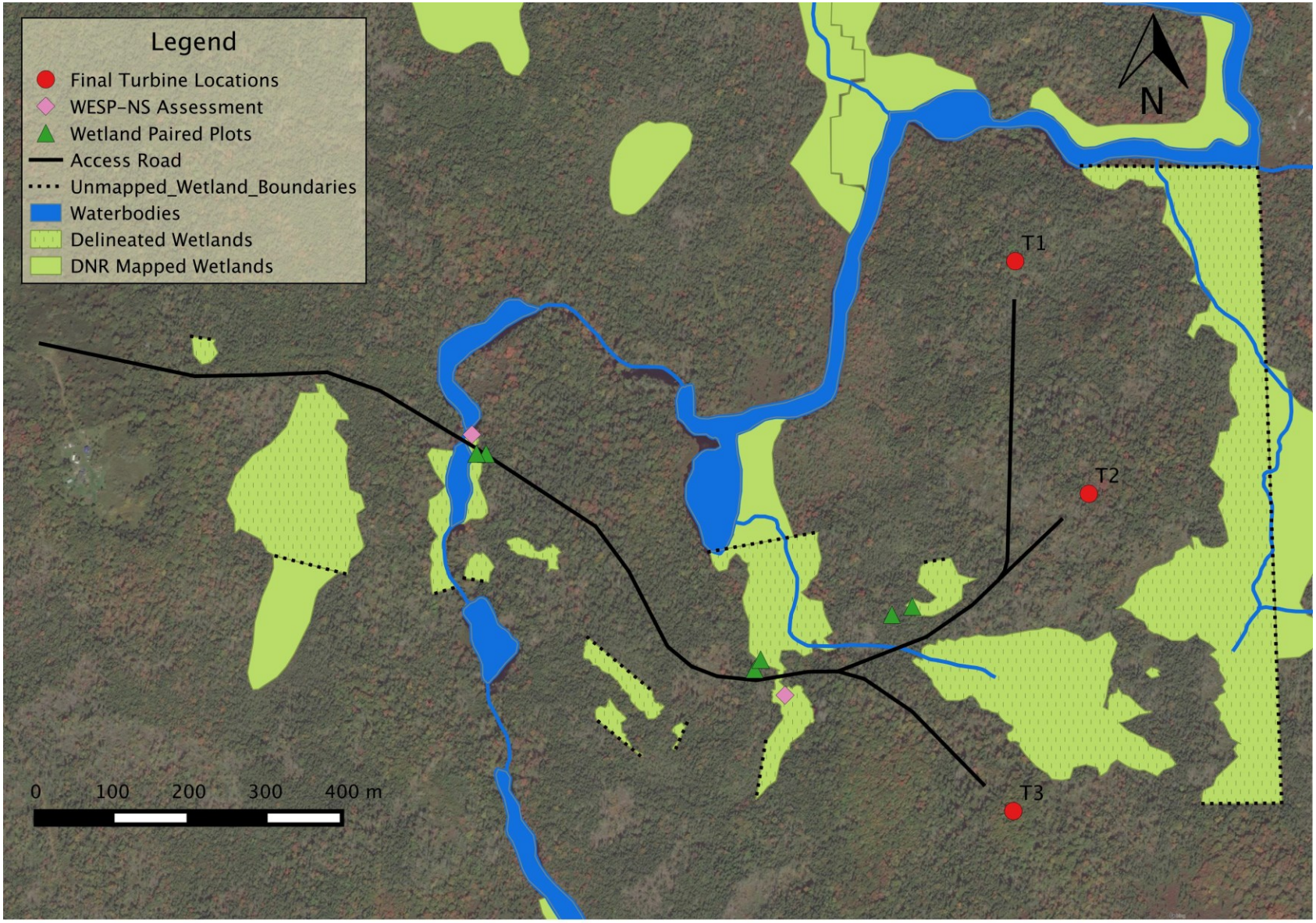

***Figure 8**: Wetlands documented through field surveys of the project site, conducted during July and August 2014 by East Coast Aquatics.*

Figure 9: *Large treed/shrub swamp, east of the turbine 1 and 2 locations.*

Figure 10: Very soft organic wetland soils to a depth of 38 cm under *Sphagnum* moss within the riparian zone of Ocean Run.

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Functional Assessment

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 (WESP-NS) (Version 3 – 2013), 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, and Alberta. WESP-NS examines 18 functions and 16 benefits wetlands using a standardized, science-based model (Adamus, 2013a, 2013b). 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.

Table 2: Wetland Ecosystem Services Scores for Harrietsfield Williamswood Wind Farm. Minimum score = 0, Maximum score = 10.

			Riparian Treed Swamp (adjacent to Ocean Run)		**Shrub-Treed Bog (adjacent to access track)**	
Group	**Number**	**Specific Functions or Values:**	**Function Score** (wetland's relative effectiveness)	**Benefit Score** (potential or actual)	**Function Score** (wetland's relative effectiveness)	**Benefit Score** (potential or actual)
Hydrologic	1	Surface Water Storage	5.62	1.67	3.38	0.56
	2	Stream Flow Support	4.81	5.10	1.46	3.67
	3	Streamwater Cooling	3.29	4.13	4.50	0.33
	4	Streamwater Warming	3.52	5.32	2.13	1.30
Water Quality	5	Sediment & Toxicant Retention & Stabilization	5.10	3.36	4.45	0.49
	6	Phosphorus Retention	5.40	4.29	6.26	1.83
	7	Nitrate Removal & Retention	4.96	6.46	4.92	3.33
Carbon	8	Carbon Sequestration	6.89	Not calculated	7.17	Not calculated
	9	Organic Nutrient Export	6.16	Not calculated	4.91	Not calculated
Fish	10	Anadromous Fish Habitat	2.92	5.58	0.00	0.00
	11	Resident & Other Fish Habitat	5.62	5.33	0.00	0.00
Aquatic Support	12	Aquatic Invertebrate Habitat	6.86	10.00	4.69	10.00
	13	Amphibian Habitat (AM)	4.95	10.00	5.81	10.00
	14	Waterbird Feeding Habitat	4.26	3.75	0.00	0.00
	15	Waterbird Nesting Habitat	5.61	10.00	3.23	10.00
Terrestrial Support	16	Songbird, Raptor, & Mammal Habitat	6.86	10.00	6.53	10.00
	17	Pollinator Habitat	4.87	10.00	3.84	10.00
	18	Native Plant Habitat	5.48	7.24	4.60	6.79

The 2014 field surveys identified two principal wetland classes that may be impacted by Harrietsfield Williamswood Wind Farm, these being riparian treed swamps and shrub-treed bogs. These wetland classes were examined using the WESP-NS model, with the scores shown in Table 2.

These wetland were selected for assessment based on a number a number of factors, including their central location within the project site and the likelihood that the wetland will be altered through the construction of site infrastructure (bridge crossing of Ocean Run and access roads). The riparian treed swamp borders the Ocean Run watercourse and grades into a series of graminoid and *Carex* wet meadows adjacent to still waters. Numerous shrub-treed bogs were identified at the site, occurring both in hydrologically isolated basins and within tertiary catchments linked to the Ocean Run watercourse. While not all wetlands to be altered as part of the project have been assessed using the WESP-NS model, the results below are felt to be generally applicable to other wetlands encountered within the project footprint.

Riparian Treed Swamp

Within the Hydrologic group, the riparian treed swamp had low to moderate functional scores for surface water storage, flow support and cooling. The reduction in these scores was driven by the limited evidence of groundwater interaction with the wetland. The Benefits scores for this group were low to moderate, given the site's relative remoteness within the landscape.

The riparian treed swamp had intermediate functional scores within the Water Quality group. The lowest score within this group was for Nitrate Removal and Retention and the highest for Phosphorus Retention. The Benefit scores for this group were low to intermediate, given the relative lack of downslope receptors that might be benefit from these functions.

Functional scores for the Carbon group were intermediate at the wetland. Within the Fish group, the function and benefit scores were to low to intermediate, no evidence was available to confirm the presence and utilization of the upper Ocean Run system by anadromous fish species.

Within the Aquatic Support group, functional scores ranged from 4.26 for Waterbird Feeding Habitat to 6.86 for Aquatic Invertebrate Habitat. The Benefit score of 10.0 for several of these functions was due to the relative lack of comparable wetland habitat at a larger landscape scale.

The riparian treed swamp had intermediate functional scores within the Terrestrial Support group, with the highest score being for Songbird, Raptor and Mammal Habitat. The abundance of dead but standing snags, provides important habitat for avian species.

Shrub-Treed Bog

The shrub-treed bog had low to intermediate scores for surface water storage, flow support and cooling. The reduction in these scores was driven by the limited evidence of groundwater interaction with the wetland. The Benefits scores for this group were low to moderate, given the wetland's limited direct connectivity with off-site receptors.

The functional scores within the Water Quality group were intermediate, with the lowest score for Sediment and Toxicant Retention and Stabilization and the highest score for Phosphorus Retention. The Benefit scores for this group were low, given the relative lack of downslope receptors that might be benefit from these functions.

Functional scores for the Carbon group were intermediate to moderate for the shrub-treed bog at the Harrietsfield Williamswood site, with a score of 7.17 for Carbon Sequestration. Within the Fish group, the function and benefit scores were zero, given the absence of fish habitat within the bog.

Within the Aquatic Support group, functional scores ranged from 0.00 for Waterbird Feeding Habitat (very limited open water within the wetland) to 5.81 for Amphibian Habitat. The Benefit score of 10.0 for several of these functions was due to the relative lack of comparable wetland habitat at a larger landscape scale.

The shrub-treed bog had intermediate functional scores within the Terrestrial Support group, with the highest score being for Songbird, Raptor and Mammal Habitat. The abundance of dead but standing snags, provides important habitat for avian species.

Overall, the WESP-NS functional assessments suggests that the wetlands examined at the Harrietsfield Williamswood site to be of moderate value, when compared against the possible ecosystem services providing by other wetlands. The wetlands to be impacted as a result of project activities are typical of numerous others encountered at landscape and regional scales.

Predicted Impacts to Wetlands

The field surveys conducted in July, August and September 2014 followed an iterative process, with the field surveys providing input to the layout and positioning of project infrastructure. The revised infrastructure locations were then re-surveyed with feedback provided to the proponent. Through repeated foot surveys of the site and redesign of project components, East Coast Aquatics Inc. and the proponent were able to minimize anticipated impacts to wetlands, by re-positioning the access road and the turbine laydown pads. This process is ongoing to further refine the locations of project infrastructure and the construction process to minimize impacts on environmental features.

Field mapping conducted during 2014 documented that the access track would have crossed a treed bog, with a potential impact of >450 m^2. Fine-scale delineation of the adjacent wetland boundaries has allowed for the access track to be re-aligned, reducing the anticipated wetland impact to <100 m^2. Similarly, the original location for turbine 3 would have intersected with a shrub-treed bog, with a potential wetland impact of >1200 m^2. The position of turbine 3 was subsequently altered to an upland area, with no anticipated wetland impact.

It is anticipated that the access road will need to the Ocean Run watercourse and its adjacent treed swamp at one location, with an anticipated wetland impact of 190 m^2 (Table 3)

The access roads will have a total width of 10 m, consisting of a 6 m wide road surface, with 2 m wide ditches on either side. Based on preliminary estimates, it is anticipated that an unavoidable alteration of 0.029 ha of wetland will impacted through the construction of access roads and the turbine laydown pads.

***Table 3**: Predicted Impacts to wetlands from the construction of site infrastructure*

Project Component	Predicted Footprint of Impact to Wetlands (m^2)	Notes
Access road crossing at Ocean Run	190	6 m road surface, with 2 m ditches on either side, for total width of 10 m
Access road at treed bog	100	
Total Wetland Impact	**290**	

The unavoidable impacts to wetlands arising from the implementation of the project will be mitigated in a number of ways. Appropriately sized culverts will be used where access roads cross wetlands to ensure impacts to local wetland hydrology is minimized. Industry-standard erosion and sedimentation control measures will be implemented to avoid impacts to adjacent wetlands. The loss of wetlands at the Harrietsfield Williamswood site will be compensated through the restoration of off-site wetlands. The proponent will retain the services of a qualified professional to undertake the compensation activities, at a site approved by Nova Scotia Environment.

Fish and Aquatic Habitats

Methodology

A preliminary desktop review of the project site and surrounding areas was undertaken to identify site topography and key watercourse features. Data sources for the desktop review included aerial photography (both current and historic), the Provincial Groundwater Maps and Databases (NSDNR, 2012), the Nova Scotia Watershed Atlas (Sterling, 2014), as well as other sources noted below.

Field surveys of aquatic habitats at the project site occurred on September 15, 2014, with the surveys undertaken by experienced biologists. Electrofishing was conducted using a Smith-Root Model 12POW, with settings adjusted to optimize catch efficiency (PDC, 400 V, 60 to 70 Hz, 2 ms), under the terms of Fisheries and Oceans Canada Science License #328116. Electrofishing was undertaken using a single pass, working in an upstream direction, through riffle and run habitat. Directed angling was undertaken using a light weight fly rod with several artificial flies tied on barbless hooks in still water and ponded habitats. Water quality observations were recorded using a YSI ProPlus Quattro multi-probe water quality meter.

Findings

The project site occurs within the catchment of the Ocean Run watercourse, a headwater portion of the Pennant River watershed (1EJ-8) (NSDNR, 2012). The overall catchment area for the Pennant River is 85 km^2. The Nova Scotia Watershed Atlas (Sterling, 2014) identified a number of stressors which have the potential to adversely impact the ecological health of the Ocean Run – Pennant River catchment. Significant stressors and their scale within the watershed include: hydrologic change (moderately high), surface erosion (moderate), water quality (low) and acid rock drainage (low). Combined, these stressors present a low to moderate threat to the watershed.

The project site is situated entirely within the Ocean Run watercourse catchment. Surface flows exit the sub-basin to the south of the project site, after passing through Grover and Sheehan Lakes, to Grand Lake where Ocean Run joins the Pennant River. The watercourse continues to the south, discharging to saltwater at Pennant Cove near Sambro. The watercourse distance from the project site to saltwater is approximately 7.6 km. Although it is situated in Halifax Regional Municipality, the watercourse has a largely wilderness character with limited points of access. Public roads intersect the watercourse at two locations on Highway 306 (Old Sambro Road) and West Pennant Road at Pennant Cove.

Figure 11: Ocean Run at planned crossing location, looking downstream. Photo taken July 2, 2015

Alexander, Kerekes and Sabean (1986) have reported on the survey of water quality and fish populations in 781 Nova Scotia lakes, carried out between 1964 and 1981. These surveys were completed as a partnership between Fisheries and Oceans Canada, the Canadian Wildlife Service and the Wildlife Division of Nova Scotia Department of Natural Resources. The study encompassed several lakes within the Ocean Run / Pennant River catchment (Table 4). Water quality measurements were recorded onsite with handheld water quality instruments. Fish samples were collected through a variety of methods, including gill netting, trap netting, beach seining, minnow trapping, and angling.

Table 4: Selected Lake Characteristics and Occurrence of Fish Species for several lakes within the Ocean Run / Pennant River catchment. Data based on Alexander et al (1986).

Lake	Conductivity	pH	Surface Area	Depth		Fish Species
	(umhos/cm)		(ha)	Max. (m)	Mean (m)	
Grand Lake	37.0	5.2	100.7	18.0	5.4	Brook trout
Moody Lake	34.0	5.3	57.8	11.0	2.7	Brook trout
Run Lake	36.0	5.0	14.5	5.0	1.4	Fished-no success
Sheehan Lake	40.0	5.0	28.3	10.0	3.2	Brook trout
Weaver Lake-North	183.0	7.5	2.8	3.0	0.9	Not fished
Weaver Lake-South	104.0	6.0	2.0	2.0	0.7	Not fished

Alexander *et al* (1986) identified only a single fish species in these lakes: Brook trout (*Salvelinus fontinalis*). The water quality measurements indicate the lakes within the catchment to be of moderate to low pH and conductivity, most likely due to prolonged acidic precipitation, leaching and limiting geological buffering capacity. The North and South Weaver Lakes, located near the headwaters of Ocean Run and adjacent to Highway 306, were atypical with higher pH and conductivity values, most likely due to the nearby drumlin fields. Similar results were observed during ECA field surveys.

Water quality within the eastern catchment was recorded at two locations (Table 5) on September 15, 2014 in conjunction with the electrofishing survey. The watercourse was found to have low pH and conductivity/total dissolved solids, with the pH values at both locations being slightly below the recommended range for the protection of freshwater aquatic life (CCME, 2007). Low pH and conductivity values are frequently encountered across many areas of the southern Nova Scotia Uplands as a result of thin soils, limited buffering capacity within catchments and decades of acidic precipitation. Dissolved oxygen values were moderate and not unexpected, given the frequent riffle sections along the Ocean Run.

Table 5: Water quality measures of Ocean Run, September 15, 2014.

Location	Water Temp.	Dissolved Oxygen	Dissolved Oxygen	Conductivity (Ambient)	Total Dissolved Solids	pH
Units	(°C)	(%)	(mg/L)	(µS/cm)	(mg/L)	
KH1-Primary location of Ocean Run crossing	17.1	78	7.4	65	50.05	6.38
KH2-Riffle habitat approximately 150m downstream of KH1	17.3	80	7.6	64.5	49.40	6.25
CCME Guidelines for Protection of Aquatic Life	Not applicable	Not applicable	5.5 to 9.5	Not applicable	Not applicable	6.5 to 9.0

During the July 7, 2014 visit to the site, ECA staff conducted a cursory examination (n0n-microscopic) for benthic invertebrates in the cobble riffle habitat at location KH2. Moderate densities of five taxonomic orders were identified within a relatively small area (<1 m^2) over a limited search duration. These included: *Trichoptera* (Caddisflies); *Ephemeroptera* (Mayflies) (two species present); *Plecoptera* (Stoneflies); *Coleoptera* (Beetles) (*Elmidae sp.*- numerous) and *Odonata* (Damselflies) (Adults observed). The diversity and abundances observed are typical for cobble substrate riffle habitats in Nova Scotia.

Through a number of visits to the HWWF site in 2014, East Coast Aquatics staff documented evidence to suggest that the Ocean Run watercourse is regularly used for recreational angling. This included: hand painted signs directing anglers to the watercourse (Figure 12), a well-used footpath linking Fraser Road with Ocean Run as well as along the watercourse, litter along shorelines, and presence of snagged fishing line and lures. Nova Scotia Department of Natural Resources staff have indicated that the primary objective for recreational anglers within the catchment is Brook trout (*Salvelinus fontinalis*), with angling

occurring during the spring and early summer in conjunction with periods of Mayfly hatches (M. Pugh, pers. com).

As part of this study, ECA made an enquiry to Nova Scotia Department of Fisheries and Aquaculture concerning records of fish species within the study area. The Department had records for the presence of Brook trout and American eel in Grand Lake and Sheehan Lake. Spring stocking of Brook trout has occurred at Grand Lake up until at least 2006 (J. LeBlanc, pers. com.). A commercial elver fishery for eel occurs near the head of tide on the Pennant River, downstream of Ocean Run and the project site (Greg Stevens, pers. com.).

Figure 12: Hand painted sign directing anglers to footpath leading to Ocean Run watercourse.

Smallmouth bass (*Micropterus dolomieu*) are known to occur within at least 188 lakes and rivers in Nova Scotia, resulting from deliberate introductions as well as accidental and illegal transfers (LeBlanc, 2010). Within the province, the species exhibits a preference for lacustrine over riverine systems, in particular lake habitats where water depths are less than 6 m. There is an indication that Smallmouth bass may have low tolerance for acidic water, although the actual pH threshold value and widespread applicability of these criteria remains unclear. LeBlanc (2010) reports the presence of Smallmouth bass was first documented at Hatchet Lake in 1988, which is a headwater lake of the Pennant River.

Salmonids, in particular Atlantic salmon (*Salmo salar*) are know to be sensitive to acidification of watersheds due to acid rain, with the populations in many rivers within Nova Scotia's Southern Uplands being extirpated (DFO, 2000). Salmon production is considered unstable with only remnant populations persisting when mean annual pH falls below 5.1. The Pennant River catchment has a mean annual pH <4.7 and is considered non-

viable for reproduction and utilization by Atlantic salmon (DFO, 2000). Atlantic salmon are considered extirpated from the watershed (ASF, 2015).

Field surveys within the project area of Ocean Run were conducted on September 15, 2014 to ascertain the current potential of fish habitat using electrofishing and directed angling. The electrofishing and angling catch results are summarized at Table 6. The electrofishing and angling datasheets are available in Appendix 1.

Table 6: Summary of Electrofishing and Directed Angling Surveys

Species	Name	Total Length (cm)				Total Number Caught
		Median	Mean	Min	Max	
American eel	*Anguilla rostrata*	32.5	33	28	40	6*
Small mouth bass	*Micropterus dolomieu*	7.4	9.6	6.1	18.5	11

* An additional 16 American eels were observed through the course of the electrofishing but not recovered.

Two sections of Ocean Run were electroseined, over a total linear distance of approximately 100 m, encompassing 1350 m^2 of riffle, run and deepwater habitat adjacent to still waters. The Ocean Run watercourse at these locations consisted of a series of stillwaters connected by riffle and run habitats. Water depths within the riffle and run sections ranged from 0.1 to 0.4 m with wetted channel widths in the range of 9 to 27 m and bankfull widths ranging from 9 to 36 m. Substrates were composed of cobble, boulders and bedrock, with abundant moss coverage. Abundant course woody debris in form of logjams was present within several of the riffle reaches (Figure 13). On July 26, 2014, water velocities within the lower electrofished reach (Site KH2) were observed to be 0.11 m/s with the discharge estimated to be 0.20 m^3/sec.

Figure 13: Log debris jam on Ocean Run watercourse at location KH2, approximately 150 m downstream of the planned crossing. Photo taken July 2, 2014.

A total of two species were documented through the electrofishing and directed angling within the Ocean Run watercourse adjacent to the HWWF site (Figure 14 for locations). At total of six American eels were caught and released, within an additional 16 observed, for a total of 22. Sexual maturation in eels seems more related to size than to age, and size at maturation varies geographically and according to sex, with male eels typically being smaller than females. Eels may remain in freshwater from 5 to 20 years or longer (DFO 2015). A total of 11 Smallmouth bass were caught and released, ranging in size from 6.1 to 18.5 cm total length. Given typical Smallmouth bass growth rates in Nova Scotia (MacMillan et al. 2002) this likely represents two year-classes. The presence of small fish that are likely in the 0+ year class would suggest the successful spawning of Smallmouth bass within the catchment (Figure 15).

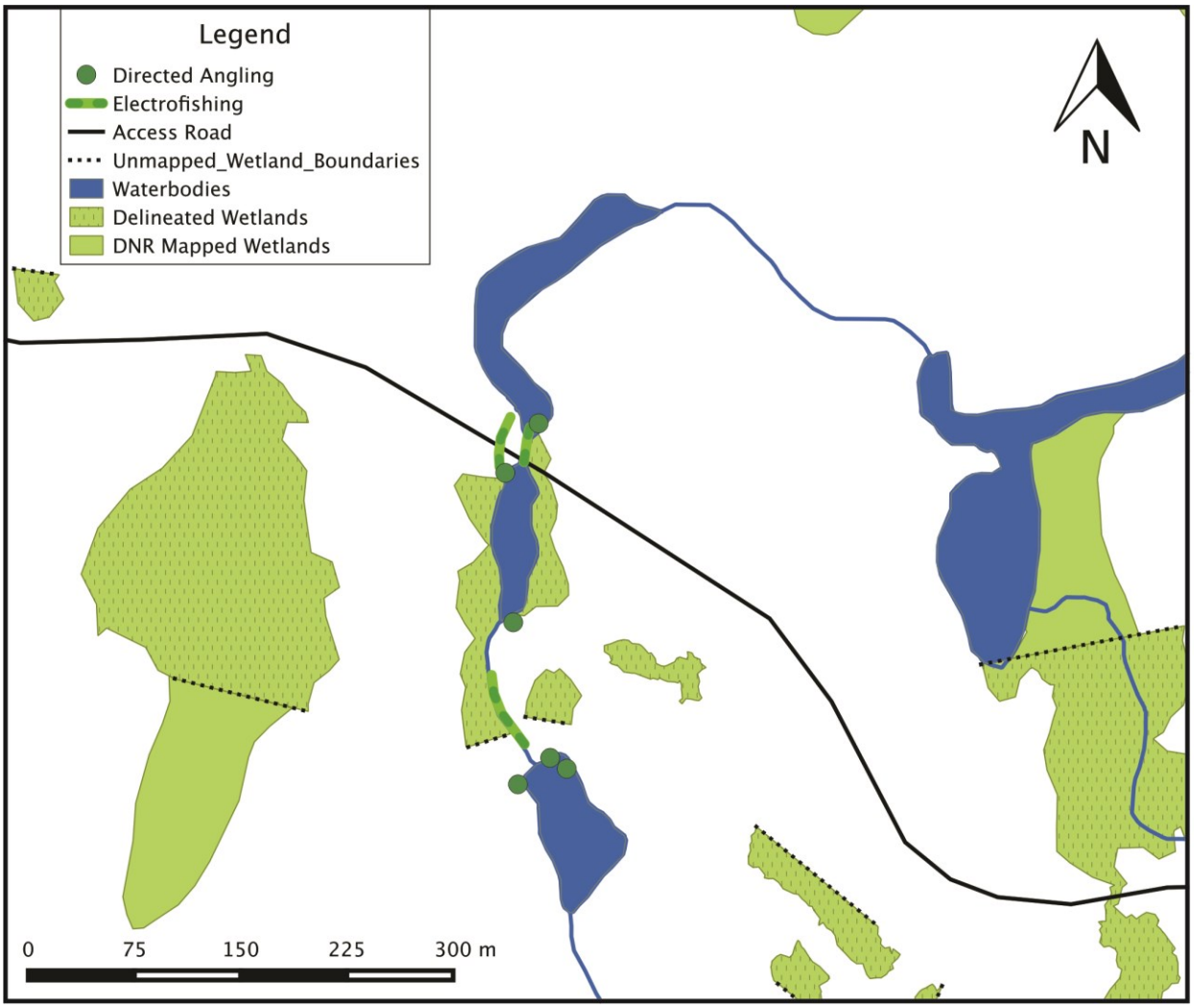

Figure 14: Fish survey locations at HWWF project site.

Figure 15: Fish species (Smallmouth bass and American eel) documented through aquatic surveys and habitats sampled along Ocean Run watercourse.

Floral Species at Risk and Species of Conservation Concern

Methodology

A preliminary desktop review of the project site and surrounding areas was undertaken to identify priority species and habitats. Data sources for the desktop review included aerial photography (both current and historic), conservation records for the site (ACCDC, 2014), as well as other sources noted below. Conservation records for the site were examined at two spatial scales (20 km and 5 km buffers) in order to better examine possible interactions with project components. The hierarchy of protection levels described in the NSE Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSE, 2009) was used to guide this process. Specifically, ACCDC data was sorted to include species at risk (COSEWIC, SARA or NSESA listed) and species of conservation concern (General Status of Wild Species 1 - Red, 2 – Orange and 3 - Yellow).

Botanical field surveys of the project site occurred on July 3 and August 26, 2014, with the surveys being undertaken an experienced botanist. These dates were selected to maximize opportunities to identify botanical species and in accordance with the NSE Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSE, 2009). The meandering route surveyed by the botanist encompassed all project components (access roads, turbine pads etc.) as well the wider footprint of the project site. The botanical surveys covered in total a linear distance of 18 km over the two survey days.

Findings

Examination of the ACCDC data (2014) for the site using a 20 km buffer identified a total of 55 floral species considered to be species at risk or species of conservation concern (Tables 6 and 7). This included four protected vascular species: Coast Pepper-Bush (*Clethra alnifolia*) (Special Concern/Vulnerable), East White Cedar (*Thuja occidentalis*) (Vulnerable), Black Ash (*Fraxinus nigra*) (Threatened), and Dense Blazing Star (*Liatris picata*) (Threatened). Two non-vascular protected species were also reported within 20 km of the project site: Boreal Felt Lichen (Atlantic population) (*Erioderma pedicellatum)* (Endangered) and Blue Felt Lichen (*Degelia plumbea*) (Special Concern/Vulnerable).

The ACCDC database (2014) had no records of provincially listed floral species within 5 km of the project site. There were 13 records of six floral species that could be considered a conservation concern that occurred within 5 km of the proposed project site (Table 8). These are: Greene's Rush (*Juncus greenei)* (S1S2, 4.6km), Knotted Pearlwort (*Sagina nodosa)* (S2S3, 4.7km), Ghost Antler Lichen (*Pseudevernia cladonia)* (S2S3, 4.5km), Little Curlygrass Fern (*Schizaea pusilla)* (S3, 4.8km), Pink Crowberry (*Empetrum eamesii)* (S3, 4.8 km) and its *atropurpureum* and *eamesii* sub species (S2S3, 3.8-4.6km) Narrow-leaved Blue-eyed-grass (*Sisyrinchium angustifolium)* (S3S4, 4.7km). Of these species, Ghost Antler Lichen and Little Curlygrass Fern are the most likely to occur on the project site. The project site is not immediately coastal, and but would provide a humid mature forest habitat. Although Ghost Antler lichen may be found inland at humid old-growth fir and spruce stands, evidence in the project area was that the site had been historically cut and has not yet regenerated to an old growth state. The nearby observations of this lichen were all made on coastal sites rather than inland. Little Curlygrass Fern can be found in freshwater

sphagnum bog habitats, which do exist at the project site. The remaining species were observed immediate to the coastline on bold exposed granite outcrops that are not characteristic of the project site, and therefore they are unlikely to be found at the project spite despite the proximity of the ACCDC observations.

The field surveys documented a total of 93 vascular plant species across the site (Appendix 2), occurring in eight habitats. One rare vascular plant species was observed during the surveys. Wiegand's Sedge (*Carex wiegandii)* was observed in a coniferous bog (Figure 16). This species has a Provincial rarity rank of S3. A rare lichen, Blue Felt Lichen (*Degelia plumbea)*, was incidentally observed. This species has an S2 Provincial rarity ranking, and is listed as Special Concern by the COSEWIC and Vulnerable Provincially. It was found in a treed swamp located on the west side of Ocean Run that was dominated by red maple and balsam fir. The understory shrub layer consists of False Mountain Holly *Nemopanthus mucronata)*, Cinnamon Fern *(Osmunda cinnamomea)*, Huckleberry *(Gaylusaccia baccata)*, Carex *trisperma* and peat mosses. *Degelia plumbea* was observed on a red maple, and the presence of this species suggests a rich lichen diversity may exist. All other species encountered during plant surveys of the project site either had a General Status Ranking of 4 – Secure / Not At Risk or Exotic. A total of four exotic taxa were identified.

Figure 16: Wiegand's sedge *Carex wiegandii* was the only rare plant observed during site surveys.

During the field surveys, several treed wetlands were encountered that contain conditions suitable for the endangered Boreal Felt lichen (*Erioderma pedicellatum*). Predictive mapping also indicates the potential for suitable habitat within the project site. This habitat consists of balsam fir stands on north facing slopes with a sphagnum dominated wetland at the base. Some common lichen species (*Coccocarpia palmicola* e.g.) that are used as indicator species for suitable habitat boreal felt lichen were not observed at the time of the surveys. A dedicated search of potential Boreal Felt habitat is pending, but has been hampered by recent winter weather conditions. The results of this search will be forwarded as available.

Table 6: ACCDC Vascular plant species at risk or of conservation concern, reported within 20 km of the project site

Scientific Name	Common Name	COSEWIC	SARA	NSESA	NS Rarity	NS General Status	# recs	DISTkm
Liatris spicata	Dense Blazing Star	Thr	Thr				1	11.4 ± 0.03
Clethra alnifolia	Coast Pepper-Bush	SC	SC	Vul	S1	3 Sensitive	2	10.6 ± 0.1
Hypericum majus	Large St John's-wort				S1	2 May Be At Risk	3	13.8 ± 7.07
Polygala polygama	Racemed Milkwort				S1	5 Undetermined	1	12.4 ± 1.0
Montia fontana	Water Blinks				S1	2 May Be At Risk	1	10.4 ± 1.0
Galium aparine	Common Bedstraw				S1	7 Exotic	5	11.2 ± 0.08
Elymus wiegandii	Wiegand's Wild Rye				S1	2 May Be At Risk	6	13.8 ± 7.07
Hieracium kalmii var. fasciculatum	Kalm's Hawkweed				S1?	5 Undetermined	2	12.3 ± 5.0
Solidago hispida	Hairy Goldenrod				S1?	2 May Be At Risk	1	13.8 ± 7.07
Thuja occidentalis	Eastern White Cedar			Vul	S1S2	1 At Risk	11	14.0 ± 7.07
Ranunculus sceleratus	Cursed Buttercup				S1S2	2 May Be At Risk	22	10.4 ± 2.5
Juncus greenei	Greene's Rush				S1S2	2 May Be At Risk	5	4.6 ± 0.5
Senecio pseudoarnica	Seabeach Ragwort				S2	3 Sensitive	6	7.5 ± 1.0
Minuartia groenlandica	Greenland Stitchwort				S2	3 Sensitive	84	6.5 ± 0.01
Hudsonia ericoides	Pinebarren Golden Heather				S2	3 Sensitive	25	7.5 ± 0.01
Vaccinium caespitosum	Dwarf Bilberry				S2	3 Sensitive	37	8.1 ± 0.01
Vaccinium uliginosum	Alpine Bilberry				S2	3 Sensitive	3	6.5 ± 1.0
Oenothera fruticosa ssp. glauca	Narrow-leaved Evening Primrose				S2	5 Undetermined	7	7.4 ± 7.07
Plantago rugelii	Rugel's Plantain				S2	5 Undetermined	7	11.1 ± 0.5
Samolus valerandi ssp. parviflorus	Seaside Brookweed				S2	3 Sensitive	47	14.2 ± 5.0
Carex atlantica ssp. capillacea	Atlantic Sedge				S2	5 Undetermined	8	8.2 ± 0.01
Listera australis	Southern Twayblade				S2	2 May Be At Risk	98	5.0 ± 0.01
Hieracium kalmii	Kalm's Hawkweed				S2?	5 Undetermined	7	8.0 ± 0.5
Hieracium kalmii var. kalmii	Kalm's Hawkweed				S2?	5 Undetermined	2	12.7 ± 5.0
Fraxinus nigra	Black Ash			Thr	S2S3	3 Sensitive	65	20.6 ± 0.01
Sagina nodosa	Knotted Pearlwort				S2S3	4 Secure	23	4.7 ± 0.5
Suaeda calceoliformis	Horned Sea-blite				S2S3	4 Secure	6	13.8 ± 7.07
Hypericum dissimulatum	Disguised St John's-wort				S2S3	3 Sensitive	4	19.4 ± 10.0
Empetrum eamesii ssp. atropurpure	Pink Crowberry				S2S3	3 Sensitive	5	4.6 ± 0.5
Empetrum eamesii ssp. eamesii	Pink Crowberry				S2S3	3 Sensitive	5	3.8 ± 0.5
Hedeoma pulegioides	American False Pennyroyal				S2S3	3 Sensitive	13	16.0 ± 5.0

Notes: SC=Special Concern; Thr=Threatened; Vul=Vulnerable; End=Endangered

Table 6 Con't: ACCDC Vascular plant species at risk or of conservation concern, reported within 20 km of the project site

Scientific Name	Common Name	COSEWIC	SARA	NSESA	NS Rarity	NS General Status	# recs	DISTkm
Polygala sanguinea	Blood Milkwort				S2S3	3 Sensitive	10	13.8 ± 7.07
Carex adusta	Lesser Brown Sedge				S2S3	3 Sensitive	4	6.8 ± 0.01
Carex swanii	Swan's Sedge				S2S3	3 Sensitive	3	16.6 ± 0.5
Spiranthes ochroleuca	Yellow Ladies'-tresses				S2S3	3 Sensitive	27	7.7 ± 0.01
Ophioglossum pusillum	Northern Adder's-tongue				S2S3	3 Sensitive	5	12.7 ± 50.0
Empetrum eamesii	Pink Crowberry				S3	3 Sensitive	81	4.8 ± 0.1
Vaccinium corymbosum	Highbush Blueberry				S3	4 Secure	2	5.0 ± 5.0
Bartonia virginica	Yellow Bartonia				S3	4 Secure	26	7.5 ± 7.07
Proserpinaca pectinata	Comb-leaved Mermaidweed				S3	3 Sensitive	24	18.7 ± 1.5
Agalinis neoscotica	Nova Scotia Agalinis				S3	4 Secure	14	20.9 ± 0.01
Limosella australis	Southern Mudwort				S3	3 Sensitive	7	12.9 ± 1.0
Verbena hastata	Blue Vervain				S3	4 Secure	77	18.9 ± 7.07
Corallorhiza trifida	Early Coralroot				S3	4 Secure	27	20.4 ± 0.01
Equisetum variegatum	Variegated Horsetail				S3	4 Secure	16	20.9 ± 0.01
Schizaea pusilla	Little Curlygrass Fern				S3	4 Secure	5	4.8 ± 10.0
Carex foenea	Fernald's Hay Sedge				S3?	4 Secure	12	6.8 ± 0.01
Viola sagittata var. ovata	Arrow-Leaved Violet				S3S4	4 Secure	15	9.9 ± 1.7
Eriophorum chamissonis	Russet Cotton-Grass				S3S4	4 Secure	7	11.1 ± 3.0
Sisyrinchium angustifolium	Narrow-leaved Blue-eyed-grass				S3S4	4 Secure	50	4.7 ± 0.5
Lycopodium complanatum	Northern Clubmoss				S3S4	4 Secure	8	15.0 ± 1.0

Notes: SC=Special Concern; Thr=Threatened; Vul=Vulnerable; End=Endangered

Table 7: ACCDC Non-Vascular plant species at risk or of conservation concern, reported within 20 km of the project site.

Scientific Name	Common Name	COSEWIC	SARA	NSESA	NS Rarity	NS General Status	# recs	DISTkm
Erioderma pedicellatum (Atlantic pop.)	Boreal Felt Lichen - Atlantic pc	End	End	End	S1S2	1 At Risk	197	12.5 ± 0.5
Degelia plumbea	Blue Felt Lichen	SC	SC	Vul	S2	4 Secure	27	8.1 ± 0.1
Pseudevernia cladonia	Ghost Antler Lichen	NAR			S2S3	3 Sensitive	13	4.5 ± 0.01
Cyrtomnium hymenophylloides	Short-pointed Lantern Moss				S2?	3 Sensitive	1	15.3 ± 5.0
Hylocomiastrum pyrenaicum	a Feather Moss				S2S3	3 Sensitive	1	10.4 ± 0.5
Usnea flammea	Coastal Bushy Beard Lichen				S2S3	3 Sensitive	1	8.3 ± 1.0

Notes: SC=Special Concern; Thr=Threatened; Vul=Vulnerable; End=Endangered

Table 8: ACCDC Floral species at risk or of conservation concern, documented within 5 km of the project site.

Scientific Name	Common Name	COSEWIC	SARA	NSESA	NS Rarity	NS General Status Rank	Number of Records; Distance (km)	Observed	Obs. Or Typical Habitat	Likelihood of Occurrence at or near Project Site
Juncus greenei	Greene's Rush				S1S2	2 May Be At Risk	4.6 ± 0.5	1945	Crevices of exposed granite sea-cliff.	Very Low
Empetrum eamesii ssp. eamesii	Pink Crowberry				S2S3	3 Sensitive	7, 3.8 ± 2.0	1945-1955	Barrens & exposed granite headlands along coast on top of rocks with thin soil & with lichens.	Very Low
Pseudevernia cladonia	Ghost Antler Lichen				S2S3	3 Sensitive	4.5 ± 0.01	198?	Coastal spruce/fir forests where foggy and cool. Inland in humid old growth.	Moderate
Sagina nodosa	Knotted Pearlwort				S2S3	4 Secure	4.7 ± 0.5	1945	Crevices of exposed granite sea-cliff.	Very Low
Sisyrinchium angustifolium	Narrow-leaved Blue-eyed-grass				S3S4	4 Secure	4.7 ± 0.5	1945	Crevices in granite rocks of sea shore	Very Low
Schizaea pusilla	Little Curlygrass Fern				S3S4	4 Secure	4.8 ± 10.0	1961	Freshwater bog.	Moderate

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Appendix 1: Electrofishing and Directed Angling Data Sheets

Electroseine Survey Data Form

East Coast Aquatics

P.O. Box 129 Bridgetown, NS B0S 1C0
(902)665-4682

Project:	Harrietsfield Wind Farm		
Watershed:	Ocean Run	**Site Description:**	Water depths 10 to 70 cm. Reach 50m long in 2 lines at primary crossing. Fished riffle between stills and deeper edges of stillwater.
Site:	KH1		
UTM: 20T	450716 4931767		
Date: dd / mm / yy	15/9/2014	**Water Temp ^{0}C:**	17.1
Survey Length (m):	50	**Air Temp ^{0}C:**	21
pH:	6.38	**Conductivity:**	65

	Avg.'s	A:	B:	C:	Dw (m):	1/4	1/2	3/4	Individual Dw$_{avg.\ (m)}$
Dbf (+m):	**15.00**	15			**A:**				
Wbf (m):	**#DIV/0!**				**B:**				
Ww (m):	**#DIV/0!**				**C:**				
Dw Avg:	**#DIV/0!**								
Dbf (m):	**#DIV/0!**								

	Electroseine setting	Start Time	End Time	Pass	Species	Total Length (mm)	Fork Length (mm)	Weight (g)	Comments
1	J4-K4 400v	18921	19452	1	AE	400			
2					AE	350			
3					AE	320			
4					AE	320			
5					AE	280			additional 8 lost during capture
6					BS	61	59		
7					BS	73	71		
8					BS	65	64		
9									
10									
11									
12									
13									

Effort (sec)	
1st Pass Effort (sec):	531
2nd Pass Effort (sec):	0
3rd Pass Effort (sec):	0
4th Pass Effort (sec):	0
Total Effort (sec):	531

Surveyed Area (m^2): length	750
Total Fish / 100m^2: (100 / su	1.1
CPUE 1st Pass (fish/100sec)	0.2
Total CPUE (fish/100sec): to	1.5

Species	**Total No: Caught:**	**Fish / 100m2**	**Total Weight Caught**	**Biomass / 100m^2**
Brook Trout	0	0.0	0	0
Rainbow Trout	0	0.0	0	0
Brown Trout	0	0.0	0	0
Atlantic Salmon	0	0.0	0	0
Creek Chub	0	0.0	0	0
Yellow Perch	0	0.0	0	0
Smallmouth Bass	3	0.4	0	0
Banded Killifish	0	0.0	0	0
Brown Bullhead	0	0.0	0	0
White Sucker	0	0.0	0	0
Eel	5	0.7	0	0
Totals :	**8**	**1.1**	**0**	**0**

Electroseine Survey Data Form

East Coast Aquatics

P.O. Box 129 Bridgetown, NS B0S 1C0
(902)665-4682

Project: Harrietsfield Wind Farm
Watershed: Ocean Run
Site: KH2
UTM: 20T 450712 4931541
Date: dd / mm / yy 15/9/2014
Survey Length (m): 50
pH: 6.25

Site Description: Boulder and bedrock lined chute run between two stillwaters

Water Temp ^{0}C: 17.3
Air Temp ^{0}C: 21
Conductivity: 64.5

	Avg.'s	A:	B:	C:	Dw (m):	1/4	1/2	3/4	Individual Dw avg. (m)
Dbf (+m):	#DIV/0!				A:				
Wbf (m):	#DIV/0!				B:				
Ww (m):	#DIV/0!				C:				
Dw Avg:	#DIV/0!								
Dbf (m):	#DIV/0!								

	Electroseine setting	Start Time	End Time	Pass	Species	Total Length (mm)	Fork Length (mm)	Weight (g)	Comments
1	K4 400v	19452	19795	1	AE	330			additional 8 lost during capture
2					BS	63	60		
3					BS	69	72		
4					BS	74	71		
5					BS	75	72		
6									
7									
8									
9									
10									
11									
12									
13									

Effort (sec)	
1st Pass Effort (sec):	343
2nd Pass Effort (sec):	0
3rd Pass Effort (sec):	0
4th Pass Effort (sec):	0
Total Effort (sec):	343

Surveyed Area (m^2): length	600
Total Fish / 100m^2: (100 / su	0.8
CPUE 1st Pass (fish/100sec)	0.3
Total CPUE (fish/100sec): to	1.5

Species	Total No: Caught:	Fish / 100m2	Total Weight Caught	Biomass / 100m^2
Brook Trout	0	0.0	0	0
Rainbow Trout	0	0.0	0	0
Brown Trout	0	0.0	0	0
Atlantic Salmon	0	0.0	0	0
Creek Chub	0	0.0	0	0
Yellow Perch	0	0.0	0	0
Smallmouth Bass	4	0.7	0	0
Banded Killifish	0	0.0	0	0
Brown Bullhead	0	0.0	0	0
White Sucker	0	0.0	0	0
Eel	1	0.2	0	0
Totals :	**5**	**0.8**	**0**	**0**

Directed Angling Survey Data Form

Project: Harrietsfield Williamswood Wind Farm

East Coast Aquatics

P.O. Box 129 Bridgetown, NS B0S 1C0
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Date	Station	Watercourse	Gear Used	No. of Fishers	Effort (min	Species	Total Leng	Fork Leng	Fish caught	Comments
15/9/2015	KH1	Ocean Run	Fly	1	20.5	BS	185.0	180.0	4	2 fish hooked but not landed
						BS	133.0	129.0		
						BS	130.0	127.0		
						BS	127.0	122.0		
15/9/2015	KH2	Ocean Run	Fly	1	10.0	Nil			0	
15/9/2015	below KH2	Ocean Run	Fly	1	12.0	Nil			0	
				Total Effort	42.5		**Total Fish**		4	

Appendix 2: Plant Survey Data

Ninety-two floral species and associated project site habitats documented through July 3 and August 26, 2014 field surveys.

Species	Common Name	General Status Rank	Fish River	Disturbed Trail to River	Coniferous Treed Bog	River Edge Meadow	Upland Coniferous Woods	Treed Swamp (BFL Habitat)	Mixed Woods Upland	Open Black Spruce Bog
Abies balsamea	Balsam Fir	4 secure	x	x			x	x	x	
Acer rubrum	Red Maple	4 secure	x	x	x		x	x	x	x
Alnus incana	Speckled Alder	4 secure	x	x		x				
Anthoxanthum odoratum	Sweet Vernal Grass	exotic		x						
Aralia nudicaulis	Wild Sarsaparilla	4 secure		x			x			
Aster acuminatus	Wood Aster	4 secure							x	
Aster nemoralis	Aster nemoralis	4 secure				x				
Aster radula	Rough Aster	4 secure						x		
Betula alleghaniensis	Yellow Birch	4 secure							x	
Betula papyrifera	Paper Birch	4 secure							x	
Calamagrostis canadensis	Blue-Joint Reedgrass	4 secure	x			x				
Carex brunnescens	Brownish Sedge	4 secure	x							
Carex bullata	Button Sedge	4 secure	x			x				
Carex echinata	Little Prickly Sedge	4 secure			x	x				
Carex folliculata	Long Sedge	4 secure				x				
Carex magellanica	A Sedge	4 secure			x			x		x
Carex stricta	Tussock Sedge	4 secure	x			x				
Carex trisperma	Three-Seed Sedge	4 secure	x		x		x	x		x
Carex wiegandii	Wiegand's Sedge	2 may be at risk						x		
Centaurea nigra	Black Starthistle	exotic		x						
Chamaedaphne calyculata	Leatherleaf	4 secure				x				x
Clintonia borealis	Clinton Lily	4 secure					x			
Coptis trifolia	Goldthread	4 secure	x				x		x	
Cornus canadensis	Dwarf Dogwood	4 secure	x		x		x	x	x	x
Dennstaedtia punctilobula	Eastern Hay-Scented Fern	4 secure							x	
Doellingeria umbellata	Parasol White-Top	4 secure		x						
Drosera intermedia	Spoon-Leaved Sundew	4 secure								x
Drosera rotundifolia	Roundleaf Sundew	4 secure	x					x		x
Dryopteris intermedia	Evergreen Woodfern	4 secure		x					x	
Dulichium arundinaceum	Three-Way Sedge	4 secure				x				
Epigaea repens	Trailing Arbutus	4 secure		x						
Eriophorum vaginatum	Tussock Cotton-Grass	4 secure						x		
Eriophorum virginicum	Tawny Cotton-Grass	4 secure								x
Fragaria virginiana	Virginia Strawberry	4 secure		x						
Galeopsis tetrahit	Brittle-Stem Hempnettle	exotic		x						
Gaultheria hispidula	Creeping Snowberry	4 secure			x		x	x		x
Gaultheria procumbens	Teaberry	4 secure	x							

Glyceria canadensis	Canada Manna-Grass	4 secure				x				
Glyceria fluitans	Water Manna Grass	4 secure				x				
Glyceria grandis	American Mannagrass	4 secure						x		
Glyceria striata	Fowl Manna-Grass	4 secure				x				
Ilex verticillata	Black Holly	4 secure	x			x				
Iris versicolor	Blueflag	4 secure	x							
Juncus effusus	Soft Rush	4 secure		x						
Kalmia angustifolia	Sheep-Laurel	4 secure	x		x		x			x
Larix laricina	American Larch	4 secure	x		x					x
Ledum groenlandicum	Common Labrador Tea	4 secure	x		x			x		x
Linnaea borealis	Twinflower	4 secure			x		x			
Listera cordata	Heartleaf Twayblade	4 secure			x					
Lysimachia terrestris	Swamp Loosestrife	4 secure	x			x		x		
Maianthemum canadense	Wild Lily-of-The-Valley	4 secure	x				x			
Maianthemum trifolium	Three-Leaf Solomon's-Plume	4 secure			x			x		x
Monotropa uniflora	Indian-Pipe	4 secure					x			
Myrica gale	Sweet Bayberry	4 secure				x				
Nemopanthus mucronatus	Mountain Holly	4 secure	x				x	x		x
Oclemena nemoralis	Bog Aster	4 secure								x
Osmunda cinnamomea	Cinnamon Fern	4 secure			x		x	x	x	x
Oxalis montana	White Wood-Sorrel	4 secure	x				x		x	
Parthenocissus quinquefolia	Virginia Creeper	exotic		x						
Photinia melanocarpa	Black Chokeberry	4 secure				x				x
Picea mariana	Black Spruce	4 secure	x		x	x	x	x		x
Picea rubens	Red Spruce	4 secure					x		x	
Pontederia cordata	Pickerel Weed	4 secure				x				
Potentilla simplex	Old-Field Cinquefoil	4 secure		x						
Prenanthes trifoliolata	Three-Leaved Rattlesnake-root	4 secure	x							
Pteridium aquilinum	Bracken Fern	4 secure		x			x			
Ranunculus acris	Tall Butter-Cup	4 secure		x						
Rhododendron canadense	Rhodora	4 secure	x							
Rhynchospora alba	White Beakrush	4 secure								x
Rubus allegheniensis	Allegheny Blackberry	4 secure		x						
Rubus chamaemorus	Cloudberry	4 secure								x
Rubus idaeus	Red Raspberry	4 secure		x						
Rubus pubescens	Dwarf Red Raspberry	4 secure	x							
Sarracenia purpurea	Northern Pitcher-Plant	4 secure								x
Sium suave	Hemlock Water-Parsnip	4 secure	x							
Solidago rugosa	Rough-Leaf Goldenrod	4 secure		x						
Solidago uliginosa	Bog Goldenrod	4 secure								x
Sorbus americana	American Mountain-Ash	4 secure		x						
Sparganium americanum	American Bur-Reed	4 secure				x				
Spiraea alba	Narrow-Leaved Meadow-Sweet	4 secure	x	x						
Thelypteris noveboracensis	New York Fern	4 secure		x						
Thelypteris palustris	Marsh Fern	4 secure				x				
Thelypteris simulata	Bog Fern	4 secure	x							

Triadenum fraseri	Marsh St. John's-Wort	4 secure				x				
Trichophorum caespitosum	Tufted Leafless-Bulrush	4 secure								x
Trientalis borealis	Northern Starflower	4 secure	x				x		x	
Vaccinium angustifolium	Late Lowbush Blueberry	4 secure		x						x
Vaccinium macrocarpon	Large Cranberry	4 secure	x							x
Vaccinium myrtilloides	Velvetleaf Blueberry	4 secure	x				x			
Vaccinium oxycoccus	vaccinium oxycoccus	4 secure						x		
Vaccinium vitis-idaea	Mountain Cranberry	4 secure							x	
Viburnum nudum	Possum-Haw Viburnum	4 secure	x		x			x		x
Viola cucullata	Marsh Blue Violet	4 secure	x							

Boreal Felt Lichen assessment for the proposed Harrietsfield Williamswood Wind Farm

March 03, 2015

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Introduction

The Boreal Felt lichen (BFL) *Erioderma pedicellatum* is an epiphytic (grows on trees), foliose (leafy) lichen which occurs in temperate and boreal Northern Hemisphere. It is still found in Nova Scotia, but is declining in abundance (Maas and Yetman, 2002). The world population of the Boreal Felt Lichen is listed as Endangered (IUCN 2010), while the Atlantic population of Boreal Felt Lichen is listed Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under the Canada Species at Risk Act (SARA). The Nova Scotia population is further listed as Endangered (NS Endangered Species Act (NESA 2003). The provincial decline has been attributed to air pollution, acid rain and habitat loss due to forestry and development (DNR 2012). Predictive habitat modeling (Cameron and Neily, 2008) and botanical field surveys indicated the potential for BFL habitat within the proposed Harrietsfield/Williamswood Wind Farm (HWWF) project site. The following report summarizes specific efforts to determine the presence of Boreal Felt Lichen within the project site.

Background

Cyanobacteria are the photosynthetic partners of the BFL fungus placing it within the group referred to as the cyanolichens. Such lichens are particularly sensitive to air pollution and water stress. The BFL occurs almost exclusively on the trunks of Balsam fir (*Abies balsamea*), and less commonly on Black spruce (*Picea mariana*) and Red maple (*Acer rubrum*). It is found in boggy balsam fir forest stands with a cool moist oceanic climate, and primarily at or near the base of north facing slopes. It further is found almost exclusively on the north side of its host tree. Many of the sites where BFL occurs are located along the border of open peatlands with small streams (i.e. Fens). Good general habitat indicators are sphagnum moss and cinnamon fern (DNR 2012). BFL is almost always found in association with the lichens *Cococarpia palmicola*, *Lobaria scrobiculata (on fir)*, and the liverwort *Frullania tamarisci* (Neily and Doggett 201?), and these species are considered indicator species for BFL within Nova Scotia (Tom Neily pers. com. 2015). In addition to these known habitat characteristics and associations for BFL, a GIS habitat model has been developed to predict areas in Nova Scotia where BFL is most likely to occur (Cameron and Neily 2008).

In undertaking biological field and desktop survey work for the HWWF Environmental Assessment registration document, it was noted that predicted BFL habitat fell within the project area, and summer field surveys by botanist Tom Neily confirmed the appropriateness of habitat to supporting BFL (see Figure 1). Despite the apparent presence of appropriate habitat, no Boreal Felt lichen was observed during the general botanical surveys of the project area on July 3 and August 26, 2014, nor were any of the indicator species. The Atlantic Canada Conservation Data Center indicates that the closest documented occurrence of Boreal Felt lichen to the HWWF project site is 12.5km away (ACCDC 2014).

Figure 1: Potential Boreal Felt lichen habitat located within the HWWF project site (20 T 451101 4931360).

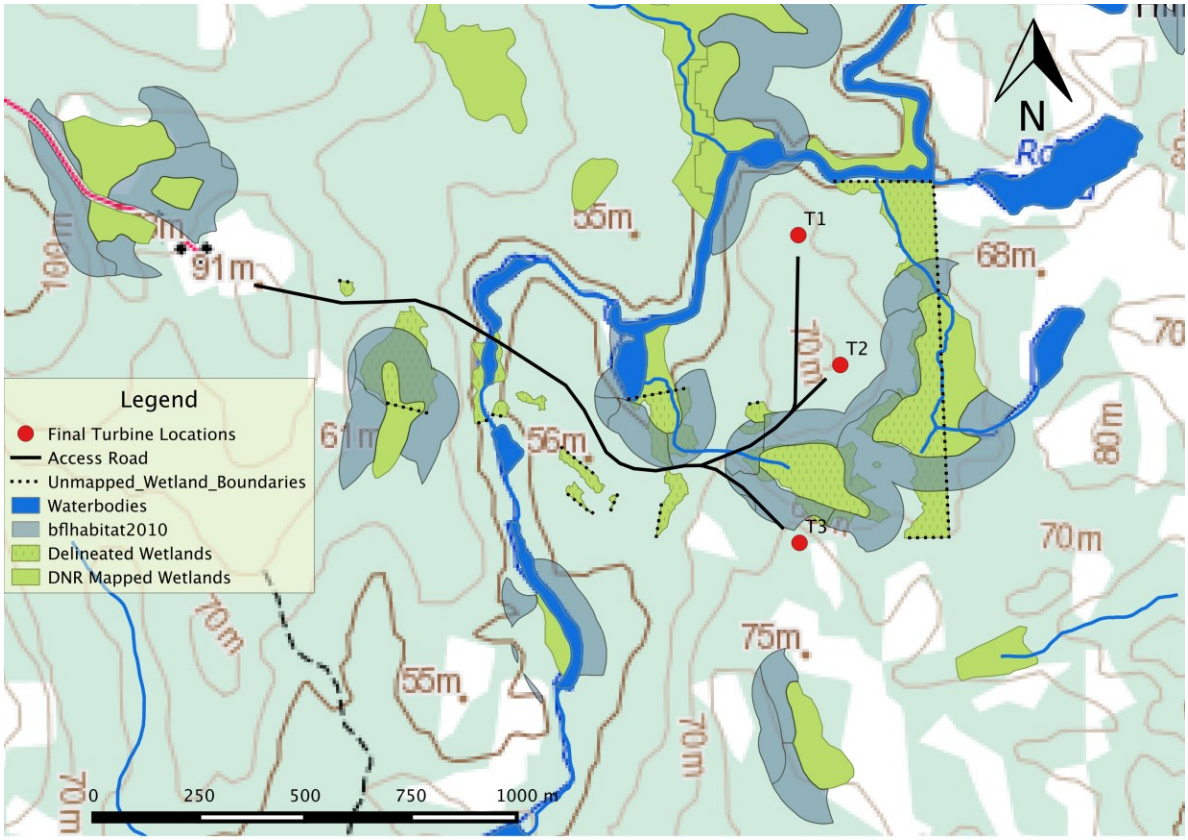

Figure 2: Overlay of proposed roadways and turbine sites for the HWWF, with field mapped wetland boundaries and Boreal Felt lichen predictive habitat mapping. Locations where wetlands and predictive BFL habitat were close to proposed infrastructure became the priority areas for field investigations, although additional area across the project site was also examined.

Following the general botanical surveys of the project area, a directed survey for BFL was undertaken on March 03, 2015. This survey was conducted by Tom Neily, Michael Parker, and Andy Sharpe. Specifically areas where proposed roadway construction and turbine laydown areas approached or intersected the predictive mapping areas were prioritized for site visit (See Figure 2). These prioritized areas included area, a). immediately northwest of the access road fork to turbine 3 and turbine 2, b). area northeast of the access road to turbine 3 and the proposed turbine 3 laydown area, c). areas north and south of a portion of the access road toward turbine 2. In addition to these higher priority areas, predictive BFL habitat east of turbine 2 and turbine 3 was also surveyed.

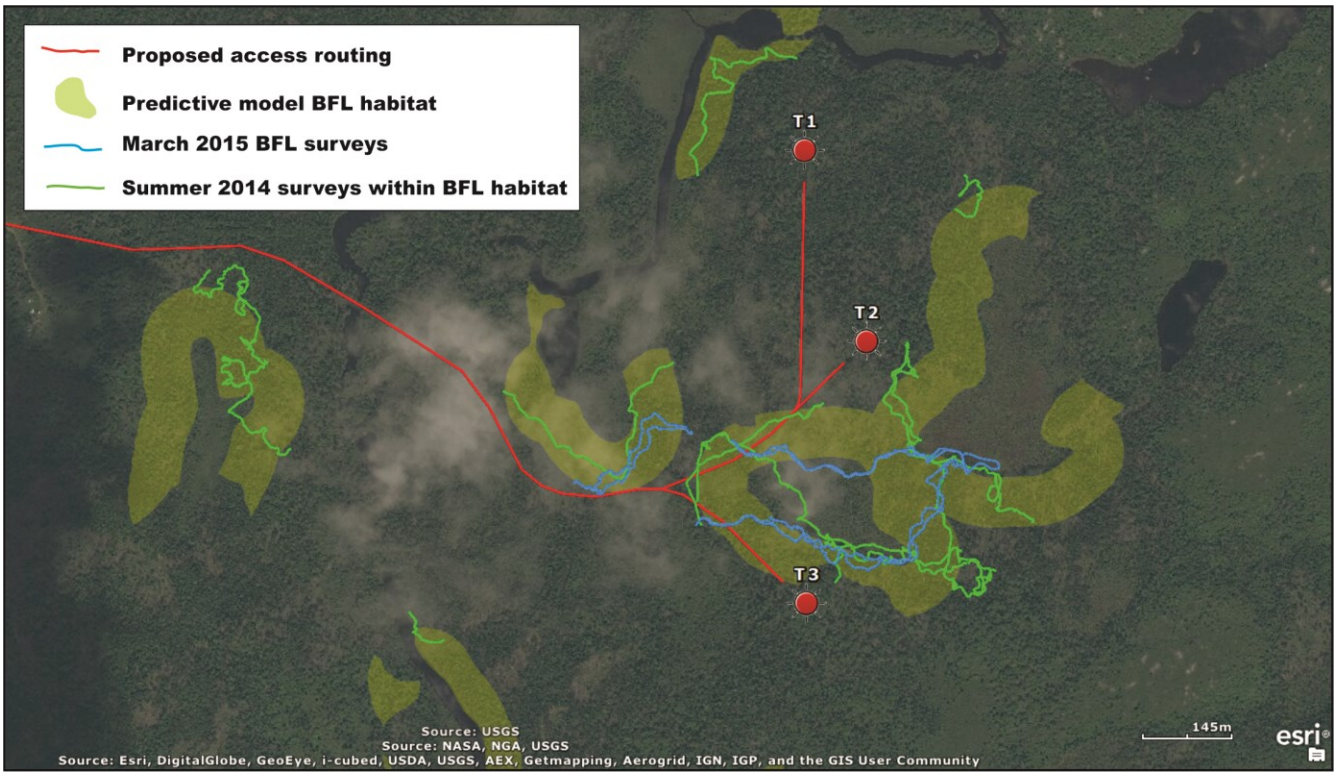

Figure 3: Proposed infrastructure layout at the HWWF project site with predictive mapping of BFL habitat and summer/winter survey tracks through the predictive habitat.

Results of General Botanical and Directed Boreal Felt Lichen surveys

No Boreal Felt lichen was observed during the general botanical surveys within the project area during July and August 2014. No indicator species (*Cococarpia palmicola*, *Lobaria scrobiculata (on fir)*, or *Frullania tamarisci)* were observed during the general botanical surveys. During the survey several treed wetlands were encountered that contain conditions suitable for the endangered BFL. This habitat consists of Balsam fir stands on north facing slopes with a sphagnum dominated wetland at the base. Peatlands supporting Cinnamon Fern, Red Maple, and Black spruce were observed in association with the suitable BFL habitat. A single occurrence of the rare and provincially vulnerable Blue Felt lichen (*Degelia plumbea*) was made (20 T 450508 4931782). Another lichen species of interest observed was *Fuscopannaria ahlneri* which is listed as S4S5. A total of 5910 linear meter of survey occurred through the predictive mapping BFL habitat during the general botanical surveys (see Figure 3). Potential BFL habitat across the entire project area, both near to and well removed from proposed infrastructure, was visited during the summer surveys.

Although no indicator species were observed at the time of the summer surveys a more focused survey was recommended to be carried out at a later date.

Figure 4: Winter Boreal Felt Lichen directed survey within appropriate predictive mapping identified habitat east of the proposed HWWF turbine 3 location, March 03, 2015.

During the March 2015 directed survey, botanist Tom Neily and biologists Andy Sharpe and Michael Parker traversed the prioritized sites for a BFL directed survey. Approximately 6000 linear meters of survey within predicted BFL habitat (Figure 4) was conducted. All of this survey was within the higher priority area immediately adjacent to proposed infrastructure development (see Figure 3 for tracks). No BFL was observed during these directed surveys, and no indicator species were observed. Limited diversity of lichens was generally observed across the site, and common cyanolichens were also noted to be limited. Based on the field surveys, none of the areas close (<100m) to the HWWF proposed infrastructure has habitat that would be considered high probability for Boreal Felt lichen. The most appropriate habitat observed was located approximately 340 m northeast of turbine 3, at the most eastward extent of the conducted surveys (see Figure 4, 20 T 451758 4931484). Yet no indicator species were observed within the area.

BFL Survey Limitations and Conclusion

Limitations exist to both the summer and winter surveys for BFL at the HWWF site. Summer 2014 season surveys through BFL habitat covered all plant species, so directed BFL search was not an explicit survey requirement. The winter 2015 survey was directed; specifically seeking to identify Boreal Felt

lichen in appropriate habitat. Limitations to the winter survey were depth of snow (~60cm) obscuring the bottom of the trees, and a very limited amount of snow on tree stems (<1%) obscuring lichen growth at the time of the survey. Project development time constraints and significant and unusual unbroken winter weather necessitated survey be executed prior to March 5th, 2015. Preferable and typical survey conditions would be during limited to no snow conditions in the late fall or late winter.

Despite, these limitations, it is felt that the appropriate BFL habitat within moderate proximity (0-150+m) to the proposed HWWF infrastructure (roads and turbine sites) was surveyed at an appropriate level of effort (total of ~ 12000 linear m over three sample dates) to reach a conclusion that it is unlikely BFL is located within the areas of moderate proximity to proposed infrastructure. Furthermore, the specific areas of proposed HWWF infrastructure and predictive BFL habitat mapping overlap are felt to have a low potential for BFL based on the quality of available habitat observed during the surveys.

Potential impacts to non-identified Boreal Felt Lichen

Despite the efforts undertaken to determine the presence of Boreal Felt lichen within the project area, its innocuous nature makes locating the species both difficult and time consuming. Although search efforts did not document any BFL or indicator species, it is possible that BFL exists within the project area. Modeling based on microclimate surveys in Nova Scotia indicates tree harvesting adjacent to BFL may increase solar radiation, wind, and temperature, which could have a negative effect on its survival. Maintaining uncut buffer zones around BFL and limiting the size of cut areas in the landscape are recommended to help conserve this endangered species (Cameron et. al. 2013). Provincial best management practices around Boreal Felt lichen recommends a minimum 100m buffer around a located specimen, and 20 m or more around the entire wetland with potential BFL habitat as evidenced by the occurrence of a specimen within the wetland or adjacent upland (DNR 2012).

Potential impacts to non-identified BFL at the HWWF could be mitigated by minimizing turbine laydown areas and access road openings within and immediately adjacent to predictive mapping BFL habitats shown in Figures 2 and 3, and ensuring a minimum 20 m forested buffer is maintained around the single large wetland area north of turbine 3 and south of turbine 2. These efforts would also help to maintain appropriate habitat into which BFL could colonize in the future.

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