Appendix C:

Bat Impact Assessment

Strum
ENVIRONMENTAL

BAT MONITORING REPORT
GAETZ BROOK, NS

December 7, 2012

December 7, 2012

Mr. Andy MacCallum
Natural Forces Technologies Inc.
#1030 - 1791 Barrington Street
Halifax, NS B3J 3L1

Dear Mr. MacCallum,

Re: Bat Monitoring Report
Gaetz Brook, NS

Attached is the Bat Monitoring Report prepared for Gaetz Brook, NS.

This report documents our observations, findings, and recommendations.

We trust this report to be satisfactory at this time. Once you have had an opportunity to review this correspondence, please contact us to address any questions you may have.

Thank you,

Garry Gregory, MSc.
Environmental Specialist
ggregory@strum.com

Carys Burgess, MMM
Senior Environmental Specialist
cburgess@strum.com

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Strum Environmental completed a study of the bat community at a proposed wind energy development, located at Gaetz Brook, Nova Scotia (the Project) on behalf of Natural Forces Technologies Inc. The objective of this study was to gather baseline data on the bat community at the Project site to facilitate pre- and post-construction comparisons and to inform the project planning process.

This report summarizes the available information pertaining to the bat community in the general Project area and presents the survey results.

2.0 PROJECT SITE DESCRIPTION

Natural Forces Technologies Inc. has proposed the development of a single turbine wind farm at Gaetz Brook, Halifax Regional Municipality, Nova Scotia (Drawing 1, Appendix A). The Project site consists of 47.4 ha of softwood forest and cutovers less than 4 km from the Chezzetcook mudflats. The landscape in the general Project area is typified by clearcut areas interspersed with windthrow and mid-aged to mature softwood stands.

3.0 RELEVANT LEGISLATION

Bats are protected in Nova Scotia under the *Wildlife Act* (R.S., c. 504, c. 2). As such, it is unlawful to kill or harass any bat without a permit from Nova Scotia Department of Natural Resources (NSDNR).

Three bat species, present in Nova Scotia, have recently been listed as 'Endangered' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). If the Government of Canada, upon review, accepts this recommended designation, these species could then qualify for protection and recovery under the *Species at Risk Act* (SARA). In addition, it is likely that these species will be added to the *Nova Scotia Endangered Species Act* (NSESA) (1998, c. 11, s. 1), which prohibits the killing or disturbance of a species at risk, the destruction or disturbance of its residence, and the destruction or disturbance of its core habitat. Currently none of the three species have a status under SARA or NSESA.

Details on these three species are included in the sections below.

Different levels of government are involved in the protection of bats through environmental assessment approval or through approval related monitoring program requirements. These include the following federal and provincial departments:

- Environment Canada – Canadian Wildlife Services (CWS);
- NSDNR – Wildlife Division; and
- Nova Scotia Environment (NSE).

4.0 STUDY METHODOLOGY

Study methodology included a desktop review of available information on the ecology of bat species in the province and the general Project area, as well as field surveys. Details of the methodologies and results are provided in the following sections.

4.1 Desktop Review

The desktop component consisted of a review of relevant literature as well as the following digital databases:

- Nova Scotia Abandoned Mine Openings Database (NSDNR 2011); and
- Nova Scotia Significant Species and Habitats Database (NSDNR 2012).

<u>4.1.1 Ecology of Bat Species in Nova Scotia</u>

Seven species of bat have been recorded in Nova Scotia (Broders *et al.* 2003):

- Big brown bat (*Eptesicus fuscus*);
- Hoary bat (*Lasiurus cinereus*);
- Little brown myotis (*Myotis lucifugus*);
- Northern long-eared myotis (*Myotis septentrionalis*);
- Red bat *(Lasiurus borealis*);
- Silver-haired bat (*Lasinycteris noctivagans*); and
- Tri-colored bat (*Perimyotis subflavus*).

Of these, only the Little brown myotis, Northern long-eared myotis, and the Tri-colored bat have known significant populations in Nova Scotia (Broders 2004).

Bat species in Nova Scotia are insectivorous (Randall 2011) and in general are most active shortly after sunset, although there is some variation in activity patterns among species (Broders *et al.* 2003). The most common resident species, the Little brown myotis and the Northern-long eared myotis, are typically active from May until August, at which time they return to caves and mine openings and commence swarming behaviours. These species congregate at these caves and mine openings, known as hibernacula, to over-winter. Cave hibernacula in Nova Scotia are most commonly found in areas with a bedrock geology consisting of limestone or gypsum, while anthropogenic openings (i.e., mines) are also exploited by bats. Tri-colored bat also over-winters in the province and typically uses the same type of habitat, but less is known about this species' hibernating ecology. Other bat species, including Hoary bat and Silver-haired bat, migrate from the province in the fall months and over-winter in the southern United States (Mosely 2007).

Although winter hibernacula provide a safe location to survive the winter months, the tendency of Little brown, Northern long-eared, and Tri-colored bats to gather at these locations increases their vulnerability to outbreaks of disease. One such example is White-Nose Syndrome (WNS); an infectious fungal disease caused by *Geomyces destructans* that has resulted in the deaths of over one million bats in eastern North America (Hallam and

McCracken 2010). This disease has spread to Atlantic Canada within the last two years, and constitutes a serious threat to bat populations in the region (Hebda 2012). Affected hibernacula can suffer 95-99% mortality (McBurney 2012), and at least two significant colonies in New Brunswick have endured collapses since the arrival of the disease in Atlantic Canada (Hebda 2012; Vanderwolf et al. 2012).

Little Brown Myotis
Little brown myotis is the most common species in Nova Scotia, and is probably ubiquitous in the province (Broders *et al.* 2003). This species' range extends throughout most of North America. The species is an effective feeder on *Lepidopterans* (moths) (Thomas et al. 2012) and will prey heavily upon aquatic insects, particularly chironomids (Belwood and Fenton 1976), explaining the tendency to observe this species in close association with water. During the day, the Little brown myotis will roost in buildings, trees, under rocks, in wood piles, and in caves, congregating in tight spaces to roost at night (Fenton and Barclay 1980). Populations of Little brown myotis are thought to be limited by roost availability rather than food supply (Fenton and Barclay 1980).

As a non-migratory species, Little brown myotis hibernates from September to early or mid-May in abandoned mines or caves (Fenton and Barclay 1980; Mosely 2007). Disturbance of hibernating individuals is thought to be a contributing factor in the decline of Little brown myotis populations in some parts of its range (Fenton and Barclay 1980), as human intrusion into winter hibernacula causes a measurable increase in bat activity, leading to increased risks of mortality from premature depletion of fat reserves (Thomas 1995).

Little brown myotis was listed as 'Endangered' by COSEWIC in an emergency assessment in February 2012, based upon the predicted functional extirpation of the species within three generations as WNS spreads throughout the region (COSEWIC 2012a).

Northern Long-eared Myotis
Northern-long eared myotis, although once considered uncommon throughout Nova Scotia (Mosely 2007), is likely ubiquitous in the forested regions of the province (Broders *et al.* 2003). This species is widely distributed in the eastern United States and Canada, and is commonly encountered during swarming and hibernation (Caceres and Barclay 2000). As a forest dweller, this species feeds primarily on butterflies and moths, beetles, Neuroptids, aphids, and flies, and it is also known to employ a gleaning foraging strategy as opposed to relying strictly on aerial pursuit of prey (as cited in Caceres and Barclay 2000; Thomas et al. 2012). During the day, Northern long-eared myotis show a preference for roosting in trees; the characteristics of which have been shown to vary according to the reproductive status of bred females (Garroway and Broders 2008). Females appear to prefer shade tolerant deciduous trees over coniferous trees, whereas males roost solitarily in coniferous or mixed-stands in mid-decay stages (Broders and Forbes 2004). Northern long-eared myotis are also non-migratory and are typically associated with Little brown myotis during hibernation, in caves or abandoned mines (Mosely 2007). Hibernation in this species is thought to begin as early as September and may last until May (as cited in Caceres and Barclay 2000).

Northern long-eared myotis was listed as 'Endangered' by COSEWIC in an emergency assessment in February 2012, based upon the predicted functional extirpation of the species within two to three generations as WNS spreads throughout the region (COSEWIC 2012b).

Tri-colored Bat

The Tri-colored bat, formerly known as the Eastern pipistrelle, is frequently observed in Nova Scotia but has a restricted distribution focused in the interior of the southwest region of the province (Farrow 2007; Farrow and Broders 2011). Research conducted at Kejimkujik National Park found Tri-colored bat to be locally abundant, and results indicate that this population may represent the only breeding population of the species in Canada (Broders *et al.* 2003). In the summer months, Tri-colored bat is concentrated in a geographic area bounded by Wolfville to the west, Halifax to the northeast, and Shelburne to the southeast (Quinn and Broders 2007). The species occurs throughout most of eastern North America, with Nova Scotia representing the northeastern extent of its range (Fujita and Kunz 1984).

Tri-colored bat requires clumps of *Usnea* lichen for roosting; a habitat feature typically associated with mature spruce and balsam fir trees (Farrow 2007; Farrow and Broders 2011). This association suggests that the species may be negatively impacted by intensive forestry practices that remove roosting habitat (Farrow 2007). The species typically forages over water bodies, but also feeds over tree canopies (reviewed by Quinn and Broders 2007) and it appears that, unlike Little brown myotis, the Tri-colored bat stays active throughout the night, possibly as a means to reduce intraspecific competition (Broders *et al.* 2003). This species is non-migratory, and generally hibernates alone, or in small numbers, in caves or abandoned mines where it appears to show a preference for small side passages, rather than main passages (Fujita and Kuna 1984; Mosely 2007). Individuals show strong fidelity to specific hibernacula, although in Nova Scotia only 10 hibernating individuals have ever been recorded (Quinn and Broders 2007).

Tri-colored bat was listed as 'Endangered' by COSEWIC in an emergency assessment in February 2012, based upon the predicted functional extirpation of the species within three generations as WNS spreads throughout the region. It is suspected that much of the Canadian Tri-colored bat population has already been affected by WNS and that the remainder will be affected within the next several years (COSEWIC 2012c).

Other Bat Species

Other bat species, including Big brown bat, Red bat, Hoary bat, and Silver-haired bat, have been recorded sporadically throughout Nova Scotia, and research suggests that there are no significant migratory movements of these species within the province (Broders *et al.* 2003). Records of these bat species in Nova Scotia are therefore considered as extralimital extensions into the province (Broders *et al.* 2003).

<u>4.1.2 Bat Hibernacula</u>

Multiple known bat hibernacula exist within a 100 km radius of the Project site (Table 1, below; Drawing 2, Appendix A).

Table 1: Known Bat Hibernacula in Nova Scotia within 100 km of the Project Site

Hibernacula	Distance from Project Site (km)	Direction
Lake Charlotte Gold Mine	17.69	E
Cave-of-the-Bats	32.82	NW
Gayes River Gold Mine	33	N
Black Brook	36.83	N
Centre Rawdon Gold Mine	57.31	NW
Hayes Cave	60.19	NNW
Woodville Ice Cave	66.52	NW
Frenchman's Cave	67.44	WNW
Miller's Creek Cave	71.86	NW
Minasville Ice Cave	74.65	NNW
Peddlar's Tunnel	76.98	NW
Walton Barite Mine	80.93	NW
New Laing Adit	82.53	NNE
Lear Shaft	86.59	N
Cheverie Cave	87.89	NW
The Ovens	95.6	SW
McLellan's Brook Cave	96.04	NE

Source: Mosely 2007

Mosely (2007) categorized known hibernacula based on the number of bats using the site or the potential of the site to provide suitable over-wintering habitat to bats. Several of these known hibernacula are considered either small or minor sites that support less than 50 over-wintering bats. These include Black Brook, Gayes River Gold Mine, Woodville Ice Cave, Frenchman’s Cave, Peddlar’s Tunnel, Walton Barite Mine, New Laing Adit, The Ovens, and McLellan’s Brook Cave. Miller’s Creek Cave, meanwhile, was once a very important hibernaculum but was quarried away in 1981 (Mosely 2007).

The Lake Charlotte Gold Mine, an abandoned mine adit (horizontal entrance), is considered to be one of the most important hibernacula in Nova Scotia. Up to 3,000 over-wintering *Myotis* spp. have been recorded at this location, although gating has precluded ongoing monitoring of this hibernating population (Mosely 2007).

The Cave-of-the-Bats is a dissolutional gypsum cave in the Dutch Settlement Area that features a flowing watercourse within the main chamber (Mosely 1996 and 2007). All three over-wintering bat species have been recorded at this site, and it is thought that over 200 bats gather here to hibernate each year (Mosely 2007). This cave has also been identified as a swarming site for all three resident species (Randall 2011).

The Centre Rawdon Gold Mine, another abandoned mine adit, is thought to support up to 650 over-wintering bats (Mosely 2007), and all three resident species were identified during late summer swarming (Randall 2011).

Hayes Cave, the most important hibernacula in Nova Scotia, is located approximately 60 km away from the Project site in the community of Maitland. Thousands of bats gather at this gypsum cave annually for both swarming (Randall 2011) and over-wintering (Mosely 2007), and is thought that bats may undertake movements of tens to hundreds of kilometres to access this and other key swarming sites (Burns and Broders 2010). Species composition at this cave includes all three resident species (Mosely 2007), with Little brown myotis being the most prevalent (Poissant and Broders 2008).

Minasville Ice Cave is also considered a significant hibernaculum. This is a dissolutional cave in gypsum that provides over-wintering habitat for several hundred bats, and all three resident species have been recorded at this location. Relatively high numbers of swarming bats were captured at this site in late summer (Randall 2011).

Lear Shaft is a series of underground mines and tunnels in the community of Londonderry. Although relatively few bats have been directly observed at this location, the large extent of available underground habitat suggests that the Lear Shaft could constitute a significant hibernaculum capable of supporting 50-1,000 over-wintering bats (Mosely 2007). This use of the Lear Shaft as a swarming site has also been verified (Randall 2011).

Cheverie Cave, located approximately 88 km from the town of Hantsport, is another dissolutional cave in gypsum that is significant with regards to hibernating bats. It is estimated that approximately 200 bats, particularly Northern long-eared myotis, gather at this site to over-winter (Mosely 2007). This location is also used as a swarming site for breeding bats in the late summer (Randall 2011).

The Nova Scotia Abandoned Mine Openings Database (NSDNR 2011) identifies 3,496 records within a 100 km radius of the Project site, including 188 within 10 km. T hese locations may provide over-wintering habitat for bats, although the majority of Nova Scotia's abandoned mine network has never been surveyed.

The NS Significant Species and Habitats database (NSDNR 2012) identifies 16 features pertaining to bats or bat habitat within a 100 km radius of the Project site. Fourteen of these records relate to known bat hibernacula already discussed. The two remaining records relate to observations of Little brown myotis 30.7 km to the west in the community of Waverley, and 99 km to the northwest in the community of Five Islands. An additional six features are classified as 'significant areas' within the database, although it is unknown if any of these relate to bats or bat habitat.

4.2 Field Surveys

Field surveys of bat migration and habitat use were carried out from August 30 to October 3, 2012 using an AnaBat SD2 Detector (Titley Electronics, Columbia, Missouri) deployed at the Project site. The AnaBat system records echolocation sounds made by the bats when flying near the detector. The distance at which bats can be detected is a function of the frequency of the call emitted by the particular species. Typically, migratory species emit calls at a low frequency which decreases the distance at which they can be detected (Weller and Baldwin 2012). The microphone was attached to a constructed tower and suspended approximately 3.5 m in the air to elevate the device above the vegetation in the immediate area (Rodhouse *et al.* 2011). This measure was taken both to reduce the effects of vegetation noise and to ensure that vegetation did not impede echolocation signals from reaching the microphone. The microphone was housed in a protective housing constructed with ABS-tubing to prevent damage resulting from adverse weather conditions, and a Plexiglas® plate angled at 45° was installed below this housing to deflect signals into the microphone.

The detector was deployed in an open cluster of young balsam fir (*Abies balsamea*) trees, adjacent to a clearing associated with a meteorological tower installed at the site (Drawing 3, Appendix A). The detector was positioned approximately 291 m to the east of the proposed turbine location.

The detector was set to record between 1900 and 0730 daily, coinciding with sunrise/sunset times, and to ensure that all periods of bat activity were encompassed in the monitoring period. The detector was visited nine days after re-deployment, at which time data was downloaded, the power source was replaced, and the system was tested to ensure proper functioning. It was determined during this testing that the system had malfunctioned due to water infiltration into the microphone housing. As a result, a new microphone was installed on September 15, 2012.

Data was downloaded into Analook software for analysis. This software uses known bat call characteristics, including frequency, shape, and duration, to identify bat calls from within the recorded audio files (O'Farrell *et al.* 1999). Where possible, calls were identified to species on the basis of their characteristics. Due to their similarity, calls of Nova Scotia's two resident *Myotis* species (Little brown myotis and Northern long-eared myotis) can be difficult to reliably distinguish from one another (O'Farrell *et al.* 1999; Broders 2011), so these calls were not identified to species.

4.2.1 Results

In total, 4,087 files were recorded, of which only 10 were determined to be bat generated ultrasound. All remaining files were determined to be extraneous noise likely caused by rustling vegetation, precipitation, or wind gusts. It should also be noted that echolocation calls were only recorded on the nights after the re-installation of the detector upon the discovery of the malfunction. All calls were recorded between September 15 and 23 and all but one were associated with *Myotis* species bats (i.e., Little brown myotis and Northern long-eared myotis). Activity was highest between September 15 and 17, during which 7 of 10 bat calls were recorded.

A single call of unknown origin was detected on September 22.

5.0 DISCUSSION OF RESULTS

The installation of wind turbines has the potential to impact bats both directly and indirectly (Arnett *et al.* 2007). Impacts include:

- mortality resulting from direct collision and/or barotrauma;
- habitat alteration; and
- sensory disturbance.

The significance of these impacts at the population level depends on a number of biotic and abiotic variables, including the number of individuals affected and the stability of the population, season, physiologic condition of the individuals affected, and weather factors.

Mortality
Necropsy of recovered carcasses found that the cause of death for bats killed at wind-energy facilities is an indiscernible combination of direct collision with the turbine blades and barotrauma (Grodsky *et al.* 2011), although more recent pathological research has found that traumatic injury is the major cause of bat mortality at wind farms and that post-mortem artifacts may manifest themselves as pulmonary barotrauma lesions (Rollins *et al.* 2012). Barotrauma is characterized by a drop in atmospheric pressure along the top of a rotating turbine blade, which causes thoracic, abdominal, and pulmonary injury to bats when passing through the low pressure area (Baerwald *et al.* 2008).

Much of the established literature has not attempted to elucidate the causes of bat mortality but has instead reported on the magnitude of mortalities. Regardless of the specific cause, large numbers of bat fatalities have been reported at wind energy facilities, particularly along forested ridgetops, in the eastern United States (Kunz *et al.* 2007a). In Canada, bat fatalities outnumber bird fatalities by 2.4:1 (EC *et al.* 2012). Since bats are long-lived and have low reproductive rates, such mortalities can potentially contribute to precipitous population decline, and can increase the risk of local extinctions (Arnett *et al.* 2007).

Research suggests that migratory tree-roosting species suffer the highest fatalities at wind farms (Kunz *et al.* 2007a; Kuvlevsky *et al.* 2007; Cryan and Barclay 2009), although deaths of Tri-colored bats constituted 25.4% of total bat fatalities at wind facilities in the eastern United States (as cited in Arnett *et al.* 2007). Migratory species, including Hoary bat, Eastern red bat, and Silver-haired bat, accounted for 71% of 2,270 bat fatalities recorded at wind energy facilities across Canada between 2006 and 2010 (EC *et al.* 2012). Most bat fatalities are reported in the late summer months (Johnson 2005) coinciding with the start of swarming and autumn migration (Arnett *et al.* 2007: EC *et al.* 2012). Periods of high mortality may therefore be linked with the timing of large-scale insect migrations when bats feed at altitudes consistent with wind turbine heights (Rydell *et al.* 2010). It has been found that bat fatalities increase exponentially with wind tower height, with turbine towers 65 m or taller having the highest fatality rates (Barclay *et al.* 2007). This hypothesis is also supported by the findings of Horn *et al.* (2008), who reported that bats were not being struck by turbine blades when flying in a straight line en route to another destination, but were struck while foraging in and around the rotor-swept zone of the turbine.

Temporal variation in bat activity and subsequent fatality rates can be influenced by weather variables, as well as the characteristics of the facility (Baerwald and Barclay 2011). Although bats exhibit species-specific responses to environmental variables (Baerwald and Barclay 2011), in general they appear to be more active when wind speeds are low, which increases the risk of collisions with rotating turbine blades (Arnett *et al.* 2007) and mortality resulting from barotrauma. Increasing the turbine cut-in speed, the minimum wind speed at which the turbine blades are permitted to begin rotating, has been shown to greatly reduce bat fatality because bats are less active at these wind speeds (Arnett *et al.* 2011).

Habitat Alteration
The construction and operation of wind-energy facilities create habitat alteration and disturbance through various means including vegetation clearing, soil disruption, and noise (NRC 2007), thereby indirectly impacting bats (Arnett *et al.* 2007). The removal of trees during the site clearing and preparation phases can be especially detrimental, particularly to those bat species which use trees as roosting habitat (Arnett *et al.* 2007).

Some studies, however, suggest that habitat changes related to wind power developments may in fact create benefits to bats by increasing cleared areas and creating access roads, both of which can be used by bats as foraging habitat (as cited in Arnett *et al.* 2007; Kunz *et al.* 2007a). In relation to this, small-scale disturbances, including creating small cutblocks or small scale access roads through forested habitat, have been shown to stimulate an increase in bat activity relative to previous years (Grindal and Brigham 1998). It is important to note, however, that increased edge habitat due to forest clearing may subsequently increase the risk of mortality by virtue of attracting bats to the area of the operating turbine (Kunz et al. 2007b).

Sensory Disturbance
Increased human presence may also disturb roosting bats (Arnett *et al.* 2007), but it is unknown if this disturbance is sufficient to disrupt normal behaviour or physiology. During hibernation, bats are sensitive to human presence, and human intrusion into hibernacula can lead to increased arousals leading to a premature depletion of fat reserves (Thomas 1995). Siting wind-energy facilities away from hibernacula is therefore recommended in the design phases of these projects.

It is unknown if noise associated with turbine operation has any measureable effect on bats, although it is thought that bats may become acoustically disoriented by the low-frequency noise emitted from rotating turbines (Kunz *et al.* 2007a). Bats have been shown, experimentally, to avoid foraging in areas with intense, broadband noise (Schaub *et al.* 2008), however this research was not conducted in the context of wind-energy development and other studies indicate that bats have been shown to forage in close proximity to operational turbines (Horn *et al.* 2008).

The Project site is not located in an area that is known to be heavily used by bats. Most of the prominent cave hibernacula are located in the central region of Nova Scotia where dissolutional bedrock of the Windsor Group is prominent. However, Little brown myotis and Northern long-eared myotis are largely considered ubiquitous throughout the province outside of winter, so it is likely that these species occur at or near the Project site during these times. Although not identified to species, the presence of *Myotis* spp. at the Project site in late September-early October was verified through the field surveys. That the Tri-colored bat was not recorded was not entirely unexpected as it is believed that this species is locally abundant only in southwestern Nova Scotia (Farrow 2007).

Low levels of bat activity observed during the field studies, combined with information obtained from the desktop review, suggests that the Project site is not in an area of particular importance to resident or migrating bats. Multiple hibernacula and swarming sites are present within a 100 km radius of the Project site, but distribution is such that bats moving between sites should not interact with Project infrastructure.

It is difficult to ascertain if low levels of bat activity, as determined through acoustic field studies, were a function of low abundance or were an artifact of the study design. Typically, bats at northern latitudes leave their summering areas to commence swarming behaviours in late summer (Burns and Broders 2010; Randall 2011) and hibernate from September to April (OMNR 2008). The valid monitoring period in the current study did not begin until mid-September, suggesting that it is possible that most of the area's resident bats had already moved to their respective winter hibernacula prior to sampling. Little brown myotis and Northern long-eared myotis are largely considered ubiquitous in forested areas throughout the province outside of winter (Broders *et al.* 2003), so it is likely that these species occur at or near the Project site during these times. Although not identified to species, the presence of *Myotis* spp. at the Project site in the fall was verified through field surveys. Habitat alteration, including the removal of forest vegetation, may adversely affect bats summering at the Project site.

The migratory species, including Hoary bat, Silver-haired bat, and Eastern red bat, usually start their southward movements in late summer/early autumn (Cryan 2003), so it is possible that summer occupants had left the area prior to sampling. Furthermore, migrating bats regularly fly at heights that exceed the detection range of the system employed in this study (Baerwald and Barclay 2009), so it is possible that these species were present in the area but went undetected. It is thought that Nova Scotia occurs at or beyond the northern range of these species and that records are extralimital (not commonly found within the given geographical area) (Broders *et al.* 2003) or represent fall stragglers (Maunder 1988). However, Eastern red bats and Silver-haired bats are known to follow coastlines during autumn migration, so migration routes for these species may coincide with the Project site. Since migratory bats are known to be the group most vulnerable to collisions with wind energy infrastructure (Kunz *et al.* 2007a; EC *et al.* 2012), the possibility exists that the Project may result in some mortality of these species.

It is difficult to determine patterns of bat usage based upon a short monitoring period, and while the results of field surveys in conjunction with desktop information suggest that the Project site does not coincide with important bat habitat, it is possible that the Project may adversely affect bat populations either directly or indirectly. In particular, the proximity of the Project site to the Atlantic coast may mean that Project infrastructure may intercept coastal migration routes. However, in light of the fact that the Project consists of a single turbine, the results of the current study do not provide any evidence that the Project site is unsuitable for development due to impacts on the bat community.

6.0 CLOSURE AND RECOMMENDATIONS

It is recommended that post-construction bat monitoring, consisting of but not necessarily limited to carcass searches, be conducted at the Project site to verify the conclusions presented in this report.

This report has been completed for the sole benefit of Natural Forces Technologies Inc. Any other person or entity may not rely on this report without the expressed, written consent of Strum Environmental and Natural Forces Technologies Inc. The conclusions presented in this report represent the best judgement of the assessor based on the current environmental standards. The assessor is unable to certify against undiscovered environmental liabilities due to the nature of the investigation and the limited data available.

This report was prepared from desktop information collected in November/December 2012 and field data obtained in September/October 2012. The results in this report rely only on the conditions identified at this time.

Should additional information become available, Strum requests that this information be brought to our attention immediately so that we can re-assess the conclusions presented in this report. This report was prepared by Garry Gregory, Environmental Specialist. Senior review was completed by Carys Burgess, Senior Environmental Specialist.

7.0 REFERENCES

Arnett, E.B., Inkley, D.B., Johnson, D.H., Larkin, R.P., Manes, S., Manville, A.M., Mason, J.R., Morrison, M.L., Strickland, M.D., and R. Thresher. 2007. Impacts of wind energy facilities on wildlife and wildlife habitat. Wildlife Society Technical Review 07-2. The Wildlife Society, Bethesda, Maryland, USA. 49 pp.

Arnett, E.D., Huso, M.M.P., Schirmacher, M.R., and J.P. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. *Frontiers in Ecology and the Environment* **9**: 209-214.

Baerwald, E.F., and R.M.R. Barclay. 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. *Journal of Mammalogy* **90**: 1341-1349.

Baerwald, E.F., and R.M.R. Barclay. 2011. Patterns of activity and fatality of migratory bats at a wind energy facility in Alberta, Canada. *Journal of Wildlife Management* **75**: 1103-1114.

Baerwald, E.F., D'Amours, G.H., Klug, B.J., and R.M.R. Barclay. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* **18**: R695-R696.

Barclay, R.M.R., Baerwald, E.F., and J.C. Gruver. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* **85**: 381-387.

Belwood, J.J., and M.B. Fenton. 1976. Variation in the diet of *Myotis lucifugus* (Chiroptera: Vespertilionidae). *Canadian Journal of Zoology* **54**: 1674-1678.

Broders, H.G. 2012. Personal communication. March 29th, 2012.

Broders, H.G., 2011. Analysis of ultrasonic anabat recordings with inferences on bat species composition and activity at the site of the proposed wind turbine farm at Glen Dhu, Nova Scotia. 19 pp.

Broders, H.G., and G.J. Forbes. 2004. Interspecific and intersexual variation in roost-site selection of Northern long-eared and Little brown bats in the Greater Fundy National Park ecosystem. *Journal of Wildlife Management* **68**: 602-610.

Broders, H.G., Quinn, G.M., and G.J. Forbes. 2003. Species status, and the spatial and temporal patterns of activity of bats in southwest Nova Scotia, Canada. *Northeastern Naturalist* **10**: 383-398.

Burns, L.E., and H.G. Broders. 2010. Structure and movements of bat populations among hibernacula in Atlantic Canada: 2010 Progress Report for the Nova Scotia Species at Risk Conservation Fund. 9 pp.

Caceres, M.C., and R.M.R. Barclay. 2000. *Myotis septentrionalis*. *Mammalian Species* Account No. 634. 4 pp.

COSEWIC. 2012a. Technical summary and supporting information for an emergency assessment of the Little brown myotis *Myotis lucifugus*. 25 pp.

COSEWIC. 2012b. Technical summary and supporting information for an emergency assessment of the Northern myotis *Myotis septentrionalis*. 24 pp.

COSEWIC. 2012c. Technical summary and supporting information for an emergency assessment of the Tri-colored bat *Perimyotis subflavus*. 25 pp.

Cryan, P. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. *Journal of Mammalogy* **84**: 579-593.

Cryan, P.M., and R.M.R. Barclay. 2009. Causes of bat fatalities at wind turbines: hypotheses and predictions. *Journal of Mammalogy* **90**: 1330-1340.

Environment Canada (EC), the Canadian Wind Energy Association (CANWEA), Bird Studies Canada (BSC), and the Ontario Ministry of Natural Resources (OMNR). 2012. Wind energy bird and bat monitoring database: summary of the findings from post-construction monitoring reports. 22 pp.

Environment Canada (EC). 2012. John Lusby Marsh National Wildlife Area. Accessed on November 29th, 2012 from http://www.ec.gc.ca/ap-pa/default.asp?lang=En&n=63101ECD-1.

Farrow, L.J. 2007. Distribution of the Tri-colored bat (*Perimyotis subflavus*) in southwest Nova Scotia relative to landscape factors. M.Sc. Thesis, Saint Mary's University, Halifax, Nova Scotia, Canada. 114 pp.

Farrow, L.J., and H.G. Broders. 2011. Loss of forest cover impacts the distribution of the forest-dwelling tri-colored bat (*Perimyotis subflavus*). *Mammalian Biology* **76**: 172-179.

Fenton, M.B., and R.M.R. Barclay. 1980. *Myotis lucifugus*. *Mammalian Species* Account No. 142. 8 pp.

Fujita, M.S., and T.H. Kunz. 1984. *Perimyotis subflavus*. *Mammalian Species* Account No. 228. 6 pp.

Garroway, C.J., and H.G. Broders. 2008. Day roost characteristics of northern long-eared bats (*Myotis septentrionalisi)* in relation to female reproductive status. *Ecoscience* **15**: 89-93.

Grindal, S.D., and R.M. Brigham. 1998. Short-term effects of small-scale habitat disturbance on activity by insectivorous bats. *Journal of Wildlife Management* **62**: 996-1003.

Grodsky, S.M., Behr, M.J., Gendler, A., Drake, D., Dieterle, B.D., Rudd, R.J., and N.L. Walrath. 2011. Investigating the causes of death for wind-turbine associated bat fatalities. *Journal of Mammalogy* **92**: 917-925.

Hallam, T.G., and G.F. McCracken. 2010. Management of the panzootic white-nose syndrome through culling of bats. *Conservation Biology* **25**: 189-194.

Hebda, A. 2012. Personal communication. March 28th, 2012.

Horn, J.W., Arnett, E.B., and T.H. Kunz. 2008. Behavioural responses of bats to operating wind turbines. *Journal of Wildlife Management* **72**: 123-132.

Johnson, G.D. 2005. A review of bat mortality at wind-energy developments in the United States. *Bat Research News* **46**: 45-49.

Kunz, T.H., Arnett, E.B., Erickson, W.P., Hoar, A.R., Johnson, G.D., Larkin, R.P., Strickland, M.D., Kuvlevsky, W.P., Jr, Brennan, L.A., Morrison, M.L., Boydston, K.K., Ballard, B.M., and F.C. Bryant. 2007a. Wind energy development and wildlife conservation: challenges and opportunities. *Journal of Wildlife Management* **71**: 2487-2498.

Kunz, T.H., Arnett, E.B., Cooper, B.M., Erickson, W.P., Larkin, R.P., Mabee, T., Morrison, M.L., Strickland, M.D., and J.M. Szewczak. 2007b. Assessing impacts of wind-energy on nocturnally active birds and bats: a guidance document. *Journal of Wildlife Management* **71**: 2449-2486.

Maunder, J.E. 1988. First Newfoundlad record of the Hoary bat, *Lasiurus cinereus*, with a discussion of other records of migratory tree bats in Atlantic Canada. *Canadian Field Naturalist* **102**: 726-728.

McAlpine, D.F. 1983. Status and conservation of solution caves in New Brunswick. New Brunswick Museum Publications in Natural Science No. 1. 32 pp.

McBurney, S. 2012. Personal communication. March 28th, 2012.

Mosely, M. 1996. The gypsum karsts and caves of the Canadian Maritimes. *Cave and Karst Science* **23**: 17 pp.

Mosely, M. 2007. Records of bats (*Chiroptera*) at caves and mines in Nova Scotia. Curatorial Report Number 99, Nova Scotia Museum, Halifax. 21 pp.

Mosely, M. 2007b. Acadian biospeleology: composition and ecology of cave fauna of Nova Scotia and southern New Brunswick, Canada. *International Journal of Speleology* **36**: 1-21.

NRC (National Research Council). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press, Washington D.C. 395 pp.

NSDNR (Nova Scotia Department of Natural Resources). 2011. Nova Scotia Abandoned Mine Openings (AMO) Database: http://gov.ns.ca/natr/meb/links/amolinks.asp. Accessed on March 26th, 2012.

NSDNR (Nova Scotia Department of Natural Resources). 2012. Nova Scotia Significant Species and Habitats Database: http://gov.ns.ca/natr/wildlife/habitats/hab-data/. Accessed on March 26th, 2012.

O'Farrell, M.J., Miller, B.W., and W.L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. *Journal of Mammalogy* **80**: 11-23.

Ontario Ministry of Natural Resources (OMNR). 2008. Fact sheet – bat hibernation and hibernacula. 2 pp.

Poissant, J.A., and H.G. Broders. 2008. Ectoparasite prevalence in *Myotis lucifugus* and *Myotis septentrionalis* (Chiroptera: Vespertilionidae) during fall migration at Hayes Cave, Nova Scotia. *Northeastern Naturalist* **15**: 515-522.

Quinn, G.M., and H.G. Broders. 2007. Roosting and foraging ecology of Tri-colored bat (*Perimyotis subflavus*) in SW Nova Scotia. Report prepared for the Nova Scotia Habitat Conservation Fund, c/o Nova Scotia Department of Natural Resources. 34 pp.

Randall, J.H. 2011. Identification and characterization of swarming sites used by bats in Nova Scotia. MES Thesis, School of Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia. 63 pp.

Rodhouse, T.J., Vierling, K.T., and K.M. Irvine. 2011. A practical sampling design for acoustic surveys of bats. *Journal of Wildlife Management* **75**: 1094-1102.

Rydell, J., Bach, L., Dubourg-Savage, M-J., Green, M., Rodrigues, L., and A. Hedenström. 2010. Mortality of bats at wind turbines links to nocturnal insect migration? *European Journal of Wildlife Research* **56**: 823-827.

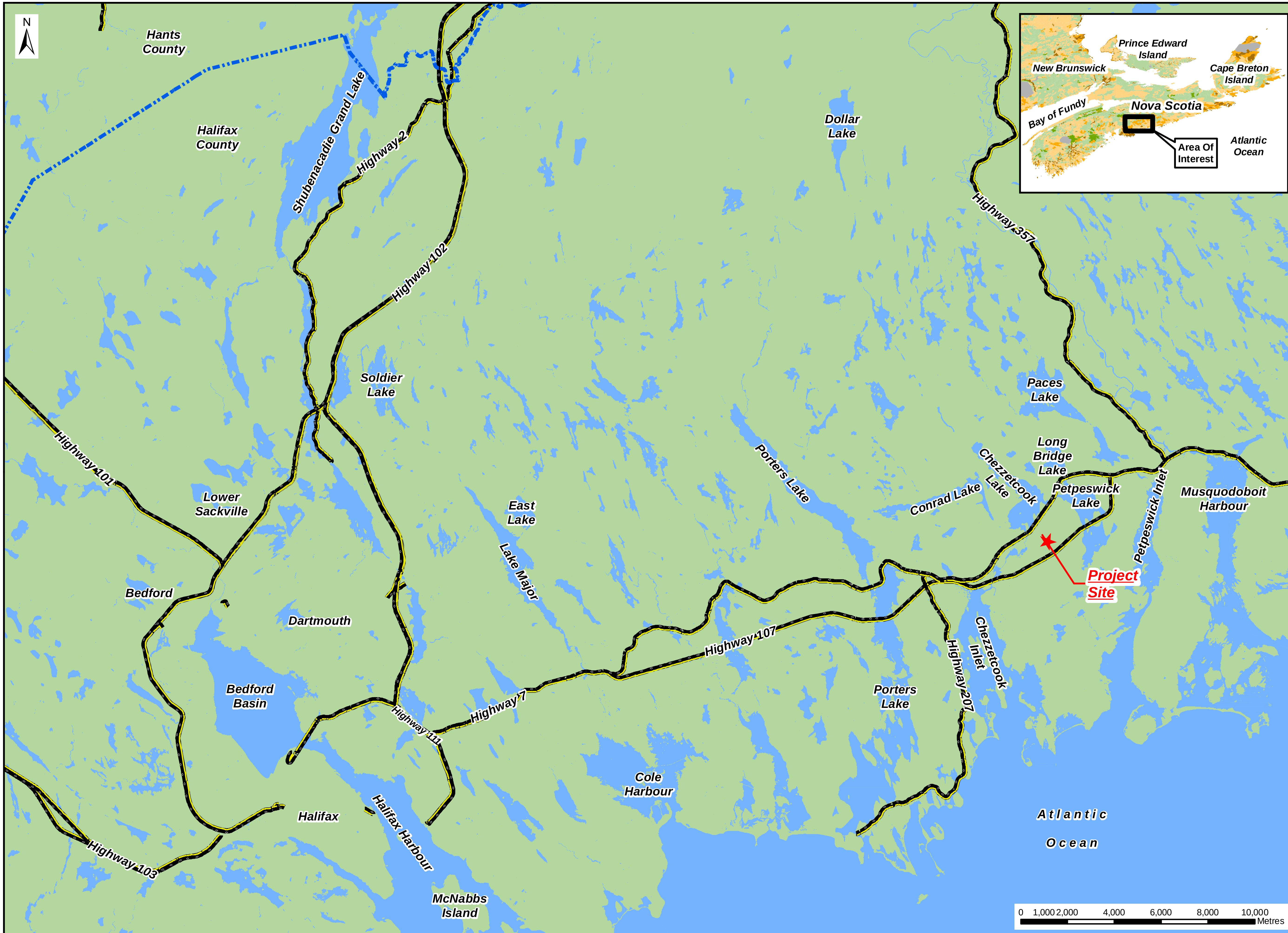
Schaub, A., Ostwald, J., and B. M. Siemers. 2008. Foraging bats avoid noise. *Journal of Experimental Biology* **211**: 3174-3180.

Thomas, D.W. 1995. Hibernating bats are sensitive to nontactile human disturbance. *Journal of Mammalogy* **76**: 940-946.

Vanderwolf, K.J., McAlpine, D.F., Forbes, G.J., and D. Malloch.bat populations and cave microclimate prior to and at the outbreak of white-nosed syndrome in New Brunswick. *Canadian Field Naturalist* **126**: 125-134.

Weller, T.J., and J.A. Baldwin. 2012. Using echolocation monitoring to model bat occupancy and inform mitigations at wind energy facilities. *Journal of Wildlife Management* **76**: 619-631.

APPENDIX A
DRAWINGS



Notes:

1. Reference: Digital Topographic Mapping By Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North.

Legend:

- County Boundary
- Highway
- Water Body

Project Site Location

Strum
ENVIRONMENTAL

Date: Dec. 2012	Project #: 12-4428
Scale: 1:150,000	Drawing #: 1
Drawn By: H. Serhan	
Checked By: G. Gregory	

Notes:

1. Reference: Digital Topographic Mapping By Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North.

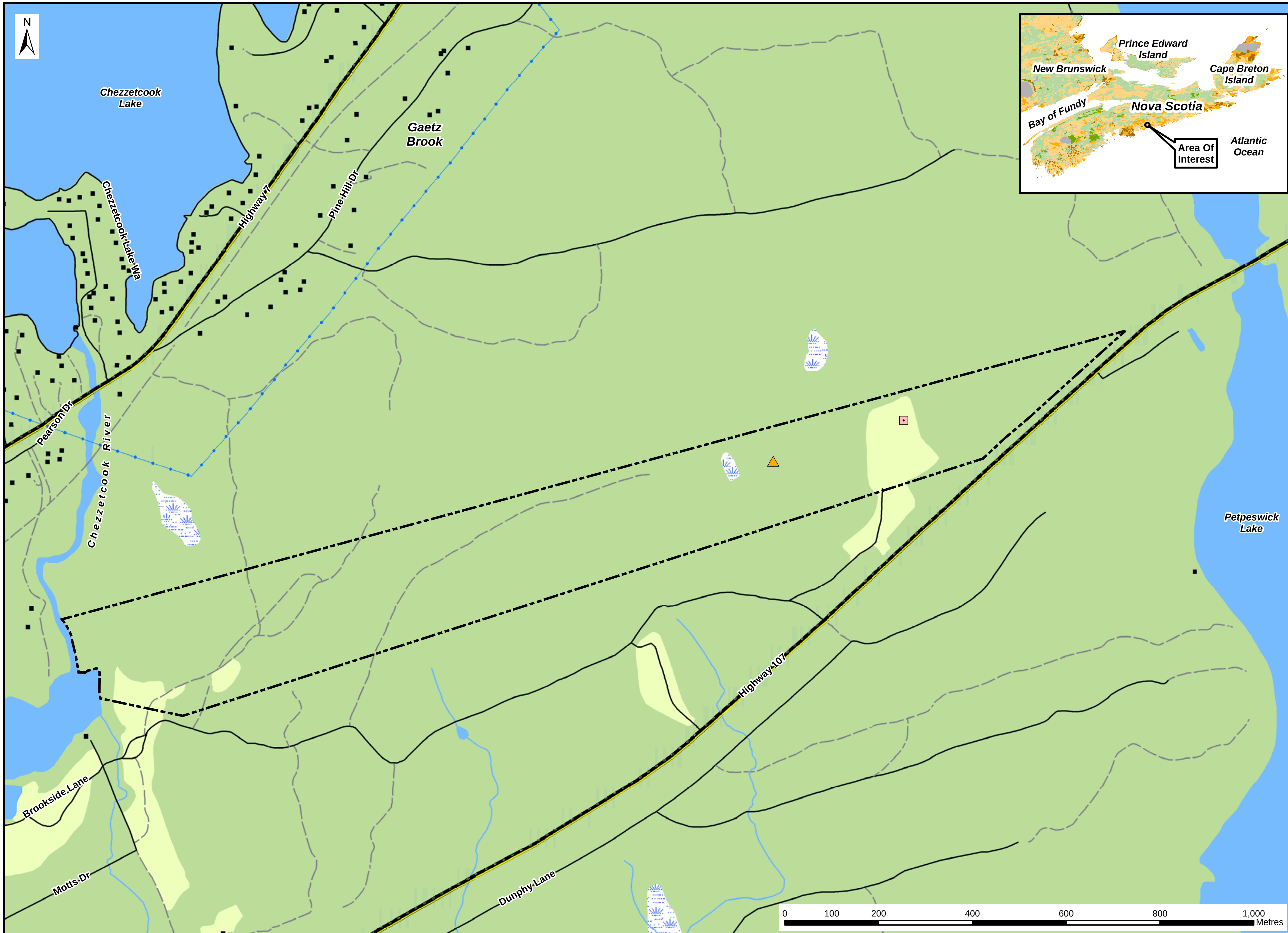
Legend:

- Project Site
- Known Bat Hibernacula
- Water Body

Known Bat Hibernacula Within 100 km

Strum ENVIRONMENTAL

Date: Dec. 2012	Project #: 12-4428
Scale: 1:550,000	Drawing #: 2
Drawn By: G. Gregory	
Checked By: A. Walter	



Notes:

1. Reference: Digital Topographic Mapping By Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. GPS Points Taken Are Typically To +/-5m Accuracy.

Legend:

- Bat Detector
- Proposed Turbine
- Project Site Boundary
- Building
- Major Roads and Highways
- Roads
- Access Roads / Trails
- Existing Transmission Lines
- Mapped Stream
- Indefinite Stream
- Water Bodies
- Mapped Wet Area
- Cleared Area

Bat Detector Location

Strum
ENVIRONMENTAL

Date: Dec. 2012	Project #: 12-4428
Scale: 1:7500	Drawing #: 3
Drawn By: H. Serhan	
Checked By: G. Gregory	