ACOUSTIC STUDY OF THE GREY BARN FARM WIND TURBINE

CHILMARK, MASSACHUSETTS

June 2013

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ACOUSTIC STUDY OF THE GREY BARN FARM WIND TURBINE CHILMARK, MASSACHUSETTS

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1.0 EXECUTIVE SUMMARY

An acoustic study was performed for the proposed wind turbine at the Grey Barn Farm in Chilmark, Massachusetts. The proposed turbine is a Northern Power NW100 100-kilowatt (kW) wind turbine with a 30-meter (m) hub height. Existing sound levels and wind speeds on the project site, and sound levels in nearby residential areas, were measured over a 17-day period from March 4 through March 21, 2013. The study's conclusions are as follows:

- Existing background L_{90}[1] sound levels during times when winds are high enough to support wind turbine operation are generally in the range of 25 to 60 dBA. An analysis of the L_{90} sound levels found them to range from 29.0 dBA for the turbine at 6 m/s (13.4 mph) wind speed to 37.3 dBA for the turbine design wind speed of 10 m/s (22.4 mph). All wind speed values are at hub height.

- The *ambient sound levels* used for the DEP compliance analysis are therefore 29.0 dBA for low wind conditions and 37.3 dBA for the design wind conditions. The DEP Noise Policy limits the increase in the ambient sound level to no more than 10 dBA at the nearest inhabited (residential) property line and at the nearest residence. The Noise Policy does not apply to the uninhabited property line to the northeast because the abutting land, owned by the Massachusetts Farm and Conservation Land Trust, is designated solely for agricultural use and residential use is precluded.

- The study results are conservative for three reasons: 1) Turbine vendor-guaranteed maximum sound power levels, plus an uncertainty factor, were assumed; 2) The acoustic model assumed favorable sound propagation with a ground-based temperature inversion, such as occurs on a clear night; and 3) winter frozen ground conditions were assumed with no attenuation from trees or vegetation.

- Wind turbine outdoor sound levels at the closest residences (40 Kenasaoome Way and 30 South Road) will be 32.9 to 38.6 dBA and will increase the ambient sound level by 3.7 to 5.4 dBA. The maximum wind turbine sound levels at the inhabited and uninhabited property lines will be 43.5 and 51.6 dBA, respectively, and will increase the ambient level by 9.3 and 16.9 dBA, respectively. The uninhabited property line sound level increase occurs at a property designated for agricultural use. All predicted sound level increases are expected to comply with the DEP Noise Policy. Sound level increases in other residential areas that are farther from the turbine will be less. Predicted octave band sound levels confirm the project will not create pure tones.

- In summary, the NW 100-kW wind turbine proposed at Grey Barn Farm is expected to fully comply with the Massachusetts DEP Noise Policy. Compliance with this policy provides a reasonable basis for concluding the community wind project will not create a nuisance.

[1] The L_{90} sound level represents the quietest 10 percent of the measurement 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**[2], which has units of 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. Every 10-dB increase is perceived as a doubling of loudness. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 dB to 85 dB.

A property of the decibel scale is that the numerical values of two separate sounds do not directly add. 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) on the decibel scale, not a doubling to 140 dB. In terms of sound perception, 3 dB is the minimum change most people can detect. 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 existing sound levels at a wind energy project site are determined primarily by the proximity to roads and highways (the source of traffic noise) and by the wind speed (the source of wind turbulence noise in trees and vegetation).

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 and correlates well with people's perception of loudness. There is also a C-weighting scale that was designed for exposure to very loud sounds, namely those over 85 decibels.[3] It is important to use the correct A-weighting scale in wind turbine sound studies where the audible sounds are in the low range of 25 to 45 decibels. If instead, for example, one applied the C-weighting scale, such an inappropriate choice would artificially inflate low-frequency sound and would not represent how wind turbine sounds are heard.

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[2] The sound pressure level is defined as $20*\log_{10}(P/P_o)$ where P is the sound pressure and P_o is the reference pressure of 20 micro-Pascals (20 μPa), which by definition corresponds to 0 dB.

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] Bolt, Beranek, and Newman, Inc., Handbook of Noise Ratings, NASA-CR-2376, April 1974, page 21.

The level of most 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. The equivalent sound level $\mathbf{L_{eq}}$ 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 energy-average sound level and it includes in its measure all of the sound we hear. EPA has determined that the L_{eq} average sound level correlates best with how people perceive and react to sound.[4]

To establish the background sound level in an area, the $\mathbf{L_{90}}$ metric, which is the sound level exceeded 90% of the time, is typically used. The L_{90} can be thought of as the level representing the quietest 10% of any time interval because 90% of existing acoustic energy has been eliminated. The L_{90} is a broadband sound pressure measure. By definition, the L_{90} metric will filter out brief, loud sounds, such as intermittent traffic on a nearby roadway.

Sound pressure 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. In the physiology of human hearing, every octave jump of a tone corresponds to a doubling of the sound frequency in Hz. For example, Middle-C on a piano has a frequency of approximately 260 Hz. High-C, one octave above, has a frequency of approximately 520 Hz. The hearing range for most people is 20 Hz to 20,000 Hz. In acoustic studies, the sound spectrum is divided into octave bands with center frequencies that are an octave apart, specifically the bands centered on 16 Hz, 31.5 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, and 16000 Hz.

Sound power level is on a decibel scale[5], leading to possible confusion since sound power (energy density) and sound pressure (what we hear) are not the same. An acoustic model uses the sound power level of a wind turbine along with other assumptions to calculate the sound pressure level heard at a receiver located a certain distance from the wind turbine.

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[4] U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," Publication EPA-550/9-74-004.

[5] The sound power level is defined as $10*\log_{10}(W/W_o)$, where W is the sound power of the source in Watts and W_o is the reference power of 10^{-12} Watts.

3.0 NOISE REGULATIONS AND CRITERIA

3.1 Massachusetts DEP Noise Policy

The Massachusetts Department of Environmental Protection (DEP) regulates noise through 310 CMR 7.10, "Air Pollution Control". 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.[6]

The ambient background level is defined by DEP as the lowest L_{90} level measured during equipment operating hours. The Noise Policy is applied to the site evaluate noise impacts at both the property line and the nearest occupied residence or other sensitive receptor. However, a noise source that would be located in an area that is not likely to be developed for residential use in the future (e.g., due to abutting wetlands or similarly undevelopable areas), or in a commercial or industrial area with no sensitive receptors may not be required to mitigate its noise impact on those areas, even though projected noise levels at the facility's property line may exceed 10 dB. A copy of the Noise Policy is provided in Appendix A.

3.2 Local Noise Regulations

There is no local regulation that has quantitative noise limits applicable for this type of sound source.

[6]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.

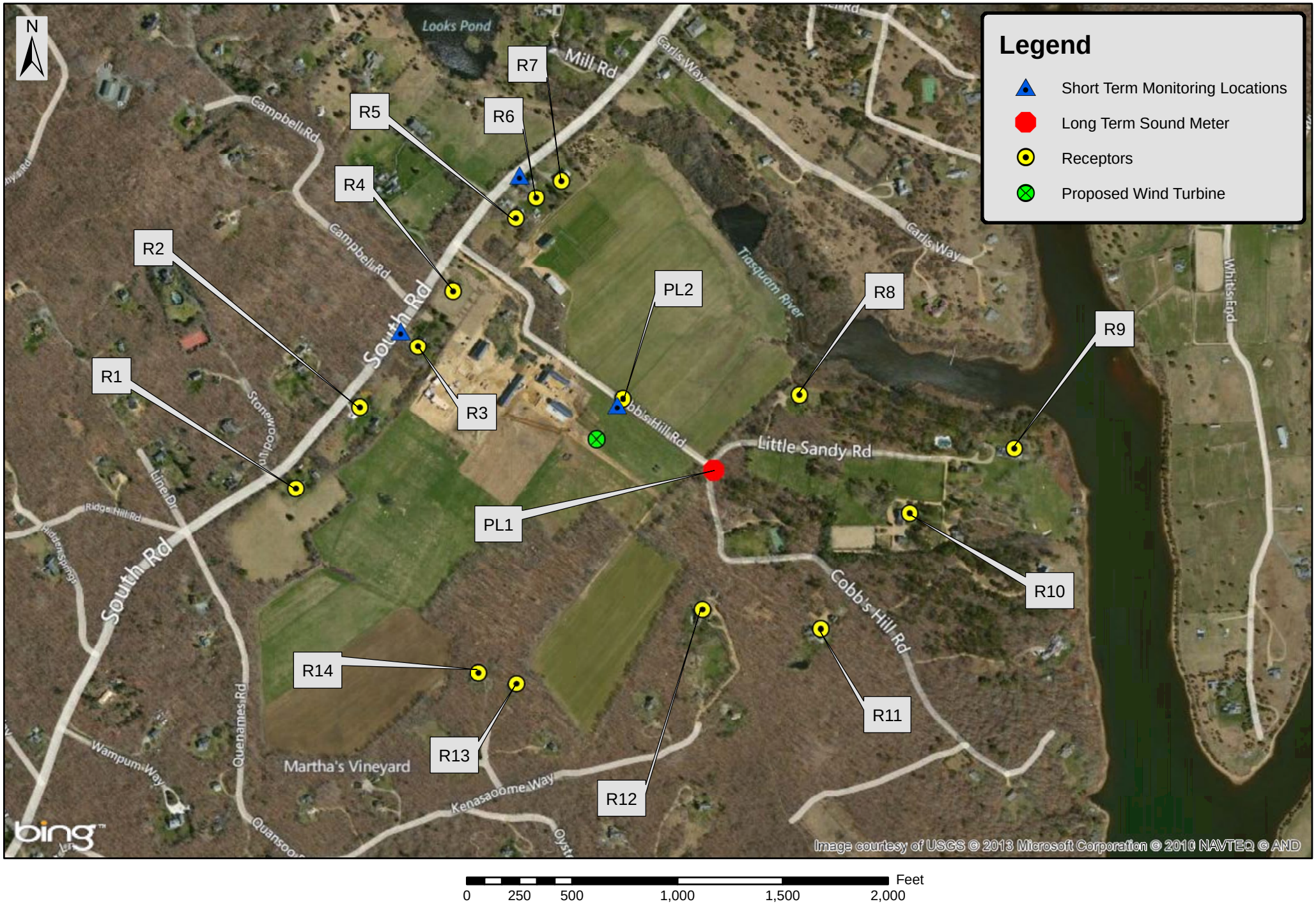
4.0 AMBIENT SOUND LEVEL AND WIND MEASUREMENTS

The proposed wind turbine will be located near the site northern property boundary. The site property is bounded by residential properties on South Road to the west, Massachusetts Farm and Conservation Land Trust agricultural property to the northeast, residential properties on Quenames Road and Kensaoome Way to the south, and the nearest residential property off of Cobbs Hill Road to the east.

The long-term sound monitoring location is along the east property boundary of the site near the closest abutting residential property. This location, Property Line-1 (PL-1), represents the nearest residential property line 525 feet to the east and south of Little Sandy Road (R-10). Homes to the west on South Road have higher ambient levels than this location. Short-term sound monitoring was done at the northern property boundary adjacent to the Massachusetts Farm and Conservation Land Trust (PL-2), the west property boundary at the closest residence at 30 South Road (R-3) and 12 South Road (R-6). Daytime and nighttime sound monitoring was performed at all three locations. These short-term monitoring locations provides information on the ambient sound levels for the residential locations labeled as R-1 through R-7 and the closest uninhabited property line. Figure 1 illustrates the location of the proposed wind turbine, long-term sound monitoring station, short-term monitoring locations and residences abutting the site, designated R-1 through R-14. The coordinates for each receptor location are in state plane coordinates (SPC).

Tech collected hourly 10-m wind speed and weather data from the National Weather Service Station at the Martha's Vineyard Airport (KMVY), located five miles northeast of the project site. Ten-meter measurements were scaled to the 30-m hub height using the wind shear coefficient of 0.39 calculated for the UMass RERL Tisbury site[7]. The wind speed data are presented along with the sound level measurements from the long-term monitoring station in Figure 2.

[7] University of Massachusetts Renewable Energy Research Laboratory, "Wind Data Report, Tisbury, Martha's Vineyard, July 1, 2007 – June 30, 2008," prepared for the Massachusetts Technology Collaborative, August 21, 2008, page 8.



Feet
0 250 500 1,000 1,500 2,000

Figure 1
Receptor and Sound Monitoring Locations for the
Grey Barn Wind Turbine Project
Chilmark, MA

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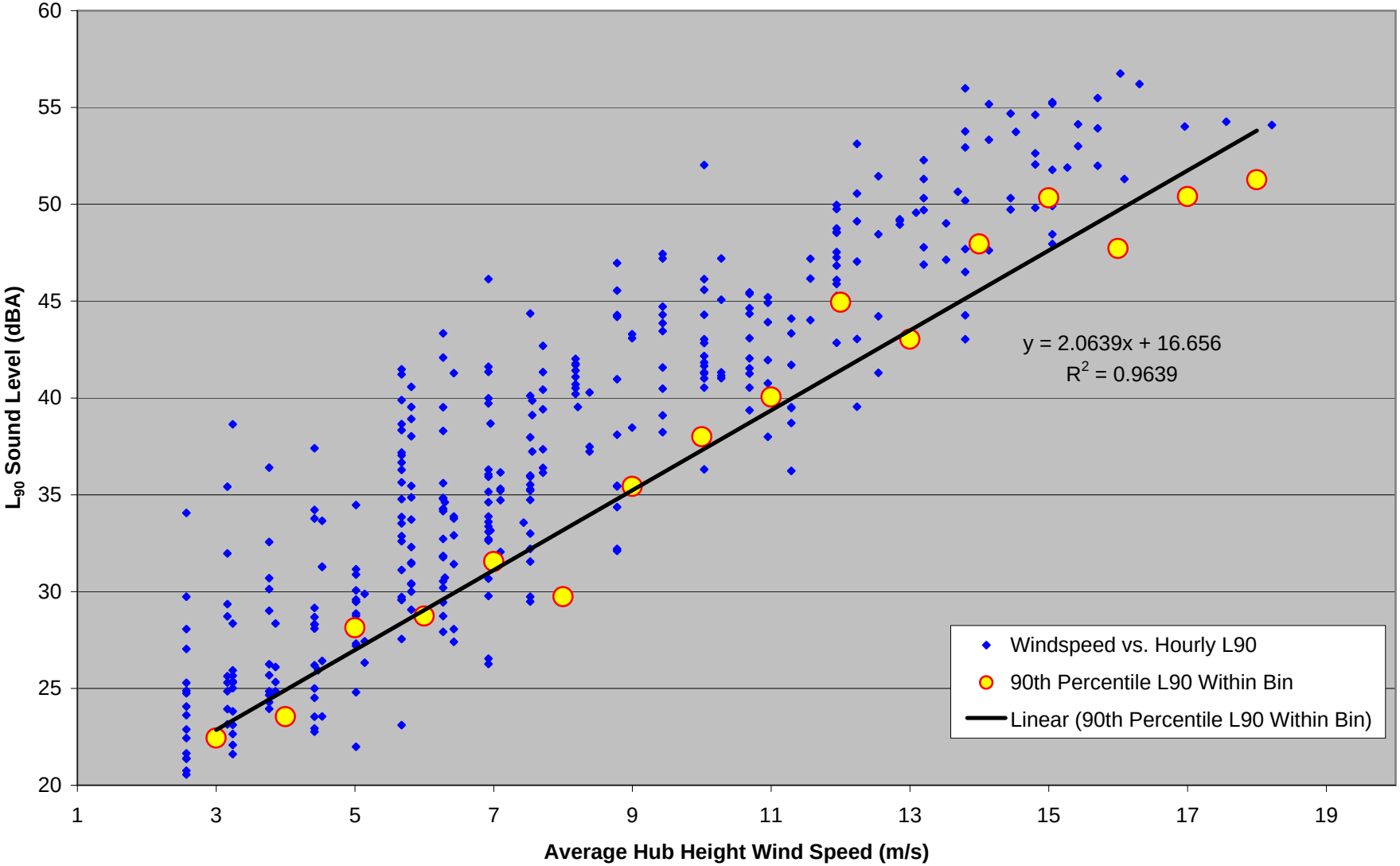
Figure 2
Average 1-Hour Hub Height Windspeed vs. L_{90} Sound Level - Chilmark, MA



Long-term sound level monitoring was performed over a 17-day period from Monday, March 4 at 11:00 a.m. through Thursday, March 21 at 8:00 a.m. to document 10-minute sound levels, day and night, over a range of wind conditions. Hub height wind speeds were at or above the turbine cut-in speed (a 10-m wind speed of 4 m/s or 8.9 mph) for approximately 83 percent of the time during the 17-day period. When the long-term monitoring station was set up, skies were sunny, the temperature was 30^0F, and winds were northwesterly at 10-15 mph. During the 17-day period, it was an active weather pattern with several rain and snow events, which included a nor'easter that occurred from March 6th though March 8th.

The sound level measurements were taken with Larson Davis Model 831 real-time sound level analyzer, 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. This meter meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Standards for Type 1 for quality and accuracy. Prior to and immediately following the measurement sessions, the sound analyzer was 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 the measurement session 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.[8]

As stated above, Tech obtained wind speed data from the NWS station at the Martha's Vineyard Airport. The station only report hourly average wind speeds. Tech had setup the sound analyzer to collect 10-minute L_{90} measurements with the plan to use wind speed data from a nearby wind turbine, which unfortunately Tech learned after the monitoring system was setup was not available. The 10-minute L_{90} sound level measurements (dBA) were averaged into hourly values and the 1-hour average hub height wind speeds (m/s) for the long-term monitoring station were assembled into a spreadsheet and the data were sorted into wind speed bins centered about integer values of the hub height wind speed. For the linear regression analysis, 16 wind speed bins were used centered on the values 3 m/s

[8] 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."

through 18 m/s. The 3m/s bin includes all periods with average wind speeds in the range or 2.6 to 3.5 m/s; the 4 m/s bin contains all periods with wind speeds in the range of 3.6 to 4.5 m/s, and so forth, with the last bin spanning 17.6 to 18.5 m/s. The L_{90} values exceeded 90% of the time by the other L_{90} values in each wind speed bin have been highlighted in Figure 2 and a linear regression line has been fit to those values. Since this series of L_{90} values for the bins exhibit a lot of variability, the ambient sound levels actually used in the acoustic study were taken from the smoothed regression line of best fit. This ensures the ambient level is a monotonically increasing function of wind speed.

For the NW100 turbine, a series of hub height wind speeds ranging from 6 m/s to 10 m/s for which the manufacturer has published sound power levels under International Standard IEC 61400-11[9] were input to the regression line equation to obtain the corresponding ambient sound levels. These are presented in Table 3.

The ambient sound level at the hub height wind speed of 6.0 m/s is 29.0 dBA, and the ambient sound level at the design wind speed of 10.0 m/s is 37.3 dBA.

Short-term daytime and nighttime measurements were taken near the eastern property boundary closest to the proposed turbine, and at the closest residences on South Road. These measurements were collected to provide information on the ambient sound levels for the residential locations close to South Road labeled as R1 through R7, and the nearest uninhabited property line (PL2). Daytime measurements were collected on March 4th from 10:00 a.m. to 11:00 a.m. and nighttime measurements were collected on March 21st from 12:00 a.m. to 1:00 a.m. The daytime L_{90} sound levels ranged from was 38.7 to 42.5 dBA and the nighttime L_{90} sound levels ranged from 27.5 to 34.5 dBA (See Appendix B). When compared to the long-term sound measurements for the same time periods, the daytime sound levels were slightly higher and the nighttime sound levels were slightly lower. Since nighttime sound levels were lower at the long-term meter, those lower sound levels were applied for all receptors in this study to maintain conservatism.

[9] Northern Power, "Acoustic Noise Measurement SummaryNorthern Power Systems NW100 at Concordia, Kansas", February 9, 2011.

TABLE 3

AMBIENT SOUND LEVELS UNDER THE NOISE POLICY FOR A NORTHERN POWER100 TURBINE, 30-M HUB HEIGHT (dBA)

Hub Height Wind Speed (m/s)	IEC 61400-11 Turbine Sound Power Level (dBA)	PL-1 Residential Property Line
6	94.1*	29.0
7	98.4	31.1
8	96.2	33.2
9	97.9	35.2
10	99.8	37.3

*No sound power level data published below 6 m/s.

5.0 CALCULATED FUTURE SOUND LEVELS

5.1 Methodology

Future sound levels from the wind turbine at the nearest residential property lines and residences 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[10]. Atmospheric absorption, the process by which sound energy is absorbed by the air, was calculated using ANSI S1.26-1995.[11] 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.[12] This is a reasonable worst-case assumption and approximates winter frozen ground conditions in the area between the turbine and the nearest residences to the north. No attenuation from trees or vegetation was assumed. 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.

For the NW100 turbine, hub height wind speed of 6.0 m/s or 13.4 mph has a sound power level of 94.1 dBA. The maximum sound power level of 99.8 dBA is reached at a hub height wind speed of 10.0 m/s or 22.4 mph. Tech assumed an uncertainty K-factor of 1.0 dBA, which was added to these sound power levels to account for uncertainty in sound power measurements and variations in turbine manufacturing (IEC Technical Specification 61400-14). Thus, the maximum modeled sound power level was 99.8 dBA.

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

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

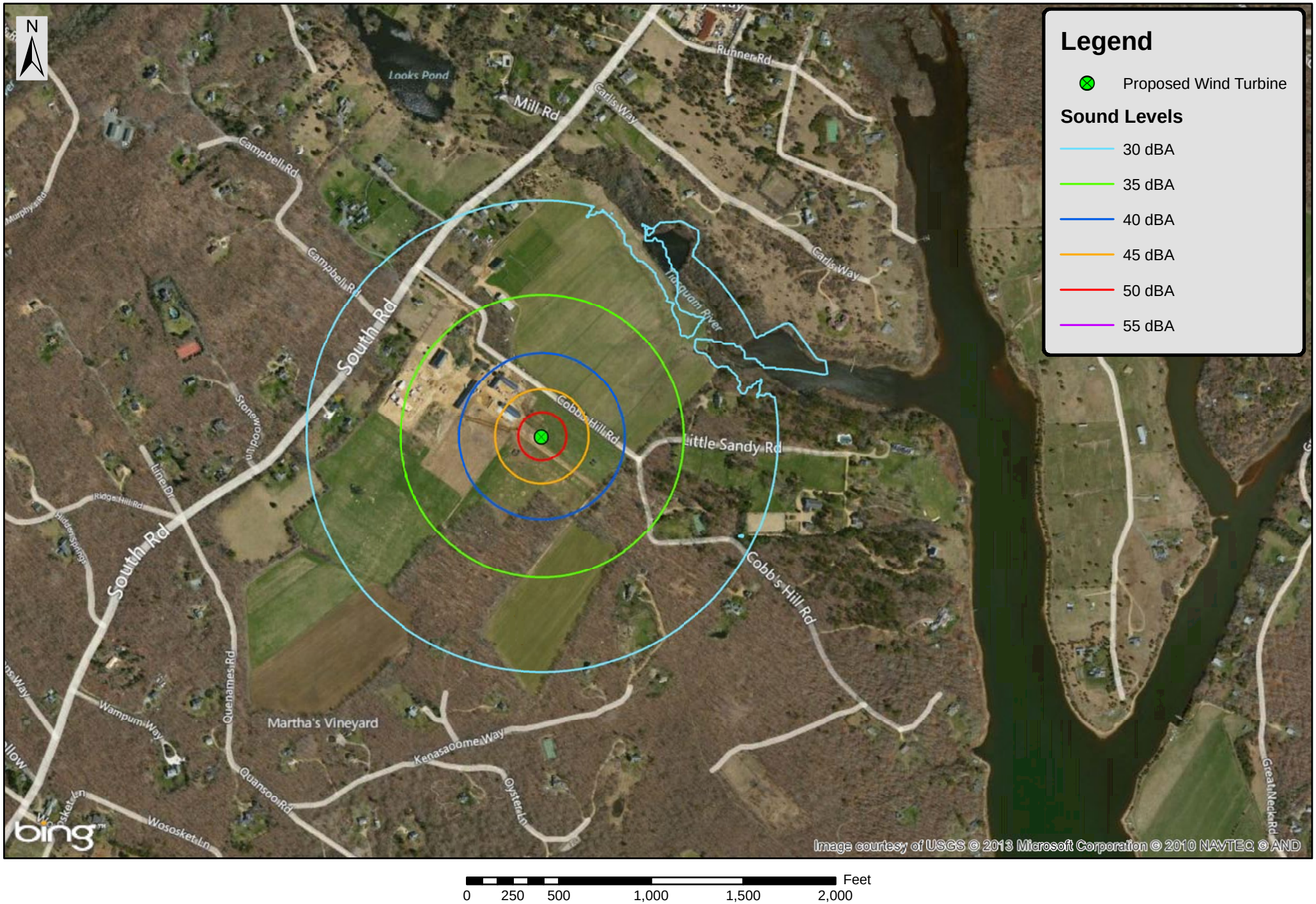
[12] Ground absorption factor G set equal to 0.5 in Cadna-A.

5.2 Results and Conclusions

Figures 3 and 4 show color-coded decibel contours (5 feet above ground level) for operation of the Grey Barn Farm wind turbine at a low wind condition of 6 m/s and a maximum sound power level wind speed of 10 m/s. Note that these figures assume 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. Model output is provided in Appendix C.

The acoustic modeling results for the wind turbine are summarized in Tables 4 through 19, which provide the highest predicted turbine sound level at the nearest sensitive receivers, and the maximum increase in the ambient sound level under the DEP Noise Policy, for five operating levels for wind speeds between 6 m/s and 10 m/s. Maximum sound level increases occur for the low wind condition of 6.0 m/s. Wind turbine outdoor sound levels at the closest residences (40 Kenasaoome Way and 30 South Road) will be 32.9 to 38.6 dBA and will increase the ambient level by 3.7 to 5.4 dBA. The maximum wind turbine sound levels at the inhabited and uninhabited property lines will be 43.5 and 51.6 dBA, respectively, and will increase the ambient level by 9.3 and 16.9 dBA, respectively. The uninhabited property line sound level increase occurs at a property owned by the Massachusetts Farm and Conservation Land Trust and is designated for agricultural use. All predicted sound level increases at residences and inhabited property lines are expected to comply with the DEP Noise Policy. Sound level increases in other residential areas that are farther from the turbine will be less. Predicted octave band sound levels confirm the project will not create pure tones.

In summary, the NW100 wind turbine proposed for the Grey Barn Farm property is expected to fully comply with the Massachusetts DEP Noise Policy. Compliance with this policy provides a reasonable basis for concluding the community wind project will not create a nuisance.



Feet
0 250 500 1,000 1,500 2,000

Figure 3
Maximum Sound Levels (dBA) from the Grey Barn Wind Turbine
at 6m/s Hub Height Wind Speed
Chilmark, MA

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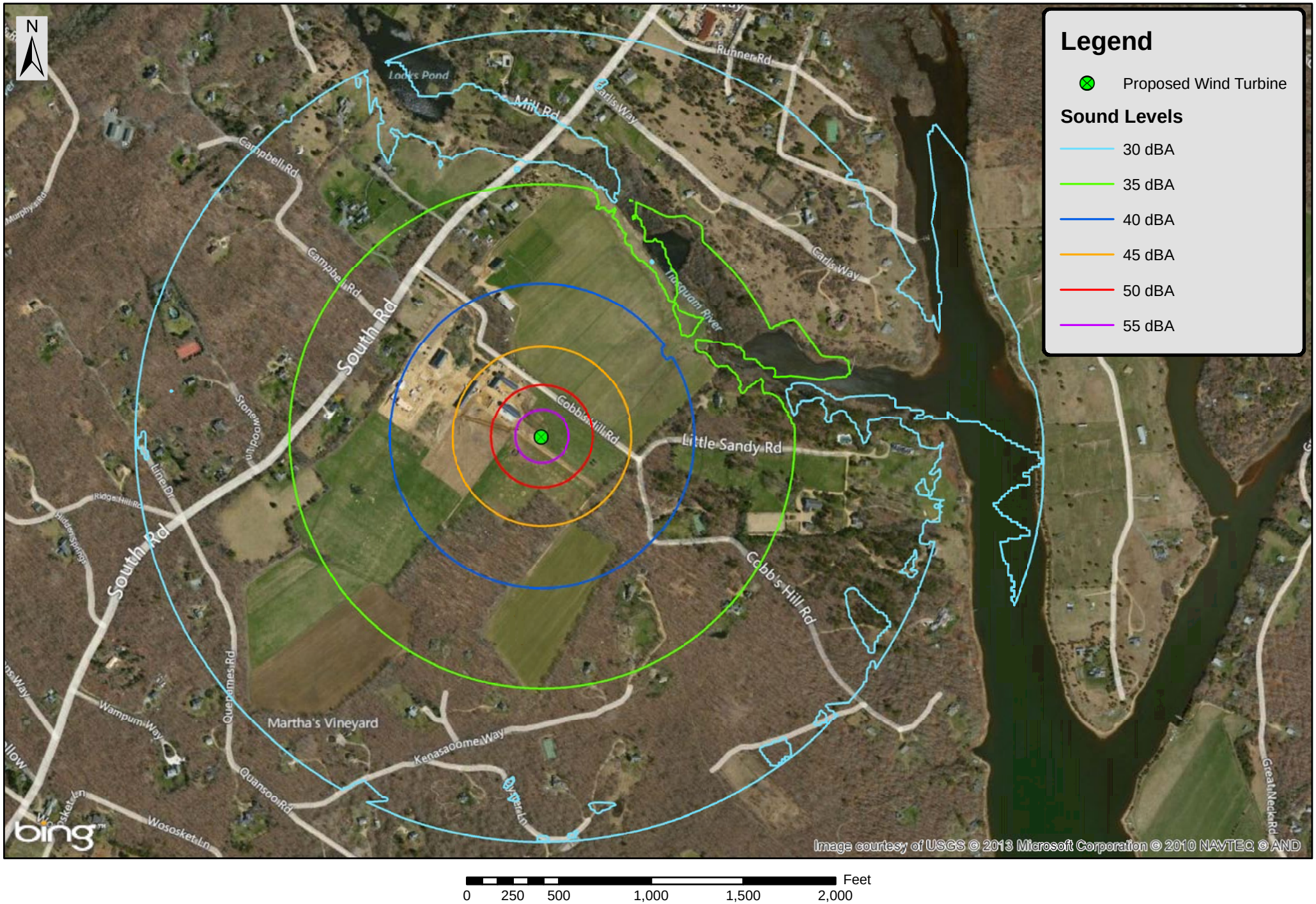

Feet
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Figure 4
Maximum Sound Levels (dBA) from the Grey Barm Wind Turbine
at Design Wind Speed
Chilmark, MA

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TABLE 4

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-1 RESIDENCE AT 50 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	28.7	31.9	2.8
7	31.1	29.4	33.3	2.2
8	33.2	30.8	35.2	2.0
9	35.2	32.5	37.1	1.9
10	37.3	34.4	39.1	1.8

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

TABLE 5

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-2 RESIDENCE AT 36 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	31.2	33.3	4.2
7	31.1	31.9	34.5	3.4
8	33.2	33.3	36.2	3.1
9	35.2	35	38.1	2.9
10	37.3	36.9	40.1	2.8

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

TABLE 6

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-3 RESIDENCE AT 30 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	32.9	34.4	5.4
7	31.1	33.6	35.5	4.4
8	33.2	35.0	37.2	4.0
9	35.2	36.7	39.0	3.8
10	37.3	38.6	41.0	3.7

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

TABLE 7

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-4 RESIDENCE AT 24 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	32.7	34.3	5.2
7	31.1	33.4	35.4	4.3
8	33.2	34.8	37.1	3.9
9	35.2	36.5	38.9	3.7
10	37.3	38.4	40.9	3.6

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

TABLE 8

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-5 RESIDENCE AT 16 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	31.3	33.3	4.3
7	31.1	32.0	34.6	3.5
8	33.2	33.4	36.3	3.1
9	35.2	35.1	38.2	2.9
10	37.3	37.0	40.2	2.9

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

TABLE 9

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-6 RESIDENCE AT 12 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	30.8	33.0	4.0
7	31.1	31.5	34.3	3.2
8	33.2	32.9	36.0	2.9
9	35.2	34.6	37.9	2.7
10	37.3	36.5	39.9	2.6

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

TABLE 10

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-7 RESIDENCE AT 10 SOUTH ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	30.3	32.7	3.7
7	31.1	31.0	34.1	3.0
8	33.2	32.4	35.8	2.6
9	35.2	34.1	37.7	2.5
10	37.3	36.0	39.7	2.4

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

TABLE 11

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-8 CLOSEST RESIDENCE ON LITTLE SANDY ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	32.6	34.2	5.1
7	31.1	33.3	35.3	4.2
8	33.2	34.7	37.0	3.8
9	35.2	36.4	38.9	3.6
10	37.3	38.3	40.8	3.5

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

TABLE 12

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-9 RESIDENCE AT END OF LITTLE SANDY ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	25.4	30.6	1.6
7	31.1	26.1	32.3	1.2
8	33.2	27.5	34.2	1.0
9	35.2	29.2	36.2	1.0
10	37.3	31.1	38.2	0.9

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

TABLE 13

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-10 RESIDENCE SOUTH OF LITTLE SANDY ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	28.2	31.7	2.6
7	31.1	28.9	33.2	2.0
8	33.2	30.3	35.0	1.8
9	35.2	32.0	36.9	1.7
10	37.3	33.9	38.9	1.6

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

TABLE 14

DEP NOISE POLICY COMPLIANCE ANLAYSIS FOR R-11 RESIDENCE AT 61 COBBS HILL ROAD, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	29.1	32.1	3.0
7	31.1	29.8	33.5	2.4
8	33.2	31.2	35.3	2.1
9	35.2	32.9	37.2	2.0
10	37.3	34.8	39.2	1.9

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

TABLE 15

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-12 RESIDENCE AT 40 KENASAOOME WAY, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	32.9	34.4	5.4
7	31.1	33.6	35.5	4.4
8	33.2	35.0	37.2	4.0
9	35.2	36.7	39.0	3.8
10	37.3	38.6	41.0	3.7

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

TABLE 16

DEP NOISE POLICY COMPLIANCE ANLAYSIS FOR R-13 RESIDENCE AT 26 KENASAOOME WAY, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	30.5	32.8	3.8
7	31.1	31.2	34.2	3.1
8	33.2	32.6	35.9	2.7
9	35.2	34.3	37.8	2.6
10	37.3	36.2	39.8	2.5

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

TABLE 17

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR R-14 RESIDENCE AT 22 KENASAOOME WAY, CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	30.3	32.7	3.7
7	31.1	31.0	34.1	3.0
8	33.2	32.4	35.8	2.6
9	35.2	34.1	37.7	2.5
10	37.3	36.0	39.7	2.4

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

TABLE 18

DEP NOISE POLICY COMPLIANCE ANLAYSIS FOR PL-2
CLOSEST PROPERTY LINE (AGRICULTURAL USE ONLY), CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	45.9	46.0	16.9
7	31.1	46.6	46.7	15.6
8	33.2	48.0	48.1	15.0
9	35.2	49.7	49.9	14.6
10	37.3	51.6	51.8	14.5

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

TABLE 19

DEP NOISE POLICY COMPLIANCE ANALYSIS FOR PL-1
CLOSEST PROPERTY LINE (WITH RESIDENCE), CHILMARK (dBA)

Hub Height Wind Speed (m/s)	Ambient L_{90} Level	Maximum Project Sound	Future Ambient Level	Net Increase
6	29.0	37.8	38.3	9.3
7	31.1	38.5	39.2	8.1
8	33.2	39.9	40.7	7.6
9	35.2	41.6	42.5	7.3
10	37.3	43.5	44.4	7.1

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

APPENDIX A

MASSACHUSETTS DEP NOISE POLICY

Massachusetts Department of ENVIRONMENTAL PROTECTION

fact sheet

Noise

Background

Noise 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 noise 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 noise source will be considered to be violating the Department's noise 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 noise sources, call the Board of Health for the municipality in which the noise source is located.

To learn more about responding to noise, 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 February 1, 1990, and has remained in effect.

Massachusetts Department of
Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of
Massachusetts
Mitt Romney, Governor

Executive Office of
Environmental Affairs
Ellen Roy Herzfelder, Secretary

Department of
Environmental Protection
Edward P. Kunce,
Acting Commissioner

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This information is available in alternate format by calling our ADA Coordinator at (617) 574-6872.

AIR & CLIMATE

Noise Pollution Policy Interpretation

Noise is a public health concern that falls within the scope of Massachusetts Department of Environmental Protection (MassDEP) authority as a form of regulated air pollution (M.G.L. Chapter 111, Sections 142A-M provide statutory authority for MassDEPs Air Pollution Control Regulations, 310 CMR 7.00).

Definitions (310 CMR 7.00)

- *Noise* is defined as "sound of sufficient intensity and/or duration as to cause a condition of air pollution."
- *Air pollution* means "the presence in the ambient air space of one or more air contaminants or combinations thereof in such concentrations and of such duration as to: (a) cause a nuisance; (b) be injurious, or be on the basis of current information, potentially injurious to human health or animal life, to vegetation, or to property; or (c) unreasonably interfere with the comfortable enjoyment of life and property or the conduct of business."

When Does MassDEP Evaluate Noise Impacts?

MassDEP evaluates how noise may affect people when 1) the agency reviews applications for approval under its air pollution regulations (310 CMR 7.02) for construction of facilities that will generate more than threshold amounts of pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, volatile organic compounds, particulate matter, and substances that are toxic in air; and 2) the agency responds to complaints from the public about noise generated by an existing source:

- When reviewing applications for pre-construction approval of new sources of air pollution, MassDEP examines the potential increase in sound levels over ambient conditions and the impacts of noise at both the source's property line and at the nearest residence or other sensitive receptor (e.g., schools, hospitals) located in the area surrounding the facility and occupied at the time of the permit review. *Please note: MassDEP requires that an air approval be obtained when a proposed facility is expected to emit more than threshold amounts of specific pollutants. If noise is the only air pollutant expected to be emitted by a facility, a pre-construction air approval is not required.*
- When MassDEP responds to a complaint about an existing source of noise, it focuses on protecting affected people at their residences and in other buildings that are occupied by sensitive receptors from nuisances and the public health effects of the noise. *Please note: An existing source of sound may or may not have needed a MassDEP air approval before it was built.*

Where Are MassDEP?s Noise Criteria Applied?

The MassDEP noise pollution policy describes criteria that MassDEP uses to evaluate noise impacts at both the property line and the nearest occupied residence or other sensitive receptor. When noise is found to be a nuisance or a threat to health, MassDEP requires the

source to mitigate its noise.

Noise levels that exceed the criteria at the source's property line by themselves do not necessarily result in a violation or a condition of air pollution under MassDEP regulations (see 310 CMR 7.10 U). The agency also considers the effect of noise on the nearest occupied residence and/or building housing sensitive receptors:

- In responding to complaints, MassDEP measures noise levels at the complainant's location and at other nearby locations that may be affected (e.g., residences and/or buildings with other sensitive receptors). If the noise level at a sensitive receptor's location is more than 10 dB, MassDEP requires the noise source to mitigate its impact.
- A new noise source will be required to mitigate its noise if levels are projected to be more than 10 dB at the nearest residence or building housing sensitive receptors.
- A new noise source that would be located in an area that is not likely to be developed for residential use in the future (e.g., due to abutting wetlands or similarly undevelopable areas), or in a commercial or industrial area with no sensitive receptors may not be required to mitigate its noise impact on those areas, even though projected noise levels at the facility's property line may exceed 10 dB. However, a new noise source that would be located in an area in which housing or buildings containing other sensitive receptors could be developed in the future may be required to mitigate its noise impact in these areas.

This policy has been designed to protect affected residents and other sensitive occupants of nearby property, but not necessarily uninhabited areas in and around the source's property. Sources of noise may need to implement mitigation if residences or buildings occupied by sensitive receptors are developed where they may be affected by the source's noise.

APPENDIX B

SHORT-TERM SOUND MONITORING RESULTS

Measurement ID #	PL 2
Start Time	3/4/13 10:15 AM
Length of Measurment	00:15:05
L_{AEQ}	**46.1**
L_{A90}	**38.7**
L_{Amax}	**70.9**
L_{Amin}	**35.2**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	71.1	55.7	86.1	48.8
31.5 Hz	61.9	51.4	76.6	46.2
63 Hz	54.3	48.8	69.2	44.4
125 Hz	50.5	43.9	69.0	40.2
250 Hz	44.4	37.5	61.9	33.7
500 Hz	42.3	35.1	64.7	32.0
1 kHz	41.8	34.1	68.1	29.6
2 kHz	38.0	28.2	64.0	24.4
4 kHz	32.9	17.4	59.8	14.7
8 kHz	28.2	13.0	59.8	12.0
16 kHz	18.7	12.2	48.0	11.8

Weather: Sunny, 33 degrees, wind 5 - 15 mph

Sounds: Traffic on South Road, wind, propeller planes, farm animals, local traffic

Measurement ID #	R 6 - South Road
Start Time	3/4/13 10:36 AM
Length of Measurment	00:15:04
L_{AEQ}	**58.2**
L_{A90}	**42.5**
L_{Amax}	**75.9**
L_{Amin}	**38.4**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	58.0	51.4	77.2	47.8
31.5 Hz	60.3	50.2	82.3	45.8
63 Hz	67.6	48.7	92.6	43.0
125 Hz	61.8	45.4	84.2	40.0
250 Hz	55.2	41.4	76.3	36.4
500 Hz	52.0	39.4	68.3	35.4
1 kHz	54.8	37.6	71.0	33.5
2 kHz	50.9	33.2	67.4	28.2
4 kHz	42.5	23.9	64.3	18.6
8 kHz	33.8	16.0	58.1	13.0
16 kHz	21.6	12.3	49.3	11.9

Weather: Sunny, 33 degrees, wind 5 - 15 mph

Sounds: Traffic on South Road, wind, farm equipment, farm animals, nearby turbine

Measurement ID #	R 3 - South Road
Start Time	3/4/13 10:52 AM
Length of Measurment	00:15:04
L_{AEQ}	**55.3**
L_{A90}	**39.8**
L_{Amax}	**73.0**
L_{Amin}	**36.3**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	54.0	50.4	69.4	47.6
31.5 Hz	54.1	49.3	69.8	45.3
63 Hz	67.5	47.4	92.7	43.3
125 Hz	58.8	43.6	82.2	39.7
250 Hz	48.8	39.0	67.7	34.4
500 Hz	48.8	37.8	67.0	33.7
1 kHz	52.2	34.6	68.1	30.6
2 kHz	48.0	29.6	62.9	24.1
4 kHz	37.5	23.1	56.7	17.9
8 kHz	27.5	16.4	46.9	13.7
16 kHz	17.6	12.5	33.7	12.0

Weather: Sunny, 33 degrees, wind 5 - 15 mph

Sounds: Traffic on South Road, wind, nearby turbine

Measurement ID #	PL 2
Start Time	3/21/13 12:00 AM
Length of Measurment	00:15:05
L_{AEQ}	**30.4**
L_{A90}	**27.5**
L_{Amax}	**48.9**
L_{Amin}	**26.1**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	42.0	39.7	51.5	36.6
31.5 Hz	40.0	37.9	50.5	34.0
63 Hz	38.6	36.3	53.6	33.4
125 Hz	35.6	33.6	54.5	30.3
250 Hz	31.6	28.6	47.2	25.5
500 Hz	28.1	26.3	46.1	23.8
1 kHz	25.2	19.6	45.0	17.4
2 kHz	19.7	11.4	41.8	10.6
4 kHz	15.8	10.6	40.6	10.4
8 kHz	14.0	12.1	33.9	11.6
16 kHz	12.6	12.1	27.3	11.9

Weather: Clear, 32 degrees, wind 0 - 5 mph

Sounds: Wind through trees, distant jet, animal sounds (birds/bats), geese, rabbits in field

Measurement ID #	R 6 - South Road
Start Time	3/21/13 12:20 AM
Length of Measurment	00:15:27
L_{AEQ}	**39.3**
L_{A90}	**34.5**
L_{Amax}	**55.8**
L_{Amin}	**31.0**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	42.3	40.0	48.5	37.0
31.5 Hz	40.6	37.2	51.8	33.7
63 Hz	39.8	35.2	60.6	32.0
125 Hz	37.7	31.3	58.4	28.6
250 Hz	40.9	35.1	58.8	31.9
500 Hz	38.0	33.7	51.5	30.3
1 kHz	33.8	28.6	51.6	23.9
2 kHz	28.7	14.9	51.6	12.7
4 kHz	21.2	11.1	46.4	10.7
8 kHz	15.4	12.1	37.2	11.5
16 kHz	12.5	12.1	26.3	11.8

Weather: Clear, 32 degrees, wind 0 - 5 mph

Sounds: Nearby wind turbine, wind through trees, geese and other wildlife, jet overhead, hum of transformer on utility pole

Measurement ID #	R 3 - South Road
Start Time	3/21/13 12:37 AM
Length of Measurment	00:15:04
L_{AEQ}	**50.4**
L_{A90}	**32.9**
L_{Amax}	**77.0**
L_{Amin}	**30.9**

Frequency	**L_{EQ}**	**L_{90}**	**L_{MAX}**	**L_{MIN}**
16 Hz	43.0	40.3	60.5	37.5
31.5 Hz	40.3	37.5	62.6	34.3
63 Hz	41.5	36.3	68.2	32.1
125 Hz	39.4	32.3	68.1	29.3
250 Hz	39.7	33.5	64.8	31.5
500 Hz	40.7	32.2	66.7	30.1
1 kHz	47.3	27.5	74.3	23.9
2 kHz	45.1	12.9	71.5	11.4
4 kHz	34.9	10.5	61.6	10.3
8 kHz	20.5	12.1	47.8	11.4
16 kHz	12.9	12.0	35.8	11.8

Weather: Clear, 32 degrees, wind 0 - 5 mph

Sounds: Nearby wind turbine, wind through trees, geese and other wildlife, jet overhead, 1 car drives past on South Rd.

APPENDIX C

CADNA-A ACOUSTIC MODEL OUTPUT

Wind Turbine Location	Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
	41 22 23.12	70 40 37.74	8.75

WIND SPEED = 6 m/s

Name	ID	Sound Level (dBA)	Noise Type	Height (m)		Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
36 South Road	R_2	31.2	Total	1.52	r	41 22 24.6	70 40 52.49	11.07
30 South Road	R_3	32.9	Total	1.52	r	41 22 27.45	70 40 48.87	9.83
24 South Road	R_4	32.7	Total	1.52	r	41 22 30.06	70 40 46.68	10.87
16 South Road	R_5	31.3	Total	1.52	r	41 22 33.51	70 40 42.79	11.24
12 South Road	R_6	30.8	Total	1.52	r	41 22 34.44	70 40 41.52	11.16
10 South Road	R_7	30.3	Total	1.52	r	41 22 35.24	70 40 39.96	11.23
Closest Little Sandy Rd.	R_8	32.6	Total	1.52	r	41 22 25.20	70 40 25.10	9.44
Residence at end of Little Sandy Rd.	R_9	25.4	Total	1.52	r	41 22 22.74	70 40 11.74	10.28
Residence south of Little Sandy Rd.	R_10	28.2	Total	1.52	r	41 22 19.68	70 40 18.23	10
61 Cobbs Hill Road	R_11	29.1	Total	1.52	r	41 22 14.23	70 40 23.79	10.95
40 Kenasaoome Way	R_12	32.9	Total	1.52	r	41 22 15.14	70 40 31.13	10.49
22 Kenasaoome Way	R_14	30.3	Total	1.52	r	41 22 12.15	70 40 45.07	10.2
26 Kenasaoome Way	R_13	30.5	Total	1.52	r	41 22 11.64	70 40 42.68	9.94
50 South Road	R_1	28.7	Total	1.52	r	41 22 20.79	70 40 56.47	10.1
Closest PL (uninhabited)	PL_1	45.9	Total	1.52	r	41 22 25.01	70 40 36.09	10.24
Closest PL (inhabited)	PL_2	37.8	Total	1.52	r	41 22 21.64	70 40 30.46	10.96

WIND SPEED = 7 m/s

Name	ID	Sound Level (dBA)	Noise Type	Height (m)		Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
36 South Road	R_2	31.9	Total	1.52	r	41 22 24.6	70 40 52.49	11.07
30 South Road	R_3	33.6	Total	1.52	r	41 22 27.45	70 40 48.87	9.83
24 South Road	R_4	33.4	Total	1.52	r	41 22 30.06	70 40 46.68	10.87
16 South Road	R_5	32	Total	1.52	r	41 22 33.51	70 40 42.79	11.24
12 South Road	R_6	31.5	Total	1.52	r	41 22 34.44	70 40 41.52	11.16
10 South Road	R_7	31	Total	1.52	r	41 22 35.24	70 40 39.96	11.23
Closest Little Sandy Rd.	R_8	33.3	Total	1.52	r	41 22 25.20	70 40 25.10	9.44
Residence at end of Little Sandy Rd.	R_9	26.1	Total	1.52	r	41 22 22.74	70 40 11.74	10.28
Residence south of Little Sandy Rd.	R_10	28.9	Total	1.52	r	41 22 19.68	70 40 18.23	10
61 Cobbs Hill Road	R_11	29.8	Total	1.52	r	41 22 14.23	70 40 23.79	10.95
40 Kenasaoome Way	R_12	33.6	Total	1.52	r	41 22 15.14	70 40 31.13	10.49
22 Kenasaoome Way	R_14	31	Total	1.52	r	41 22 12.15	70 40 45.07	10.2
26 Kenasaoome Way	R_13	31.2	Total	1.52	r	41 22 11.64	70 40 42.68	9.94
50 South Road	R_1	29.4	Total	1.52	r	41 22 20.79	70 40 56.47	10.1
Closest PL (uninhabited)	PL_1	46.6	Total	1.52	r	41 22 25.01	70 40 36.09	10.24
Closest PL (inhabited)	PL_2	38.5	Total	1.52	r	41 22 21.64	70 40 30.46	10.96

WIND SPEED = 8 m/s

Name	ID	Sound Level (dBA)	Noise Type	Height (m)		Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
36 South Road	R_2	33.3	Total	1.52	r	41 22 24.6	70 40 52.49	11.07
30 South Road	R_3	35	Total	1.52	r	41 22 27.45	70 40 48.87	9.83
24 South Road	R_4	34.8	Total	1.52	r	41 22 30.06	70 40 46.68	10.87
16 South Road	R_5	33.4	Total	1.52	r	41 22 33.51	70 40 42.79	11.24
12 South Road	R_6	32.9	Total	1.52	r	41 22 34.44	70 40 41.52	11.16
10 South Road	R_7	32.4	Total	1.52	r	41 22 35.24	70 40 39.96	11.23
Closest Little Sandy Rd.	R_8	34.7	Total	1.52	r	41 22 25.20	70 40 25.10	9.44
Residence at end of Little Sandy Rd.	R_9	27.5	Total	1.52	r	41 22 22.74	70 40 11.74	10.28
Residence south of Little Sandy Rd.	R_10	30.3	Total	1.52	r	41 22 19.68	70 40 18.23	10
61 Cobbs Hill Road	R_11	31.2	Total	1.52	r	41 22 14.23	70 40 23.79	10.95
40 Kenasaoome Way	R_12	35	Total	1.52	r	41 22 15.14	70 40 31.13	10.49
22 Kenasaoome Way	R_14	32.4	Total	1.52	r	41 22 12.15	70 40 45.07	10.2
26 Kenasaoome Way	R_13	32.6	Total	1.52	r	41 22 11.64	70 40 42.68	9.94
50 South Road	R_1	30.8	Total	1.52	r	41 22 20.79	70 40 56.47	10.1
Closest PL (uninhabited)	PL_1	48	Total	1.52	r	41 22 25.01	70 40 36.09	10.24
Closest PL (inhabited)	PL_2	39.9	Total	1.52	r	41 22 21.64	70 40 30.46	10.96

WIND SPEED = 9 m/s

Name	ID	Sound Level (dBA)	Noise Type	Height (m)		Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
36 South Road	R_2	35	Total	1.52	r	41 22 24.6	70 40 52.49	11.07
30 South Road	R_3	36.7	Total	1.52	r	41 22 27.45	70 40 48.87	9.83
24 South Road	R_4	36.5	Total	1.52	r	41 22 30.06	70 40 46.68	10.87
16 South Road	R_5	35.1	Total	1.52	r	41 22 33.51	70 40 42.79	11.24
12 South Road	R_6	34.6	Total	1.52	r	41 22 34.44	70 40 41.52	11.16
10 South Road	R_7	34.1	Total	1.52	r	41 22 35.24	70 40 39.96	11.23
Closest Little Sandy Rd.	R_8	36.4	Total	1.52	r	41 22 25.20	70 40 25.10	9.44
Residence at end of Little Sandy Rd.	R_9	29.2	Total	1.52	r	41 22 22.74	70 40 11.74	10.28
Residence south of Little Sandy Rd.	R_10	32	Total	1.52	r	41 22 19.68	70 40 18.23	10
61 Cobbs Hill Road	R_11	32.9	Total	1.52	r	41 22 14.23	70 40 23.79	10.95
40 Kenasaoome Way	R_12	36.7	Total	1.52	r	41 22 15.14	70 40 31.13	10.49
22 Kenasaoome Way	R_14	34.1	Total	1.52	r	41 22 12.15	70 40 45.07	10.2
26 Kenasaoome Way	R_13	34.3	Total	1.52	r	41 22 11.64	70 40 42.68	9.94
50 South Road	R_1	32.5	Total	1.52	r	41 22 20.79	70 40 56.47	10.1
Closest PL (uninhabited)	PL_1	49.7	Total	1.52	r	41 22 25.01	70 40 36.09	10.24
Closest PL (inhabited)	PL_2	41.6	Total	1.52	r	41 22 21.64	70 40 30.46	10.96

WIND SPEED = 10 m/s

Name	ID	Sound Level (dBA)	Noise Type	Height (m)		Coordinates Latitude Deg Min Sec	Longitude Deg Min Sec	Elev. (m)
36 South Road	R_2	36.9	Total	1.52	r	41 22 24.6	70 40 52.49	11.07
30 South Road	R_3	38.6	Total	1.52	r	41 22 27.45	70 40 48.87	9.83
24 South Road	R_4	38.4	Total	1.52	r	41 22 30.06	70 40 46.68	10.87
16 South Road	R_5	37	Total	1.52	r	41 22 33.51	70 40 42.79	11.24
12 South Road	R_6	36.5	Total	1.52	r	41 22 34.44	70 40 41.52	11.16
10 South Road	R_7	36	Total	1.52	r	41 22 35.24	70 40 39.96	11.23
Closest Little Sandy Rd.	R_8	38.3	Total	1.52	r	41 22 25.20	70 40 25.10	9.44
Residence at end of Little Sandy Rd.	R_9	31.1	Total	1.52	r	41 22 22.74	70 40 11.74	10.28
Residence south of Little Sandy Rd.	R_10	33.9	Total	1.52	r	41 22 19.68	70 40 18.23	10
61 Cobbs Hill Road	R_11	34.8	Total	1.52	r	41 22 14.23	70 40 23.79	10.95
40 Kenasaoome Way	R_12	38.6	Total	1.52	r	41 22 15.14	70 40 31.13	10.49
22 Kenasaoome Way	R_14	36	Total	1.52	r	41 22 12.15	70 40 45.07	10.2
26 Kenasaoome Way	R_13	36.2	Total	1.52	r	41 22 11.64	70 40 42.68	9.94
50 South Road	R_1	34.4	Total	1.52	r	41 22 20.79	70 40 56.47	10.1
Closest PL (uninhabited)	PL_1	51.6	Total	1.52	r	41 22 25.01	70 40 36.09	10.24
Closest PL (inhabited)	PL_2	43.5	Total	1.52	r	41 22 21.64	70 40 30.46	10.96