TOWN OF EDGARTOWN

WIND ENERGY FEASIBILITY STUDY

MASSACHUSETTS TECHNOLOGY COLLABORATIVE, RENEWABLE ENERGY TRUST

[DRAFT]

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Via email

June **[23]**, 2009

Renewable Energy Trust
Massachusetts Technology Collaborative
75 North Drive
Westborough, Massachusetts 01581

Ladies and Gentlemen:

Subject: **Wind Energy Feasibility Study**
Edgartown, Martha's Vineyard, Massachusetts
[DRAFT]

NOTICE AND ACKNOWLEDGEMENTS

This report, sponsored by the Renewable Energy Trust ("RET"), as administered by the Massachusetts Technology Collaborative ("MTC"), was prepared by the consulting team of R. W. Beck, Inc. ("R. W. Beck") and DNV Global Energy Concepts, Inc. ("DNV GEC") (collectively the "Consultant") at the direction of and for the benefit of MTC pursuant to Work Order Number 09-01 dated February 25, 2009 and the Master Services Agreement dated November 1, 2003. R. W. Beck, DNV GEC, any of their affiliates, subsidiaries, directors, officers, employees, and sub-consultants make no warranties, expressed or implied, with respect to the report and accept no liability for consequential damages or loss, monetary or otherwise, suffered due to decisions made based upon this report. The opinions expressed in this report do not necessarily reflect those of MTC or the Commonwealth of Massachusetts (the "Commonwealth"), and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it.

ABSTRACT

This feasibility study investigates the feasibility, planning, and development issues of wind energy generation at Edgartown, Massachusetts ("Edgartown"). This feasibility study considers a single wind energy plant concept located at the Edgartown Wastewater Treatment Facility (the "WWTF"), analyzes wind data from Martha's Vineyard as collected by the University of Massachusetts Renewable Energy Research Laboratory ("RERL"), performs a feasibility assessment, identifies predevelopment tasks, identifies specific site preparation work, evaluates certain project economics, identifies technical data required to prepare anticipated permits and approvals applications, considers community electric loads, considers electric interconnect to the WWTF, provides photo simulations, considers environmental receptors, and identifies certain conclusions and observations regarding the technical feasibility of the proposed project.

The following list of keywords is for RET's project database and website search feature.

- Edgartown
- Feasibility
- Planning
- Development
- Wind
- Energy
- R. W. Beck, Inc.
- DNV Global Energy Concepts, Inc.
- Wind Turbine Generator
- RERL
- Permits and Approvals
- Electric Loads
- Electric Interconnect
- Wastewater Treatment Facility, WWTF
- Wind Resource Assessment
- Photo Simulations
- Environmental Receptors
- Renewable
- Massachusetts Technology Collaborative, MTC

EXECUTIVE SUMMARY

MTC retained the Consultant to conduct a feasibility study of implementing wind energy generation at Edgartown's WWTF. This feasibility study has been performed in close cooperation with Edgartown staff. The objective of this feasibility study is to: (a) identify a conceptual wind energy plant design; (b) perform technical feasibility and certain predevelopment analyses; (c) identify site preparation work that could be completed in advance of project development; (d) perform certain analyses needed to finalize the wind turbine site; (e) evaluate certain project economics; (f) identify certain technical data to be used for certain permit and approval applications; and (g) provide certain opinions regarding the technical feasibility of the proposed project. On the basis of the Consultant's level of review and the documentation reviewed, this feasibility study supports the following conclusions:

- **[The WWTF site appears to be a technically viable location for a wind energy plant.]**
- **[The Consultant has identified no problematic technical issues regarding construction or transportation of equipment to the WWTF site.]**

- **[One wind turbine can be electrically interconnected to the WWTF's electric distribution system to export power to the NSTAR system as well as supply the intermittent needs of the WWTF.]**

- **[While there will be a visual impact in Edgartown, the Consultant has identified no other problematic environmental issues. The Consultant recommends further environmental impact analysis particularly with regard to Edgartown's Core Habitat designation.]**

- **[The proposed turbine location identified in this report should be able to meet the requirements of the Edgartown Bylaw with regard to setback and noise, and there are turbines available that meet the requirements under the Edgartown Bylaw with regard to height and noise.]**

INTRODUCTION

This feasibility study is in response to the scope of work negotiated with MTC which is described more fully in a professional services agreement with MTC. This report (the "Report") identifies issues raised during preparation of the feasibility study and is submitted to MTC for its review and use. All statements in the Report concerning the various technical issues are on the basis of information provided to us by Edgartown, MTC, RERL, equipment vendors, and those assumptions identified in this Report.

Edgartown has selected the WWTF site as the focus for a potential development location. This study and Report focuses solely on this area of Edgartown. Additionally, Edgartown asked that this study initially consider a wind energy plant comprised of one wind turbine.

The objective in this Report is to prepare a wind energy planning and development study intended to provide sufficient information to support local decision-making regarding whether or not to proceed with a wind development project. The study addresses technical, environmental, and regulatory aspects of the proposed wind energy plant to:

- Identify conceptual wind energy plant configuration;
- Evaluate technical feasibility of conceptual wind energy plant configuration;
- Understand environmental and community impacts as well as community acceptance;
- Develop capital and operating cost assumptions;
- Document and evaluate permitting and approvals aspects; and
- Estimate wind energy production levels for conceptual wind energy plant.

The study is not intended to identify and evaluate project ownership and financing options (e.g. local bonding, public-private partnerships) nor does this study include a project pro forma analysis. We understand that MTC is separately preparing a generic evaluation of community wind ownership and financing options.

This feasibility study is intended to extend the results of an earlier screening analysis (contracted by MTC and performed by others) to a conceptual level project feasibility, planning, and predevelopment topics. Accordingly, the scope of this study and Report includes the following:

1. Evaluate technical issues related to development of the project, including: site characteristics; electrical infrastructure; neighborhood impacts; environmental impacts; wind turbine location; and geotechnical topics.

2. Review and evaluate wind data collected on site by other parties, including correlation with appropriate long-term wind data sources, to the extent feasible, refine estimates of the wind resource at the project site; and develop a wind resource profile for use in estimating annual electricity production and the allocation of generated electricity between on-site loads and exports to the utility system.

3. Characterize WWTF electric loads, including diurnal and seasonal variability if possible, and understand the potential for use of wind-generated electricity at the WWTF.

4. Estimate turbine annual energy production and the allocation of generated electricity among WWTF loads and exports to the grid.

5. Identify likely required permits and approvals, including federal, state, local, and utility interconnection approvals, identify additional activities that must be completed prior to filing for permits and approvals, and estimate the timeframe for securing same.

6. Prepare photo-simulations depicting a one-wind turbine project from up to four vantage points in Edgartown.

Unless referring to other sources that specifically use traditional British/American-based English units, this Report will provide data and results in Système International ("SI") units to be consistent with the raw wind data available and to be consistent with wind industry standard practice.

SITE PROFILE

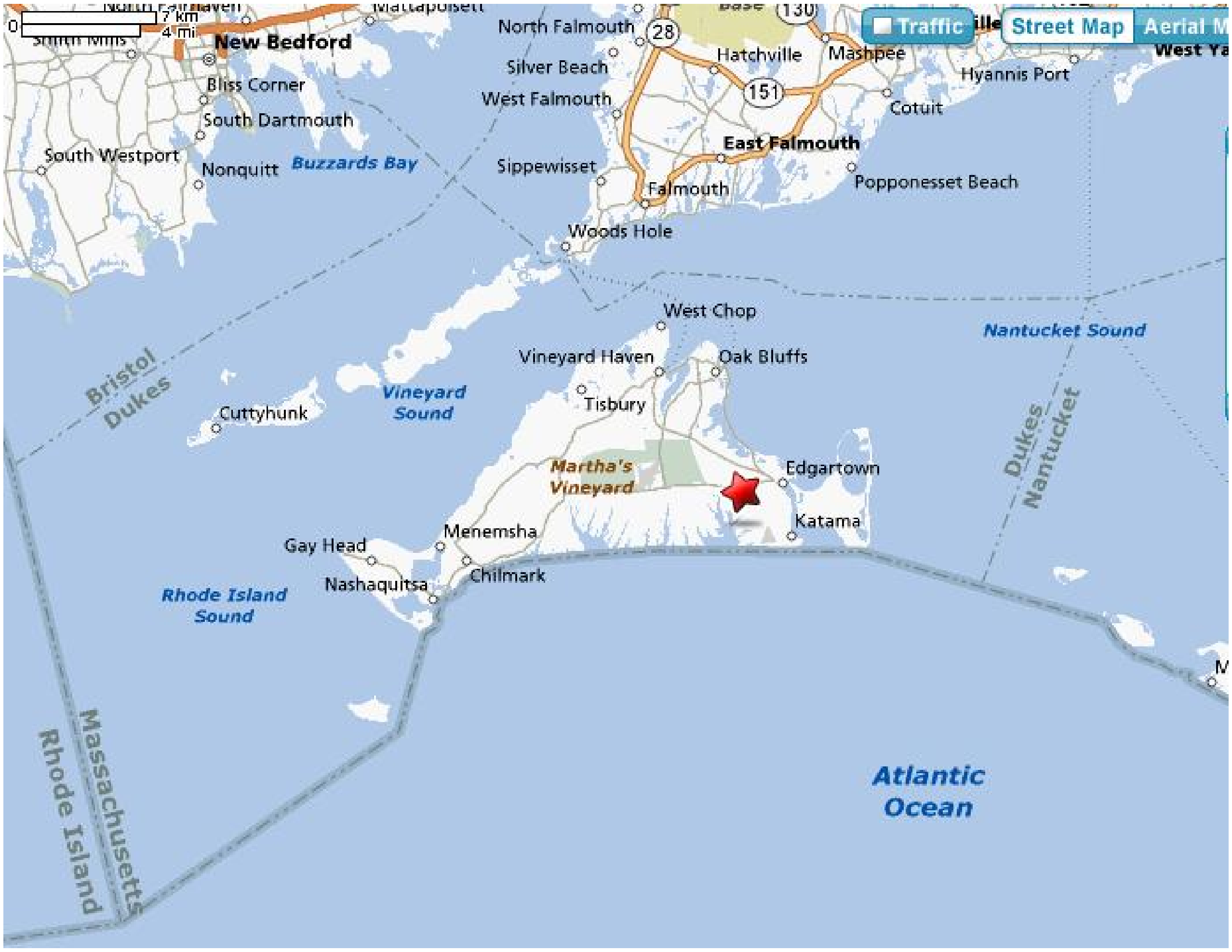
Edgartown, which was originally settled in 1642 and incorporated in 1671, is located on the island of Martha's Vineyard and it is the County Seat of Dukes County, Massachusetts; it is principally a summer and tourist destination. Edgartown is located at the eastern end of Martha's Vineyard. According to the United States Census Bureau, Edgartown has a total area of 317.9 square kilometers ("km^2") of which 69.9 km^2 of it is land and 248.0 km^2, or 78 percent, of it is water. Edgartown is 103rd out of 351 communities in Massachusetts by land area and is the largest town by land area in Dukes County.

Edgartown is bordered by Nantucket Sound to the northeast and east, the Atlantic Ocean to the south, West Tisbury to the west, and Oak Bluffs to the north. Edgartown also shares a common corner with Tisbury, along with West Tisbury and Oak Bluffs. Edgartown is approximately 116 kilometers ("km") south-southeast of Boston, Massachusetts; 90 km southeast of Providence, Rhode Island; and 303 km north-northeast of New York City; and its general latitude and longitude are 41°23'20"N and 70°30'50"W; refer to Figure 1 below.

Figure 1

Edgartown Wind Energy Feasibility Study

Edgartown, Massachusetts



Source: MapQuest, ©2009

Site and Existing Conditions

The WWTF site, which is shown in Figure 2, occupies approximately 0.94 hectares of town-owned land and is located at 330 West Tisbury Road. The WWTF site is on the south side of West Tisbury Road approximately 2.5 km west of Edgartown center, approximately 5 km east of Martha’s Vineyard Airport, and approximately halfway between Edgartown Center and east edge of Correllus State Forest.

Figure 2

Edgartown Wind Energy Feasibility Study

WWTF Site and Surrounding Area

Source: Google Earth ©2009

Note that the proposed turbine location is identified in greater detail further in this Report. As shown in Figure 2 above, the site is wooded along its boundaries. There are several buildings and structures scattered within the WWTF site that are devoted to pumping, maintenance, water treatment, and other water supply-related activities. Additionally, the southern portion of the WWTF site is comprised of infiltration ponds.

The general area proposed for the wind turbine is roughly in the middle of the WWTF site, as shown in Figure 2. The proposed turbine location is a grassy area on the north side of the infiltration ponds. It is located behind a maintenance garage, approximately 40 meters east of the southeast corner of the main WWTF building.

With the exception of the elevation difference between the infiltration ponds and the remainder of the site, the entire WWTF site is relatively flat with a gradual downward slope to the southeast. The ground elevations at the WWTF site vary between 6 meters above sea level ("asl"), within the infiltration ponds, to 12 m asl near the clarifiers. The approximate ground elevation at the proposed turbine location is 10.5 m asl. The surrounding trees are estimated to be less than 10 m tall.

The property directly to the north of the WWTF site is comprised of undeveloped woodlands. Residential areas are located beyond this property to the northwest and northeast of the WWTF site. Agricultural property abuts the eastern side of the WWTF site. However, as seen in Figure 2 the nearest residential neighbors (receptors) to the WWTF site are located to the south and west of the property. The nearest residences are approximately 200 m west and 150 m southeast of the proposed turbine location.

Electric Infrastructure

Edgartown is within the regional NSTAR Electric ("NSTAR") distribution system. Edgartown purchases power from NSTAR for its municipal buildings and loads.

The WWTF site is supplied from a single overhead 23 kilovolt ("kV") distribution line from the NSTAR distribution system which provides power to the WWTF. The WWTF is connected by an overhead radial feeder from the main distribution circuit that runs along West Tisbury Road. The connection from the overhead system is through an underground cable connected to the overhead system through a fused switch mounted on the pole at the end of the overhead circuit. The cable runs from the pole, under the parking lot to a 23 kV-480 volt ("V") pad-mounted transformer identified as "BU-258", which is estimated to be rated 350 kilovolt-amperes ("kVA"), and an electric meter owned by NSTAR located adjacent to the building containing the main switchgear for the WWTF. The low-voltage side of the transformer supplies the main 480 V switchboard in the WWTF.

The capacity of NSTAR's local distribution system in the vicinity of the WWTF as well as the distribution system feeding other municipal buildings is unclear. When the interconnection application process with NSTAR is commenced, one of the first needs will be to determine that sufficient ampacity exists in the local distribution system to carry excess power or exported power generated from a wind turbine at the WWTF. Based on typical electrical distribution system design, the Consultant would expect that the existing overhead conductors will be of sufficient ampacity to carry the electrical output of the proposed wind turbine; but this should be confirmed.

The NSTAR studies conducted as part of the interconnection application process will need to determine whether the local distribution system could absorb a fluctuating generating power output of up to 600 kilowatts ("kW") exported to it without causing instability on the distribution system. The level of power able to be exported to the NSTAR system without causing instability may be less than 600 kW.

Accordingly, until the interconnection application process is commenced and NSTAR is able to provide information regarding the capacity of its local distribution and analyze the impact of added generation on the local distribution system, the Consultant believes the prudent course is to maintain flexibility in the project development process in the event that the results of the NSTAR system impact studies require changes in the plans for the wind turbine installation at the WWTF site. For further detail regarding the NSTAR system and grid, refer to the discussion of electric interconnect further in this Report.

Electric Load Profile of the WWTF

Recent electric utility billing data (November 2004 through February 2009) provided by Edgartown's operating staff at the WWTF is summarized in Table 1.

Table 1
WWTF Electric Energy and Demand Billing Data

Month Year	Demand, kW	Peak, kWh	Low-A, kWh	Low-B, kWh	Total, kWh
November 2004	156	12,156	26,528	46,156	84,840
December 2004	196	11,922	25,904	41,722	79,548
January 2005	148	11,223	24,019	39,254	74,496
February 2005	150	11,437	25,276	45,283	81,996
March 2005	173	12,252	27,255	42,477	81,984

Table 1
WWTF Electric Energy and Demand Billing Data

Month Year	Demand, kW	Peak, kWh	Low-A, kWh	Low-B, kWh	Total, kWh
April 2005	195	20,121	15,532	35,975	71,628
May 2005	204	20,530	13,188	37,886	71,604
June 2005	190	20,910	13,519	36,131	70,560
July 2005	214	26,971	16,768	47,113	90,852
August 2005	240	30,477	18,725	61,138	110,340
September 2005	224	30,765	18,820	54,203	103,788
October 2005	218	11,828	7,507	22,293	41,628
November 2005	203	17,423	15,914	37,907	71,244
December 2005	142	9,814	22,853	36,669	69,336
January 2006	157	12,553	28,567	47,356	88,476
February 2006	157	10,416	23,231	36,277	69,924
March 2006	153	10,756	24,006	43,562	78,324
April 2006	185	12,227	18,881	34,832	65,940
May 2006	175	18,647	10,888	30,153	59,688
June 2006	231	24,486	14,716	47,054	86,256
July 2006	230	29,758	19,059	54,371	103,188
August 2006	251	34,684	22,095	63,797	120,576
September 2006	253	33,023	21,074	69,407	123,504
October 2006	229	29,956	18,961	53,431	102,348
November 2006	259	21,257	21,716	47,987	90,960
December 2006	147	8,830	20,672	36,738	66,240
January 2007	136	10,348	23,932	37,924	72,204
February 2007	161	11,175	25,121	40,456	76,752
March 2007	165	11,794	23,704	43,750	79,248
April 2007	165	17,757	10,870	32,129	60,756
May 2007	154	17,835	9,799	28,874	56,508
June 2007	241	25,108	14,658	46,214	85,980
July 2007	250	31,376	19,132	56,760	107,268
August 2007	240	37,723	23,484	75,065	136,272
September 2007	257	34,506	21,070	62,600	118,176
October 2007	264	32,274	19,862	58,840	110,976
November 2007	211	18,566	15,067	42,843	76,476
December 2007	123	9,643	22,664	36,369	68,676
January 2008	138	9,338	21,571	34,659	65,568
February 2008	140	9,793	21,947	40,536	72,276
March 2008	153	10,662	21,554	36,436	68,652
April 2008	176	17,876	10,992	32,776	61,644
May 2008	172	18,506	10,785	34,537	63,828
June 2008	226	26,884	16,069	46,747	89,700
July 2008	244	31,724	19,225	64,599	115,548
August 2008	247	32,922	20,068	59,786	112,776
September 2008	256	34,655	20,878	61,455	116,988
October 2008	245	29,157	18,111	54,528	101,796
November 2008	239	22,974	19,185	50,301	92,460
December 2008	122	7,412	16,264	30,024	53,700
January 2009	113	9,177	20,679	35,832	65,688
February 2009	107	8,085	18,661	29,894	56,640

Table 1
WWTF Electric Energy and Demand Billing Data

Month Year	Demand, kW	Peak, kWh	Low-A, kWh	Low-B, kWh	Total, kWh

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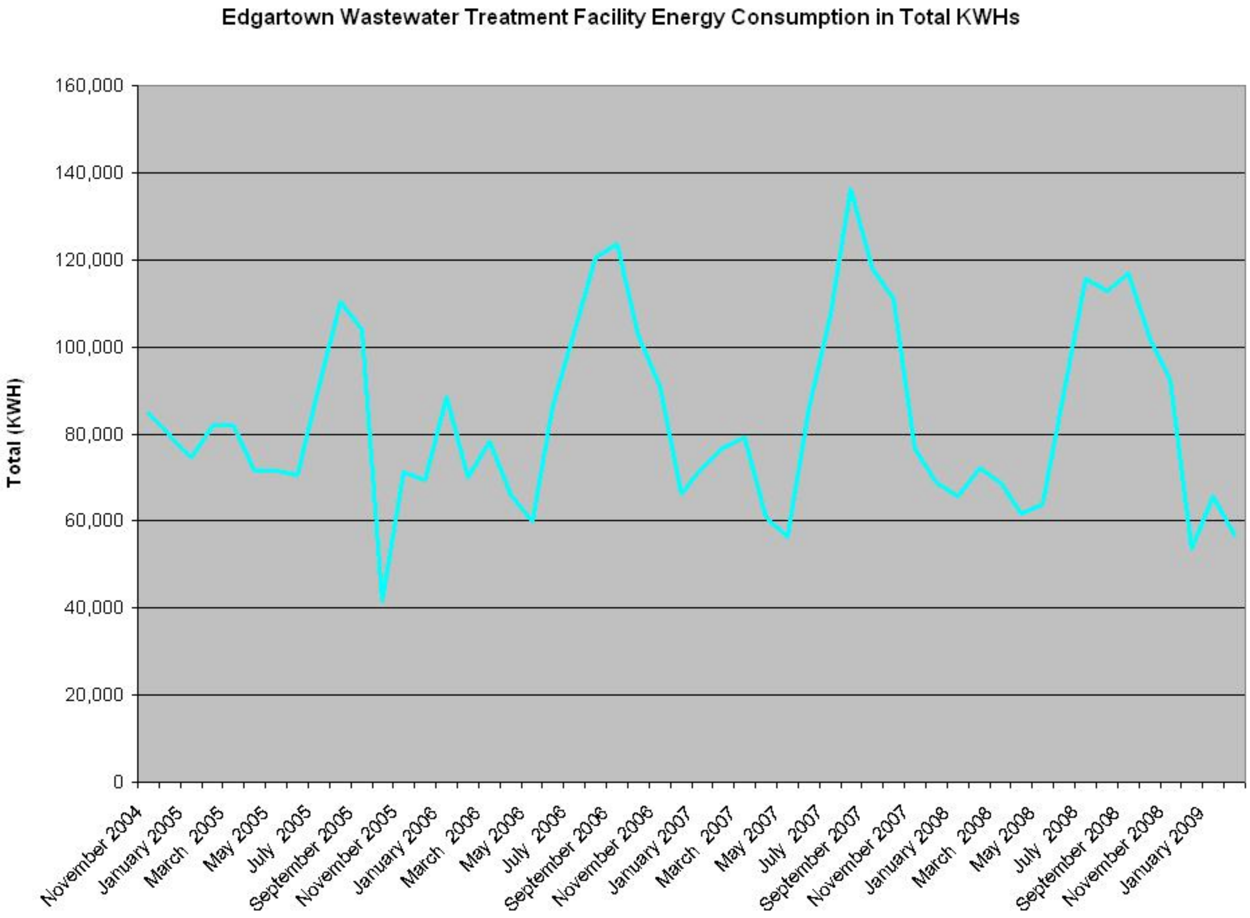
1. Data provided by Edgartown WWTF staff and derived from electric utility billing invoices.

Electricity for the WWTF is purchased from NSTAR under Rate 24 SEMA, which is a sub-category of NSTAR's Large General Time-of-Use G-3 Rate, which is approved as No. 332F by the Massachusetts Department of Telecommunication and Energy. Rate 24 is for NSTAR customers with a load that is greater than 500 kW during at least twelve consecutive billing months. Rate 24 has a peak and two off-peak periods, identified as Peak Load, Low Load A, and Low Load B. Peak Load is from 9:00 a.m. to 6:00 p.m., Monday through Friday, during Eastern Daylight Time; and from 4:00 p.m. to 9:00 p.m., Monday through Friday, during Eastern Standard Time. Low Load B is from 10:00 p.m. to 7:00 a.m., Monday through Friday, and all hours on Saturday and Sunday, during both Eastern Daylight Time and Eastern Standard Time. Low Load A includes all hours not included in Peak Load and Low Load B. Figures 3A and 3B depict the WWTF's electric energy usage (kWh) and demand (kW) patterns from November 2004 through February 2009.

Figure 3A

Edgartown Wind Energy Feasibility Study

WWTF Electric Energy Usage Profile, Monthly Total kWh

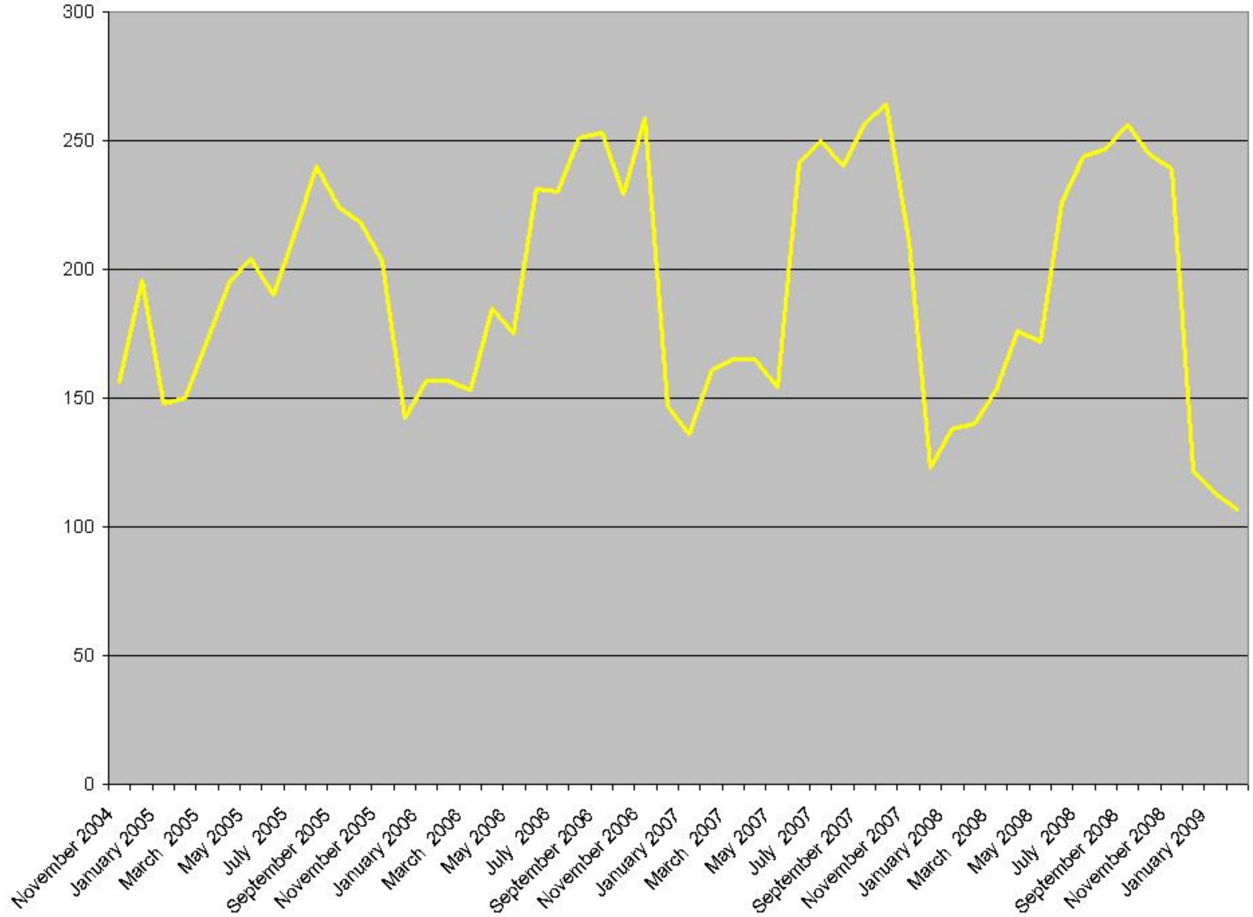


Source: Edgartown WWTF

Figure 3B

Edgartown Wind Energy Feasibility Study

WWTF Electric Energy Demand Profile, Monthly Peak kW



Source: Edgartown WWTF

After analysis, the electric utility billing data (November 2004 through February 2009) indicate that the WWTF's peak electric demand ranges from 107 kilowatts ("kW") to 264 kW with an average of 193 kW. Monthly energy usage at the WWTF appears to have slightly increased from 2004 to 2009 with monthly electric energy usage ranging from approximately 41,600 kilowatt-hours ("kWh") to 136,300 kWh with an average of 83,600 kWh. This data suggest an average monthly electric load at the WWTF ranging from approximately 57 kW to 187 kW with a long-term average electric load of approximately 114 kW. During the four calendar years from 2005 through 2008, the annual average energy usage at the WWTF was 1,014,777 kWh.

The data indicate that there is a large enough base electric load at the WWTF to support the concept of a wind energy plant displacing energy needs at the WWTF; however, it is expected that a significant amount of energy generated would be exported. Further discussion of the amount of potential energy use and export follows in this Report.

WIND RESOURCE ASSESSMENT AND ENERGY ASSESSMENT

Wind data from a meteorological ("met") tower located at the former septic lagoon site in Tisbury, Martha's Vineyard, MA were furnished to the Consultant by MTC for the purposes of estimating the wind resource and expected annual energy output for the proposed wind power project at the WWTF. RERL installed the met tower in June 2007 and managed the data collection until June 2008. The RERL provided the Consultant with validated ten-minute meteorological data from July 2007 through June 2008. Data from July 2007 through June 2008 were used by RERL in preparation of the Wind Data Report presented to MTC on August 21, 2008.

Estimating the Wind Resource at the Edgartown WWTF

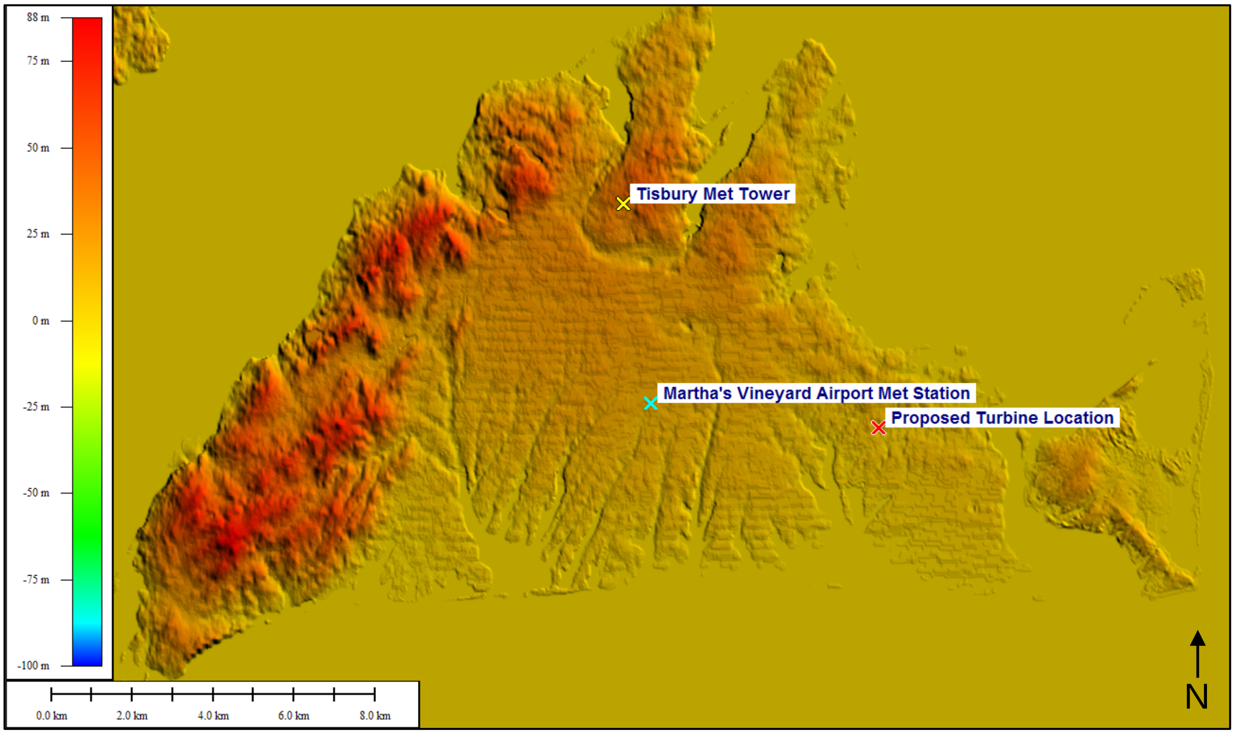
To estimate the wind resource at the WWTF turbine location based on the Tisbury measured data, the Consultant examined factors that could create differences in the wind resource between the two sites. Among the factors considered were differences in topographic conditions and local site exposure to the wind, regional data sources, regional wind patterns, and the wind resource estimates at both sites as predicted by the Southern New England Wind Map produced by AWS Truewind.

Figure 4 illustrates the geographic locations of the met tower in Tisbury, the potential turbine at the WWTF, and a met station at the Martha's Vineyard Airport (the "Airport") that will later be discussed as a regional data source. The met tower location in Tisbury is approximately 8.4 km northwest of the WWTF in Edgartown. The Airport is located approximately 5 km away from both the Tisbury met tower and the WWTF.

Figure 4

Edgartown Wind Energy Feasibility Study

Data Collection Locations in Relation to Edgartown WWTF Turbine Location



Projection: Massachusetts Mainland State Plane, Meters, NAD83
Digital Elevation Model: United States National Elevation Data database, 30 m resolution

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The Tisbury met tower is located on the north side of Martha's Vineyard at an elevation of 36.5 m. Per the RERL's site description, the met tower was located in a clearing at the former septic lagoon site, which was generally clear with trees bordering the property at distances ranging from 100 to 200 ft away from the met tower. The WWTF sits on the eastern side of Martha's Vineyard at an elevation of 6.5 m. Like the Tisbury met tower site, the WWTF site is generally clear with trees and brush bordering the property. The proposed turbine location sits in a sparsely treed area of the WWTF site that will require clearing prior to turbine construction that will make the local exposure to the wind at the proposed turbine location similar to that of the Tisbury met tower location.

A 30 m difference in elevation exists between the met tower and the WWTF. Because the Tisbury site is at a slightly higher elevation, it could be more likely to experience higher wind speeds than the WWTF. However, since the prevailing wind direction is from the southwest through north (see wind direction section for more detail) the wind flow at the Tisbury tower is obstructed by more complex upwind terrain compared to the WWTF site; the WWTF site is closer to the ocean and the wind flow is interrupted by fewer upwind obstructions.

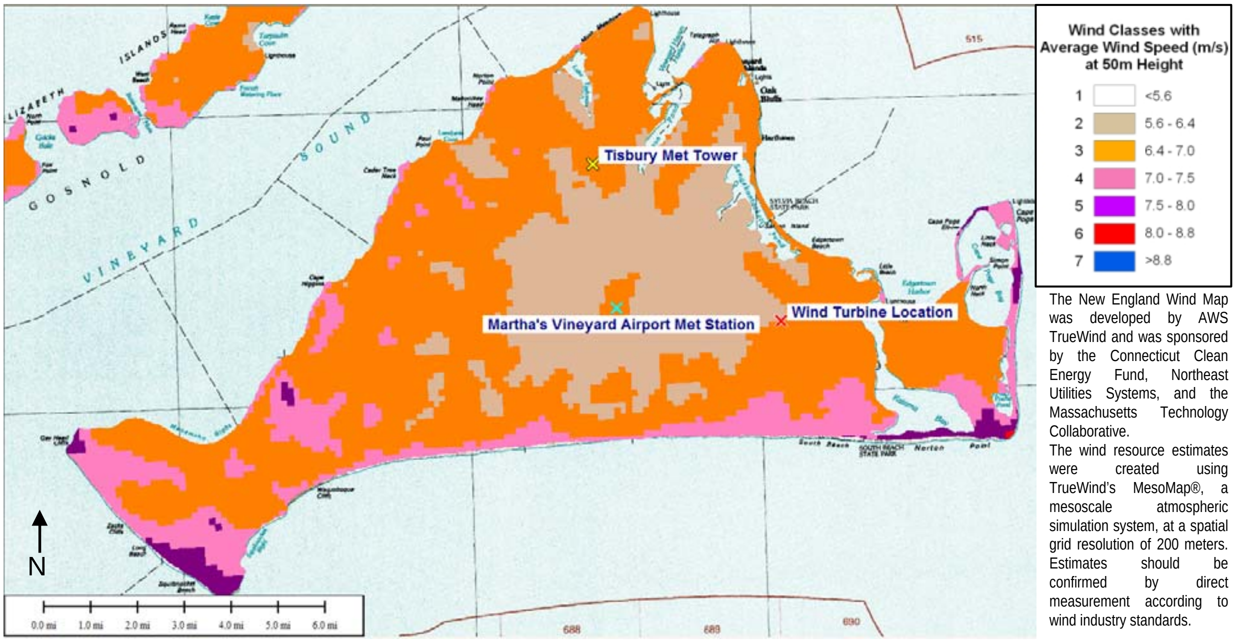
With the goal of establishing a relationship between the measured wind data at the Tisbury met tower and a second inland site with measured data, the Consultant obtained wind data from the Airport, located approximately 5 km south of the Tisbury met tower. Hourly wind speed data measured at a height of 21 m are available since January 1998. The Consultant performed a linear regression analysis using concurrent monthly average wind speeds from the Tisbury met tower and the Airport for the overlapping period of record. The data from the two sites are well correlated with an R-squared value of 0.91. Because the upwind exposures are similar at the Airport and the WWTF, it is likely that the wind resource at the WWTF is also well correlated with the Tisbury met tower site.

Figure 5 shows the Southern New England Wind Map developed by AWS Truewind and the locations of both met towers and the WWTF. The Tisbury met tower and the Airport met tower are both located in areas estimated to have a Class 3 wind resource at a height of 50 m above ground level ("agl"). The WWTF location is in a Class 2 area; however, given the 200 m resolution of the wind map and the WWTF's location just 20 m inside the Class 2 area, the WWTF could experience winds at the high end of Class 2 or the low end of Class 3. The Consultant did not find sufficient evidence based on the Southern New England Wind Map to conclude that the Tisbury met tower and the WWTF site have a significantly different estimated wind resource.

Figure 5

Edgartown Wind Energy Feasibility Study

Wind Map and Locations of Met Towers and the WWTF



The New England Wind Map was developed by AWS TrueWind and was sponsored by the Connecticut Clean Energy Fund, Northeast Utilities Systems, and the Massachusetts Technology Collaborative.
The wind resource estimates were created using TrueWind's MesoMap®, a mesoscale atmospheric simulation system, at a spatial grid resolution of 200 meters. Estimates should be confirmed by direct measurement according to wind industry standards.

Projection: Massachusetts Mainland State Plane, Meters, NAD83

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After thorough examination of the aforementioned factors, the Consultant determined that the wind resource measured at the Tisbury met tower is representative of the wind resource estimated at the WWTF in Edgartown. Therefore, the measured data from the Tisbury met tower, with additional synthesized data based on the correlation with the Airport data, were used for this feasibility study.

Data Review and Validation

The RERL provided the Consultant with a met tower commissioning sheet documenting the tower installation and sensor configuration. The tower was instrumented with four anemometers, two each at 49 m and 35 m agl. The anemometers at each level were mounted on 1.5-m (59-inch) side-mount booms, one northeast and one southwest of the tower. The tower was also instrumented with two wind vanes, one each at 49 m, and 35 m agl. The wind vanes were mounted on 1.1-m (43-inch) side-mount booms on the north side of the tower. The instrumentation could not be inspected during the site visit on March 3, 2009 because the tower had been decommissioned prior to the visit.

The Consultant reviewed the validated data set provided by the RERL and quality checked the raw data set using industry standard techniques and best practices. The Consultant found approximately one month of missing data due to logger failure (mid-December 2007 to mid-January 2008) and other intermittent periods of missing data. A few hours of wind speed data were removed by the Consultant to account for tower shadow effects and other irregularities. After the Consultant's validation review, the monthly data recovery of 49-m wind speeds was 93 percent, excluding the months of December 2007 and January 2008 which experienced data recovery rates of approximately 50 percent.

To adjust for the significant loss of data during the relatively windy months of December and January, the Consultant established a correlation to a long-term reference site and synthesized the data missing as a result of the logger failure. Based on the linear relationship between the Tisbury data and the data from the Airport, a scale factor was applied to the hourly Airport data to synthesize hourly Tisbury met data for the missing data period in December 2007 and January 2008.

With the addition of the synthesized data, the effective data recovery rate of the 49-m wind speeds increased to 99 percent during the months of December 2007 and January 2008 and 94 percent for the entire period of record.

Wind Data Summary

A monthly summary of the 49-m and 35-m measured wind speeds is presented in Table 2, which indicates an average 49-m wind speed of 5.3 meters per second ("m/s") measured during the period of record.

Table 2
Measured Monthly Average Wind Speeds, m/s

Month	49-m Measurement Height	35-m Measurement Height
July 2007	4.3	4.1
August	4.1	3.9
September	4.5	4.4
October	4.8	4.7
November	5.9	5.3
December (1)	***5.8***	N/A
January 2008 (1)	***6.1***	N/A
February	6.2	5.5

Table 2
Measured Monthly Average Wind Speeds, m/s

Month	49-m Measurement Height	35-m Measurement Height
March	6.6	5.8
April	5.2	4.5
May	5.9	5.1
June	4.6	3.7
Annual Average (1)	***5.3***	***4.7***

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1. Data in bold italics where synthesized based on the relationship to the Martha's Vineyard Airport met tower.
2. N/A indicates less than 70 percent data recovery.
3. Data for 35-m measurement height were not synthesized.

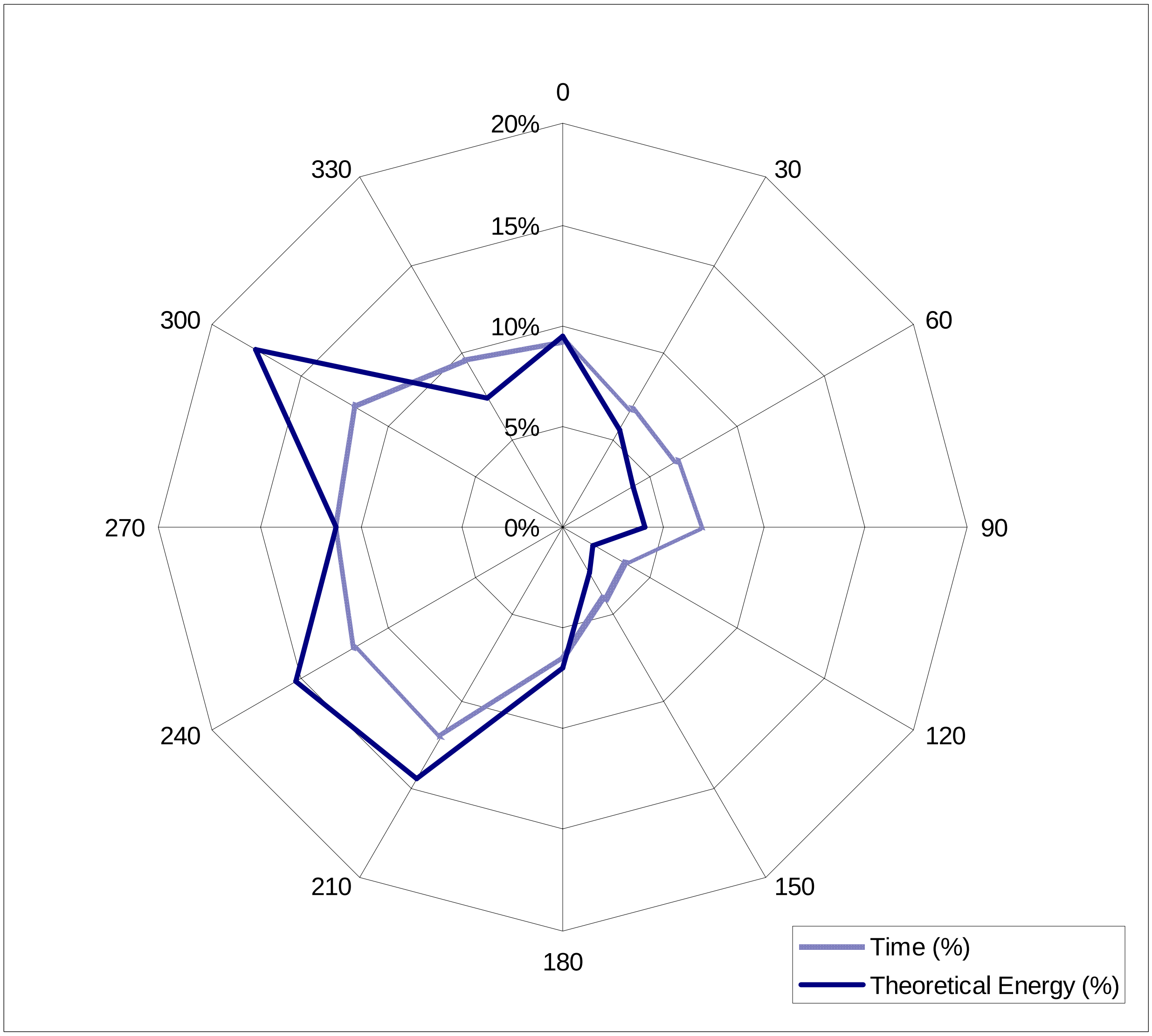
Wind Direction

A wind rose graph presenting directional summaries of the measured data set is provided in Figure 6. The graph shows the percent of total time and percent of total theoretical energy available in the wind for each direction sector. As shown in Figure 6, based on the available data, the predominant energy directions during the period of record were from the southwest through north, which is similar to the predominant direction based on duration of time. There is a relatively higher percentage of theoretical energy from the northwest direction, which is a result of higher winds in the winter months, when the predominant wind direction is from the northwest. The wind rose graph is created from concurrent wind speed and direction data and is therefore limited to hours where both wind speed and direction data are available. These results are based on approximately 12 months of measured data. The wind rose from the Airport met station, which is based on 11 years of data, indicates a primary southwest wind direction, in both frequency of time and energy. The discrepancy in observed direction between the met data and the Airport may be a result of differences in local topographical effects or obstructions near the Airport anemometer.

Figure 6

Edgartown Wind Energy Feasibility Study

Wind Rose from July 2007 to June 2008
as Measured at the Tisbury Met Tower



Turbulence Intensity

Turbulence intensity ("TI") is calculated as the ratio of the wind speed standard deviation to the wind speed. Turbulence decreases with height above ground level; consequently, TI at the upper measurement level on the tower (49 m) were extrapolated to the turbine hub heights (50 m, 65 m, and 75 m) by applying wind shear to calculate a hub height wind speed while keeping the standard deviation constant. This method has been shown to reliably predict the decrease in turbulence with height across measurement levels on towers, and should produce reasonable predictions of the hub-height turbulence.

The average measured TI by direction at the upper measurement level and the estimated TI by direction at the highest hub height under consideration (75 m) are presented in Table 3.

Table 3
Mean Turbulence Intensity by Direction Sector, Percent

Direction Sector, degrees	**Height agl**	
	49 m	**75 m**
0	20	17
30	22	19
60	23	20
90	21	19
120	17	15
150	16	14
180	18	16
210	20	18
240	23	21
270	21	18
300	20	18
330	20	17
Average (1)	**20**	**18**

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1. Average TI value shown for wind speeds greater than 4 m/s.

TI by wind speed for the measured height and turbine hub height is shown in Table 4.

Table 4
Mean Turbulence Intensity by Wind Speed, Percent

Wind Speed, m/s	**Height, m agl**	
	49 m	**75 m**
1	50	48
2	29	30
3	21	21
4	19	18
5	20	18
6	21	18
7	22	18
8	22	19
9	22	18
10	22	18
11	21	18

Table 4
Mean Turbulence Intensity by Wind Speed, Percent

Wind Speed, m/s	Height, m agl	
	49 m	**75 m**
12	21	18
13	21	19
14	21	18
15	21	18
16	21	18
17	21	18
18	20	18
19	20	18
20	N/A	17
21	N/A	17
22	N/A	17
Weighted Average (>4 m/s)	**20**	**18**

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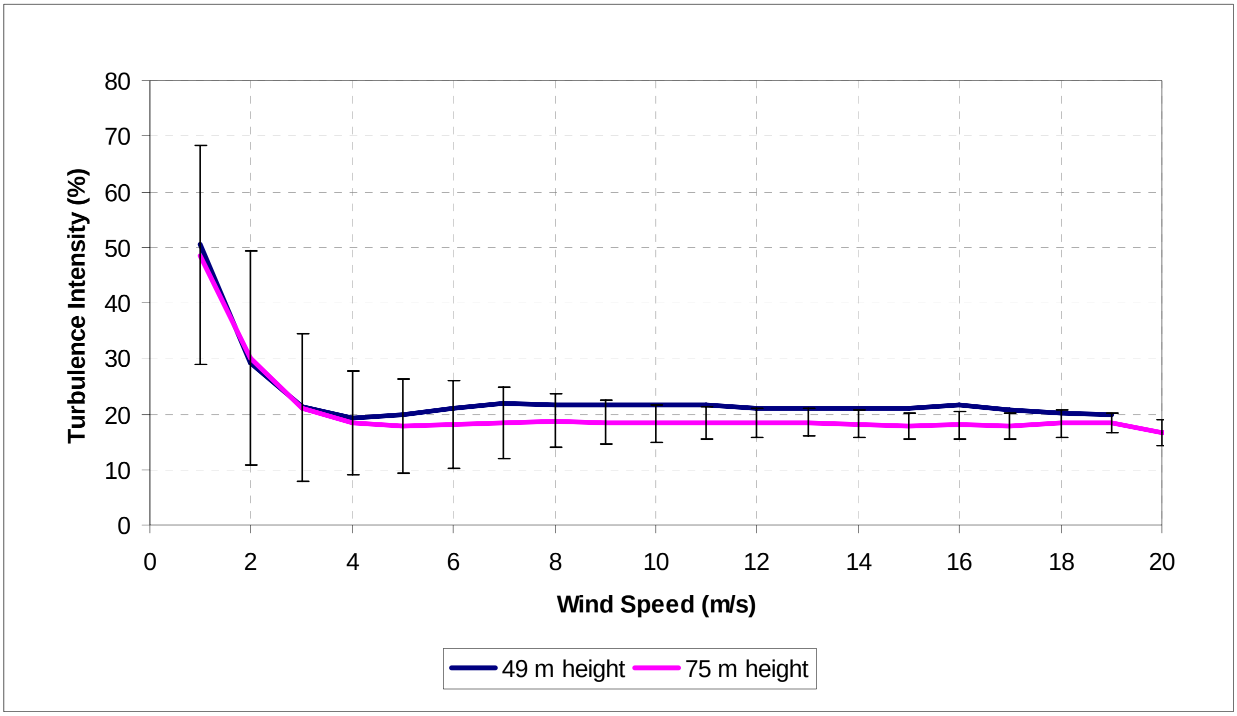
1. N/A indicates no data at indicated wind speed bins.

Average TI by wind speed is also shown for the upper measurement level and a 75-m hub height in Figure 7. The overall average TI at the met tower site, calculated from wind speeds greater than 4 m/s, is approximately 0.20 at the 49-m measurement height and 0.18 at a 75-m hub height.

Figure 7

Edgartown Wind Energy Feasibility Study

Average Turbulence Intensity by Wind Speed at upper measurement level and 75-m hub height



The International Electrotechnical Commission ("IEC") defines different categories of wind turbines based on the mean TI at 15 m/s for which the turbine model is designed to operate. As shown in Table 3, the estimated mean TI at 15 m/s is 0.18 at 75 m agl, which is in the high range of acceptable TI levels. The relatively high TI value, combined with high wind shear (discussed in a later section), may raise turbine suitability concerns. The turbine manufacturer will need to verify site suitability once Edgartown enters discussion with a specific turbine supplier.

Long-Term Representativeness

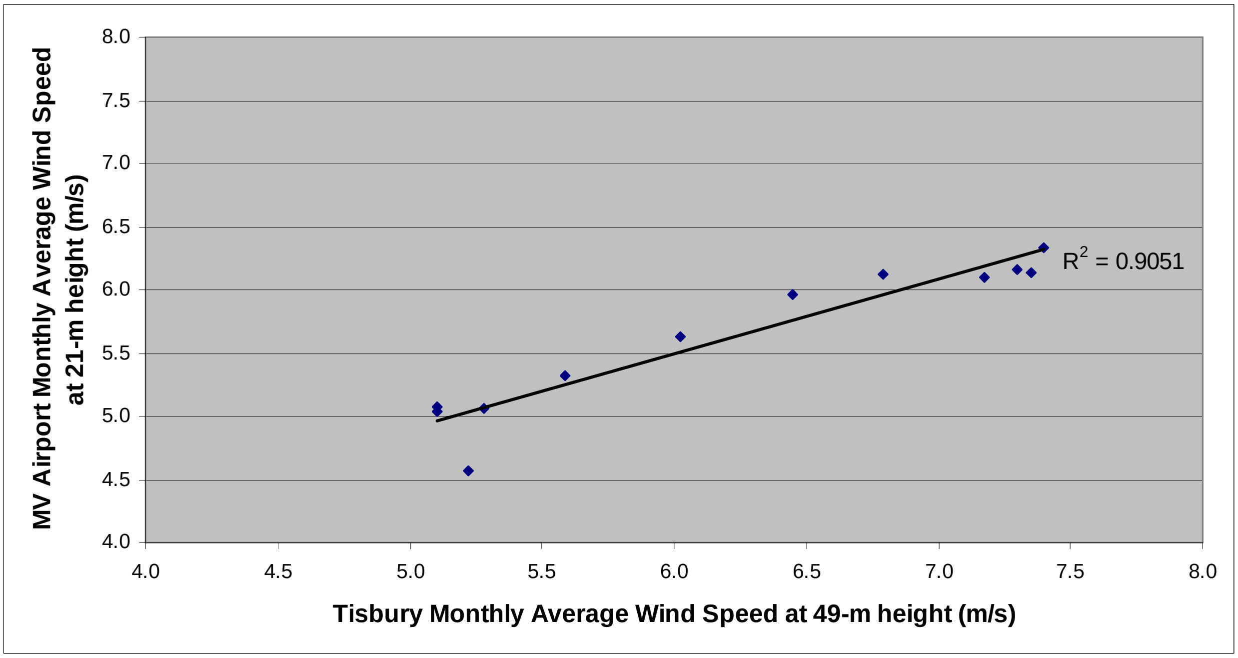
Data collected from the Tisbury met tower may represent a period of relatively high or low wind speeds compared to the long-term average. To determine the representativeness of the data collection period and make adjustments to long-term conditions, the Consultant established a correlation to a long-term reference site. The Consultant obtained data from the Airport, located approximately 5 km south of the Tisbury met tower. The period of record for the MV data set is January 1998 through the present. Over the past few years, the U.S. National Weather Service and the U.S. Federal Aviation Administration ("FAA") have been converting Automated Surface Observation System ("ASOS") station anemometry to sonic anemometers. This type of instrumentation change can affect the long-term consistency of the data. According to documents from the National Weather Service, the Airport station anemometer does not appear to have been converted to a sonic anemometer. Consequently, the data set should provide an accurate representation of interannual wind speed trends.

The Consultant performed a linear regression analysis using concurrent monthly average wind speeds from the met tower and from the airport for the overlapping period of record. The data from the two sites are well correlated with an R-squared value of 0.91. The daily correlation between the sites was similar. The results of the monthly correlation analysis are shown in Figure 8.

Figure 8

Edgartown Wind Energy Feasibility Study

Linear Regression: Monthly Average Wind Speed from July 2007 through June 2008



Based on the findings described above, the Consultant adjusted the one year of met tower data on a monthly basis using long-term monthly adjustment factors derived from the long-term Airport data set. The adjustment factor is multiplied by the 49-m wind speed on a per record basis to produce a long-term 49-m height wind speed at the met tower location. Table 5 presents the reference station monthly average wind speeds from 1998 through 2008, the met data monthly average wind speeds, and the calculated monthly adjustment factors for the met tower period of record. The monthly adjustment factors represent the ratio between the reference site's long-term average wind speed for each month, and the reference site's monthly average wind speed during the period of record. For example, in January 2008, the adjustment factor of 1.03 in Table 5 indicates that January's long-term average wind speed is 3 percent higher than the average wind speed in January 2008. Therefore all of the hub-height wind speed records in January 2008 are multiplied by 1.03.

Table 5
Long-Term Wind Speed Analysis – Martha's Vineyard Airport

Year	**Month**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1998	5.1	5.1	5.4	4.6	5.0	4.5	3.5	3.2	3.6	4.7	4.5	4.5
1999	5.2	5.0	6.2	4.7	4.2	4.1	3.8	3.7	4.0	4.4	5.2	4.9
2000	6.0	4.9	5.4	5.7	4.7	4.2	3.7	3.5	3.7	3.9	4.7	5.3
2001	3.8	5.2	5.3	4.4	4.5	3.8	3.4	3.2	3.5	4.6	4.6	4.3
2002	4.6	4.9	5.5	5.0	5.1	4.4	3.9	4.0	4.1	4.7	5.5	5.3
2003	5.5	5.3	4.7	5.5	4.4	3.7	3.8	4.0	3.5	4.5	4.9	6.0
2004	5.7	4.7	5.4	5.1	4.4	3.9	3.9	3.9	3.8	4.1	4.6	5.1
2005	5.3	4.6	4.8	5.2	4.9	3.9	3.6	3.6	3.6	5.3	5.0	4.7
2006	5.2	5.3	4.7	5.3	5.2	4.5	4.3	3.5	3.9	5.1	4.3	4.8
2007	5.3	5.4	5.6	5.3	4.5	4.6	3.9	3.7	4.0	4.2	5.1	4.8
2008	4.9	4.9	5.4	4.5	5.2	3.7	3.8	3.0	4.1	4.4	4.2	5.7
Ave	5.1	5.0	5.3	5.0	4.7	4.1	3.8	3.6	3.8	4.5	4.8	5.0
MET TOWER PERIOD OF MEASUREMENT AVERAGE												
2007	N/A	N/A	N/A	N/A	N/A	N/A	4.3	4.1	4.5	4.8	5.9	5.8
2008	6.1	6.2	6.6	5.2	5.9	4.6	N/A	N/A	N/A	N/A	N/A	N/A
LONG-TERM ADJUSTMENT FACTOR												
	1.03	1.02	0.99	1.12	0.91	1.11	0.98	0.97	0.96	1.08	0.93	1.05

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1. NA = not available.

Overall, the monthly adjustment factors result in an aggregate long-term adjustment of approximately 1 percent on the met tower wind speed, indicating that the met tower period of record was reasonably representative of long-term conditions. The potential impact of the long-term adjustment on estimated energy production is included in the uncertainty analysis.

Wind Shear and Estimated Hub-Height Wind Speeds

To estimate the wind speeds at the proposed wind turbine hub heights, the vertical wind speed profile was estimated using the measured data and the characteristics of the met tower site. Wind shear was calculated using the 49-m and 35-m wind speed measurements. To reduce tower-shadow error, wind shear was only calculated when each anemometer was clear of significant tower wake. Data when wind speeds at any level were less than 4 m/s were also excluded from the wind shear analysis.

Referring to Equation 1 below, the wind shear exponent, α , is calculated using the power law method of wind shear calculation,

$$\alpha = \frac{\ln\left(\frac{V(z)}{V(z_r)}\right)}{\ln\left(\frac{z}{z_r}\right)}$$ Equation 1

where V(Z) is the wind speed at height Z, V(Zr) is the reference wind speed, Z is the proposed turbine hub height, and Zr is the reference height. Table 6 shows the wind shear exponents calculated from the measured data.

Table 6
Vertical Wind Shear Exponent Calculation from the Measured Data

Hour	1	2	3	4	5	6	7	8	9	10	11	12	Avg.
0	0.43	0.41	0.43	0.48	0.54	0.46	0.34	0.32	0.23	0.12	0.36	0.42	0.38
1	0.43	0.41	0.43	0.48	0.52	0.43	0.30	0.33	0.11	0.18	0.35	0.41	0.37
2	0.43	0.42	0.43	0.49	0.52	0.46	0.31	0.37	0.20	0.17	0.34	0.41	0.38
3	0.43	0.44	0.44	0.51	0.53	0.46	0.29	0.39	0.22	0.17	0.34	0.40	0.38
4	0.42	0.42	0.43	0.51	0.48	0.45	0.37	0.40	0.23	0.17	0.36	0.40	0.39
5	0.41	0.44	0.42	0.46	0.44	0.32	0.27	0.32	0.26	0.15	0.34	0.39	0.35
6	0.41	0.42	0.41	0.36	0.39	0.27	0.16	0.17	0.11	0.16	0.34	0.41	0.30
7	0.42	0.36	0.37	0.31	0.34	0.29	0.14	0.11	0.07	0.12	0.35	0.39	0.27
8	0.35	0.32	0.34	0.30	0.34	0.25	0.06	0.11	-0.03	0.08	0.30	0.39	0.23
9	0.33	0.29	0.31	0.28	0.33	0.22	-0.03	0.04	-0.02	0.05	0.26	0.34	0.20
10	0.32	0.30	0.30	0.26	0.32	0.21	-0.06	0.08	-0.02	0.08	0.27	0.34	0.20
11	0.31	0.29	0.30	0.25	0.30	0.25	-0.03	0.05	0.02	0.04	0.28	0.35	0.20
12	0.31	0.31	0.29	0.27	0.32	0.22	-0.06	0.02	-0.01	0.09	0.27	0.35	0.20
13	0.34	0.33	0.30	0.24	0.32	0.22	-0.05	-0.01	0.01	0.05	0.30	0.36	0.20
14	0.35	0.33	0.31	0.27	0.34	0.23	-0.01	0.01	0.01	-0.01	0.31	0.37	0.21
15	0.39	0.35	0.31	0.29	0.35	0.25	0.04	0.05	-0.01	0.06	0.34	0.41	0.23
16	0.43	0.37	0.35	0.33	0.37	0.26	0.05	0.11	0.04	0.15	0.39	0.42	0.27
17	0.44	0.40	0.41	0.37	0.42	0.29	0.14	0.09	-0.03	0.13	0.40	0.43	0.29
18	0.46	0.42	0.45	0.43	0.46	0.37	0.17	0.13	0.09	0.18	0.39	0.42	0.33
19	0.44	0.44	0.46	0.46	0.52	0.43	0.25	0.11	0.13	0.11	0.39	0.44	0.35
20	0.44	0.42	0.47	0.46	0.53	0.40	0.26	0.20	0.11	0.12	0.40	0.42	0.35
21	0.43	0.41	0.43	0.47	0.54	0.44	0.33	0.18	0.11	0.11	0.38	0.43	0.36
22	0.46	0.43	0.43	0.46	0.55	0.47	0.31	0.35	0.15	0.11	0.40	0.42	0.38
23	0.45	0.43	0.42	0.46	0.53	0.44	0.31	0.25	0.15	0.14	0.37	0.43	0.36
Overall	**0.40**	**0.38**	**0.39**	**0.38**	**0.43**	**0.34**	**0.16**	**0.17**	**0.09**	**0.11**	**0.34**	**0.40**	**0.30**

The calculated wind shear values are slightly higher than expected for a site on relatively flat terrain. Shear exponents of approximately 0.20 to 0.30 are expected for low forests (or suburban development) in moderately complex terrain. Possible explanations for the higher than expected wind shear values is that the lower anemometers were influenced by the surrounding vegetation, or the sensor heights listed in the tower documentation are not precise. Both scenarios will introduce error in the shear exponent calculation. Other sources of random or biased error may also be influencing the data, such as sensors that are not level or functioning properly.

Due to the lack of confidence in the vertical wind speed profile using the measured shear exponents, an alternative method was used to estimate the wind shear based on ground cover conditions at the met tower site.

The Consultant calculated an "effective ground level" at which the wind speeds are expected to be close to zero. For the Tisbury site, the surrounding vegetation was estimated to be 10 m tall, and the effective ground level was estimated at 90 percent of this height, or 9 m. The met tower measurement heights were reduced by 9 m and the wind shear was recalculated based on the new measurement height values. Using this method, the Consultant estimated the average wind shear at the met tower site to be 0.23. When applying this wind shear to the measured 49 m data, the monthly and diurnal pattern of the measured wind shear values was preserved, but the magnitude was adjusted from an overall average of 0.30 to 0.23. The downward adjustment results in a more conservative hub height wind speed estimate for the met tower site.

Using these assumptions, including the tree-adjusted shear value, the long-term, annual average wind speed at a height of 50 m agl was calculated to be 5.4 m/s. The long-term annual average wind speed at 75 m agl was calculated at 6.1 m/s. The estimated wind speed is substantially lower than the value shown on the New England Wind Map. Table 7 lists the long-term estimated monthly average wind speeds at the upper measurement height (49 m agl) and the three considered hub heights for the met tower site.

Table 7
Estimated Long-Term Monthly Average Wind Speeds

Month	49 m Height	50 m Height	65 m Height	75 m Height
Jan	6.2	6.3	6.9	7.3
Feb	6.3	6.4	7.0	7.4
Mar	6.5	6.6	7.2	7.6
Apr	5.8	5.8	6.4	6.7
May	5.3	5.4	6.0	6.3
Jun	5.0	5.0	5.4	5.7
Jul	4.2	4.2	4.3	4.4
Aug	4.0	4.0	4.1	4.2
Sep	4.3	4.3	4.4	4.5
Oct	5.2	5.2	5.4	5.5
Nov	5.5	5.6	6.1	6.3
Dec	6.1	6.2	6.8	7.2
Average	**5.4**	**5.4**	**5.8**	**6.1**

The estimated wind speeds at heights higher than the 49 m measurement height are sensitive to the wind shear assumption. The baseline values are a best estimate of site conditions; however, there is a high level of uncertainty associated with these estimates. As an example, Table 8 shows the influence on the estimated long-term average wind speed at 75 m agl from varying estimates of wind shear. The range of hub height wind speed values resulting from possible shear values is included in the uncertainty analysis.

Table 8
Long-Term Average Wind Speeds for Several Different Wind Shear Values

Wind Shear Exponent	75 m agl Long-Term Wind Speed, m/s
0.20	6.0
0.23(1)	6.1
0.30(2)	6.3

---

1. Represents the Consultant's best estimate given the information available.
2. Represents the measured vertical wind shear coefficient, which is believed to be impacted by surrounding vegetation.

Table 9 presents the annualized wind frequency distribution at various potential wind turbine hub heights above ground level.

Table 9
Annualized Wind Speed Frequency Distribution

Wind Speed Bin Center, m/s	Annualized Hours at 50 m agl	Annualized Hours at 65 m agl	Annualized Hours at 75 m agl
0.5	241	220	219
1	84	87	84
1.5	130	109	100
2	243	212	199
2.5	376	308	271
3	480	397	376
3.5	655	522	471
4	778	673	615
4.5	818	734	685
5	837	782	722
5.5	804	778	743
6	655	697	695
6.5	511	594	636
7	427	467	508
7.5	318	394	411
8	286	300	336
8.5	218	273	276
9	198	222	243
9.5	145	173	206
10	105	165	160
10.5	97	126	155
11	69	86	114
11.5	64	84	89
12	51	67	75

Table 9
Annualized Wind Speed Frequency Distribution

Wind Speed Bin Center, m/s	Annualized Hours at 50 m agl	Annualized Hours at 65 m agl	Annualized Hours at 75 m agl
12.5	45	57	71
13	39	50	58
13.5	28	43	48
14	20	38	45
14.5	15	32	38
15	8	19	30
15.5	6	16	23
16	4	10	16
16.5	3	8	13
17	1	7	10
17.5	1	3	7
18	1	3	6
18.5	0	1	2
19	N/A	0	3
19.5	N/A	1	1
20	N/A	0	0
20.5	N/A	0	1
21	N/A	N/A	0
21.5	N/A	N/A	0
22	N/A	N/A	0
>22	N/A	N/A	N/A

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1. A "0" indicates between 0 and 0.5 hours in the wind speed bin.
2. An "N/A" indicates 0 hours in the wind speed bin.

Gross Energy Estimates

The proposed turbine location is 8.4 km southeast of the met tower location. Differences in topography between the two sites could result in a different wind resource, and consequently different potential energy yield at each site. As was discussed previously, the Consultant examined topography and other factors that could create differences in the wind resource between the Tisbury met tower and the WWTF site and determined that the wind resource measured at the Tisbury met tower is representative of the wind resource estimated at the WWTF in Edgartown. Therefore, the data set used for this feasibility study is the Tisbury met tower data from July 2007 through June 2008. Based on the met data set and long-term temperature, the WWTF site air density is estimated at 1.23 kilograms per cubic meter (kg/m^3).

The estimated hourly average wind speeds at 50-m, 65-m, and 75-m turbine hub heights were summarized in annualized frequency distributions. The gross annual energy production was calculated for various turbine model scenarios using the density-specific power curve from representative wind turbines and the annual average wind speed frequency distribution at the appropriate turbine hub height. The wind turbines studied are the 600-kW Vestas RRB PS600 with a 47-m rotor diameter, the 600-kW Fuhrländer FL600 with a 50-m rotor diameter, the 600-kW Enertech E-48 with a 48-m rotor diameter, and the 600-kW Elecon Turbowinds TS-600-48DS with a 48-m rotor diameter. The Fuhrländer FL600 wind turbine was used as the basis for this study, and the majority of the analysis focuses on that wind turbine. There are several other wind turbine models currently available that may also be suitable for the WWTF site. The Consultant expects the results of this analysis to be representative of the range of results that would be obtained if other similar wind turbines were analyzed; however, a detailed analysis of candidate wind turbines should be conducted before detailed project design and equipment procurement activities commence. In addition, the turbine manufacturer must be consulted to determine site suitability.

The power produced by a wind turbine is a function of wind speed. The relationship between wind speed and power is defined by a power curve, which is unique to each turbine model and, in some cases, unique to site-specific settings such as turbulence and air density. Manufacturers typically publish power curves for “standard” atmospheres (sea-level elevation and average temperature of 15˚C), which results in an air density of 1.225 kg/m^3. The Consultant adjusted the manufacturer’s power curves to the estimated site air density (1.23 kg/m^3) per established industry practices (IEC 61400-12-1 guidelines). The air density specific power curves for the wind turbines used in this report are provided as a single continuous table, Table A-1, in Appendix A of this Report.

Table 10 summarizes the gross energy production estimates from each wind turbine model. In each case, the wind frequency distribution was adjusted to the specified turbine hub height.

Table 10
Estimated Gross Annual Energy Output on a per Turbine Basis

Parameter	**Turbine Model**			
	PS600	**FL600**	**E-48**	**T-600-DS**
Rotor Diameter, m	47	50	48	48
Hub Height, m	65	75	65	50
Rated Power, MW	0.6	0.6	0.6	0.6
Gross Annual Output, MWh	1050	1490	1200	1020
Gross Annual Capacity Factor, percent	20.0%	28.3%	22.9%	19.4%

Expected Energy Losses

The gross annual energy presented above represents the energy delivered at the base of the tower under ideal conditions. Net annual energy production takes into account typical losses and represents the energy delivered to the grid interconnection point for a typical (i.e., average) year. For the Edgartown WWTF site, the Consultant estimated energy losses from a variety of sources. Exact losses can vary significantly from project to project; for example, some projects with poor transmission access may experience significant line outages or curtailment. For the purpose of this assessment, the Consultant assumed typical values for parameters where site-specific information was not available at this time. The following items provide an overview of the sources of losses. For the purpose of uncertainty modeling, the following losses are normally distributed with uncertainty values listed at one standard deviation, unless otherwise noted.

Routine Maintenance Downtime: This item includes energy lost during periods of routine maintenance of the wind turbines. Time spent for maintenance of typical modern megawatt-scale wind turbines is approximately 40 hours to 120 hours per year. The magnitude can vary depending on turbine complexity, cleaning requirements, and frequency of larger tasks such as gear oil changes. For the Edgartown scenario, the Consultant estimated routine maintenance downtime of 60 hours per year (or 0.7 percent of the year). The relationship between time spent on routine maintenance and energy loss was also modeled as an uncertainty, with a best estimate of a multiplier of 0.6 of energy per unit time and an uncertainty of 0.1 around this estimate. Consequently, the P_{50} case represents an energy loss of approximately 0.4 percent.

Fault Downtime: Some downtime will be incurred associated with turbine faults. The P_{50}-case fault downtime values estimated by the Consultant were approximately 1.5 percent for Year 1 and approximately 1.1 percent (or 100 hours per year) thereafter. This estimate assumes that the wind turbines will be monitored remotely and that faults will be reset in a timely manner. Based on the Consultant's experience with other projects using pitch-regulated turbines, fault downtime is heavily weighted towards high-wind periods. Consequently, the relationship between faults and energy loss was also modeled as an uncertainty, with a best estimate of a multiplier of 1.7 of energy per unit time and an uncertainty of 0.2 around this estimate. The Consultant estimated the resulting P_{50} average energy loss as approximately 2.0 percent.

Minor Component Failure Downtime: Some downtime will be incurred associated with failures of smaller components such as motors, relays, valves, power electronics, sensors, controllers, and bushings; and other small malfunctions normally experienced by modern megawatt-scale wind turbines. As the equipment ages, failure of minor components with design lives less than 20 years is expected to increase.

Based on experience, the Consultant estimated the minor component failure downtime values to be 1 percent over Years 1-5, 2.2 percent over Years 6-10, 2.8 percent over Years 11-15, and 3.2 percent thereafter. The majority of the components evaluated are expected to have mean lives of approximately 10 years, so the replacement rate tends to level off later in the project life. The Consultant's expectation based on experience with operating wind projects is that component failures will be slightly weighted towards high-wind periods; consequently, the relationship between minor component failures and energy loss was also modeled as an uncertainty, with a best estimate of a multiplier of 1.2 of energy per unit time and an uncertainty of 0.1 around this estimate. The Consultant estimated the resulting P_{50} average energy loss as approximately 2.8 percent.

Major Component Failure: Some downtime will be associated with major systems in the turbines. Examples of such events include gearbox, generator, or blade replacements, yaw system failures, turbine fires, or similar problems. These issues may cause the wind turbines to be off line for an extended period of time. While a typical year may have relatively limited downtime associated with major failures relative to the project life average, the infrequent events can result in significant lost energy. These losses are also expected to increase over time, as turbine systems wear out and more gearboxes and other components fail. The Consultant estimates that the frequency of failure of major components is expected to begin increasing in Years 6-10 of the turbine's life and continue to increase for the remainder of the turbine design life.

The P_{50}-case major component failure downtime values estimated by the Consultant were 1 percent for Years 1-5, 2 percent for Years 6-0, 3 percent for Years 11-15, and 4 percent for Years 16-20. The losses associated with major failures were modeled as an asymmetrical distribution with a long tail, representing small possibilities of significant downtime; however, the majority of losses are expected to be at or less than the mean. The Consultant's expectation based on experience with operating wind projects is that component failures will be slightly weighted towards high-wind periods. Consequently, the relationship between major component failures and energy loss was also modeled as an uncertainty, with a best estimate of a multiplier of 1.2 of energy per unit time and an uncertainty of 0.1 around this estimate. The Consultant estimated the resulting P_{50} average energy loss as approximately 3 percent.

Balance-of-Plant Downtime: Approximately 10 hours to 20 hours of downtime are associated with annual maintenance on project infrastructure (such as the project substation, pad-mount transformers, etc.). These activities are typically planned events that coincide with low-wind months and days. Unplanned failures and repairs associated with a wind energy plant's balance-of-plant systems and equipment ("BOP"), such as substation transformer failures, electrical collection system or communication system problems, or transmission outages are uncommon; however, their impact on lost production could be considerable. The mean loss related to both planned and unplanned BOP events has been estimated to be 0.5 percent and is not expected to increase over time. The losses associated with BOP failures were modeled as an asymmetrical distribution with a long tail, representing small possibilities of significant downtime; however, the majority of losses are expected to be at or less than the mean.

Turbine Wake: As will be discussed in a later section, the proposed site layout includes only one wind turbine location. Consequently, wake losses are estimated to be 0 percent.

Electric Line: Electric line losses are primarily a function of efficiency of the transformers used at the facility, sizing of the electric cabling comprising the on-site collection and distribution system, and parasitic consumption in very low wind conditions. The Consultant assumed a mean electric loss of 1.5 percent, which generally reasonable considering the proposed electric system. A standard deviation of 0.5 percent was assumed and possible losses ranged between 0.5 percent and 2.5 percent.

Turbulence/Control System: Turbulence and control system losses include a variety of issues related to the normal control of the wind turbine that prevent performance in accordance with the reference power curve. These issues include high-wind hysteresis (production lost during the time it takes to recover from automatic high-wind shutdowns), low-wind hysteresis (startup and cut-in), off-yaw operations, and cable untwists. The Consultant estimated 1 percent losses for these issues, with a range from 0 percent to 2 percent.

Power Performance: Turbines may perform at a level different from the reference power curve for reasons other than those counted in other losses, such as blade soiling and degradation, turbulence, etc. This is modeled as a distribution of possible outcomes with a most likely value of 0 percent, a small potential for up to 3 percent higher performance and a small potential for 5 percent lower performance. The P_{50} case is equivalent to a 0.25 percent reduction in power averaged over the life of the project.

Blade Soiling: This item, which includes accumulation of dirt and insects on blades, can impact energy production. These losses will be site-dependent; the Consultant estimated 0.5 percent since the WWTF site is not particularly dry or dusty and because the primary wind turbine under consideration is pitch-regulated and is affected less from these issues than stall-regulated wind turbines.

Blade Degradation: Typically, turbine performance decreases somewhat over the life of a project. Degradation of the blade surface is the largest factor that can produce such a change. The turbine blade performance will gradually degrade over time. A small annual decrease in performance was included in the model, with a most likely case loss averaging approximately 0.4 percent over 20 years (beginning with zero losses and slowly increasing following an exponential decay curve to 1 percent by Year 20).

Icing/Weather: The types and magnitudes of weather-related losses will vary by project and may include icing, high- or low-ambient temperature cutouts, reduced site access due to inclement weather, and shutdowns to avoid hail, lightning, or other storm damage. The Consultant's experience with operating projects in similar climates indicates that the weather-related losses are highly variable from site to site and from year to year. For example, the frequency and duration of icing events can vary substantially, with most years having little ice while others experience events where sites are frozen for days at a time with little or no turbine production. Similarly, lightning damage to turbines occurs in infrequent, intermittent events, but can produce significant periods of downtime.

Based on a review of the meteorological data and the frequency of icing occurrences summarized in the RERL Tisbury data summary report, the Consultant estimated a typical case loss of 2.0 percent for weather conditions, with a range of potential weather losses from 0.5 percent to 4.5 percent. This results in a P_{50} loss of 2.8 percent. It should be noted that this value represents energy loss and not percentage of time lost, as weather downtime frequently occurs during higher-than-average wind conditions.

Effect of Asymmetric Uncertainties: Some of the loss factors described earlier are asymmetric (or lopsided) in nature. To the extent loss factors are asymmetric, the effect of the asymmetry is captured in the spread of the P1-P99 energy estimate values as well as the P_{50} loss values. Although the uncertainties described below are symmetric, their effect on energy is asymmetric because of the non-linear relationship of wind speed to energy. That is, small increases in average winds result in proportionally smaller changes in energy compared to small decreases in average winds. The effect of this asymmetric energy uncertainty distribution is small compared to other losses, but it does result in a small energy loss factor that is included as the effect of asymmetric uncertainties. In this study, the effective asymmetric uncertainties loss was 0.4 percent.

Table 11 summarizes the values estimated for each energy loss category.

Table 11
Summary of P_{50} Long-Term Average Losses

Losses	**Long-Term P_{50} Losses, percent of energy**
Routine maintenance	0.4
Faults	2.0
Minor components (1)	2.8
Major components (1)	3.0
Balance of plant	0.5
Wake	0.0
Electrical line	1.5
Turbulence and controls	1.0
Power performance	0.2
Blade soiling	0.5
Blade degradation (1)	0.4
Weather, including icing, lightning, hail	2.8
Effect of asymmetric uncertainties	0.4
Total	**13.5**

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1. Values are long-term averages over a 20-year project life and are lower in initial years of operation.
2. Total shown may not be straight total of categorical losses due to uncertainties around each loss and stochastic modeling results.

Uncertainties

This section describes the various sources of uncertainty in the energy analysis for the proposed project given the aforementioned assumptions and considerations. The uncertainties are typically estimated as percentages of the mean wind speed for a site. Based on the wind frequency distribution for the project and the Fuhrländer FL600 wind turbine power curve, there is an approximate relationship of an uncertainty of 2.0 percent on energy for each 1 percent uncertainty on wind speed. This relationship varies with speed because the power curve flattens at high wind speeds; there is a smaller increase in energy when wind speeds increase relative to the magnitude of the decrease in energy as wind speeds decrease. After converting all uncertainties to percentages of energy, the uncertainties were added as the square root of the sum of the square of each value. Except as noted below, all uncertainties on wind speed shown are assumed to be normally distributed; uncertainty values listed are at one standard deviation.

Anemometer Accuracy: This parameter represents the variability in measurement of wind by individual anemometers. An uncertainty of approximately 1.5 percent on wind speed was estimated based on the typical error on measurements found in testing of a large number of NRG Maximum #40 anemometers similar to those used as the primary anemometer at the Tisbury met tower site.

Tower Effects/Measurement Biases: Some uncertainty is associated with the effects of mounting anemometers on towers; even when mounted according to industry-standard procedures, small speed-up and slow-down effects are seen on measurements on tubular tilt-up towers. At the Tisbury met tower site, pairs of anemometers are present at the 49-m and 35-m levels, allowing for selection of unwaked wind speeds and minimization of measurement effects. Based on a review of the documentation of the mounting arrangements on the towers and a review of the data, the Consultant estimated an overall site-wide average wind speed uncertainty of 1.5 percent for this issue.

Data Capture/Recovery, Quality Control/Validation Procedures: This uncertainty covers issues related to missing, invalid, or questionable data. Several periods of data were removed from the met tower data set for a variety of reasons, including icing and missing data. The Consultant estimated an uncertainty of 2.0 percent on wind speed for this issue.

Representativeness of Period of Record: Data from a single long-term meteorological station were investigated to determine the interannual wind conditions for the region. The interannual variability was calculated at approximately 3.1 percent of the mean. This degree of variability is consistent with the expected wind variability in the region. There is an 11-year period of record at the reference site that was used in this analysis. Based on these values, the uncertainty associated with the representativeness of the period of record equals 3.1 percent divided by the square root of 11, or 0.9 percent on wind speed.

Reference Site Relationships/ Consistency of Long-Term References: This topic represents the uncertainty on the relationship to the long-term reference station used to adjust the observed site wind speeds to long-term conditions, and also on the consistency of the long-term data sets used to describe the wind conditions between tower locations. The Consultant expects the uncertainty on the relationship to be low based on the strong correlation to site wind speeds and the long period of data available as a long-term reference. The Consultant estimated the combined uncertainty for these issues at 1.0 percent.

Wind Shear Estimates: There is some uncertainty on whether the shears measured over the period at the tower locations are representative of the long term. Shear can also vary based on the exposure at a met tower relative to turbine locations, seasonal variation, vegetation or seasonal changes in vegetation, and other effects. The Consultant estimated the overall shear uncertainty based on a combination of these issues. The effective aggregate uncertainty associated with shear was estimated at approximately 2.0 percent on wind speed, due to the difference between the measured shear and the Consultant's expectations of reasonable shear values based on other sites in similar terrain.

Topographic Effects: This uncertainty represents the potential difference in wind speed between the met tower location and the wind turbine location. Based on a review of topographic information and the significant distance (8.4 km) between the met tower location and the proposed turbine location, the Consultant expects that variation in wind speeds between the met tower and wind turbine location is possible; therefore, the Consultant estimated the uncertainty on wind speed at 6.0 percent.

Wind Frequency Distribution: The uncertainty on the wind frequency distribution represents the possibility that for a given wind speed the energy production may be higher or lower than expected due to a more or less favorable distribution of winds. For example, the frequency of high-wind cutouts; a year with several intense storms may record substantial time at wind speeds above the 25 m/s turbine cutout speed, thereby increasing the overall average wind speed but not increasing the energy production. There are two aspects to this uncertainty: the first represents the uncertainty on the distribution measured over the period of measurement at the Tisbury met tower site and the second represents the year-to-year variability in the wind speed distribution. The Consultant estimated an annual variability of 3.0 percent on energy related to differences in wind distribution.

Wind Speeds over Project Life Relative to Long-Term Average: Uncertainty exists regarding whether the true long-term mean wind speed will occur over the project life. Given an assumed 20-year project lifespan and a 3.1 percent interannual variability, this uncertainty is calculated as 3.1 percent divided by the square root of 20, or 0.7 percent on wind speed.

Changes in Long-Term Average Wind Speed: Changes to local or global climate patterns may produce changes in site wind conditions over the life of the project; there is uncertainty as to whether such changes are occurring, and if so, to what extent. The Consultant assumed a 1.0 percent uncertainty on wind speed to account for this issue.

Table 12 summarizes the uncertainty on wind speed and energy for each component and the root-sum-square of each component.

Table 12
Summary of Uncertainty Estimates

	Fuhrländer FL600 Wind Turbine	
Uncertainty Type	**Uncertainty on Wind Speed**	**Uncertainty on Energy**
Anemometer Accuracy	1.5%	3.0%
Tower Effects on Measurements	1.5%	3.0%
Data Reduction Procedure Accuracy	2.0%	4.0%
Representativeness of Period of Record	0.9%	1.8%
Long-Term Correlation	1.0%	2.0%
Wind Shear Uncertainty	2.0%	4.0%
Topographic Affects	6.0%	12.0%
Frequency Distribution	3.0%	6.0%
Wind Speeds During Project Life Relative to Long-term Average	0.7%	1.4%
Changes in Long-term Average	1.0%	2.0%
Root-Sum-Square	7.8%	15.6%

Net Energy Estimates

The net energy production estimates at a range of confidence levels are evaluated using a stochastic model to evaluate the uncertainty in the assumptions, methods, and losses used for the analysis. Distributions appropriate for each were determined and a probabilistic description of the annual net energy was built integrating each source. The model was then run in 10,000 iterations with each parameter changed randomly and independently to describe the distribution of net energy estimates. These results were then summarized to determine the probability of exceedance at various levels of confidence.

Table 13 presents the resulting net energy estimates and capacity factors for one 75-m hub-height Fuhrländer FL600 wind turbine located on the proposed WWTF site at a range of probability-of-exceedance levels. For example, the table shows that there is a 75 percent probability that the energy production from the project will exceed 1,160 MWh/yr and a 25 percent probability the energy production will be less.

Table 13
20-Year Average Net Annual Energy Estimates, One Fuhrländer FL600 Wind Turbine

Probability of Exceedance	Net Energy, MWh/yr	Net Capacity Factor
1%	1760	33.5%
5%	1620	30.9%
10%	1550	29.4%
25%	1420	27.1%
50%	1290	24.5%
75%	1160	22.0%
90%	1040	19.8%
95%	980	18.6%
99%	860	16.4%

Estimated net power production on a 12-month by 24-hour basis ("12x24") for one Fuhrländer FL600 wind turbine is presented in Table 14; such a 12x24 matrix provides information regarding the expected seasonal and diurnal variation in power output. The estimates include the expected energy losses described above, distributed evenly all across all hour and months. Note that this matrix is an estimate of the pattern of average power production. The actual power production in any given hour or month may deviate significantly from this pattern. For example, net production may be relatively lower than anticipated in winter months due to higher losses caused by extreme weather events. In addition, the uncertainty for a given hour of a given month is much larger than the uncertainty on the annual energy production.

Table 14
Estimated 12-Month by 24-Hour Net Power Production for One Fuhrländer FL600 Wind Turbine, kW

Hour	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
0	220	220	240	190	160	120	70	50	60	100	160	230	150
1	220	220	240	170	150	110	60	60	40	120	160	230	150
2	230	200	250	180	150	120	60	50	50	130	170	240	150
3	220	200	260	170	150	110	60	50	60	110	170	240	150
4	210	210	250	160	150	110	60	60	60	100	180	220	150
5	190	200	260	170	140	80	50	50	60	100	180	230	140
6	210	190	240	160	140	60	50	40	60	110	190	220	140
7	200	180	240	160	150	70	50	50	60	120	190	220	140
8	210	190	220	160	150	80	50	70	60	130	170	210	140
9	250	210	210	170	150	80	40	70	60	120	170	200	140

Table 14
Estimated 12-Month by 24-Hour Net Power Production for
One Fuhrländer FL600 Wind Turbine, kW

Hour	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
10	250	220	220	180	160	100	40	70	70	110	180	220	150
11	250	240	230	200	160	120	50	70	70	100	170	230	160
12	240	240	220	200	170	120	50	60	80	110	160	230	160
13	230	250	240	200	190	150	70	60	80	110	150	240	160
14	220	240	250	200	190	160	70	60	80	100	140	220	160
15	220	210	250	220	170	160	80	50	70	100	130	190	150
16	200	170	240	190	170	140	90	50	60	110	120	190	140
17	210	160	220	180	150	120	70	40	30	110	120	180	130
18	220	200	200	200	150	110	50	30	40	130	130	190	140
19	220	180	200	190	160	120	40	30	40	110	140	190	140
20	220	200	210	200	150	110	40	40	40	120	140	220	140
21	230	220	190	190	140	120	50	40	40	120	140	220	140
22	230	210	210	180	150	130	60	50	50	120	160	220	150
23	230	220	230	160	150	130	60	50	50	110	170	220	150
Ave	**220**	**210**	**230**	**180**	**160**	**110**	**60**	**50**	**60**	**110**	**160**	**220**	**150**

For comparison purposes, the net annual energy estimates for other types of wind turbines are presented in Table 15, based on a 50 percent probability of exceedance level.

Table 15
20-Year Average Net Annual Energy Estimates, Single Turbine,
50 percent Probability of Exceedance

Turbine Model	Quantity	Net Energy, MWh/yr	Net Capacity Factor
PS600	1	910	17.3%
FL600	1	1290	24.5%
E-48	1	1040	19.8%
T-600-48DS	1	880	16.7%

CONCEPTUAL DESIGN

Site Physical Characteristics

The Consultant's objective for this topic was to assess the WWTF site's physical characteristics, including topography, land cover, land use, access roads, and buildings; to evaluate the suitability of potential wind turbine locations from an operational viewpoint; to describe required and recommended spatial separation of the wind turbine from buildings and pedestrian or vehicular traffic; to evaluate the ability to deliver wind turbine components and installation equipment to the site (via land or air); and to identify necessary access road modifications required for each potential wind turbine location.

Based on detailed maps and other information provided by Edgartown and observations made during site visits, the Consultant evaluated the WWTF site to determine its suitability for utility-scale wind energy project development. Topics that the Consultant investigated include:

- The constructability of the wind energy project at the WWTF site;
- The suitability of potential wind turbine locations with regard to operational considerations;
- The presence of any buildings or other obstacles that may hamper construction, transportation, or energy generation at the site.

Following is a summary of the investigation including recommendations of topics that Edgartown should consider to move forward with the development of a wind power project.

Obstructions to the Wind Resource

Wind speed and direction data measured at the Tisbury met tower from July 2007 through June 2008 indicate the prevailing wind direction, from both time duration and an energy-content basis, are generally from the northwest (see the wind resource section for more detail). Besides the trees noted previously, there are no significant upwind obstructions to the wind resource at the potential wind turbine location that would need to be taken into account in this analysis.

Required Setbacks and Height Restrictions

Airspace Evaluation

MTC contracted Aviations Systems, Inc. to perform an airspace obstruction evaluation regarding Edgartown (the "Airspace Evaluation"). The Airspace Evaluation dated December 4, 2007, was specific to a potential turbine location with coordinates generally at the WWTF using a site elevation of 29 feet above mean sea level and a turbine height of 397 feet agl. The Airspace Evaluation concluded that the nearest public or military air facility is the Katama Airpark, which is approximately 1.67 nautical miles from the WWTF site and that the WWTF site is approximately 44.7 nautical miles from the federal government's North Truro Long Range Radar facility and that – subject to current policy of the National Air Defense and the Department of Homeland Security – any proposed wind turbine may be required to undergo an individual assessment by FAA. The Airspace Evaluation further concludes that any wind turbine up to 188 feet agl "…should receive routine approval" and any wind turbine from 188 feet agl to 397 feet agl "…should be approvable but require extended study."

Additionally, the U. S. Department of Defense, Missile Defense Agency ("USDOD") operates an early warning radar system at the Cape Cod Air Force Station, which is identified as the PAVE Phased-Array Warning System ("PAWS"). The PAVE PAWS is used primarily to detect and track sea-launched ballistic missiles and inter-continental ballistic missiles and secondarily to track and detect Earth-orbiting satellites. A land-based wind turbine could potentially interfere with the PAVE PAWS if the turbine is located within the PAVE PAWS coverage area and depending on the turbine's height and proximity to the PAVE PAWS installation.

Wind Bylaw

The Town of Edgartown has enacted the Edgartown Zoning Bylaw, Article 4.2, conditionally allowing by special permit the use of wind energy conversion systems (the "Wind Bylaw"). Under the Wind Bylaw, a wind turbine must maintain a minimum setback distance equal to the maximum tip height ("MTH") of the wind turbine plus twenty feet (i.e., 6.1 m) from any neighboring property line. The Wind Bylaw contains other conditional provisions including, among other things, the restriction of tower climbing access and the applicant's ability to demonstrate that the turbine will not cause excess noise or interference with local television and radio reception.

The setback required by the Wind Bylaw is consistent with ranges of setbacks used in similar wind turbine projects with which the Consultant is familiar. For example, the Model Amendment to a Zoning Ordinance or By-Law prepared by the Massachusetts Division of Energy Resources includes a setback distance equal to 1.5 times the MTH of the wind turbine blades from the nearest existing residential or commercial structure. This is generally referred to as a safety setback, and the area within this setback should be clear of occupied buildings, roads, or other areas normally occupied by the public and on-site personnel.

Table 16 identifies the MTH and a distance equal to the Edgartown Wind Bylaw setback for different wind turbine models. Based on the proposed turbine location (see the wind turbine location section for more detail) each of the turbine types presented in Table 16 satisfy the Wind Bylaw minimum setback distance with regard to receptors off the WWTF site.

Table 16
Dimensions of Potential Wind Turbine Models

Turbine Model	Rated Capacity, kW	Rotor Diameter, m	Hub Height, m	MTH, m	Wind Bylaw Setback (MTH plus 6.1), m
Vestas RRB PS600	600	47	65	88.5	94.6
Fuhrländer FL600	600	50	75	100	106.1
Enertech E-48	600	48	65	89	95.1
Elecon Turbowinds T-600-48DS	600	48	50	74	80.1

The Massachusetts Department of Environmental Protection ("MDEP") has a policy requiring that commercial developments not increase background noise levels more than 10 dB measured at a property boundary. An acoustic analysis completed by Tech Environmental, Inc. examined the potential sound impact of three of the four proposed turbine models: the Vestas RRB PS600, Fuhrländer FL600, and Enertech E-48. The study concluded that the project should comply with the MDEP Noise Policy for the aforementioned turbine models located at approximately the proposed turbine location shown in Figure 9. (Refer to further discussion in the environmental subsection of this Report.) It is likely that the Elecon Turbowinds TS-600-48DS should also comply with the MDEP Noise Policy given the findings for the other turbines in its class.

The FAA may impose height restrictions on the project. As previously discussed, the Airspace Evaluation concludes that a wind turbine with a MTH of up to 121 m (397 feet) agl should be approvable but may require extended analysis. This potential height restriction does not appear to impact the possible Vestas RRB, Fuhrländer, Enertech, or Elecon Turbowinds turbine options shown in Table 16 but a determination from the FAA based on the actual turbine location will be required.

Wind Turbine Location

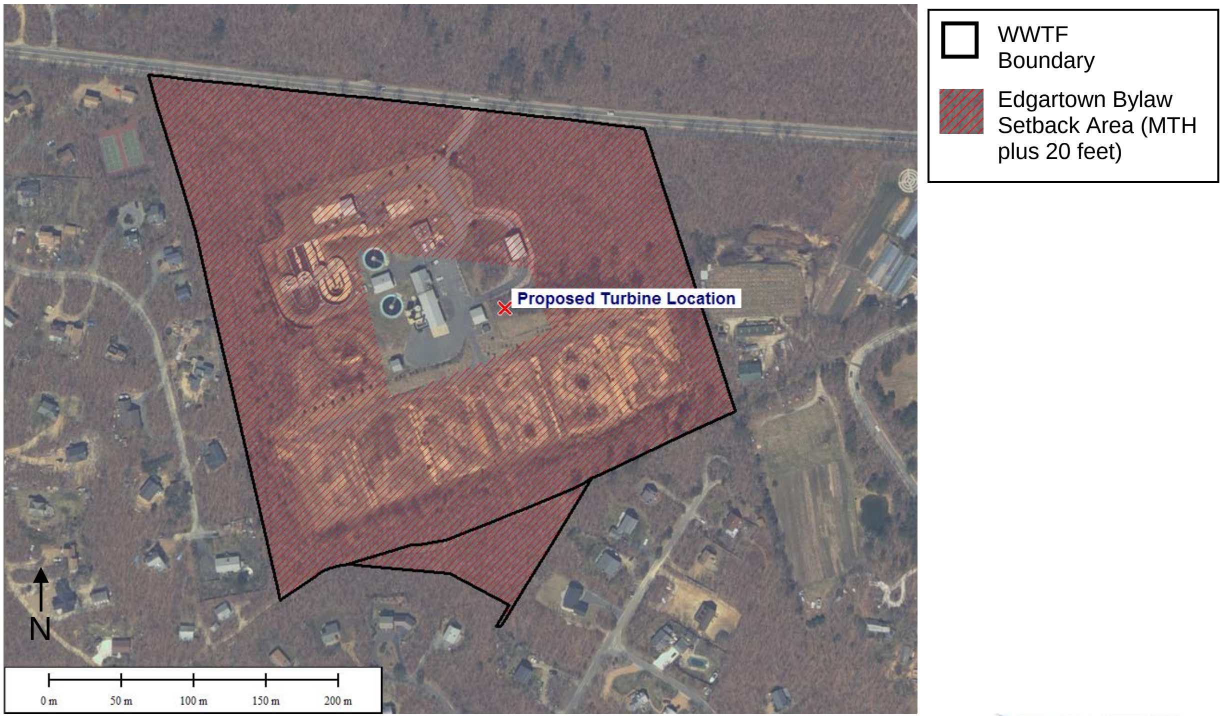
Based on the Consultant's review of the elevation map of the property, the WWTF site is relatively flat with elevation ranging from 4 m to 11 m above sea level. The highest elevations on the WWTF site, and subsequently the area of greatest wind exposure, are located in the central and northern sections of the property.

Based on the setback requirements discussed above, the Consultant estimates that the central portion of the WWTF is capable of supporting one 600 kW class wind turbine with a rotor diameter of approximately 50 m and a hub height of 75 m. Figure 9 depicts the proposed wind turbine location based on the Fuhrländer FL600 with a tower height of 75 m and a rotor diameter of 50 m (maximum tip height of 100 m). The location represents what is expected to be the highest wind resource and lowest construction cost location that is suitable for wind turbine installation on the property. The proposed location takes into account the prevailing wind direction, elevation, access to roads, and the setbacks as described above.

Figure 9

Edgartown Wind Energy Feasibility Study

One-Turbine Layout, Fuhrländer FL600 with MTH of 100 m



Projection: Massachusetts Mainland State Plane, Meters, NAD83
Aerial Imagery: Office of Geographic and Environmental Information (MassGIS)

Transportation Considerations

Given the size of the wind turbine components and the roadway geometry in the vicinity of both the Woods Hole and Vineyard Haven ferry terminals, we do not believe that transport of the wind turbine components via highway (to Woods Hole and via ferry to Martha's Vineyard) is a feasible option. However, transport of the wind turbine components by barge is expected to be a viable transportation option. It is our understanding that the majority of the freight brought to Martha's Vineyard is offloaded in Vineyard Haven, the port located within Tisbury. Further, we understand that there are two potential locations within the town of locations within the Town of Tisbury where wind turbine components could be offloaded.

Once on the island, routing the turbine components to the WWTF will be along local, two-lane surface roadways. There are a number of horizontal curves along several transportation routes, and we expect modifications to the public roadways and temporary utility relocations will be required to accommodate the required turning radii of the turbine transport vehicles.

From Vineyard Haven to the WWTF site, we believe that there are two potential routes that should be further evaluated. The first potential routing (from Vineyard Haven) would be via South Main Street to Edgartown-Vineyard Haven Road to Barnes Road to Edgartown-West Tisbury Road to the WWTF site. The second potential routing would be via South Main Street to State Road to Edgartown-West Tisbury Road. While both sites would be required to traverse the potentially problematic intersection at Five Corners (in Vineyard Haven), we believe that the more round-about routing via West Tisbury will encounter fewer turns/intersections that could required modifications.

Civil and Site Modifications

Site Development

For the WWTF site, development activities will consist of modifications to the existing site entrance, minor upgrades to existing access roadways, and clearing and leveling of the proposed turbine site. Widening of the existing driveway access to allow blade and/or nacelle transport to enter the WWTF site from West Tisbury road will likely be required. Additionally, construction of the wind turbine site will require that a circular area approximately 80 m in diameter, or approximately 0.49 hectare (“ha”), be cleared and leveled. Where the existing tree line is within this limit, the felling of trees will be required. This will require the removal of a number of trees to the east of the existing storage garage (located) along the east side of the WWTF parking area. The Consultant expects that a small access roadway, or widening of the paved parking lot area north of the storage garage will be required to provide access to the wind turbine. Widening or realigning the access driveway from Edgartown-West Tisbury to the turbine site may also be required to allow easier delivery of the turbine components. Ultimately, once the wind turbine has been erected, the Consultant anticipates that the portions of the roadways or parking areas used as an access roadway will be decompacted at the end of construction and generally returned to the original configuration. However, any remaining access roadway constructed for permanent access to the turbine will be approximately 5 m wide.

Subsurface Considerations

Though the Consultant did not conduct a geotechnical or soils analysis, the Consultant did not observe any conditions that would suggest that a wind energy facility as described in this Report could not be built. Based on the boring logs prepared for the construction of the WWTF, it appears that the soils that underlie the potential wind turbine site is comprised mainly of non-cohesive fine to medium silty sandy soils (generally comprised of fine to coarse medium sand). The Consultant therefore does not consider the existing ground conditions to pose a unique challenge to wind turbine project construction.

Construction Routing

The following discussion is in the context of accessing the proposed wind turbine locations directly from Edgartown-West Tisbury Road using as much of the existing WWTF roadway and parking areas as much as possible so as to minimize land impact. As indicated above, it will be necessary to widen the existing driveway intersection with Edgartown-West Tisbury road to meet the turning radius of the wind turbine hauling equipment. Further, we expect that a minor realignment of the existing access driveway will be required to allow easier access to the proposed turbine site.

Minimal topographic information was provided for review. However, based upon the Consultant’s observations at the WWTF site, the Consultant generally does not believe that significant cuts or fills will be required to meet the curve radius and roadway grade requirements for the haul equipment that are specified by the wind turbine manufacturer.

In general any new on-site access roads that will be constructed to allow the delivery and erection of the wind turbines will have a minimum width of 5 m (in accordance with the wind turbine manufacturer's recommendations).

The Consultant assumes that any required realignment of the access roadway, or widening of the existing parking lot will be constructed using compacted gravel in accordance with the wind manufacturers' requirements. Based on our experience with projects with similar subgrade conditions, we expect that the minimum recommended roadway thickness will be approximately 300 millimeters ("mm") comprised of gravel compacted to a minimum of 95 percent of its maximum dry density as determined by ASTM D1557.

Construction of the wind turbine site and the access road would be accomplished by conventional means and methods. Clearing of the WWTF site would likely be performed by bulldozers. As the observed surface soils appeared to consist predominantly of sandy materials, blasting is not expected to be required. Once the WWTF site and access roadway is cleared, bulldozers, graders, vibrating rollers, and other conventional earthmoving equipment would be used to grade and compact the access road.

Electric Interconnect

The Consultant observed the electrical infrastructure at the WWTF and the manner in which it is connected to the NSTAR distribution system. The infrastructure that is relevant to the interconnection of a wind turbine generator ("WTG") is between the 480 V main switchboard that serves as the main electrical distribution hub of the WWTF and the NSTAR pole at the edge of the property which serves to connect the WWTF to the NSTAR 23 kV (nominal) overhead distribution system. The existing connection is comprised of the switchboard and a transformer estimated to be in the range of 350 kVA (based on its physical size and the maximum demand of the WWTF) 23 kV to 480/277 and metering owned by NSTAR, and fused switches and lightning arresters on the NSTAR riser pole that is in turn connected to the NSTAR overhead distribution system serving the general area around the WWTF. The switchboard and transformer are connected by underground cables owned by the WWTF and the transformer and fused switch on the riser pole are connected using an underground cable running under the WWTF parking lot and entrance road. The switchboard was observed to have no spare spaces to install a new circuit breaker for a WTG connection and there is no available space in the switchgear room to add a section to the switchgear to add such a new circuit breaker.

In developing a conceptual plan for the interconnection of the WTG, several factors must be taken into consideration. First is that using a 600 kW class WTG with the potential to generate up to 600 kW at peak output will result in more power than can be transferred across the existing transformer which is estimated to be rated for 350 kVA which would be a reasonable size given that the WWTF peak load which is reported to be 256 kW over the past four years. A second factor is that WTG in this power class are designed to be connected at a higher voltage than the 480 V that serves the WWTF. Therefore the existing transformer could not be used even if the kVA rating were on the order of 800 kVA which is typical for a 600 kW class WTG. The voltage from the Fuhrländer WTG is 690 V and is usually transformed up to a nominal voltage of 23 kV to 35 kV using a transformer at the base of the WTG that may be supplied as part of the WTG or by the BOP contractor. The purpose of transforming the voltage up is to reduce the size of the collector system cable that interconnects the WTG and reduce losses in the cable. A smaller size cable will cost less and the sizing of the cable will take into consideration the balance between cost and system losses. Finally, there is the issue of no longer requiring the interconnection located "behind the meter" so that credit can be taken for the total generation against other Edgartown electric consumers under the Massachusetts net-metering regulations. As a result of these factors the interconnection concept will require the interconnection of the WTG to the NSTAR 23 kV distribution system in the vicinity of NSTAR riser pole #67-1 at the entrance to the WWTF site.

Taking the factors discussed above the conceptual plan of interconnection will include a transformer at the base of the WTG to raise the voltage to 23 kV (nominal) to match the NSTAR distribution voltage, a recloser and protective relaying equipment in a pad mounted enclosure at the base of the WTG to meet NSTAR system protection requirements, collector system cables routed from the turbine to the point of interconnection on a new riser pole or on a new pole in that vicinity. The collector system cables are proposed to be three single conductor, aluminum, 25 kV, Size 1/0 cables with ethylene-propylene insulation and an overall PVC jacket and will be direct buried in a trench along with a Size 1/0 ground cable and a fiber optic cable to bring WTG control and operating data back to a remote wind turbine monitoring computer (a single PC assumed purchased with the WTG) to be located somewhere in the WWTF main building. The fiber optic will branch off the cable run at a point opposite the WWTF main building and be run underground across the paved parking area to the building. At a new riser pole (or poles) in the vicinity NSTAR pole 67-1, where the existing cables from the WWTF rise to connect to NSTAR , the new cables from the WTG will connect to the NSTAR overhead distribution lines through a fused switch. The riser pole and switch would be installed and owned by NSTAR.

Based on discussions with NSTAR for a previous project, at the point of interconnection where the line side of the switch is connected to the NSTAR overhead line, NSTAR will likely require the installation of a recloser, 23 kV metering including metering transformers, a radio control link for control of the recloser and a telephone link to transmit metering data to NSTAR. This latter equipment will be designed and installed by NSTAR. The interconnection concept is indicated on the "Conceptual Electrical One-Line Diagram, 011582-ESK-10" included in Appendix B of this Report. During the process of negotiating an interconnection agreement with NSTAR, this concept may be modified somewhat in terms of requiring an additional pole for the NSTAR equipment, whether NSTAR or Edgartown will own the fused disconnect switches on the pole(s) and other details. It is assumed that no additional modifications to the existing electrical infrastructure serving the WWTF will be required because the interconnection will be made electrically "in front of" the facilities serving the WWTF. Edgartown will be required to compensate NSTAR for its engineering and construction costs.

Net Metering

Net metering in Massachusetts was enacted and signed by the Governor on July 2, 2008 as The Green Communities Act ("TGCA"); however, the Massachusetts Department of Public Utilities ("DPU") must first adopt new net-metering rules before these changes can take effect. The TGCA establishes three separate categories of net-metering facilities: Class I facilities are generally defined as systems up to 60 kW in capacity; Class II facilities are generally defined as systems greater than 60 kW and up to 1 MW in capacity that generate electricity from agricultural products, solar energy, or wind energy; and Class III" facilities are generally defined as systems greater than 1 MW and up to 2 MW in capacity that generate electricity from agricultural products, solar energy, or wind energy.

During March 2009 the DPU proposed a Model Net Metering Tariff (D.P.U. 09-03) for public comment. In this proposed tariff with regard to the Edgartown wind energy project, a Class II Net Metering Facility is an Agricultural Net Metering Facility, Solar Net Metering Facility, or Wind Net Metering Facility with a generating capacity of more than 60 kilowatts but less than or equal to one megawatt; provided, however, that a Class II Net Metering Facility owned or operated by a Customer which is a municipality or other governmental entity may have a generating capacity of more than 60 kilowatts but less than or equal to one megawatt per unit.

During January 2009 the Massachusetts Department of Energy Resources ("MDER") issued draft guidelines for public comment for qualifying under the TGCA, and further issued a guidance document for same during June 2009.

Additionally, the current understanding is that investor-owned utilities ("IOUs") must offer net metering. The aggregate capacity of net metering is limited to 1 percent of each utility's peak load. The treatment of customer net excess generation ("NEG") varies for each of the three facility classes and by technology type. In general, for NEG at the end of a billing period, Class I solar and wind facilities, Class II facilities, and Class III facilities receive credit that is somewhat less than the utility's retail rate. Credits may be carried forward to the next month indefinitely, and credits from Class I and Class II wind and solar facilities may be transferred to another customer of the same utility. Credits from Class III facilities may be transferred to other customers with the utility's permission. The TGCA also allows utility companies to offer up to 50 MW of power-purchase agreements to residential and commercial customers over the next two years, subject to approval by the DPU.

Energy Utilization: Generation and Export

As previously referenced in this Report, the electrical usage data provided by Edgartown indicates that there is enough of a base load at the WWTF to support the concept of the wind energy plant displacing energy needs at the WWTF. The electrical energy generated by the wind turbines will vary with the wind resource and there will be periods during which the wind turbines will not generate electricity.

As previously indicated in this Report, after analysis of wind data, the data suggest that the P_{50} twenty-year average net annual energy generation from one 600 kW Fuhrländer wind turbine at a 24.5 percent net capacity factor (refer to Table 13) is estimated to be 1,290 MWh/y over a twenty-year average.

The operating nature of a wastewater treatment plant is typically a combination of constant electric loads (i.e., base loads) and batch process electric loads (i.e., periodic or cyclic loads). The electrical usage data provided suggest that is indeed the case with the WWTF as the raw data in Table 1 and shown in Figures 3A & 3B indicate varying peak electric demands and further indicate that the annual average energy needs at the WWTF is 1,014,777 kWh per year.

Accordingly, there will be periods during which the generation from the wind turbines will be greater than the WWTF load thus resulting in a net export of energy, and there will also be periods during which the WWTF load will be greater than the wind turbines output thus requiring that the WWTF continue to purchase energy from NSTAR. Further analysis of these data to attempt to determine how much of the wind turbine's energy would be used by the WWTF and how much would be exported is not a part of this feasibility study or Report.

Existing Infrastructure

Documentation and drawings depicting the present underground infrastructure supporting the WWTF were not provided to the Consultant; therefore, the Consultant cannot ascertain if the proposed turbine locations/foundations and the supporting electric collection system might interfere with existing underground sewer lines, water supply lines, settling pond lines, treated-discharge lines, natural gas lines, or other buried infrastructure. The Consultant recommends that during the development process for the proposed wind energy project that such an interference analysis be performed using accurate as-built drawings of the WWTF's supporting infrastructure, and that additional means such as Dig Safe be used to supplement such analysis.

With that said, the current location and layout of the WWTF suggest that all supporting buried infrastructure traverses on the road-side of the WWTF or between the WWTF process building and settling ponds. Under this assumption, the Consultant's conceptual electrical design anticipates that the electrical collection system would travel from the northern wind turbine to the southern wind turbine, northwest to the WWTF process building, and then along the southwest perimeter of the WWTF process building.

Preliminary Work

Work that can be performed in advance of the actual construction of the wind turbine and BOP includes all the site preparation work as identified below.

1. Geotechnical investigations and surveys. Subsurface investigations should be performed to confirm the soil parameters that will be used to determine the foundation requirements and access road design parameters. The Consultant recommends that soil borings be taken at the proposed wind turbine location. Typically with other wind projects with which the Consultant is familiar, a single boring is taken for each turbine location regardless of the type of foundation chosen by the project design contractor. Additionally, one or two test pits should be dug along the proposed access road alignment.

2. Site clearing operations. Limited removal of the existing trees at the wind turbine site and the creation of an access area can be performed in advance of the actual wind turbine procurement activities, provided that the locations of the turbine has been finalized and preferably designed.

3. Grading. Limited grading operations at the WWTF site and along the access road alignment can be performed; however, final grading would be dependent on the proposed project's design.

4. Electrical. Installation of electrical conduits and manholes (including trenching operations) in advance of receiving turbines on site; however, electrical design would need to be far enough along, if not completed, to commit to such work.

ENVIRONMENTAL AND REGULATORY CONSIDERATIONS

Key Permits, Approvals, and Analyses

The proposed wind energy project at the WWTF would need to be designed, constructed, and operated in accordance with applicable federal, state, and local regulations, codes, standards, guidelines, policies, and laws. The key permits, approvals, and analyses likely to be needed for a wind energy project at the WWTF are summarized in Table 17 and discussed as follows.

Table 17
Edgartown Wind Energy Generation
Summary of Likely Key Permits, Approvals, and Analyses

Permit/Approval	Responsible Agency	Purpose / Comments
FEDERAL		
Aeronautical Obstruction Clearance, Determination of No Hazard to Air Navigation ("DNH")	U.S. Federal Aviation Administration ("FAA")	To indicate that the turbine tower does not interfere with air navigation.
Radio Spectrum Transmission Analysis	U.S. National Telecommunications and Information Administration ("NTIA")	To identify if proposed turbine locations will interfere with communications transmissions, if applicable.
National Pollutant Discharge Elimination System ("NPDES") Stormwater Discharge General Permit for Construction	U.S. Environmental Protection Agency ("USEPA")	For stormwater management during construction activities.
NPDES Stormwater Discharge General Permit for Operations	USEPA	For stormwater management during operations.
Threatened and Endangered ("T&E") Species Determination, Section 7 of Endangered Species Act	U.S. Fish and Wildlife Service ("USFWS")	To assess impact of project on T&E Species and other species of concern. Possible assessment could include: natural resource characterization report, breeding bird survey, and wildlife habitat evaluation. May result in USFWS request for post-construction monitoring plan. MTC has independently performed a Phase I Avian Risk Assessment in the Cape Cod region but it is unclear if the results of same can be used for Edgartown

Table 17
Edgartown Wind Energy Generation
Summary of Likely Key Permits, Approvals, and Analyses

Permit/Approval	Responsible Agency	Purpose / Comments
STATE		
Massachusetts Environmental Policy Act ("MEPA") Review	Massachusetts Executive Office of Environmental Affairs ("MEOEA"), Massachusetts Environmental Policy Act Office	MEPA review will be required; however, it is unlikely that an Environmental Impact Report ("EIR") will be required as the project is not expected to trigger EIR thresholds. Preparation and submittal of an Environmental Notification Form ("ENF") will be required. Will require a review under Massachusetts Article 97 for applicable public lands.
Biological Assessment Approval Endangered Species Impact Assessments Migratory Birds Impact Assessments	Massachusetts Department of Environmental Protection ("MDEP")	As required to assess impact of project on T&E or special-concern species. May result in MDEP request for post-construction monitoring plan.
General National Pollutant Discharge Elimination System ("NPDES") Permit for Discharges of Stormwater Associated with Construction Activities	MDEP	Under applicable state and federal codes for stormwater discharges for construction sites disturbing one or more acres of land. Requires the preparation of a Storm Water Pollution Prevention Plan ("SWPPP").
Cultural and Historical Resources Determinations	Massachusetts Historical Commission ("MHC")	As required to assess the impact of the project on cultural and historical resources.
Highway Weight Exceedance Permit Highway Occupancy Permit	Massachusetts Highway Department ("MHD")	As required/applicable in accordance with state regulations with regard to construction activities that impact state roads.
Green Community Certification	Massachusetts Department of Energy Resources ("MDER"), Green Communities Division	To establish Edgartown as a Green Community in support of the proposed project as required by The Green Communities Act of 2007 ("TGCA").
Aviation Interference and Project Review	Massachusetts Aeronautics Commission ("MAC")	To assess project impact to regional air navigation, if applicable.
NPDES General Permit for Stormwater (for operations)	MDEP	Required for stormwater management during operation. Requires the preparation of a SWPPP. Requires submittal of Notice of Termination of construction permit.

Table 17
Edgartown Wind Energy Generation
Summary of Likely Key Permits, Approvals, and Analyses

Permit/Approval	Responsible Agency	Purpose / Comments
LOCAL		
Planning Approvals and Special Permits	Edgartown, Planning Board and other departments as applicable/interested	As required by the Zoning ByLaws dated October 1, 2008 with regard to the wind energy conversion systems (WECS"). Requires decommissioning of the wind energy project after two years of non-use.
Building Permit	Edgartown	As required / applicable in accordance with municipal codes, ordinances, and regulations.
UTILITY		
Uniform Approval for Distributed Generation Interconnect	NSTAR Electric / Commonwealth Electric Company	For interconnect approval

Local Approvals

Edgartown has a requirement of the Zoning ByLaws dated October 1, 2008 (the "Zoning ByLaws") with regard to the wind energy conversion systems (WECS"). The specific requirements for a WECS are outlined in the Zoning ByLaws. Edgartown has a multi-discipline review process as part of its zoning code, under which the town's planning board will distribute project plans to all town departments and agencies for review as applicable. The Zoning ByLaws requires decommissioning of the wind energy project after two years of non-use.

Massachusetts Approvals

The proposed project involves development of a renewable energy facility, the impacts of which allow certain state permitting agencies to act on the project. The principal regulatory process under which the project will likely be subject would be the MEPA approval. Though the project will not affect greater than 25 acres of land (a MEPA trigger), the project will likely need to undergo review pursuant to Section 11.03 (1) (b) 1 of the MEPA regulations, because the project requires state permitting and the project involves a form of financial assistance from an agency of the Commonwealth. The MEPA jurisdiction extends to all aspects of the project that may cause significant damage to the environment as defined in the MEPA statute. Pursuant to the MEPA (M.G.L. c. 30, ss. 61-62H) and Section 11.06 of the MEPA regulations (301 CMR 11.00), it is unlikely that the proposed project will require preparation of an EIR. Preparation of an ENF will be required, particularly to demonstrate that the potential impacts of the project will not warrant preparation of an EIR.

The project results in the direct alteration of a limited land area, most of which has already been developed by Edgartown for WWTF site development. The amount of disturbed land is below the mandatory EIR threshold (50 acres) for land alteration; therefore, an EIR should not be required based on this trigger.

The project will require physical modifications to public properties. Such activities do not necessarily constitute the conversion of Article 97 lands to a non-Article 97 use, nor do such activities constitute the release of an interest in land held for conservation purposes; however, other aspects of the project may result in conversion of Article 97 lands. These issues should be reviewed by appropriate Edgartown officials.

Federal Approvals

There are certain other key permits and approvals that should be discussed, most notably the FAA DNH. Under FAA regulations, application for a DNH must be made to the FAA for: (a) any construction or alteration exceeding 200 ft (61 m) above ground level; (b) any construction or alteration within 20,000 ft (6.1 km) of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with at least one runway more than 3,200 ft (975 m), within 10,000 ft (3.5 km) of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 ft (975 m), or within 5,000 ft (1.5 km) of a public use heliport which exceeds a 25:1 surface; (c) any highway, railroad or other traverse way whose prescribed adjusted height would exceed the above noted standards; (d) when requested by the FAA; or (e) any construction or alteration located on a public use airport or heliport regardless of height or location. These requirements are part of FAA Advisory Circular AC 70/T460-1K and -2K. Upon application for a DNH, FAA performs an obstruction evaluation for the proposed structure, which in the case of the Edgartown project would be the wind turbine and prior to construction possibly the construction cranes.

Refer to the Airspace Evaluation discussion in this Report. Obstruction lighting may be required as there are no other permanent tall towers in the vicinity. The project is not expected to employ lighting during daytime hours and may likely use medium-intensity red obstruction lights with the longest allowable off-cycle during nighttime hours. Lighting requirements will need to balance visual concerns and potential impacts on birds and bats (some of which may be attracted to certain types of lighting) with the need to ensure the safety of the structures, particularly with respect to aviation. The project site is relatively close to the Martha’s Vineyard airport and the project may penetrate certain aviation spaces. The FAA will review wind turbine location and height, and issue essentially binding recommendations on lighting as part of its “Part 77” review process. The FAA process is intended to balance consideration of safety, aesthetics, and environmental impact. The project would be required to implement the least intrusive lighting plan allowable by the FAA to ensure an appropriate level of aviation safety.

Other Environmental Assessments and Considerations

While the Consultant did not observe obvious environmental concerns during the Consultant’s visit to the WWTF site, the Consultant does recommend environmental surveying.

Wetlands

The project will not result in alteration of any wetlands. It should be noted however that the proposed location at the WWTF is not a registered wetland.

Rare Plant Species

Through research of available public databases, the Consultant could not identify rare plant species at the WWTF site. In the event that a rare plant is identified at the WWTF site, the project may need to develop a transplantation program and conservation management plan for impacts to rare plants, as well as require a Conservation Permit from the Massachusetts Division of Fisheries and Wildlife.

Rare or Endangered Species

Through research of available public databases, the Consultant could not identify rare or endangered species at the WWTF site.

Air Quality Mitigation

The project will produce air quality benefits for the Commonwealth. The project will be required to avoid or minimize negative impacts to the greatest feasible extent, and to mitigate any unavoidable impacts. The project permitting review process is expected to identify and develop appropriate mitigation for any unavoidable impacts. It is expected that mitigation commitments, if any, would become environmental regulatory conditions from applicable agencies as the project moves through the permitting process.

Operations Monitoring and Decommissioning

The Consultant anticipates that certain government wildlife and resource management agencies, including the MEOEA, the Massachusetts Audubon Society, and the Conservation Law Foundation, will request that the project provide post-construction monitoring of impacts to birds and bats. Development of a monitoring program will provide evidence to evaluate the accuracy of the predictions for minimal impacts to wildlife, as well as scientifically useful information in a much broader context of the Commonwealth's energy and environmental policies. The Consultant anticipates that the project will need to perform this post-construction monitoring commensurate with the size and potential impacts of the project and consistent with the requirements of any applicable permits as a baseline-level of research. The Consultant anticipates that the project will be expected to develop a decommissioning plan as part of the local review of the project.

Areas of Cultural or Historic Significance

The proposed wind project site is a pre-disturbed, industrial facility, and potential conflicts with areas of cultural or historic significance are expected to be minimal. While certain sites on Martha's Vineyard is included in the State Register of Historic Places, these sites appear to be located beyond the impact threshold distance from the WWTF site.

Avian Impacts

The project may be required to prepare a Wildlife Habitat Evaluation, Natural Resource Characterization Report, Breeding Bird Survey, and Phase I Avian Risk Assessment, with the latter likely requested by USFWS. The Consultant understands that the MTC has performed Phase I Avian Assessments for the Cape Cod region as well as other regions in the Commonwealth, the results of which may be useful for the Edgartown project. It is not anticipated that the project would result in a materially significant take of rare birds or bats.

Noise

As part of the local review process, the project will likely need to conduct a study of project-related noise impacts and develop sound contours for the project with emphasis on residential structures that may fall within the sound contours associated with the project. The MDEP has a noise guideline requiring that commercial developments not increase background noise levels more than 10 dB measured at a property boundary. An acoustic analysis completed by Tech Environmental, Inc. in June 2008 examined the potential sound impact of three of the four turbine models identified previously in this Report: the Vestas RRB PS600, Fuhrländer FL600, and Enertech E-48. With increases in ambient noise at the nearby residences attributable to the turbines estimated to be 1 dBA to 6 dBA, the study concluded, "The wind turbine project should comply with the MDEP Noise Policy for [the PS600, FL600, and E-48 turbine models] concerning the increases in total sound level at all nearby residential properties." The study also concluded that under certain conditions the project may be audible outdoors near the residences closest to the turbine, but it should not be audible indoors at the closest residences under any conditions. The Consultant did not record or monitor ambient noise levels at the WWTF site. The Consultant recommends that a more detailed study of analysis of ambient noise and potential noise impacts be undertaken

Advance Permitting Activities

As previously discussed in this section of the Report, there are several permitting and approval activities that will be required for the proposed wind energy project to be developed. In general the majority of these permits and approvals can be applied for in advance on the basis of generic project and wind turbine information; however, there are certain permits and approvals that can only be applied for after the actual wind turbine (i.e., manufacturer and model) has been selected or procured, so that key technical data can be provided in the applications.

For example, the FAA DNH for the turbine site can be applied for on the basis of an assumed MTH for the turbine and will not require a significant amount of advance engineering/design; but, it will require identification of the exact location for the wind turbine. Site plans will need to be prepared with the general arrangement of equipment, foundations, access roads, and electric cabling.

An electric one-line diagram to support construction and application for interconnect with NSTAR will need to identify certain technical information that can only be known after a wind turbine has been selected.

Regardless of what entity (e.g., Edgartown, contractor) develops the proposed wind energy project, in the context of those permits, approvals, and analyses identified in Table 17, the following permitting and approval process is suggested.

1. Finalize wind turbine location.
2. Initiate FAA DNH approval process seeking approval for highest potential turbine height.
3. Initiate MEPA review process.
4. Initiate Building Permit approval process under Planning ByLaws for WECS.
5. Initiate Green Communities Certification process.

Barring unforeseen circumstances and potential intervener delays, the Consultant expects that a minimum of approximately six months will be required to acquire the key environmental permits and approvals needed to construct the proposed wind energy project.

Photo Visualizations

To understand what a 600 kW-class wind turbine may look like at the WWTF site, the Consultant developed several photo visualizations, or simulations, of a 600 kW-class wind turbine located on the prospective site from various locations in the community, which appear in Appendix C herein. The wind turbines used in the images have a hub height of 75 m and a rotor diameter of 50 m, which is the largest turbine currently under consideration for the project. The maximum tip height is therefore 100 m. The photo simulations are not provided for turbine models with smaller dimensions.

Photo visualizations were developed from photographs taken from nearby representative positions where the proposed wind turbine is expected or suspected to be visible, based on the topography and vegetation. The investigated locations consisted of public land, roads, and one private residence. The currently proposed wind turbine location described in this report was assumed in the photo visualization.

The photographs were taken on a clear, sunny day in March 2009, in which turbines would be most visible and corresponds with minimum leaf density on deciduous vegetation. The proposed wind turbine is expected to be seen from fewer vantage points in the summer when the deciduous trees grow their leaves. The wind turbine's distance above the horizon as shown in the photo visualizations, is based on the Consultant's estimation of the relative elevation difference between the vantage point and the wind turbine site using publicly available digital elevation model data with a 10-m spatial resolution. Thus the actual views may differ from those shown here.

Since the primary wind direction is southwest (about 210° from true north), the turbine in the photos is oriented to face into this direction. The sun angle, light intensity level, and shadows on the turbine have been adjusted to most closely match the local conditions at the time the photo was taken. The WindFarm software program (ReSoft Ltd.) was used to create all photo simulations.

Referring to Appendix C of this Report, Figure C-1 shows the vantage points and proposed wind turbine location for which photo visualizations were developed. Figures C-2 through C-6 show the photo visualizations for each vantage point.

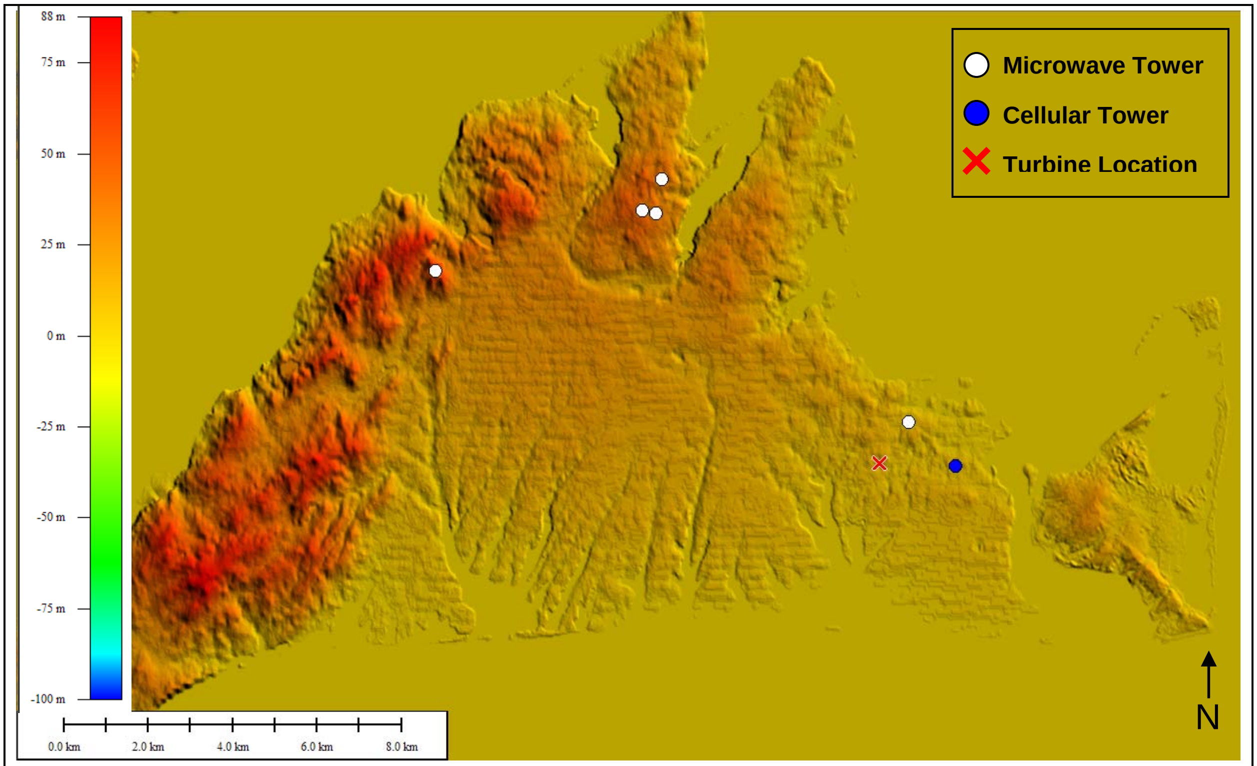
Communications Infrastructure

Wind turbines, like all tall structures, can create interference or degradation of certain communication signals if they are located in the line-of-sight of communications equipment such as microwave, radio, or satellite dishes. Figure 10 shows the location of known communications towers within 10 km of the WWTF site as of early 2009. The closest communication equipment to the WWTF are two towers, one microwave and one cellular, approximately 1.2 km to 1.7 km to the northeast and east, respectively. Analysis of line-of-sight signal interference is beyond the scope of this review. Further analysis is required, which would take into account the proposed turbine dimensions, turbine location, and transmittal paths of various types of communication signals in the area.

Figure 10

Edgartown Wind Energy Feasibility Study

Location of Select Communications Infrastructure near the WWTF



Projection: Massachusetts Mainland State Plane, Meters, NAD83
Digital Elevation Model: United States National Elevation Data database, 30 m resolution
Tower Locations: Office of Geographic and Environmental Information (MassGIS)

Shadow Flicker

Shadow flicker caused by wind turbines is defined as alternating changes in light intensity due to the moving blade shadows cast on the ground and objects (referred to as receptors), including windows at residences. Shadow flicker typically occurs when a receptor is in a position where the wind turbine blades interfere with low-angle sunlight (i.e., the turbine blades pass through the path between the sun and the receptor). Shadow flicker associated with wind turbines can cause disturbances to residents if the orientation of the home and the turbine are such that the residence experiences significant periods of shadow flicker impact.

The shadows cast by wind turbines will vary with several factors including season, time of day, surrounding terrain and obstacles, cloud cover, distance from the turbine(s), turbine size, and wind speed and direction. These factors can impact the number of hours that a given receptor will experience shadow flicker as well as the intensity of the shadow flicker which is defined as the relative contrast between the presence and absence of a shadow at a given location.

The height of the sun in the sky varies by season, as does the time and location at which it rises and sets. In the winter, the sun rises late in the southeast, travels in a low arc across the southern sky in the northern hemisphere, and sets early in the southwest. Because it is so low in the sky, it casts longer shadows. In the summer, the sun arcs through the sky at its highest angle, and casts the shortest midday shadows. However, in the summer, the sun also rises earliest and sets latest, and covers a wider range of directions, from the northeast around the south to the northwest. Therefore, the summer sun casts shadows that span a broader direction range than in other seasons, and its early sunrise and late sunset create shadows earlier in the morning and later in the evening than in other seasons.

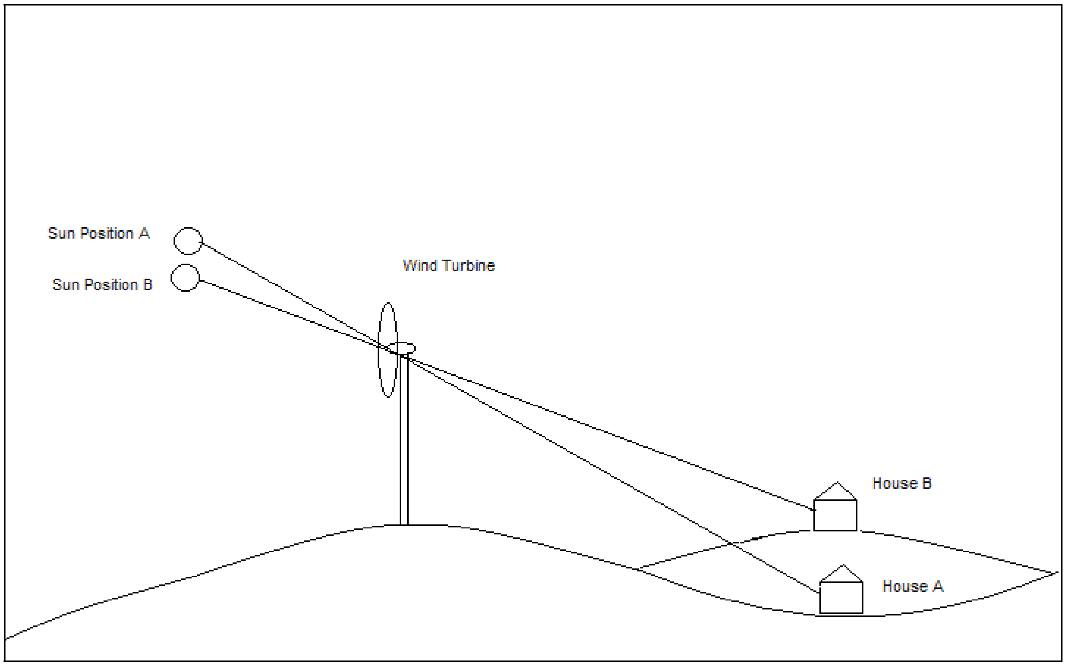
The lateral extent of the blade shadow depends on wind direction, as the wind turbines yaw to face into the wind during operation. For example, during westerly winds, the turbine rotor will face to the west, and a relatively small shadow would be cast on a receptor if the sun is in line with the plane of the rotor, as it is at midday in the winter (sun from the south and lower in the sky). In these cases, the rotor shadow will be in the shape of a narrow ellipse and virtually no shadow flicker will be observable. However, when the sun is low in the sky and perpendicular to the rotor plane, a larger area of moving blade shadows will be cast on the ground. In these cases, the ellipse will be wider. Generally, a southern or northern wind will have minimum shadow impact because the widest shadows would be cast at midday when shadows are also the shortest (closest to the wind turbine) due to the sun's position high in the sky. Conversely, the greatest potential for shadow flicker impact occurs when winds come from the east or west early or late in the day. Additionally, shadow flicker does not occur when the turbines are not spinning. Therefore, when wind speeds are below the operating range for the turbine, shadow flicker is non-existent.

The size of the wind turbine and the relative position of the turbine relative to the receptor have a significant impact on shadow flicker. A larger rotor diameter obviously results in a larger area within which the blades will cast a shadow. Additionally, the portion of the blade that passes between the sun and the receptor will have varying impacts on the intensity of the shadow flicker due to the variation in width of the wind turbine blade from the widest point near the hub to the narrowest point at the tip. As viewed from the same location, a larger section of the blade will cover a greater portion of the sun than a smaller section of the blade resulting in a higher intensity shadow (greater reduction in the amount of light reaching the receptor). Shadows become less sharp (more diffuse) as distance increases between the shadow-casting object and the receptor. When considering shadows cast by objects at a long distance from the receptor, at a sufficient distance no noticeable shadow forms at all because the object does not significantly block the sun's light. Instead, light diffracts (or bends) around the edges of the object, and the object itself appears relatively small compared to the apparent size of the sun. The elevation of a receptor relative to the turbines impacts the angle at which the sun is shaded at that location. For example, if the receptor is located at a lower elevation than the turbine, the position in the sky at which the sun would cause shadow flicker at the receptor is higher relative to that for a receptor located at the same elevation as the turbine. This is illustrated in Figure 11 below. In Figure 11, the sun must be in Position A to cause shadow flicker at House A, whereas the sun must be in Position B to cause shadow flicker at House B. At Position A, the sun is higher in the sky and more intense than at Position B resulting in more intense shadow flicker.

Figure 11

Edgartown Wind Energy Feasibility Study

Illustration of the Impact of Relative Elevation on Shadow Flicker



Shadow flicker is strongest when the sun is not obscured by clouds. Shadows may still be cast on cloudy days; however, they are much more diffuse and the shadow flicker intensity is greatly reduced. Other obstructions such as vegetation can affect the shadow flicker at a receptor by blocking or diffusing the shadow cast by a turbine and eliminating or reducing the intensity of the shadow flicker. The analysis provided in this report does not evaluate the flicker intensity, but rather focuses on the total amount of time (hours per year) that shadow flicker can potentially occur at receptors regardless of how intense the shadow flicker is.

Shadow flicker impacts were calculated for the Edgartown project area using WindPRO software. This model generates site-specific results, taking site location (latitude/longitude), elevation, and monthly average cloud cover into account. The model also takes wind direction into account by modeling the average amount of time per year the turbine is yawed in various directions. Obstruction objects such as trees or buildings are not accounted for in the model. As the sun approaches the horizon, it is less intense and therefore the shadow influence is reduced. As solar radiation passes through the atmosphere, it is scattered and absorbed by the air and suspended particles. According to a generally accepted standard, the model did not calculate shadow influence when the sun is at or below an angle of 3 degrees above the horizon. The model is considered conservative in that it does not take into account additional attenuation effects of the variance of solar penetration through the atmosphere with the angle of the sun. For example, the solar radiation path through the atmosphere is 15 times higher at 3 degrees above the horizon, than when the sun is overhead. (Source: Superna Energy LLC. “Lempster Wind Project Shadow Impact Assessment”, dated August 10, 2006.)

The assumptions applied in the WindPRO model are generally conservative, and err on the side of over-predicting shadow impacts. Cloud cover tends to be greater in the mornings and evenings than it is midday. Similarly, shadows are longer (although more diffuse) when the sun is lower in the sky. Because cloud cover data were available as monthly averages rather than by time of day, the model results will be conservative. The model assumes that the turbines are always operating. In reality, no flickering effect occurs in calm or very low winds, when the rotor is stationary or turning too slowly to cause flicker. Obstructing objects such as trees, silos, or buildings may block shadow impacts on some receptors; these factors are not reflected in the model results.

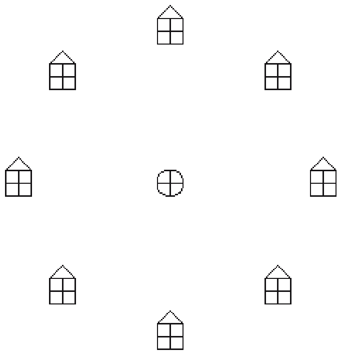
To address shadow flicker generally, theoretical houses have been assumed to be located at eight compass points around a representative turbine, as illustrated in Figure 12. A model was built with houses at distances of 230 m (750 feet), 305 m (1000 feet), and 458 m (1500 feet) from the turbine, representing the approximate setback distances to the project boundary, an intermediate distance, and the approximate maximum distance at which shadow flicker is expected to have impacts.

Each house is assumed to have a generic 1 m by 1 m square window located 1 m above ground level and facing the turbine. It is likely that many houses will have windows that are not perpendicular to turbines, which will decrease the shadow impact on these houses. The model was run with a 75-m hub height and an approximately 50-m rotor diameter, which is representative of the Fuhrländer FL600. The results assume the turbine is yawed to various directions according to the annual direction distribution of the wind regime at the Edgartown site. The results also take elevation differences, but not other structures or vegetation into account.

Figure 12

Edgartown Wind Energy Feasibility Study

Sample Layout for Shadow Flicker (D = 230 m, 305 m, and 458 m)



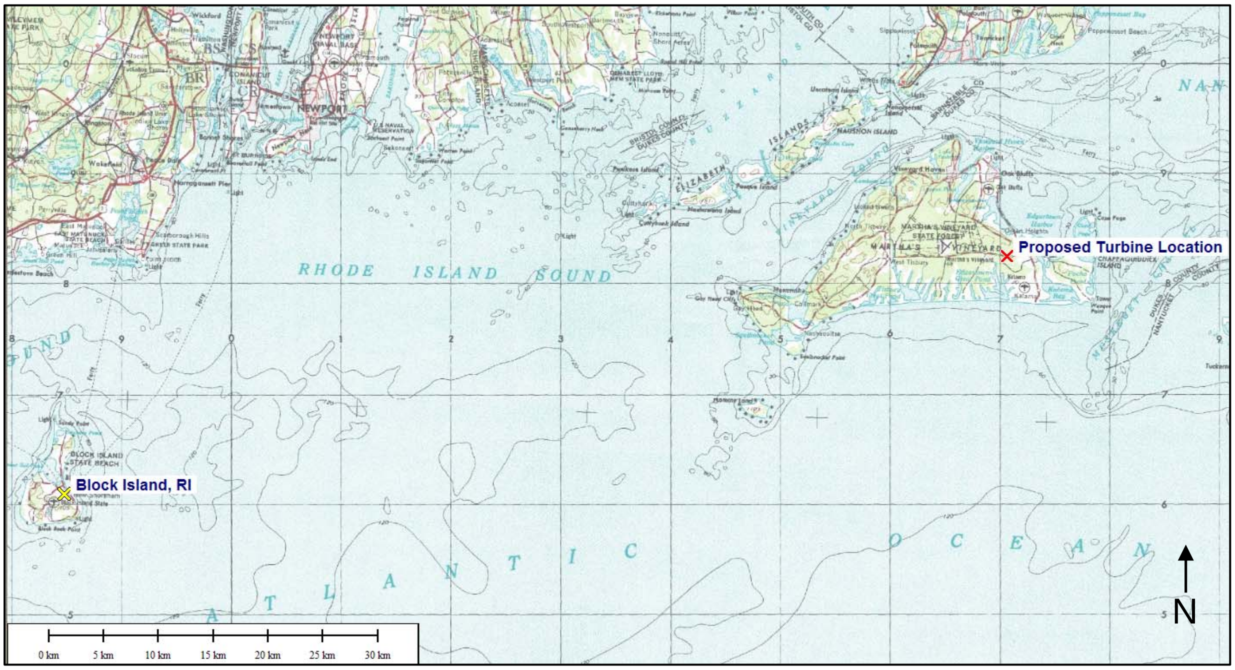
Turbine is in center with window receptors perpendicular to the turbine at eight compass points.

The nearest source of long-term cloud cover data from the National Climatic Data Center comes from the Block Island, Rhode Island station. These data include mean monthly cloud cover data averaged over a 50-year period. Monthly data are presented as mean days per month characterized as “Clear,” “Partly Cloudy,” and “Cloudy” between sunrise and sunset. “Clear” is defined as 0-2 eighths of the sky being obstructed by cloud cover, “Partly Cloudy” specifies clouds in 3-6 eighths of the sky, and “Cloudy” represents 7-8 eighths of the sky being cloud covered. From these data, monthly sunshine probabilities were derived (as 100 percent minus percent of “Cloudy” days) and applied in the model, as shown in Table 18. As illustrated in Figure 13 the Block Island station is approximately 88 km west-southwest of the WWTF site.

Table 18
Cloud Cover Data for Block Island, Rhode Island

Month	Sunshine During Daylight, Percent
Jan	55%
Feb	57%
Mar	58%
Apr	53%
May	58%
Jun	60%
Jul	58%
Aug	58%
Sep	63%
Oct	61%
Nov	57%
Dec	55%

Figure 13
Edgartown Wind Energy Feasibility Study
Location of Block Island Station Relative to Proposed Project Site



✗ Proposed Turbine Location

✗ Block Island Station

Projection: Massachusetts Mainland State Plane, Meters, NAD83
Data Layer: United States Geological Survey

GEC
a DNV company

For the theoretical receptors that have potential shadow flicker impacts, Appendix D of this Report graphically indicates the days of the year and hours of the day in which shadow flicker impacts could occur. The shaded area on each plot illustrates the time of shadow impact. Generally, the results show that receptors to the south of a turbine do not have impacts, and that receptors farther away from a turbine would have fewer hours of impact. Also, with the exception of short midday impacts in the winter due to low sun angles, the results show that receptors 458 m away have impacts limited to mornings and evenings, when the sun angle is low and shadows tend to be more diffuse. Table 19 provides a summary of shadow flicker impacts for receptors 230 m, 305 m, and 458 m from the turbine, respectively.

Table 19
Potential Shadow Flicker Summary

Direction from Turbine	Days of Potential Impact per Year	Maximum Hours per Day[1]	Mean Hours per Day[2]	Total Annual Hours
AT 230 M (750 FEET) FROM PROPOSED TURBINE SITE				
North	0.00	0.00	0.00	0.00
Northeast	110.00	0.87	0.26	28.15
East	71.00	0.82	0.23	16.17
Southeast	0.00	0.00	0.00	0.00
South	0.00	0.00	0.00	0.00
Southwest	0.00	0.00	0.00	0.00
West	74.00	0.82	0.23	16.88
Northwest	116.00	0.85	0.21	24.10
AT 305 M (1000 FEET) FROM PROPOSED TURBINE SITE				
North	0.00	0.00	0.00	0.00
Northeast	90.00	0.68	0.19	17.27
East	52.00	0.63	0.17	9.07
Southeast	0.00	0.00	0.00	0.00
South	0.00	0.00	0.00	0.00
Southwest	0.00	0.00	0.00	0.00
West	53.00	0.63	0.17	9.27
Northwest	86.00	0.68	0.19	16.68
AT 458 M (1500 FEET) FROM PROPOSED TURBINE SITE				
North	0.00	0.00	0.00	0.00
Northeast	34.00	0.35	0.10	3.35
East	33.00	0.43	0.13	4.17
Southeast	0.00	0.00	0.00	0.00
South	0.00	0.00	0.00	0.00
Southwest	0.00	0.00	0.00	0.00
West	34.00	0.43	0.12	4.17
Northwest	46.00	0.43	0.12	5.38

---

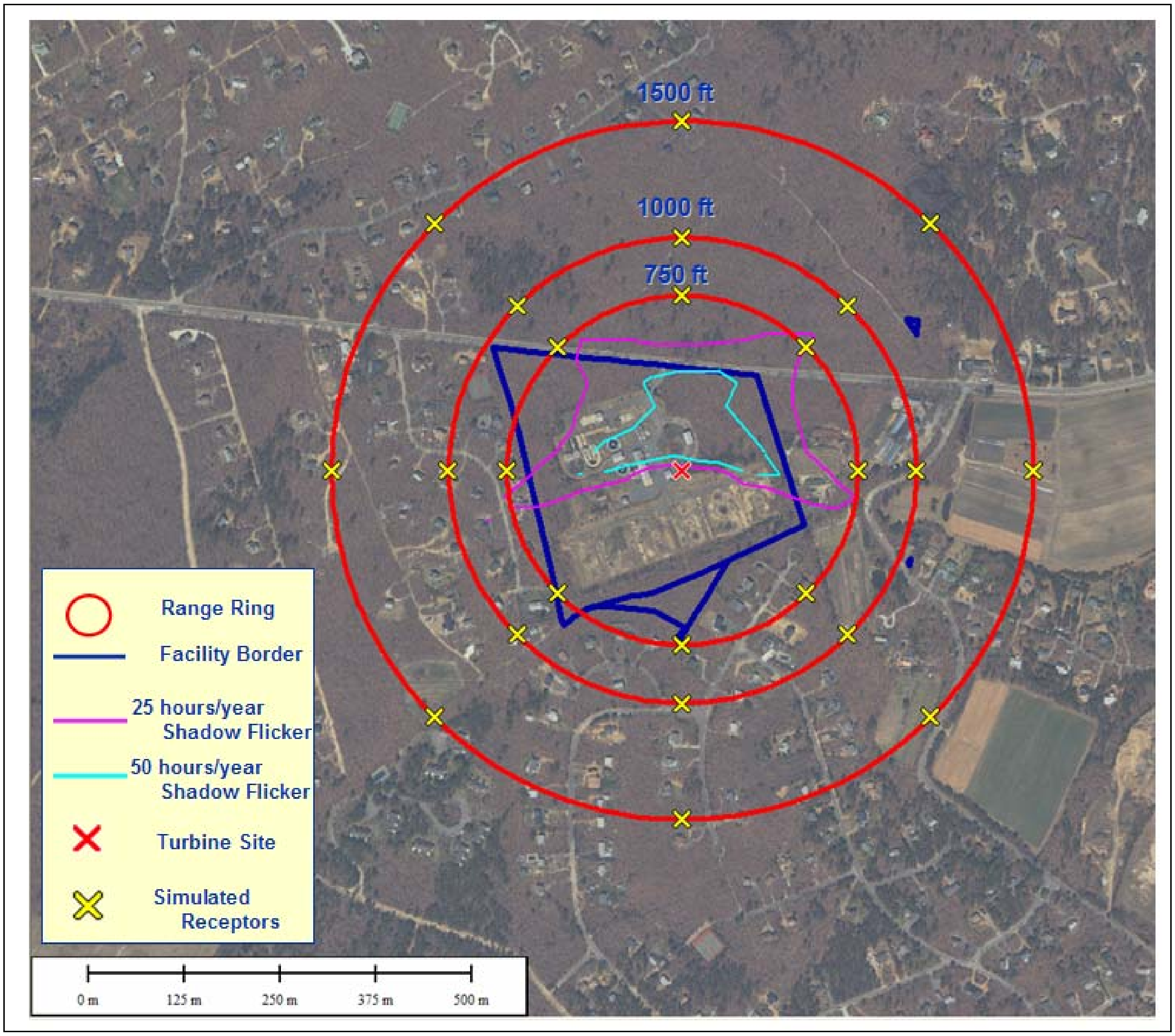
1. Not reduced to account for cloud cover or turbine yaw direction; assumes sky is always clear and turbine is facing the sun.
2. Mean hours per day calculated only on days with potential impact. Days without impact are not factored into the average. Mean hours per day would be much lower if days with no potential impact were factored in.

Figure 14 shows shadow flicker contours generated by the proposed turbine site on the project area. The simulated receptor points on Figure 11 correspond to the measurement locations used to generate the results in Table 19. Lines represent equal number of hours per year of shadow flicker. Almost all of the area with 50 annual hours or more of shadow flicker falls within 305 m of a turbine. Generally, the potential shadow flicker impacts at a distance of 305 m or greater from a turbine are limited to receptors located to the east to east-southeast or west to west-southwest of a turbine. Figure 14 shows a map of the entire project area with shadow flicker contours resulting from the additive shadow flicker effects of one turbine at the project. Less than 25 hours per year of potential shadow impacts are predicted outside the project boundary to the south. Some areas within about 230 m to the northeast of the base of the turbine have impacts exceeding 25 hours per year.

Figure 14

Edgartown Wind Energy Feasibility Study

Shadow Flicker around the Proposed Turbine Site



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1. Lines represent equal number of hours per year of shadow flicker.

PLANNING LEVEL PROBABLE CAPITAL COSTS AND O&M COSTS

Capital Costs

Equipment, material, and transportation pricing was based on published pricing and budget quotations where available and was supplemented by information from the Consultant's proprietary cost databases (the "Cost Databases"), which contain information on similar equipment purchased for other projects with which the Consultant is familiar. Installation labor hours were developed mainly from the Cost Databases and then adjusted based on the project's location, site conditions and expected labor productivity.

Turbine Capital Costs

One Fuhrländer FL600 turbine as discussed herein is estimated to cost approximately $1,550,000 for the wind turbine and tower (FOB manufacturer) including transportation and an FAA-required aviation beacon. It should be understood that the final wind turbine cost will depend on a number of factors such as warranty, options purchased, market factors, and contract negotiations. The estimated cost is based on engineering judgment as opposed to an actual quote from the turbine manufacturer. The Consultant has attempted to account for pricing premiums applied by turbine manufacturers for the small quantity, one-time purchase represented by this project. There is a high degree of pricing uncertainty due to the dynamic turbine purchase market currently prevailing in the wind industry. Several wind turbines other than those identified herein may also be suitable for the WWTF site. Costs for comparable machines may differ from those mentioned herein; however, on a unit cost basis ($/kW), these figures can be viewed as representative of wind turbines in this capacity range. To obtain more accurate cost estimates, a request-for-proposals is typically issued following feasibility and pre-development studies. More accurate costs based on the specific characteristics, conditions and requirements of the project can then be obtained from a review of proposal submissions.

Turbine Transportation Costs

Transportation costs are assumed inclusive in the cost for the one Fuhrländer FL600 turbine discussed herein, excluding road modifications if required, and do not include any unexpected costs in transport to an island. Transportation of the Fuhrländer FL600 will consist of a mix of ocean freight and truck transport depending on the origination point of the equipment, and the "best known methods" for transport in the region. These costs will vary depending on the exact origin of each piece of equipment and on the exact transportation methods and routes used by the wind turbine supplier or transportation contractor. Road modifications are not included because the need and extent if necessary of such modifications are unclear; such costs may likely be absorbed by project contingency.

Civil, Sitework, and Erection

Civil, sitework, and erection costs encompass the scope of civil and sitework discussed herein. This item includes site preparation (including removal of trees and site grading), excavation and backfill for wind turbine foundations, concrete work, the installation of a compacted gravel access roadway (from the existing WWTF paved area) to the wind turbine sites, and pad mounted electrical equipment at the wind turbines. Modifications to the main WWTF driveway entry and/or off-site roadway modifications are not included in this line item. Labor costs are based on regional (Massachusetts) labor rates.

Electrical Systems

Electrical systems costs encompass the scope of electrical work discussed herein. This item includes the costs for the step-up transformer, pad mounted recloser, material and installation of the collector system cable, ground conductor and fiber optic cable. An estimate has been included as a separate line item as an order of magnitude estimate NSTAR costs at the point of interconnection including a riser pole, fused disconnect switch, primary metering, a recloser and communications. This value will ultimately be determined by NSTAR based on its design of these facilities as part of a formal interconnection agreement process.

Total Construction Costs

The estimated total construction cost is the sum of all of the costs described above.

Owner's Costs

Owner's project costs are in addition to the constructor probable costs. These costs include the owner's (or developer's) costs for project management, administration, permitting, interfacing with municipal agencies, land and right of way acquisition, local benefits, costs for construction of the electric interconnection, spare parts, insurance, taxes, legal costs, accounting, working capital allowances, and similar costs not included in the construction contractors scope. These costs vary significantly from project to project and can be from 15 percent to 45 percent of the construction cost. The owner should evaluate these costs based on its experience and include a realistic value in its financial analysis. For the purposes herein the Consultant used approximately 20 percent.

Contingency

A project contingency allowance for unknown costs is normally included. On the basis of the Cost Databases, this allowance is commonly at least 5 percent to 10 percent of the total construction costs. To provide a breakdown of procurement and construction contingency, the Consultant has included an allowance for material and equipment costs and for construction costs. For this proposed project the Consultant has allowed a contingency of approximately 20 percent of anticipated project costs.

Total Estimated Project Costs (without Finance Costs)

This is the total estimated cost of the project and is the sum of the construction costs and other project costs described above. This total does not include insurance costs, tax costs, finance costs or cost of a construction loan.

Summary of Planning Level Capital Costs

Table 20 summarizes the Consultant's opinion of the proposed wind energy plant's probable planning level capital costs.

Table 20
Summary of Probable Planning Level Project Capital Costs (1)
for Edgartown's One-Turbine Project

Item	Cost for One Turbine
Subtotal for wind turbine generator (2)	$1,550,000
Subtotal for civil/sitework and turbine erection	$260,000
Subtotal for electrical systems and erection	$280,000
Subtotal - Construction Costs	$2,090,000
Owner's Costs, including engineering & permitting	$600,000
Subtotal – Project Costs	$2,690,000
Subtotal for NSTAR Interconnection Costs (3)	$80,000
Project Contingency	$554,000
Total Estimated Project Costs	**$3,324,000**
Installed Cost per Kilowatt ($/kW)	$5,540

Table 20
Summary of Probable Planning Level Project Capital Costs (1) for Edgartown's One-Turbine Project

Item	Cost for One Turbine

---

(1) In 2009 dollars.

(2) Based on one Fuhrländer FL600 turbine. Quotes from turbine suppliers are not available. Value indicated is an estimate for a small volume, one time order. A high degree of pricing uncertainty exists given current market conditions.

(2) Electrical equipment to interface with the utility grid as required depending upon the particular final interconnect design by NSTAR.

Operations and Maintenance Costs

Turbine

Recurring turbine operations and maintenance ("O&M") costs will vary depending on a number of factors. Turbine O&M costs vary significantly depending on the O&M strategy employed, the reliability of the equipment and the roles and responsibilities of the equipment manufacturer in providing service and warranty repairs. Turbine O&M costs are generally divided into the following categories:

- Operations (e.g., resetting the wind turbine when tripped off-line due to a fault).
- Scheduled, preventive maintenance on the wind turbine and other equipment (e.g., routine oil changes and inspections of transformer).
- Unscheduled maintenance including activities ranging from simple component replacements to major component repairs.
- Periodic component overhauls and scheduled replacements (as specified by wind turbine supplier).
- The first three categories occur during the course of each year while the fourth category occurs at periodic intervals over the life of the project.

For purposes of this evaluation, recurring turbine O&M costs have been estimated for an assumed warranty period (first two years) and escalating in subsequent years. These turbine O&M estimates are not specifically for the wind turbines proposed herein but representative of a typical 600 kW wind turbine, since the analysis of a specific wind turbine is not warranted by the scope of this study. Individual components of this total cost will vary. Most notably, the repair costs of a wind turbine are expected to increase above inflation.

Table 21 indicates how O&M costs are expected to change over the project life. These estimates assume the purchase of a two-year, all-inclusive turbine O&M warranty.

Table 21
Estimated O&M Costs of a Typical One-Turbine Wind Project (1) (2)

O&M Item	Years 1-2	Years 3-5	Years 6-10	Years 11-15	Years 16-20
Operations, scheduled and unscheduled maintenance, warranty (first two years)	$24,000	$24,000	$28,000	$34,000	$40,000

---

(1) Typical 600 kW turbine – one turbine.

(2) Constant 2009 dollars.

The greatest unknowns with the near-term recurring costs are the service and warranty provisions and payment terms that are negotiated as part of the wind turbine purchase. The biggest unknowns associated with long-term recurring costs are the reliability and lifetime of major wind turbine components such as gearboxes, generators, and blades. This is especially true for a single-wind turbine installation. For large projects, the reliability and replacement costs can be estimated with reasonable certainty on an average project-wide basis. While some wind turbines have better than average reliability and others worse than average, a single wind turbine with only slightly better or worse reliability than the fleet-wide average may result in much lower or higher costs than average and these costs are not offset by the averaging affects of a larger project. This long-term recurring cost uncertainty can be reduced by entering into longer than a two-year warranty contract; however, few wind turbine manufacturers offer all-inclusive warranty periods longer than five years. Machinery insurance can also be purchased to shelter the owner from some of the risk.

Wind energy plant maintenance would be categorized in three distinct areas: preventive, corrective, and predictive. It is conceivable that Edgartown employees or the WWTF's third-party operators could perform some preventive maintenance and some minor corrective maintenance; but, the Consultant does not recommend this. Most corrective maintenance, major preventive maintenance, and all predictive maintenance should be provided by outside contractors or the wind turbine manufacturer. Maintenance management is expected to be performed using industry-standard computer based planning software, which would include programming the manufacturer's recommended maintenance requirements into the software. Routine preventive maintenance activities would be performed by technicians assigned to day-to-day work. The wind turbine would generally run unattended, and have a 6-month scheduled service interval.

The wind energy plant would need a long-term major maintenance plan to schedule preventive maintenance activities. Major equipment overhaul – either preventive or corrective – is expected to be contracted to the manufacturer or a qualified off-site contractor. The Consultant expects that that the wind turbine would be maintained under a long-term service contract.

Other O&M Costs

Other than those specifically identified herein, no other O&M costs have been considered.

The wind energy plant is expected to maintain an appropriate set of spare parts on hand. For space reasons, certain major items may be inventoried in other nearby facilities. Spare parts could be stored in a separate secured room nearby – possibly in one of the maintenance buildings at the WWTF.

ASSUMPTIONS AND REFERENCES

Principal Considerations and Assumptions

In the preparation of this Report and the opinions presented in this Report, the Consultant has made certain assumptions with respect to conditions which may exist or events which may occur in the future. While the Consultant believes these assumptions to be reasonable for the purpose of this Report, they are dependent upon future events, and actual conditions may differ from those assumed.

In addition, the Consultant has used and relied upon certain information provided by sources which the Consultant believes are reliable. While the Consultant believes the use of such information and assumptions to be reasonable for the purposes of this Report, the Consultant offers no other assurances with respect thereto and some assumptions may vary significantly due to unanticipated events and circumstances. To the extent that actual future conditions differ from those assumed in this Report or provided to us by others, the actual results of the Consultant's analyses will vary from those projected in this Report. This Report summarizes the Consultant's work up to the date of the Report; thus, changed conditions occurring or becoming known after such date could affect the material presented to the extent of such changes.

References and Data Sources

The following references and data sources were utilized for this study:

1. Manwell, James et. al., University of Massachusetts Amherst Renewable Energy Research Lab, Wind Data Report Tisbury, Martha’s Vineyard, MA July 1, 2007 – June 30, 2008.

2. New England Wind Map, TrueWind Solutions.

3. Wind resource data collected at Edgartown site by the University of Massachusetts Renewable Energy Research Laboratory.

4. Town of Edgartown Zoning Bylaws, Article IV, Section 4.2.h, “Wind Energy Conversion System”.

5. NSTAR Electric/Commonwealth Electric Company, Standards for Interconnection of Distributed Generation, DTE0238 Tariff, April 2004.

6. Massachusetts Environmental Policy Act Guidelines (various), Massachusetts Executive Office of Environmental Affairs.

7. Massachusetts DEP Guidelines (various), Massachusetts Department of Environmental Protection.

8. Code of Federal Regulations (various), U.S. Government Various Agencies.

9. Model Amendment to a Zoning Ordinance or By-law: Allowing Wind Facilities by Special Permit, Massachusetts Executive Office of Environmental Affairs.

Respectfully submitted,

R. W. BECK, INC.
DNV GLOBAL ENERGY CONCEPTS, INC.

APPENDICES

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APPENDIX A: WIND TURBINE POWER CURVES

Turbine Model	Vestas RRB PS600	Fuhrländer FL600	Enertech E-48	Elecon Turbowinds TS-600-48DS
Wind speed (m/s)	**Power (kW)**	**Power (kW)**	**Power (kW)**	**Power (kW)**
0.0	0	0	0	0
0.5	0	0	0	0
1.0	0	0	0	0
1.5	0	0	0	-1
2.0	0	0	0	-1
2.5	0	0	0	-2
3.0	0	8	4	3
3.5	0	15	14	13
4.0	21	27	24	26
4.5	32	42	40	41
5.0	42	61	56	59
5.5	61	85	77	77
6.0	81	116	99	104
6.5	112	152	130	136
7.0	143	191	161	165
7.5	181	238	198	211
8.0	219	291	235	236
8.5	261	348	295	284
9.0	304	412	354	354
9.5	353	471	405	414
10.0	402	520	456	461
10.5	438	565	499	513
11.0	474	594	541	546
11.5	503	602	568	573
12.0	533	610	595	599
12.5	549	615	598	616
13.0	564	615	600	625
13.5	573	615	600	627
14.0	582	615	600	616
14.5	590	615	600	623
15.0	597	615	600	621
15.5	599	615	600	616
16.0	600	615	600	612
16.5	601	615	600	602
17.0	602	615	600	605
17.5	601	615	600	605
18.0	600	615	600	604
18.5	600	0	600	601
19.0	600	0	600	604
19.5	600	0	600	569
20.0	600	0	600	570
20.5	600	0	600	548

Turbine Model	**Vestas** **RRB PS600**	**Fuhrländer** **FL600**	**Enertech** **E-48**	**Elecon Turbowinds** **TS-600-48DS**
Wind speed (m/s)	**Power (kW)**	**Power (kW)**	**Power (kW)**	**Power (kW)**
21.0	600	0	600	484
21.5	600	0	600	0
22.0	600	0	600	0
22.5	600	0	600	0
23.0	600	0	600	0
23.5	600	0	600	0
24.0	600	0	600	0
24.5	600	0	600	0
25.0	600	0	600	0
+25	0	0	0	0

---

1. Curves adjusted to 1.23 kg/m3 air density

APPENDIX B: ELECTRICAL ONE-LINE DIAGRAM

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APPENDIX C: PHOTO VISUALIZATIONS

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Figure C-1

Edgartown Wind Energy Feasibility Study

Infrastructure Photo visualization vantage points and the proposed turbine site

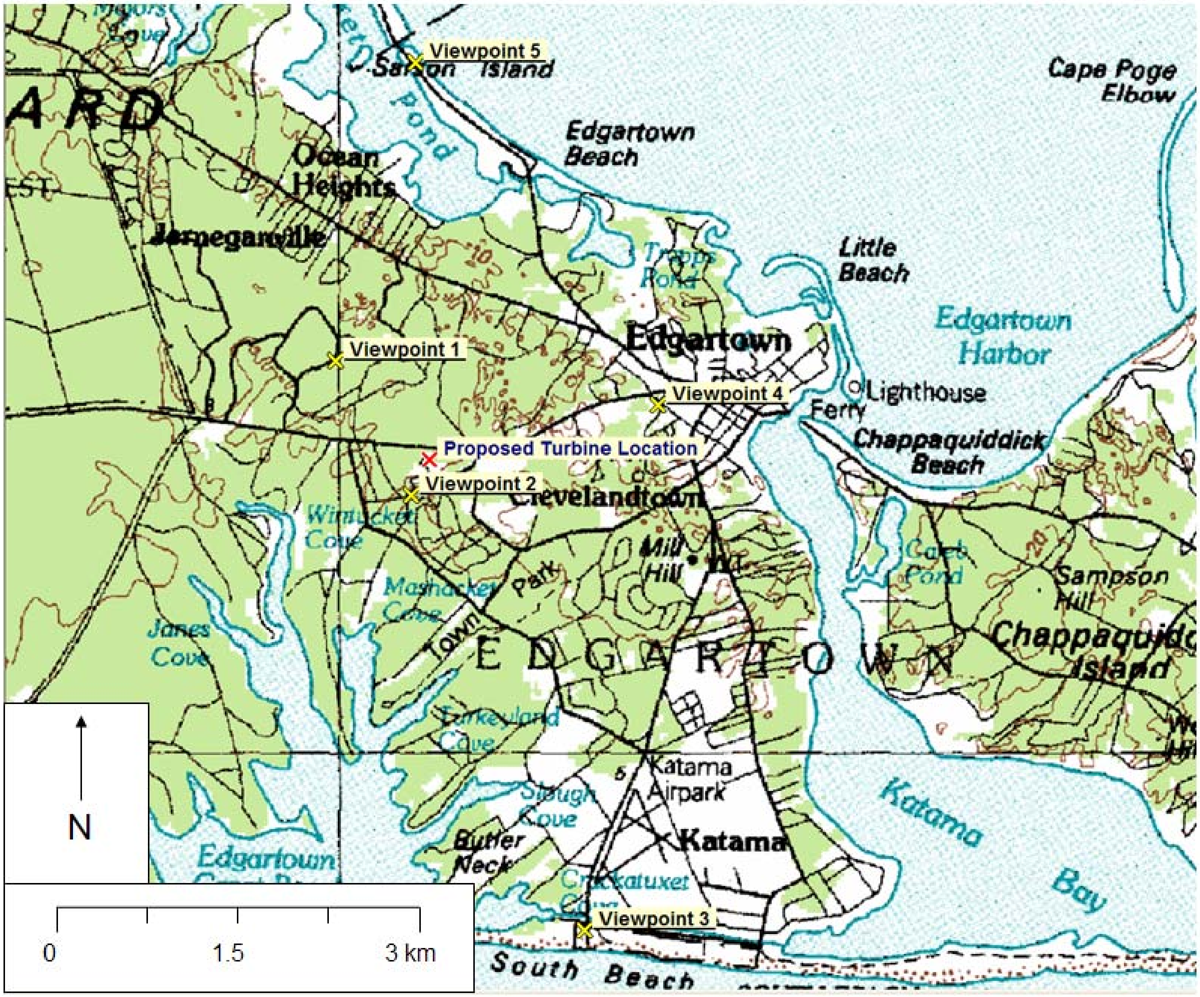

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Figure C-2

Edgartown Wind Energy Feasibility Study

Viewpoint 1 - Vineyard Golf Course, 1.1 km NW of the Site Looking SE

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Figure C-3

Edgartown Wind Energy Feasibility Study

Viewpoint 2 - Grey Gull Circle, 0.3 km NNE of the Site, Looking SSW

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Figure C-4

Edgartown Wind Energy Feasibility Study

Viewpoint 3 - South Beach at Herring Creek Road, 4.1 km SSW of the Site Looking NNW

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Figure C-5

Edgartown Wind Energy Feasibility Study

Viewpoint 4 - Edgartown School, 1.9 km ENE of the Site Looking WSW

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Figure C-6

Edgartown Wind Energy Feasibility Study

Viewpoint 5 - Big Bridge, 3.3 km NNW of the Site Looking SSW

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APPENDIX D: SHADOW FLICKER ANALYSIS

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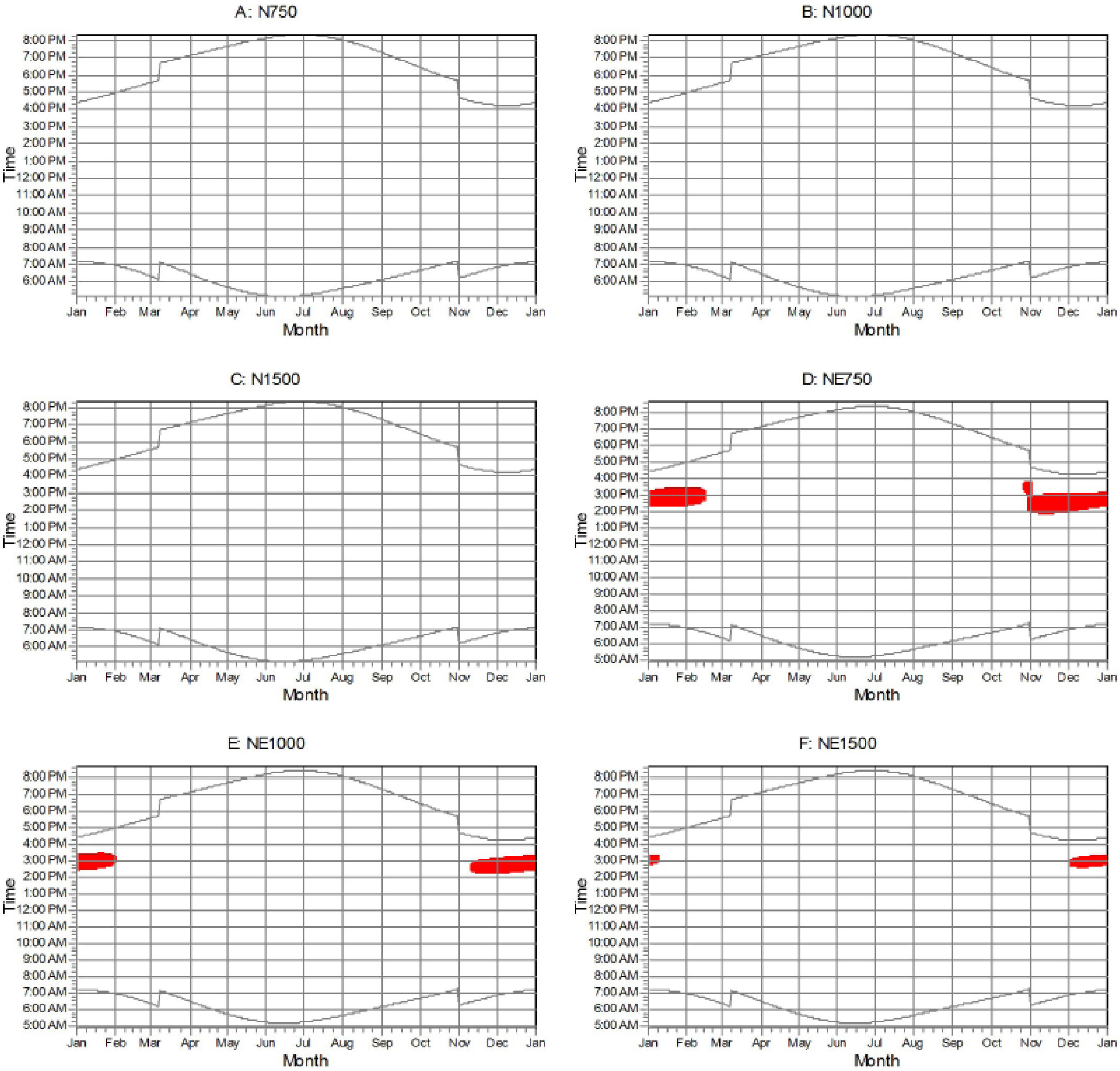
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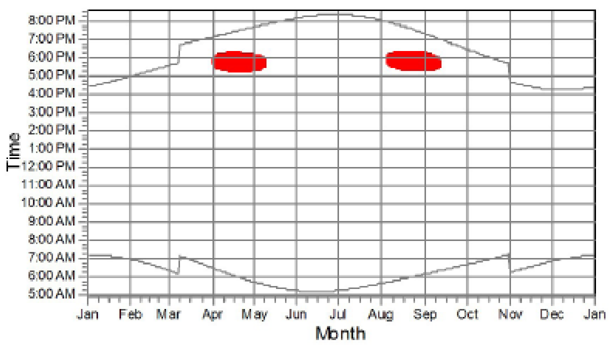

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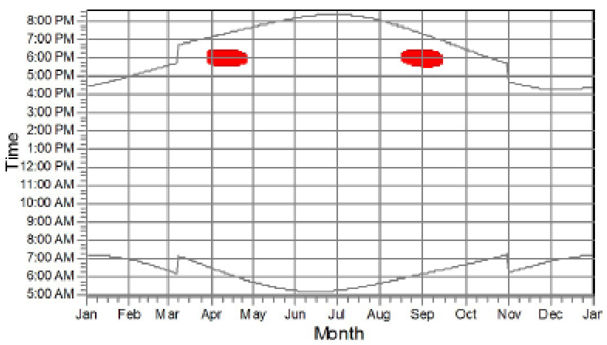

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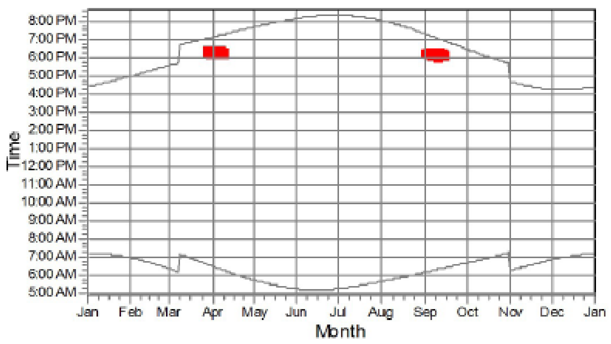

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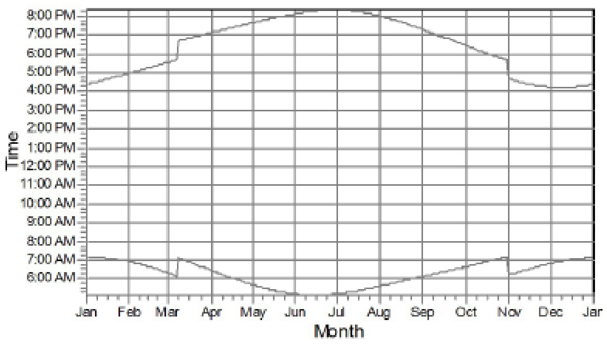

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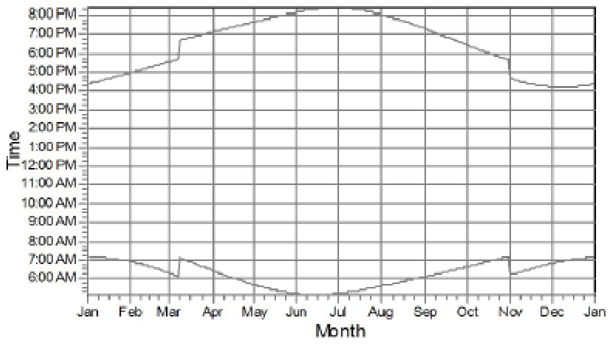

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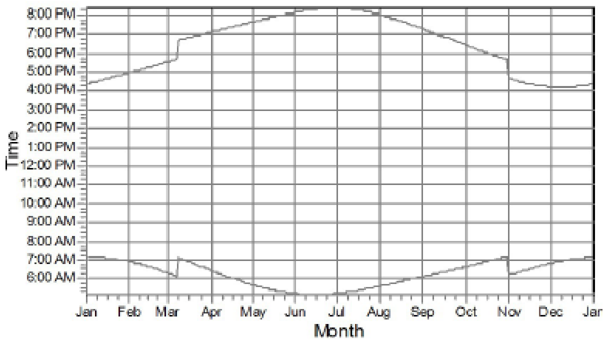

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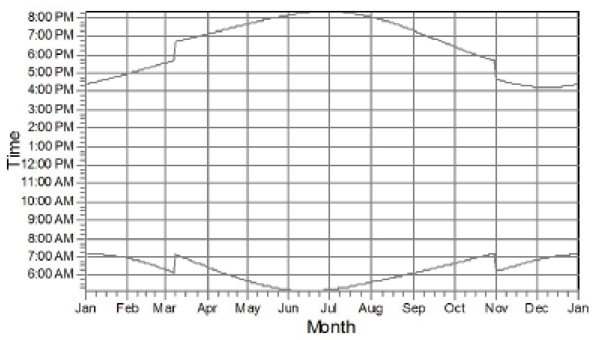
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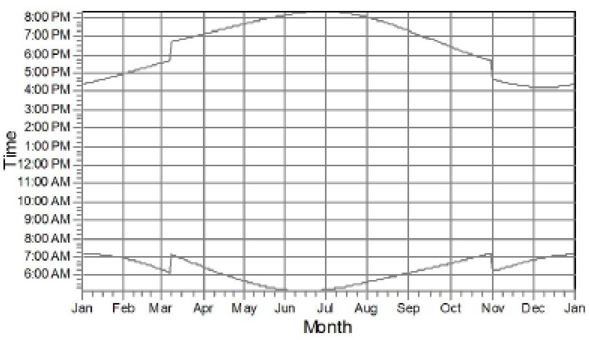
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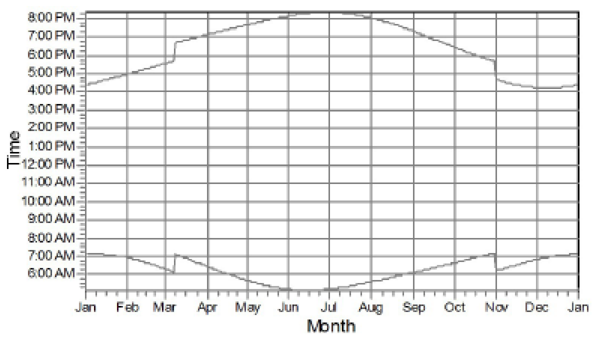
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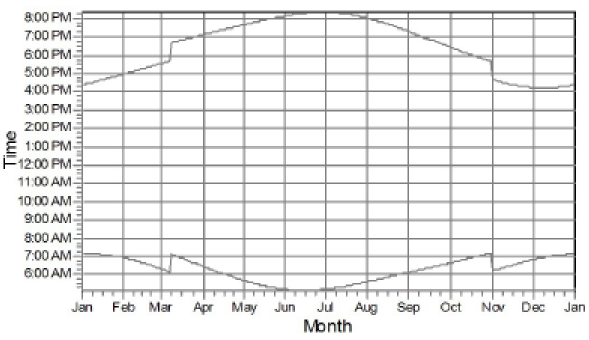
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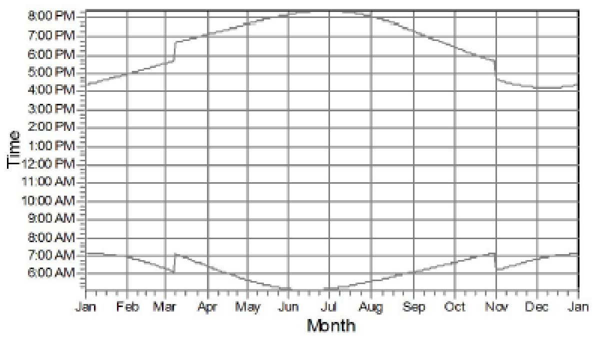
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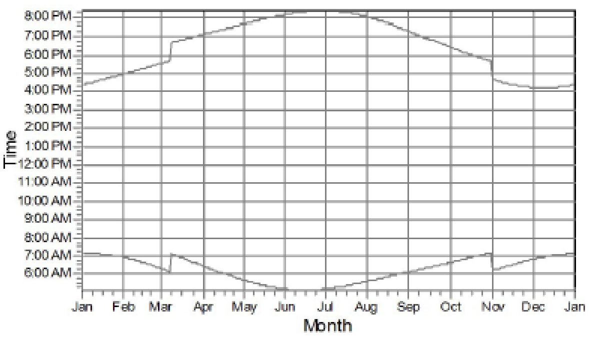
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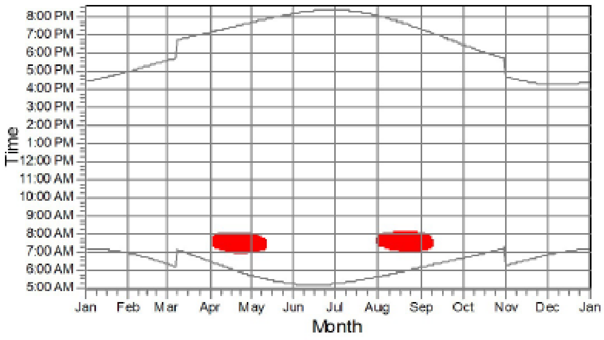
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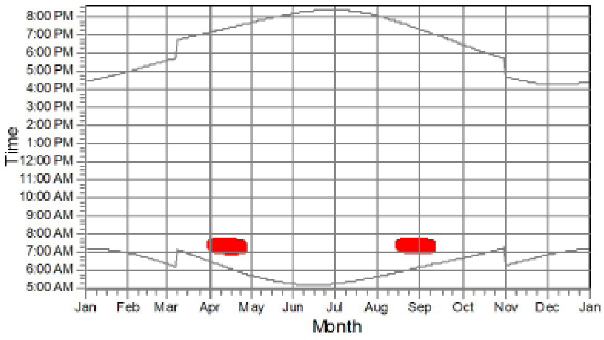
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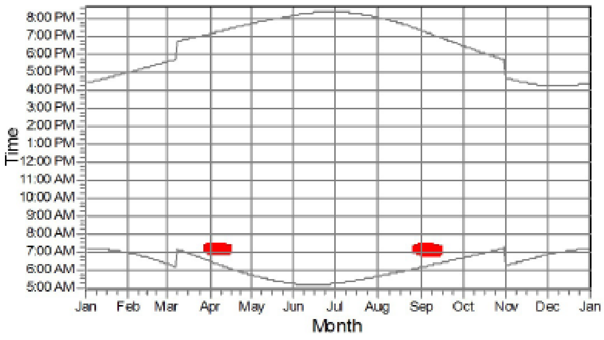
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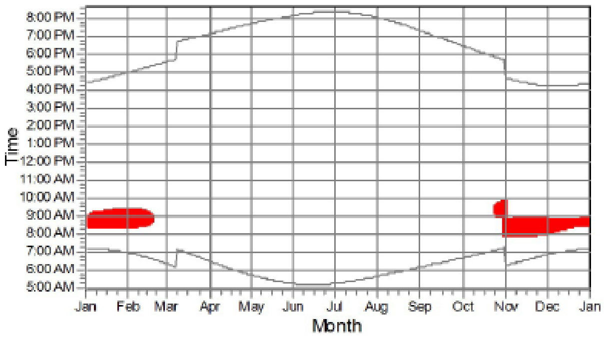
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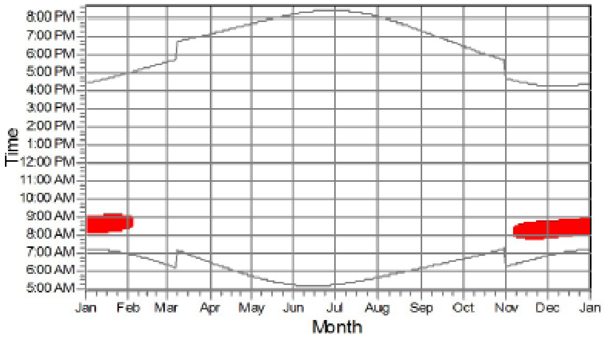
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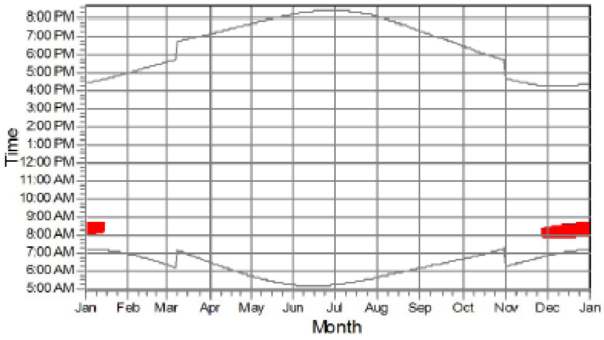
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