Appendix C:

Bat Activity Survey

Characterization of the magnitude of bat activity at the proposed Amherst Community Wind Farm Project, Cumberland County, NS

Final Report Prepared for:
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Context

Project Background

Natural Forces is proposing to install three wind turbines to generate electricity near the community of Amherst, Cumberland County, Nova Scotia. The project is in an early phase with wind monitoring on site with a measurement tower (MET tower) and Sonic detection and ranging (SODAR) unit.

Commercial scale wind energy production is one of the fastest growing sectors of the global energy industry as the demand for renewable energy sources for electricity generation continues to increase (Nelson 2009). This demand, combined with recent advances in wind turbine technology that have improved the cost-competitiveness of wind energy, has led to a global increase in the number of wind energy installations. In Canada, energy production and regulation falls under provincial jurisdiction and thus most renewable energy targets are set at the provincial level. In the province's Renewable Electricity Plan, the Provincial Government of Nova Scotia has set an aggressive target of 40% of the province's electricity needs to be met by renewable energy by the year 2020 (Nova Scotia Department of Energy 2010). Of this amount, 25% has been set as coming from made-in-Nova Scotia sources by 2015, and the wind energy sector is anticipated to be the largest contributor in meeting these goals. As of 2014, Nova Scotia power estimates that close to 10% of current electricity needs are met by wind energy (NSP 2014). The Amherst Community Wind Farm project is part of the Community Feed-In Tariff program (COMFIT) of the Renewable Electricity Plan which facilitates small-scale, local renewable projects that involve community groups.

Despite the many environmental benefits of electrical generation via wind energy, the rapid global growth of the wind energy sector has raised concerns regarding the impacts of these developments on both resident and migratory populations of wildlife (Arnett et al. 2008b). Large numbers of bat fatalities have occurred at wind energy facilities (Johnson 2005a) and this is gaining considerable global attention. As a result, fatalities of bats have become a primary environmental concern associated with wind energy development.

Efforts to minimize conflicts between wildlife and wind energy have focused mainly on two areas: risk avoidance and impact mitigation (Weller and Baldwin 2012). Impact mitigation refers to those efforts focused on developing methods to reduce wildlife fatalities at operational wind facilities and does not apply to this project at this time. Risk avoidance involves conducting surveys prior to construction to avoid sites, or areas within sites, with high levels of usage by wildlife. The assumption of this approach is that low indices of activity prior to construction should result in low fatality rates post-construction since there should be fewer animals 'available' to be killed. This further assumes that bats are not attracted to the infrastructure once built (Baerwald and Barclay 2009). As the planning phase proceeds for the development of the project, surveys of the wildlife at the proposed site are being undertaken to address any potential wildlife issues related to the development of the site. This document provides a summary of the echolocation survey undertaken for bats at the Amherst Community Wind Farm Project in 2014.

Regulatory Context

The following legislation and policy were considered in relation to the proposed survey at the Amherst Community Wind Farm Project:

- Federal Species at Risk Act (http://laws-lois.justice.gc.ca/eng/acts/S-15.3/page-1.html)
- Nova Scotia *Wildlife Act* (http://nslegislature.ca/legc/statutes/wildlife.pdf)
- Nova Scotia *Endangered Species Act* (http://www.novascotia.ca/legislature/legc/statutes/endspec.htm)

Additional resources that are relevant to the proposed surveys used include:

- Atlantic Canada Conservation Data Centre (http://www.accdc.com/)
- Wild Species: The General Status of Species in Canada (http://www.wildspecies.ca/home.cfm?lang=e)
- Global Species Rankings (http://www.natureserve.org/explorer/)

Study Objectives

The objectives of this project were to:

(1) Provide information on the occurrence and relative magnitude of bat activity in the proposed development area, based on analysis of echolocation survey results;

(2) Provide relevant information on the resource requirements of local bat species that may be useful for the decision-making process on the proposed development; and

(3) Make relevant recommendations based on the results of this project and recent developments in the field of bats and wind energy.

Review of Key Issues

Background

As of July (2014) in Nova Scotia, there are >150 wind turbines in operation with a total capacity of approximately 335 MW (CanWEA 2014). As of yet, we are not aware of any incidents of major mortality, though bats have been killed. For context and qualification, most of these turbines have been in operation for only a short period of time (months to less than 10 years) and it is not known how thoroughly all existing operational turbines have been surveyed for bat fatalities, or how well documented and reported the findings are. In the following sections we discuss the various means by which bats may be impacted by wind energy developments, including direct mortality, changes to habitat availability, and disruption of movement patterns (e.g., foraging, mating, migrations, or abandonment of sites).

Direct Mortality

Proximate causes of bat fatalities at wind energy developments may be due to direct strike by rotating turbine blades, collision with turbine towers, barotrauma or any combination of the three. Barotrauma involves tissue damage to the lungs due to rapid or excessive air-pressure reduction near moving turbines blades (Baerwald et al. 2008, Cryan and Barclay 2009). The discussion of the relative role of barotrauma in the death of bats at wind energy developments remains on-going (Grodsky et al. 2011, Capparella et al. 2012, Rollins et al. 2012). In North America, significant bat fatality events at wind energy developments occur primarily in the late summer and early fall, peaking during the period that coincides with fall migration (Johnson 2005b, Cryan and Brown 2007, Arnett et al. 2008a). These trends have led researchers to believe that migration plays a key role in the susceptibility of certain bat species to wind turbine fatalities (Cryan and Barclay 2009). Although some fatality has also been documented during the spring (Brown and Hamilton 2006, Arnett et al. 2008a), numbers are much lower, and are thought to be a result of more scattered migratory behaviour, or possibly the use of different routes compared to fall migration.

The species that have the largest number of kills at wind farms are the long-distance migratory bats, including the hoary bat (*Lasiurus cinereus*), the eastern red bat (*L. borealis*), and the silver-haired bat (*Lasionycteris noctivagans*). In North America, these species make up about 75-80% of the documented fatalities at wind energy developments, with the hoary bat alone comprising almost half (Kunz et al. 2007, Arnett et al. 2008a). The cumulative impacts of current mortality rates as a result of wind turbines on these affected species could have long-term population effects (Kunz et al. 2007). With mortalities at wind turbines in Europe from a large catchment area, including resident and migrating individuals, (Voigt et al. 2012, Lehnert et al. 2014), these effects could be having large scale impacts on these species. Bat fatalities in North America have also been reported for resident hibernating bat species, including the big brown bat (*Eptesicus fuscus*), the little brown bat (*Myotis lucifugus*), the northern long-eared bat (*M. septentrionalis*), and the tri-colored bat (*Perimyotis subflavus*) (Nicholson 2003, Johnson 2005b, Jain et al. 2007, Arnett et al. 2008a). At some sites in the eastern United States high numbers of fatalities of these resident, hibernating species have been reported (Kunz et al. 2007).

Various explanations for the high incidence of bat fatalities at wind energy developments have been proposed (Johnson 2005b, Kunz et al. 2007, Arnett et al. 2008a, Cryan and Barclay 2009). Estimates of the number of bat fatalities vary widely from less than 3 bats/turbine/year (Johnson et al. 2003, Johnson et al. 2004) to upwards of 50 bats/turbine/year (Nicholson 2003, Kerns et al. 2005, Jain et al. 2007). Given the considerable variability in species composition and rates of bat fatalities among wind energy facilities, it is likely that location-specific qualities of individual facilities are important (e.g., located along migration routes or other flight corridors). It has also been proposed that the use of turbines with increasing height has extended developments further into the flight space used by migrating bats (Barclay et al. 2007). However, behavioural observations of bats around wind turbines shows flight patterns typical of foraging activity prior to collisions with turbines which may put bats at increased risk for collisions or interactions (Horn et al. 2008). Recent work has demonstrated that many bats are actively foraging during migration (Reimer et al. 2010, Valdez and Cryan 2013). Others have hypothesized that collisions may result from bats being attracted to turbines out of curiosity, misperception (failure to avoid a detected obstacle or interference with perception of an obstacle), or as potential feeding, roosting, and mating opportunities (reviewed in Cryan and Barclay 2009). New work using thermal imaging cameras found bats closely approached turbine structures (monopoles, nacelles and turbine) as well as made flight loops, dives, and hovering behaviours , and chased other bats around structures (Cryan et al. 2014). The authors suggest that bats are attracted to these structures, perhaps to roost, forage around or seek mates, but to date, the cause(s) of bat fatalities at turbines remains unclear and is an active area of research.

As mortalities may be the result of site-specific and design-specific characteristics and conditions, it is important to conduct site-specific monitoring studies to make reliable inferences on the potential impacts of a wind energy development on local bat populations (American Society of Mammalogists 2008).

Habitat Availability

In forested landscapes, habitat availability for bats may be impacted by the alteration or removal of vegetation to accommodate roads and wind turbine installations. This may include the direct loss of resources (e.g., roost trees), fragmentation of habitat components (e.g., foraging and roosting areas), or other disturbance that may cause bats to vacate certain areas. Together these can act to degrade the local environment for bat colonies/populations that reside in the area during the summer. This negative impact of new wind energy developments is likely to occur, and will contribute to the cumulative effect of habitat loss that is occurring throughout the range of most bat species (Altringham 2011).

At the site level, small-scale clearings in forested landscapes have been shown to attract certain bat species, which use these areas for foraging (Grindal and Brigham 1998, Hayes and Loeb 2007). Removal of vegetation can create edges and small clearings which can act to concentrate prey for bats. The extent to which this loss of vegetation can be perceived to be beneficial to bats is not known. Further, the extent of fragmentation varies from site to site, as there must be a balance between the availability of suitable roosting resources with the availability of suitable foraging areas within commuting distance to provide conditions that favour the occupancy of resident bat species (Henderson and Broders 2008). Differential effects of forest fragmentation are known for different species of a bat community (Patriquin and Barclay 2003, Segers and Broders 2014) thus necessitating the need for bat species considerations in managements plans, not just broad level management plans for bat communities.

Movement Patterns

From the perspective of bat movement, resident bats may be affected by wind energy developments through alterations to foraging areas and possible disruption of commuting movements between roosting and foraging areas. There is some genetic evidence to suggest that bat movements can be impeded by fragmentation of habitat, which can scale up to population or distributional level effects (Kerth and Petit 2005, Meyer et al. 2009). However, this is not well understood for most species.

Little is known about the dynamics of movement (e.g., altitude, travel routes, frequency of visitation) of resident, hibernating bats to and from hibernation sites. Anecdotal evidence suggests that bats likely use ridges and other linear landscape elements (e.g., riparian corridors) as travel routes, depending on the landscape (Arnett 2005, Lausen 2007, Furmankiewicz and Kucharska 2009). In the late summer and early autumn large numbers of bats congregate at the entrances to underground hibernacula in an activity referred to as 'swarming' (Davis and Hitchcock 1965, Fenton 1969, Thomas and Fenton 1979, Glover and Altringham 2008). During the swarming period bats do not roost in hibernacula; research being conducted in Nova Scotia indicates that resident bats are 'on the move', roosting transiently on the landscape (Lowe 2012), though we do not have a full understanding of the dynamics of these behaviours. Swarming may serve several functions, including courtship, copulation, and orienting young-of-the-year to over-wintering sites (Fenton 1969, Thomas and Fenton 1979).

Movement data from Ontario and Manitoba suggests that resident bats may move up to at least 120 km between hibernacula within a year, and up to at least 500 km between years (Fenton 1969, Norquay et al. 2013). In New England, there are records of bats moving 214 km between hibernacula within one year, with one female moving 128 km in only three nights during spring emergence from hibernation (Davis and Hitchcock 1965). Thus these resident hibernating species are at least capable of large scale migratory movements on the order of hundreds of kilometers. It is not known whether flight behaviour (e.g., height, routes, etc.) during this time differs from when resident species are in their summering area; the paucity of information on this aspect of their biology would appear to be one of the largest impediments in accurately predicting the impact of wind energy developments on local bat populations (Weller et al. 2009).

Bats in Nova Scotia

Nova Scotia Bat species

In Nova Scotia there are occurrence records for six species of bats (Table 1; van Zyll de Jong 1985, Broders et al. 2003, Segers et al. 2013), and each have been documented to have experienced fatalities at wind turbine sites (Arnett et al. 2008a). There are three species of long-distance migratory bats recorded in the province, the hoary bat, the eastern red bat, and the silver-haired bat. These three species have extensive distributional ranges throughout North America, with Nova Scotia at or near their northern range limit (van Zyll de Jong 1985). Low numbers of echolocation recordings of the long-distance migratory species in Nova Scotia by Broders (2003), other unpublished work, and recent compilation of sighting records (Lucas and Hebda 2011), suggests that there are no significant populations or large scale migratory movements of these species in the province. However, they do occur regularly and are often associated with coastal or off-shore autumn occurrences (Cryan and Brown 2007, Czenze et al. 2011, Segers et al. 2013). Two species of bats in the genus *Myotis*, the little brown bat and the northern long-eared bat, are the only abundant and widely distributed bats in Nova Scotia (Broders et al. 2003, Henderson et al. 2009). These 5–8 g insectivorous bats are sympatric over much of their range (Fenton and Barclay 1980, van Zyll de Jong 1985, Caceres and Barclay 2000). A third species, the tri-coloured bat, has a significant population in the province, however they are likely restricted to southwest Nova Scotia (Broders et al. 2003, Rockwell 2005, Farrow and Broders 2011). These three species are gregarious species that over-winter in caves and abandoned mines in the region (Moseley 2007, Randall and Broders 2014). There is only one unconfirmed observation of the big brown bat, also a gregarious species, hibernating at a cave in central mainland Nova Scotia (Taylor 1997).

Ecology of Resident Species

Northern long-eared, little brown and tri-coloured bats are expected to be the most likely species to occupy the proposed development area. The life history of these species is typical for temperate, insectivorous bats. Their annual cycle consists of a period of activity (reproduction) in the summer, and a hibernation period in the winter. Females of the three species bear the full cost of reproduction in the summer, from pregnancy to providing sole parental care to juveniles (Barclay 1991, Hamilton and Barclay 1994, Broders 2003).

The northern long-eared bat is a forest interior species that primarily roosts and forages in the interior of forests (Broders 2003, Jung et al. 2004, Henderson and Broders 2008). Females form maternity colonies, roosting in coniferous or deciduous trees, depending on availability (Foster and Kurta 1999, Broders et al. 2006, Garroway and Broders 2008). Males typically roost solitarily in either deciduous or coniferous trees (Lacki and Schwierjohann 2001, Jung et al. 2004, Ford et al. 2006). The little brown bat is a generalist species that is associated with forests, as well as human-dominated environments (Barclay 1982, Jung et al. 1999). This species has been found to forage over water and in forests (Anthony and Kunz 1977, Fenton and Barclay 1980), and both males and females (i.e., maternity colonies) have been documented roosting in both buildings and trees (Crampton and Barclay 1998, Broders and Forbes 2004). During the summer, it appears that most of the commuting and foraging activity of northern long-eared and little brown bats occurs close to the ground (Broders 2003). Nonetheless, our ability to survey bat activity at high altitudes is extremely limited, and therefore our ability to make inference on the vertical distribution of bats is also limited.

The third species that occurs year-round in Nova Scotia is the tri-colored bat, is not likely to occur in the proposed development area as it is locally abundant in southwest Nova Scotia (Farrow and Broders 2011). In Nova Scotia, work that we have done in Kejimkujik National Park suggests that this species roost in *Usnea* lichen species and forages over waterways (Poissant et al. 2010).

White Nose Syndrome

In 2012, three species of bats found in Nova Scotia were listed by COSEWIC as Endangered, and in 2013 were listed as Endangered by the Province of Nova Scotia. This is primarily due to the spread of an emerging infectious disease known as White Nose Syndrome (WNS) that is responsible for unprecedented mortality in hibernating bats through much of eastern North America (Blehert et al. 2009, United States Fish & Wildlife Service 2012). The condition is caused by *Pseudogymnoascus destructans* (formerly *Geomyces destructans)*, a cold-loving fungus that thrives in cave conditions and as such, impacts bat population directly during the winter hibernation period (Lorch et al. 2011, Blehert 2012, Minnis and Lindner 2013). It is thought to disrupt patterns of torpor which results in death by starvation or dehydration (Cryan et al. 2010, Reeder et al. 2012, Warnecke et al. 2013). First documented in New York State in 2006 (Blehert et al. 2009), WNS spread rapidly to 22 states and five Canadian provinces by 2013 and is thought to be responsible for the death of more than 5.5 million bats (United States Fish & Wildlife Service 2012). White Nose Syndrome has been confirmed among populations of seven species of bats. The little brown bat, the most abundant species in the region currently affected by WNS, has experienced the most dramatic population declines (Frick et al. 2010). Some hibernacula have seen mortality rates of 90 to 100 percent of resident hibernating bats as a result of infection with WNS (United States Fish & Wildlife Service 2012), leading researchers to believe that WNS could lead to local extinctions of the little brown bat, as well as other species (Frick et al. 2010).

White Nose Syndrome was first documented in Nova Scotia in April 2011 and declines of 80% to 100 % have since been recorded in winter populations (Broders and Burns, unpublished data). A similar magnitude of decline in summer activity was also observed from 2012 to 2013, following the first full winter WNS was documented in the province (Segers and Broders 2014). Therefore, it would be prudent to protect any surviving animals that may be genetically predisposed to surviving the infection. Even prior to WNS, bats were increasingly recognized as a conservation priority in North America. Now, in consideration of the sharp declines and rapid spread of WNS, serious concerns have been raised about the impact of WNS on the population viability of affected bat species, consequently impacting the conservation status of bat species at the local, national and global level (Table 1). Given that hibernacula represent one of the more critical resources for bats, as they allow successful over-wintering, they are important to protect.

Proximity to Hibernacula

The Nova Scotia Proponent's Guide to Wind Power Projects (Nova Scotia Environment 2012) states that wind farm sites within 25 km of a known bat hibernacula have a 'very high' site sensitivity. There are no known hibernacula within 25 km of the Amherst Community Wind Farm Wind Project area (Moseley 2007, Randall and Broders 2014). The closest known bat hibernacula to the site occur in New Brunswick with Underground Lake Cave located at 41.4 km W, Whites Cave at 42.4 km WNW and Berryton Cave, the historically largest known bat hibernaculum in NB at 56.9 km W (McAlpine 1983, Vanderwolf et al. 2012). The nearest known bat hibernaculum, in Nova Scotia is Lear shaft which is located approximately 54.8 km SE from the proposed development area. Other hibernacula include Minasville at 68.1 km SSE, Cheverie Cave at 75.1 km S and Hayes Caves, the largest known historical hibernaculum at 81.0 km SE.

Table 1. Over-wintering strategy and conservation status of bat species recorded in Nova Scotia.

Species	Overwintering Strategy	Global Ranking[1]	COSEWIC Status	ACCDC status[3]	NSESA[4]
Little brown bat	Resident hibernator	G3	Endangered[2]	S1	Endangered
Northern long-eared bat	Resident hibernator	G2G3	Endangered[2]	S1	Endangered
Tri-coloured bat	Resident hibernator	G3	Endangered[2]	S1	Endangered
Big brown bat	Resident hibernator	G5	Not assessed	N/A	Not listed
Hoary bat	Migratory	G5	Not assessed	S1	Not listed
Silver-haired bat	Migratory	G5	Not assessed	S1	Not listed
Eastern red bat	Migratory	G5	Not assessed	S1	Not listed

[1] Global Ranking based on the NatureServe Explorer: G1 = Critically Imperiled, G2 = Imperiled, G3 = Vulnerable, G4 = Apparently Secure, G5 = Secure. All the above species were reassessed in July 2012.
[2] Assessed by COSEWIC and designated in an emergency assessment on February 3, 2012.
[3] Atlantic Canada Conservation Data Centre ranking, based on occurrence records from NB and NS: S1 = Extremely rare: May be especially vulnerable to extirpation (typically five or fewer occurrences or very few individuals).
[4] Listing status under the Nova Scotia Endangered Species Act: Endangered = a species facing imminent extirpation or extinction; species were reassessed in July 2013.

Methods

Study Area

The project area is approximately 5 km from the town of Amherst (population ≈ 9500) in Cumberland County. This area is within Northumberland Plain district of the Carboniferous Lowlands Theme Region (Davis and Browne 1996) and is in the Maritime Lowlands Ecoregion (Webb and Marshall 1999). Coniferous and mixedwood forests dominate this area composed of red spruce, balsam fir, red maple and eastern white pine with sugar maple and yellow birch found on higher slopes. Interspersed among forests are agricultural lands and old fields.

Ultrasonic Surveys

We used four automated bat detectors (3x model Song Meter SM2Bat+, Wildlife Acoustics, Concord, MA; 1x Anabat, Titley Scientific, Columbia, MO) to sample at four locations within the proposed development area (Table 2, Figure 1). One detector was placed on the edge of the forest near the entrance to the site, and a second was placed at the measurement tower with microphones recording at 2 m and at ≈ 33 m AGL mounted on the MET tower. The third and fourth detectors were placed on forest edges (Table 3). Microphones on the SM2Bat+ units were oriented slightly down to shed rain. The seasonal timing of sampling likely corresponded to the end of the summer residency period, through to the autumn movements of resident species to local hibernacula, and autumn migration by migratory species. Detectors were programmed to turn on ½ hour before and after sunset and were reprogrammed throughout the season to adjust for increasing night length.

Identification of many bat species is possible because of the distinctive nature of their echolocation calls (Fenton and Bell 1981, O'Farrell et al. 1999). Species were quantitatively identified using Kaleidoscope™ software (Wildlife Acoustics) which compares recorded sequences to known echolocation call sequences supplied to the company. We used the “Bats of North America 2.1.0” classifier of the program with the region set as Eastern Canada, and only included the 7 species with records for the province. Following the automatic classification by this program, we manually inspected all call spectrograms and assigned/confirmed call sequence identification. In the case of species in the genus *Myotis* (northern long-eared and little brown bat), we did not identify sequences to the species level for two reasons. First, the Kaleidoscope program uses reference calls from other regions of the species ranges and thus a regional-specific call library is not available for these species. Second, since the calls of the two species can be quite similar depending on the spatial context (Barclay 1999, Broders et al. 2004b), they cannot often not be reliably separated and we had some calls that were clearly *Myotis* species but not auto-identified by the program to one species or another. Recordings from both detector types (SM2Bat+ and Anabat) were subject to the same identification process with manual verification for Anabat files in AnalookW. We used the number of recorded echolocation files as the unit of bat activity, which approximates an echolocation call sequence, defined as a continuous series of greater than two calls (Johnson et al. 2004). Because an individual bat may be recorded making multiple passes, the data presented represent a measure of bat activity, and cannot be used as a direct measure of the number of bats within or passing through an area.

Differences in bat call sequence detections, call quality and ultimately species identifications are known among different models of bat detectors. Recent comparisons have shown that Wildlife Acoustics SM2Bat units record more bat call sequence files than Anabat units (Allen et al. 2011, Adams et al. 2012) and these differences must be incorporated into the interpretations and inferences of data when using both detectors.

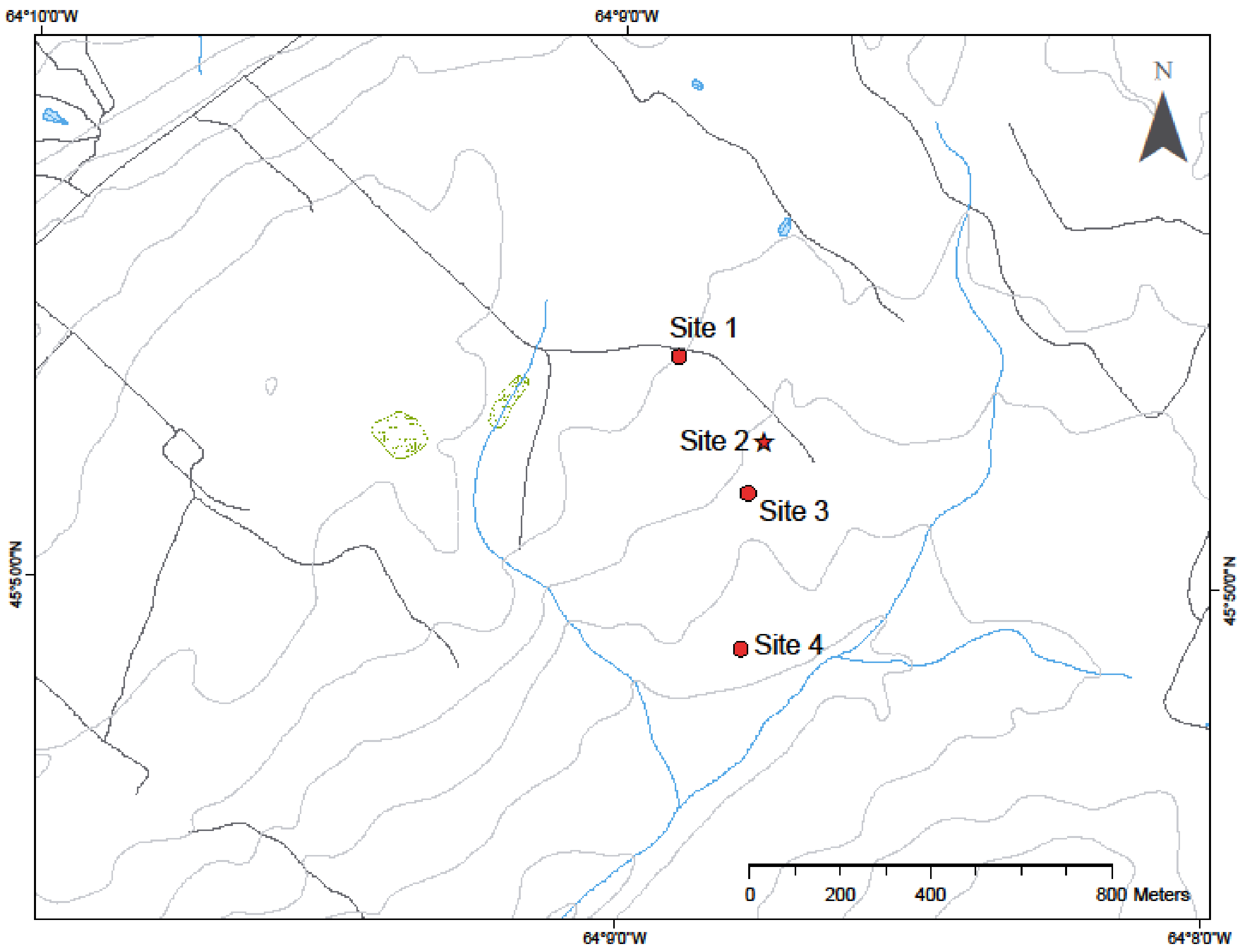

Figure 1. Locations of bat detectors used to sample for bat activity the Amherst Community Wind Farm Project, August to October 2014. GIS data supplied by Service Nova Scotia and Municipal Relations. The star indicates the MET tower that the detector had a high microphone placed on at Site 2.

Table 2. Locations of ultrasonic survey sites for the 2014 survey of bat activity at the proposed Amherst Community Wind Farm Project, Cumberland County, Nova Scotia. Coordinates are NAD83 UTM Zone 20.

Site	Location	Detector type	Coordinates		Deployed	Retrieved
1	Forest edge	Anabat	410822 E	5076671 N	21 Jul 2014	04 Nov 2014
2	MET tower	SM2Bat+	411009 E	5076486 N	21 Jul 2014	04 Nov 2014
3	Forest edge	SM2Bat+	410975 E	5076369 N	21 Jul 2014	04 Nov 2014
4	Forest edge	SM2Bat+	410958 E	5076025 N	21 Jul 2014	04 Nov 2014

Table 3. Site descriptions for ultrasonic survey sites for the 2014 survey of bat activity at the Amherst Community Wind Farm Project, Cumberland County, Nova Scotia.

Site	Description
1	Located along forest edge oriented into a clearing deployed at ground level
2	Detector at MET tower with one microphone at 2 m and a second microphone on the tower at ≈33 m AGL
3	Located along a forest edge with microphone oriented out into the clearing, microphone at 2 m AGL
4	Located along a forest edge, microphone oriented out into the clearing, microphone at 2 m AGL

Assessment of Potential for Hibernacula

To assess the potential for hibernacula to occur in proximity to the project area, we examined the available literature and the Nova Scotia Abandoned Mine Openings (AMO) Database (Fisher and Hennick 2009). To assess the AMO, database location and attribute data were imported into a Geographic Information System (GIS; ArcMap 10.2, ESRI, Redlands, California). We estimated the centre of the Amherst Community Wind Farm project area and buffered the surrounding landscape to 25 km since wind farm sites within 25 km of a known bat hibernacula are to be considered to have a 'very high' site sensitivity (Nova Scotia Environment 2012). Records of underground abandoned mine openings occurring within the buffer were then exported into a spreadsheet where we subsequently excluded specific AMO's as being unlikely hibernacula based on four sequential attribute criteria (Table 4).

Table 4. Attributes of fields used from the Nova Scotia Abandoned Mine Openings Database used to exclude openings from the list of unexplored potential hibernacula for bats near the Amherst Community Wind Farm Project Area, Cumberland County, Nova Scotia.

Ordering	Field Heading	Criteria used for exclusion
1	Origdepth	≤19 m in depth
2	Flooded	attribute = T (true)
3	Protection	those that are backfilled, excavated and backfilled, filled or sealed
4	Plug	those containing a plug of rock, rock & vegetation, rock & garbage, garbage (and where field "Landuse"= municipal garbage dump site)

Results

The Anabat detector and two SM2Bat+detectors (Sites 2 & 3) were deployed from 21 July to 04 November and continuously recorded during this time. The SM2Bat+ detector at site 4 was vandalized sometime after 12 September and before 26th of September. We can only validate it was fully operational and recording from the period 21 July to 11 September 2014 based on recordings and our site visit to download data. A total of 477 detector nights were sampled where one bat detector running continuously from sunset to dawn is considered as 1 detector night.

Within the proposed wind energy development area there were 2047 acoustic files recorded on the 4 detectors. A total of 1028 of these were classified as bat-generated ultrasound files and the remaining classified as extraneous noise (Table 5). Of the 1028 echolocation sequences, 16 were recorded at site 1 (Anabat), 58 were recorded at site 2 on the low microphone, 80 were recorded at site 2 on the high microphone, 27 were recorded at site 3 and 847 were recorded at site 4. The vast majority of call sequences (955/1028; 92.9 %) were classified as hoary bat call sequences. This was followed by 4.7 % (48/1028) classified as *Myotis* species (i.e., includes northern long-eared and little brown bats); as stated above no attempt was made to identify these call sequences to the species. We also detected 18 call sequences as silver-haired bat sequences representing 1.7 % of the total bat call sequences. The calls of big brown and silver-haired bats can be difficult to distinguish between (Betts 1998). However, based on our knowledge of bats in Nova Scotia where only one, unverified record occurs of the big brown bat, we believe these sequences are silver-haired bat sequences. Lastly we classified 7 sequences as belonging to red bats representing 0.7 % of the total recorded bat call sequences. Two of these sequences were of short duration making them of lower quality to identify (detected on Aug 8 and September 12 at site 2 on the high microphone). However, the characteristics of the call pulses within the sequences files (e.g., minimum frequency, slope) were consistent with red bat calls.

The average number of recorded bat call sequences per night (averaged over all detectors at all four sites together) in the proposed development area was 2.16 (SD =21.1) during the sampling period. To place the relative magnitude of activity recorded in the study area into context, in 129 nights of monitoring along five forested edges in the Greater Fundy National Park Ecosystem from June to August 1999, the average number of sequences per night was 27 (SD = 44; Broders unpublished data). In 650 nights of monitoring at river sites in forested landscapes in southwest Nova Scotia from June to August of 2005-2006, the average number of sequences per night was 128 (SD = 232; Farrow unpublished data), though note that rivers act to concentrate bat activity, as they are used as foraging and commuting corridors (Laval et al. 1977, Fenton and Barclay 1980, Krusic et al. 1996, Zimmerman and Glanz 2000, Lacki et al. 2007). Both of these previous comparisons were conducted prior to the emergence of white nose syndrome and therefore are likely not directly comparable. In a forested landscape in Colchester County, Nova Scotia, an approximate 99% decrease in bat echolocation activity was detected after significant mortality was noted in Nova Scotia following the arrival of white nose syndrome to the province. In that study the average number of bat call sequences recorded at forested and riparian areas, per night, dropped from 111.22 (SD 163.54) in 2012 to 0.95 (SD=1.84) in 2013 (Segers and Broders 2014).

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Table 5. Number of echolocation bat call sequence files recorded per night for the 2014 survey of bat activity at the proposed Amherst Community Wind Farm Project, Cumberland County, Nova Scotia. LAB= *Lasiurus borealis,* LAC= *Lasiurus cinereus,* MYO = *Myotis* species, LAN = *Lasionycteris noctivagans*.

	Site 1			Site 2 low mic				Site 2 high mic				Site 3			Site 4				Nightly
Night of	LAB	LAC	MYO	LAB	LAC	LAN	MYO	LAB	LAC	LAN	MYO	LAC	LAN	MYO	LAB	LAC	LAN	MYO	Total
21-Jul-14	0	0	0	1	3	3	3	0	7	0	0	2	0	1	0	122	0	0	142
22-Jul-14	0	0	0	0	2	0	0	0	4	0	0	1	0	0	0	263	0	0	270
23-Jul-14	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	357	0	0	360
24-Jul-14	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	6	0	0	10
25-Jul-14	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	25	0	0	28
26-Jul-14	0	2	0	0	1	0	0	0	1	0	0	0	0	0	0	4	0	1	9
27-Jul-14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	8
28-Jul-14	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	15	0	1	19
29-Jul-14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	10
30-Jul-14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
31-Jul-14	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	1	5
1-Aug-14	0	0	1	1	0	0	12	0	0	0	0	0	0	1	0	0	0	2	17
2-Aug-14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
3-Aug-14	0	1	0	0	2	0	0	0	5	0	0	1	0	1	0	2	0	0	12
4-Aug-14	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
5-Aug-14	0	0	0	0	21	0	0	0	28	0	0	1	0	0	1	0	0	0	51
6-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Aug-14	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
8-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Aug-14	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	3
10-Aug-14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Aug-14	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3
13-Aug-14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1

	Site 1			Site 2 low mic				Site 2 high mic				Site 3			Site 4				Nightly
Night of	LAB	LAC	MYO	LAB	LAC	LAN	MYO	LAB	LAC	LAN	MYO	LAC	LAN	MYO	LAB	LAC	LAN	MYO	Total
14-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Aug-14	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2
17-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Aug-14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
19-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
22-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
24-Aug-14	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
25-Aug-14	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	4
26-Aug-14	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	5
27-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
28-Aug-14	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2
29-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Aug-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	10
31-Aug-14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Sep-14	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2
3-Sep-14	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
4-Sep-14	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	6	2	0	11
5-Sep-14	0	0	0	0	0	1	0	0	1	1	0	3	0	1	0	1	2	0	10
6-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
8-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
10-Sep-14	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	3

	Site 1			Site 2 low mic				Site 2 high mic				Site 3			Site 4				Nightly
Night of	LAB	LAC	MYO	LAB	LAC	LAN	MYO	LAB	LAC	LAN	MYO	LAC	LAN	MYO	LAB	LAC	LAN	MYO	Total
11-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Sep-14	0	0	0	0	0	0	0	1	0	0	1	0	0	1	-	-	-	-	3
13-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
14-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-	-	-	-	2
15-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
16-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
17-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
18-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
19-Sep-14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-	-	-	-	1
20-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
21-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
22-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
23-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
24-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
25-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
26-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
27-Sep-14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	-	-	-	1
28-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
29-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
30-Sep-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
1-Oct-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
2-Oct-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
3-Oct-14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-	-	-	-	1
4-Oct-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0
Data not shown from 5-Oct-14 to 03-Nov-14 when no bat call sequences were recorded																			
Site totals	1	11	4	2	32	5	19	2	69	6	3	11	2	14	2	832	5	8	1028
Project Ave																			2.16
Num nights																			106

The symbol "– "means the detector was not validated as recording on that night

According to the Nova Scotia Abandoned Mine Openings Database (Fisher and Hennick 2009), there are 366 underground abandoned mine opening records in the vicinity of the Amherst Community Wind Farm Project (within 25 km). Following our exclusion analysis, 56 of the AMO records remain that could potentially act as bat hibernacula (Appendix 1) where to our knowledge they have never been surveyed for bats before.

Discussion

In our work at the Amherst Community Wind Farm Project, we have recorded high bat species richness where 5-6 species were detected that includes resident and migratory species. Hoary bats were recorded at high activity levels with the species detected on 28 nights, the most we have detected in any of our previous projects in Atlantic Canada.

Hoary bats were detected during the residency portion of the survey with sequences recorded on 17 of 20 nights sampled prior to 10 August; an approximate date of when migration activity begins to increase. The majority of the hoary bat call sequences were temporally and spatially clustered with 97.8 % of the total hoary bat call sequences recorded at site 4 from July 21 to August 4th. On the three nights with the highest number of sequences recorded, they were recorded from approximately 21:30 to 04:30. The high levels of activity (i.e., the total call sequences recorded and high number of nights recorded on), and the clustering of activity early on in the survey period may suggest the presence of resident hoary bats that summer around the area. Typically, sightings/recordings of hoary bats in the province are rare and occur most often in the late summer/early autumn migratory period. We cannot make inference on the number of individual hoary bats in the area that made the calls because an individual bat may be recorded making multiple passes. High activity can thus result from just a few individuals that are foraging nearly continuously around a particularly rich and available prey source or from many individuals using the same area. In this case the exceptionally high magnitude of activity of this species was concentrated at just 1 of four detector sites (site 4), suggesting that high activity was not widespread. Regardless, more intensive surveys earlier, and throughout the summer would be required to assess the full extent to which hoary bats are resident in the area.

Collectively, call sequences of the other migratory species (red and silver-haired bats) represented only 2.5% of the total calls recorded. The low number of call sequences attributed to the red and silver-haired bat, suggests that there are no large populations or significant migratory movements of these species at the study area. This fits with our current knowledge of the status of this species in the province where sightings are rare and often occur in the late summer/early autumn on the coast or offshore (Broders et al. 2003, Czenze et al. 2011, Lucas and Hebda 2011, Segers et al. 2013). However, occurrences do occur regularly, albeit in low frequency, and these species, along with hoary bats, are especially vulnerable to wind facilities. All three migratory species are generally solitary, tree-roosting species with extensive distributional ranges throughout North America (van Zyll de Jong 1985, Naughton 2012). These species have received the greatest attention with regards to wind energy developments because they make up the large majority of documented fatalities at existing developments in North America. Any mortality of hoary, red or silver-haired bats would be significant to Nova Scotia given there low numbers in the region. Significant bat fatality events at wind energy developments occur primarily in the late summer and early fall, peaking during the period that coincides with the long-distance fall migration of these species (Johnson 2005b, Cryan and Brown 2007, Arnett et al. 2008a). This has led researchers to believe that migration plays a key role in the susceptibility of certain bat species to wind turbine fatalities (Cryan and Barclay 2009). It has been proposed that this may be because these species travel at a height that puts them at increased risk of collisions with rotating turbine blades (Barclay et al. 2007, Arnett et al. 2008a).

For the *Myotis* spp., interpretation of these data are problematic for assessing relative risk to bats at the proposed development given our knowledge of the devastating impacts that white nose syndrome has had, and is having, on local bat populations. The disease is now confirmed in nine counties in mainland Nova Scotia and three counties in Cape Breton including the county where the project area is located. Elsewhere, white nose syndrome significantly reduced the summer *Myotis* bat activity by as high as 75% (Dzal et al. 2011, Jachowski et al. 2014). In the winter of 2012-2013, there were hundreds of fatalities recorded at several known hibernacula in the province and annual monitoring counts of bats at such hibernacula were down, on average, by 94% (Broders and Burns, unpublished data). These observations are suggestive of a major mortality event in the area, likely decreasing the magnitude of bat activity in many areas in the summer. This is supported by other work we are conducting in the region suggesting a >99% reduction in the magnitude of echolocation activity in 2013, relative to 2012 (Segers and Broders 2014), and decimation of a number of maternity colonies in the region. For these reasons this dataset must be interpreted with caution.

After the hoary bat call sequences, the majority of the identified echolocation sequences recorded for this project were attributable to the two species of *Myotis* bats known to occur in Nova Scotia, the little brown bat and the northern long-eared bat. This was expected as they were the only abundant and widely-distributed species in the province, and are two of only three species that had large numbers in the province (Broders et al. 2003). Although we did not distinguish the calls of *Myotis* species, the majority of the recorded sequences likely represent the little brown bat, as this species is known to forage in open areas and over water. The northern long-eared bat is a recognized forest interior species (Jung et al. 1999, Henderson and Broders 2008), and is less likely to use open areas for foraging and commuting (Henderson and Broders 2008). Additionally, the northern long-eared bat has lower intensity echolocation calls and is thus not recorded as well as the little brown bat (Miller and Treat 1993, Broders et al. 2004a).

Myotis species are relatively new to the list of species among fatalities at wind turbines sites. This may be due to the fact that the first large scale wind developments were located primarily in western North America, typically in agricultural and open prairie landscapes (reviewed in Johnson 2005b). Fatalities of these resident, non-migratory species were largely absent from these sites, likely due to the association of these species with forested landscapes. More recently, evidence of *Myotis* fatalities resulting from collisions with wind turbines have been noted at sites in eastern North America (reviewed in Johnson 2005b, Jain et al. 2007, Arnett et al. 2008a). Although there are fewer documented fatalities of *Myotis* bats compared to long-distance migratory species, there is still a risk of direct mortality.

Other than direct bat mortality as a result of collisions with turbines, there is also the potential that disruption of the forest structure (e.g., removal of trees and fragmentation of forest stands for roads and clearings) will degrade the local environment for colonies/populations of *Myotis* bats that reside in the area during the summer. This can occur by the elimination of existing roost trees, the isolation of trees left standing, as well as the elimination or degradation of foraging areas for bats.

Additionally, resident bat species make what are generally considered to be short distance migrations (range of tens to hundreds of kilometres) from their summering areas to underground sites where they hibernate. Little is known about the flight behaviour and dynamics of these movements (i.e., height of travel, and routes); therefore, it is difficult to predict the specific effects that wind developments will have on the movements of local populations of bats in the spring or fall from summering sites to hibernation sites.

Given the context of white-nose syndrome, as discussed above, there was no acoustic evidence of a significant movement of *Myotis* bats through the area investigated during this pre-construction survey of bat activity. The overall magnitude of activity was low compared to baseline levels (collected prior to 2007), and more comparable to levels recorded in 2013 (following white nose syndrome) that one would expect in a forested ecosystem in the region. Although we cannot rule out the possibility that mortality events associated with this development will occur, we have found no evidence to suggest that the proposed project will cause large numbers of direct mortality of bats. That being said, in light of white nose syndrome and the recent listing of the several resident species as endangered, the significance of any mortality is much greater than it would have been just a couple of years ago. However, this study recorded the highest concentration of hoary bats that we have recorded in Atlantic Canada. This activity was greatest in the early part of our survey (late July) and may indicate resident bats in the area. Further, as discussed above, any mortality of hoary bats (or the other migratory species) would also be significant to the province given their low numbers in the province.

Recommendations

1. *Pre-construction monitoring* – Given the findings of high hoary bat activity during the summer residency period in this study (2014), we recommend follow up monitoring to make better inference on the use of the site as summer habitat.

2. *Post-construction monitoring* – A rigorous post-construction monitoring program, appropriately designed to account for searcher efficiency and scavenger rates, needs to be established to quantify bat fatality rates. These surveys should be conducted over an entire season (April to October), but especially during the fall migration period (mid-August to late-September) for at least two years. Should fatalities occur, they should be investigated with respect to their spatial distribution relative to wind turbines, turbine lighting, weather conditions, and other site specific factors. Should trends be identified, operations should be adjusted in an adaptive management framework whereby mitigation can be focused on any identified high risk areas/infrastructure to minimize future fatalities. These data are essential for assessing potential risks at future developments in the region via assessment of cumulative effects; therefore it is critical that the results of these surveys be appropriately reported.

3. *Retain key bat habitat* – Key bat habitat should be identified in the project area (e.g., wetlands, riparian areas, mature deciduous-dominated forest stands) and retained to continue to support any existing summer colonies and or potential fall movement corridors of bats. Forested wetlands/riparian areas may be used by bats during migratory phases which would be important to retain as some bats do make migratory stopovers to feed and/or roost (McGuire et al. 2012). In this case, as much of the remaining forest and forest patches should be maintained as these will provide roosting and foraging habitat for resident bats. The forest-clearcut edges also

provide foraging habitat for bats. Retention of these bat habitat resources should be in a spatial manner that provides connectivity in the project area and with the larger landscape to ensure foraging and roosting areas remain well connected. Consideration of the potential for fragmentation of bat habitat resources should also be taken with regards to the development of road networks and transmission lines in the project area.

4. *Return to pre-project state upon decommissioning* – The project area should be returned to the state that existed prior to the development of the site once the project is decommissioned. This should include planning to ensure the continuity of forest stand succession to provide and maintain appropriate roosting areas well into the future as existing roost trees die off. Retention of forest stands of a range of ages will provide mature trees for bat roosting resources in the future.

5. *Develop an operations fatality mitigation plan* – Recent experimental case studies in Alberta and the United States have demonstrated dramatic reductions in bat fatalities at operational wind energy facilities can be made by changing operational parameters during the peak fatality period (Baerwald et al. 2009, Arnett et al. 2010). These include changes to when turbine rotors begin turning in low winds via alterations to wind-speed triggers and blade angles to lower rotor speed. These studies have found decreases in bat mortalities ranging from 44% to as high as 93% reductions on a nightly basis at relatively low cost to annual power production loss, at approximately ≤ 1%. This plan should be adaptive as operations continue through time and be in place prior to operations commencing such that if any bat mortalities be observed at the site once operational, the plan can be implemented immediately.

6. *Remain up to date with current research* –There is presently an abundance of on-going research aimed at determining the impacts of wind energy developments on populations of bats. Other studies are focusing on investigating the efficacy of potential mitigation measures, including the effects of weather on bat activity patterns and collisions with wind turbines, and possible bat deterrents (including acoustic (Arnett et al. 2013)and radar emissions). As these are active areas of research, it is essential that the most current studies and guidelines are used to guide management decisions and development plans for wind energy projects.

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Appendix 1. Identified abandoned mine openings (AMO's) from the Nova Scotia AMO Database that are located within 25 km of the Amherst Community Wind Farm Project and have the potential to be bat hibernacula.

Shaft ID	Location (as listed in the database)	Original Depth (m)	Land ownership
RIV-2-197	RIVER HEBERT	24	Private
SST-1-004	SALTSPRINGS STATION	30	Private
JMA-2-106	MACCAN	32	Private
RIV-2-204	RIVER HEBERT EAST	40	Private
RIV-2-221	RIVER HEBERT	41	Private
RIV-2-067	RIVER HEBERT EAST	50	Private
RIV-2-053	RIVER HEBERT	54	Private
RIV-2-200	RIVER HEBERT	60	Private
RIV-1-324	RIVER HEBERT	60	Private
RIV-2-066	RIVER HEBERT EAST	68	Private
RIV-2-078	RIVER HEBERT EAST	70	Private
RIV-2-079	RIVER HEBERT EAST	70	Private
RIV-2-209	RIVER HEBERT	70	Private
SCD-1-039	SPRINGHILL	72	Private
RIV-2-049	RIVER HEBERT	80	Private
RIV-2-238	RIVER HEBERT EAST	90	Private
RIV-2-076	RIVER HEBERT EAST	90	Private
RIV-2-215	RIVER HEBERT EAST	90	Private
RIV-2-062	RIVER HEBERT EAST	90	Private
RIV-2-205	RIVER HEBERT EAST	90	Private
RIV-2-237	RIVER HEBERT EAST	95	Private
RIV-2-235	RIVER HEBERT	98	Private
RIV-2-075	RIVER HEBERT EAST	110	Private
RIV-2-041	RIVER HEBERT	120	Private
RIV-2-321	RIVER HEBERT EAST	130	Private
RIV-2-060	RIVER HEBERT EAST	130	Private
RIV-1-028	RIVER HEBERT	160	Private
RIV-2-040	RIVER HEBERT	160	Private
RIV-2-035	RIVER HEBERT	165	Private
RIV-2-070	RIVER HEBERT EAST	165	Private
RIV-2-214	RIVER HEBERT EAST	170	Private
RIV-2-061	RIVER HEBERT EAST	188	Private
RIV-1-233	RIVER HEBERT	190	Private
RIV-2-216	RIVER HEBERT EAST	200	Private
RIV-2-048	RIVER HEBERT	205	Private

Shaft ID	Location (as listed in the database)	Original Depth (m)	Land ownership
RIV-1-029	RIVER HEBERT	210	Private
RIV-2-045	RIVER HEBERT	225	Private
RIV-2-046	RIVER HEBERT	225	Private
RIV-2-042	RIVER HEBERT	235	Private
RIV-2-077	RIVER HEBERT EAST	260	Private
RIV-2-054	RIVER HEBERT	265	Private
RIV-2-239	RIVER HEBERT EAST	340	Private
RIV-2-080	RIVER HEBERT EAST	340	Private
RIV-2-068	RIVER HEBERT EAST	380	Private
RIV-2-073	RIVER HEBERT EAST	384	Private
RIV-2-203	RIVER HEBERT EAST	400	Private
RIV-2-038	RIVER HEBERT	488	Private
RIV-2-059	RIVER HEBERT EAST	488	Private
RIV-2-043	RIVER HEBERT	640	Private
RIV-2-074	RIVER HEBERT EAST	830	Private
RIV-2-032	RIVER HEBERT	920	Private
RIV-2-072	RIVER HEBERT EAST	1,000.00	Private
RIV-2-047	RIVER HEBERT	1,095.00	Private
RIV-2-033	RIVER HEBERT	1,120.00	Private
SCD-1-043	SPRINGHILL	584	Crown
SCD-1-007	SPRINGHILL	584	Crown

Appendix 2. Survey site photographs

Figure A1: Bat detector (Anabat) placement at site 1. Red rectangle shows placement of detector and inset shows a front view of the detector.

Figure A2. Bat detector (SM2Bat+) placement at site 2 showing the low microphone on the 2x2 (2 m AGL). Red rectangle shows the high microphone position on the MET tower (≈33 m AGL).

Figure A3. Bat detector (SM2Bat+) placement at site 3 along a forest edge.


Figure A4. Bat detector (SM2Bat+) placement at site 4 along a forest edge.

Appendix D:

Archaeological Resource Impact Assessment

Amherst Wind Project

Archaeological Resource Impact Assessment

Heritage Research Permit A2014NS041

November 2014

Davis MacIntyre & Associates Limited
109 John Stewart Drive, Dartmouth, NS B2W 4J7

Amherst Wind Project
Archaeological Resource Impact Assessment

Heritage Research Permit A2014NS041

Davis MacIntyre & Associates Limited
Project No. 14-015.2

November 2014

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Report Compiled by: Courtney Glen, April MacIntyre & Irene Hart

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Cover Image: The meteorological tower for the Amherst Wind Project, looking southeast.

Executive Summary

Davis MacIntyre & Associates Limited was contracted by Natural Forces to conduct an archaeological resource impact assessment of the proposed Amherst Wind Project in Cumberland County. The purpose of the assessment was to determine the potential for archaeological resources within the study area and to provide recommendations for mitigation, if necessary. The assessment included a historic background study and reconnaissance. An initial reconnaissance of a preliminary layout was conducted in June 2014. A second reconnaissance of the final layout was conducted in November 2014.

The results of the archaeological resource impact assessment indicates that the study area is of low potential for First Nations resources. Furthermore, no historic period archaeological resources were identified within the impact area during the assessment. The only cultural activity that was observed during the reconnaissance was modern, mainly logging and active agriculture. Therefore, no further mitigation is recommended. However, should development plans change so that areas not assessed during this investigation are to be impacted (by access roads or turbine sites), it is recommended that those areas be subject to an archaeological assessment.

Finally, in the unlikely event that archaeological resources are encountered during ground disturbance activities, it is required that all activity cease and the Coordinator of Special Places (902-424-6475) be contacted immediately.

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1.0 Introduction

In May 2014, Davis MacIntyre & Associates Limited was contracted by Natural Forces to conduct an archaeological resource impact assessment of a proposed wind project near Amherst, Cumberland County. The purpose of the assessment was to determine the potential for archaeological resources within the impact area, and to provide recommendations for further mitigation if necessary.

The assessment was conducted under Category C Heritage Research Permit A2014NS041 (Appendix A). This report conforms to the standards of the Nova Scotia Department of Communities, Culture and Heritage and the Heritage Research Permit requirements as per the Special Places Protection Act (*R.S., c. 438, s. 1.).*

2.0 Study Area

The study area is located approximately 3.0 kilometers east of Amherst in Cumberland County, on John Black Road. Natural Forces proposes to construct a 6.0 MW wind farm that will include three turbines and necessary access roads. In June 2014, an initial layout was provided for access roads and the three turbine candidate sites. The layout was revised, however, in November 2014 (Figure 2.0-1). The foundation excavation for each turbine will be approximately 2 meters deep and 15 meters in diameter. Access roads will be 6 metres wide, with a maximum width of 12 metres. There is an existing road within the study area, which leads to toward turbine candidate site #1 and currently terminates at the data collector. The existing road will likely be upgraded and a new access road constructed where necessary.

A buffer of 80 metres was established around the turbine candidate sites. The purpose of the buffers was to provide a possible impact area to be examined during field reconnaissance with the understanding that if any impact is subsequently planned for outside of the 80 metre buffer areas, additional field reconnaissance will be required.

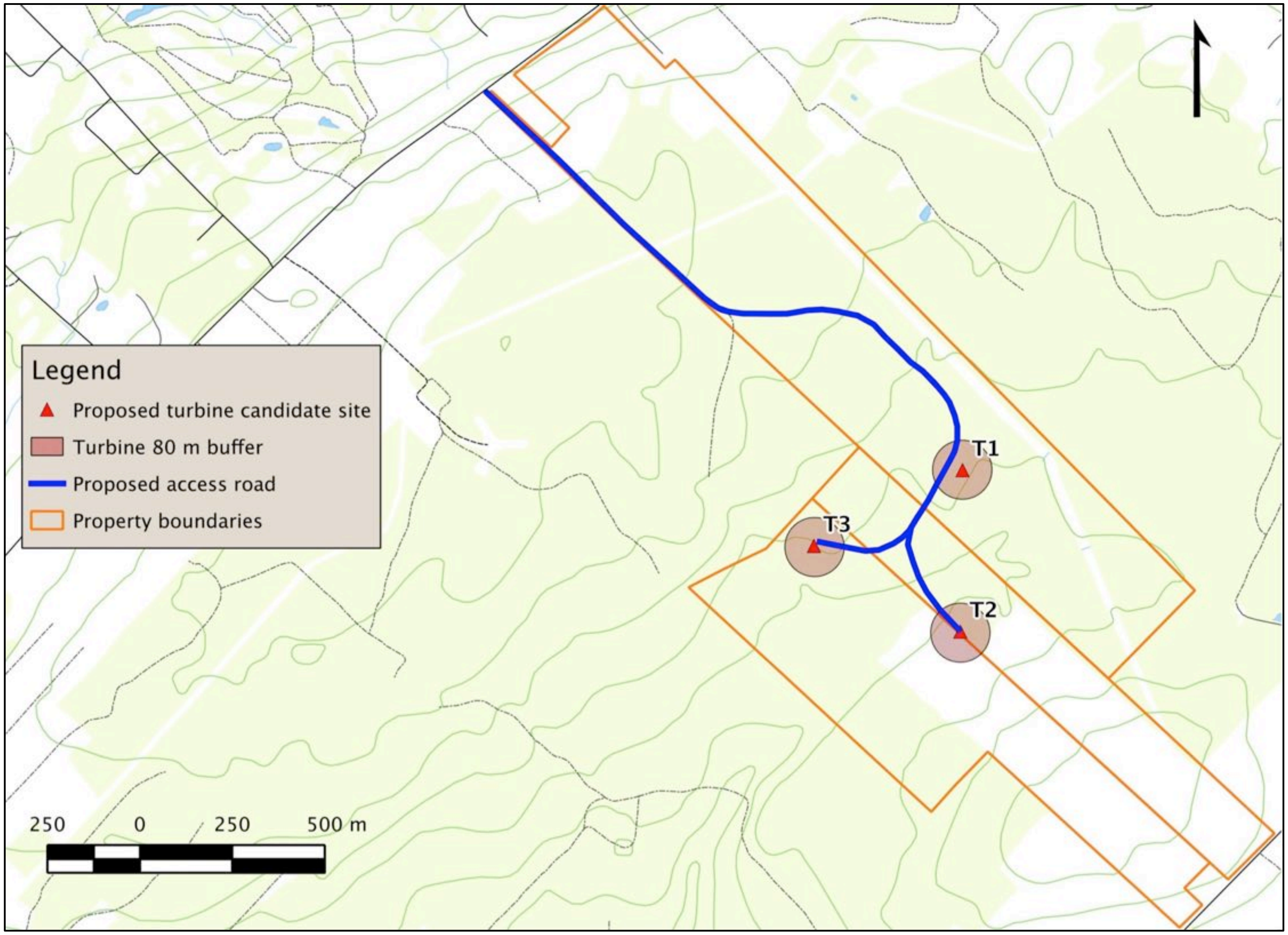

Figure 2.0-1: Map of the proposed Amherst wind project development showing the November 2014 layout (Data courtesy of Natural Forces).

Amherst is located in theme region #521a, the Northumberland Strait sub-Unit of the Northumberland Plain theme region (Figure 2.0-2). This region covers the area from Cumberland Basin to Pictou and contains an anticline that runs from Pugwash Harbour to Nappan and Amherst Point. The area contains fine red sandstones. The region has a dendritic drainage pattern and mainly drains into the Northumberland Straith, although the southwest area, including the Nappan River, drains into the Cumberland Basin. The soil ranges from sandy loam to sandy clay loam and is derived from sandstone and shales which underlie the entire area. The subsoil tends to be compacted and impermeable and the soils are usually imperfectly drained.

The forests tend to be dominated by Black Spruce, Jack Pine, White Spruce, Red Spruce and Red Maple with some Eastern Hemlock and White Pine. However, much of the area is oldfields or is still actively farmed, creating a significant amount of active and abandoned farmland. The region is home to animals such as coyotes, muskrat, mink, racoon and red fox. The waterways are productive, containing some River Otter, and Atlantic Salmon, Gaspereau, Brown Trout and Brook Trout.[1]

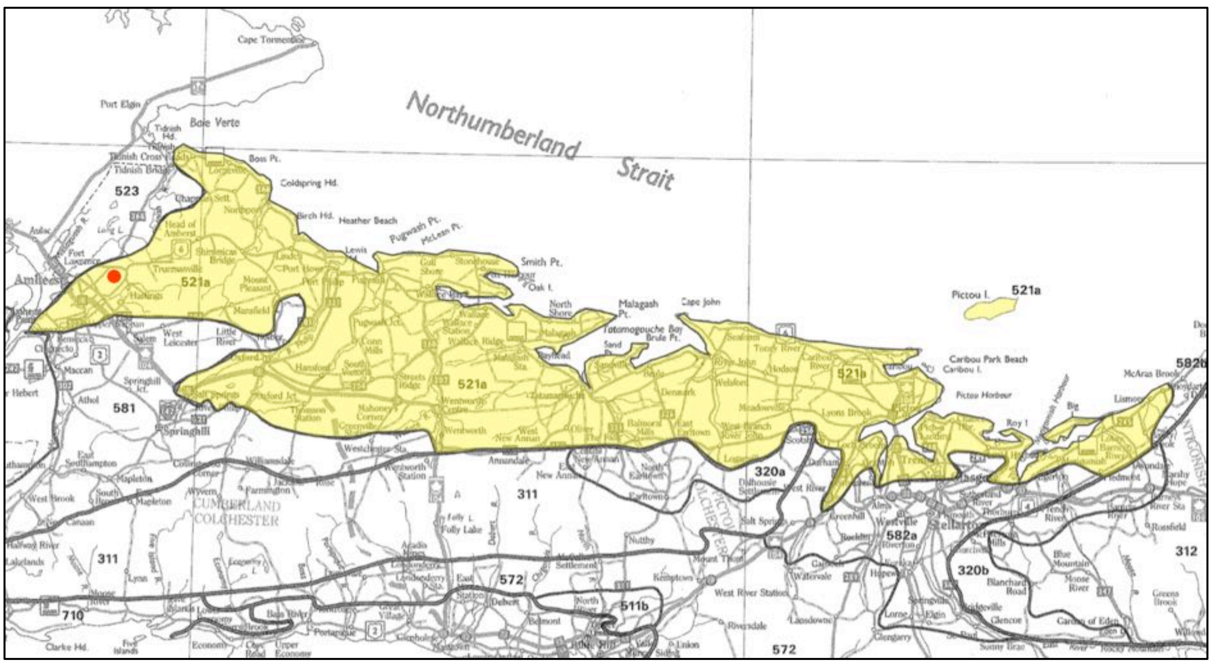

Figure 2.0-2: Natural Theme Regions of Nova Scotia, showing region #521a (highlighted in yellow) – Northumberland Plain, Northumberland Strait, sub-Unit.[2] The approximate location of the study area is indicated in red.

[1] Davis and Browne, 1996: 108-111.
[2] Adapted from Davis and Browne, 1996.

3.0 Methodology

A historic background study was conducted by Davis MacIntyre & Associates Limited in June 2014. Historical maps and manuscripts and published literature were consulted as well as previous archaeological assessments in the general vicinity. The Maritime Archaeological Resource Inventory, a database of known archaeological resources in the Maritime region, was searched to understand prior archaeological research and known archaeological resources neighbouring the study area. Finally, a field reconnaissance was conducted in order to further evaluate the potential for archaeological resources. An initial reconnaissance was conducted in June 2014 of the preliminary access road and turbine site layout. The details of this reconnaissance can be found in appendix B. A reconnaissance of final layout was conducted in November 2014.

3.1 Maritime Archaeological Resource Inventory

The Maritime Archaeological Resource Inventory was consulted in June 2014 in order to determine if known archaeological sites or resources exist within or near the study area. Ten sites were found in the general area of Cumberland County, although none were found in close proximity to the study area.

A cluster of known sites is located approximately 9 kilometers northwest of the proposed Amherst wind project. These sites include the Acadian village of Beaubassin (BlDb-07 and BlBd-20), the British Fort Lawrence (BlBd-08), the Amherst terminus of the Chignecto Marine Transport Railway (BlBd-09) and an isolated First Nations find (BlBd-17). The isolated find was an Adena celt preform found during construction activities of the Fort Lawrence reconstruction.

Seven additional known sites are located within 10 to 15 kilometers of the study area. These sites include four precontact First Nations resources. Two late Archaic/ early Ceramic period sites (c. 2500 years ago) were recorded near Harrison Lake (BkDb-01, BkDb-02), an isolated late Archaic artifact was found near Amherst Point (BkDb-04) and an isolated find dating to the Archaic period (9000 to 2500 years ago) was recorded near Nappan (BkBd-06).

Two 19th century cellar depressions were recorded on Amherst Point (BkDb-03) and six 19th or 20th century cellar depressions were recorded on Minudie Marsh (BkDb-05 and BkDc-01) as part of a larger historic village site.

The lack of recorded archaeological resources in close proximity to the study area is likely an indication of a lack of detailed archaeological surveys being completed in the area, rather than a lack of archaeological resources, especially considering the large amount of known historic and First Nations occupation in the area.

3.2 Historic Background

3.2.1 The Precontact Period

The history of human occupation in Nova Scotia has been traced back approximately 11,000 years ago, to the Palaeo-Indian period or *Sa'qewe'k L'nu'k* (11,000 – 9,000 years BP). The only significant archaeological evidence of Palaeo-Indian settlement in the province exists at Debert/Belmont in Colchester County.

The *Saqiwe'k Lnu'k* period was followed by the *Mu Awsami Kejikawe'k L'nu'k* (Archaic period) (9,000 – 2,500 years BP), which included several traditions of subsistence strategy. The Maritime Archaic people exploited mainly marine resources while the Shield Archaic concentrated on interior resources such as caribou and salmon. The Laurentian Archaic is generally considered to be a more diverse hunting and gathering population.

The Archaic period was succeeded by the Woodland/Ceramic period or *Kejikawek L'nu'k* (2,500 – 500 years BP). Much of the Archaic way of subsistence remained although it was during this period that the first exploitation of marine molluscs is seen in the archaeological record. It was also during this time that ceramic technology was first introduced.

The Woodland period ended with the arrival of Europeans and the beginning of recorded history. The initial phase of contact between First Nations people and Europeans, known as the Protohistoric period, was met with various alliances particularly between the Mi'kmaq and French.

The Mi'kmaq inhabited the territory known as *Mi'kma'ki* or *Megumaage*, which included all of Nova Scotia including Cape Breton, Prince Edward Island, New Brunswick (north of the Saint John River), the Gaspé region of Quebec, part of Maine and southwestern Newfoundland (Figure 3.2-1). A portion of Nova Scotia and New Brunswick, including the Amherst region of Cumberland County, was known by the Mi'kmq as *Siknikt* meaning "drainage area".[3]

[3] Confederacy of Mainland Mi'kmaq, 2007:11.

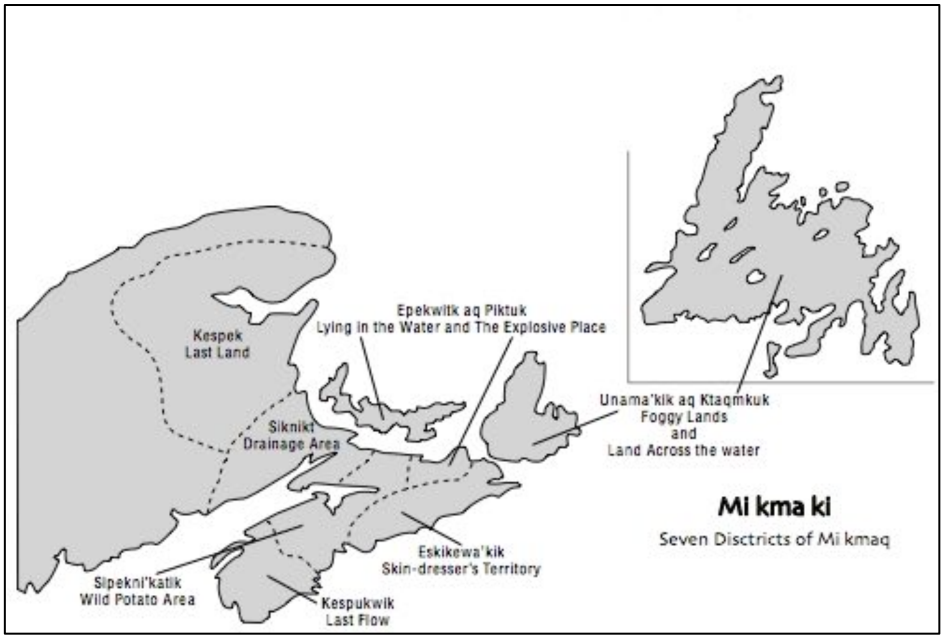

***Figure 3.2- 1: Map of the Mi'kmaki territories.*[4]**

3.2.2 Historic Period

There is a long, rich history of settlement and agricultural land use within Amherst and the Cobequid area. The abundant marshlands provided resources for the Mi'kmaq, as well as for early Acadian settlers, who transformed otherwise unusable land into fertile farms with their well engineered and efficient dyke water systems. These systems have been re-established throughout history to provide rich farmland used by local farmers to this day.

The earliest residents of the Amherst area in the historical period would have been the Mi'Kmaq. Mi'kmaw encampments are known to have existed along the southern ridge above the marsh land at a village site named *Nemalooscudaagan*, and another further west called *Weehakage* on the Amherst point.[5] Found along the shores of the LaPlanche River, these encampments were presumably abandoned by the Mi'Kmaq in 1694 due to plague.[6] These sites would eventually be re-inhabited by the Acadians.

The Acadians were the first recorded Euro-Canadian settlers in the Amherst area.[7] They transformed the marshlands into agricultural goldmines and pastures, which gave them prominent resources thanks to their specialized dyke drainage systems.

[4] Confederacy of Mainland Mi'kmaq, 2007:11.
[5] Furlong 2001:vii.
[6] Bird c. 1942:31.
[7] Bird c. 1942:2.

These provided an abundance of crops, such as wheat, hay, oats, rye, barley, corn, flax and hemp.[8]

The closest Acadian village to the study area was probably *La Planche*, located in the vicinity of East Amherst (Figure 3.1-2). Another village, *Ville La Butte* is thought to have been located in the present site of the town of Amherst. These villages were constructed as log homes overtop of the deserted Mi'kmaw encampments near the *La Planche* River, today known as the Laplanche River. *La Planche* River was given its name as the French had a 'great plank' which they used as a footbridge to cross the river at low tide. [9] This village was eventually burned due to raids in 1750. *La Butte* is noted to have stood until 1755 when it too was burned.[10]

Beaubassin, another Acadian village, was located on the Fort Lawrence Ridge. It was founded in 1671 by Jacques Bourgeois and five other families who moved from Port Royal.[11] The area expanded rapidly and by 1686 there were 22 houses on the ridge with the census recording 127 persons, as well as an abundance of livestock[12]. Beaubassin village thrived as the centre of a trading network for the Mi'kmaq and the people of Louisburg.[13]

Due to high tensions between the French and the English, these village sites were targeted areas of raiding for the New Englanders. Beaubassin eventually succumbed to these raids as the village was burned down in both the years 1696 and 1704. By 1750, the French population in the general area was approximately 2,500. [14] During the same year, Abbe Jean-Louis Le Loutre and "his Natives" forced the Acadians from Beaubassin to the French side of the Isthmus River and, once again, the homes and pastures of the village were set in flames.[15]

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[8] Jobb 2005::45-46
[9] Bird c. 1942:31.
[10] Nadon 1968:30,36.
[11] Jobb 2005:43.
[12] Acadian Census 1686.
[13] Davis MacIntyre & Associates Limited 2012:16.
[14] Jobb 2005:43.
[15] Jobb 2005:84.

***Figure 3.2- 2: Map of settlement in Nova Scotia in 1755, north at top. Note that the map does not depict* La Planche *or* La Butte *on the River La Planche (purple). The approximate study area is shown in red.*[16]**

In an attempt to gain military control of the area, Fort Lawrence was built in the fall of 1750 by Charles Lawrence, just north of *Beaubassin*. In retaliation, the French built Fort *Beausejour* on the present day, Aulac Ridge, west of Fort Lawrence. Fort *Beausejour* was attacked in a combined effort of British and New England forces from Fort Lawrence in 1755. The English were successful in capturing the fort, renaming it Fort Cumberland.[17]

After the deportation of the Acadians in 1755, settlement patterns came to a slow in the Amherst area and the Acadian dyke systems seemed to come to a fair amount of destruction in the years to come. A particularly rough storm hit the area in 1759, damaging the dykes. The damage was so extensive that the dykes were unusable, leaving barely any trace of them at all.[18]

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[16] Lewis 1755.
[17]Furlong 2001:vii, ix.
[18] Brebner 1937:60-61.

By the end of 1763, three British townships existed in the Chignecto area. Running across the Isthmus was Amherst, Cumberland and Sackville. The township of Amherst was named by Joseph Morse for Lord Jeffrey Amherst. Jeffrey Amherst was a British military hero for leading the final siege of Louisburg in 1758. He had never set foot in North America prior to the siege.[19]

After 1763, the populations began to grow as the new British township of Amherst was now granted to 42 families; each was given a woodlot, farm lot and marsh lot. The town was originally plotted by British engineers in the area of West Amherst. These lots were never used and the town grew further inland at its present site today.[20] The new British settlers were unable to renew the fertile dyked marshlands. Instead, farm lots were made on the southern slopes and they used the salt marshes only for pasturage and marsh hay. In some areas, Acadian prisoners were used to repair and instruct New Englanders on how to properly use the dyke systems. [21] These dyke lands were extremely fertile. Thus, they were kept and used to the most of their extent. Some of the families came to assist in the dyke maintenance, such as the Noiles, Bourque, and Gould families, who returned to Minudie and Nappan.[22]

The town of Amherst began to grow again after 1774. At this time, settlers from Yorkshire, England came to settle in the area. The Yorkshire peoples expanded the Tantramar marsh, which includes the Amherst marshes, by 80,000 acres through dyking.[23] This enabled the Chignecto and Tantramar farmers to become very prosperous off of the fertile marshland.

Although settlement was growing in Amherst, the study area itself appears to have been relatively devoid of cultural activity by 1779 (Figure 3.2-3). A 1779 map of the area shows settlement clustered along the rivers, including the Nappan and Laplanche rivers. However, the study area is located inland, between these two watercourses, where there is no depicted settlement.

By the 1850's, and into the early 1900's, early mechanized mowing and raking machines were beginning to come into use. Barns across the marshlands were built to store this rich marsh hay.[24] The hay was being exported to England and Newfoundland to feed workhorses, at a cost of $20 to $25 a tonne. [25]

In 1869, the Acadian dykes again succumbed to flooding due to a disastrous storm. The infamous Saxby Gale drove the tides over the dykes, causing hay and hay barns to float out into the Cobequid bay.[26]

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[19]Furlong 2001:x.
[20]Boomer 1937:43-45.
[21]Brebner 1937:43-45, 114.
[22]Boomer 1937:43-45.
[23]Cumberland County Museum and Archives n.d.:4.
[24]Boomer c. 1907:2,5.
[25]Cumberland County Museum and Archives n.d.:4.
[26]Boomer c. 1907:6.

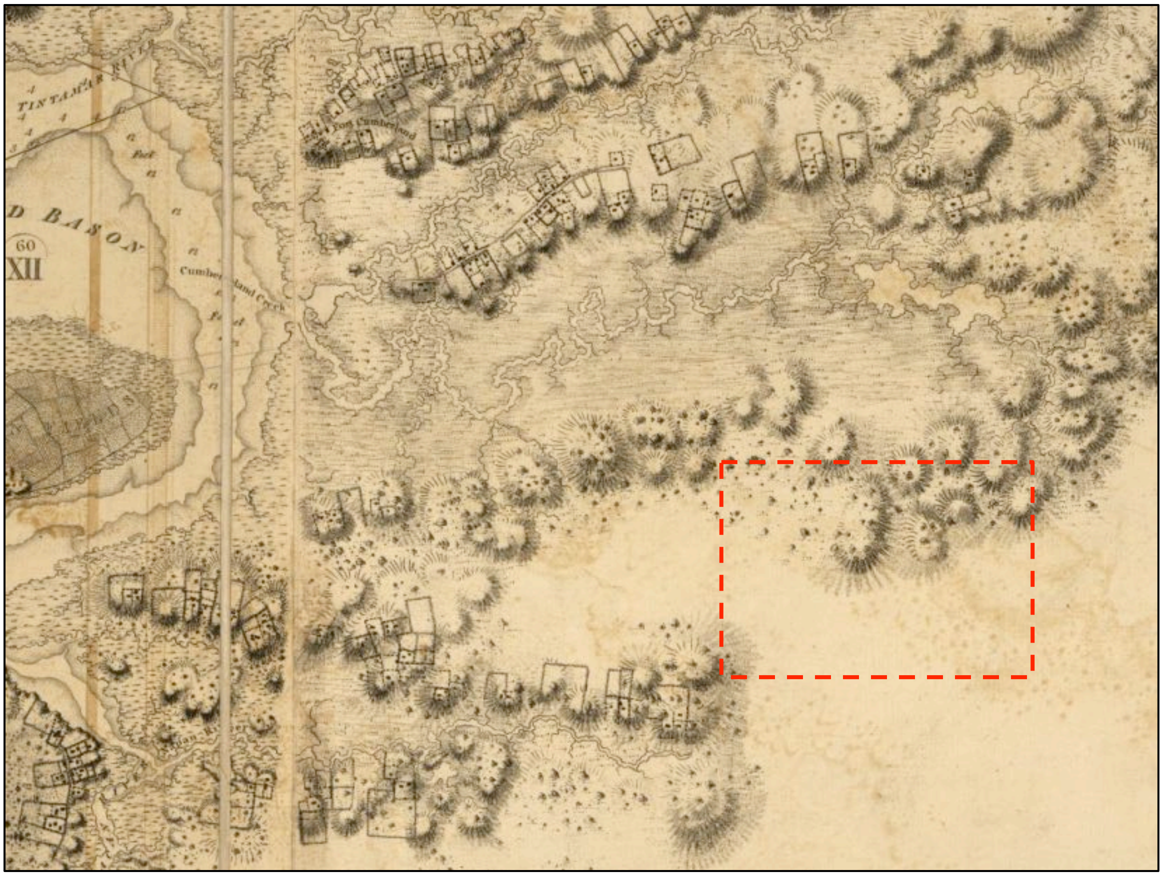

Figure 3.2- 3: 1779 map of the Amherst area showing settlement, north at the upper-right corner.[27] The approximate location of the study area is shown in red.

In 1888, the beginning of construction began for the Chignecto Marine Transport Railway. The engineer, Henry Ketchum, proposed the idea and his plans for the railway to the minister of Railways and Lands, Sir Charles Tupper. It was supposed to be a substitute for a canal between the Bay of Fundy and the Gulf of St. Lawrence over the Isthmus of 17 miles (27 km), from Tidnish to Fort Lawrence and the Cumberland Basin, with a dock at each end.[28] Work began in 1888, although the CMTC (Chignecto Marine Transport Company) ran out of money in 1891 and was unable to continue construction. The Canadian government refused to contribute more money, causing the project to be abandoned in 1893.[29] Remains of the railroad can still be seen today.

In 1900, the dykes were again damaged by an extreme high tide that swept over the Amherst marshes. A new dyke, 2 miles long and 6 feet high, was constructed to protect 13 acres of farmland. It had been maintained by the English and their

27 Des Barres 1779.
28 Coll, n.d.:1; Underwood 1995:17.
29 Coll n.d.:2-3.

descendants. This new dyke was also swept apart a year later. Another was built 7 feet high and 13 feet across its base. This one was noted to have lasted much longer than the others. [30]

Come the 1930's, the marsh hay market had crashed. To fuel the workforce, less hay was needed. This stifled the previously prosperous business of marsh hay sales, as farmers were lucky to receive $5 to $7 per tonne. This was barely enough to pay for labour and shipping, eventually leaving fields fallow and dykes unattended.[31]

During the Second World War, however, marsh hay was once again in demand. Marsh and dyke repairs were carried out between 1943 and 1947 and the Maritime Marshland Rehabilitation Administration was formed.[32] Large scale mechanical moving and upkeep of marsh soil eventually allowed for better draining. The long history of the Acadian dyke systems still contribute to the fertile marshlands of the Amherst area used by farmers to this day.

The Acadian settlements seem to appear mostly in the opposing direction of the study area or in the present location of the town of Amherst. Although the study area is mainly outside of any depicted settlement, the closest township to the location is the present area known as Hastings (Figure 3.2-4). Formerly known as Porter Town, its name was changed by provincial statue in 1864. Its present name honours the English statesman Warren Hastings. The area does not seem to include any significant European or Acadian settlements. However, a way office was established there in 1864 and a school was built in 1870.[33]

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[30] Boomer c. 1907:6.
[31] Cumberland County Museum Archives n.d.:5-7.
[32] Cumberland County Museum Archives n.d.:7-8.
[33] Fergusson 1967:283.

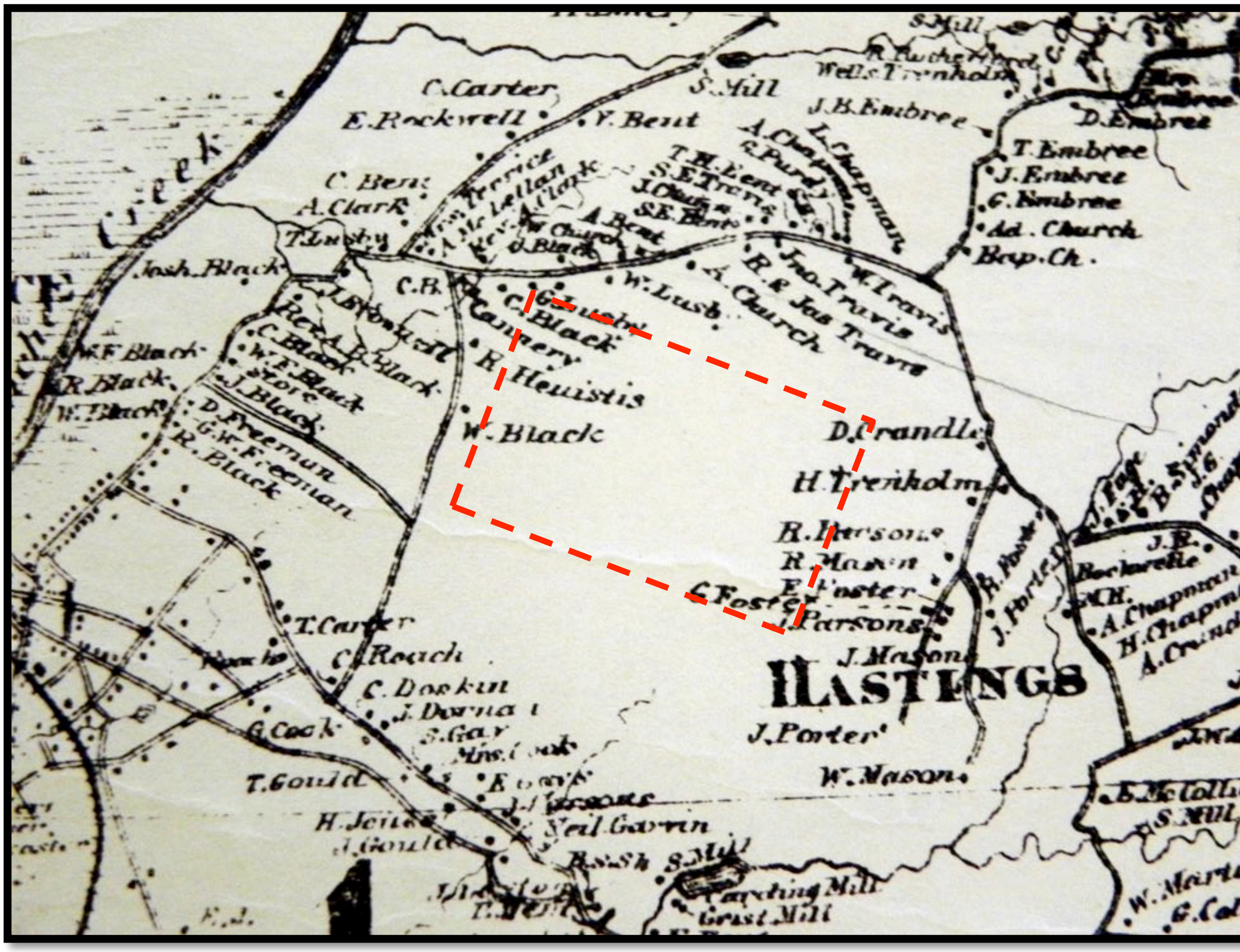

Figure 3.2- 4: The 1873 map of Cumberland County by A.F. Church, showing the approximate location of the study area (red)[34]. Note the clustering of cultural activity along the roads and lack of activity inland.

3.3 Field Reconnaissance

A reconnaissance of the initial June 2014 layout was conducted on 23 June 2014. The details of this reconnaissance can be found in appendix B. An archaeological field reconnaissance of the final November 2014 layout was conducted on 12 November 2014. The reconnaissance was facilitated by a hand-held GPS and GPS data supplied by the client. A total of approximately 2.5 kilometres of proposed access road was surveyed, including approximately 1.6 kilometres of access road located along an existing logging road. A buffer of approximately 20 metres on either side of the proposed access road was investigated. All three proposed turbines sites were also surveyed.

[34] Church 1873.

The existing access road, probably originally a logging road, connects to Black John Road. From Black John Road, the access road crosses an area with a blueberry field on the southwest side (Plate 1) and a grass field on the northeast (Plate 2). After approximately 400 metres, the access road meets a gate and moves into a wooded area. The terrain around the access road shows indications of logging, including cut stumps and skidder tracks (Plate 3). The area to the northeast of the access road is wet. There are many exposed soils along the access road, which were examined but appeared to be culturally sterile (Plate 4).

The access road crosses part of a natural gas pipeline (Plate 5) and enters into an area that had been extensively clear-cut recently and contains young regrowth. After approximately 1.5 kilometres, the access road passes the meteorological tower, in the midst of recent clear-cut (Plate 6). The existing access road terminates at a data collector (Plate 7).

From here, the proposed access road passes through an area characterized by young regrowth of spruce, birch, and maple with a fern understory. A portion of the road runs along an old skidder trail that is wet. The terrain in general is rough and hummocky and several other skidder trails and cut stumps can be seen. This area has been cut in the last 20 years. The terrain at turbine candidate site #1 is much the same, though tamarack can also be seen, further evidence that this area is wet and the soil poorly drained. At the turbine site, there appears to have been more recent selective cutting in the last five years (Plate 8).

From here, the reconnaissance progressed along the access road to turbine candidate site #3. A significant portion of the access road passes through an expansive recent clear cut, much of which has been flagged as wetland (Plate 9). The clear cut is criss-crossed by a network of skidder trails. At the south end of the clear cut, the land gradually slopes down and the road then passes through a mature forest which is predominantly spruce with a moss and fern understory. A brook drains the clear cut wetland above. The brook is approximately 1 metre wide and 10 centimetres deep, on average (Plate 10). The terrain here along the access road to turbine candidate site #3 is relatively rough with no indications of past cultural activity.

Turbine candidate site #3 is located in the same mature forest. The immediate area is predominantly spruce, approximately 60 to 70 years old. The forest floor is moss covered, wet and hummocky (Plate 11). Again, there is no evidence of past cultural activity.

From here, the reconnaissance progressed along the northern edge of the mature forest (where it transitions into the expansive clear cut to the north), to turbine candidate site #2. The turbine site is located on the periphery between an active agricultural field to the southwest and a hay field to the northeast. A tree line between the two fields runs along a drainage ditch (Plate 12). With the exception of recent clear cutting and active agriculture, there was no evidence of cultural activity.

From turbine candidate site #2, the reconnaissance moved along the access road from the turbine site back to the north side of the expansive clear cut, where it meets the access road between turbine sites #1 and #3. The southern end of the access road to turbine candidate site #2 has been recently clear cut up to the agricultural fields. The road slopes down here to a small brook which is likely a tributary of the same brook encountered on the access road to turbine site #3 (Plate 13). The brook is draining from an area to the north that was previously dammed by a beaver. The dam appears to have been breached.

4.0 Results and Discussion

There is no evidence of historic cultural activity in the impact areas of the proposed access roads and turbine candidate sties. The only indications of cultural activity were found to be fairly modern, consisting of modern logging activity such as skidder trails, clear-cut, logging roads and cut stumps, modern agricultural activity, and a natural gas pipeline.

Although there was historic activity in the general vicinity of Amherst, historic maps and documents indicated there was little historic cultural activity in the study area itself. Additionally, the potential for First Nations archaeological resources in the impact area is low. The only noted watercourse is small and non-navigable. The study area is generally poorly drained and wet and the terrain rough and uneven. First Nations peoples are known have been in the general vicinity and may have taken advantage of the area for hunting and/or gathering. However, there is little reason for them to have settled here. Activity such as short-term forays into the area for hunting and/or gathering is unlikely to leave an archaeological footprint.

5.0 Conclusions and Recommendations

Avoidance is the preferred method of mitigation in all instances where archaeological resources are present. The results of the historic background study and archaeological reconnaissance indicate that the study area is of low potential for First Nations archaeological resources. Furthermore, no historic period archaeological resources were encountered during the reconnaissance. The only identified cultural activity consisted of modern logging and agricultural activity.

Should development plans change so that areas not previously assessed by archaeologists are to be impacted by access roads or turbine sites it is recommended that those areas be subjected to an archaeological assessment by a qualified archaeologist.

Finally, in the unlikely event that archaeological features are encountered during ground disturbing activities, it is required that all activity cease and the Coordinator of Special Places (902-424-6475) be contacted immediately regarding a suitable method of mitigation.

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PLATES

Plate 1: Looking northwest over the existing access road to John Black Road, with the blueberry field shown on the left of the road.

Plate 2: Looking southeast over the access road and grass field to the northeast of the road.

Plate 3: A view of cut stumps beside an overgrown skidder trail (right) located to the southwest of the access road, looking southwest.

Plate 4: Examination of exposed soils at the edge of the existing access road, looking northeast.

Plate 5: Looking west toward the existing access road along the natural gas pipeline.

Plate 6: The meteorological tower in recent clear-cut, looking southwest.

Plate 7: The data collector at the terminus of the access road, looking east.

Plate 8: Turbine candidate #1 site, looking west.

Plate 9: Looking southwest at the clear cut along the proposed access road to turbine candidate site #3.

Plate 10: Brook along the access road to turbine candidate site #3, looking south.

Plate 11: Turbine candidate site #3, looking west northwest.

Plate 12: Looking east at turbine candidate site #2. The hay field can be seen in the background. The active agricultural field is to the photographer's left, out of frame. The tree line along the edge of the hay field runs along a drainage ditch.

Plate 13: Looking northwest at turbine site #2 with the access road on the photographer's right.

APPENDIX A:
Heritage Research Permit

NOVA SCOTIA

Heritage Research Permit (Archaeology)

Office Use Only
Permit Number:

A2014NS041

Special Places Protection Act 1989

(Original becomes Permit when approved by Communities, Culture and Heritage)

Greyed out fields will be made publically available. Please choose your project name accordingly

Surname Glen	First Name Courtney
Project Name Amherst Wind Farm	
Name of Organization Davis MacIntyre & Associates	
Representing (if applicable)	
Permit Start Date 28 May 2014	Permit End Date 30 September 2014

General Location: Amherst, Cumberland County

Specific Location: *(cite Borden numbers and UTM designations where appropriate and as described separately in accordance with the attached Project Description. Please refer to the appropriate Archaeological Heritage Research Permit Guidelines for the appropriate Project Description format)*

Turbine 1: 20 T 411071 E 5076395 N (WGS 84)
Turbine 2: 20 T 411249 E 5075974 N (WGS 84)
Turbine 3: 20 T 410760 E 5075948 N (WGS 84)

Permit Category:
Please choose one

- [ ] Category A – Archaeological Reconnaissance
- [ ] Category B – Archaeological Research
- [x] Category C – Archaeological Resource Impact Assessment
- [x] I certify that I am familiar with the provisions of the *Special Places Protection Act* of Nova Scotia and that I have read, understand and will abide by the terms and conditions listed in the Heritage Research Permit Guidelines for the above noted category.

Signature of applicant [signature] For Courtney Glen	Date 14 May 2014
Approved by Executive Director [signature]	Date May 23-14

APPENDIX B:
June 2014 Reconnaissance Letter

DAVIS MACINTYRE & ASSOCIATES
ARCHAEOLOGICAL CONSULTANTS

10 June 2014

Sean Weseloh McKeane
Coordinator, Special Places
Communities, Culture and Heritage
PO Box 456, STN Central
Halifax, NS B3J 2R5

CC:
Amy Pellerin
Natural Forces
1801 Hollis Street, Suite 1205
Halifax, NS B3J 3N4

Re: A2014NS041 – Amherst Wind Project

Dear Mr. McKeane,

This letter details the preliminary findings of the June 2014 field reconnaissance for the initial layout of the Amherst Wind project. During the June 2014 field reconnaissance, a large beaver dam was found at one of the proposed turbine locations, prompting the layout of the project to be revised. A reconnaissance of the revised layout was conducted in November 2014 and these findings, along with a historic background study of the area and any necessary recommendations for mitigation will be detailed in an archaeological resource impact assessment (ARIA) for HRP A2014NS041. This letter will be included in the ARIA report as Appendix B.

The June 2014 access road layout included approximately 1.6 kilometres of an existing road, which did not change from the initial layout to the revised November 2014 layout and will therefore be reported on in the forthcoming ARIA report. The June 2014 layout of the access road and turbine candidate sites is attached as Figure 1.

An archaeological field reconnaissance was conducted on 23 June 2014. The reconnaissance was facilitated by a hand-held GPS and GPS data supplied by the proponent. A buffer of 80 metres surrounding the June 2014 proposed access roads (approximately 1 kilometre in length) was surveyed. The three proposed turbine sites were also surveyed, although there was difficulty in accessing turbine site #2.

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DAVIS MACINTYRE & ASSOCIATES
ARCHAEOLOGICAL CONSULTANTS

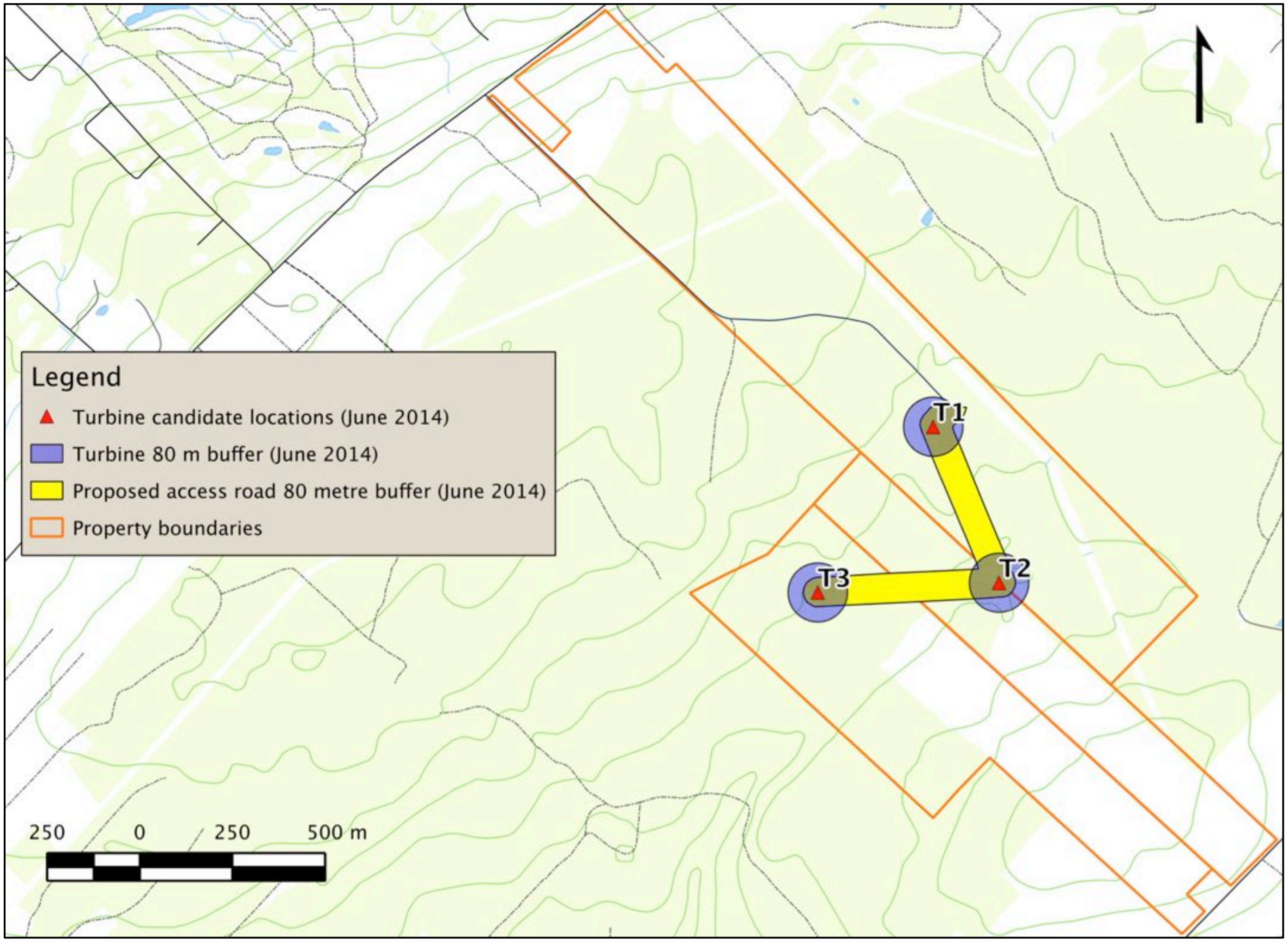

Figure 1: The June 2014 access road layout and proposed turbine candidate sites, with 80 metre buffers indicating the area that was surveyed.

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The proposed turbine candidate site #1 is located in an area characterized by young regrowth of spruce and birch, with a fern understory (Plate 1). The terrain is rough and very uneven. The area showed signs of logging, including skidder trails and piles of dry logs.

Plate 1: Looking southwest over proposed turbine candidate site #1.

From turbine candidate site #1, the proposed access road will cut southeast to turbine candidate site #2. This portion of the proposed access road crosses an area of predominately young re-growth with some patches of mature trees (Plate 2). Again, the area shows signs of logging. After approximately 250 metres, the proposed access road enters an area of very recent clear-cut. The area is also very wet (Plate 3).

Plate 2: A view of the mature trees and young re-growth in the path of the proposed access road, looking south.

Plate 3: Looking south over the wet clear-cut area, including water-logged skidder tracks, along the proposed access road approximately 130 metres from turbine candidate site #2.

The area becomes progressively wetter towards turbine candidate site #2 and it became difficult to survey the area approximately 50 metres northwest from the turbine candidate site, where the team turned around to attempt to approach from another direction (Plate 4). Upon approaching the candidate site from the southwest, a large beaver dam was encountered. The dam is built up from the ground level, most likely taking advantage of an existing wetland (Plate 5). The dam is probably partially responsible for the inundation of turbine candidate site #2. The team was therefore unable to access turbine candidate site #2 and most of the 80 metre buffer surrounding it.

The northern edge of the proposed access road buffer from turbine candidate site #2 to turbine candidate #3 crosses the same area of recent clear-cut noted in plate 3. Although this clear-cut area is higher than the wetland around turbine candidate site #2, deep skidder tracks filled with ground water were noted across the entire clear-cut area.

Plate 4: A view of the wetland around turbine candidate site #2, looking southeast. Note the standing water.

Plate 5: A close-up of the beaver dam, looking east. Note how the dam has been built up from the ground.

The southern side of the proposed access road buffer cuts through a mature forested area. This mature forest was also encountered on the northern side of the proposed access road after approximately 330 metres. The mature forest is predominately spruce, with a moss and fern understory. There were few indications of cultural activity and these include an overgrown road that appeared to still be in use by recreational vehicles (Plate 6) and a hunting blind (Plate 7).

Plate 6: Looking east along an overgrown road within the proposed access road buffer.

Plate 7: A view of the hunting blind (blue) located in the proposed access road buffer, looking south. Note the mature forest surrounding the blind.

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Several small watercourses were noted along this section of the proposed access road (Plate 8). These watercourses are shallow, non-navigable and are probably part of the drainage system for the wetland around turbine candidate site #2. The watercourses are less than 1 metre to 1.5 metres wide and less than 50 centimetres deep. Turbine candidate site #3 is located in an area of mature growth spruce and birch. The area is a little wet and the terrain is rough and uneven (Plate 9).

Plate 8: A small, non-navigable watercourse probably related to drainage of the area, looking west. This was typical of the watercourse encountered in the south end of the study area.

Plate 9: A view of the approximate location of turbine candidate site #3, looking south.

During the preliminary June 2014 reconnaissance, no areas of heightened archaeological potential were noted and no cultural features, aside from modern logging activities and a hunting blind, were noted. A large beaver dam and associated pond were identified at the edge of the 80 metre buffer for turbine candidate site #2 (Table 1). The June 2014 field survey identified no historic or First Nations archaeological resources within the impact area. The potential for First Nations or historic resources within the surveyed area is also low. The only identified cultural activity consisted of modern activities, such as logging and hunting.

***Table 1: Areas of cultural or notably natural activity with UTM coordinates (NAD83) identified in the preliminary June 2014 field reconnaissance*.**

Cultural or natural activity	Coordinates	Archaeological Significance
Hunting blind	20 T 410824 5075896	Low
Beaver dam and pond	20 T 411156 5075968	N/A

DAVIS MACINTYRE & ASSOCIATES
ARCHAEOLOGICAL CONSULTANTS

If Heritage staff find this letter acceptable, I would appreciate if a copy of your letter be forwarded to our client as follows:

Amy Pellerin
Natural Forces
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Please do not hesitate to contact me if this letter is not acceptable or if more information is required.

Regards,

Courtney Glen
Senior Archaeologist

CC: A. Pellerin, Natural Forces

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