Cape Cod Community College
Wind Energy Avian Assessment

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Abstract and Keywords

This report presents a Phase I Avian Risk Assessment for a proposed 1.5-megawatt class wind turbine at the Cape Cod Community College campus in Barnstable, Massachusetts. The assessment includes a literature review, consultation with regional experts, and a site visit. Together these sources of information provide an indication of the type and number of birds and bats that are known or suspected to use the project site and adjacent areas. This information was used to assess the degree of risk to birds and bats from wind power development at the site.

Nothing in the literature suggests that the site is an important nesting or foraging area for federal or state endangered or threatened species, or species of concern. Based on the inspection of the site and a substantial number of reports documenting the effects of wind turbines on avian communities, the proposed project is likely to be of minimal risk to birds. The collision risk to resident bats (i.e., little brown myotis, eastern pipestrelle, northern myotis, and big brown bat) on the project site is expected to be minimal and similar to the risk from collision with other vertical structures including communication towers. However, the potential impacts to migrating bats (i.e., hoary bat, silver-eared bat, and red bat) are unknown due to the lack of information on the migration routes of these species.

The following is a list of Keywords.

Avian
Bats
Breeding Birds
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Flyway
Habitat
Hibernation
Low Income Initiative
Massachusetts Natural Heritage Program
Migration
MTC
Navigational Lighting
Risk
USFWS
Wind Energy
Wind Turbine

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EXECUTIVE SUMMARY

This report presents a Phase I Avian and Bat Risk Assessment for a proposed 1.5-megawatt (MW) class wind turbine at the Cape Cod Community College (CCCC) campus in Barnstable, Massachusetts. The assessment included a literature review, consultation with regional experts (agency staff and environmental organizations), and a site visit on January 19, 2005. Together these sources of information provide an indication of the type and relative numbers of birds and bats that are known or suspected to use the project site and areas near the site. This information provided the basis for the assessment of the degree of risk to birds and bats from wind power development at the site.

The CCCC wind power project would have an estimated maximum capacity to generate approximately 1.5 MW from a single turbine. The turbine would be situated on a tubular tower with a hub height of between 65 and 80 meters (213 to 262 feet) with a rotor diameter of about 77 to 80 meters (262 feet). Overall height of the turbine with the rotor in the 12 o'clock position would be approximately 104 to 120 meters (341–394 feet). The tower would be lit according to Federal Aviation Administration (FAA) guidelines, which specifies dual-medium intensity lighting. Electrical collection lines on site would be underground.

The turbine would be located on a knoll within 150 feet of the CCCC campus parking lot. The terrain is relatively hilly (in reference to areas near the shore) and wooded. The woods are composed of an Oak-Pine covertype with pitch pine (*Pinus rigida*) and black oak (*Quercus velutina*) co-dominant. The understory is vegetated with holly (*Ilex opaca*), white pine saplings, lowbush blueberry (*Vaccinium angustifolium*), wintergreen (*Gaultheria procumbens*), sheep laurel (*Kalmia angustifolia*), and bearberry (*Arctostaphylos uva-ursi*).

Nothing in the literature reviewed suggests that the site is an important nesting or foraging area for federally endangered or threatened species. The U.S. Fish and Wildlife Service and the Commonwealth of Massachusetts have been contacted for confirmation regarding the lack of presence of endangered or threatened species, or species of concern at the project site. The U. S. Fish and Wildlife Service (USFWS) has indicated that no known species under their jurisdiction are known to inhabit the project area. The Massachusetts Natural Heritage Program and Endangered Species Program (MNHESP) has indicated that there are no known rare birds, bats, or exemplary natural communities near the project site.

Based on the site and a substantial quantity of reports documenting the effects of wind turbines on avian communities, the proposed project is likely to be of low risk to birds. With respect to collision impacts, it is likely that small, but not biologically significant numbers of night-migrating songbirds may collide with the turbines. The collision risk to resident bats (i.e., little brown myotis, eastern pipestrelle, northern myotis, and big brown bat) on the project site is expected to be minimal and similar to the risk from collision with other vertical structures including communication towers. However, the potential impacts to migrating bats (i.e., hoary bat, silver-eared bat, and red bat) are largely unknown due to the lack of information on the migration routes of these species.

Based on site reconnaissance, a literature review, and consultation with experts during the development of this risk assessment, the following recommendations are made for the CCCC Wind Power Project. These recommendations would reduce the potential risk to birds and bats and are in accordance with the American Conservancy Wind Energy Policy.

- Electrical collection lines between the wind turbine and substation should be underground. Any aboveground transmission lines, interconnects, and substations should be insulated and configured per APLIC (Avian Power Line Interaction Committee) guidelines. These guidelines are accepted by the U. S. Fish and Wildlife Service as the best means for avoiding electrocutions and collision impacts.

- Any navigational safety lighting that may be required by the FAA should be the minimum number, intensity, and number of flashes per minute (longest duration between flashes) allowable by the FAA. Strobe lights, which flash quickly, are preferred rather than solid or pulsating incandescent list, which are thought to be more likely to attract night-migrating birds. It is imperative that all other forms of lighting should be extinguished at night at, or immediately adjacent to, the project site, such as floodlights, to avoid attracting night migrants to the vicinity of the turbines.

- Support towers should not include areas where birds would be prone to perch, nest or roost such as external ladders.

- Post-construction, the woodland should be allowed to regenerate as close as possible to the turbine, road, and other infrastructure to reduce the potential for forest fragmentation and subsequent impacts to forest-nesting birds. A management plan should be prepared to detail this process.

- Post construction monitoring should be conducted following installation to help further understand the effects of wind turbines on birds and bats.

1.0 INTRODUCTION

This report presents a Phase I Avian and Bat Risk Assessment for a proposed 1.5 MW class wind turbine at the Cape Cod Community College (CCCC) campus in Barnstable, Massachusetts (see Figure 1). The Phase I Assessment is used to determine potential risk to birds and bats at a proposed wind power site. The Phase I Assessment is designed to provide preliminary information to help guide developers, regulators, environmentalists, and other stakeholders through the process of determining risk at a particular site and how impacts or potential impacts may need further study.

The assessment includes a literature review, interviews with local and regional experts (agency staff, environmental organizations, and local birders), and a site visit on January 19, 2005. Together, these sources of information provide an indication of the type and general abundance of birds and bats that are known or suspected to use the proposed site and the surrounding areas. This information is used to assess the degree of risk to birds and bats from wind power development at this particular site. In addition, the concerns of regulators and environmental organizations are determined and incorporated into the risk assessment.

The major factors that have the potential to impact birds and bats at wind power facilities are mortality from collision, displacement, and habitat loss. Although there have been little documented impacts to avian and bat species at wind turbine sites, with the possible exception of Altamont, California for avian species and Mountaineer, West Virginia and Buffalo Mountain, Tennessee for bat species, each site needs to be addressed individually. Careful siting of wind turbines is important in minimizing impacts to birds and bats.

The CCCC Wind Power Project is planned to generate up to a maximum of 1.5 megawatts (MW) of electric power. The project would consist of a single 1.5 MW class turbine, which would be owned and operated by the Massachusetts Technology Collaborative (MTC) under the Low Income Initiative (LII). The tower height with the rotor in the 12 o'clock position would be approximately 104 to 120 meters (341–394 feet). The turbine would be mounted on a tubular tower without perching areas and lit according to FAA recommendations. An access road would be constructed to the turbine location for construction, operation, and maintenance. Electrical lines connecting the turbines would be underground and would connect to the existing electrical system of the campus near the North Classroom Building. Electrical output from the turbine would be used on site to the extent possible with surplus energy sold into the wholesale power markets.

Figure 1 Site Locus

1.1 Methodology

The site was visited on January 19, 2005 during which transects across the project area were traversed. During the visit, habitat and topography were examined and the avifauna present was observed. The site visit was not meant to be a quantitative survey or inventory of birds on the site and surrounding area. Instead, the purpose of the site visit was to gain an understanding of the habitat and topographic features at the prospective site so that the species that might be present may be more accurately estimated.

To assess potential avian impacts, a literature search was conducted that focuses on pertinent materials (printed, published, unpublished, and electronic media) including Audubon Christmas Bird Counts, hawk migration literature/newsletters, USGS Breeding Bird Surveys, Massachusetts Natural Heritage Program database, U.S. Fish and Wildlife Service database, Massachusetts Breeding Bird Atlas, and other sources of information on birds that might nest on, migrate through, stop over on during migration, forage on, winter on, or concentrate at the site. Information requests were submitted to the USFWS, MANHESP, and Massachusetts Audubon Society (Massachusetts Audubon Society declined to reply). Information from these diverse sources is integrated into a report that summarizes the species that are present or likely to be present at a site, potential avian risk from wind turbine construction at the site, and a comparison of the site to risk at other sites where risk has been determined empirically. Finally, specific suggestions for further studies are made if indicated.

Although there is abundant literature available on bird migration, habitats, and avian impacts from wind turbines, comparatively little information of this sort is available for bats. Due to this discrepancy and the fact that birds and bats are biologically very different, this assessment considers the potential risks to bats separately. The literature search included bat natural history and habitat information, bat mortality studies at other wind turbine locations, and the results of bat surveys within the Camp Edwards portion of the Massachusetts Military Reservation (MMR) in 1999 and 2000. In addition to the literature review, bat assessment includes results from the site visit of January 19, 2005. From this information, the degree of risk to bats from wind development at this particular site has been assessed to the extent possible.

2.0 AVIAN HABITAT ANALYSIS AND LITERATURE SEARCH

2.1 Habitat

Information regarding topography and habitat of the site and surrounding area within a reasonable distance was first gathered using a 1:25,000 USGS topographic map (see Figure 1) and later from a site visit described below. In addition, datalayers from MASSGIS were overlaid on the project site to help identify any environmental constraints. The proposed elevation of the site is approximately 120 feet NGVD and the turbine location is proposed on a knoll within 150 feet of a CCCC parking lot. The terrain east of the parking lot is generally hilly and wooded (see Figure 2). The CCCC campus is on the western side of the parking lot.

The CCCC campus is bordered on three sides by major roadways. Route 6 borders the site to the south, Route 132 to the west, and Route 6A to the north. To the east, the land is wooded for roughly one mile until Old Jail Lane, which has residences along it. The forested land is approximately 360 acres.

The wooded portion is Oak-Pine woodland. Pitch pine (*Pinus rigida*) is dominant with black oak (*Quercus velutina)*. Near the proposed site, white pine (*Pinus strobus*) and oak provide a thick canopy. The understory is relatively open and is vegetated with holly (*Ilex opaca*), white pine saplings, lowbush blueberry (*Vaccinium angustifolium*), wintergreen (*Gaultheria procumbens*), sheep laurel (*Kalmia angustifolia*), and bearberry (*Arctostaphylos uva-ursi*). The wooded area near the proposed turbine is crossed by trails and open areas associated with a disc (Frisbee) golf course.

The site is located between two water bodies—Barnstable Harbor and Wequaquet Lake (see Figure 1). A Great Marsh is associated with Barnstable Harbor and Sandy Neck, which are approximately one-half mile north of the proposed turbine location. The Great Marsh and Sandy Neck are an important component of the ecology of Cape Cod.

Sightings of almost 300 species of birds and 160 species of vascular plants, including some 85 varieties of wildflowers, have been noted within the Sandy Neck and Great Marsh system (Nature Conservancy 2005). The area was recently designated an Audubon Important Bird Area. Important Bird Areas are classified as sites that provide essential habitat to one or more species of breeding, wintering, and/or migrating birds (Mass Audubon(a) 2005).

At more than six miles in length, Sandy Neck is one of the largest barrier beaches on the North Atlantic Coast. It provides important nesting and feeding habitat for a number of birds, including the federally and state threatened piping plover and state special concern least terns, as well as numerous migrating shorebirds (The Nature Conservancy 2005).

The Barnstable Marsh comprises the second largest salt marsh system in Massachusetts. An ongoing study by Massachusetts Coastal Zone Management indicates that it is one of the highest quality (least impacted) marshes on Cape Cod. The Barnstable Marsh provides habitat for fish and birds, as well as feeding and nesting areas for the threatened diamond-back terrapin. (The Nature Conservancy 2005).

Figure 2. Vegetative Community Map

Wequaquet Lake is approximately 0.9 miles south of the proposed turbine site. At 654 acres, Wequaquet Lake is the third largest freshwater water body on Cape Cod (USGS 2005). The lake is surrounded by dense residential development and the water body is impaired because of elevated levels of mercury. The Massachusetts Department of Public Health (MDPH) has issued fish consumption advisory for the lake (EOEA 2005). The lake is a migratory stopover location for waterfowl and provides some nesting opportunities for resident waterfowl.

2.2 Rare Species

Information regarding federally or state protected species and significant habitats was requested from the USFWS and the MANHESP. These letters introduced the agencies to the project and allow for governing agencies and local experts to comment on species that may be impacted by proposed turbines.

The USFWS indicates that no federally listed or proposed, threatened, or endangered species or critical habitats under jurisdiction of the USFWS are known to occur in the project area. The MANHESP has indicated that there are no known rare birds or exemplary natural communities near the project site.

2.3 Potential Avian Species

Several sources of information were reviewed to identify potential breeding birds that may utilize the site—the Massachusetts Breeding Bird Atlas (Petersen and Meservey 2003), USGS Breeding Bird Surveys, Christmas Bird Counts (CBC), and a habitat assessment. Together, these information sources and databases provide an adequate means to determine whether rare, threatened, or endangered species are present at a site or within tens of miles of a site proposed for wind power development.

The Massachusetts Breeding Bird Atlas (BBA) was based on surveys of “blocks” of a USGS topographic map conducted between 1974 and 1979. A topographic map covers an area slightly less than 60 square miles. Each USGS topographic map was divided into six blocks that were each approximately 10 square miles. A total of 989 blocks were surveyed in Massachusetts during the five-year Atlas period. The Atlas uses a species-by-species approach and provides a map of the distribution of species nesting in the state. A list of bird species documented in the project area block is listed in Table 1 below. The BBA revealed no federally or state listed species or candidate species nesting at or near the project site. Three rare species were identified in two blocks north and northeast of the subject block. The Piping Plover (federally and state threatened), Common Tern (state special concern), and Least Tern (state special concern) are documented along the shores of Barnstable Harbor and Chapin Beach. Piping Plovers, Common Terns, and Least Terns typically nest on beaches and grassy dunes near the shore. Suitable nesting habitat for these birds is located approximately 3.6 and 5.9 miles north of the proposed turbine location. Common and least terns forage almost exclusively on fish and follow schools of fish out to 10 or more miles offshore. Terns forage by flying and diving from 10–50 feet above the water. Piping Plovers feed entirely onshore and are confined to the vicinity of their nests during that season (Kerlinger and Curry 2002).

Table 1. Breeding Birds In Proximity of the Cape Cod Community College Based on the Massachusetts Breeding Bird Atlas

Species	Probability of Breeding in Block
Broad-wing Hawk	Confirmed
Mourning Dove	Probable
Blue Jay	Probable
Purple Martin	Confirmed
Black-capped Chickadee	Probable
Wood Thrush	Probable
American Robin	Probable
Northern Mockingbird	Probable
European Starling	Confirmed
Song Sparrow	Probable
Brown-headed Cowbird	Possible
Baltimore Oriole[1]	Probable
House Finch	Confirmed
American Goldfinch	Probable
House Sparrow	Confirmed

Notes:
1–The Baltimore Oriole is a listed species under the U.S. Fish and Wildlife Birds of Conservation Concern. Listed species are those migratory and non-migratory bird species (beyond those already designated as Federally threatened or endangered) that represent the highest conservation priorities and draw attention to species in need of conservation action.

Data from one USGS Breeding Bird Survey route (Table 2) from East Dennis to West Barnstable was also used to determine the types of birds that are likely to nest in the general project area and on the actual project site. The USGS sponsors the annual Breeding Bird Survey (BBS), which is a 24.5-mile (39.4 km) road survey of nesting birds. Fifty, three-minute stops are conducted at 0.5-mile (0.8 km) intervals during which time all birds seen or heard within 0.25 miles (0.4 km) are recorded. The survey is repeated several times each spring during the nesting season.

The Breeding Bird Route follows Route 6A in East Dennis, Yarmouth, Barnstable, and West Barnstable. Areas within 0.25 miles of Route 6A include tidal creeks and marshes such as Chase Garden Creek, Bridge Creek, Scorton Creek, Bass Hole Marsh, and Barnstable Marsh. These large marshes provide exceptional bird habitat. However, the CCCC is inland and composed of upland habitat. Suitable nesting habitat for marsh or shore birds does not occur on the CCCC campus.

Table 2. USGS Breeding Bird Survey for 1989 through 1998 along a 25-mile Portion of Route 6A from East Dennis to West Barnstable, Massachusetts.

Species	Birds/Route[1]	Suitable Land on the Cape Cod Community Campus to Nest
Double-crested Cormorant	0.09	NS
American Bittern	0.03	NS
Great Blue Heron	0.03	NS
Snowy Egret	0.03	NS
Green Heron	0.33	NS
Black-crown Night Heron	0.39	NS
Canada Goose	0.97	NS
Mute Swan	0.12	NS
American Black Duck	1.15	NS
Mallard	1.27	NS
Osprey	0.09	NS
Broad-winged Hawk	0.03	NS
Red-Tailed Hawk	0.06	S
American Kestrel	0.21	S
Ring-necked Pheasant	1.09	S
Ruffed Grouse	0.03	SS
Northern Bobwhite	22.30	SS
Killdeer	0.18	SS
American Woodcock	0.09	SS
Herring Gull	22.88	NS
Great Black-backed Gull	1.09	NS
Common Tern[2*]	0.45	NS
Least Tern[2*]	0.12	NS
Rock Dove	1.61	S
Mourning Dove	33.88	S
Black-billed Cuckoo	0.55	S
Yellow-billed Cuckoo	0.33	SS
Eastern Screech-Owl	0.03	S
Great Horned Owl	0.06	S
Whip-poor-will*	0.03	S
Chimney Swift	8.70	SS
Ruby-throated Hummingbird	0.03	S
Belted Kingfisher	0.18	NS
Red-bellied Woodpecker	0.21	S
Downy Woodpecker	4.58	S
Hairy Woodpecker	0.94	S
Northern Flicker	5.48	S
Eastern Wood-Pewee	3.00	S
Willow Flycatcher	0.09	NS
Willow/Alder Flycatcher	0.09	NS

Species	Birds/Route[1]	Suitable Land on the Cape Cod Community Campus to Nest
Eastern Phoebe	0.82	SS
Great Crested Flycatcher	3.58	S
Eastern Kingbird	2.09	SS
White-eyed Vireo	0.03	SS
Red-eyed Vireo	3.42	SS
Blue Jay	28.79	S
American Crow	41.52	S
Purple Martin	0.03	NS
Tree Swallow	1.61	SS
N. Rough-winged Swallow	0.09	NS
Bank Swallow	0.24	NS
Barn Swallow	7.06	NS
Black-capped Chickadee	34.58	S
Tufted Titmouse	11.88	SS
Red-breasted Nuthatch	0.18	S
White-breasted Nuthatch	1.30	S
Brown Creeper	0.09	S
Carolina Wren	4.88	SS
House Wren	2.76	SS
Veery	0.06	NS
Hermit Thrush	0.24	S
Wood Thrush*	2.24	SS
American Robin	56.97	S
Gray Catbird	34.27	S
Northern Mockingbird	6.88	S
Brown Thrasher	0.36	S
European Starling	45.97	S
Cedar Waxwing	5.79	S
Blue-winged Warbler*	0.15	NS
Northern Parula	0.06	NS
Yellow Warbler	8.24	SS
Chestnut-sided Warbler	0.24	S
Pine Warbler	6.27	S
Prairie Warbler*	0.24	S
Black-and-White Warbler	0.94	S
American Redstart	1.18	S
Ovenbird	4.55	SS
Common Yellowthroat	19.67	SS
Scarlet Tanager	0.42	S
Eastern Towhee	16.70	S
Chipping Sparrow	12.18	S
Field Sparrow	0.85	SS
Song Sparrow	28.73	SS

Species	Birds/Route[1]	Suitable Land on the Cape Cod Community Campus to Nest
Northern Cardinal	23.48	SS
Indigo Bunting	0.03	S
Red-Winged Blackbird	22.09	NS
Eastern Meadowlark	0.27	NS
Common Grackle	67.88	S
Brown-headed Cowbird	7.03	S
Orchard Oriole	0.09	SS
Baltimore Oriole*	13.00	S
Purple Finch	1.67	S
House Finch	31.61	S
Pine Siskin	0.03	S
American Goldfinch	23.73	SS
House Sparrow	41.52	S

Abbreviations and Notes

S – Suitable (preferred nesting habitat is present)
SS – Somewhat Suitable (preferred nesting habitat may not be present, but secondary nesting habitat is present)
NS – Not Suitable (preferred and secondary nesting habitat is not present)

1 – These numbers reflect the abundance of the species near the survey route. They are averages of the total counts along the route for the period 1989–1998. Because each survey route is 24.5 mi long, and consists of 50, 3-minute counts along the length of the route, the abundance estimate represents the number of birds that a very good birder would encounter in about 2.5 hours of roadside birding in the area near the BBS route.

2 – MA Special Concern – species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they would easily become threatened within Massachusetts.

*–The Common Tern, Least Tern, Whip-poor-will, Wood Thrush, Blue-winged Warbler, Prairie Warbler, and Baltimore Oriole, are listed species under the U.S. Fish and Wildlife Birds of Conservation Concern. Listed species are those migratory and non-migratory bird species (beyond those already designated as Federally threatened or endangered) that represent the highest conservation priorities and draw attention to species in need of conservation action.

2.4 Migration

Cape Cod is located along the Atlantic Flyway, which is a series of migration routes. The Atlantic coast is an integral part of the Atlantic Flyway. On a single autumn night several years ago, radar on Cape Cod indicated that 12 million songbirds passed overhead (Birdcast 2005 and Ferbank 2005). Many bird species use coastlines or other prominent features to aid in navigation during migration. Cape Cod extends eastward into the Atlantic Ocean from the mainland and is often the last area of land that migratory birds use for food before flying hundreds of miles over open ocean along their migratory path. Some birds leave Cape Cod during their fall migration and fly over open ocean for 80 to 90 hours before reaching Bermuda and Antigua. Cape Cod also offers large salt marshes and mudflats on which birds feed during migration, which requires significant food resources.

An interesting Cape Cod avian phenomenon is that some birds, especially hawks that do not like to fly over open water, follow the southern coast of Cape Cod northward to its tip in Provincetown. Birds that do not want to fly over Cape Cod Bay turn back, flying south along the northern shore of the Cape, and continue towards the mainland. This phenomenon can result in a large number of birds in Provincetown where they congregate before retreating along the Cape (Mass Audubon(b) 2005). In the spring, large numbers of passerines (perching and song birds) are found in Beech Forest in Provincetown. The birds are reluctant to fly over open water and wait until the weather is favorable before continuing the flight north (Robins 2005). Pilgrim Heights in Truro, south of Provincetown, has become a good hawk-watching location in the spring.

The timing of migration varies among bird species. The majority of land birds travel at night, usually taking off within one-half to one hour after sunset and continuing to fly for several hours. Almost all hawks, eagles, and vultures migrate during the daytime. Takeoff is often delayed until mid-morning when thermal updrafts are stronger. Raptors, such as falcons that are less dependent on soaring, often take off earlier in the day than the soaring species. Waterfowl and shorebirds migrate both by day and night (Richardson 1998).

Birds migrate at diverse altitudes, however most stay within the following ranges.

- Songbirds: 500–6,000 feet (150–2000 meters) Seventy-five percent of songbirds migrate between 500 and 2,000 feet (150-600 meters) (Smithsonian Migratory Bird Center 2005)
- Shorebirds: 1,000–13,000 feet (300–4,000 meters)
- Waterfowl: 200–4,000 feet (60–1,200 meters)
- Raptors: 700–4,000 feet (200–1,2000 meters)

These data are supported by various radar and other studies conducted in the United States and Europe. Most modern turbines extend to a maximum of 300–390 feet (90–120 meters). A small percentage of migrants passing over wind power sites are likely to fly within the altitude range of turbine swept areas. Birds are also potentially at risk when taking off or descending near turbines, especially when some feature of the turbine, such as lighting or perching may be attractive to them.

Weather and wind patterns can affect migration altitudes. Opposing winds aloft can force birds to fly at lower altitudes. Wind speeds are typically lower close to the ground than at higher altitudes. By flying at lower altitudes when faced with a head wind, birds can reduce their energy cost. However, most species will avoid flying into strong winds while migrating and wait until winds are favorable. Sometimes birds take off under favorable conditions, but encounter poor conditions during their flight. This may force them to fly at lower altitudes and put them more at risk for collision with wind turbines.

When poor visibility occurs, nocturnal migrants are thought to be strongly attracted by lights, especially by bright steady burning lights that continuously illuminate the fog and/or precipitation in the airspace around the light. The greatest number of bird collisions with tall structures (typically tall communication towers with guy wires and steady burning lights) occurs on nights with poor visibility. This is likely due to birds flying at lower altitudes during inclement weather, and their attraction to light. For this reason, when obstruction lights are required, they should be flashing, not steady burning. Floodlighting of tall structures should be avoided, especially on nights with inclement weather (Richardson 1998).

2.5 Habitat loss

Habitat loss and avoidance is a potential impact from wind turbines. Some studies have shown that birds will avoid areas after turbines are erected. Studies have been published on the displacement and avoidance impacts of wind turbines and associated infrastructure and activities on grassland and shrub-steppe breeding songbirds and other open country birds (prairie and sage grouse, shorebirds, and waterfowl, etc.). Some of these studies have documented decreased densities of and avoidance by grasslands songbirds and other birds as a function of distance to wind turbines and roads. The level of impact varies by species, and ongoing research is quantifying the distance of avoidance caused by the presence of infrastructure and human activity. Some birds seem to adapt (habituate) to areas previously avoided (National Wind 2004). Access and maintenance roads can also cause habitat loss and fragmentation.

3.0 AVIAN RISK ANALYSIS

Three types of local impacts to birds have been demonstrated at existing wind farms—1) direct mortality from collisions, 2) indirect impacts from avoidance, and 3) habitat disruption and displacement. Birds sometimes die at wind power sites as a result of collisions with wind turbines, meteorological towers (and their supporting guy wires), and maintenance vehicles traveling roads. There have been numerous studies and reviews of avian impacts from wind turbine generators of varying sizes in the United States, Canada, and Europe (Erickson et al. 2001). Results from these studies vary and data continue to change as more wind power sites are studied and as sites are studied longer. However the results from these studies continue to show a consistent trend—mortality rates at wind power sites, especially at new sites, are low. Numerous studies confirm that collision-induced mortalities at wind projects have not resulted in biologically significant population changes (Chautaqua Windpower 2004).

Habitat loss and avoidance is a concern at large windfarms. Avoidance of wind turbines has been observed at large windfarms in open areas. In contrast, the proposed turbine at the CCCC campus is a single turbine in a wooded area adjacent to a parking lot. Impacts from habitat loss and avoidance should be minimal.

The latest compilation of avian-wind power studies to date was completed in November 2004 by the National Wind Coordinating Committee (NWCC). The NWCC is a national consensus-building group comprised of federal and state wildlife agencies, industry, and environmental organizations. Fatality estimates have been calculated using data from 12 wind power projects outside California[1]. Based on these 12 studies, fatality rates average 2.3 birds per turbine per year and 3.1 birds per megawatt per year of capacity in the United States. Wind turbines typically vary by size according to their megawatt output so a mortality rate per megawatt is a more accurate assessment than simply examining the number of turbines and mortalities. There have been no documented large fatality events[2] of songbirds at wind power projects (National Wind Coordinating Committee 2004).

In comparison, avian collision rates for other human-made structures have been estimated in the United States (Erickson et al. 2001). Ironically, many of these other causes of avian mortality are commonplace, unregulated activities for which no environmental assessment is required.

- Vehicles—60 million to 80 million
- Buildings and windows—98 million to 980 million
- Powerlines—tens of thousands to 174 million
- Communications towers— 4 million to 50 million
- Wind generation facilities—10,000 to 40,000

The large differences in total mortality from these sources are strongly related to the differences in the total number (or miles) of structure in each category. There are approximately 4 million miles of roads, 4.5 million commercial buildings and 93.5 million houses, 500,000 miles of bulk transmission lines (and an unknown number of miles of distribution lines), 80,000 communication towers and 15,000 commercial wind turbines (by end of 2001) in the US. However, even if windplants were numerous (e.g. 1 million turbines), windplants would likely cause no more than a few percent of all avian collision deaths related to human structures (Erickson et al. 2001). Based on current estimates, windplant related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. one out of every 5,000 to 10,000) of the annual avian collision fatalities in the United Sates (Sagrillo 2003). There are also other sources that contribute significantly to overall avian mortality. For example, the National Audubon Society and the American Bird Conservancy estimates that avian mortality due to house cats is in the hundreds of millions (National Audubon Society 2005 and American Bird

[1] California is excluded from most studies because turbines are older (pre-1998) and do not reflect current turbine size and design. In addition one wind power site in California at Altamont Pass has outdated lattice structure towers and was sited in an area with a heavy concentration of raptors and prey items. These three factors have resulted in avian mortality greater than any other location in the United States and are considered an anomaly.

[2] Large-scale fatality events in ornithological literature generally refer to a single, one night collision event usually involving hundreds to thousands of birds at a single structure, such as a tall communication tower with guy wires, or lighthouse.

Conservancy 2005). Pesticide use, oil spills, electrocution, disease, etc., are other significant sources of avian mortality (Erickson et al. 2001).

3.1 Avian Mortality at Windfarms

Wind turbines may influence avian species in several ways. Certain species may be impacted by loss of habitat from noise or movement related to the construction and operation of the turbine. Direct effects from wind turbines may result in collision with rotor blades, guy wires, lattice structures, and the attraction of structure lighting. Following is a list of the common causes of mortality from wind power facilities.

Collision with Turbine Blades

Although the impact of wind turbine rotors on birds is considered minimal, there are instances of mortality (Kingsley and Whittam, 2001). There have been many studies conducted at various sites throughout the world, but no significant impacts have been found, except perhaps at Altamont Pass in California. Altamont has little in common with the proposed turbine at CCCC campus. Altamont is a large wind farm (5,000 turbines) with lattice structures, small and fast rotating blades, and a large raptor population with a prevalence of prey species. The turbine at CCCC is a single turbine, with a slower-moving blade and a tubular tower. It is believed that a larger diameter, slower-turning rotor blade could be more readily seen by birds and thus avoided. There is no major concentration of birds or prey items at the site as with the Altamont Pass site.

Because studies have continued to demonstrate low mortality rates at wind farms, it appears that most birds must be able to avoid collisions with the turbine blades and towers. For birds that fly through the rotor swept area, (i.e. the area in which the turbine rotor rotates), collision rates are low. In one study, Winkleman (1994) observed that 84% (43 of 51) of the birds passing through the rotor swept zone were not killed. Other documented observations have shown similar results. In The Netherlands, Winkelman (1994) calculated that 1.2% of birds passing at the maximum wind turbine height were killed. In Spain, similarly low mortality has been observed at a very large wind farm (>1,000 turbines) located in a major migratory flyway. In Belgium, the chance of a gull colliding with a wind turbine was estimated to be 0.05% and a tern 0.2% (BirdLife 2003). Radar studies have shown that most birds exhibit a lateral avoidance of structures and avoid collision.

Turbine Tower Shape

The design of the wind turbine proposed by CCCC will minimize impacts. The tower will be tubular in shape. Tubular turbine towers have replaced lattice-shaped towers, reducing the likelihood of birds perching or nesting on the tower, and thus reducing potential collisions.

Guy Wires

Guy wires are often the reason for the majority of avian fatalities on tall towers. Modern wind turbines, including the proposed CCCC turbine, do not require guy wires, thus reducing the potential for collision.

Turbine Height and Lighting

Chief concerns among governing agencies and biologists with regard to structures and avian collisions are height and lighting. Some types of lighting on human structures (buildings, bridges, towers, etc.) have been shown to attract birds, especially birds migrating at night in bad weather with poor visibility. The Federal Aviation Administration (FAA) requires that structures with heights over 200 feet above sea level be lit for aviation safety. Steady-burning lights are of particular concern.

The turbine proposed at CCCC will be 104 to 120 meters (341–394 feet) to the tip of the rotor. The height of the turbine is well below the altitude at which most migratory species fly. FAA guidance for lighting turbines allows for medium intensity red and white strobe lights with the minimum flash rate of 20 flashes per minute. The white strobe during the day and lower intensity red strobe at night minimizes the visual impact to human observers at night and reduces the probability of collision by night migrating songbirds, while ensuring visibility and pilot safety. Preliminary indications are that these lights do not appear to attract birds (American Bird Conservancy 2005). It is imperative that all other forms of lighting are extinguished at night at, or immediately adjacent to, the project site to avoid attracting night migrants to the vicinity of the turbines.

Based on recent studies at modern wind farms, it is clear that avian fatalities at wind turbine sites are uncommon or rare events. Behavioral studies have shown that birds apparently see the turbines and recognize them as obstacles (Chautaqua Windpower et al. 2004). Studies of birds approaching wind turbines indicate that most birds change their flight behavior to avoid wind turbines (Chautaqua Windpower et al. 2004, Strickland et al. 2001a; BirdLife 2002; and Sterner 2002). Studies comparing flight behavior over wind turbines to control areas without wind turbines show that migrating birds pass over wind farms at higher altitudes than over reference areas (BirdLife 2002).

In a study in Tarifa, Spain based on observation of 72,000 migrating birds, it was noted that birds flew at higher average altitudes (>100 m versus 60 m) over wind turbines than over two other observation areas without wind turbines (Janss 2000). In Spain, low mortality has been observed at a large wind farm (>1,000 turbines) located in a major migratory pathway. Based on 1,000 hours of observation, Janss (2000) observed only two raptors killed during the passage of a minimum of 47,500 raptors.

3.2 Species of Concern

There are several species and species groups that need to be investigated with regard to potential impacts of the proposed CCCC wind turbine. These are species that have been observed in the area or that may breed in, travel through, or migrate over the area. Although significant impacts are not likely, the following species need to be considered in the permitting stage of the proposed project.

Raptors

Raptors have been a species of concern at certain sites, most notably at Altamont Pass, California. They have been especially susceptible to collision at older sites that have shorter towers, faster rotor speeds, lattice structures, and many turbines placed close together leaving little room for birds to pass between blades. Raptors appear to have little difficulty avoiding turbines when flying or soaring (Orloff and Flannery 1992 and Morrison 1998).

A pair of red-tailed hawks is known to nest on the CCCC campus (Patrick Tatano personal communication 2005). Wind turbines are thought to be of a somewhat higher risk to migratory birds than resident birds. While migrant birds have a brief exposure period compared to resident birds (residents are continually flying in the vicinity of turbines whereas migratory birds may only pass the turbine twice in one year), resident birds appear to become habituated to wind turbines, avoid flying close to them, and show less reaction to them (Chautaqua Windpower et al. 2004; Winkelman 1985; Janss 2000; Percival 2001).

Migratory Birds

Migratory songbirds commonly fly over the CCCC site in large numbers in the spring and the fall. Bird collisions with turbines are more frequent when blade height is greater than 150 m (492 feet) (Rogers et al. 1977). Studies have shown that turbines up to 300+ feet have not been responsible for large numbers of fatalities of night-migrating songbirds (Kerlinger 2001). Songbirds typically migrate over the proposed site at much higher altitudes than the proposed turbine. Studies of birds approaching wind turbines indicate that most birds change their flight behavior to avoid wind turbines (Strickland et al. 2001a; BirdLife 2002, 2003; Sterner 2002). Studies comparing flight behavior over wind turbines compared to control areas without wind turbines show that migrating birds pass over wind farms at higher altitudes than over reference areas (BirdLife 2002).

Shorebirds

Shorebirds may fly through the proposed site during migration, but likely at much higher altitudes (estimated at 1,000–13,000 feet). The Piping Plover (federally and state threatened), Common Tern (state special concern), and Least Tern (state special concern) are documented along the shores of

Barnstable Harbor and Chapin Beach. Piping Plovers, Common Terns, and Least Terns typically nest on beaches and grassy dunes near the shore. Suitable nesting habitat for these birds is approximately 3.6 and 5.9 miles north of the proposed turbine location. Common and least terns forage almost exclusively on fish and thy follow schools of fish out to 10 or more miles offshore. Terns forage by flying and diving from 10–50 feet above the water. Piping Plovers feed entirely onshore and are confined to the vicinity of their nests during that season (Kerlinger and Curry 2002). Overall risks to shorebirds is likely to be low, although migrating shorebirds may pass through the project area when landing or taking off from their breeding habitats or migratory stopover locations that are on Cape Cod.

3.3 Summary and Conclusion

The wind turbine proposed by the MTC should have no biologically significant impact to avian species. Displacement of species due to habitat loss will be minimal because of the physical nature of the site. Collisions with the turbine should have no significant impact because the turbine is a single, tubular structure with minimal lighting and no associated guy wires. Although the turbine would be located within a migratory flyway, the height of the tower and turbine blades would not likely impact birds that would either be flying above the rotor swept area or around the single turbine. Nothing in the literature suggests that the site is an important nesting or foraging area for federal or state endangered or threatened species, or species of concern. Based on the site and a substantial quantity of reports documenting the effects of wind turbines, the proposed project is likely to be of minimal risk to birds. With respect to collision impacts, it is likely that small, but not biologically significant numbers of night-migrating songbirds may collide with the turbines.

4.0 BAT ASSESSMENT

4.1 Bat Habitat Analysis and Literature Search

4.1.1 Habitat

As described in detail in Section 2.1 above, the proposed wind turbine would be located on a knoll within 150 feet of the Cape Cod Community College (CCCC) campus parking lot in Barnstable, Massachusetts. The terrain is relatively hilly (in reference to areas near the shore) and wooded. The woods are composed of an Oak-Pine covertype with pitch pine (*Pinus rigida*) and black oak (*Quercus velutina*) co-dominant. The understory is vegetated with holly (*Ilex opaca*), white pine saplings, lowbush blueberry (*Vaccinium angustifolium*), wintergreen (*Gaultheria procumbens*), sheep laurel (*Kalmia angustifolia*), and bearberry (*Arctostaphylos uva-ursi*).

4.1.2 Rare Species

Information regarding federally or state protected species and significant habitats was requested from the USFWS and the Massachusetts Natural Heritage and Endangered Species Program (NHESP). These letters introduced the agencies to the project and allow for governing agencies and local experts to comment on species that may be impacted by the proposed turbines.

The USFWS indicates that no federally listed or proposed, threatened, or endangered species or critical habitats under jurisdiction of the USFWS are known to occur in the project area. The NHESP has indicated that there are no known rare bats or exemplary natural communities near the project site.

4.1.3 Potential Bat Species

Southeastern Massachusetts is included in the range of seven bat species (Cardoza et al. 1999; DeGraaf and Yamasaki 2001). These species are the big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), northern myotis (*Myotis septentrionalis*), eastern pipistrelle (*Pipistrellus subflavus*), little brown myotis (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*). Four of these species were documented during surveys within the Camp Edwards portion of MMR in 1999 and 2000, including the big brown bat, red bat, northern myotis, and the eastern pipistrelle (Massachusetts Army National Guard 2001). The distance from MMR to the proposed MTC Site at Cape Cod Community College in Barnstable, Massachusetts is approximately 11 miles (17.7 km).

Due to their generally robust populations throughout their ranges, none of these bats are listed on the Massachusetts or federal lists of rare, threatened, or endangered species. Most of the seven bat species that occur in southeastern Massachusetts are classified as "uncommon to rare" in the southeastern Massachusetts portion of their ranges (DeGraaf and Yamasaki 2001). The characteristics of each are summarized below.

Big Brown Bat

The big brown bat occurs statewide in Massachusetts, but has not been identified in Martha's Vineyard or Nantucket Island (Cardoza et al. 1999). It inhabits cities, towns, and rural areas, and is less commonly found in heavily forested regions (Mulheisen and Berry 2000). This bat tends to be a habitat generalist, using a variety of hardwood and softwood forests and features, especially still water, roads, and trails, and regenerating shrub/sapling stands (DeGraaf and Yamasaki 2001). This bat has been found in human dwellings, barns, silos, and churches, and has also been found roosting in storm sewers, expansion joint spaces in concrete athletic stadiums, and mines. Big brown bats breed from September through March, and the young are usually born in

June. Hibernation begins in November. They usually travel no more than 30 to 50 miles (48.3 to 80.5 km) from maternity colonies to hibernation sites (Bat Conservation International, Inc. (BCI) 2001; DeGraaf and Yamasaki 2001; Kurta 1995). Big brown bats feed primarily on coleopteran (sheath winged insects such as beetles, fireflys and weevils) species, but may feed on a variety of other insect prey. They forage at night, flying over a range of heights above ground from approximately 16 to 160 feet (5 to 50 meters) within approximately half a mile (0.8 km) of day roosts (Kurta and Baker 1990 *in* DeGraaf and Yamasaki 2001).

Red Bat

Red bats occur statewide in Massachusetts (Cardoza et al. 1999). They tend to choose habitats that are sparsely to moderately populated by humans, and are rare in heavily urbanized areas. Similar to the brown bat, the red bat utilizes hardwood and softwood forests as well as features such as still water, roads, and trails, and regenerating shrub/sapling stands. They begin foraging 1 to 2 hours after sunset, flying high at first and eventually coming within 6.5 to 30 feet (2 to 4 meters) of the ground as darkness approaches (BCI 2001). Red bats breed from August through September, and the young are born the following year in late May to early June (DeGraaf and Yamasaki 2001). Red bats are migratory, arriving in the northern climates in mid-April and leaving in late October. They usually winter from Maryland to the Gulf States, typically hibernating in hollow trees and choose roosting sites in dense foliage. Red bats are strong fliers, and are capable of covering great distances over water (DeGraaf and Yamasaki 2001). Although they are fast flyers, their long narrow wings give them poor maneuverability (BCI 2001).

Northern Myotis

The northern myotis, also known as the northern long-eared bat, occurs statewide in Massachusetts but has not been observed on Nantucket Island (Cardoza et al. 1999). This bat is largely associated with boreal forests (Ollendorff 2002) but also occurs in mature forests of oak, hickory, maple, hemlock, red cedar, or birch (BCI 2001). In areas of North America and Canada, the northern myotis roosts in buildings, under exfoliating bark, and in the cavities of dead trees. Caves and underground mines are its choice sites for hibernating. The northern myotis forages over ponds and clearings within forests, below tree canopy but above the shrub layer. This species is a slow flier but has high maneuverability, allowing individuals to forage in thick forest habitats (DeGraaf and Yamasaki 2001). These bats appear to feed exclusively beneath the canopy level, often 3.3 to 9.8 feet (1 to 3 meters) above ground along forested hillsides and ridges (BCI 2001). The northern myotis is not a migratory species and appears to make only local seasonal movements (BCI 2001).

Eastern Pipistrelle

The eastern pipistrelle occurs statewide in Massachusetts but has not been positively identified on Martha's Vineyard or Nantucket Island (Cardoza et al. 1999). Summer roosts are usually caves or mines, except in colder northern areas, where pipistrelles may be found in houses or hollow trees during summer months. The eastern pipistrelle performs short annual migrations between winter hibernation and summer nursery sites. Such travel is not known to exceed 50 miles (80 km), and averages 31 miles (50 km) or less (BCI 2001). The eastern pipistrelle forages over water and along forest-field edges and typically avoids dense forests (DeGraaf and Yamasaki 2001). It prefers to feed over rivers, pastures, and high in bordering trees and feeds on flies, beetles, ants, bugs, moths and wasps.

Little Brown Myotis

The little brown myotis occurs statewide in Massachusetts (Cardoza et al. 1999). This bat forages over streams and ponds, where its diet consists of aquatic insects (mainly midges, mosquitoes, mayflies, and caddisflies) (DeGraaf and Yamasaki 2001). It also feeds over forest trails and lakes in a forest-dominated landscape where it consumes beetles, moths, stoneflies, true bugs, and termites. Breeding occurs from September to October, and the young are born from mid-June to early July. The little brown myotis seeks cavities for shelter, roosting, and brooding. In summer, females brood their young in dark, warm sites such as barns, attics, caves, hollow tree cavities, and other protected areas. Roost sites are highly variable and not well known. Little brown myotis hibernate in clusters during the winter months. Caves or mines are preferred, but large tree cavities with favorable microclimates may be used (Snyder, undated). Although not known as a migratory species, little brown myotis may travel up to 31 to 310 miles (50 to 500 km) between summer and winter roosts (BCI 2001).

Silver-Haired Bat

The silver-haired bat occurs statewide in Massachusetts (Cardoza et al. 1999). Foraging typically occurs around sunset in mixed, coniferous and hardwood forest areas near lakes, streams, and ponds (DeGraaf and Yamasaki 2001). This bat forages for emerging aquatic insects, flies, beetles, and moths often less than 20 feet (6.1 meters) above the surface. Individuals have their own hunting territories, often approximately 328 feet (100 meters) in diameter, and may travel up to 1.2 to 31 miles (2 to 50 km) to reach these sites (BCI 2001). The silver-haired bat breeds in late September, and the young are born between June and July. This is a migratory species that travels along coastal flyways in the northeast to the southern parts of its range in late October before returning in April (DeGraaf and Yamasaki 2001).

Hoary Bat

The hoary bat appears to occur statewide in Massachusetts (Cardoza et al. 1999). This species is found in forests, open cultivated areas, and small towns. It prefers coniferous forests but also utilizes woodland edges, deciduous woods, hedgerows, and trees in parks (DeGraaf and Yamasaki 2001). Breeding occurs during September to November, and the young are born in late May to early June. The hoary bat begins foraging in the fifth hour after sunset, and tends to forage in uncluttered areas at heights 23 to 49 feet (7 to 15 meters) above the ground. This species is generally solitary, except during migration. Migration to the southern United States and Central America occurs August through October (BCI 2001).

4.2 Bat Risk Analysis

This section discusses potential impacts of the proposed wind turbines on local bat populations as a result of both habitat loss from construction and bat collision mortality during operation.

4.2.1 Habitat Loss

Habitat loss and avoidance is a potential impact to bats from the construction and operation of wind turbines. Although it is unknown what species of bats are currently using the project site, inferences have been made based on the habitat preferences of each species described in Section 4.1.3 above and the habitat features provided by the site, as described in Section 4.1.1 above. The following summarizes the potential habitat provided by the site for each of the seven bat species:

- **Big brown bat:** The big brown bat is a habitat generalist, but prefers deciduous forests (BCI 2001). The project site may provide nesting habitat for maternity colonies in hollow oak trees and conifer snags, and the site may provide foraging habitat for males and females, which show no preference for feeding over water versus land or forests versus clearings (BCI 2001).

- **Red bat:** The red bat is a migratory species that roosts in the foliage of deciduous trees. Their roosting preferences include: 1) dense vegetation above, 2) unobstructed space below, 3) no potential perches beneath, 4) dark-colored ground cover, 5) sufficient surrounding vegetation to protect from wind and enhance heat and humidity retention, and 6) southern exposure (BCI 2001). They forage in a variety of habitats, mostly along the edges of clearings (BCI 2001). Based on these habitat requirements, the project site may provide foraging and roosting habitat for red bats.

- **Northern myotis:** The northern myotis prefers boreal forests, but may also occur in mature forests of oak, hickory, maple, hemlock, red cedar, birch, or ponderosa pine (BCI 2001).

They forage in these forests, along hillsides and ridges (BCI 2001). Due to the absence of caves or abandoned mines, the project site does not appear to contain hibernacula for this species during the winter. The project area is on the edge of a wooded area that may provide habitat for the species.

- **Eastern pipistrelle:** The eastern pipistrelle shows a preference for hibernating and roosting in caves, mines, and buildings, none of which occur in the project area (DeGraaf and Yamasaki 2001; BCI 2001). This species prefers to forage over ponds and waterways, which also do not occur on the project site. Therefore, this site does not appear to provide appropriate habitat for the eastern pipistrelle.

- **Little brown myotis:** The little brown myotis lives in a variety of forested habitats during the summer, and over-winters in caves and mines (BCI 2001). They primarily feed over water, but non-reproductive individuals may forage in a variety of habitats. The project site may provide summer roosting habitat for this species and foraging habitat for non-reproductive individuals. The site does not provide hibernacula for little brown myotis, due to the absence of caves and mines.

- **Silver-haired bat:** The silver-haired bat occurs in forested habitats and roosts in tree cavities (BCI 2001). They feed in areas sheltered by vegetation over streams, ponds, or roadsides (BCI 2001). Although the project site may provide roosting habitat for the silver-haried bat during the summer, it does not contain the appropriate foraging habitat.

- **Hoary bat**: The hoary bat occupies a variety of habitats, including both coniferous and deciduous forests (DeGraaf and Yamasaki 2001). During the summer, they prefer tree roosts in edge habitats close to feeding grounds. Feeding grounds are typically mixed forest and vegetation types with small open areas and edges. The project site may provide appropriate roosting and foraging habitat for the hoary bat during the summer.

Overall, the site may provide summer roosting habitat for bats. However, the relative scarcity of these bats in southeastern Massachusetts, the proximity of the site to major roadways, and the relative scarcity of large snags in the project area may limit the abundance of bats in this area. The proposed turbine is near the edge of a parking lot and maintained trails. The project footprint will impact only approximately 1.2[3] acres of land. The wooded area just to the east of the proposed turbine location is over 360 acres. Loss of habitat from the proposed turbine is not anticipated to significantly impact local bat populations.

[3] Cape Cod Community College Wind Development Feasibility Study, Draft Report 10/6/04, Global Energy Concepts, Inc & R.W. Beck, Inc.

4.2.2 Bat Collision Mortality

In studies of inland wind farms and bats, relatively few bat mortalities were recorded compared to the overall size of local bat populations (e.g., Howe et al. 2002). Comparative study data from areas with relatively large numbers of bat species near turbines suggest that bat collision mortality during breeding season was "virtually non-existent" (West 2002). During the breeding season, many of the bats found in southeastern Massachusetts tend to remain in proximity to maternity colonies and roosting areas (e.g., Paradiso 1969; Jackson 1961). Therefore, the proposed wind turbines are not expected to impact local breeding populations of bats.

The use of echolocation may explain why bat collision mortality is low during the breeding season. Although bats have relatively good eyesight, most depend on a highly developed echolocation system to navigate, avoid obstacles, and capture insects in the dark (Harvey et al. 1999). Bats emit pulses of very high-frequency sound (inaudible to human ears) at a rate of a few to 200 per second, depending on the species. By using echolocation, bats can discern objects in their path by listening to the echoes reflected back to them (Witt 1999). Bat echolocation and collision mortality studies suggest that only a small fraction of detected bat passes near turbines result in collisions (Johnson et al. 2002). In addition, studies of captive hoary bats have shown that they are able to avoid colliding with moving objects more successfully than stationary ones (Jen and McCarty 1978). Despite their use of echolocation, bat collision mortality at wind turbines does occur and may exceed avian collision mortality at some sites (Johnson 2004). Foraging and migration are the two primary behaviors requiring flight time that may put bats at risk of collision.

In addition to assisting bats with prey location, echolocation may minimize bat collisions with wind turbines during foraging flights. In studies of foraging bats at the National Wind Technology Center in Golden, Colorado and a European wind park, bats were observed foraging within proximity (1 meter in the European study) of an operating wind turbine, yet no mortality was documented (U.S. Department of Energy 2002; Bach et al. 1999).

Based on the bat behavioral studies reviewed by West, Inc. (2002), hoary and eastern red bats typically forage from treetop level to within a meter of the ground, silver-haired bats spend most of their time foraging at heights less than 19.7 feet (6 meters), and big brown bats forage from 23 feet (7 meters) to 33 feet (10 meters) above ground (Barclay 1984; Fitzgerald et al. 1994). Little brown bats forage almost exclusively less than 16.5 feet (5 meters) above the ground (Fenton and Bell 1979). These foraging altitudes are well below the proposed lower rotor swept zone (25 to 41.5 meters (82 to 136 feet)).

In studies of inland wind farms and bats, resident bat populations seemed to be at substantially less risk of collision with wind turbines than were migrants (West 2002). Most bat mortality documented at wind plants in the United States occurred during the migration season, in late summer and early fall, and involved migratory tree and foliage roosting bats, of which the hoary and eastern red bat were the most prominent species in the eastern United States and the Midwest (West 2002). Several hypotheses have been developed to explain bat collisions with wind turbines. Several researchers believe that although bats rely on echolocation when foraging, migrating bats may navigate without echolocation (Kunz, undated; Johnson 2004).

Migration behavior varies among the bats with range in southeastern Massachusetts. The eastern pipistrelle migrates less than 30 miles (48.3 km), generally over land, between its maternity colonies and hibernation sites (Kurta 1995). Other species migrate from New England to their southern ranges, from the Mid-Atlantic States to Central America. Many species of bats make extensive use of linear features in the landscape such as ridges or rivers while commuting (Limpens and Kapteyn, 1991) and migrating (Humphrey and Cope 1976; Timm 1989), which may indicate a preference for overland migration routes. However, the migration routes of these bats are not well documented. There is also little information available about the heights at which bats migrate, although Altringham (1996) reported that at least some groups of bats are known to migrate at altitudes higher than the upper rotor swept zone (i.e., above 394 feet (120 meters)).

As described in Section 3.1 above, the proposed turbine would be lit according to Federal Aviation Administration (FAA) guidelines, which specifies dual-medium intensity lighting. Lighting of turbines and towers does not appear to affect bat collision rates. FAA lighting on turbines was not found to increase the probability of bat collisions at the Buffalo Ridge, Minnesota Phase III site (West 2002).

Overall, bat collisions with wind turbines result in an average bat fatality rate in the U.S. of 3.4 fatalities per turbine per year, or 4.6 fatalities per MW per year (Johnson 2004). The highest mortality rates have been observed in the Eastern U.S., which averages 46.3 fatalities per turbine per year, or 32 per MW per year; however, this is an average of only two bat mortality studies conducted in Mountaineer, West Virginia and Buffalo Mountain, Tennessee. In general, studies of inland wind farms and bats indicate that relatively few bat mortalities occur compared to the overall size of local bat populations (e.g., Howe et al. 2002). The collision risk to resident bats (i.e., little brown myotis, eastern pipestrelle, northern myotis, and big brown bat) on the project site is expected to be minimal and similar to the risk from collision with other vertical structures including communication towers. However, the potential impacts to migrating bats (i.e., hoary bat, silver-eared bat, and red bat) are unknown due to the lack of information on the migration routes of these species.

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Appendix A

Correspondence