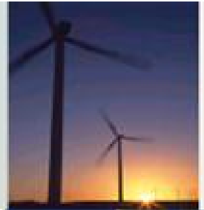
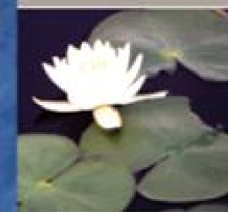


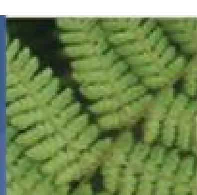


Wind Turbine Generator Feasibility Study

Prepared for:
Commonwealth Wind Incentive Program
Community Scale
Massachusetts Clean Energy Center
55 Summer Street, 9th Floor
Boston, MA 02110

Submitted by:
Town of Swampscott
22 Monument Street
Swampscott, MA 0197

In Partnership with:
Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, MA 01915



June 1, 2011

MERIDIAN ASSOCIATES

Table of Contents

Appendix

List of Abbreviations

ACEC	Area of Critical Environmental Concern
AGL	Above Grade Level
ASTM	American Society for Testing and Materials
AWEA	American Wind Energy Association
CEC	Massachusetts Clean Energy Center
CMR	Code of Massachusetts Regulations
dB	Decibels
DEP	Massachusetts Department of Environmental Protection
DES	New Hampshire Department of Environmental Services
FERC	Federal Energy Regulatory Commission
Ft	Feet
GIS	Geographical Information Systems
GWh	Giga Watt Hours
km	Kilometers
kV	Kilovolts
kVA	Kilovolts Amperes
kW	Kilowatts
kWh	Kilowatt Hours
m	Meters
MassCEC	Massachusetts Clean Energy Center
MEPA	Massachusetts Environmental Policy Act
MHC	Massachusetts Historical Commission
MHD	Massachusetts Highway Department
mph	Miles per Hour
m/s	Meters per Second
MTC	Massachusetts Technology Collaborative
MW	Megawatt
NHESP	Natural Heritage and Endangered Species Program
PPA	Power Purchase Agreement
RPS	Renewable Portfolio Standards
rpm	Revolutions per Minute
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Volt
WECs	Wind Energy Conversion System
WTG	Wind Turbine Generator

1. EXECUTIVE SUMMARY AND RECOMMENDATIONS

a. Executive Summary

The location of the proposed wind turbine generator is sited in the south western portion of the Town of Swampscott, Essex County, Massachusetts. Swampscott is a 3.6 square-mile seaside community to approximately 14,600 residents and located just 15 miles northeast of Boston. This property, which occupies 14.8 acres of town owned land, is located off Forest Street on a town acquired easement (Park and Recreation Easement) of approximately 10.1 acres which sits adjacent to the Swampscott Middle School.

The turbine is to be situated behind the School and its accompanying open athletic fields. Properties immediately surrounding the site consist of the Tedesco Country Club, which occupies 144 acres, to the north, east and west. Residential Neighborhoods inhabit the land to the south. Site elevations range between 17m and 28m (56ft.–92ft.).

In an effort to offset electric power costs and to reduce greenhouse emissions, the Town of Swampscott is considering the construction of a Wind Turbine Generator. The site has sufficient wind to be considered a financially feasible on-site wind generation project. This finding is based upon the modeled wind analysis in the Commonwealth of Massachusetts from the Massachusetts Geographical Information System (MassGIS) website and maps developed by AWS Truewind Solutions under directives from the Massachusetts Technology Collaborative and both onsite wind data collected from a SODAR unit and purchased Virtual Met Mast Data.

After a full acoustic analysis, including ambient sound measurements It was determined that the Massachusetts Department of Environmental Protection (DEP) noise guideline of 10 dB(A) increases in noise levels will not be exceeded by the wind turbine operation for the EWT 900 kW and Unison 750 kW turbines. Exceedance may occur for the 1.5 MW and 600 kW turbines.

In addition, Federal Aviation Administration (FAA) turbine height restrictions have been evaluated, as well as siting and environmental constraints.

Pro-Forma Economic Analysis

The economic analysis for the installation of each a 600 kW, 750 kW, 900 kW and 1.5 MW wind turbine at the site as Identified above was based on a set of reasonable assumptions for numerous vital economic factors. Employing the maximum Massachusetts Clean Energy Center (MCEC) Commonwealth Wind Incentive Program funding, simple financing, and an annual inflation of electricity rate equal to 2.5% the economic return for this project is as follows:

Multiple financial scenarios have been considered for the proposed project. These scenarios evaluated each of the four size turbines under financed, non-financed and PPA conditions with and without maximum contributions from MassCEC for turbine erection. The best financial scenario for a municipally owned and operated wind turbine that conforms to applicable environmental and regulatory guidelines is for the EWT 900 kW turbine at a 75 m hub height at the Swampscott Middle School. This scenario yields a positive return at (16) sixteen years and a net present value at year twenty (20) equal to approximately $905,604 under financed conditions with maximum contribution from MassCEC.

P50 Cost Analysis for Wind Turbine Generators installed at the Town of Swampscott Middle School @ P50 Exceedance under Financed Conditions

	Elecon 600 kW		Unison 750 kW		EWT 900 kW		GE 1.5MW	
	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding
Hub Height (m)	60	60	60	60	75	75	80	80
Total Installed Cost ($)	2,200,000	2,200,000	2,800,000	2,800,000	3,00,000	3,000,000	4,200,000	4,200,000
Annual Energy Output at P50 (kWh)	1,100,912	1,100,912	1,317,973	1,317,973	1,747,888	1,747,888	3,770,887	3,770,887
Electricity Cost ($/kWh)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Electricity Inflation Rate (%)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Bond Interest Rate (%)	5	5	5	5	5	5	5	5
Loan Term (yrs.)	20	20	20	20	20	20	20	20
REC Revenue ($/kWh)	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
MassCEC Funding ($)	0	320,500	0	339,855	0	355,677	0	400,000
Positive Return (yrs.)	20	18	21	19	18	16	13	12
NPV at year 20 ($)	-141,509	471,556	-321,157	328,931	225,251	905,604	2,560,099	3,325,235

P90 Cost Analysis for Wind Turbine Generators installed at the Town of Swampscott Middle School at a P90 Exceedance under Financed Conditions

	Elecon T600		Unison 750 kW		EWT 900 kW		GE 1.5sle	
	without MassCEC Funding	with MassCEC Funding	with MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding
Hub Height (m)	60	60	60	60	75	75	80	80
Total Installed Cost ($)	2,200,000	2,200,000	2,800,000	2,800,000	3,00,000	3,000,000	4,200,000	4,200,000
Annual Energy Output at P90 (kWh)	901,449	901,449	1,075,497	1,075,497	1,442,394	1,442,394	3,092,499	3,092,499
Electricity Cost ($/kWh)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Electricity Inflation Rate (%)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Bond Interest Rate (%)	5	5	5	5	5	5	5	5
Loan Term (yrs.)	20	20	20	20	20	20	20	20
REC Revenue ($/kWh)	0.035	0.035	0.030	0.030	0.030	0.030	0.035	0.035
MassCEC Funding ($)	0	320,500	0	339,855	0	355,677	0	400,000
Positive Return (yrs.)	24	21	25	23	21	19	15	14
NPV at year 20 ($)	-479,724	133,341	-732,307	-82,219	-292,754	387,600	1,409,805	2,174,941

b. Recommendations:

- Based on the wind resources, economic analyses and environmental considerations, the proposed wind turbine generator should be a 900 kW rated power turbine, as manufactured by EWT with a tower height of 75m, and rotor diameter of54m.

- Preferably, the wind turbine generator should be located at the highest elevation on the site property which meets all applicable setbacks and pertinent rules and regulations. Per topographic maps from the Massachusetts Geographic System (MassGIS) this location is at an elevation of 26m (85 ft).

- Locate Wind Turbine Generator at least 415 feet from existing property line to meet Town of Swampscott Zoning Code setbacks requirements.

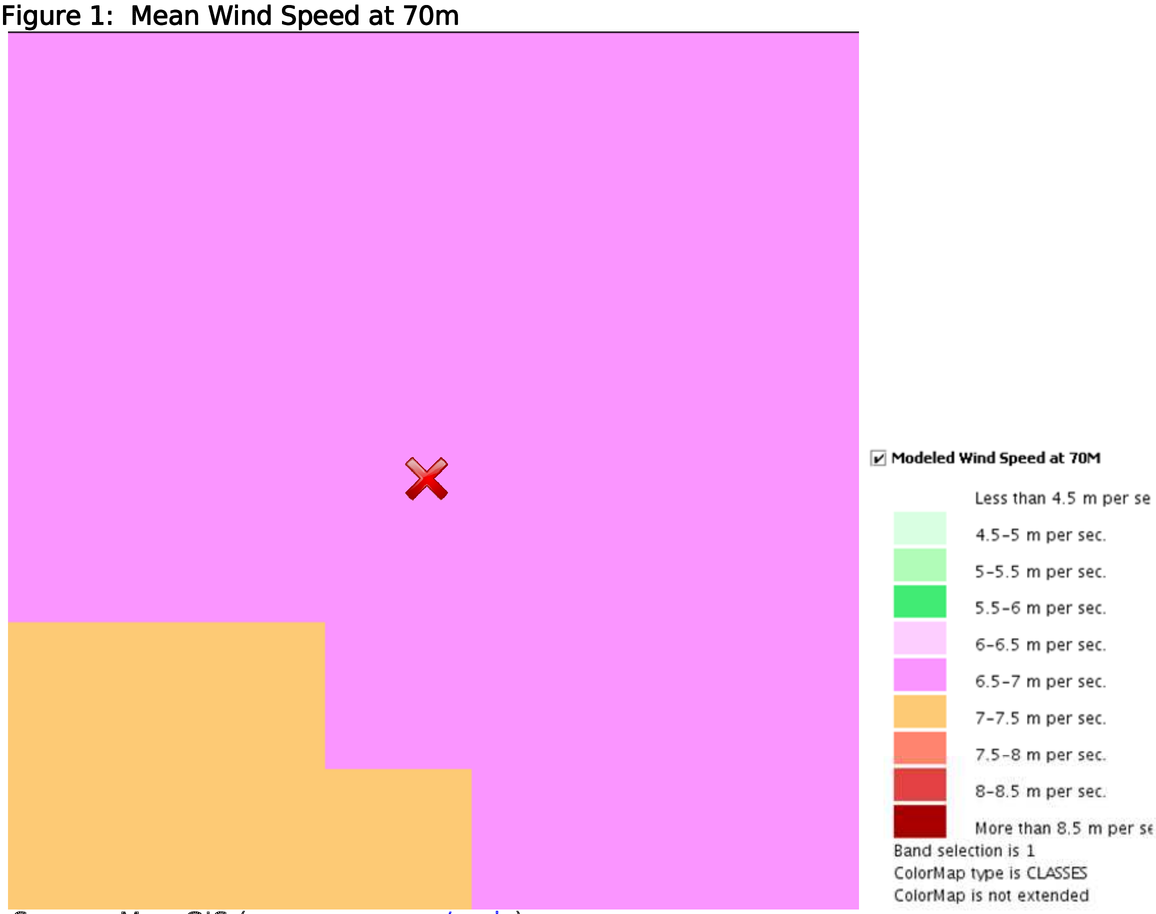
2. WIND RESOURCE EVALUATION

a. Wind Resource Evaluation

The wind speed and turbulence was studied at the proposed site in order to provide the most accurate value of energy production possible. Recognizing the true wind power at The Town of Swampscott Middle School allows for a more precise estimate of project feasibility and profitable returns for the proposed wind power project.

Massachusetts Geographic Information Systems (MassGIS) produced an estimated average annual wind speed at Swampscott Middle School at 6.25 m/s at a height of 50m and 6.75 m/s at a height of 70m. Figure 1 displays the mean wind speed at these specified heights. Wind Speeds at the proposed site range between 6.5 – 7.0 m/s (14.5 and 15.7 mph) at 70 meter height per MassGIS Wind Resources Map, which falls within the Massachusetts Clean Energy Center (MassCEC) Commonwealth Wind Initiative recommended minimum wind speed. These wind speeds are as stated from MassGIS and have not been have not been adjusted for ground cover.

Figure 1: Mean Wind Speed at 70m

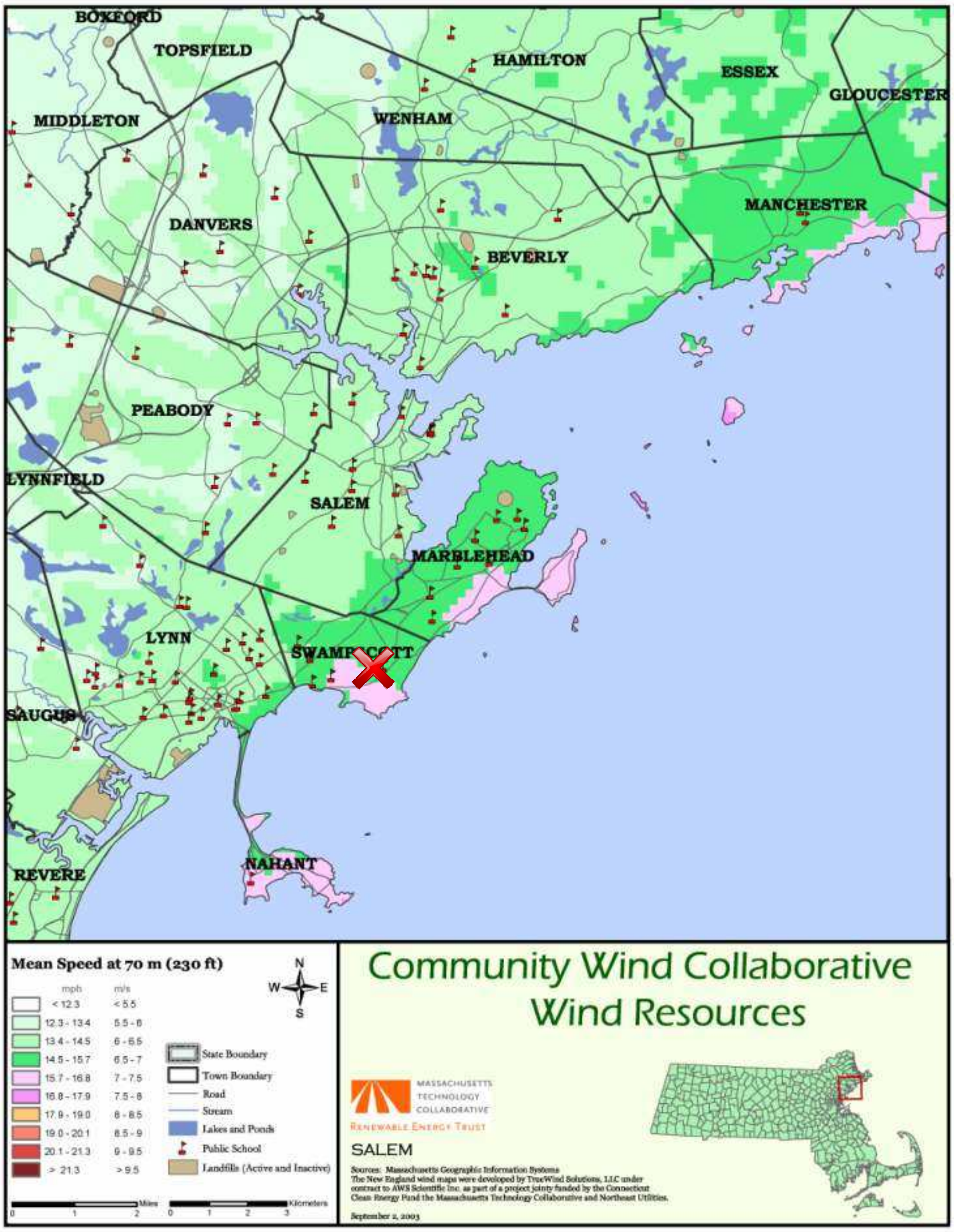


Source: MassGIS (www.mass.gov/mgis)

 Location of proposed Wind Turbine Generator

MassCEC provides Wind Resource Maps, Figure 2, for each Town/City in the Commonwealth. Analysis of this map reveals that at 70m the mean wind speed is approximately 6.0 to 6.5 m/s. MassCEC also provides a Commonwealth Wind Evaluation Siting Tool which adjusts for local tree cover and obstacles. This resource reported that wind speeds corrected for site factors at the Middle School are approximately 6.9 m/s at 70m.

Figure 2: Community Wind Collaborative Wind Resources Map



Location of proposed Wind Turbine Generator

i. Site Wind Resource Profile

The site location of the proposed wind turbine is off of Forest Street at the Swampscott Middle School, in the Town of Swampscott, Massachusetts. The location is adjacent to the Middle School's open athletic fields, on an easement held by the Town from the privately owned Tedesco Country Club property. Unless a portion of the Tedesco Golf Course was cleared and utilized for the installation of one or more anchors, there was inadequate space at this site for the erection of a MET tower. The possibility of erecting a MET tower at a remote location for wind monitoring was explored but ruled out.

As a result, the wind resource data collection method chosen was to acquire one year's worth of Virtual Met Mast data and to collect two (2) months of site data using Sonic Detection and Ranging (SODAR) equipment.

SODAR Data Collection

SODAR wind data collection apparatus was installed on October 28, 2010 by Second Wind Inc. and immediately began collecting wind measurement data. Data was collected through January 11, 2011, a time period greater than two (2) months. The Triton SODAR unit was positioned at an elevation approximately 25m (82') above sea level (ASL) at a location of 42° 28' 35"N 70° 54' 07"W. This position is situated in the north central portion of the Middle School site property amidst a one of the ball fields as shown below in Figure 3.

Figure 3: SODAR Unit Location

Second Wind's Triton Sonic Wind Profiler provides accurate wind speed measurements by computing the scattering of sounds waves by atmospheric turbulence at 20m vertical intervals from 40m to 200m. This data is collected every 10 minutes using SkyServe®, a data access and monitoring secure web server.

The wind monitoring system rests directly on the ground and no foundation is necessary. The apparatus installed consists of the following items; Triton base unit with footprint of 2m x 3m, two (2) batteries, two (2) solar panels, Globalstar modem and antenna, and four (4) screw-in-ground anchors. A visual representation of the SODAR unit at Swampscott Middle School is proved as Figure 4.

Key Benefits of the Triton Wind Profiler are as follows:

- Ultra-low, 7 Watt power consumption enables continuous, unattended operation.
- Collection height data to 200m
- Data access and monitoring via SkyServe® Satellite Wind Data Service
- No permitting required
- Easy to deploy — can be installed and collecting data within 2 hours

Complete Triton Sonic Wind Profiler Specifications are attached as Appendix A.

Figure 4: SODAR Unit

SODAR Performance Study

On November 4, 2010 Second Wind Inc. conducted a Performance Study to evaluate the quality of the Triton data at the newly commissioned collection site. After reviewing the gross data recovery, percent of valid data vs. height, average signal-to-noise ratio, signal and noise vs. height, wind speed correlation scatterplots, and wind speed distribution , direction, and profile it was determined the Triton unit installed at Swampscott Middle School was operating correctly, as each test results fell within the predetermined acceptable range. The complete Triton Performance Study – Meridian Associates, dated November 4, 2010 is included as Appendix B.

Collected SODAR Data

Data collected from the SODAR unit was remotely updated to the secure web server SkyServe® Satellite Wind Data Service every 10 minutes via Globalstar Satellite. This remote communications system is always accessible and allows for raw 10 minute average data to be downloaded in comma-separate-value (CSV) file format which can then be converted to excel format for further analysis.

SkyServe® provides graphical display tools that permit for immediate representation of operational and wind data for any specified time period and height during the collection period. The figures below, Figure 5 through Figure 9, are the results as delivered by SkyServe for compilation of measured heights.

Figure 5: SODAR Operational Data

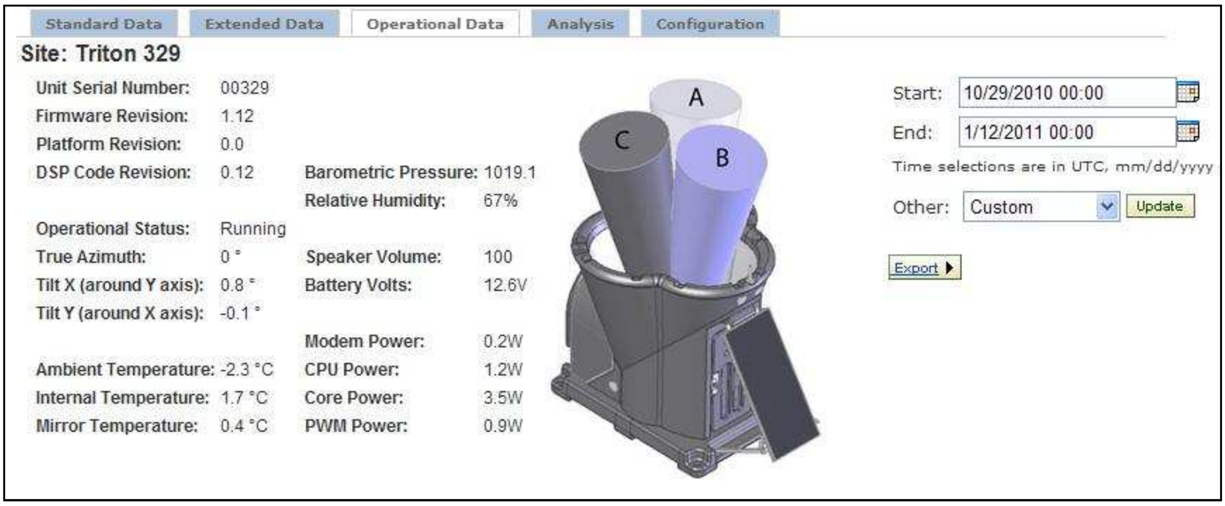


Figure 6: SODAR Summary of Averages

Averages over Selected Interval < Prev | Next >

Height (m)	Wind Speed (horiz) (m/s)	Wind Direction (°)	Wind Speed (vert) (m/s)	Quality (%)	Confid-ence (%) A	B	C	SNR (dB) A	B	C	Signal (dB) A	B	C	Number of Shots A	B	C	Valid Spectra A	B	C
200	8.2	207.5	-0.9	22	19.9	18.8	19.2	5	4.9	5	13.3	13.3	13.3	96.2	96.2	96.2	41.1	40.4	41.2
180	8.2	217.2	-0.7	33	28	26.2	26.6	5.7	5.5	5.6	13.4	13.4	13.4	96.2	96.2	96.2	48.6	47.3	48.1
160	8.3	224.8	-0.4	50	40.5	38	38.3	6.8	6.5	6.6	13.5	13.5	13.5	96.2	96.2	96.2	59.2	57.3	58.2
140	8.1	226.6	-0.2	70	56.5	55.1	54.8	8.4	8	8.1	13.8	13.8	13.8	96.2	96.2	96.2	71.2	70.2	70.7
120	7.7	228.7	-0.1	86	74.2	72.9	73.1	10.6	10.1	10.2	14.1	14.1	14.1	96.2	96.2	96.2	82	81.4	81.9
100	7.2	231.3	-0.1	93	86.7	85.7	86.1	13	12.5	12.6	14.6	14.6	14.6	96.2	96.2	96.2	87.9	87.3	87.5
80	6.7	233	-0.1	95	90.5	90.4	90.7	14.8	14.4	14.6	15.2	15.1	15.1	96.2	96.2	96.2	88.8	88.7	89
60	6	235.6	-0.2	95	90.8	89.9	89.9	15.6	15.2	15.1	15.8	15.8	15.8	96.2	96.2	96.2	88.5	87.7	87.8
50	5.6	240.4	-0.2	96	90.8	91.1	93.3	15.7	15.5	15.4	16.2	16.1	16.1	96.2	96.2	96.2	88.5	88.7	91
40	5	242.9	-0.2	85	89.9	91.8	71.3	15.3	15.4	11.5	16.6	16.5	16.9	96.2	96.2	96.2	87.6	89.4	69.4

Figure 7: SODAR Temperature and Voltage Readings

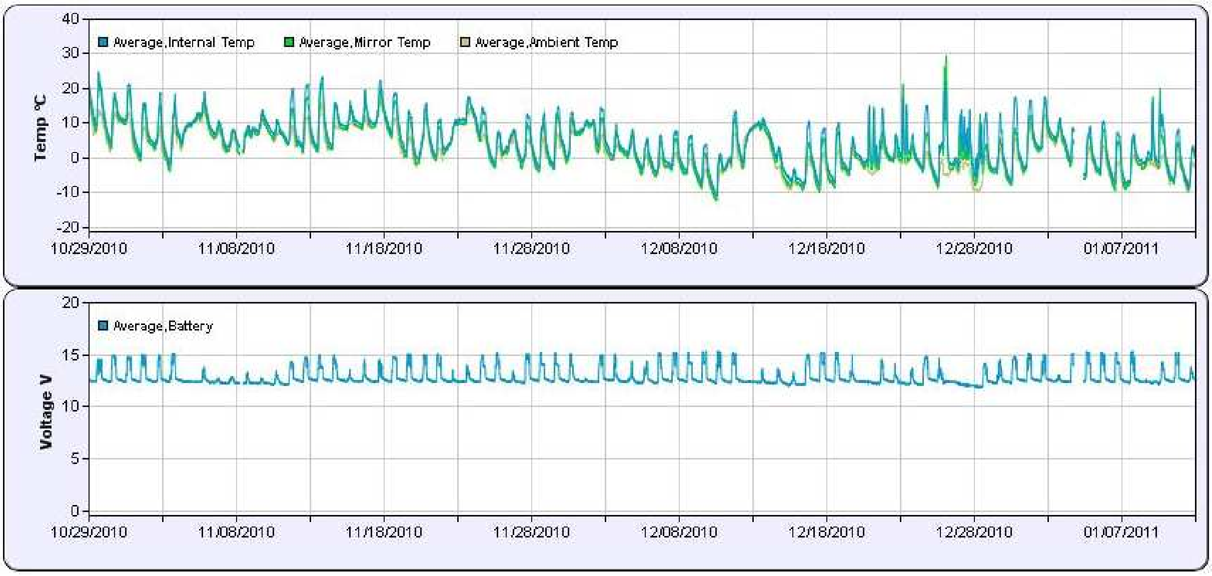


Figure 8: SODAR Wind Speed, Direction and Turbulence Results

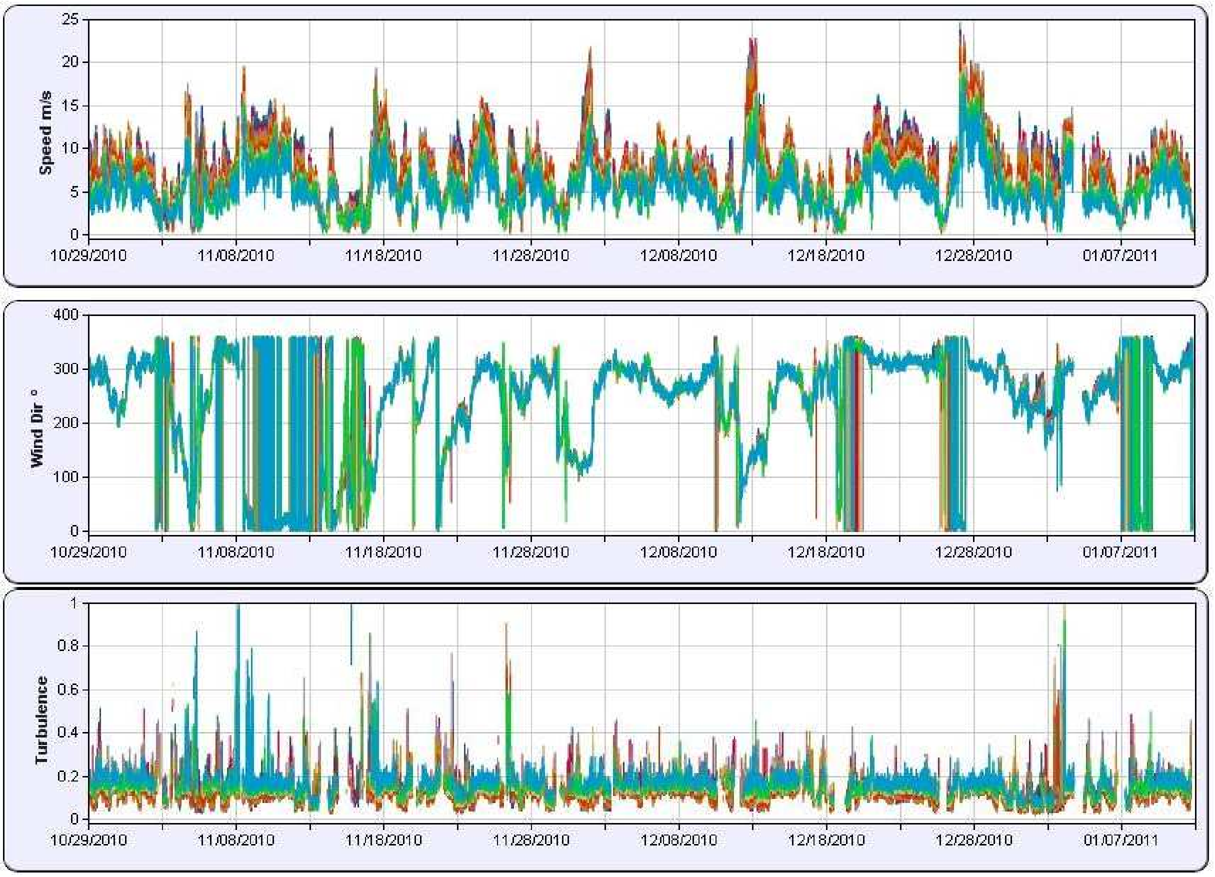
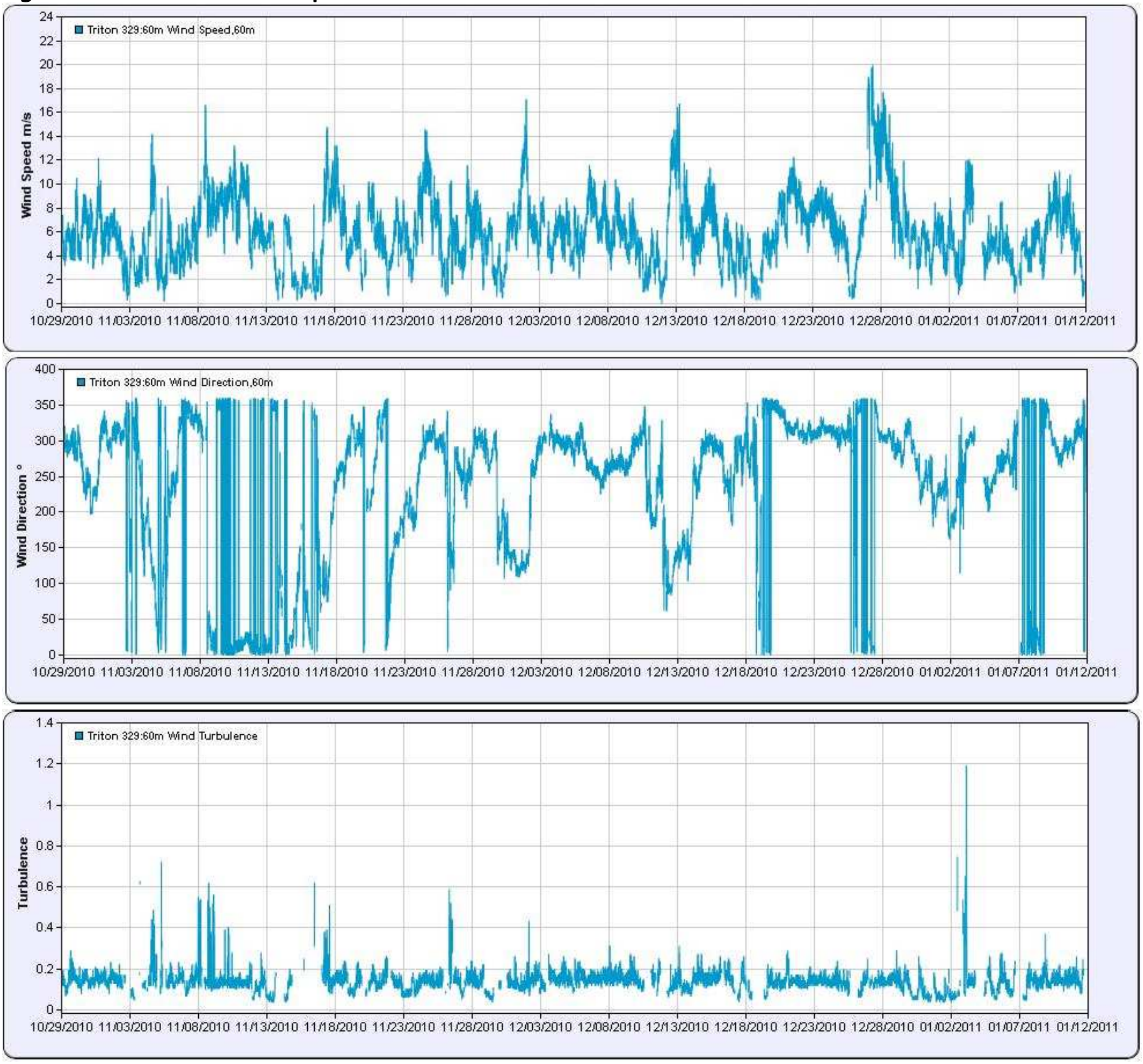


Figure 9: SODAR Wind Speed Averages by Height

Q > 85%			
Height	Wind Speed	Wind Direction	Avg. Wind Speed
200m	NA	NA	9.8 m/s
180m	NA	NA	9.4 m/s
160m	NA	NA	9 m/s
140m	NA	NA	8.4 m/s
120m	NA	NA	8 m/s
100m	NA	NA	7.4 m/s
80m	1.2 m/s	296° [WNW]	6.8 m/s
60m	1.7 m/s	263° [WSW]	6.1 m/s
50m	NA	NA	5.6 m/s
40m	NA	NA	5.3 m/s

SkyServe® also offers the opportunity to obtain similar graphical results for individually specified measurement heights as captured by the SODAR apparatus. Figure 10 is representative of the wind speed, wind direction and turbulence at a 60m height at Swampscott Middle School.

Figure 10: SODAR Wind Speed, Direction and Turbulence Results at 60m



Site Correlation

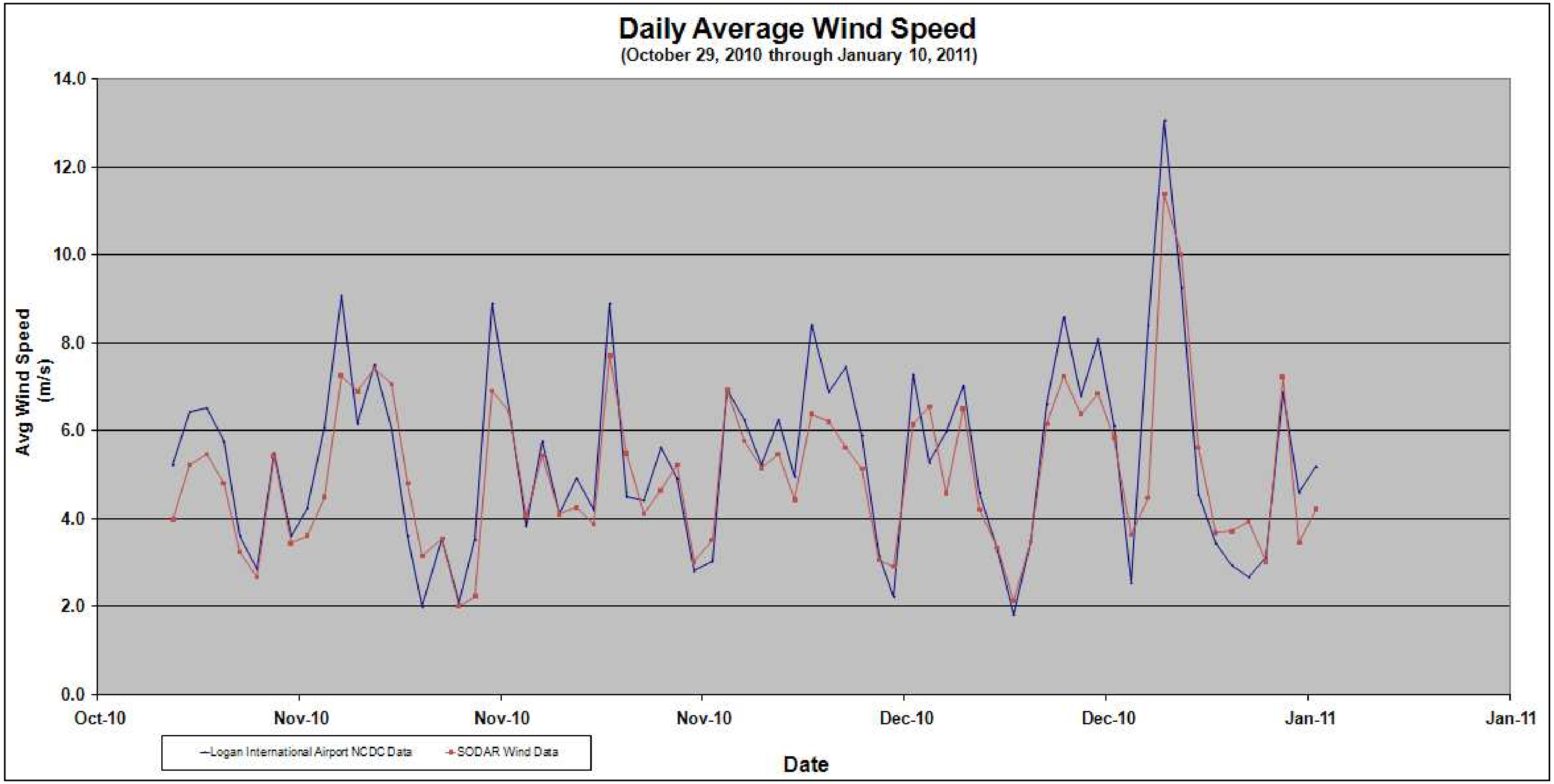
Daily wind speed and wind direction data was purchased from the National Climatic Data Center (NCDC) for the Logan International Airport (BOS) in Boston, Massachusetts to conduct a site correlation wind speed analysis. The Quality Controlled Local Climatological Data was ordered for the time period equivalent to that of on-site met tower data collection (October 29, 2010 – January 12 2011).

As depicted in Figure 11, BOS lies approximately 10 miles southwest of the Swampscott Middle School site with Boston Harbor and the Atlantic Ocean abutting the airport to the south and east. Densely developed urban areas surround the remainder of the site. The wind data collection apparatus sits at 42.361°N and 71.011°W at an elevation of 6m (19’). It is located approximately amidst Logan International Airport terminal runways in a very flat and wide open area. The Met Tower stands approximately 10m (26’) tall and makes hourly observations of wind speed and direction per NCDC.

Figure 11: SODAR Unit vs. NCDC Wind Data Collection Sites

Concurrent daily average wind speed data from October 29, 2011 through January 10, 2011 for the collected SODAR and the Logan International (BOS) NCDC wind data are plotted against the one another on the following page in Chart 1.

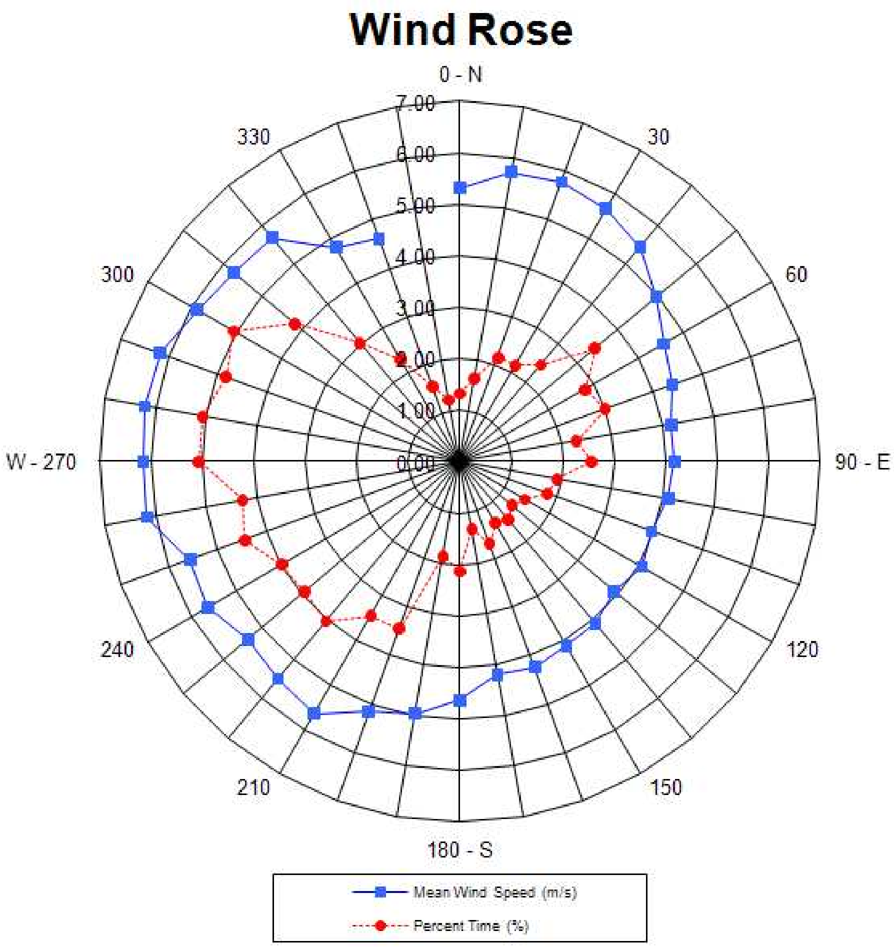
Chart 1: Daily Average Wind Speed



Wind Directional Data

In Figure 12, we provide a wind rose that contains the joint frequency distribution of site winds and the level of associated wind speeds at the met tower. The figure indicates that the predominant wind directions are fairly uniform – with the direction of west having the most energy-productive winds. However not a vast amount of wind-generated electricity is produced from the direct north or southeast directions.

Figure 12: Wind Rose

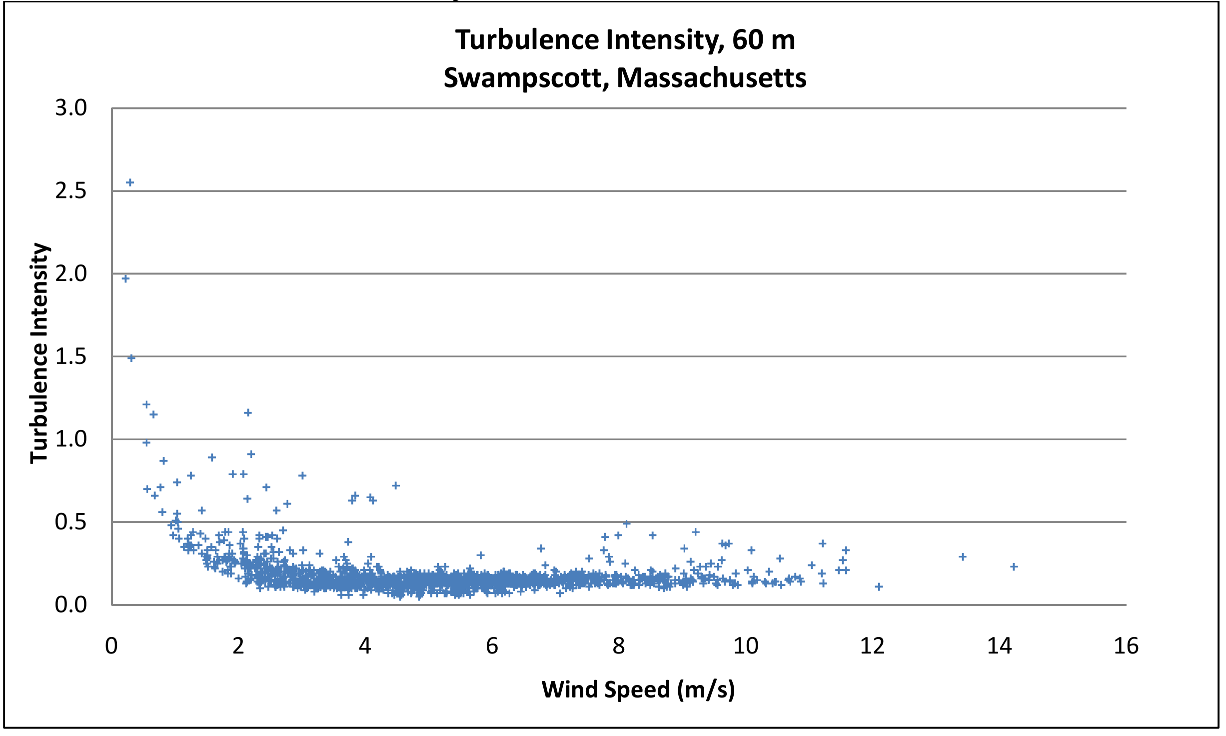


Turbulence Intensity

Turbine intensity is the measurement of the fluctuation of wind speed or gusts over the average wind speed over a measured period of time. Turbulence intensity is calculated as the standard deviation of the wind speed divided by the wind speed. Turbulence intensity decrease with height, therefore the actual T1 measured at 60m is plotted below in Chart 2.

The turbulence intensity average at @ 10 m/s for the 50m height is approximately 15%.

Chart 2: Turbulence Intensity



ii. Wind Resource at Hub Height

A Measure-Correlate-Predict (MCP) wind regression analysis was used to develop correlation factors between the collected MET tower data and the yearlong daily BOS data as obtained from NCDC. The MCP was use to estimate the long-term winds at the site for the most comparative anemometer level (40m SODAR data collection height) at which winds were measured. We arrived at the following results for the regression analysis and curve fits for the 40m level:

40m Level = 1.0931 x BOS Data - 0.0739, R = 0.9019

Chart 3 shows Met Tower data vs. Logan International Airport (BOS) NCDC Data with the linear regression fit:

Chart 3: Linear Regression

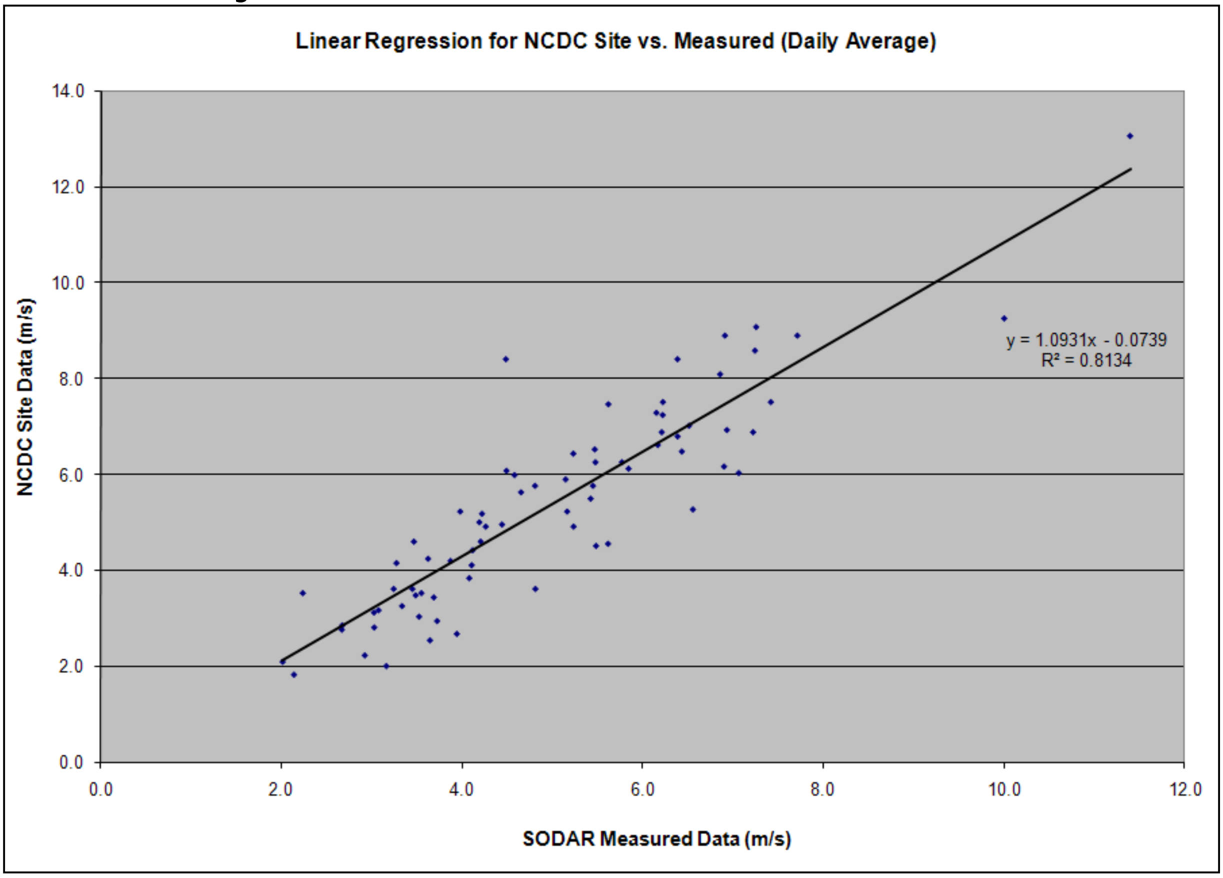


Table 1 provides a comparison of the average wind speed as measured on the site via the SODAR unit at a 40m height, the Logan International Airport (BOS) wind data as provided by NCDC (the “direct” wind data) and the “corrected” wind speed (calculated by the applying the linear regression to the direct NCDC wind data).

Table 1: Average Wind Speeds (m/s)

Month	Average Wind Speed (m/s) at 40m Height		
	SODAR	Direct NCDC	Corrected NCDC
November	4.70	4.92	5.31
December	5.45	5.90	6.37
Average	5.08	5.41	5.84

Wind Shear

Wind shear (i.e., variation in the horizontal component of wind speed as a function of height (agl)) was examine based on the two (2) months plus (October 29, 2010 to January 11, 2011) of data from the SODAR unit on site. The variation of the horizontal component of wind speed with height above the ground is described by the following equation:

$$V_2/V_1 = (H_2/H_1)^{\alpha} \qquad (1)$$

Where:

- V_2 and V_1 are the wind speeds at reference heights 2 and 1, respectively,
- H_2 and H_1 are the reference heights 2 and 1 in consistent units (i.e. meters or feet), and
- Alpha is the power-law wind shear coefficient.

Wind shear is a function of the frictional effects of the ground surface cover. The wind power law attempts to emulate this change in wind speed with height through use of the power law exponent, or alpha value. One of the major sources of error in wind project theoretical energy estimates is the extrapolation of wind speeds from the measurement level to the wind turbine hub height.

Wind speeds collected by the SODAR unit at the 60m and 80m heights were used in conjunction with the parameters set forth above to calculate the wind shear for the fall and winter season. The coefficients were calculated as stated on Table 2.

Table 2: Season Wind Shear Coefficient

Season	α Coefficient
Fall	0.394
Winter	0.445
Average	0.420

Wind shear values at Swampscott Middle School are relatively high for New England due to its topography and proximity to the Atlantic Ocean. Due to the high shear coefficient alpha, as hub height increases wind speed will gradually increase. Various manufacturers have different requirements for shear and turbulence intensity. Prior to selecting a turbine these parameters will have to be evaluated by the manufacturer.

iii. Long Term Wind Correlation

Year Long Virtual Met Mast Data (YL VMM) data was purchased from AWS Truewind for the Swampscott Middle as the long term wind correlation data set. This VMM data is generated by making multiple modifications to a random 8760-hour sample of meso-scale and micro-scale data from the Wind Trends database over a thirteen (13) year period. An estimated wind profile for the chosen site is then used to scale this data to a particular hub height. This set provides statistically representative time series of hourly data which accounts for diurnal and seasonal patterns, along with extreme wind events and other influential environmental variables at a point location. The YL VMM serves as an estimate of the typical annual energy output at a specified hub height for the proposed site and provides the following essential data:

- Annual and monthly mean wind speed distribution
- Date and time
- Temperature and pressure
- Direction
- Hub Height Speed
- Air Density

The accuracy of AWS Truewind's Virtual Met Mast is within 5-7% in complex (mountainous) terrain and less than 5% in simpler topography.

The VMM data that was purchased was acquired at a 60m hub height. An average of the calculated seasonal wind shear coefficients was applied to the thirteen (13) years of VMM daily wind speed data, as provided AWS Truewind, to determine the average wind speeds at 50m, 70m, and 80m and hub heights. A summary by month of these calculated values are below in Table 3.

Table 3: Long Term Corrected Wind Speeds

Year	VMM Long Term	Hub Height (m)			
		50	60	70	80
January	6.99	6.48	6.99	7.46	7.89
February	6.41	5.94	6.41	6.84	7.23
March	6.88	6.37	6.88	7.34	7.76
April	5.84	5.41	5.84	6.23	6.59
May	5.25	4.87	5.25	5.61	5.93
June	5.28	4.89	5.28	5.63	5.95
July	5.02	4.65	5.02	5.35	5.66
August	5.07	4.70	5.07	5.41	5.72
September	5.17	4.79	5.17	5.51	5.83
October	5.60	5.19	5.60	5.98	6.32
November	5.87	5.44	5.87	6.26	6.62
December	6.60	6.11	6.60	7.04	7.44
Average	5.83	5.40	5.83	6.22	6.58

Long Term Frequency Distribution

The frequency distribution for the long term wind correlation, calculated as described in Section 2.a.iii, is given for each of the analyzed hub heights. The long term frequency distributions are shown as Chart 4, 5, 6, and 7 for corresponding hub heights at 30m, 60m, 70m, and 80m.

Chart 4: Long Term Frequency @ 50m

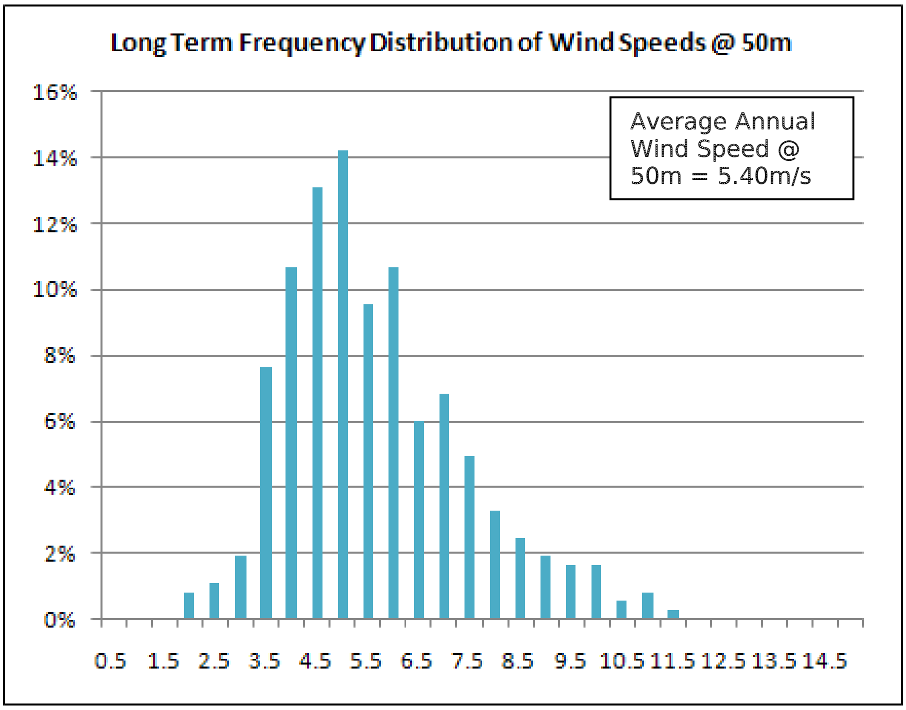


Chart 5: Frequency Distribution for 60m

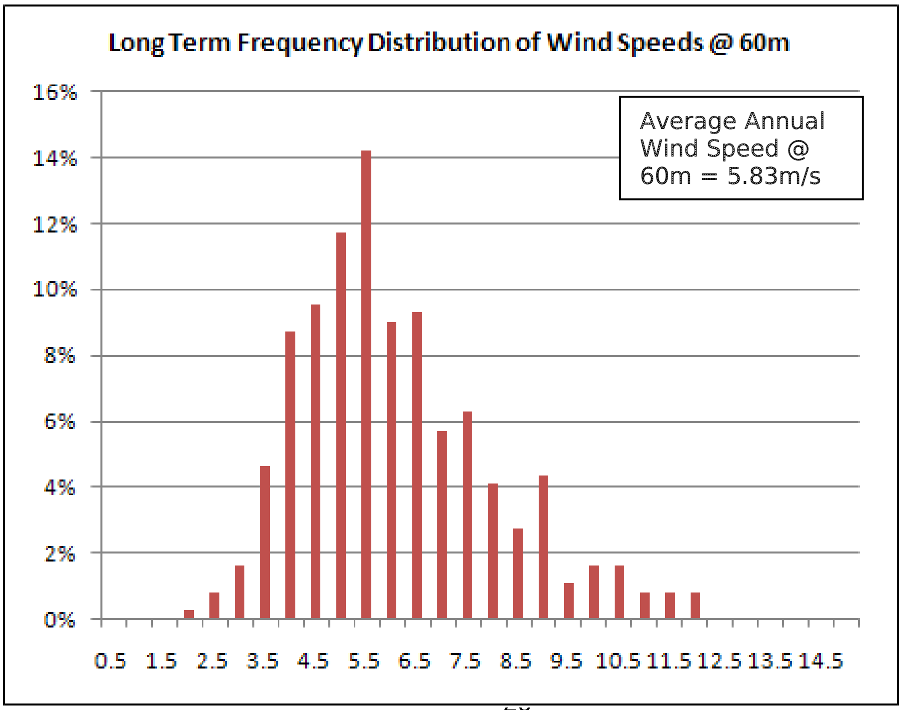


Chart 6: Frequency Distribution for 70m

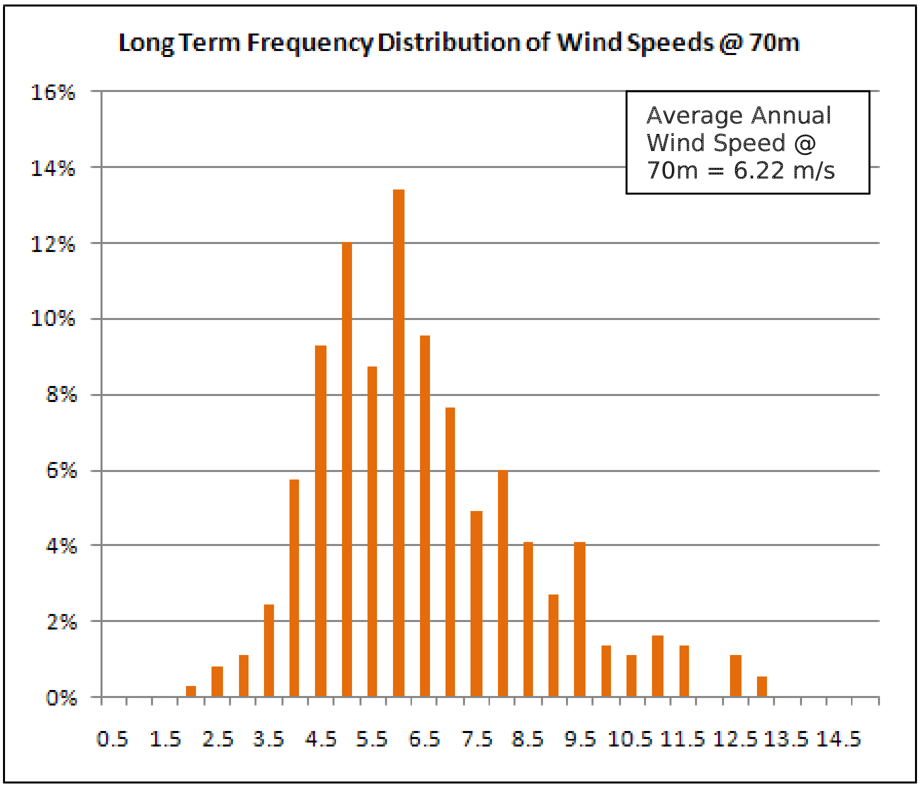
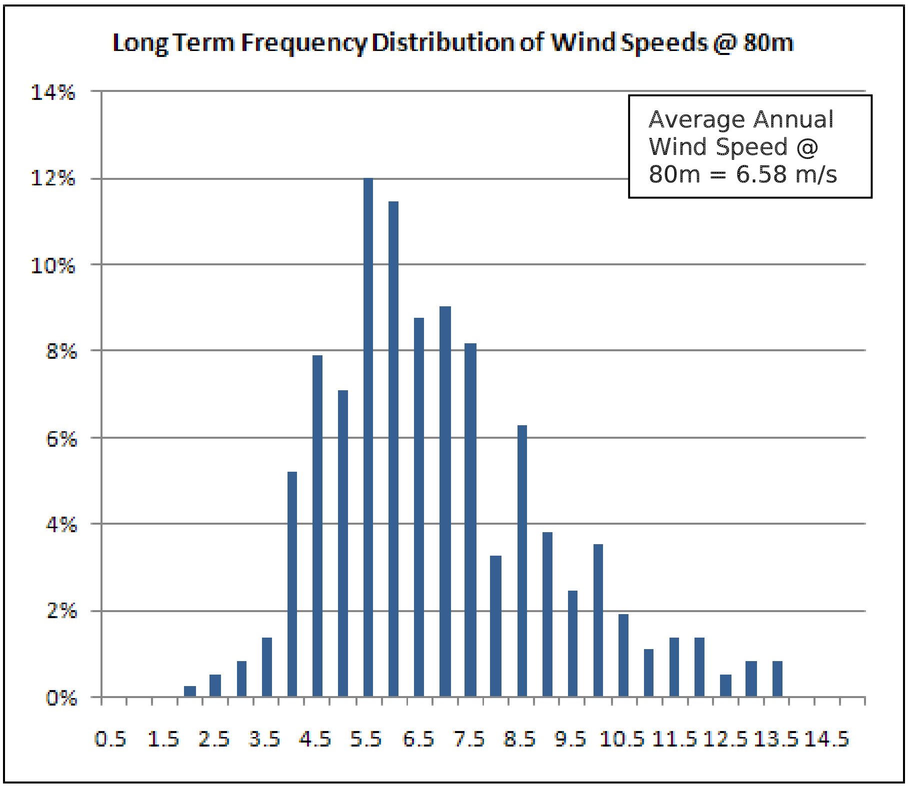


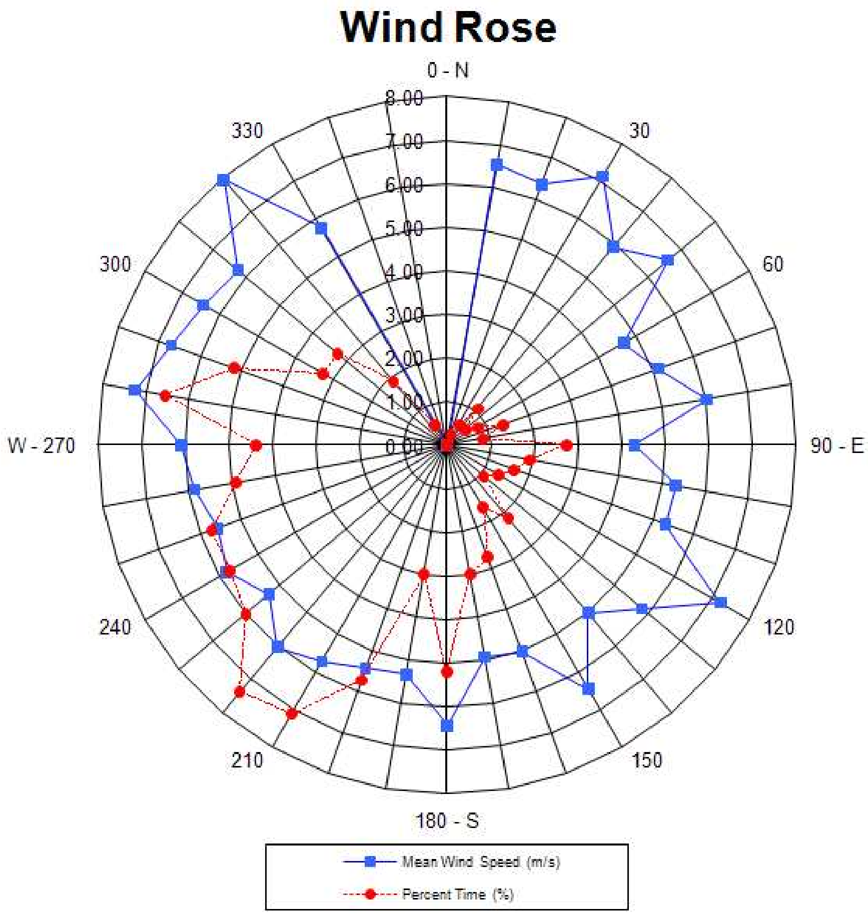
Chart 7: Frequency Distribution for 80m



Long Term Wind Directional Data

In Figure 13, we provide a wind rose that contains the joint frequency distribution of long term site winds and the level of associated wind speeds as provided by AWS Truewind Virtual Met Mast Data. The figure indicates that the predominant wind directions are fairly uniform – with the direction of south west having the most energy-productive winds. However not a vast amount of wind-generated electricity is produced from the direct north or east directions.

Figure 13: Long Term Wind Rose



iv. P50 and P90 Exceedance Levels

The average annual wind speed (Table 4) is derived from wind speed data collection and applied test and filters. To account for uncertainties due to inter-annual variability of wind speeds, cup anemometer, wind shear calculation, and MCP algorithm calculation that might impact the wind turbines performance the P50 and P90 Exceedance levels are calculated. The average annual wind speed values correspond to the P50 confidence value estimate, meaning that there is a 50 percent chance that the true long-term average wind speed is higher, and a 50 percent chance it is lower. The P90 level is the estimate of average annual wind speed that will be exceeded with a 90% probability.

Table 4: Average Annual Wind Speed at P50 and P90

Hub Height (m)	Average Annual Wind Speed (m/s)	
	at P50	at P90
50	5.40	5.13
60	5.83	5.53
70	6.22	5.90
80	6.58	6.25

Uncertainty Analysis

Uncertainty Analysis

To determine the sensitivity of the production to variations in wind speed and to estimate the magnitude of variations possible, an analysis combining the following uncertainty and production loss factors (Table 5 and Table 6) was performed.

Table 5: Uncertainty Factors

Uncertainty Parameter	Standard Deviation in Wind Speed (%)
Inter-Annual Variability of Wind Speed	1.66
Wind Shear Calculation	2.30

- **Inter- Annual Variability:** this is a measure of how well understood the long-term wind resource is, and is determined by the length of the long-term data set analyzed.

- **Wind Shear Calculation:** this value is a measure of how well the onsite data correlated to the long-term data source.

Table 6: Production Losses

Production Losses	Loss (%)
Topographic Effects	0.5
Site Obstructions/Waking	0.0
Estimated additional losses	
WTGs Availability	2.0
Utility Grid Availability	0.25
Electrical Losses	2.5
Cold Temperature Shutdown	0.5
High-Wind Hysteresis	0.0
Blade Contamination	0.5
Wind Farm Waking Effects	0.0
Square Root Sum of Losses	2.15

- **Topographic Effect:** This is the loss (or gain) due to wind speed reductions (or increases) between the net tower and turbine caused by the site's topography. This value varies somewhat by turbine height and rotor diameter.

- **Site Obstruction/Waking:** This is the energy loss due to the effect one turbine will have on another, or the wake caused by any structure on the wind turbines. This effect varies by rotor diameter and speed.

- **Turbine Availability:** Wind turbine manufacturers will specify an availability level to be covered in a warranty. This value assumes the turbine's availability is only at the warranted value.

- **Grid Availability:** An estimate is made as to the amount of time that the utility will be available to receive power from the project. All grid systems are offline periodically for maintenance, and projects in more remote locations are generally connected to weaker grid systems that are more prone to failure. Losses for grid availability vary between 0.1 percent for very strong grid systems to as high as 5 percent for weak systems.

- **Electrical Losses:** Losses in the lines and electrical equipment prior to the plant's revenue meters are covered by this factor. Points of significant electrical losses in a wind energy project usually include the underground and overhead distribution lines connecting the turbines to a substation, and the substation's primary transformer. Typical electrical loss values range from as low as 1 percent up to 10 percent or more, depending on the project layout and equipment used.

- **Cold Temperature Shut Down:** During winter storms, snow and ice will build on the wind turbine blades causing the same degradation as caused by dust and insects. While this contamination will build much faster than summer contamination, it is often cleared after a few hours of direct sunlight (even at continued subzero temperatures). Based on the climate in the project area, a loss of 0.5 percent was assumed for the lost energy due to icing.

- **High Wind Hysteresis:** When wind speeds exceed the operational range of a wind turbine, the turbine shuts down to protect itself. Such shutdowns normally require the turbine to remain offline for several minutes, even if the wind speed returns to the operational range in a shorter time. Sites with a significant number of these high wind events suffer lost energy due to this hysteresis effect, which is in addition to the amount of time the average wind speed remains above the cut-out wind speed. Because the project site does not have a significant number of high wind events on record, no losses due to hysteresis were applied.

- **Blade Contamination:** Wind turbine performance is sensitive to the cleanliness of the turbine's blades. In areas of high dust or insects, contamination can build up on the turbine blades that will limit the turbine's performance (causing losses of up to 5 percent or more). Often the blades are cleaned by occasional rainfall, but in some areas periodic blade washing is required. An annual loss of 0.5 percent was assumed for blade contamination.

v. Wind Turbine Output Potential

In addition to our more conservative wind speed estimate which is based on MCP wind data Wind Pro Software was used to determine the wind turbine output potential for the three turbines evaluated by entering the collected SODAR wind data. The calculation was based on the inserted data, calculated on site shear wind gradient exponent and the selected power curve. The METEO Module calculated that the mean wind speed for the Elecon T600 and GE 1.5sle Wind Turbines at 60m and 80m hub heights is as follows:

- Elecon T600 at 60m – 5.85 m/s
- GE 1.5sle at 80m – 6.61m/s

(1) Site Obstructions

The site location of the proposed wind turbine at the Swampscott Middle School, being situated adjacent to the Middle School's open athletic field and being surrounded by wooded terrain that makes up the topography of Tedesco Country Club's golf course, made it a good candidate for wind data collection by means of Sonic Detection and Ranging (SODAR) equipment. Unless a portion of the golf course was cleared and utilized for the installation of one or more anchors, there was inadequate space at this site for the erection of a MET tower.

The SODAR unit was situated centrally in the northern most ball field in the northwest corner of the site. Areas to the immediate south and southeast are additional open baseball fields. Surrounding the fields are wooded/vegetated areas with the Tedesco Country club's golf course cutting through the land to the north and west. Land beyond is urbanized with residential developments and commercial buildings. The closest residential structure is over 700 feet to the southeast off of Nason Road and the closest structure is just over 400 feet directly south amidst the fields.

(2) Wind Resource Profile

Appendix C contains the full wind resource profile for the Elecon T600 at a 60m hub height and for the GE 1.5sle at an 80m hub height as produced by WindPRO.

vi. Site Viability

The Swampscott Middle School Site has sufficient wind for overall viability of this project at Site 1 for the erection of either a 600 kW, 750 kW, 900 kW or 1.5 MW Wind Turbine.

vii. Wind Resource Recommendations

Various manufacturers have different requirements for shear and turbulence intensity. Prior to selecting a turbine, these parameters will be to be evaluated by the manufacturer, however no additional wind resource monitoring or validation is recommended.

3. CHARACTERISTICS OF SITE VICINITY

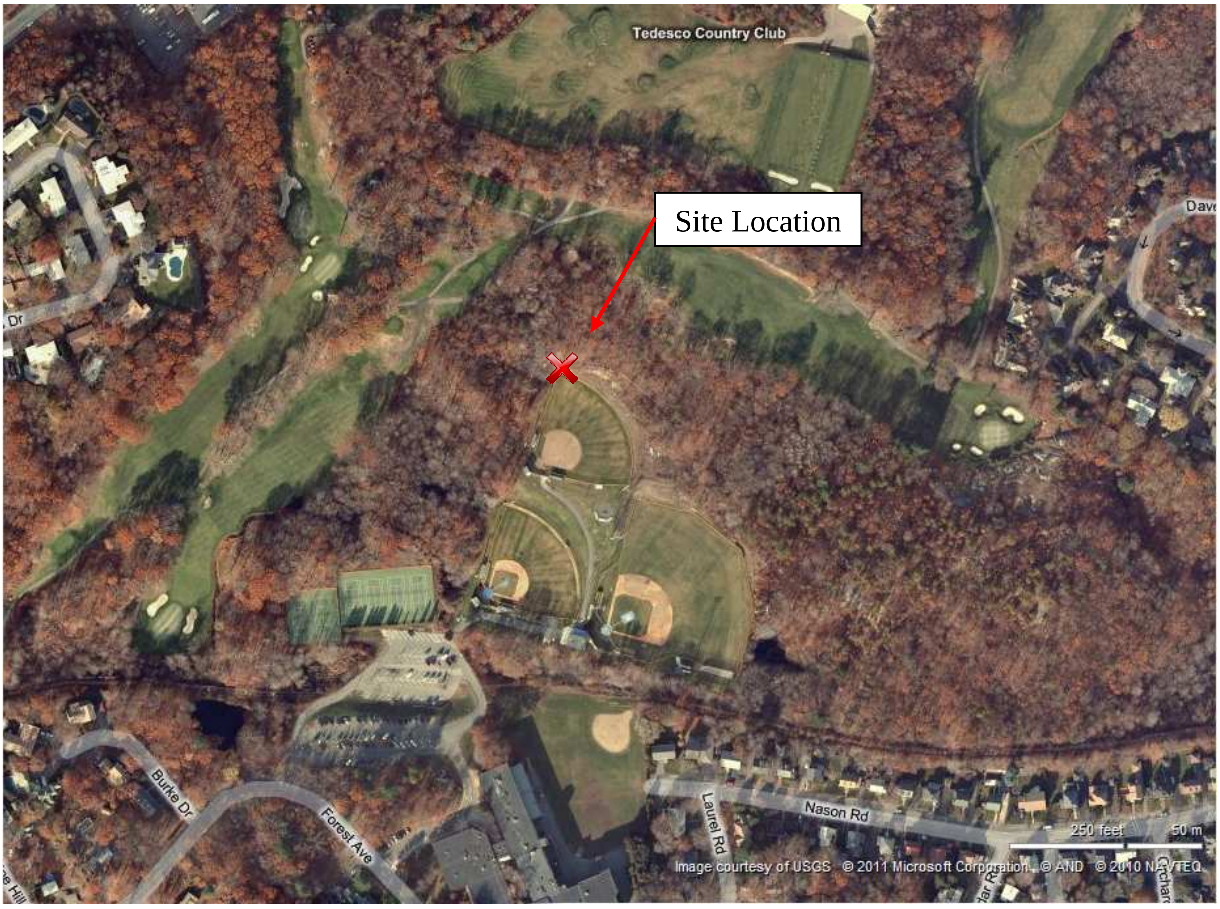
a. General Description

The proposed site is located at the Swampscott Middle School, which is located off of Forest Street in the southwestern portion of the Town of Swampscott, Essex County, Massachusetts The Town of Swampscott is bordered by the Atlantic Ocean to the east, on the south by the City of Lynn and on the north by the Town of Swampscott and the Town of Marblehead. Swampscott is a 3.6 square-mile seaside community to approximately 14,600 residents and located just 15 miles northeast of Boston.

The location of the proposed wind turbine generator is located off Forest Street on a town acquired easement (Park and Recreation Easement) of approximately 10.1 acres which sits adjacent to the Swampscott Middle School property that occupies 14.8 acres of town owned land. The turbine is to be situated behind the School and its accompanying open athletic fields. Properties immediately surrounding the site consist of the Tedesco Country Club, which occupies 144 acres, to the north, east and west. Residential Neighborhoods inhabit the land to the south. Site elevations range between 17m and 28m (56ft.–92ft.).

The lot is primarily classified as Residential A2 District by the Swampscott Zoning Board. Refer to Figure 14 for MassGIS USGS Locus Map.

Figure 14: MassGIS USGS Locus Map



Source: Bing Maps (USGS)

Location of proposed Wind Turbine Generator

Swampscott Middle School building was originally constructed in 1963 as the Swampscott Middle School. The brick building covers a footprint of approximately 72,000 square feet. On the property there are also landscaped areas, sports facilities, parking areas and access drives and wooded areas composed mainly of deciduous trees.

The prospective home to a 900 kW turbine is situated within the Park and Recreation Easement Primary Parcel on a cleared area d between two ball fields. A summary of the site's coordinates, base elevation, and distances to nearest property line and residence are included as Table 7.

Table 7: Summary of Site Location and Setbacks

	Latitude	Longitude	Site Base Elevation	Distance to Nearest	
				Property Line	Residence
Site 1	42°28'36" N	70°54'07 W	26m (85')	500'	615'

Swampscott Middle School is located in an electric utility capacity constrained area and opportunities for clean renewable distributed energy generation of this magnitude will aid the town in achieving energy sustainability, jointly improving the environment and national security. The turbine will provide the town with clean renewable energy, as well as offset energy costs. Additionally, this project continues in the tradition of the Commonwealth's commitment to energy conservation and natural resource sustainability.

b. Visual and Noise Receptors

i. Potential Visual Impacts

A photomontage has been prepared using WindPRO Software to simulate the view of the proposed turbine. See the attached photos for before and after pictures taken from various vantage points of typical 600 kW and 1.5 MW turbines. Additional photomontages for each of the turbines studied are available in Appendix D.

With Proposed 600kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Swampscott Middle School Parking Lot

With Proposed 600 kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA

Photomontage Including 600 kW and 1.5 MW Wind Turbine

View from Swampscott Middle School Ball Fields

With Proposed 600 kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Laurel Road

With Proposed 600kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Salem Street

With Proposed 600 kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Route 1A

With Proposed 600kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Davenport Drive

With Proposed 600 kW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Swampscott Middle School, MA
Photomontage Including 600 kW and 1.5 MW Wind Turbine
View from Parsons Drive

ii. Potential Noise Impacts

Applicable noise standards for the proposed wind turbine are the Massachusetts Department of Environmental Protection (DEP) noise guidelines. The City of Swampscott has no relevant noise ordinance. The proposed wind turbine siting location is approximately 500 feet from the nearest property line and 615 feet from the nearest residence. This regulation is as follows:

Massachusetts Department of Environmental Protection (DEP) noise guidelines: The Code of Massachusetts Regulations (title 310, Section 7.10, amended September 1, 1972) empowers the Division of Air Quality Control (DAQC) of the Department of Environmental Protection (DEP) to enforce its noise standards. According to DAQC Policy 90-001 (February 1, 1990), a source of sound will be considered to be violating the Department's noise regulations if the source

> (1) increases the broadband sound level by more than 10dBA above ambient
>
> (2) produces a "pure tone condition", when any octave-band center frequency sound pressure level exceeds the two adjacent frequency sound pressure levels by 3 decibels or more

Ambient is defined as the background A-weighted sound level that is exceeded 90 percent of the time (i.e. L90) measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 meters per second (m/s) (9 mph) measured at a height of 10 meters (m). Therefore, it is appropriate to estimate likely background L90 when winds are blowing at speeds of 4 m/s or higher, for the purposes of comparison to the turbine noise emissions

WindPRO Analysis

Using WindPRO Software eight (8) residential receptors were analyzed to determine the effects on acoustics by the installation a 600 kW or a 1.5 MW wind turbine; five (5) receptors were placed in the densest residential areas surrounding the proposed turbine, two (2) to the north, one at the Tedesco Country Club and One along Route 1A, and one (1) at the Middle School. These locations were chosen for analysis because they represent areas that may be influenced the most by the installation of a wind turbine generator and any potential noise nuisance. An assumed conservative ambient noise level of 32 db(A) was used for this analysis.

The analyses for the eight (8) residential receptors previously described are displayed on the Table 8 and 9 and the complete WIndPRO Decibel results for the proposed turbines are attached as Appendix E.

Noise Study

Howard Quin Consulting (HQC) in association with Harris Miller Miller & Hanson, Inc. (HMMH) was contracted by Meridian Associates to perform a noise study for the proposed wind turbine installations for turbines ranging from 600 kW to 1.5 MW. In the report, applicable noise standards and criteria were reviewed, the modeling used to project noise emissions from the selected wind turbine was described, and an analysis of tall the information to assess potential noise impacts from the project was completed. In addition, background measurements were made at five nearby locations, three short-term, and two long term to determine the ambient sound levels. These measurements of existing conditions were conducted from April 30, 2011 to May 2, 2011

According to the Town of Swampscott Wind Turbine Noise Study in Appendix E, Town of Swampscott Wind Turbine Noise Study by Howard Quin Consulting LLC, predictions to six (6) noise sensitive areas were evaluated using actual measured turbine noise levels for the design speed of 8 m/s measured at a 10 m height. The analysis is listed below in Tables 7, 8 and 9.

Table 7: Predicted Total Noise Levels from Proposed Elecon 600 kW Wind Turbine

Site Address	Predicted Turbine Leq dB(A)	Measured Background L90 dB(A)	Predicted Total Leq dB(A)	Difference dB(A)
Davenport Road Closest Residence	40.5	31	41.0	10.0
Davenport Road 2nd Closest Residence	39.3	31	39.9	8.9
Nason Road Closest Residence	41.6	32	42.0	10.0
Nason Road 2nd Closest Residence	41.2	32	41.7	9.7
Parsons Drive Closest Residence	41.5	33	42.1	9.1
Burke Drive Closest Residence	37.0	30	37.8	7.8

Table 8: Predicted Total Noise Levels from Proposed EWT 900 kW and Unison 750 kW Wind Turbines

Site Address	Predicted Turbine Leq dB(A)	Measured Background L90 dB(A)	Predicted Total Leq dB(A)	Difference dB(A)
Davenport Road Closest Residence	39.2	31	39.8	8.8
Davenport Road 2nd Closest Residence	38.1	31	38.9	7.9
Nason Road Closest Residence	40.1	32	40.7	8.7
Nason Road 2nd Closest Residence	39.7	32	40.4	8.4
Parsons Drive Closest Residence	40.0	33	40.8	7.8
Burke Drive Closest Residence	35.7	30	36.7	6.7

Table 9: Predicted Total Noise Levels from Proposed Hyundai 1.5 MW Wind Turbines

Site Address	Predicted Turbine Leq dB(A)	Measured Background L90 dB(A)	Predicted Total Leq dB(A)	Difference dB(A)
Davenport Road Closest Residence	40.9	31	41.3	10.3
Davenport Road 2nd Closest Residence	39.8	31	40.3	9.3
Nason Road Closest Residence	41.8	32	42.2	10.2
Nason Road 2nd Closest Residence	41.4	32	41.9	9.9
Parsons Drive Closest Residence	41.8	33	42.3	9.3
Burke Drive Closest Residence	37.2	30	38.0	8.0

Based on this study, the following was concluded:

- The Massachusetts Department of Environmental Protection (DEP) noise guideline of 10 dB(A) increase in noise levels will not be exceeded by he proposed wind turbine operation at all noise-sensitive areas for the EWT 900 kW and Unison 750 kW turbines for the Hyundai 1.5 MW and Elecon 600 kW turbines, exceedance may occur under design speed operating conditions.

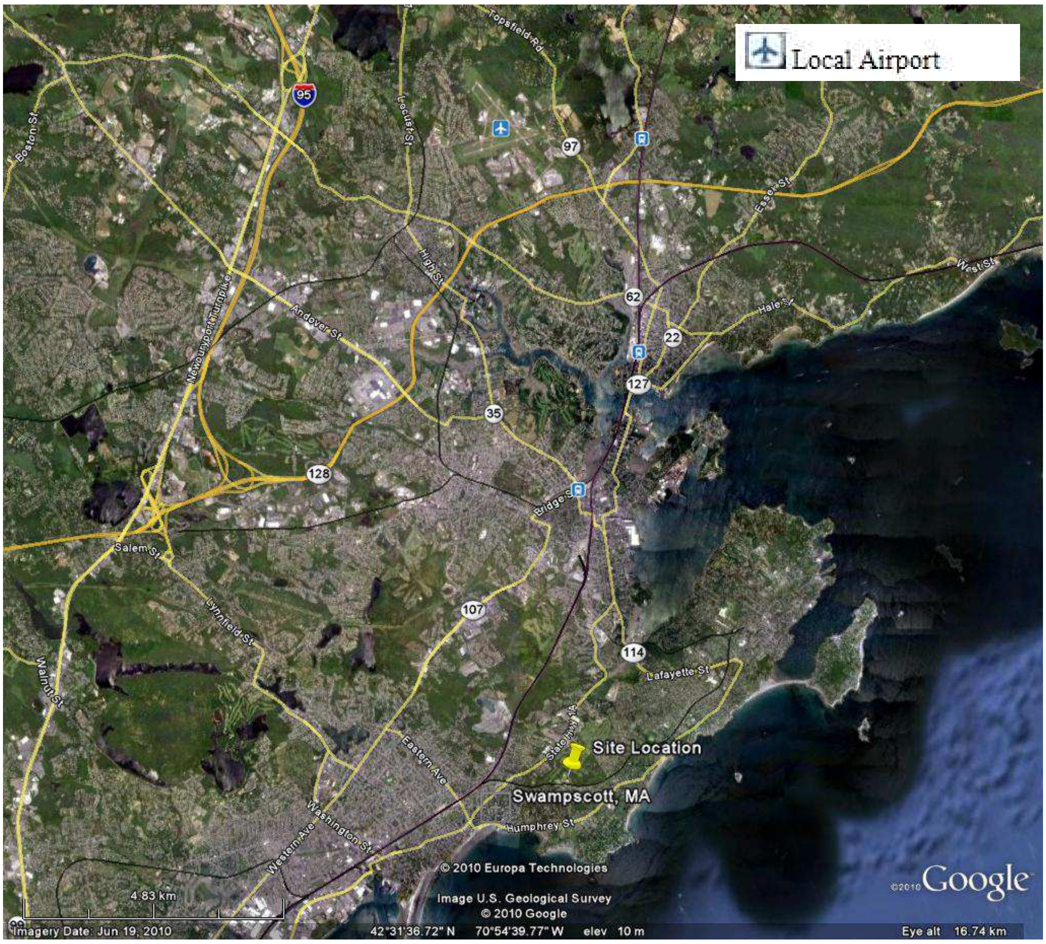
- The Project will be in compliance with the DEP noise guidance for a pure tone condition for all turbines.

c. Airports and Air Navigation Facilities

i. Proximity of Airports and Air Navigation Facilities

There are no airports within five (5) miles of the proposed wind turbine generator located at the Swampscott Middle School. Beverly Municipal Airport is 7.7 miles from the site and Logan International Airport is approximately 8.5 miles away. The site's proximity to Beverly Airport can be seen in Figure 15.

Figure 15: Local Airports



ii. Federal Aeronautics Administration

See Section 7.c.i Under Permits and Approvals for filing and determination details.

d. Electronic Communications Facilities

All Federal Communications Commission (FCC) registered electronic communications facilities within a 3-mile radius of the project site have been identified. These positions were located using Mobiledia http://www.cellreception.com/towers) and City-Data (http://www.city-data.com/city/Massachusetts.html) websites. A summary of these findings is located in Appendix G. Although most communication signals are completely unaffected by wind turbines, in some instances AM radio signals could potentially be affected and microwave signals can be blocked by the wind turbine if it is in direct line between the microwave transmitter and receiver it.

The impact of a potential interference is not likely but should be examined further if deemed necessary.

e. Community Acceptance

The Town of Swampscott has decided to wait for results of this feasibility study to establish the viability of this project before pursuing community outreach. Prior to permitting the Town will engage abutting resident owners in regards to the proposed project.

4. INSTALLATION SITE PHYSICAL CHARACTERISTICS

a. Site Physical Characteristics

The Town of Swampscott's Middle School campus is located on 14.8 acres of town owned land with an accompanying 10.1 acre Park and Recreation Easement to house athletic fields. The property consists mainly of open sports facilities with an academic and administrative building, landscaped and parking areas, and wooded area full of deciduous and coniferous trees.

Massachusetts Electric Company holds rights to an easement along the former Boston and Maine Railroad Right of Way for transmission lines. This easement runs centrally through the property dividing the location of the Middle School structure and the athletic fields

The plan is to utilize an already cleared section of the site, just northeast of the three baseball fields to erect the proposed 900 kW wind turbine generator as depicted on the Figure 16 and Site Plan, Appendix F.

Figure 16: Property Characteristics

Scale: 1" = 400'

❌ Location of proposed Wind Turbine Generator

b. Current and Anticipated Uses

Swampscott Middle school is the academic home to the town's 5th, 6th, 7th and 8th graders. It is anticipated that all of the wind turbine energy will be utilized by the site to run academic and administrative facility and associated athletic field accessory structures and lighting through net-metering on the Swampscott property.

c. Site Infrastructure

The Swampscott Middle School property has an extensive buried infrastructure. A complete Interconnection Study will be performed prior to the installation of a wind turbine. At that time the site infrastructure will be fully explored. Installation Site Electrical Infrastructure is discussed in Section 5 of this Feasibility Study

d. Safety and Operational Suitability

Overall, the project site in the Town of Swampscott is a safe and suitable site to erect a turbine. As proposed, the wind turbine will be installed on the far end of lot, beyond the ball fields and away from the daily activities of the school and adjacent roadways.

There is always a slight concern of ice throw when a turbine is erected in climates that are susceptible to winter storms. Ice can accumulate on the turbine blades and potential be thrown off if the turbine is in operation or more commonly ice fragments may fall from the machine when it is shutdown. Mitigation measures, such as ice sensors, balance monitoring, and preventative shut down, are available to minimize potential risks.

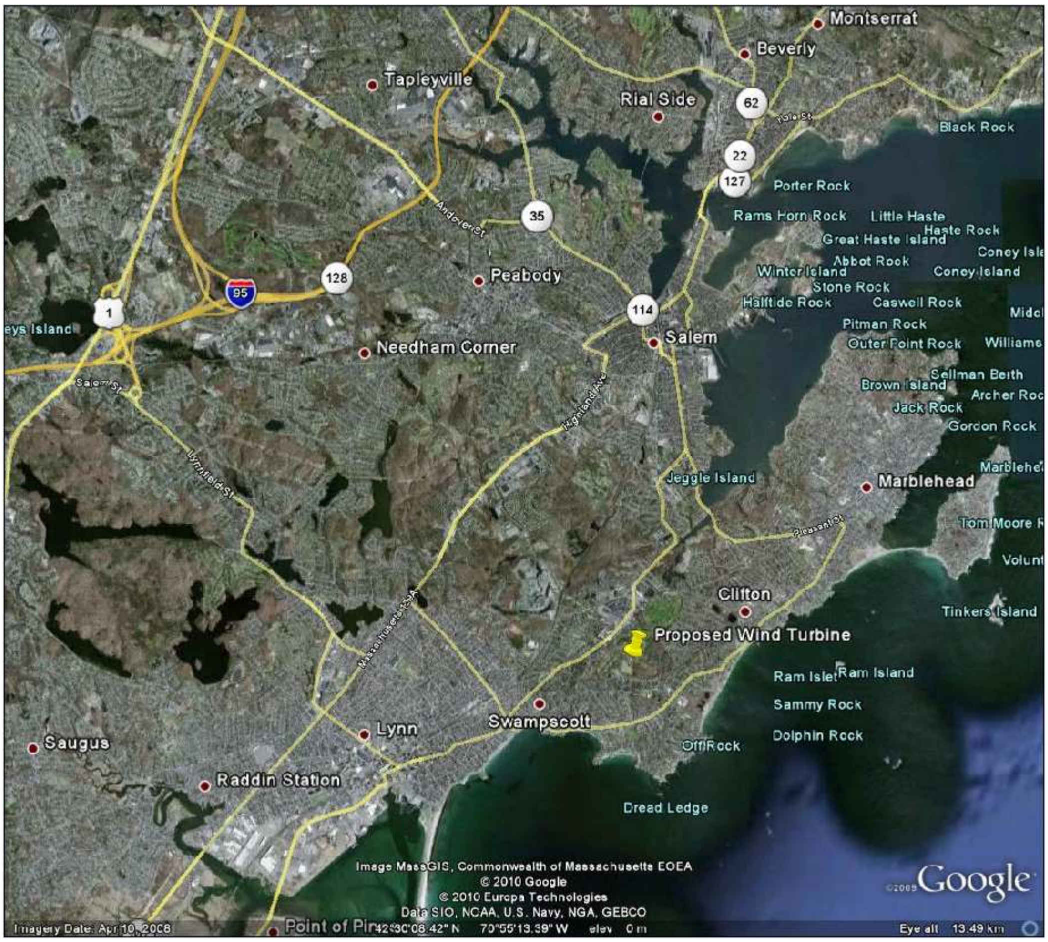
e. Spatial Separation

Not Applicable – there is only one (1) proposed turbine to be erected at the site and there are no other wind turbine generators in the vicinity of the Swampscott Middle School property.

f. Site Access

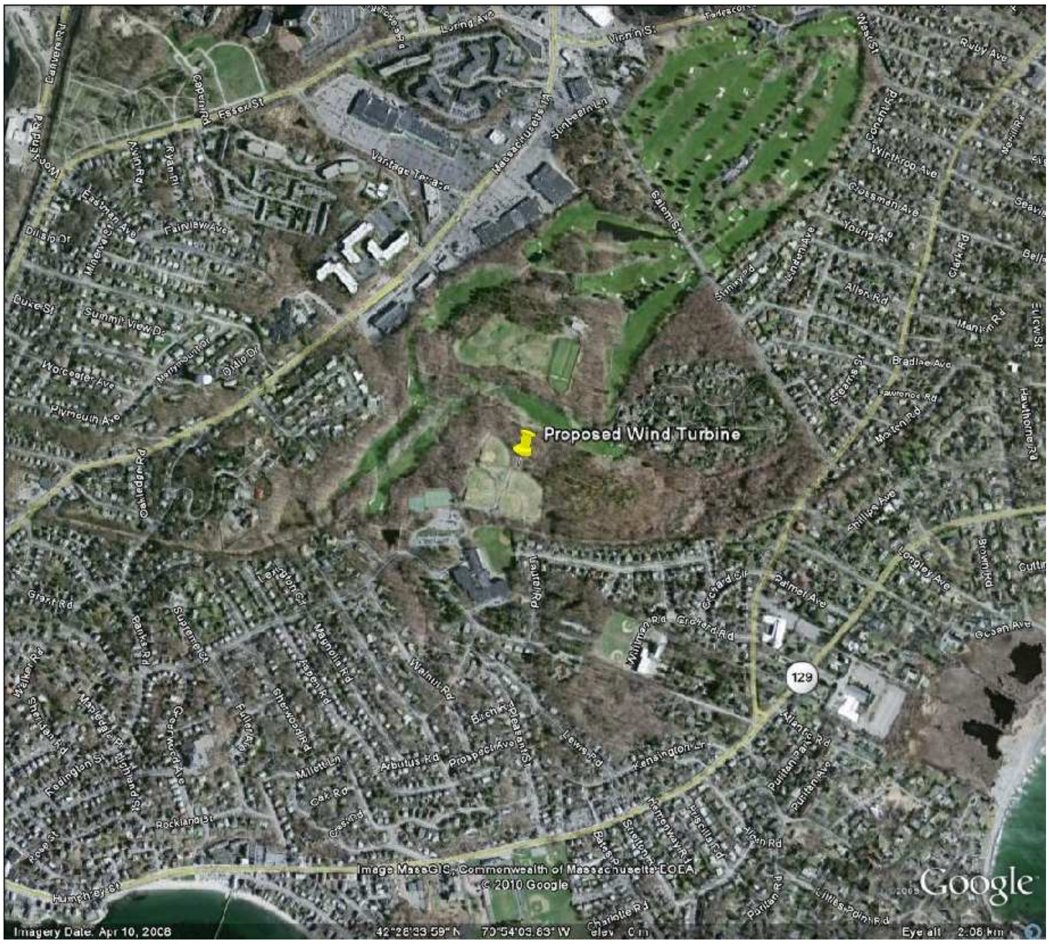
Boston's North Shore is easily accessible via major interstate highways such as Route 95, Route 128, and Route 1. From these travel ways the proposed Forrest Avenue site location, adjacent to the Swampscott Middle School, is centrally located within ½ mile of both Route 129 and Route 1A. These routes have fairly large turning radii allowing for the passage of the extensive length of the WTG blades and turbine components.   An Orthophoto map of possible access routes to the Swampscott site is shown as Figure 17.

Figure 17: Swampscott Middle School Campus Access



As shown in Figure 18, Access to the Site is obtainable from 10-foot wide paved road that runs behind the ball fields at the Forest Street location. This area is wooded so minor clearing and temporary removal of portions of the fence may be necessary. Easements on nearby owned properties may be required for right of entry.

Figure 18: Site 1 Access



Although minor on-site improvements may be necessary, construction at Swampscott Middle School is not expected to disrupt the normal facility operations as there is adequate space for construction staging and turbine erection.

5. ELECTRICAL INFRASTRUCTURE

The existing electrical infrastructure consists of a 3-phase distribution line. All power from the proposed turbine generator will be directed via underground duct banks to the existing electrical infrastructure at the Middle School. The turbine will require an exterior transformer at the base of the turbine and may require additional components such as re-closers per the direction of National Grid. An Interconnection Study will be performed by the utility provider prior to connection of the turbine to the grid.

a. Potential Interconnection Locations

The site has been evaluated for potential interconnection point to the electrical transmission grid. Although National Grid has not yet finished their assessment of the line voltages for this area it has been identified that a 13.8 kV three phase line is located in front of the middle school. For this study, the closest connection point has been assumed in front of the middle school, located less than one-quarter mile from the proposed location. While this report discusses potential interconnection points, a full interconnect study will need to be prepared for and reviewed by National Grid against their inventory to determine the actual location of interconnection to maximize safety and reliability of the system. This study is typically a lengthy and costly process. Interconnection fees are not known until the time of filing for the permit and the study by the utility has been completed, for this reason, it is typically recommended to initiate the interconnect permit very early in the design phase of the project.

National Grid has taken the position to limit the amount of distributed generation to existing transmission lines to 3MW for 13.8kV lines. Projects exceeding these faceplate ratings will require dedicated services from the project to the nearest substation.

Distributed Generation economic benefits typically become compromised when grid interconnection lies greater than 1.5 miles from the site, as typical 3 phase transmission costs range from $50-$60/ft or $264,000 - $316,800 per mile.

Given the above constraints, the maximum distributed generation project size for this site is 3.0MW, which could come from a 900 kW wind turbine generator, and could still have capacity to allow for 2.1 MW or other generation such as solar PV. A connection to the existing 3 phase lines 750 feet away, would yield a transmission connection of approximately $41,250.

b. Interconnection Feasibility

Interconnection at Swampscott Middle School does not appear to be a fatal flaw. An Interconnection Study will be performed by the utility provider prior to determine the point of connection of the turbine to the grid.

c. Electrical Output Opportunities

It is anticipated that all of the energy produced by the wind turbine will be utilized by the site to run the Middle School's academic and appurtenant facilities. The wind at the proposed site is a natural renewable energy resource available within property's boundaries that has the potential to benefit the environment as well as the school.

In the event that there is excess power generated at the site; the balance of power will be "NET-METERED" behind the meter to credit the electrical power usage of other Town of Swampscott public facilities as allowed by recent legislature under the Green Communities Act. This reduction in power costs is intended to ease the cost burden implemented onto the tax-paying residents of Swampscott.

d. Load Profile and Electric Rate Structure

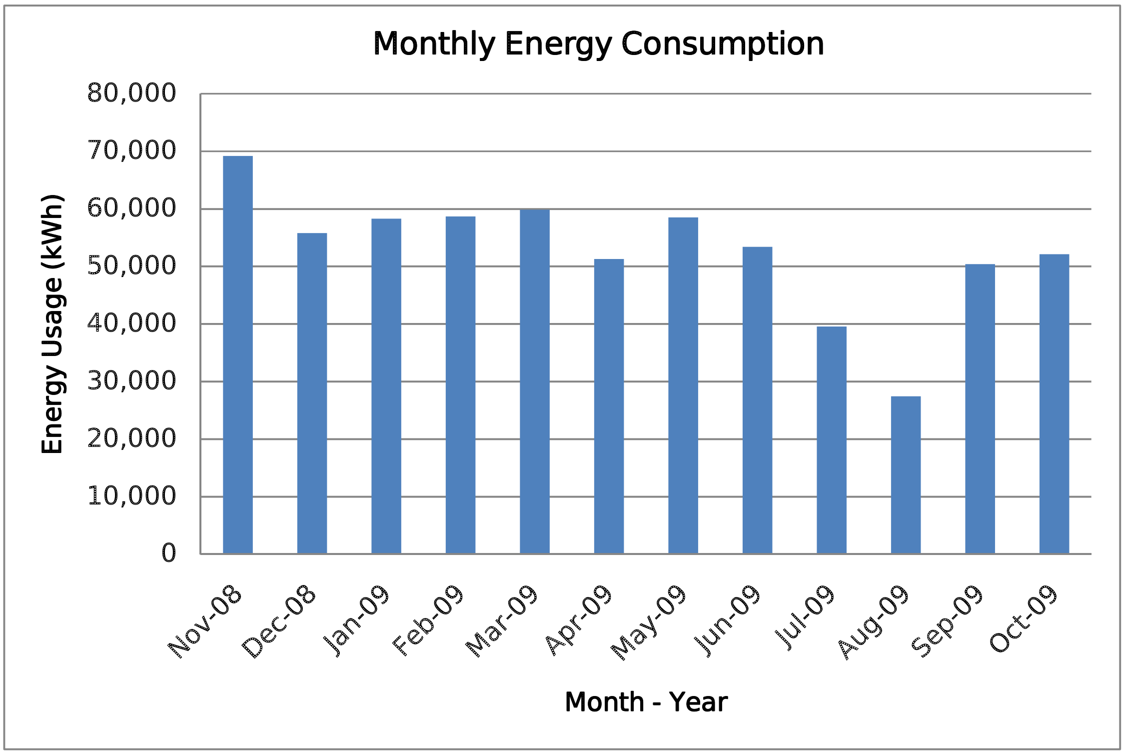
Swampscott Middle School is located in a medium density residential neighborhood adjacent to Route 24. An already cleared section of the site is planned to be utilized for the installation of the Wind Turbine. It is anticipated that all of the wind energy produced by the installation of a wind turbine generator will be utilized by Swampscott Middle School

The monthly retail electricity usage (kWh) for the project in for the Middle School and the Little League Ball field for November 2008 through October 2009 is as provided in Table 10 and Chart 8:

Table 10: Monthly Electricity Usage (kWh)

Month	Year	Middle School (kWh)	Ball Field (kWh)	Total (kWh)
November	2008	68,160	1,000	69,160
December	2008	54,120	1,700	55,820
January	2009	55,680	2,600	58,280
February	2009	56,760	1,900	58,660
March	2009	58,800	1,100	59,900
April	2009	48,960	2,300	51,260
May	2009	49,320	9,200	58,520
June	2009	46,800	6,600	53,400
July	2009	33,360	6,200	39,560
August	2009	25,560	1,900	27,460
September	2009	49,920	500	50,420
October	2009	51,720	400	52,120
Annual Energy Consumption (kWh)				634,560

Chart 8: Monthly Electricity Usage (kWh)



The above average annual electricity usage and peak electricity demand for the project was provided by National Grid for Rate Class G-3

Electrical use records are included as Appendix H.

6. ENVIRONMENTAL CONCERNS

a. Site Vegetation and Wetland Resources

i. Site Vegetation

The immediate site location of the proposed wind turbine generator is clear of any significant plant life. The abutting land to the north and west of the proposed site of the wind turbine generator is rich in vegetation. Coniferous and deciduous trees with underlying shrubs and plants blanket the area. Ball fields, with low lying grass, extend between approximately 300 feet to 500 feet to the south and west of project base.

ii. Wetland Resources

National Wetlands Inventory Map

The National Wetlands Inventory is a record collection of the characteristics, extent and status of the nation's wetlands and deep water habitats in the form of topical maps administered by the U.S. Fish and Wildlife Service. Figure 19 depicts such areas as solid or hatched areas.

The proposed turbine is to be constructed over 350' from the nearest wetland. Two areas classified as wooded marsh wetlands per MassGIS National Wetlands Inventory occupy. The nearest is located 350' to the west of the proposed wind turbine location, west of the ball fields and north of the tennis courts. The second location of wetlands on the Swampscott Middle School property is to the southwest, beyond the ball fields and adjacent to the of the railroad tracks.

Although no construction activities will take place within a wetland area or buffer zone, mitigation will be in accordance with all applicable rules and regulations but at minimum will include erosion and sedimentation control during the construction period

Figure 19: National Wetlands Inventory Map

Symmes Maini & McKee Associates

Layout of Playfields Plan by Symmes Maini & McKee Associates of Cambridge, MA (Plan Book 395, Plan 93 of Southern Essex Registry of Deeds), filed February 17, 2006 depicts detailed wetland delineation on and adjacent to the Middle School property and Park and Recreation Easement. According to this plan, the nearest wetland is roughly 220 feet directly east of the proposed turbine site location

b. Potential Environmental Impacts

Using MassGIS data layers, the project site was reviewed to determine which, if any, areas were potentially environmentally sensitive. The layers that were explored were:

Areas of Critical and Environmental Concern

Areas of Critical and Environmental Concern (ACEC) are locations in Massachusetts that are valued significant because they are places within the state that contain exclusive resources of natural and cultural importance. ACECs are nominated by communities in the Commonwealth to the state Secretary of Environmental Affairs and administered by the Department of Conservation and Recreation. There were no ACEC's located in the vicinity of the project site.

Scenic Landscapes

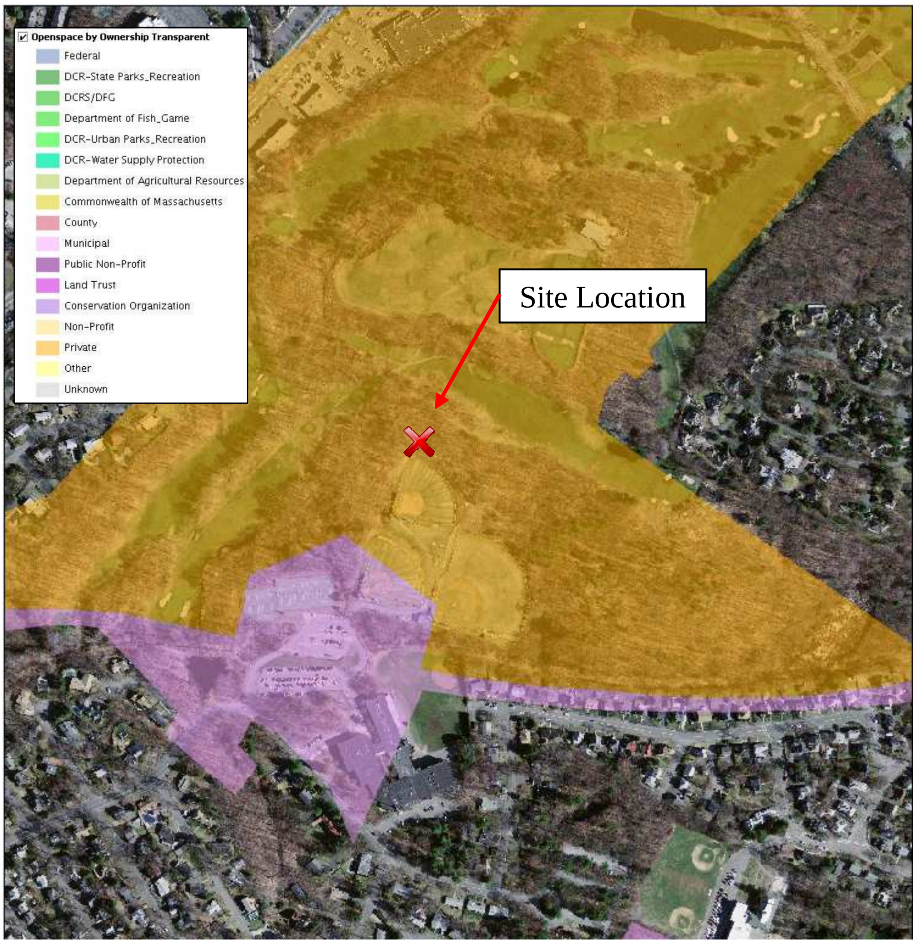
The Department of Conservation and Recreation's Landscape Inventory Project illustrates identified Scenic Landscapes of Massachusetts in a data layer for general planning purposes. No Scenic Landscapes are visible from the location of the proposed turbine

Protected and Recreational Open Space

The Protected and Recreational Open Space Data Layer contains the boundaries of conservation lands and outdoor recreational facilities in Massachusetts. The associated database contains relevant information about each parcel, including ownership, level of protection, public accessibility, assessor's map and lot numbers, and related legal interests held on the land, including conservation restrictions.

The entire Swampscott Middle School property is classified as Municipal Protected and Recreational Open Space while the Park and Recreation Easement, land where the proposed turbine is to be constructed, is located in Private Protected and Recreational Opens Space as shown below in Figure 20.

Figure 20: Protected and Recreation Open Space Map



Estimated Habitats for Rare Wildlife and Priority Habitats for Rare Species

Estimated Habitats of Rare Wildlife data layers represents estimations of the habitats of state protected rare wildlife (plants and animals) and Priority Habitats data layer represents estimations of state-listed rare species (animals only) habitats in Massachusetts. No Estimated Habitats of Rare Wildlife are visible from the location of the proposed turbine.

Vernal Pool

Vernal pools are small ponds characterized by lack of fish and periods of dryness. Vernal pool habitat is extremely important to a variety of wildlife species including some amphibians that breed exclusively in vernal pools, and other organisms, which spend their entire life cycles confined to vernal pool habitat. Many additional wildlife species utilize vernal pools for breeding, feeding and other important functions.

Figure 21: Vernal Pool

Symmes Maini & McKee Associates

Layout of Playfields Plan by Symmes Maini & McKee Associates of Cambridge, MA (Plan Book 395, Plan 93 of Southern Essex Registry of Deeds), filed February 17, 2006 calls out the location of certified vernal pools on and adjacent to the Middle

School property and its associated Park and Recreation Easement. According to this plan, a vernal pool sits over 400 feet to the west of the proposed turbine site location.

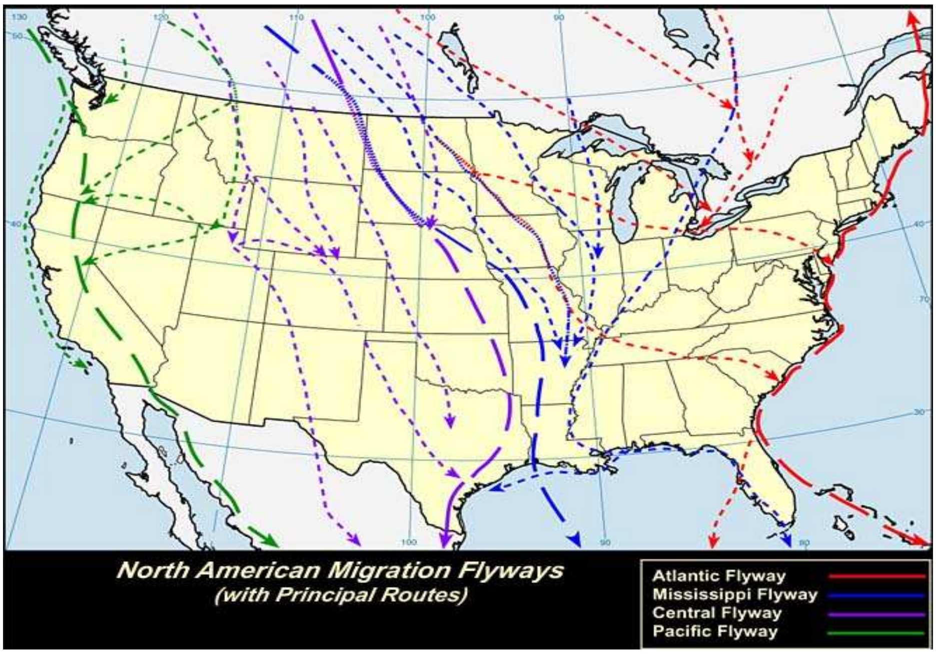
i. Impact on Bat and Avian Wildlife

Migrating Birds

According to the North American Migration Flyways Map, refer to Figure 22, the major flyway flight path of the Atlantic Flyway is located in close proximity to the site of the proposed turbine. The Atlantic Flyway primarily runs along the offshore waters of the Atlantic coast from its northern origin in the eastern Arctic Islands and coast of Greenland down to the Caribbean Sea. The flyway embraces several primary migration routes and many more that are important as tributaries, some of the latter being branches from primary routes of other flyways.

Potential impacts to migrating birds will be somewhat of concern because of the site's closeness to the migratory flyway. Importantly, the Swampscott Middle School Wind Turbine project is only a single large turbine, not a multi-unit wind farm. The blade speed on commercial scale turbines is very slow compared to earlier wind turbines that were smaller and rotated at high speeds.

Figure 22: North American Migration Flyways



Source: http://www.birdnature.com/allflyways.html

Avian Population Impacts

To date, no population impacts have been demonstrated or suspected to have resulted from collisions with wind turbines (Kerlinger 2005). Typically, fatalities associated with wind turbine sites have mostly involved common, widely distributed species. Accordingly, population declines associated with wind industry have not been demonstrated.

Bat Population Impacts

In New England, and particularly in the general area of the Swampscott, MA turbine site, there are not large colonies of bats. Instead, local species tend to congregate in small nursery groups in the spring of up to 200 bats where babies are born and raised. Most bats spend their days in eaves of houses, behind shutters of houses, or in other dark protected places. The big brown bat tends to be more tolerant of the winters in Massachusetts and will stay near and around their local areas all year. The coast of Massachusetts does not have large caves that can serve to house large numbers of bats. Accordingly, some bats (little brown myotis) do migrate to large caves in the western part of Massachusetts where they can better tolerate the winter weather.

We do not expect that bats will be a significant issue pertaining to the Swampscott Wind Turbine Project, as our local bats do not congregate in large numbers, nor do they migrate in large numbers.

Based on prior studies, it is our professional opinion that the construction of the Swampscott Middle School Wind Turbine Project will not adversely affect the resident or migrant bird and bat populations of Swampscott, Massachusetts.

The benefits of wind-generated power are great and are increasing nationwide during this time. It is important that the wind industry be thoughtful and responsible regarding any potential impacts it may have on existing environmental resources. The Swampscott Wind Turbine project consists of one large, slowly rotating generator on a tubular tower at a maximum height of 196-feet, with turbine blades rising on rotation to 266-feet in the air. For the reasons stated above, impacts to migration and/or resident bird species are expected to be minimal.

7. REQUIRED REVIEWS, PERMITS, AND APPROVALS

a. Zoning Requirements

The Swampscott Middle School property, the home of the proposed turbine, is owned and operated by the Town of Swampscott, Massachusetts. Construction on town owned property is exempt from all local setbacks and zoning requirements and therefore the Town of Swampscott Zoning By-laws are not applicable to this project.

Although the site location is exempt from the local zoning by laws, Swampscott Middle School is located on land designated as A2 Residential One-Family as defined in the Zoning Ordinance for the Town of Swampscott and all setbacks and local requirements will be met to the maximum extent practical.

b. Wind Energy Conversion System Bylaws

The Town of Swampscott has not adopted a Wind Energy Conversion Facility By-law regulating the construction of wind turbines; therefore, no special permit is necessary.

An As-of-Right Zoning Ordinance or Bylaw: Allowing Use of Wind Energy Facilities was prepared by the Department of Energy Resources Massachusetts Executive Office of

Environmental Affairs in March of 2009 and was used as a guideline for siting the turbine with in the Town of Swampscott property. The suggested standards that were implemented were as follows:

- The height of the wind energy facility shall not exceed 450 feet in height.
- A wind turbine shall not be sited within:

  (a) A distance equal to the height of the wind turbine from buildings, critical infrastructure, or private or public ways that are not part of the wind energy facility

  (b) Three times (3x) the height of the turbine from the nearest existing residential structure; or

  (c) One point five times (1.5x) the height of the turbine from the nearest property line.

A copy of the model ordinance is included in Appendix I.

c. Required Permits and Approvals

i. The Federal Aviation Association (FAA)

A Notice of Proposed Construction or Alteration is required by the FAA for any structure that is proposed to be 200 feet or above ground level.

On May 3, 2010 Form 7640-1 was filed with the FAA for a 300 foot structure at the proposed site and was assigned the Aeronautical Study Number (ASN) 2010-WTE-7112-OE. The FAA has conducted their aeronautical study under the provisions of 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77. On June 9, 2010 a Determination of 'No Hazard to Air Navigation' was issued for a total height of 300' AGL and will accommodate the total height of the studied 600 kW and 750 kW turbines.

A supplemental Notice of Proposed Construction or Alteration was filed on May 25, 2011 to review compatibility of structures up to a height of 389' AGL, a height equal to or greater than the total height of the proposed 900 kW and studied 1.5MW turbines. It is anticipated that a Notice of 'No Hazard to Air Navigation" will be issued.

The results are included as Appendix J.

ii. The Massachusetts Aeronautics Commission (MAC)

A Request for Airspace Review by the MAC was required pursuant to the aviation law requirements of the Commonwealth. The request was filed on October 21, 2010 and a final determination stating the project does not violate MAC Laws or Regulations is anticipated.

iii. Building Permit to be issued by the Town of Swampscott Building Inspector

A Building Permit from the Town of Swampscott Building Inspector is required prior to any construction within the Town's limits.

iv. Filing with Massachusetts Department of Environmental Protection or Town of Swampscott Conservation Commission

Filing is not necessary with either the Massachusetts Department of Environmental Protection or with the Town of Swampscott Conservation Commission under the Wetlands Protection Act (M.G.L. chapter 131, Section 40) or Town of Swampscott By-law. Town of Swampscott and its surrounding area do not contain resource areas protected by this act. Such resources areas include Bordering Vegetated Wetlands, Land Subject to Flooding and their associated buffer zones.

Onsite landscape evaluation and review of Mass GIS Wetland Inventory data layer indicates that no portion of the project will be conducted on such protected wetland resource areas or their related buffer zones within the property. Therefore this project is not subject to such filings

v. List of Potential Required Permits and Approvals

Table 11: Local Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
Town of Swampscott Zoning Board	Special Permit	Not Applicable – Town Owned Land	1 - 2 months	Project will follow all local requirements to maximum extent practical.
Town of Swampscott Building Inspector	Building Permit	Applicable	1 - 2 months	Project will follow all local requirements to maximum extent practical.
Town of Swampscott Conservation Commission	Notice of Intent (NOI)	Projects within wetlands or associated buffer zone	3 months	WECS to be located outside wetlands and associated buffer zone.

Table 12: State Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
Energy Facility Board (EFSB)	Transmission line approval	Transmission interconnection Required for wind farms over 100 MW or new transmission lines over one mile long or over 69 kV		No electricity to be sold to grid. Proposed site of single turbine will be less than 100 MW and new transmission lines will be less than 100 feet.
ISO-New England	NEPOOL Interconnection System Impact Study and Facility Study (Form 18.4)	Required for projects over 5 MW	9 - 12 months	This project will be less than 5 MW therefore does not require submittal. No electricity sold to grid.
Massachusetts Aeronautical Commission (MAC)	Request for Airspace Review	Filing required for all structures greater than 200 feet	3 - 4 months	MAC approval currently being sought for height up to 300 feet AGL
Massachusetts Department of Environmental Management	Massachusetts Forest Cutting Practices Regulations	Project Criteria	Not Applicable	
Massachusetts Department of Environmental Management & US EPA	NPDES individual Storm water General Permit and Notice of Intent (joint State/Federal Program under the Clean Waters Act (CWA)	Applicable if more than one acre of land is being disturbed or if wastewater is discharged/there is storm water runoff.	9 - 12 months	Not Applicable - less than one acre of land is being disturbed. Minimal Storm water runoff.
Massachusetts Department of Environmental Protection (MassDEP)	Noise Control Policy	Project Criteria	1 - 2 months	There shall be an increase of no more than 10 dB(A) above ambient at the nearest property line

				or residence
	Water Quality Certification under the Massachusetts Water Quality Act (sect. 401)	Applicable for projects altering more than 5000 square feet of wetlands	3 months	Less than 5000 sq. ft. of wetlands disturbed
	Wetlands Program Policy	Project Criteria for Activities in the Buffer Zone under the Wetlands Protection Act Regulations	Not Applicable	Not Applicable for development outside buffer zones adjacent to wetlands
Massachusetts Department of Highways	General Access Permit	Applicable if modifications to State roadways are necessary	2 - 3 months	Modifications to roadways may be required
	Oversized or Overweight Load Permit	Required for movement of oversized project equipment.	2 - 3 months	Transportation Route approval required for oversized turbine components
Massachusetts Environmental Protection Agency (MEPA)	Notice of Intent (NOI)	Project to take place outside buffer zone of any wetland	3 months	
	Environmental Notification Form (ENF)	ENF required for projects where > 25 acres of land directly altered	3 months	Project does not trigger ENF <25 acres disturbed
	Environmental Impact Review (EIR)	EIR required for projects where > 50 acres of land altered - triggered by ENF	6 - 9 months	Project does not trigger EIR < 50 acres disturbed

Massachusetts Historical Commission	Archaeological and Historical Project Notification Form (PNF)	Required for projects that could potentially effect archaeological or historical resources	3 - 4 months	All new projects receiving funding, permits, or license from any state or federal agency must file a PNF
Massachusetts Natural Heritage and Endangered Species Program	Conservation and Management Permit	Applicable if a "take" is required as stated in the Massachusetts Endangered Species Act	3 - 4 months	Not Applicable - No 'take" of endangered, threatened, or species of special concern
	Notice of Intent (NOI)	Required for wetland alterations or projects in an "estimated habitat".	3 - 4 months	A desktop analysis was completed to determine No threatened, endangered, or species of special concern listed are at the proposed site by the State.
Massachusetts Turnpike Authority	Special Hauling Permit	Required for the transportation of turbine components over State Highways	24 hours notice	
Natural Heritage and Endangered Species (NHESP)	Environmental Notification Form (ENF) and Massachusetts Endangered Species Act (MESA) Checklist	Review of projects that will disturb less than 5 acres of estimated habitats	30 days	
National Grid	Interconnection with existing transmission system study	Notification must be made when doing work and/or if electricity generated will be tied into existing transmission system.		

Table 13: Federal Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
Environmental Protection Agency (EPA)	National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) & Notice of Intent (NOI)	Applicable if construction of WTG will result in the disturbance of > 1 acre of land	9 - 12 months	Notification Only
Federal Aviation Association (FAA)	Notice of Proposed Construction or Alteration (Form 7460-1)	Filing required for all structures greater than 200 feet	At least 30 Days prior to construction	Received FAA approval for height up to 400 feet AGL
Federal Energy Regulatory Commission (FERC)	FERC Certification of Qualifying Facility (Form No. 556)	Required in order to enter purchase/sale agreement for power w/any electric utility	10 Business Days (3 months for formal certificate)	
Fish & Wildlife Service (FWS)	Informal Consultation Notification	Endangered Species Act requires applicant to request a list of all candidate species and critical habitats prior to construction.	Not Applicable	Notification Only
	Habitat Conservation & Incidental Take Permit	Not Applicable		No Take Permit will be required
United States Fish & Wildlife Service (USFWS)	Bat and Avian Impact Review	Required by Migratory Bird Treaty Act for any project with potential to harm migratory bird species.	2 months	Required

vi. Additional Research

It is not expected that additional research will be required other than that previously laid out in the local, state and federal regulations matrix above.

vii. Estimated Timeframe for Securing Permits and Approvals

Permits and approval timeframes are listed in the applicable Local, State and Federal Regulations Charts.

8. CONCEPTUAL WIND PLANT CONFIGURATIONS

a. Wind Turbine Candidates

The proposed renewable energy system is to be a 600 kW, 750 kW, 900 kW or a 1.5 MW AC wind turbine generator. These are medium scale commercial wind turbines with specifications as shown below on Table 14:

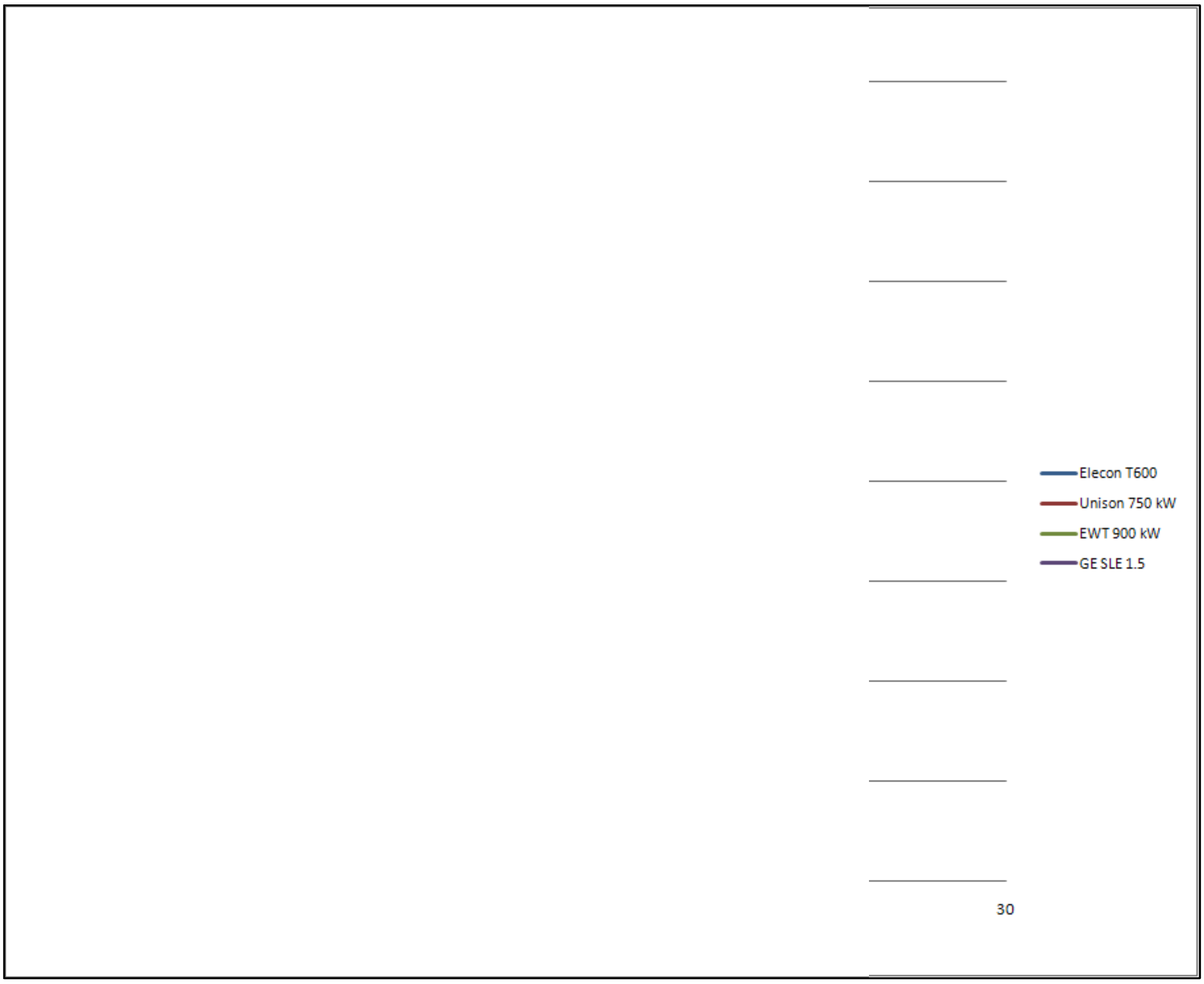
Table 14 Turbine Heights

Faceplate Rating	Manufacturer	Turbine Model	Approx. Rotor Diameter	Approx. Hub Height	Approx. Max. Blade Tip Height
600	Elecon	T600-48ds	48m (157')	60m (197')	84m (276')
750	Unison	U54	54m (177’)	60m (197')	87m (285’)
900	EWT	54-900kW	54m (177’)	75m (246’)	102m (335’)
1500	GE Energy	1.5sle	77m (253')	80m (262')	119m (389')

Each of the specified heights are in compliance with FAA regulations and have been determined to provide no hazard to air navigation as evidence in correspondence from FAA and MAC, attached as Appendices E and F accordingly.

The proposed renewable energy systems are 3-bladed wind turbines with gearing, a generator, and instrumentation needed to implement “net metering” for Swampscott Middle School and the Town of Swampscott. Chart 9 represents each of the machine’s power curves and technical specifications from each of the manufacturers has been included in Appendix K.

Chart 9: Power Curves



b. Assumed Turbine Characteristics

Per discussions with the Town of Swampscott, the wind turbine Generator chosen for installation at the proposed site shall abide by the following criteria:

- There must be prior installations of the selected WTG in the United States.
- The WTG must be as large as the site permits given height restrictions implemented by the Federal Aviation Association (FAA).
- Operation and Maintenance support must be available directly through the manufacturer.

The proposed renewable energy system is to be a medium scale commercial wind turbine mounted on a monopole with gearing, a generator and the necessary instrumentation needed to implement net-metering.

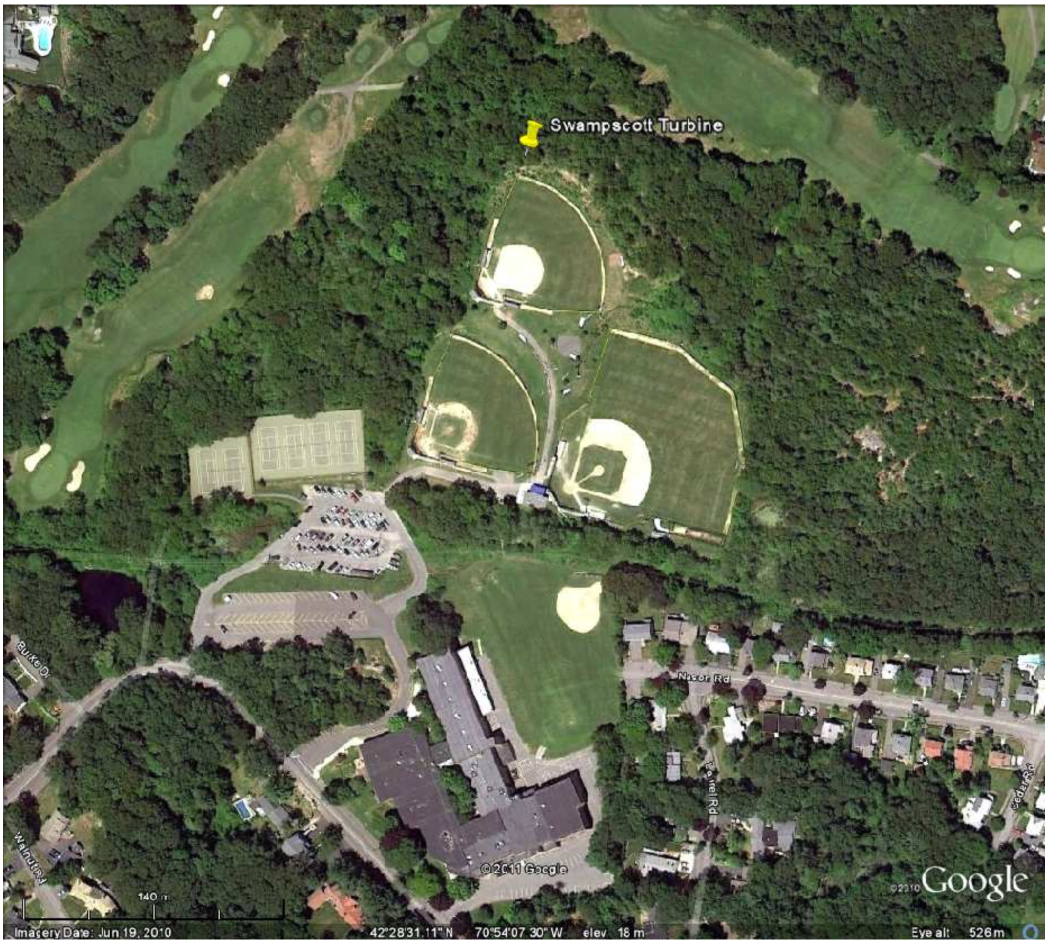
c. Wind Turbine Plant Configurations

Not Applicable - there is only one (1) proposed turbine to be erected at the site.

d. Wind Turbine Installation Location(s)

The wind turbine is proposed to be constructed in the far northwest of the property as shown on the Orthophoto below as Figure 22 and on the Site Plan attached as Appendix F. This location is situated at approximately 42°28’36"N 70°54'07 W at an elevation of 26m (85') This location is currently blanket in trees and shrubs to the north, east and west and will need to be cleared for turbine assembly. This location was chosen because it maximizes the distance between from residences from noise and visual receptors while keeping within the setback regulations set forth by the Town of Swampscott.

Figure 22: Orthophoto from Google Earth



e. Spatial Separation

Not Applicable – there is only one (1) proposed turbine to be erected at the site and there are no other wind turbine generators in the vicinity of the Town of Swampscott property.

f. Shadow Flicker Impacts

Wind Turbine Generator's blades create a moving shadow during daylight hours. This moving shadow creates a periodic obstruction of light. This periodic obstruction of light causes a "blinking" effect, which occurs approximately three times the rotational speed of the rotor. Flicker only occurs during sunny periods, when the turbine is not obscured by foliage, and when the turbine is in motion.

Although there are no regulations pertaining to flicker in the United States, the Commonwealth of Massachusetts, or the Town of Swampscott, the standard practice is to limit the amount of flicker to any one receptor to 30 hours per year[1].

This periodic shadow can be modeled using software specifically designed to measure the effect flicker at various design points, or "receptors", and is reported in terms of hours/year. Flicker for receptors can be analyzed with WindPRO software, which accounts for several factors in its calculations including:

- Location of the Sun for each minute of every day
- Direction of the Wind Turbine (using wind direction data)
- Times the Wind Turbine is in operation (using wind speed data)
- Topography of the Landscape

Flicker analysis is accurate to 5 minute intervals[2] in its calculations but it does not take into account obstacles between the Wind Turbine and the receptors such as:

- Trees, and associated foliage
- Manmade structures including Buildings, Bridges, Walls, Dwellings, etc.

Residential neighborhoods encircle the location of proposed wind turbine generator. The WTG will cast a shadow to the west during early morning hours and to the east in the late afternoon hours on operational sunny days.

Elecon T600 Shadow Flicker Study

Location of Receptors

Eight (8) residential receptors were analyzed to determine the effects on acoustics by the installation a 600 kW wind turbine; five (5) receptors were placed in the densest residential areas surrounding the proposed turbine, two (2) to the north, one at the Tedesco Country Club and One along Route 1A, and one (1) at the Middle School. These locations were chosen for analysis for the reason that they represent areas that may be influenced the most by the installation of a wind turbine generator and any potential flicker.

[1] Shadow Casting from Wind Turbines, www.windpower.org/en/tour/env/shadow/index.htm
[2] EMD WindPRO Software was designed to analyze the effects of Wind Turbine Generator Shadows based on 5-minute solar increments.

Results

The analyses for the eight (8) residential receptors previously described are displayed on the tables below. The estimated hours of shadow flicker for the analysis are listed in Table 15 and the estimated time of day and month of year in Table 16. The values/assumptions used in the calculations based on the "real case" scenario. The results are as follows:

Table 15: Estimated Hours/Year of Flicker Shadow Generated

Shadow Receptor	Location	Shadow Hours per Year (h/yr)	Shadow Days per Year (d/yr)	Max Shadow Hours per Day (h/d)
A	Tedesco Country Club	3:09	36	0:27
B	Davenport Drive	7:26	46	0:36
C	Rt. 1A - Commercial Bldg.	9:56	66	0:34
D	Parsons Drive	8:43	49	0:38
E	Swampscott Middle School	0:00	0	0:00
F	End of Nason Road	0:00	0	0:00
G	Burke Drive	0:00	0	0:00
H	End of Neighborhood Road	0:00	0	0:00

Table 16: Estimated Time of Day and Month of Year Flicker Shadow Generation

Shadow Receptor	Day/Month	Time of Day	Days per Year	Avg. Duration of Flicker per Day (min)	Maximum Duration of Flicker (min)
A	12/04 - 01/08	14:17 - 14:49	36	5	27
B	03/21 - 04/12	17:34 - 18:11	23	10	36
	08/31 - 09/22	17:27 - 08:04	23	10	34
C	11/19 - 01/23	08:07 - 08:57	66	9	34
D	03/17 - 04/09	07:10 - 07:50	24	11	38
	09/03 - 09/27	07:00 - 07:40	25	11	38
E	-	-	-	-	-
F	-	-	-	-	-
G	-	-	-	-	-
H	-	-	-	-	-

Chart 9 is a graphical representation of the shadow effects on each of the receptors according to the date and time of day. The Shadow Map of Figure 23 illustrates the manner in which the turbine will cast a shadow over the surrounding terrain, in total hours per year. The chart and figure represent the worst case scenario (sun sitting all hours of day and turbine operating constantly) effects that the turbine will have on nearby residential dwellings.

Conclusions

Using expected turbine operating hours, the most effected receptor was Receptor C, which sits approximately 1200 feet to the northwest of the proposed 600 kW Elecon wind turbine at the Commercial Building residing on Route 1A. It is anticipated that this location will receive a maximum of 10 hours of flicker per year, with an estimated maximum of 34 shadow minutes per day. It is projected Receptors B and C, which lie directly to the east on Davenport Drive and due west on Parsons Drive respectively, will cast between 7 and 9 hours of flicker in a calendar year. Receptor A, at Tedesco Country Club, is expected to come in approximately 3 hours per year and the remaining four (4) receptors will not experience shadow effects from the installation of a 600 kW wind turbine.

All receptors will be affected minimally, with values significantly less than the generally accepted 30 hours per year.

Chart 9: Calendar Map – Elecon 600kW

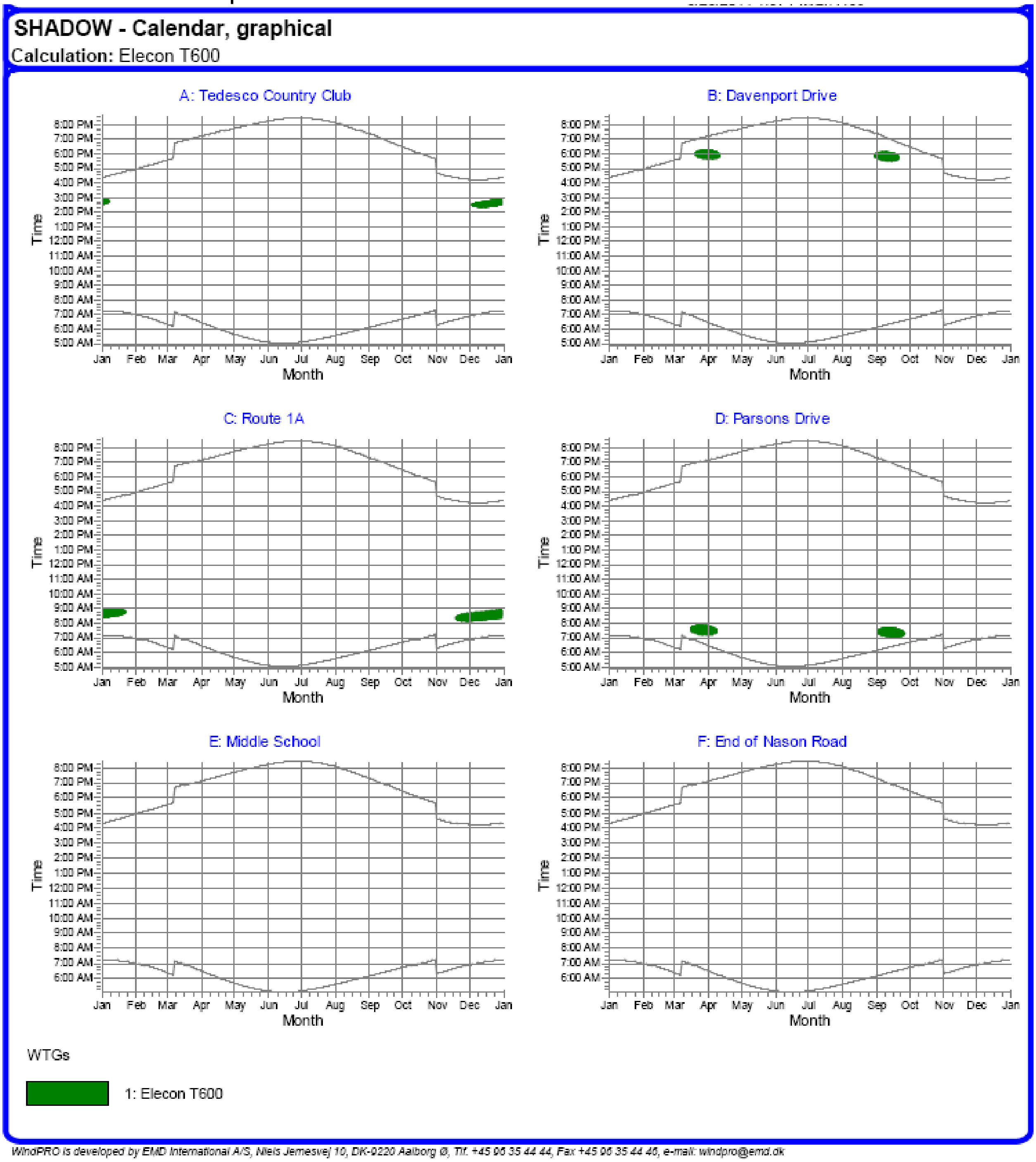
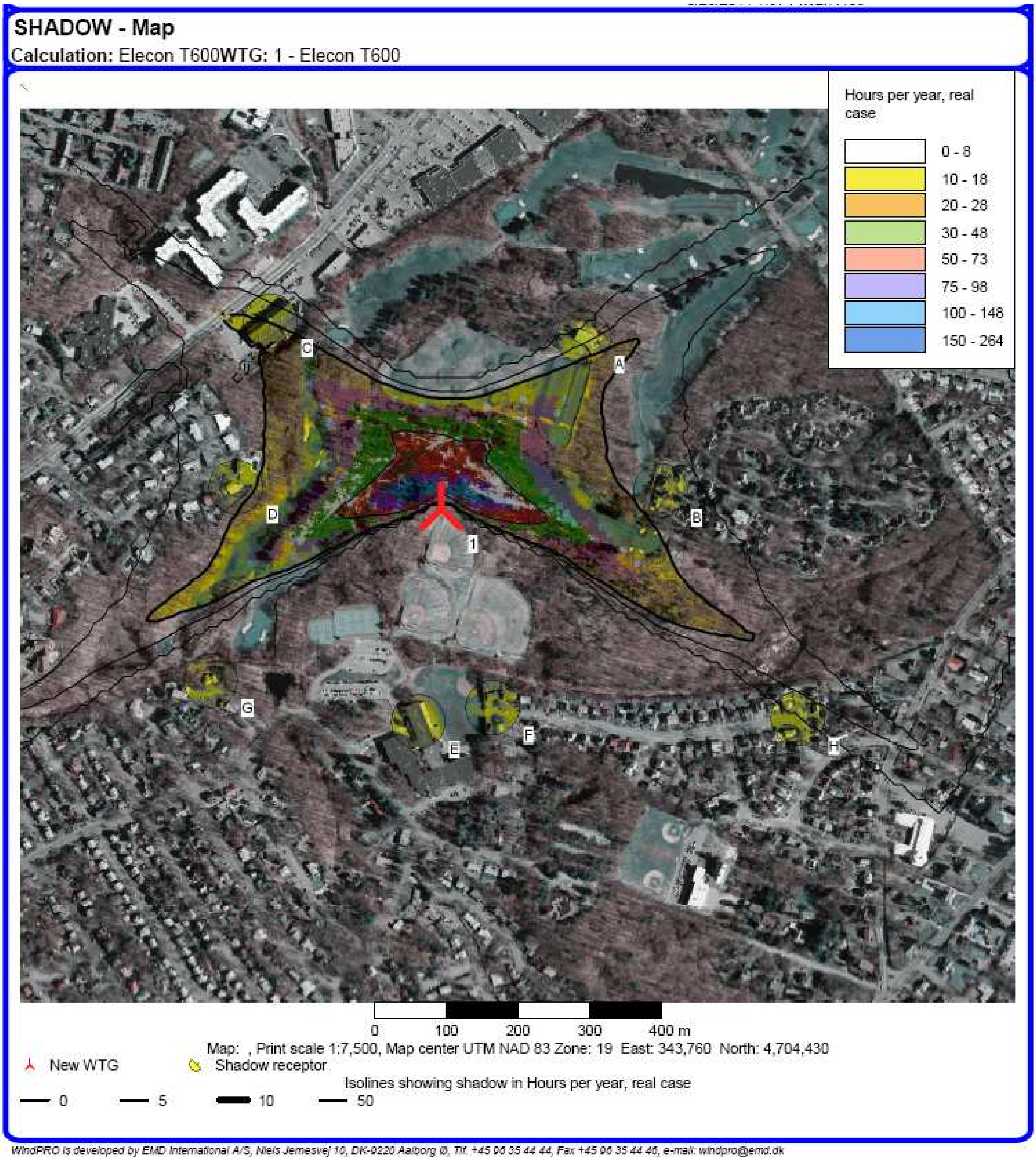


Figure 23: Shadow Map – Elecon 600kW



GE 1.5sle Shadow Flicker Study

Location of Receptors

Eight (8) residential receptors were analyzed to determine the effects on acoustics by the installation a 600 kW wind turbine; five (5) receptors were placed in the densest residential areas surrounding the proposed turbine, two (2) to the north, one at the Tedesco Country Club and One along Route 1A, and one (1) at the Middle School. These locations were chosen for analysis for the reason that they represent areas that may be influenced the most by the installation of a wind turbine generator and any potential flicker.

Results

The analyses for the eight (8) residential receptors previously described are displayed on the tables below. The estimated hours of shadow flicker for the analysis are listed in Table 17 and the estimated time of day and month of year in Table 18. The values/assumptions used in the calculations based on the “real case” scenario. The results are as follows:

Table 17: Estimated Hours/Year of Flicker Shadow Generated

Shadow Receptor	Location	Shadow Hours per Year (h/yr)	Shadow Days per Year (d/yr)	Max Shadow Hours per Day (h/d)
A	Tedesco Country Club	18:22	86	0:01
B	Davenport Drive	18:25	74	0:55
C	Rt.1A - Commercial Bldg.	22:16	99	0:52
D	Parsons Drive	21:42	80	1:00
E	Swampscott Middle School	0:00	0	0:00
F	End of Nason Road	0:00	0	0:00
G	Burke Drive	0:00	0	0:00
H	End of Neighborhood Road	0:00	0	0:00

Table 18: Estimated Time of Day and Month of Year Flicker Shadow Generation

Shadow Receptor	Day/Month	Time of Day	Days per Year	Avg. Duration of Flicker per Day (min)	Maximum Duration of Flicker (min)
A	11/09 - 02/02	13:47 - 15:04	86	13	61
B	03/21 - 04/26	17:13 - 18:09	37	14	55
	08/17 - 09/22	17:08 - 18:05	37	16	55
C	11/02 - 02/08	08:01 - 09:17	99	13	52
D	03/16 - 04/24	07:08 - 08:10	40	16	60
	08/18 - 09/27	07:03 - 08:04	40	17	60
E	-	-	-	-	-
F	-	-	-	-	-
G	-	-	-	-	-
H	-	-	-	-	-

Chart 10 is a graphical representation of the shadow effects on each of the receptors according to the date and time of day. The Shadow Map of Figure 24 illustrates the manner in which the turbine will cast a shadow over the surrounding terrain, in total hours per year. The chart and figure represent the worst case scenario (sun sitting all hours of day and turbine operating constantly) effects that the turbine will have on nearby residential dwellings.

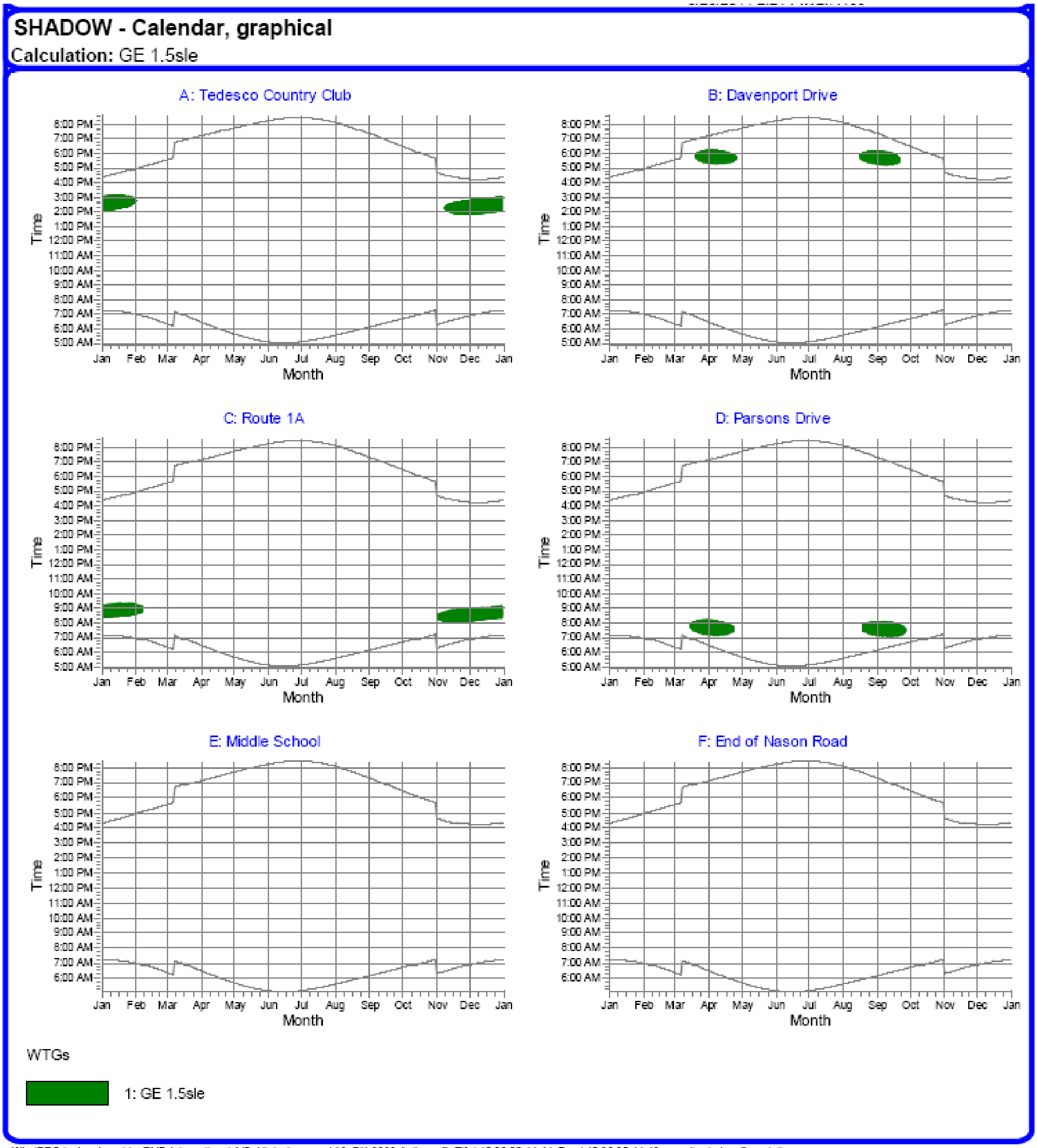
Conclusions

Using expected turbine operating hours, the most effected receptor was Receptor C, which sits approximately 1200 feet to the northwest of the proposed 1.5 MW GE wind turbine at the Commercial Building residing on Route 1A. It is anticipated that this location will receive a maximum of 22 hours of flicker per year, with an estimated maximum of 52 shadow minutes per day. It is projected Receptors A, B and C, which lie to the north, to the east on Davenport Drive and due west on Parsons Drive respectively, will cast between 18, 18, and 21 hours of flicker in a calendar year. The remaining four (4) receptors will not experience shadow effects from the installation of a 1.5 MW wind turbine.

It should be noted that although the generally accepted 30 hours per year threshold of flicker is surpassed in the majority of receptors there are no current regulations governing the hours/year of wind turbine flicker and the results of the shadow flicker analysis is calculated for real case scenario. This shadow calculation is a conservative estimate and actual flicker may be more or less. Also, mitigation measures, such as tree plantings and programmed temporary shut downs, can be applied if necessary.

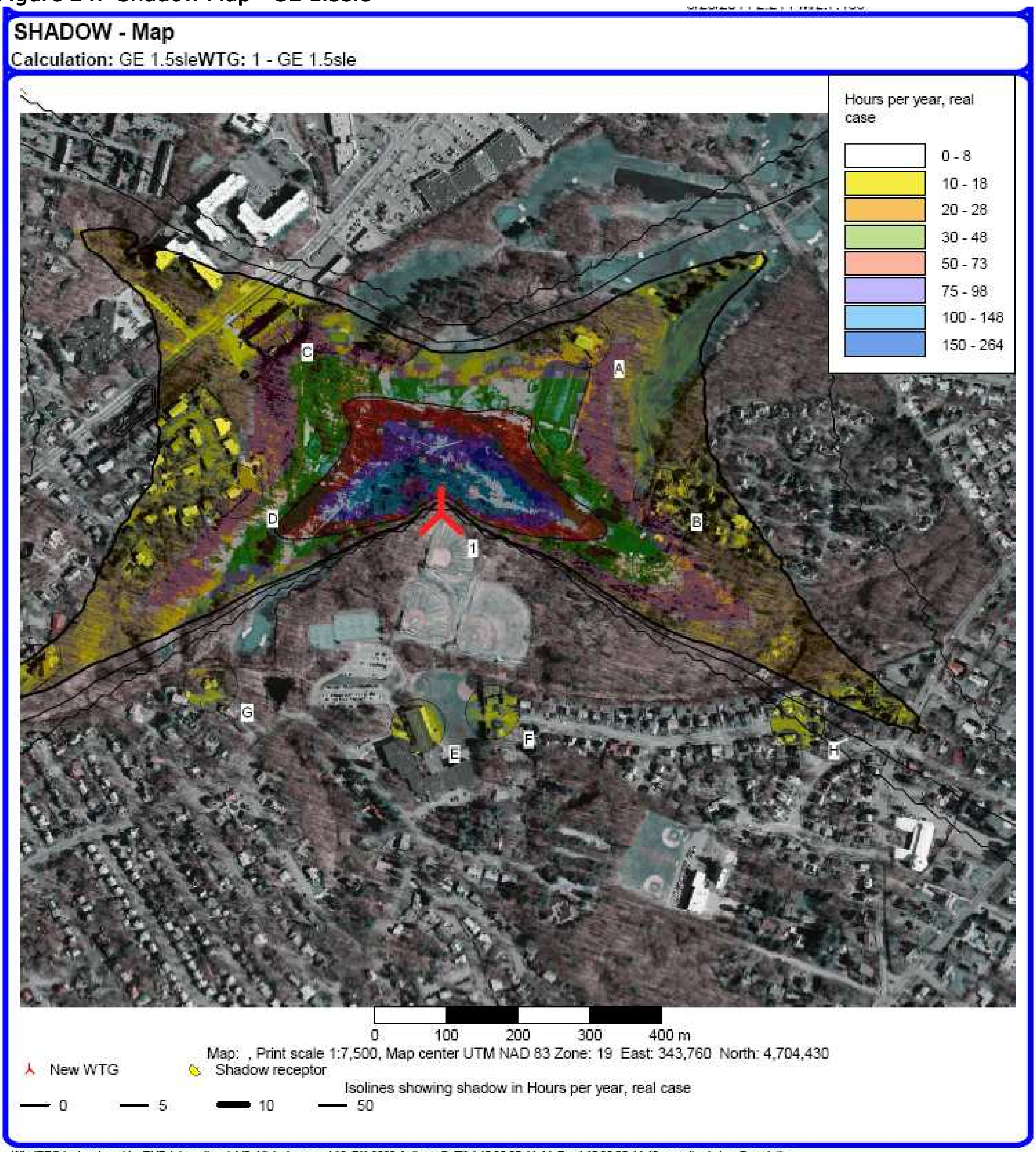
Complete WindPRO Shadow Flicker Results are attached in Appendix L

Chart 10: Calendar Map – GE 1.5sle



WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tlf. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

Figure 24: Shadow Map - GE 1.5sle



WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tlf. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

g. Acoustic Impact

See Section 3.b.ii **Potential Noise Impact**

h. Appropriateness and Community Impact of WTG Locations

A wind turbine installed at 207 Forrest Avenue, at Swampscott Middle School in Swampscott, Massachusetts is well suited. Swampscott Middle School will produce on-site renewable power generation to reduce greenhouse gas emissions, offset energy costs, as well as improve the institutions overall energy efficiency. The commission of a turbine, as a result of the efforts put forth by the Town, will serve as a positive example for not only the private industries of Swampscott but to neighboring communities.

The proposed location of the wind turbine generator within the town limits is quite appropriate. Swampscott Middle School sits on the north western outskirts of the town away from the densely populated neighborhoods. The turbine is proposed to be situated at a distance far enough from homes that the negative visual and audio affects of the turbine will be nominal to the nearby residents. The trees will help reduce the ambient noise produced by the turbine. The shadow/flicker caused by the blades passing between the sun and earth are minimal, affecting just a few small neighboring communities.

Once commissioned, the turbine and its accompanying instrumentation will be able to be used to directly educate the middle school students about wind technology, energy issues and serve as an educational model for the town to demonstrate a responsible approach to energy generation.

9. PROJECT SITE PLAN

a. Project Site Plan

See Appendix F.

10. WIND PLANT ENERGY PRODUCTION

The probability of Exceedance for Annual Energy Production was calculated to account for uncertainties due to measurement, modeling and wind speed variability and production losses that might impact the wind turbines performance. On the following table we have summarized the analysis that leads to a projection of a net annual energy production at both a P50 and P90 Exceedance level using the calculated long term correlated wind speeds at the appropriate heights.

Table 19: Summary of Probability of Exceedance Annual Energy Production

	Elecon 600 kW @ 60m		Unison 750 kW @ 60m		EWT 900 kW @ 75m		GE Energy 1.5MW @ 80m	
	P50	P90	P50	P90	P50	P90	P50	P90
Net Production (kWh)	1,100,912	901,449	1,317,973	1,075,497	1,747,888	1,442,394	3,770,887	3,092,499
Capacity Factor (%)	21	17	20	16	22	18	29	24

Complete P50 and P90 Turbine Production Calculations are included as Appendix M.

a. Behind the Meter Annual Energy Production

It is anticipated that all of the annual energy produced by will be consumed through net-metering at Swampscott Middle School.

b. Performance Degradation

11. WIND PLANT COSTS

a. Wind Plant Costs

To produce a sensible economic pro-forma estimated capital costs were determined for the design and construction phases of this project. These values were derived using the most up to date equipment pricing from existing projects constructed in the past two (2) years in the Commonwealth of Massachusetts, influential site characteristics, and wind industry best practices. Table 16 shows the estimated capital costs for the Design and Construction phases of the project.

Table 20: Estimated Total Construction Costs

Turbine	Hub Height	Cost
600 kW	60m	$2,200,000
750 kW	60m	$2,800,000
900 kW	75m	$3,000,000
1.5 MW	80m	$4,200,000

12. PROJECT REVENUES

a. Value of Power

The value of power used on site is calculated to be 13.2¢ per kWh utilizing net metering legislation and electrical records obtained from the Town.

b. Value of RECs

The assumed value of Renewable Energy Credits (RECs) sold over the life of the project are 3.0¢ per kWh. Currently long term REC purchase deals by private entities and other organizations, such as Mass Energy Consumers Alliance have recently made deals at 3.0¢ per kWh.

c. Value of Wind-Generated Electricity

The value of wind-generated electricity used on site is calculated to be 13.2¢ per kWh utilizing net metering legislation and electrical records obtained from Swampscott Middle School.

d. Cash Flows

A complete cash flow analysis is included as the Financial Pro-Forma in Appendix N A summary of the cash flow analysis for the 600 kW and 1.5MW turbines at the hub height explored both with and without funding from Massachusetts Clean Energy Center for both P50 and P90 Exceedance levels are in the Tables 25 and Table 26 below.

13. Financial Analysis

a. Assumptions Made

In the following tables, Table 22 and Table 23, we have summarized the overall results of the economic analysis based on a set of reasonable assumptions for the following factors:

- WTG installed cost. These values were derived using the most up to date equipment pricing from existing projects constructed in the past two (2) years in the Commonwealth of Massachusetts, influential site characteristics, and wind industry best practices.

- Annual wind turbine generator operation & maintenance and insurance costs with an inflation rate of 2.5%.

- The value of Renewable Energy Certificates (RECs) of 3.0¢/kWh.

- The average levelized value of each kWh of electricity produced by the WTG of 13.2¢/kWh, escalated at 2.5% annually. A ten year analysis of electricity prices yields an inflation exceeding an average of 2.5% annually. A conservative value of 2.5% has been used in this analysis.

- The possible maximum support from the Massachusetts Clean Energy Center to offset a portion of the purchase price. Below are the available incentive levels or Design & Construction grants.

Table 21: Design & Construction Incentive Levels, per Turbine

Capacity (kW)	Non-Public	Public
600	$208,325	$320,500
1000	$237,133	$364,820
1500+	$260,000	$400,000

- Discount future income at 6% for net present value calculations.

- Power Purchase Agreement (PPA) rate of 1.3¢/kWh was determined after speaking with numerous PPA providers. These PPA providers offered a hedge rate at 90% of the current rate. In a PPA, a third-party owner will purchase, construct, own, operate and maintain a wind energy system and will sell power to the Town at a discounted rate. For the purpose of a financial study, the savings of electricity (approximately 10%) is used as the avoided cost. As there is no capitol cost with a PPA structure, the payback is immediate, or zero years.

b. Life Cycle Cost

The life cycle cost for the wind plant configuration is summarized in Table 22 and Table 23.

c. Rate of Return

The rate of return for the wind plant configuration is summarized in Table 22 and Table 23.

Table 22: P50 Cost Analysis for Wind Turbine Generators installed at the Town of Swampscott Middle School @ P50 Exceedance under Financed Conditions

	Elecon 600 kW		Unison 750 kW		EWT 900 kW		GE 1.5MW	
	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding
Hub Height (m)	60	60	60	60	75	75	80	80
Total Installed Cost ($)	2,200,000	2,200,000	2,800,000	2,800,000	3,00,000	3,000,000	4,200,000	4,200,000
Annual Energy Output at P50 (kWh)	1,100,912	1,100,912	1,317,973	1,317,973	1,747,888	1,747,888	3,770,887	3,770,887
Electricity Cost ($/kWh)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Electricity Inflation Rate (%)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Bond Interest Rate (%)	5	5	5	5	5	5	5	5
Loan Term (yrs.)	20	20	20	20	20	20	20	20
REC Revenue ($/kWh)	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
MassCEC Funding ($)	0	320,500	0	339,855	0	355,677	0	400,000
Positive Return (yrs.)	20	18	21	19	18	16	13	12
NPV at year 20 ($)	-141,509	471,556	-321,157	328,931	225,251	905,604	2,560,099	3,325,235

Table 23: P90 Cost Analysis for Wind Turbine Generators installed at the Town of Swampscott Middle School at a P90 Exceedance under Financed Conditions

	Elecon T600		Unison 750 kW		EWT 900 kW		GE 1.5sle	
	without MassCEC Funding	with MassCEC Funding	with MassCEC Funding	without MassCEC Funding	with MassCEC Funding	without MassCEC Funding	without MassCEC Funding	with MassCEC Funding
Hub Height (m)	60	60	60	60	75	75	80	80
Total Installed Cost ($)	2,200,000	2,200,000	2,800,000	2,800,000	3,00,000	3,000,000	4,200,000	4,200,000
Annual Energy Output at P90 (kWh)	901,449	901,449	1,075,497	1,075,497	1,442,394	1,442,394	3,092,499	3,092,499
Electricity Cost ($/kWh)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Electricity Inflation Rate (%)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Bond Interest Rate (%)	5	5	5	5	5	5	5	5
Loan Term (yrs.)	20	20	20	20	20	20	20	20
REC Revenue ($/kWh)	0.035	0.035	0.030	0.030	0.030	0.030	0.035	0.035
MassCEC Funding ($)	0	320,500	0	339,855	0	355,677	0	400,000
Positive Return (yrs.)	24	21	25	23	21	19	15	14
NPV at year 20 ($)	-479,724	133,341	-732,307	-82,219	-292,754	387,600	1,409,805	2,174,941

d. Project Viability

The economic analysis for the installation of each a 600 kW, 750 kW, 900 kW and 1.5 MW wind turbine at the site as Identified above was based on a set of reasonable assumptions for numerous vital economic factors. Employing the maximum Massachusetts Clean Energy Center (MCEC) Commonwealth Wind Incentive Program funding, simple financing, and an annual inflation of electricity rate equal to 2.5% the economic return for this project is as follows:

Multiple financial scenarios have been considered for the proposed project. These scenarios evaluated each of the four size turbines under financed, non-financed and PPA conditions with and without maximum contributions from MassCEC for turbine erection. The best financial scenario for a municipally owned and operated wind turbine that conforms to applicable environmental and regulatory guidelines is for the EWT 900 kW turbine at a 75 m hub height at the Swampscott Middle School. This scenario yields a positive return at (16) sixteen years and a net present value at year twenty (20) equal to approximately $905,604 under financed conditions with maximum contribution from MassCEC.