ACOUSTIC STUDY OF THE UP-ISLAND SCHOOL DISTRICT WIND TURBINE

WEST TISBURY, MARTHA'S VINEYARD

December 2009

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ACOUSTIC STUDY OF THE UP-ISLAND SCHOOL DISTRICT WIND TURBINE WST TISBURY, MARTHA'S VINEYARD

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1.0 EXECUTIVE SUMMARY

The Up-Island Regional School District of Martha's Vineyard proposes to locate a 250-kW Wind Energy Solutions Model WES-30 wind turbine on the grounds of the West Tisbury School, north of the School. A study of the noise from the proposed wind turbine was performed. Existing sound levels on the school grounds were measured at three locations west, north and south of the proposed turbine, during the six-day period of November 24-30, 2009 when hub-height winds were 2 to 43 mph. Acoustic modeling was done for the design wind speed operating condition of 8 m/s (18 mph) that corresponds to a maximum sound pressure level of 45 A-weighted decibels (dBA) at a horizontal distance of 300 m. The study's conclusions are as follows:

- Existing L_{90} background sound levels[1] along the property boundaries range from 22 to 50 A-weighted[2] decibels (dBA). Existing L_{eq} average sound levels[3] in this area are 26 to 63 dBA. Existing L_{90} and L_{eq} sound levels increase as wind speed increases.

- The minimum L_{90} sound level measured during a period when the wind turbine would be operating was 22 dBA. This is the ambient level defined for use in the DEP Noise Policy. The DEP Noise Policy implements the State Noise Regulation (310 CMR 7.10).

- While the minimum measured 1-hour L_{90} sound level occurred on Thanksgiving Day, very low L_{90} sound levels in the 20s of dBA also occurred for several hours on the previous day, Wednesday November 25, when winds were strong enough at hub height to support turbine operation and wind speeds were above the turbine's design speed at which the turbine begins producing maximum sound power. That is, the selected ambient sound level for the DEP compliance demonstration is not a rare occurrence.

- Maximum turbine outdoor sound levels at the West Tisbury School property boundaries will be 53 dBA, and at the two nearest residences maximum turbine sound levels will be in the range of 43 to 46 dBA.

- The wind turbine will increase the ambient L_{90} sound level by 21 to 31 dBA along the property boundaries and at the two nearest residences. The DEP Noise Policy limit for property boundaries and nearest residences is an increase of no more than 10 dBA.

- The wind turbine Project does not comply with the Massachusetts DEP Noise Policy concerning the increase in sound level at the School's property boundaries and at the two nearest residences due to the close proximity of the proposed wind turbine to those locations and the very low background sound levels that exist in this area when the School is not in session.

[1] The L_{90} sound level represents the quietest 10 percent of any 1-hour period.

[2] The A-weighting scale is used in community noise studies to approximate the hearing response of the human ear.

[3] The L_{eq} sound level is the energy-average sound level for a 1-hour period.

2.0 COMMON MEASURES OF COMMUNITY SOUND

All sounds originate with a source – a human voice, vehicles on a roadway, or an airplane overhead. The sound energy moves from the source to a person's ears as sound waves, which are minute variations in air pressure. The loudness of a sound depends on the sound pressure level, defined as the ratio of two pressures: the measured sound pressure from the source divided by a reference pressure (the quietest sound we can hear). The unit of sound pressure is the decibel (dB). The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. On this scale, the quietest sound we can hear is 0 dB, while the loudest is 120 dB. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 dB to 100 dB.

A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. In terms of the human perception of sound, a halving or doubling of loudness requires changes in the sound pressure level of about 10 dB; 3 dB is the minimum perceptible change for broadband sounds, i.e. sounds that include all frequencies. Typical sound levels associated with various activities and environments are presented in Table 1. The distance to a major road often determines the acoustic environment in a semi-rural area such as the Kingston site, as roadway traffic establishes the background sound levels. In particular, noise from Route 3 determines much of the background level at locations near this site.

Sound exposure in a community is commonly expressed in terms of the A-weighted sound level (dBA); A-weighting approximates the frequency response of the human ear. Levels of many sounds change from moment to moment. Some are sharp impulses lasting one second or less, while others rise and fall over much longer periods of time. There are various measures of sound pressure designed for different purposes. To establish the background (ambient) sound level in an area, the $\mathbf{L_{90}}$ metric, which is the sound level exceeded 90 percent of the time, is typically used. The $\mathbf{L_{90}}$ can also be thought of as the level representing the quietest 10 percent of any time period and is a broadband sound pressure measure. The $\mathbf{L_{eq}}$, or equivalent sound level, is the steady-state sound level over a period of time that has the same acoustic energy as the fluctuating sounds that actually occurred during that same period. It is commonly referred to as the average sound level. Sound level measurements typically

include an analysis of the sound spectrum into its various frequency components to determine tonal characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines eleven octave bands from 16 to 16,000 Hz.

TABLE 1

VARIOUS INDOOR AND OUTDOOR SOUND LEVELS

Outdoor Sound Levels	Sound Pressure (μPa)		Sound Level (dBA)	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 5 m
Jet Over-Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area--Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
Quiet Urban Area -- Daytime	20,000	-	60	
		-	55	Quiet Conversation at 1m
Quiet Urban Area--Nighttime	6,325	-	50	Dishwasher Next Room
		-	45	
Suburban Area--Nighttime	2,000	-	40	Empty Theater or Library
		-	35	
Rural Area--Nighttime	632	-	30	Quiet Bedroom at Night
		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	Average Whisper
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	Human Breathing
Reference Pressure Level	20	-	0	Threshold of Hearing

Notes:
μPa - Micropascals describe sound pressure levels (force/area).
dBA - A-weighted decibels describe sound pressure on a logarithmic scale with respect to 20 μPa.

3.0 MASSACHUSETTS DEP NOISE POLICY

The Department of Environmental Protection (DEP) regulates noise through 310 CMR 7.10, "Air Pollution Control". The regulations are included in Appendix A. In these regulations "air contaminant" is defined to include noise and a condition of "air pollution" includes the presence of an air contaminant in such concentration and duration as to "cause a nuisance" or "unreasonably interfere with the comfortable enjoyment of life and property". Regulation 7.10 prohibits "unnecessary emissions" of noise. The DEP Noise Policy (Policy Statement 90-001, July 1, 1990) interprets a violation of this noise regulation to have occurred if the sound source causes either:

1) An increase in the broadband sound pressure level of more than 10 dBA above the ambient, or

2) A "pure tone" condition.[4]

The ambient background level is defined by DEP as the lowest L_{90} level measured during equipment operating hours.

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[4]A "pure tone" condition occurs when any octave band sound pressure level exceeds both of the two adjacent octave band sound pressure levels by 3 dB or more.

4.0 AMBIENT SOUND LEVEL AND WIND MEASUREMENTS

For the wind turbines examined in this report, operation occurs whenever the wind speed at the hub height (55 meters above grade) is greater than the turbine cut-in wind speed, which is 3 m/sec for the WES-30. The hub-height design wind speed of 8 m/s (18 mph) is the lowest speed at which maximum sound power occurs. The WES-30 turbine produces a maximum sound power level at the design wind speed, which is equivalent to a sound pressure level of 45 dBA at a horizontal distance of 300 m.

The proposed wind turbine will be located north of the West Tisbury School, as described in project feasibility report.[5] Figure 1 shows the location of the three sound monitoring stations north, south and west of the turbine tower. Sound level and wind measurements were made during the six-day period Tuesday November 24 through Monday November 30, 2009. A total of 144 hours of sound data were collected at the Locations #1 (to the south) and #2 (to the west). At Location #3 (to the north), equipment failure occurred on November 27 due to rain; the analyzer did however successfully record 66 hours of sound level measurements at Location #3. Wind speed for each hour was obtained from the 10-meter tower at the Martha's Vineyard Airport. The measured on-site wind data are presented in Table B-1 in Appendix B.

The DEP Noise Policy defines the ambient sound level as the lowest L_{90} level measured during hours when the new source (wind turbine in this case) could operate. In the residential areas adjacent to the Town land, this includes any hour day or night when the hub height winds are high enough to support turbine operation. To estimate hub height (55 m) wind speeds, the measured 10 m wind speed was extrapolated to hub height using the power law wind profile[6] with a power law exponent of 0.31 measured by the Renewable Energy Research Laboratory at its Hyannis wind monitoring site. The result of this calculation states that wind speed at the 55-meter hub height is on average 1.7 times the 10-meter wind speed. Thus a hub height wind speed of 3 m/s, or 7 mph, corresponding to the start of turbine operation for the WES-30 equates to a 10-m wind speed of 4 mph (7/1.7 = 4).

[5] Boreal Renewable Energy Development, "Draft Wind Turbine Feasibility Study – West Tisbury School," October 2009.

[6] International Electrotechnical Commission, International Standard IEC 61400-11, "Wind turbine generator systems- Part 11: Acoustic sound measurements techniques," 2006, page 20.

Long-term sound level monitoring was performed from Noon November 24, 2009 through Noon November 30, 2009 to document L_{90} and L_{eq} hourly sound levels, day and night, over a range of wind conditions. Ten meter average wind speeds were at or above the turbine cut-in speed for most of the monitoring period with winds as high as 25 mph on November 27. A 10-m wind of 25 mph corresponds to a hub-height wind of 42 mph. When the long-term sound monitoring stations were set up, skies were overcast, the temperature was about 52^0 F and the winds were 21 mph from the northwest. The audible sounds were wind in the trees, children in the playground, and intermittent traffic noise. Measured sound levels are higher at Location #1 next to the school building than at the other two locations due to the proximity of human activity.

All sound level measurements were taken with Larson Davis Model 820 real-time sound level analyzers, which are equipped with precision condenser microphones having an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. These meters meet or exceed all requirements set forth in the American National Standards Institute (ANSI) Standards for Type 1 for quality and accuracy. Prior to and immediately following both measurement sessions, the sound analyzers were calibrated (no level adjustment was required) with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). All instrumentation was laboratory calibrated per ANSI recommendations. For all measurement sessions, the microphone was fitted with an environmental windscreen to negate wind noise and mounted at a height of 1.3 meters above grade. Measurements were made away from any vertical reflecting surfaces in compliance with ANSI Standard S12.9.[7] The sound data are summarized in Appendix B.

Table B-1 summarizes the hourly measurements of L_{90} and L_{eq} sound levels at the three long-term monitoring stations and the estimated hourly average wind speed at hub height. The values that are in bold text in Table B-1 correspond to hours when the wind turbines will likely be operating (hub height wind speeds of 7 mph or greater). Wind speeds were high enough for turbine operation during all but nine hours of the sound monitoring program.

The data in Appendix B reveal existing L_{90} background sound levels at the three monitoring stations during times when winds are high enough to support wind turbine operation are in the range of 22 to

[7] Acoustical Society of America, ANSI Standard S12.9-1997/Part 2, "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-Term Wind-Area Sound."

50 dBA. Existing L_{eq} average sound levels in this area are 26 to 63 dBA. Existing sound levels increase with wind speed. The measured minimum and maximum sound levels at each location are summarized at the end of Table B-1 along with the slope (A) and intercept (B) of a simple linear equation for L_{90} sound level as a function of hub height wind speed (WS); the function form is $L_{90} = A*Log_{10}[WS] + B$.

The lowest L_{90} sound level during turbine operation, corresponding to the MassDEP ambient level, is 22 dBA, measured at Location #2 from 7 to 8 a.m. on November 26, 2009. During that hour the hub height wind speed is estimated to have been 10.2 mph and the turbine would have been operating. This sets the sound limit from turbine operation at the property line and nearest residence to no more than 32 dBA (= 22 + 10). While the minimum measured 1-hour L_{90} sound level occurred on Thanksgiving Day, very low L_{90} sound levels in the 20s of dBA also occurred for several hours on the previous day, Wednesday November 25, when winds were strong enough at hub height to support turbine operation and wind speeds were above the turbine's design speed at which the turbine begins producing maximum sound power. That is, the selected ambient sound level for the DEP compliance demonstration is not a rare occurrence.

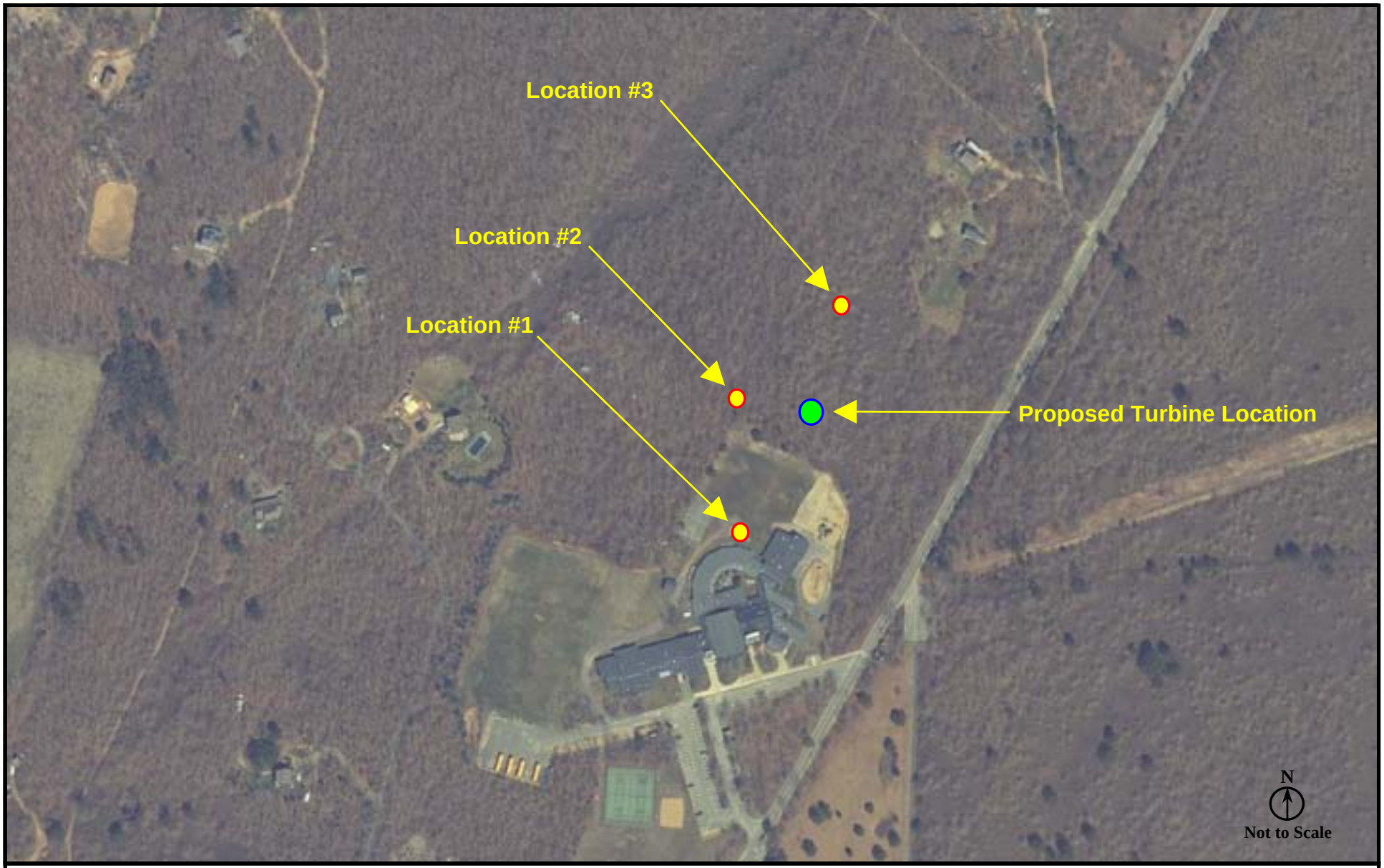

Figure 1.

Sound Monitoring Locations
West Tisbury Wind Turbine

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5.0 CALCULATED FUTURE SOUND LEVELS

5.1 Methodology

Future sound levels from the proposed WES-30 wind turbine on the school property lines and beyond were calculated with the Cadna/A acoustic model. Cadna/A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613[8]. Atmospheric absorption, the process by which sound energy is absorbed by the air, was calculated using ANSI S1.26-1995.[9] Absorption of sound assumed standard day conditions and is significant at large distances. Ground surfaces were assumed to be mixed ground consisting of both hard and porous (vegetated) surfaces.[10] This is a reasonable worst-case assumption and approximates winter frozen ground conditions in the area between the turbine and the nearest homes. Digital terrain heights were extracted from MassGIS. The model assumes favorable sound propagation as occurs with a ground-based temperature inversion, such as might occur on a clear night. At other times, atmospheric turbulence and wind shadow effects will reduce sound levels by 5 to 20 dBA from those presented below.

5.2 Results and Conclusions

Figure 2 shows color-coded decibel contours (5 feet above ground level) for the maximum sound levels from the WES-30 wind turbine (operating at or above its design wind speed), the School property lines and the location of the nearest residences. Note that Figure 2 assumes the sound receiving location is always downwind of the wind turbine, and the figures present a composite worst-case in which all locations are simultaneously downwind of the wind turbine.

The acoustic modeling results are summarized in Table 3 and provide the highest predicted turbine sound levels at the two nearest West Tisbury School property lines and at the two nearest residences; Table 3 also lists the maximum increase in the ambient sound level under the DEP Noise Policy. Maximum wind turbine outdoor sound levels at the property lines will be 53 dBA and at the two

[8] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.

[9] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.

[10] Ground absorption factor G set equal to 0.5 in Cadna-A.

nearest residences maximum sound levels will be 43 to 46 dBA. The maximum sound level increases are in the range of 24 to 31 dBA and far above the maximum 10-dBA increase allowed in the DEP Noise Policy. The wind turbine Project does not comply with the Massachusetts DEP Noise Policy concerning the increase in sound level at the School's property boundaries and at the two nearest residences due to the close proximity of the proposed wind turbine to those locations and the very low background sound levels that exist in this area when the School is not in session.

TABLE 3

DEP NOISE POLICY COMPLIANCE AT NEARBY RESIDENCES AND PROPERTY LINES FOR THE WES30 250-KW TURBINE CUT-IN WIND SPEED CONDITION (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Closest Residence on Dr. Fisher Road	21.8	46.1	46.1	24.3
Closest Residence on Halcyon Way	21.8	42.9	42.9	21.1
Eastern Property Line	21.8	53.0	53.0	31.2
Western Property Line	21.8	52.6	52.6	30.8

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

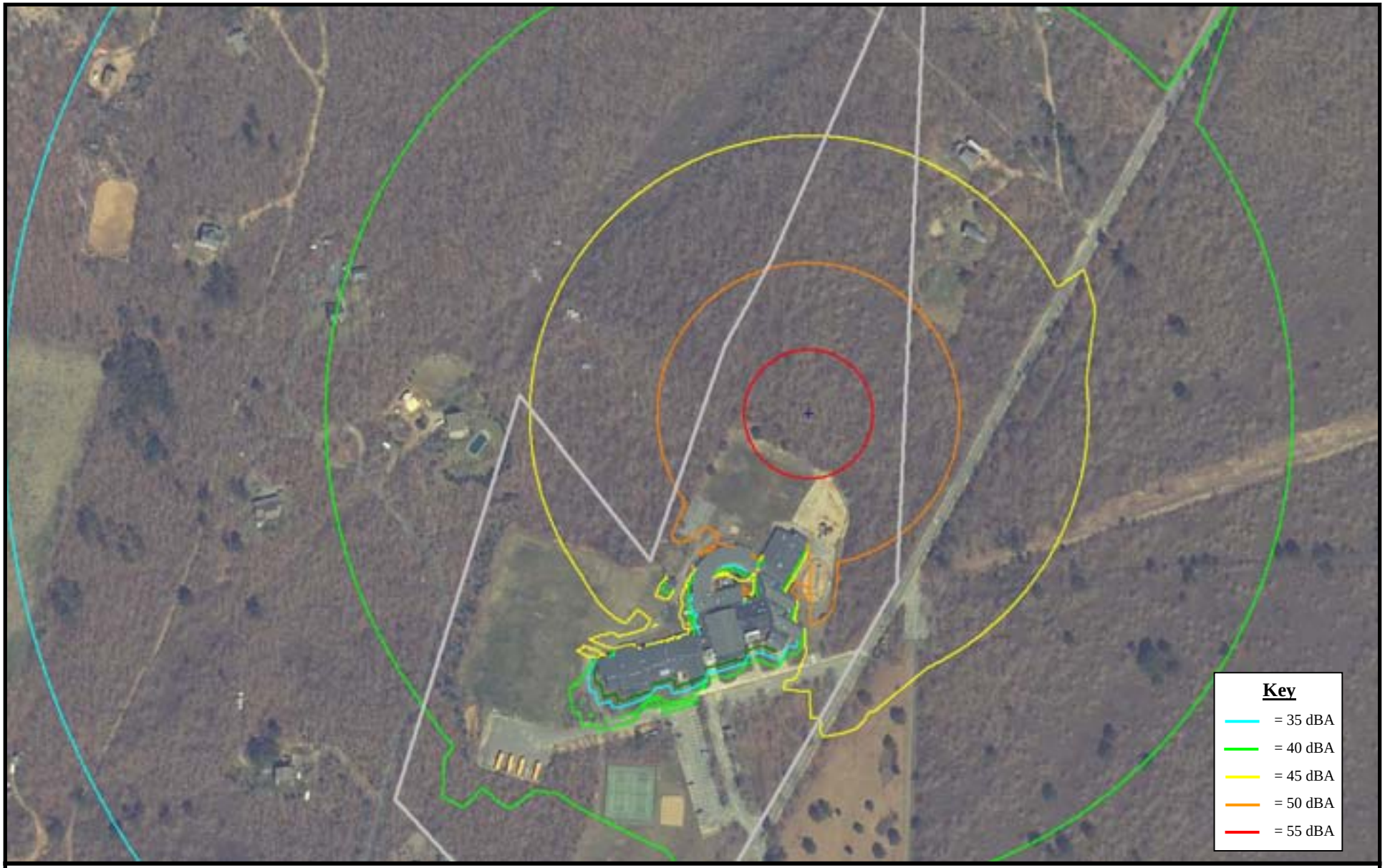

Figure 2.

Maximum Sound Levels (dBA)
West Tisbury Wind Turbine

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APPENDIX A

MASSACHUSETTS DEP NOISE POLICY

MADEP NOISE POLICY

Sound

Background

Sound is a type of air pollution that results from sounds that cause a nuisance, are or could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business. Types of sounds that may cause sound include:

- "Loud" continuous sounds from industrial or commercial activity,demolition, or highly amplified music;
- Sounds in narrow frequency ranges such as "squealing" fans or other rotary equipment; and
- Intermittent or "impact" sounds such as those from pile drivers, jackhammers, slamming truck tailgates, public address systems,
etc.

Policy

A sound source will be considered to be violating the Department's sound regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient,
   or
2. Produce a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. "Ambient" is defined as the background A-weighted sound level that is exceeded 90% of the time, measured during equipment operating hours. "Ambient" may also be established by other means with consent of the Department.

For more information:
For complaints about specific sound sources, call the Board of Health for the municipality in which the sound source is located. To learn more about responding to sound, odor and dust complaints or to request state assistance or support, please contact the service center in the nearest DEP regional office.

- Central Region, Worcester: (508) 792-7683
- Northeast Region, Wilmington: (978) 661-7677
- Southeast Region, Lakeville: (508) 946-2714
- Western Region, Springfield: (413) 755-2214

This Policy was originally adopted by the MA Department of Public Health in the early 1970's. It was reaffirmed by DEP's Division of Air Quality Control on July 1, 1990, and has remained in effect.

APPENDIX B

MEASURED SOUND LEVEL AND WIND DATA

Table B-1.
Measured Sound Levels and Wind Speeds

	Hour Starting	Wind Speed	Wind Speed	Location #1		Location #2		Location #3	
Date	Time (EST)	10-m (mph)	55-m Hub (mph)	L90 (dBA)	Leq (dBA)	L90 (dBA)	Leq (dBA)	L90 (dBA)	Leq (dBA)
11/24/2009	12	20	**34.0**	46.7	ND	45.3	52.7	44.3	49
11/24/2009	13	21	**35.7**	47.8	58.2	46.3	51.7	46.2	50.4
11/24/2009	14	22	**37.4**	48	51.1	46.2	50.8	46.6	51
11/24/2009	15	20	**34.0**	46.1	48.9	43.1	47.1	43.2	47.6
11/24/2009	16	20	**34.0**	45.4	48.8	41.9	46.4	42.3	46.5
11/24/2009	17	16	**27.2**	44.2	47.2	39.3	45.7	39.3	45.3
11/24/2009	18	17	**28.9**	43.8	46.1	38.3	44.2	37.7	42.8
11/24/2009	19	21	**35.7**	44	46.2	38.5	47.3	38.1	43.6
11/24/2009	20	16	**27.2**	43.6	45.5	37.2	46.7	36.2	42.6
11/24/2009	21	15	**25.5**	44	45.3	36.7	44.8	35.5	40.3
11/24/2009	22	13	**22.1**	43.5	45.2	35.4	44.3	34.2	40.4
11/24/2009	23	14	**23.8**	43.2	44.4	33.4	42.2	31.6	37.3
11/25/2009	0	12	**20.4**	43.2	44.1	31.6	40.9	28.4	35
11/25/2009	1	12	**20.4**	43.2	44.1	31.9	40.5	28.3	33.2
11/25/2009	2	15	**25.5**	43.2	44	32.6	40.7	28.7	33.9
11/25/2009	3	13	**22.1**	43.5	44.4	32.4	37.7	29	34.5
11/25/2009	4	15	**25.5**	43.4	44.3	32.2	37.1	28.2	33.7
11/25/2009	5	12	**20.4**	43	44.1	32.2	37.2	27.8	33.5
11/25/2009	6	12	**20.4**	41.2	46	31.7	40.3	28.6	36.6
11/25/2009	7	12	**20.4**	41.4	45.5	35.8	41.4	32.1	39.1
11/25/2009	8	10	**17.0**	42	46.1	37.9	43.9	34.7	41.5
11/25/2009	9	9	**15.3**	42.3	46.9	37.6	ND	35.2	43.6
11/25/2009	10	10	**17.0**	41.5	46.6	35.4	ND	33.2	40.2
11/25/2009	11	15	**25.5**	41.7	46.2	35.8	ND	34.4	41.5
11/25/2009	12	10	**17.0**	42.2	45.6	35	ND	33.6	41.4
11/25/2009	13	9	**15.3**	41.6	45.6	32	ND	31.9	40.7
11/25/2009	14	8	**13.6**	43.6	46	30.8	ND	32.6	40.6
11/25/2009	15	7	**11.9**	43.3	45.6	29.9	ND	31.4	40.5
11/25/2009	16	5	**8.5**	43.4	46.4	31.8	ND	32.8	42.6
11/25/2009	17	5	**8.5**	43.2	46.5	32	ND	31.1	43.2
11/25/2009	18	5	**8.5**	43.2	47.5	30.6	ND	31.9	45.1
11/25/2009	19	5	**8.5**	43.2	44.9	31.7	ND	31.6	39.1
11/25/2009	20	3	5.1	43.2	45.5	28.7	ND	29	39.7
11/25/2009	21	1	1.7	43.1	44.4	28.2	ND	27.8	36.7
11/25/2009	22	3	5.1	43.2	44.3	22.8	ND	27.5	35
11/25/2009	23	3	5.1	43.1	43.8	23.6	ND	27.3	33.3
11/26/2009	0	3	5.1	43.3	44.2	28.1	37.5	28.3	33.4
11/26/2009	1	3	5.1	44.1	44.5	27.9	32.8	28	32.4
11/26/2009	2	5	**8.5**	44	44.4	24.3	28.9	26.7	30.7
11/26/2009	3	3	5.1	43.2	44.2	23.4	29	25.9	31.3
11/26/2009	4	1	1.7	43.2	44	23.6	27.2	26.4	30.4

Table B-1.
Measured Sound Levels and Wind Speeds

	Hour Starting	Wind Speed	Wind Speed	Location #1		Location #2		Location #3	
Date	**Time (EST)**	**10-m (mph)**	**55-m Hub (mph)**	**L90 (dBA)**	**Leq (dBA)**	**L90 (dBA)**	**Leq (dBA)**	**L90 (dBA)**	**Leq (dBA)**
11/26/2009	5	3	5.1	43	43.7	22.5	25.7	27.8	32.1
11/26/2009	6	7	**11.9**	41.1	44.5	23.9	30.4	28	34.6
11/26/2009	7	6	**10.2**	40.1	51.5	21.8	34.7	27.1	44.7
11/26/2009	8	8	**13.6**	39.4	48.9	22.1	29.1	26.7	39.7
11/26/2009	9	7	**11.9**	40.1	43.9	25.4	33.4	29.8	40.7
11/26/2009	10	6	**10.2**	39.3	46.3	28.1	31.5	26.8	38.7
11/26/2009	11	7	**11.9**	39.3	45.9	27.7	31.3	26.4	41.6
11/26/2009	12	9	**15.3**	40	46.3	29.2	33.6	26.4	36.3
11/26/2009	13	7	**11.9**	40.6	44	26.7	29.6	26.5	36.4
11/26/2009	14	10	**17.0**	43.3	46.3	29.2	32.2	27.7	40.7
11/26/2009	15	10	**17.0**	43.3	45.4	28.9	31.9	28.5	38.7
11/26/2009	16	7	**11.9**	43.2	44.8	28.5	31	26.7	37
11/26/2009	17	9	**15.3**	43.2	45	28.7	32.6	27.4	38.6
11/26/2009	18	9	**15.3**	43.2	47	29.2	34	27.7	44.4
11/26/2009	19	10	**17.0**	43.1	44.6	28.6	33.6	27.6	37.6
11/26/2009	20	13	**22.1**	43.2	44.5	28.5	30.9	29	36.5
11/26/2009	21	14	**23.8**	43.2	45.1	28.3	32.5	30.2	39
11/26/2009	22	13	**22.1**	43.3	45.1	28.4	32.4	31.3	38.5
11/26/2009	23	14	**23.8**	43.2	44.6	26.6	30.7	30.3	37.5
11/27/2009	0	14	**23.8**	43.5	44.4	26.5	29.5	30.2	35.4
11/27/2009	1	16	**27.2**	44.1	44.9	26.3	30.5	32.6	38.9
11/27/2009	2	15	**25.5**	44.2	45.3	24.6	32.8	33.8	40.4
11/27/2009	3	13	**22.1**	45.1	47.4	33.5	42.7	40.5	49.6
11/27/2009	4	15	**25.5**	44.6	46	31.6	39.7	39.3	46.7
11/27/2009	5	16	**27.2**	43.7	44.9	27.7	36.9	33.9	43.4
11/27/2009	6	12	**20.4**	42.5	45.4	35	40.4	*Equipment failure due to rain*	
11/27/2009	7	14	**23.8**	44.2	46.6	38.1	42.3		
11/27/2009	8	13	**22.1**	43.1	46.2	33.2	39		
11/27/2009	9	13	**22.1**	42.9	51.5	29.6	35.2		
11/27/2009	10	14	**23.8**	43.2	47.4	30.2	34.8		
11/27/2009	11	14	**23.8**	44.4	47.4	34.7	40.4		
11/27/2009	12	21	**35.7**	44.6	47.8	32.2	39.6		
11/27/2009	13	22	**37.4**	45	47.2	24.7	38.7		
11/27/2009	14	15	**25.5**	46.4	49	33.1	41.3		
11/27/2009	15	17	**28.9**	45.4	47.8	28.8	35.6		
11/27/2009	16	16	**27.2**	44.5	49.2	28	37.2		
11/27/2009	17	21	**35.7**	44.7	48.5	30.6	39.4		
11/27/2009	18	18	**30.6**	44.8	47.5	28.7	38.3		
11/27/2009	19	15	**25.5**	46	48.7	29.9	40.6		
11/27/2009	20	17	**28.9**	46.3	49	33.1	40.5		
11/27/2009	21	24	**40.8**	48.2	51.7	33.9	44.4		

Table B-1.
Measured Sound Levels and Wind Speeds

	Hour Starting	Wind Speed	Wind Speed	Location #1		Location #2		Location #3	
Date	Time (EST)	10-m (mph)	55-m Hub (mph)	L90 (dBA)	Leq (dBA)	L90 (dBA)	Leq (dBA)	L90 (dBA)	Leq (dBA)
11/27/2009	22	25	**42.5**	48.6	52.9	35.7	43.1		
11/27/2009	23	18	**30.6**	47.7	51.6	32.2	43		
11/28/2009	0	21	**35.7**	49	53.2	34.9	44.8		
11/28/2009	1	24	**40.8**	50.1	53.6	39.1	45.9		
11/28/2009	2	23	**39.1**	49.7	54.2	37.7	46.1		
11/28/2009	3	24	**40.8**	50.1	63.1	37.5	47.4		
11/28/2009	4	21	**35.7**	50.4	59.2	39.1	46.6		
11/28/2009	5	13	**22.1**	49.7	60.6	39.1	45.9		
11/28/2009	6	25	**42.5**	48.6	59.6	39	44.7		
11/28/2009	7	18	**30.6**	45.3	55	33.2	42.9		
11/28/2009	8	17	**28.9**	45.3	56.6	34.1	42		
11/28/2009	9	21	**35.7**	45.1	60.1	34.1	42.2		
11/28/2009	10	17	**28.9**	44.5	59.5	32.2	39.6		
11/28/2009	11	20	**34.0**	46.4	61	35.3	42.4		
11/28/2009	12	25	**42.5**	48.4	61.4	37.8	44.7		
11/28/2009	13	24	**40.8**	48.4	63.2	37.9	45.1		
11/28/2009	14	21	**35.7**	46.6	58.7	35.4	42.3		
11/28/2009	15	18	**30.6**	45.7	56.2	34.9	41.4		
11/28/2009	16	20	**34.0**	45.5	52.9	36.3	43.1		
11/28/2009	17	25	**42.5**	46.5	55.3	38.9	46.3		
11/28/2009	18	22	**37.4**	46.5	54.4	37.5	45.5		
11/28/2009	19	21	**35.7**	46.5	58.1	40	45.3		
11/28/2009	20	22	**37.4**	45.6	57.8	37.6	44.2		
11/28/2009	21	18	**30.6**	46	55.9	39	45		
11/28/2009	22	17	**28.9**	46	58.1	40	45.3		
11/28/2009	23	15	**25.5**	45.3	55.2	36	42.1		
11/29/2009	0	12	**20.4**	44.8	54.6	35.2	40.7		
11/29/2009	1	12	**20.4**	44.5	52.3	34.7	40.6		
11/29/2009	2	16	**27.2**	44.4	55.6	33.7	39.9		
11/29/2009	3	12	**20.4**	44.5	54	35	40.2		
11/29/2009	4	10	**17.0**	44.2	51.6	34.1	39.5		
11/29/2009	5	9	**15.3**	43.6	50.9	32.3	37.5		
11/29/2009	6	7	**11.9**	42.1	47.8	29.2	33.8		
11/29/2009	7	12	**20.4**	42.3	48.8	31.2	37.8		
11/29/2009	8	10	**17.0**	42	52	33.4	43.7		
11/29/2009	9	12	**20.4**	42.3	53.3	35.9	44.6		
11/29/2009	10	9	**15.3**	42	52	34.2	47		
11/29/2009	11	13	**22.1**	42	49	34.2	44.1		
11/29/2009	12	15	**25.5**	42.3	50.6	36	44.5		
11/29/2009	13	15	**25.5**	43.4	50.6	38.1	45		
11/29/2009	14	9	**15.3**	44.6	54.2	36.2	49.8		

Table B-1.
Measured Sound Levels and Wind Speeds

	Hour Starting	Wind Speed	Wind Speed	Location #1		Location #2		Location #3	
Date	**Time (EST)**	**10-m (mph)**	**55-m Hub (mph)**	**L90 (dBA)**	**Leq (dBA)**	**L90 (dBA)**	**Leq (dBA)**	**L90 (dBA)**	**Leq (dBA)**
11/29/2009	15	8	**13.6**	44.1	51.2	32.7	45.4		
11/29/2009	16	8	**13.6**	43.6	50.8	32.7	47.1		
11/29/2009	17	7	**11.9**	43.6	48.7	30.4	43.7		
11/29/2009	18	5	**8.5**	44	44.9	29.8	35.3		
11/29/2009	19	5	**8.5**	44.1	45.9	29.3	35.5		
11/29/2009	20	7	**11.9**	44.1	48.1	28.4	33.3		
11/29/2009	21	7	**11.9**	44.1	46	27.6	31.4		
11/29/2009	22	8	**13.6**	44.2	48.7	28.5	31.8		
11/29/2009	23	6	**10.2**	44.5	48.6	27.6	29.7		
11/30/2009	0	7	**11.9**	44.6	50.4	27.9	30.4		
11/30/2009	1	13	**22.1**	45.1	51.7	28.7	33.8		
11/30/2009	2	12	**20.4**	45.3	55.1	31.7	36.5		
11/30/2009	3	17	**28.9**	45.2	53.7	31.8	36.6		
11/30/2009	4	13	**22.1**	44.8	50.3	31.1	36.2		
11/30/2009	5	14	**23.8**	45.3	51.9	34.6	40		
11/30/2009	6	14	**23.8**	44.3	53.8	35.2	41.5		
11/30/2009	7	16	**27.2**	44.4	53.5	36.5	42.6		
11/30/2009	8	16	**27.2**	46.2	54.1	39.2	44.8		
11/30/2009	9	16	**27.2**	45.8	55.7	38.2	48.8		
11/30/2009	10	15	**25.5**	48.5	61	38.9	48.8		
11/30/2009	11	18	**30.6**	47.6	59.8	39.8	48.3		
Minimum				**39.3**	**43.7**	**21.8**	**25.7**	**25.9**	**30.4**
Maximum				**50.4**	**63.2**	**46.3**	**52.7**	**46.6**	**51.0**
Slope				**4.6**		**12.0**		**10.4**	
Intercept				**38.3**		**17.1**		**19.4**	
Wind speeds in bold are at or above the lowest cut-in speed of 4 mph.					ND = No Data				