# SOUND LEVEL ASSESSMENT REPORT

## Ball Hill Wind Project
## Towns of Villenova & Hanover
## Chautauqua County, NY

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December 22, 2015

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# 1.0 EXECUTIVE SUMMARY

Epsilon Associates, Inc. (Epsilon) has conducted a sound level assessment for Renewable Energy Systems Americas, Inc. (RES) of the Ball Hill Wind Project, a proposed wind power generation facility in Chautauqua County, New York. RES is considering up to 36 wind turbine generators comprised of either GE 2.3-116 or Vestas V110-2.2 models with a hub height of 94 to 95 meters and a rotor diameter of 110 to 116 meters. The study references a previously completed sound-monitoring program conducted to determine existing sound levels in the vicinity of the Project, includes computer modeling to predict future sound levels when the wind turbines and associated electrical substation are operational, and compares the operational sound levels to applicable state and local criteria.

Sound impacts associated with all 36 proposed wind turbine generators and proposed electrical substation were modeled at 335 receptors representing the closest structures to the Project using Cadna/A noise calculation software. Maximum operational sound levels at all of the modeled receptors are predicted to be equal to or less than 50 dBA, in compliance with local noise limits specified by the Towns of Hanover and Villenova. Additionally, the Project is anticipated to meet the suggested noise guidelines recommended by the New York State Department of Environmental Conservation (NYSDEC) to avoid the potential for adverse noise impacts in the community.

An evaluation was also performed to assess tonality and low frequency sound with respect to Project operation. No pure tones were identified in the sound power level spectra for either the GE 2.3-116 or Vestas V110-2.2 unit, nor in the calculated received sound pressure levels at the closest structures to the Project. Low frequency sound levels at all receptors are also well below the recommended criteria to avoid disturbance indoors as well as any potential vibration and rattle.

# 2.0 PROJECT OVERVIEW

Renewable Energy Systems Americas, Inc. (RES) is proposing to install thirty six (36) GE 2.3-116 or Vestas V110-2.2 wind turbines at the proposed Ball Hill Wind Project site (the Project) located in the Towns of Hanover and Villenova in Chautauqua County, NY. Hessler Associates, Inc. (Hessler) completed a background sound level monitoring program in March 2008 to determine existing sound levels in the vicinity of the Project. Epsilon Associates, Inc. (Epsilon) has conducted computer modeling to predict future sound levels when the proposed wind turbines and associated electrical substation would be operational. The results of this analysis and an evaluation of compliance with applicable criteria are presented herein.

# 3.0 SOUND METRICS

There are several ways in which sound levels are measured and quantified, all of which use the logarithmic decibel (dB) scale to accommodate the wide range of sound intensities found in the environment. An interesting property of the logarithmic scale is that the sound pressure levels of two distinct sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total sound level is only a three-decibel increase (to 53 dB), not a doubling to 100 dB. Thus, every three dB change in sound level represents a doubling or halving of sound energy. A change in sound level of less than three dB is generally considered just perceptible to the human ear[1].

Another property of the decibel scale is that if one source of sound is 10 dB (or more) louder than another source, then the quieter source does not contribute significantly to the overall sound level which remains the same as that of the louder source. For example, the combined sound level of a source of sound at 60 dB plus another source of sound at 47 dB is simply 60 dB.

The sound level meter used to measure noise is a standardized instrument.[2] It contains "weighting networks" to adjust the frequency response of the instrument to approximate that of the human ear under various conditions. One network is the A-weighting network (there are also B- and C-weighting networks). The A-weighted scale (dBA) most closely approximates how the human ear responds to sound at various frequencies, and is typically used for community sound level measurements[3]. Sounds are frequently reported as detected with the A-weighting network of the sound level meter. A-weighted sound levels emphasize the middle frequency (*i.e.,* middle pitched – around 1,000 Hertz (Hz) sounds), and de-emphasize lower and higher frequency sounds. A-weighted sound levels are reported in decibels designated as "dBA." For reference, sound pressure levels for some common indoor and outdoor environments are shown in Figure 3-1.

Two methods exist for describing sounds in our environment that vary with time: these are exceedance levels and the equivalent level, both of which are derived from a large number of moment-to-moment A-weighted sound level measurements. Several sound level metrics that are commonly reported in community sound monitoring programs are described below.

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1 Bies, David A., and Hansen, Colin H. *Engineering Noise Control: Theory and Practice*. 4th ed. New York: Spon Press, 2009. 85. Print

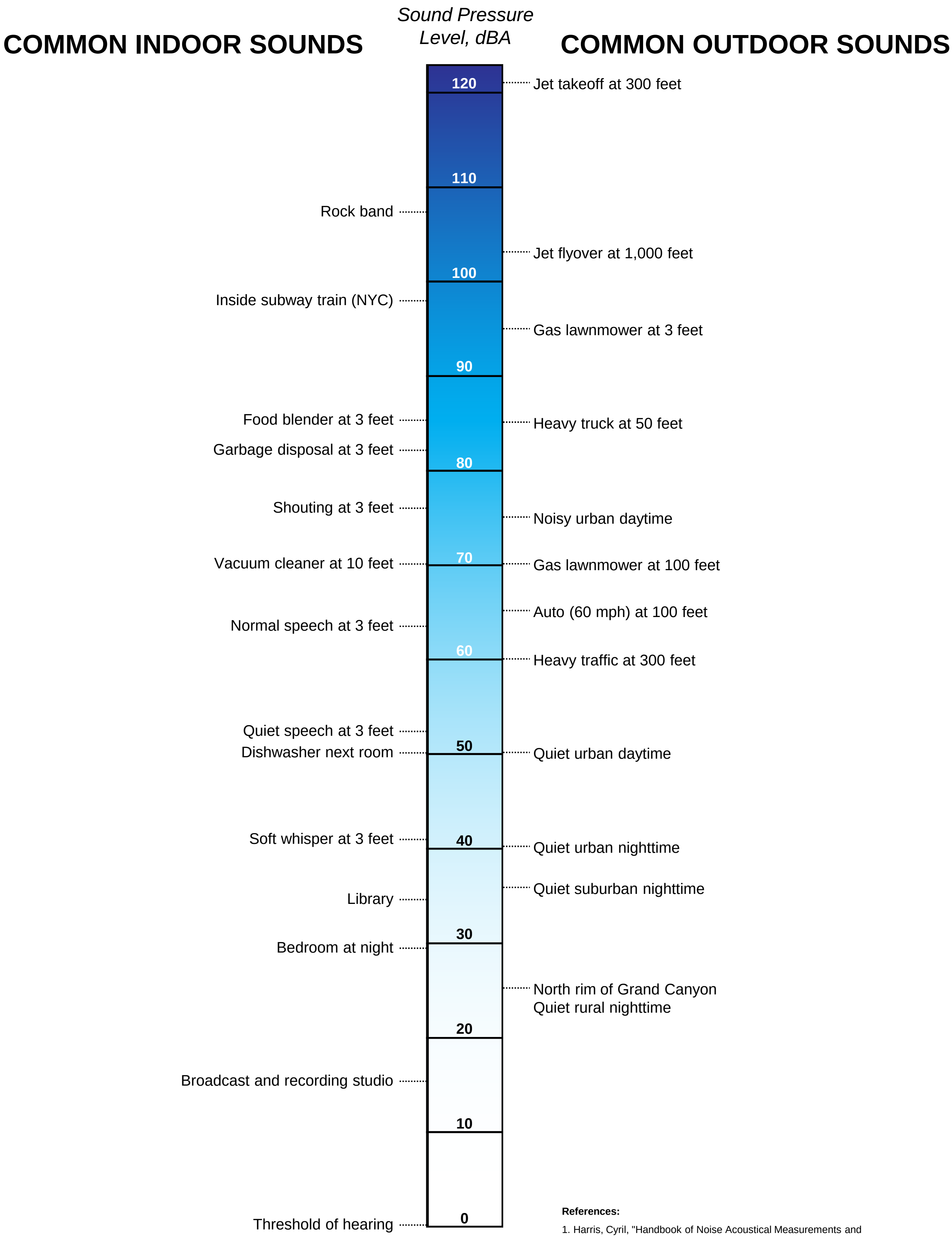
2 American National Standards Institute. "*ANSI S1.4-1983: Specification for Sound Level Meters.*" Acoustical Society of America.

3 Bies, David A., and Hansen, Colin H. *Engineering Noise Control: Theory and Practice*. 4th ed. New York: Spon Press, 2009. 103. Print

- Exceedance levels, designated $L_n$, where n can have a value of 0 to 100 percent, are values from the cumulative amplitude distribution of all of the sound levels observed during a measurement period. $L_{90}$ is the sound level in dBA exceeded 90 percent of the time during the measurement period and is close to the lowest sound level observed. It is essentially the residual sound level when there are no obvious nearby intermittent noise sources.

- $L_{eq}$, the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.,* the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated $L_{eq}$ and is also A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with linear mean square sound pressure values, the $L_{eq}$ is mostly determined by occasional loud noises, such as a passing vehicle or an aircraft flyover.

In short, by using various sound metrics it is possible to separate prevailing, steady sounds (the $L_{90}$) from occasional, louder sounds ($L_{10}$) in the acoustic environment or combined equivalent levels ($L_{eq}$).




**References:**

1. Harris, Cyril, "Handbook of Noise Acoustical Measurements and Noise Control", p 1-10., 1998
2. "Controlling Noise", USAF, AFMC, AFDTC, Elgin AFB, Fact Sheet, August 1996
3. California Dept. of Trans., "Technical Noise Supplement", Oct, 1998



**Figure 3-1**

**Common Sound Levels in the Environment**

# 4.0 NOISE REGULATIONS

Noise is officially defined as "unwanted sound". The principal feature of this definition is that there must be sound energy and that there must be someone hearing it who considers it unwanted. Noise impact is judged on two bases: the extent to which governmental regulations or guidelines may be exceeded, and the extent to which it is estimated that people may be annoyed or otherwise adversely affected by the sound. Regulatory authority for assessing and controlling noise is contained in both the State Environmental Quality Review Act (SEQRA) and specific Department program policy documents. Specific regulatory references are discussed below.

## 4.1 Federal Regulations

There are no federal community noise regulations applicable to wind farms.

## 4.2 New York State Regulations

Noise is an aspect of the environment under SEQRA (see 6 NYCRR 617.2(1)), and a substantial adverse change in existing noise levels can be (if not mitigated to the maximum extent practicable) among the indicators of significant adverse impacts on the environment.

## 4.3 Local Regulations

Article XVI, Section 1606 (Zoning District and Bulk Requirements), Parts 3 through 6 of the Town of Hanover Wind Law contains a noise limit applicable to Wind Energy Conversion Systems (WECS) which requires that:

> "The statistical sound pressure level generated by a WECS shall not exceed $L_{10}$ – 50 dBA measured at any off site residence existing at the time of application. If the ambient sound level exceeds 48 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement.

In the event audible noise due to WECS operation contains a steady pure tone, such as a whine, screech or hum, the standards for audible noise set forth in this subsection shall be reduced by five dBA. A pure tone is defined to exist if the 1/3 octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels of the two contiguous bands by:

- 5 dB for center frequencies of 500 Hz or above
- 8 dB for center frequencies between 160 and 500 Hz
- 15 dB for center frequencies less than or equal to 125 Hz

In the event the ambient noise level (exclusive of the development in question) exceeds the applicable standard given above, the applicable standard shall be adjusted so as to equal the ambient noise level."

Section 690.12 (Setbacks for Wind Energy Conversion Systems), Parts A through D of Local Law No. 1 of 2007 for the Town of Villenova contains an identical noise limit to the Town of Hanover, as described above.

## 4.4 NYSDEC Guidelines

The NYSDEC has published a guidance document[4] for assessing noise impacts (NYSDEC, 2001). The guidance document states that the addition of any noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dBA. Ambient sound levels in industrial or commercial areas may exceed 65 dBA with a high end of approximately 79 dBA. In these instances, mitigation measures utilizing best management practices should be used in an effort to ensure minimum impacts.

This guidance document also states that sound level increases from 0-3 dBA should have no appreciable effect on receptors, increases from 3-6 dBA may have potential for adverse noise impact only in cases where the most sensitive of receptors are present, and increases of more than 6 dBA may require a closer analysis of impact potential depending on existing sound levels and the character of surrounding land use and receptors. An increase of 10 dBA deserves consideration of avoidance and mitigation measures in most cases.

The typical ability of an individual to perceive changes in noise levels is summarized in Table 4-1. These guidelines allow direct estimation of an individual's probable perception of a change in community noise levels.

**Table 4-1 Thresholds for Sound Pressure Level Increases**

| Increase in Sound Pressure (dBA) | Community Reaction |
|---|---|
| 0-3 | No appreciable effect |
| 3-6 | Potential effect for sensitive receptors |
| Over 6 | Closer analysis required |
| Source: NYSDEC, "Assessing and Mitigating Noise Impacts", Division of Environmental Permits, February 2, 2001. | |

4 Program Policy Assessing and Mitigating Noise Impacts issued by the New York State Department of Environmental Conservation (NYSDEC), Feb. 2001

# 5.0 EXISTING SOUND LEVELS

Details of the existing sound level measurement methodology, measurement locations, instrumentation, and meteorological conditions can be found in §2.0 of the Environmental Sound Survey and Noble Impact Assessment Report issued by Hessler Associates, Inc. [Report No. 1813-063008-A], dated July 16, 2008 ("Hessler's Report"). A brief discussion of the measured background sound levels as a function of wind speed for use in evaluating compliance with NYSDEC noise guidelines can be found in §6.0 below.

# 6.0 FUTURE CONDITIONS

## 6.1 Equipment and Operating Conditions

### *6.1.1 GE 2.3-116*

Each of the thirty-six (36) proposed GE 2.3 MW-116 wind turbines being considered for the Ball Hill Wind Project have a rotor diameter of 116 meters and a hub height of 94 meters. Table 6-1 presents the manufacturer-provided broadband sound power level, PWL, as a function of wind speed for the GE unit used as input to the model. Under peak sound-producing operating conditions, each turbine has an A-weighted sound power level of 107.5 dBA plus an uncertainty factor of 2.0 dBA, as provided by the manufacturer. Octave-band sound power levels are presented in Table 6-2 for hub height wind speeds of 10 m/s, corresponding to the maximum A-weighted sound power level output. This represents the operating condition for which compliance with the Town of Hanover and Town of Villenova noise limit of 50 dBA shall be evaluated.

Table 6-1 GE 2.3-116 Broadband Sound Power Level (dBA) as a Function of Wind Speed

| | Wind Speed at Hub Height of 94m AGL (m/s) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | ≥10 |
| Turbine PWL[1] (dBA) | 95.0 | 95.8 | 98.2 | 101.6 | 104.5 | 105.8 | 107.5 |

1. Does not include uncertainty factor

Table 6-2 GE 2.3-116 Octave-Band Sound Power Levels (dBA)

| Turbine PWL[1] (dB) by Octave-Band Center Frequency (Hz) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 78.7 | 88.7 | 95.1 | 99.9 | 102.9 | 102.1 | 97.7 | 89.2 | 68.4 |

1. Octave-band sound power levels at hub height wind speeds of 10 m/s, not including uncertainty factor

The NYSDEC criteria discussed in §4.4 is based on an evaluation of the increase over ambient sound levels which vary both as a function of turbine output and wind speed. Critical operating conditions occur at a wind speed when the turbine sound level is highest relative to the ambient sound level. Table 6-3 below compares the relative difference between turbine output and ambient sound level based on the regression analysis provided in Figure 2.7.2 of Hessler's report which presents the measured background $L_{eq}$ sound level as a function of normalized wind speed at 10 meters AGL.

It can be seen from Table 6-3 that a hub height wind speed of 10 m/s corresponds to the highest wind turbine sound power output relative to measured background sound levels, representing "critical-case" conditions in terms of an increase over ambient. For the GE 2.3-116 turbine model, this same condition happens to coincide with the wind speed of maximum turbine sound level output.

Table 6-3 Comparison of Background SPL and GE 2.3-116 Turbine PWL to Determine "Critical-Case" Design Wind Speed

| Wind Speed at 94m (m/s) | 4 | 5 | 6 | 7 | 8 | 9 | **10** | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| Wind Speed at 10m[1] (m/s) | 2.8 | 3.5 | 4.2 | 4.9 | 5.6 | 6.3 | **7.0** | 7.7 | 8.4 | 9.1 |
| Turbine PWL (dBA) | 95.0 | 95.8 | 98.2 | 101.6 | 104.5 | 105.8 | **107.5** | 107.5 | 107.5 | 107.5 |
| Background $L_{eq}$ SPL[2] (dBA) | 39.4 | 40.2 | 40.9 | 41.7 | 42.5 | 43.2 | **44.0** | 44.7 | 45.5 | 46.2 |
| Turbine PWL – Background SPL (dBA) | 55.6 | 55.6 | 57.3 | 59.9 | 62.0 | 62.6 | **63.5** | 62.8 | 62.0 | 61.3 |

1. Normalized using logarithmic profile described in IEC Standard 61400-11, Equation (7)
2. Calculated using regression line equation provided in Figure 2.7.2 of Hessler's report

### *6.1.2 Vestas V110-2.2*

Each of the thirty-six (36) proposed Vestas V110-2.2 wind turbines being considered for the Ball Hill Wind Project have a rotor diameter of 110 meters and a hub height of 95 meters. Table 6-4 presents the manufacturer-provided broadband sound power level, PWL, as a function of wind speed for the Vestas unit used as input to the model. Under peak sound-producing operating conditions, each turbine has an A-weighted sound power level of 107.7 dBA plus an uncertainty factor of 2.0 dBA, as provided by the manufacturer. Octave-band sound power levels, as calculated from one-third octave band data, are presented in Table 6-5 for hub height wind speeds of 10 m/s, corresponding to the maximum A-weighted sound power level output. This represents the operating condition for which compliance with the Town of Hanover and Town of Villenova noise limit of 50 dBA shall be evaluated.

Table 6-4 Vestas V110-2.2 Broadband Sound Power Level (dBA) as a Function of Wind Speed

| | Wind Speed at Hub Height of 95m AGL (m/s) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | ≥10 |
| Turbine PWL[1] (dBA) | 96.4 | 97.9 | 101.9 | 103.9 | 106.4 | 107.6 | 107.7 |

1. Does not include uncertainty factor

Table 6-5 Vestas V110-2.2 Octave-Band Sound Power Levels (dBA)

| Turbine PWL[1] (dB) by Octave-Band Center Frequency (Hz) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 75.1 | 84.9 | 92.3 | 97.3 | 101.3 | 103.3 | 101.5 | 94.0 | 82.7 |

1. Octave-band sound power levels at hub height wind speeds of 10 m/s, not including uncertainty factor

The NYSDEC criteria discussed in §4.4 is based on an evaluation of the increase over ambient sound levels which vary both as a function of turbine output and wind speed. Critical operating conditions occur at a wind speed when the turbine sound level is highest relative to the ambient sound level. Table 6-6 below compares the relative difference between turbine output and ambient sound level based on the regression analysis provided in Figure 2.7.2 of Hessler's report which presents the measured background $L_{eq}$ sound level as a function of normalized wind speed at 10 meters AGL.

It can be seen from Table 6-6 that a hub height wind speed of 9 m/s corresponds to the highest wind turbine sound power output relative to measured background sound levels, representing "critical-case" conditions in terms of an increase over ambient. For the Vestas V110-2.2 116 turbine model, the turbine sound power output at this wind speed is only 0.1 dBA less than the maximum output at 10 m/s.

**Table 6-6 Comparison of Background SPL and Vestas V110-2.2 Turbine PWL to Determine "Critical-Case" Design Wind Speed**

| Wind Speed at 94m (m/s) | 4 | 5 | 6 | 7 | 8 | **9** | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| Wind Speed at 10m[1] (m/s) | 2.8 | 3.5 | 4.2 | 4.9 | 5.6 | **6.3** | 7.0 | 7.7 | 8.4 | 9.1 |
| Turbine PWL (dBA) | 96.4 | 97.9 | 101.9 | 103.9 | 106.4 | **107.6** | 107.7 | 107.7 | 107.7 | 107.7 |
| Background $L_{eq}$ SPL[2] (dBA) | 39.4 | 40.2 | 41.0 | 41.7 | 42.5 | **43.2** | 44.0 | 44.7 | 45.5 | 46.3 |
| Turbine PWL – Background SPL (dBA) | 57.0 | 57.7 | 60.9 | 62.2 | 63.9 | **64.4** | 63.7 | 63.0 | 62.2 | 61.4 |

1. Normalized using logarithmic profile described in IEC Standard 61400-11, Equation (7)
2. Calculated using regression line equation provided in Figure 2.7.2 of Hessler's report

### *6.1.3 Substation*

A single utility scale transformer associated with the proposed substation was included in the model assuming the sound power level inputs presented in Table 6-7 below, based on information provided by RES for a representative unit.

**Table 6-7 Substation Transformer Sound Power Levels[1] (dBA)**

| dBA | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
|---|---|---|---|---|---|---|---|---|---|
| 106.8 | 64.0 | 83.2 | 95.3 | 97.8 | 103.2 | 100.4 | 96.6 | 91.4 | 82.3 |

1. Based on standard NEMA TR.1 Table 0-1 for one MVA, 120 kV utility scale transformer with 5 dB noise reduction by octave-band.

## 6.2 Modeling Methodology

Sound impacts associated with the proposed wind turbine generators and proposed substation transformer were predicted using Cadna/A noise calculation software (DataKustik Corporation, 2015). This software, which implements the ISO 9613-2 international standard for sound propagation (Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation), offers a refined set of computations accounting for local topography, ground attenuation, drop-off with distance, barrier shielding, and atmospheric absorption of sound from multiple sound sources.

Inputs and significant parameters employed in the model are described below:

- *Project Layout:* A project layout comprised of a total of 36 proposed wind turbine locations and a proposed substation location was provided by RES along with a shapefile of the Project property boundary for use as input in the model.

- *Sensitive Receptors:* A shapefile of 335 structures was provided by RES and used as input to the model. All receptors were modeled with a height of 1.5 meters AGL to mimic the ears of a typical standing observer.

- *Terrain Elevation:* Elevation contours for the modeling domain with 3 meter resolution were directly imported into Cadna/A which allowed for consideration of terrain shielding where appropriate. These contours were generated from elevation information derived from the National Elevation Database (NED) developed by the U.S. Geological Survey.

- *Source Sound Levels & Controls:* Manufacturer-provided octave-band sound power levels for the GE 2.3-116 and Vestas V112-3.3 MW units, presented above in §6.1.1 and §6.1.2, respectively, were used as input in the model.

- *Meteorological Conditions:* A temperature of 10ºC (50ºF) and a relative humidity of 70% was assumed in the model.

- *Ground Attenuation:* Spectral ground absorption was calculated using a G-factor of 0.5 to represent a moderately reflective surface.

Several modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by the user, were implemented in the Cadna/A model to ensure conservative results (i.e., higher sound levels), and are described below:

- Modeled source sound power level inputs represent acoustic emissions measured in accordance with IEC 61400-11 corresponding to maximum sound power output, plus an additional manufacturer-provided uncertainty factor of 2 dBA.

- All modeled sources were assumed to be operating simultaneously and at the design wind speed corresponding to maximum sound power emissions.

- Predicted sound levels were computed with the assumption that each receptor was always located directly downwind from every turbine simultaneously. While a physical impossibility, this provides conservative results and is required by the ISO 9613-2 standard.

- As per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night.

- A mixture of hard and porous ground was assumed for the surrounding Project area to represent a surface that is partially reflective, a conservative assumption for much of the year when the ground would be covered in vegetation.

- Meteorological conditions assumed in the model (T = 10°C/RH = 70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1 kHz octave-bands where the human ear is most sensitive.

- No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

Sound levels due to the operation of all 36 wind turbines were modeled at each of the 335 specific receptors representing the closest structures to the Project. In addition, sound levels were modeled across a large grid of receptor points, spaced 100 meters apart, to create sound level isopleths across the entire Project area.

## 6.3 Modeling Sound Level Results

### *6.3.1 GE 2.3-116*

Modeling results for the GE 2.3-116 turbine, representing maximum Project-only $L_{10}$ sound levels, are illustrated in Figure 6-1 as iso-dBA contour lines overlaid on aerial imagery of the Project site. Predicted $L_{10}$ sound levels, ranging from 21 to 50 dBA, and $L_{eq}$ sound levels, ranging from 20 to 49 dBA, are presented in tabular form in Table A-1of Appendix A at all 335 discrete modeling receptors representing the closest structures to the Project. These predicted sound levels which contain a manufacturer-provided uncertainty factor of 2 dBA are "Project-only" and do not include any contributions from existing background sound sources. The calculated maximum $L_{10}$ values shown in Figure 6-1 and presented in Table A-1 include an adjustment of 1 dBA added to the modeled maximum $L_{eq}$ turbine sound levels. This allows for the approximate conversion of $L_{eq}$ to $L_{10}$ sound levels used for evaluating compliance with the local noise limits, and is based on empirical data from several Epsilon Associates, Inc. measurement programs where wind turbines are the primary noise source.

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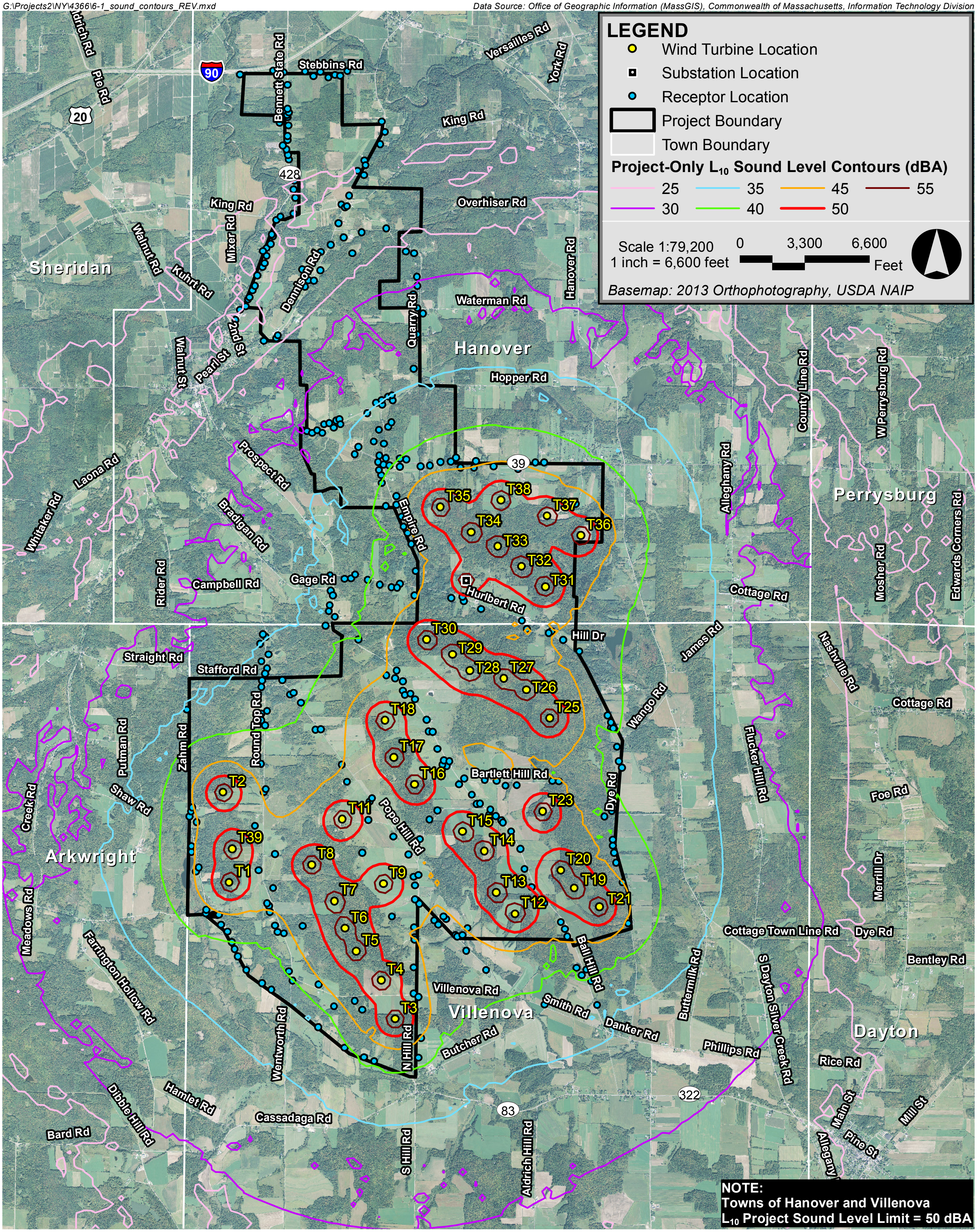
*Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division*




**Ball Hill Wind Project** **Hanover & Villenova, New York**

Epsilon ASSOCIATES INC.

**Figure 6-1**

*Maximum Project-Only $L_{10}$ Sound Levels*
*GE 2.3-116 (10m/s at 94m HH)*

### 6.3.2 *Vestas V110-2.2*

Modeling results for the Vestas V110-2.2 turbine, representing maximum Project-only $L_{10}$ sound levels, are illustrated in Figure 6-2 as iso-dBA contour lines overlaid on aerial imagery of the Project site. Predicted $L_{10}$ sound levels, ranging from 18 to 50 dBA, and $L_{eq}$ sound levels, ranging from 17 to 49 dBA, are presented in tabular form in Table B-1of Appendix Bat all 335 discrete modeling receptors representing the closest structures to the Project. These predicted sound levels which contain a manufacturer-provided uncertainty factor of 2 dBA are "Project-only" and do not include any contributions from existing background sound sources. The calculated maximum $L_{10}$ values shown in Figure 6-2 and presented in Table B-1 include an adjustment of 1 dBA added to the modeled maximum $L_{eq}$ turbine sound levels. This allows for the approximate conversion of $L_{eq}$ to $L_{10}$ sound levels used for evaluating compliance with the local noise limits, and is based on empirical data from several Epsilon Associates, Inc. measurement programs where wind turbines are the primary noise source.

The calculated "critical-case" $L_{eq}$ values presented in Table B-1 at a hub height wind speed of 9 m/s include an adjustment of 0.1 dBA subtracted from the modeled maximum $L_{eq}$ turbine sound levels produced at a hub height wind speed of 10 m/s. This accounts for the difference between turbine sound power levels under conditions of maximum output (10 m/s at hub height) and greatest Project impact in terms of an increase over background (9 m/s at hub height).

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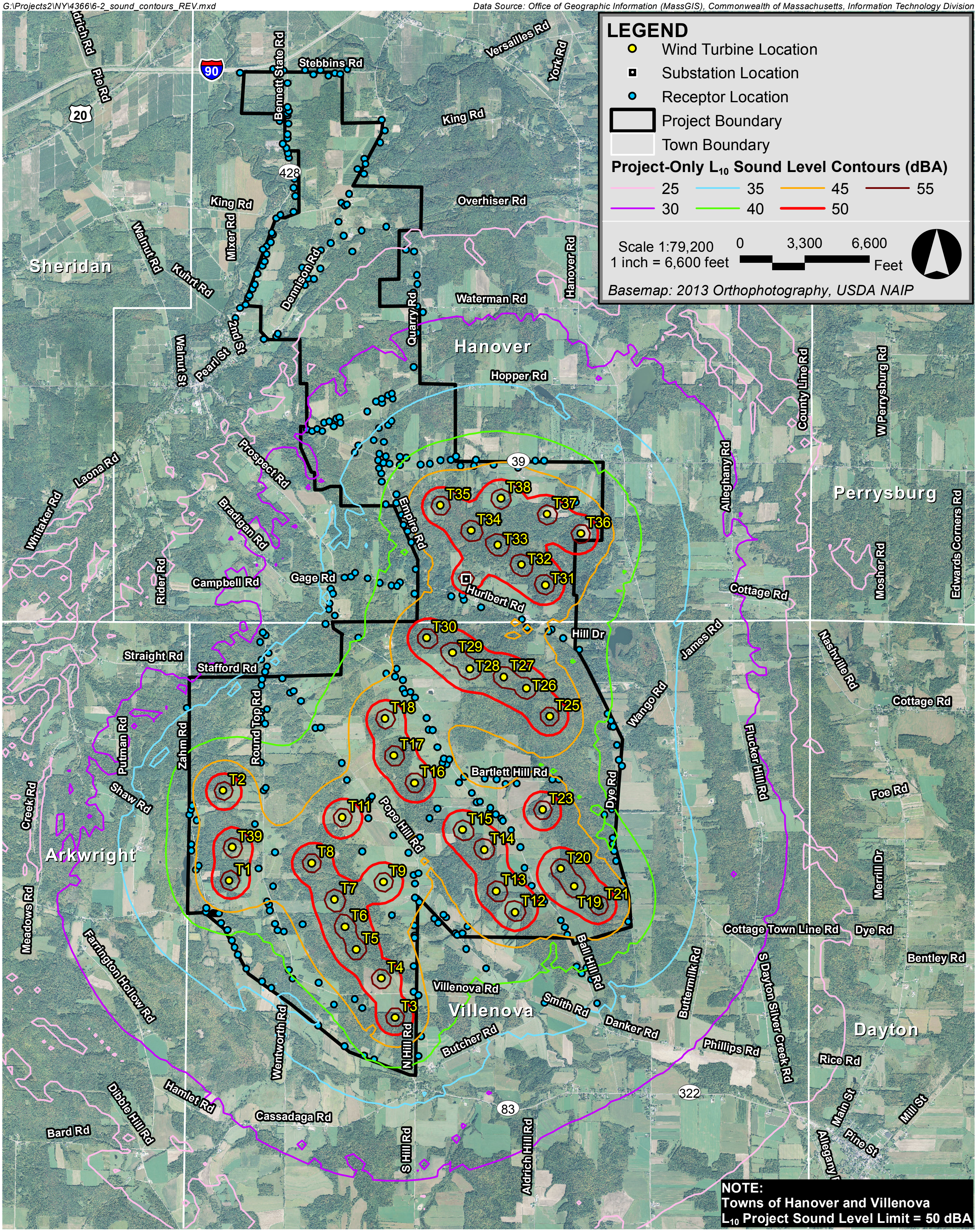
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division




**Ball Hill Wind Project** **Hanover & Villenova, New York**

Epsilon ASSOCIATES INC.

**Figure 6-2**

*Maximum Project-Only $L_{10}$ Sound Levels*

*Vestas V110 2.2 MW (10m/s at 95m HH)*

# 7.0 EVALUATION OF SOUND LEVELS

## 7.1 GE 2.3-116

### *7.1.1 Local Regulations*

As presented in Table A-1 of Appendix A and illustrated in Figure 6-1, predicted $L_{10}$ sound levels from the Project under conditions of maximum wind turbine sound power output (corresponding to a hub height wind speed of 10 m/s) are less than or equal to the 50 dBA limit specified by the Towns of Hanover and Villenova at all 335 receptors representing the closest structures to the Project.

With regard to "pure tones", as defined in §4.3, an evaluation of the maximum one-third octave-band sound power levels for the GE 2.3-116 model, provided by the turbine manufacturer, is presented in Table 7-1. This analysis indicates that even under conditions of maximum turbine sound power output, corresponding to hub height wind speeds of 10 m/s, no pure tones shall be emitted.

Table 7-1 Tonal Analysis & Compliance Evaluation: GE 2.3-116 Sound Power Level Emissions

| One-Third Octave-band Center Frequency (Hz) | Sound Power Level[1] (dB) | Average Sound Power Level of Contiguous Bands (dB) | Difference between Sound Power Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 25 | 113.0 | - | - | - | - |
| 32 | 112.2 | 112.3 | 0 | 15 | Yes |
| 40 | 111.5 | 111.3 | 0 | 15 | Yes |
| 50 | 110.4 | 110.6 | 0 | 15 | Yes |
| 63 | 109.6 | 109.6 | 0 | 15 | Yes |
| 80 | 108.8 | 108.5 | 0 | 15 | Yes |
| 100 | 107.4 | 107.5 | 0 | 15 | Yes |
| 125 | 106.2 | 106.3 | 0 | 15 | Yes |
| 160 | 105.2 | 105.2 | 0 | 8 | Yes |
| 200 | 104.1 | 104.4 | 0 | 8 | Yes |
| 250 | 103.5 | 103.6 | 0 | 8 | Yes |
| 315 | 103.1 | 102.9 | 0 | 8 | Yes |
| 400 | 102.2 | 102.3 | 0 | 8 | Yes |
| 500 | 101.5 | 101.4 | 0 | 5 | Yes |
| 630 | 100.5 | 100.2 | 0 | 5 | Yes |
| 800 | 98.8 | 98.9 | 0 | 5 | Yes |
| 1000 | 97.3 | 97.4 | 0 | 5 | Yes |
| 1250 | 96.0 | 95.5 | 1 | 5 | Yes |
| 1600 | 93.6 | 93.7 | 0 | 5 | Yes |
| 2000 | 91.4 | 91.4 | 0 | 5 | Yes |
| 2500 | 89.2 | 89.0 | 0 | 5 | Yes |
| 3150 | 86.5 | 85.6 | 1 | 5 | Yes |

Table 7-1 Tonal Analysis & Compliance Evaluation: GE 2.3-116 Sound Power Level Emissions (Continued)

| One-Third Octave-band Center Frequency (Hz) | Sound Power Level[1] (dB) | Average Sound Power Level of Contiguous Bands (dB) | Difference between Sound Power Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| **4000** | 81.9 | 81.4 | 1 | 5 | Yes |
| 5000 | 76.3 | 75.1 | 1 | 5 | Yes |
| 6300 | 68.2 | 67.1 | 1 | 5 | Yes |
| **8000** | 57.8 | 57.5 | 0 | 5 | Yes |
| 10000 | 46.7 | - | - | - | - |

1. One-third octave-band sound power level for GE 2.3-116 turbine at hub height wind speeds of 10m/s
2. Rounded to the nearest whole number decibel
3. Compliance evaluation of "pure tone" criteria described in §4.3

Additionally, one-third octave-band received sound pressure levels were calculated at the closest structure (receptor #164) to a turbine (T11), accounting for geometric divergence and atmospheric absorption, at a distance of approximately 1,320 feet (400 meters). Results presented in Table 7-2 show that received sound pressure levels due to the Project are not expected to result in any pure tones, as defined by the Towns of Hanover and Villenova.

Table 7-2 Tonal Analysis: GE 2.3-116 Received Sound Pressure Levels

| One-Third Octave-band Center Frequency (Hz) | Received Sound Pressure Level[1] (dB) | Average Sound Pressure Level of Contiguous Bands (dB) | Difference between Sound Pressure Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 25 | 52.7 | - | - | - | - |
| **32** | 51.9 | 51.9 | 0 | 15 | Yes |
| 40 | 51.2 | 51.0 | 0 | 15 | Yes |
| 50 | 50.1 | 50.2 | 0 | 15 | Yes |
| **63** | 49.2 | 49.2 | 0 | 15 | Yes |
| 80 | 48.4 | 48.1 | 0 | 15 | Yes |
| 100 | 47.0 | 47.1 | 0 | 15 | Yes |
| **125** | 45.8 | 45.8 | 0 | 15 | Yes |
| 160 | 44.7 | 44.6 | 0 | 8 | Yes |
| 200 | 43.5 | 43.7 | 0 | 8 | Yes |
| **250** | 42.7 | 42.8 | 0 | 8 | Yes |
| 315 | 42.2 | 41.9 | 0 | 8 | Yes |
| 400 | 41.1 | 41.2 | 0 | 8 | Yes |
| **500** | 40.1 | 40.0 | 0 | 5 | Yes |
| 630 | 38.9 | 38.5 | 0 | 5 | Yes |
| 800 | 36.9 | 37.0 | 0 | 5 | Yes |
| **1000** | 35.1 | 35.2 | 0 | 5 | Yes |
| 1250 | 33.4 | 32.7 | 1 | 5 | Yes |
| 1600 | 30.3 | 30.4 | 0 | 5 | Yes |

Table 7-2 Tonal Analysis: GE 2.3-116 Received Sound Pressure Levels (Continued)

| One-Third Octave-band Center Frequency (Hz) | Received Sound Pressure Level[1] (dB) | Average Sound Pressure Level of Contiguous Bands (dB) | Difference between Sound Pressure Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 2000 | 27.4 | 27.3 | 0 | 5 | Yes |
| 2500 | 24.3 | 23.4 | 1 | 5 | Yes |
| 3150 | 19.4 | 17.8 | 2 | 5 | Yes |
| 4000 | 11.2 | 10.0 | 1 | 5 | Yes |
| 5000 | 0.7 | 5.6 | -5 | 5 | Yes |
| 6300 | 0.0 | 0.3 | 0 | 5 | Yes |
| 8000 | 0.0 | 0.0 | 0 | 5 | Yes |
| 10000 | 0.0 | - | - | - | - |

1. Calculated sound pressure level due to a single turbine at a distance of ~1,320 feet (receptor #164), based on maximum GE2.3-116 one-third octave-band sound power levels for hub height wind speeds of 10 m/s
2. Rounded to the nearest whole number decibel
3. Compliance evaluation of "pure tone" criteria described in §4.3

### *7.1.2 NYSDEC Criteria*

The predicted $L_{eq}$ sound levels at the nearest structures presented in Table A-1 of Appendix A were compared to the existing ambient $L_{eq}$ sound levels with respect to the NYSDEC criteria discussed in §4.4. As shown in Table 6-3, the calculated background sound level for the Project area at the "critical-case" hub height wind speed of 10 m/s is 44.0 dBA. In order for the Project to meet the suggested 6 dBA cumulative increase threshold recommended in the NYSDEC guidance document, $L_{eq}$ sound levels from the Project should remain at or below 49.4 dBA. That is to say, a Project level of 49.4 dBA added to a background level of 44.0 dBA would result in a combined level of 50.5 dBA, which is 6 dBA above background, when rounded to the nearest whole decibel.

Maximum $L_{eq}$ sound levels from the Project are predicted to be no greater than 49.0 dBA even under conditions of maximum turbine sound power output. Additionally, future sound levels combining the Project with the existing background are anticipated to remain less than or equal to 50 dBA, well below the suggested 65 dBA threshold recommended in the NYSDEC guidance document.

### *7.1.3 Low Frequency Sound*

Table 7-3 compares predicted maximum Project-only $L_{10}$ sound levels in the 32, 63 and 125 Hz octave-bands to the equivalent outdoor sound pressure levels corresponding to the NC-30 noise criteria curve recommended for bedrooms and to levels associated with "moderately perceptible vibration and rattle."[5] Results indicate that of the ten residential locations of greatest potential Project impact, predicted sound levels are well below both relevant criteria, indicating that no low-frequency sound impacts are expected.

Table 7-3 Predicted Worst-Case Low Frequency Sound Levels

| Modeling Receptor ID | Sound Pressure Level (dB) | | |
|---|---|---|---|
| | 31.5 Hz (dB) | 63 Hz (dB) | 125 Hz (dB) |
| 185 | 66 | 63 | 55 |
| 184 | 65 | 62 | 55 |
| 117 | 63 | 61 | 55 |
| 186 | 65 | 62 | 54 |
| 116 | 63 | 61 | 54 |
| 164 | 65 | 61 | 54 |
| 187 | 65 | 62 | 54 |
| 188 | 65 | 62 | 54 |
| 190 | 65 | 61 | 54 |
| 191 | 65 | 61 | 54 |
| NC-30 Equivalent Outdoor Sound Pressure Levels | 74 | 66 | 57 |
| Equivalent Outdoor Sound Pressure Levels for Moderately Perceptible Vibration & Rattle | 71 | 79 | NA |

Another metric commonly used to assess low frequency noise is the "C-weighted" sound level. For the GE 2.3-116 turbine, the maximum C-weighted sound level at any of the 335 modeling receptors representing the closest structures to the Project is predicted to be less than or equal to 66 dBC. For context, ANSI Standard B133.8 "Gas Turbine Installation Sound Emissions" describes a threshold of 75 to 80 dBC as the approximate level at which complaints and the perception of vibrations due to airborne sound may occur.

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5 O'Neal, Robert D., Hellweg Jr., Robert D., Lampeter, Richard M. "Low Frequency Noise and Infrasound from Wind Turbines." Noise Control Engineering Journal 59.2 (2011): 139. Print.

## 7.2 Vestas V110-2.2

### *7.2.1 Local Regulations*

As presented in Table B-1 of Appendix B and illustrated in Figure 6-2, predicted $L_{10}$ sound levels from the Project under conditions of maximum wind turbine sound output (corresponding to a hub height wind speed of 10 m/s) are less than or equal to the 50 dBA limit specified by the Towns of Hanover and Villenova at all 335 receptors representing the closest structures to the Project.

With regard to "pure tones", as defined in §4.3, an evaluation of the maximum one-third octave-band sound power levels for the Vestas V110-2.2 model, provided by the turbine manufacturer, is presented in Table 7-4. This analysis indicates that even under conditions of maximum turbine sound power output, corresponding to hub height wind speeds of 10 m/s, no pure tones shall be emitted.

Table 7-4 Tonal Analysis: Vestas V110-2.2 Sound Power Level Emissions

| One-Third Octave-band Center Frequency (Hz) | Sound Power Level[1] (dB) | Average Sound Power Level of Contiguous Bands (dB) | Difference between Sound Power Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 25 | 110.2 | - | - | - | - |
| **32** | 108.8 | 109.0 | 0 | 15 | Yes |
| 40 | 107.7 | 108.1 | 0 | 15 | Yes |
| 50 | 107.4 | 106.6 | 1 | 15 | Yes |
| **63** | 105.5 | 106.1 | -1 | 15 | Yes |
| 80 | 104.8 | 105.0 | 0 | 15 | Yes |
| 100 | 104.4 | 104.2 | 0 | 15 | Yes |
| **125** | 103.6 | 103.4 | 0 | 15 | Yes |
| 160 | 102.4 | 102.5 | 0 | 8 | Yes |
| 200 | 101.3 | 102.0 | -1 | 8 | Yes |
| **250** | 101.5 | 100.8 | 1 | 8 | Yes |
| 315 | 100.3 | 100.2 | 0 | 8 | Yes |
| 400 | 98.8 | 100.4 | -2 | 8 | Yes |
| **500** | 100.5 | 99.2 | 1 | 5 | Yes |
| 630 | 99.5 | 100.1 | -1 | 5 | Yes |
| 800 | 99.6 | 99.2 | 0 | 5 | Yes |
| **1000** | 98.8 | 98.5 | 0 | 5 | Yes |
| 1250 | 97.4 | 98.0 | -1 | 5 | Yes |
| 1600 | 97.1 | 96.7 | 0 | 5 | Yes |
| **2000** | 95.9 | 95.0 | 1 | 5 | Yes |
| 2500 | 92.9 | 93.1 | 0 | 5 | Yes |
| 3150 | 90.3 | 90.4 | 0 | 5 | Yes |
| **4000** | 87.9 | 87.4 | 1 | 5 | Yes |
| 5000 | 84.5 | 84.8 | 0 | 5 | Yes |
| 6300 | 81.7 | 80.5 | 1 | 5 | Yes |

## Table 7-4 Tonal Analysis: Vestas V110-2.2 Sound Power Level Emissions (Continued)

| One-Third Octave-band Center Frequency (Hz) | Sound Power Level[1] (dB) | Average Sound Power Level of Contiguous Bands (dB) | Difference between Sound Power Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 8000 | 76.4 | 76.6 | 0 | 5 | Yes |
| 10000 | 71.5 | - | - | - | - |

4. One-third octave-band sound power level for Vestas V110-2.2 turbine at hub height wind speeds of 10m/s
5. Rounded to the nearest whole number decibel
6. Compliance evaluation of "pure tone" criteria described in §4.3

Additionally, one-third octave-band received sound pressure levels were calculated at the closest structure (receptor #164) to a turbine (T11), accounting for geometric divergence and atmospheric absorption, at a distance of approximately 1,320 feet (400 meters). Results presented in Table 7-5 show that received sound pressure levels due to the Project are not expected to result in any pure tones, as defined by the Towns of Hanover and Villenova.

## Table 7-5 Tonal Analysis: Vestas V110-2.2 Received Sound Pressure Levels

| One-Third Octave-band Center Frequency (Hz) | Received Sound Pressure Level[1] (dB) | Average Sound Pressure Level of Contiguous Bands (dB) | Difference between Sound Pressure Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| 25 | 49.9 | - | - | - | - |
| 32 | 48.5 | 48.6 | 0 | 15 | Yes |
| 40 | 47.4 | 47.8 | 0 | 15 | Yes |
| 50 | 47.1 | 46.3 | 1 | 15 | Yes |
| 63 | 45.1 | 45.7 | -1 | 15 | Yes |
| 80 | 44.4 | 44.6 | 0 | 15 | Yes |
| 100 | 44.0 | 43.8 | 0 | 15 | Yes |
| 125 | 43.2 | 42.9 | 0 | 15 | Yes |
| 160 | 41.9 | 41.9 | 0 | 8 | Yes |
| 200 | 40.7 | 41.3 | -1 | 8 | Yes |
| 250 | 40.7 | 40.0 | 1 | 8 | Yes |
| 315 | 39.4 | 39.2 | 0 | 8 | Yes |
| 400 | 37.7 | 39.3 | -2 | 8 | Yes |
| 500 | 39.1 | 37.8 | 1 | 5 | Yes |
| 630 | 37.9 | 38.4 | -1 | 5 | Yes |
| 800 | 37.7 | 37.3 | 0 | 5 | Yes |
| 1000 | 36.6 | 36.3 | 0 | 5 | Yes |
| 1250 | 34.8 | 35.2 | 0 | 5 | Yes |
| 1600 | 33.8 | 33.3 | 0 | 5 | Yes |
| 2000 | 31.9 | 30.9 | 1 | 5 | Yes |
| 2500 | 28.0 | 27.6 | 0 | 5 | Yes |
| 3150 | 23.2 | 22.6 | 1 | 5 | Yes |
| 4000 | 17.2 | 16.0 | 1 | 5 | Yes |
| 5000 | 8.9 | 8.6 | 0 | 5 | Yes |
| 6300 | - | - | - | 5 | Yes |

## Table 7-5 Tonal Analysis: Vestas V110-2.2 Received Sound Pressure Levels (Continued)

| One-Third Octave-band Center Frequency (Hz) | Received Sound Pressure Level[1] (dB) | Average Sound Pressure Level of Contiguous Bands (dB) | Difference between Sound Pressure Level and Contiguous Average[2] (dB) | Tonal Limit (dB) | Meets Tonal Limit?[3] |
|---|---|---|---|---|---|
| **8000** | - | - | - | 5 | Yes |
| 10000 | - | - | - | - | - |

4. Calculated sound pressure level due to a single turbine at a distance of ~1,320 feet (receptor #164), based on Vestas V110-2.2 one-third octave-band sound power levels for hub height wind speeds of 10 m/s
5. Rounded to the nearest whole number decibel
6. Compliance evaluation of "pure tone" criteria described in §4.3

### *7.2.2 NYSDEC Criteria*

The predicted $L_{eq}$ sound levels at the nearest structures presented in Table B-1 of Appendix B were compared to the existing ambient $L_{eq}$ sound levels with respect to the NYSDEC criteria discussed in §4.4. As shown in Table 6-6, the calculated background sound level for the Project area at the "critical-case" hub height wind speed of 10 m/s is 43.2 dBA. In order for the Project to meet the suggested 6 dBA cumulative increase threshold recommended in the NYSDEC guidance document, $L_{eq}$ sound levels from the Project should remain at or below 48.6 dBA. That is to say, a Project level of 48.6 dBA added to a background level of 43.2 dBA would result in a combined level of 49.7 dBA, which is 6 dBA above background, when rounded to the nearest whole decibel.

Maximum $L_{eq}$ sound levels from the Project are predicted to be no greater than 48.6 dBA even under conditions of maximum turbine sound power output. Additionally, future sound levels combining the Project with the existing background are anticipated to remain less than or equal to 50 dBA, well below the suggested 65 dBA threshold recommended in the NYSDEC guidance document.

### *7.2.3 Low Frequency Sound*

Table 7-6 compares predicted maximum Project-only $L_{10}$ sound levels in the 32, 63 and 125 Hz octave-bands to the equivalent outdoor sound pressure levels corresponding to the NC-30 noise criteria curve recommended for bedrooms and to levels associated with "moderately perceptible vibration and rattle."[6] Results indicate that of the ten residential locations of greatest potential Project impact, predicted sound levels are well below both relevant criteria, indicating that no low-frequency sound impacts are expected.

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6 O'Neal, Robert D., Hellweg Jr., Robert D., Lampeter, Richard M. "Low Frequency Noise and Infrasound from Wind Turbines." Noise Control Engineering Journal 59.2 (2011): 139. Print.

Table 7-6 Predicted Worst-Case Low Frequency Sound Levels

| Modeling Receptor ID | Sound Pressure Level (dB) | | |
|---|---|---|---|
| | 31.5 Hz | 63 Hz | 125 Hz |
| | (dB) | (dB) | (dB) |
| 185 | 62 | 59 | 52 |
| 184 | 62 | 58 | 52 |
| 117 | 60 | 58 | 53 |
| 186 | 62 | 58 | 52 |
| 116 | 60 | 58 | 52 |
| 164 | 61 | 58 | 51 |
| 187 | 61 | 58 | 51 |
| 188 | 61 | 58 | 51 |
| 190 | 61 | 58 | 51 |
| 191 | 61 | 57 | 51 |
| NC-30 Equivalent Outdoor Sound Pressure Levels | 74 | 66 | 57 |
| Equivalent Outdoor Sound Pressure Levels for Moderately Perceptible Vibration & Rattle | 71 | 79 | NA |

Another metric commonly used to assess low frequency noise is the “C-weighted” sound level. For the GE 2.3-116 turbine, the maximum C-weighted sound level at any of the 335 modeling receptors representing the closest structures to the Project is predicted to be less than or equal to 63 dBC. For context, ANSI Standard B133.8 “Gas Turbine Installation Sound Emissions” describes a threshold of 75 to 80 dBC as the approximate level at which complaints and the perception of vibrations due to airborne sound may occur.

## 7.3 Construction Noise

A qualitative discussion of construction noise related to the proposed Ball Hill Wind Project can be found in §3.9 of Hessler’s report.

# 8.0 CONCLUSIONS

A comprehensive sound level assessment conducted for the Ball Hill Wind Project indicates that predicted sound level impacts from the 36 proposed GE 2.3-116 or Vestas V110-2.2 wind turbine generators and proposed electrical substation are expected to meet the Town of Hanover and Town of Villenova noise limit at each of the closest residences to the Project. Additionally, the Project is anticipated to meet the suggested criteria recommended in the NYSDEC guidance document for avoiding the potential for adverse community noise impacts. No pure tones were identified in the sound power level spectra, nor in the calculated received sound pressure levels at the closest receptor for either turbine model under consideration. Low frequency sound levels at the closest receptors to the Project are also predicted to be well below the recommended criteria to avoid disturbance, vibration, and rattle indoors.

Due to the nature of wind turbine noise and the relative background sound levels in the area, noise from the project is likely to be audible at times at some of the closest residences. However, conservative modeling assumptions were made to account for the occasional occurrence of conditions which may favor propagation of sound from the Project or increase the perceptibility of turbine noise. A vast majority of the time, nominal sound levels from the project are likely to be significantly less than those predicted in this analysis which are based on worst-case conditions. Project impacts are anticipated to meet state guidelines for minimizing adverse impacts as well as all local noise limits applicable to the Project.

# Appendix A

# GE2.3-116 Sound Level Modeling Results

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 1 | 302816 | 265915 | 47 | 46 |
| 2 | 303062 | 265009 | 44 | 43 |
| 3 | 305191 | 265773 | 44 | 43 |
| 4 | 302077 | 267473 | 47 | 46 |
| 5 | 303317 | 270713 | 39 | 38 |
| 6 | 306562 | 273118 | 44 | 43 |
| 7 | 306428 | 273119 | 44 | 43 |
| 8 | 306290 | 273124 | 44 | 43 |
| 9 | 306043 | 273124 | 45 | 44 |
| 10 | 305504 | 273134 | 44 | 43 |
| 11 | 304572 | 271425 | 44 | 43 |
| 12 | 304504 | 271850 | 44 | 43 |
| 13 | 304445 | 272016 | 45 | 44 |
| 14 | 304388 | 272119 | 44 | 43 |
| 15 | 304351 | 272270 | 44 | 43 |
| 16 | 304271 | 272458 | 43 | 42 |
| 17 | 304269 | 272595 | 43 | 42 |
| 18 | 304110 | 272442 | 42 | 41 |
| 19 | 304044 | 272792 | 40 | 39 |
| 20 | 304035 | 272914 | 40 | 39 |
| 21 | 304005 | 272998 | 39 | 38 |
| 22 | 304070 | 273082 | 39 | 38 |
| 23 | 304326 | 273049 | 41 | 40 |
| 24 | 304647 | 273058 | 43 | 42 |
| 25 | 304795 | 273071 | 44 | 43 |
| 26 | 305272 | 273037 | 45 | 44 |
| 27 | 305479 | 273038 | 45 | 44 |
| 28 | 305780 | 273057 | 46 | 45 |
| 29 | 306159 | 273007 | 46 | 45 |
| 30 | 307052 | 272474 | 48 | 47 |
| 31 | 306568 | 264695 | 39 | 38 |
| 32 | 307872 | 265954 | 44 | 43 |
| 33 | 307785 | 266589 | 45 | 44 |
| 34 | 307687 | 266902 | 42 | 41 |
| 35 | 307651 | 267057 | 41 | 40 |
| 36 | 307631 | 267162 | 41 | 40 |
| 37 | 307630 | 267259 | 40 | 39 |
| 38 | 307500 | 267618 | 41 | 40 |
| 39 | 307676 | 267861 | 40 | 39 |
| 40 | 307620 | 267705 | 41 | 40 |
| 41 | 307768 | 268373 | 39 | 38 |
| 42 | 307726 | 268473 | 39 | 38 |
| 43 | 307695 | 268697 | 40 | 39 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 44 | 307607 | 268996 | 40 | 39 |
| 45 | 307636 | 268987 | 40 | 39 |
| 46 | 307607 | 269078 | 41 | 40 |
| 47 | 307551 | 269187 | 41 | 40 |
| 48 | 307113 | 270181 | 43 | 42 |
| 49 | 301431 | 266088 | 44 | 43 |
| 50 | 301447 | 266087 | 44 | 43 |
| 51 | 301464 | 266086 | 44 | 43 |
| 52 | 301481 | 266086 | 44 | 43 |
| 53 | 301496 | 266085 | 44 | 43 |
| 54 | 301513 | 266086 | 44 | 43 |
| 55 | 301551 | 265937 | 43 | 42 |
| 56 | 301651 | 265829 | 41 | 40 |
| 57 | 301718 | 265666 | 40 | 39 |
| 58 | 301760 | 265559 | 39 | 38 |
| 59 | 301810 | 265444 | 39 | 38 |
| 60 | 301946 | 265227 | 37 | 36 |
| 61 | 302184 | 265032 | 37 | 36 |
| 62 | 302333 | 264927 | 37 | 36 |
| 63 | 303060 | 264346 | 37 | 36 |
| 64 | 304610 | 263870 | 42 | 41 |
| 65 | 303931 | 263816 | 41 | 40 |
| 66 | 303770 | 263877 | 41 | 40 |
| 67 | 303465 | 264022 | 39 | 38 |
| 68 | 304652 | 264176 | 45 | 44 |
| 69 | 301317 | 266111 | 43 | 42 |
| 70 | 301319 | 266170 | 44 | 43 |
| 71 | 301159 | 266760 | 45 | 44 |
| 72 | 301208 | 266825 | 46 | 45 |
| 73 | 301095 | 267065 | 45 | 44 |
| 74 | 301096 | 267157 | 44 | 43 |
| 75 | 301171 | 267530 | 45 | 44 |
| 76 | 301060 | 267617 | 44 | 43 |
| 77 | 301086 | 267702 | 44 | 43 |
| 78 | 301107 | 267760 | 45 | 44 |
| 79 | 301021 | 269276 | 36 | 35 |
| 80 | 302247 | 270408 | 35 | 34 |
| 81 | 302198 | 270448 | 34 | 33 |
| 82 | 302160 | 270303 | 35 | 34 |
| 83 | 302179 | 270025 | 37 | 36 |
| 84 | 302284 | 270129 | 37 | 36 |
| 85 | 302268 | 269916 | 37 | 36 |
| 86 | 302233 | 269840 | 37 | 36 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 87 | 303169 | 270580 | 38 | 37 |
| 88 | 303225 | 270805 | 38 | 37 |
| 89 | 303238 | 270896 | 37 | 36 |
| 90 | 303247 | 271357 | 37 | 36 |
| 91 | 303250 | 271126 | 37 | 36 |
| 92 | 303287 | 271050 | 38 | 37 |
| 93 | 303566 | 271315 | 39 | 38 |
| 94 | 306679 | 270496 | 45 | 44 |
| 95 | 306857 | 270363 | 44 | 43 |
| 96 | 305663 | 265233 | 42 | 41 |
| 97 | 305360 | 265532 | 44 | 43 |
| 98 | 304548 | 265897 | 45 | 44 |
| 99 | 304552 | 265741 | 45 | 44 |
| 100 | 303305 | 264670 | 44 | 43 |
| 101 | 302659 | 265073 | 39 | 38 |
| 102 | 302424 | 265823 | 44 | 43 |
| 103 | 302293 | 266227 | 45 | 44 |
| 104 | 302212 | 267996 | 45 | 44 |
| 105 | 302181 | 269216 | 39 | 38 |
| 106 | 306140 | 268101 | 46 | 45 |
| 107 | 303467 | 271303 | 38 | 37 |
| 108 | 303636 | 271373 | 39 | 38 |
| 109 | 303830 | 271290 | 40 | 39 |
| 110 | 304018 | 271217 | 41 | 41 |
| 111 | 304327 | 271230 | 43 | 42 |
| 112 | 304195 | 271180 | 42 | 42 |
| 113 | 304282 | 271175 | 43 | 42 |
| 114 | 304554 | 271050 | 45 | 44 |
| 115 | 305124 | 271012 | 48 | 48 |
| 116 | 305317 | 270961 | 49 | 48 |
| 117 | 305299 | 271032 | 49 | 49 |
| 118 | 306219 | 270653 | 47 | 46 |
| 119 | 306294 | 270529 | 46 | 45 |
| 120 | 306635 | 270468 | 46 | 45 |
| 121 | 305217 | 265751 | 44 | 43 |
| 122 | 305294 | 265773 | 44 | 43 |
| 123 | 305376 | 265881 | 45 | 44 |
| 124 | 304860 | 266004 | 45 | 44 |
| 125 | 304920 | 265937 | 44 | 43 |
| 126 | 305040 | 266024 | 45 | 44 |
| 127 | 305001 | 266065 | 45 | 44 |
| 128 | 304540 | 266678 | 47 | 46 |
| 129 | 304612 | 266708 | 47 | 46 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 130 | 304624 | 266261 | 46 | 45 |
| 131 | 304563 | 266547 | 47 | 46 |
| 132 | 304560 | 266330 | 47 | 46 |
| 133 | 304201 | 266060 | 48 | 47 |
| 134 | 304553 | 265710 | 45 | 44 |
| 135 | 304540 | 265268 | 46 | 45 |
| 136 | 304543 | 264872 | 47 | 46 |
| 137 | 304616 | 264818 | 47 | 46 |
| 138 | 303744 | 264614 | 47 | 46 |
| 139 | 303625 | 264756 | 47 | 46 |
| 140 | 302600 | 265208 | 42 | 41 |
| 141 | 302531 | 265801 | 44 | 43 |
| 142 | 302390 | 265923 | 44 | 43 |
| 143 | 302307 | 266133 | 45 | 44 |
| 144 | 302265 | 266270 | 46 | 45 |
| 145 | 302360 | 266507 | 46 | 45 |
| 146 | 302130 | 266778 | 48 | 47 |
| 147 | 302387 | 267035 | 47 | 46 |
| 148 | 302243 | 268037 | 44 | 43 |
| 149 | 302170 | 268433 | 43 | 42 |
| 150 | 302230 | 269033 | 40 | 39 |
| 151 | 302179 | 269113 | 39 | 38 |
| 152 | 302266 | 269257 | 39 | 38 |
| 153 | 302179 | 269629 | 38 | 37 |
| 154 | 302182 | 269727 | 37 | 36 |
| 155 | 302498 | 269739 | 38 | 37 |
| 156 | 302621 | 269512 | 39 | 38 |
| 157 | 302678 | 269533 | 39 | 38 |
| 158 | 302789 | 269383 | 40 | 39 |
| 159 | 303018 | 268964 | 42 | 41 |
| 160 | 303099 | 268975 | 42 | 41 |
| 161 | 303425 | 268424 | 45 | 44 |
| 162 | 303853 | 267847 | 48 | 47 |
| 163 | 303895 | 267899 | 48 | 47 |
| 164 | 303835 | 267563 | 49 | 48 |
| 165 | 304226 | 267300 | 46 | 45 |
| 166 | 304458 | 267026 | 47 | 46 |
| 167 | 304634 | 267265 | 46 | 45 |
| 168 | 304790 | 267568 | 48 | 47 |
| 169 | 304905 | 267711 | 48 | 47 |
| 170 | 306789 | 268162 | 46 | 45 |
| 171 | 306695 | 268166 | 46 | 45 |
| 172 | 306134 | 268292 | 45 | 44 |

**Table A-1**

Predicted Sound Level Modeling Results

GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 173 | 305966 | 268095 | 46 | 45 |
| 174 | 305827 | 268168 | 45 | 44 |
| 175 | 305647 | 268181 | 45 | 44 |
| 176 | 307391 | 264688 | 38 | 37 |
| 177 | 307293 | 265060 | 40 | 39 |
| 178 | 307067 | 265261 | 42 | 41 |
| 179 | 307146 | 265153 | 41 | 40 |
| 180 | 307223 | 265239 | 41 | 40 |
| 181 | 306927 | 265751 | 46 | 45 |
| 182 | 306887 | 265867 | 47 | 46 |
| 183 | 306826 | 265976 | 48 | 47 |
| 184 | 306568 | 266269 | 50 | 49 |
| 185 | 306372 | 266516 | 50 | 49 |
| 186 | 306260 | 266797 | 49 | 48 |
| 187 | 306195 | 267114 | 49 | 48 |
| 188 | 306052 | 267381 | 49 | 48 |
| 189 | 305900 | 267559 | 48 | 47 |
| 190 | 305931 | 267524 | 48 | 47 |
| 191 | 305710 | 267647 | 48 | 47 |
| 192 | 305811 | 267625 | 48 | 47 |
| 193 | 305735 | 267726 | 48 | 47 |
| 194 | 305520 | 267811 | 48 | 47 |
| 195 | 305569 | 267820 | 47 | 46 |
| 196 | 305441 | 267956 | 47 | 46 |
| 197 | 305246 | 268115 | 46 | 45 |
| 198 | 305326 | 268206 | 46 | 45 |
| 199 | 305057 | 268405 | 47 | 46 |
| 200 | 304987 | 268424 | 47 | 46 |
| 201 | 305010 | 268492 | 47 | 46 |
| 202 | 305096 | 268476 | 46 | 45 |
| 203 | 304909 | 268664 | 47 | 46 |
| 204 | 304773 | 268939 | 47 | 46 |
| 205 | 304832 | 268934 | 47 | 46 |
| 206 | 304742 | 269119 | 47 | 46 |
| 207 | 304117 | 269810 | 45 | 44 |
| 208 | 304248 | 269765 | 46 | 45 |
| 209 | 304371 | 269567 | 47 | 46 |
| 210 | 304405 | 269501 | 47 | 46 |
| 211 | 304558 | 269436 | 47 | 46 |
| 212 | 304491 | 269521 | 47 | 46 |
| 213 | 304369 | 269714 | 46 | 45 |
| 214 | 304276 | 269887 | 46 | 45 |
| 215 | 303681 | 270366 | 41 | 40 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 216 | 304110 | 273182 | 39 | 38 |
| 217 | 304010 | 273223 | 38 | 37 |
| 218 | 303987 | 273122 | 39 | 38 |
| 219 | 304167 | 273070 | 40 | 39 |
| 220 | 304326 | 273176 | 40 | 39 |
| 221 | 304425 | 273164 | 41 | 40 |
| 222 | 304956 | 273123 | 44 | 43 |
| 223 | 305118 | 273130 | 44 | 43 |
| 224 | 305198 | 273188 | 43 | 42 |
| 225 | 303630 | 273247 | 36 | 35 |
| 226 | 303679 | 273355 | 36 | 35 |
| 227 | 304080 | 273406 | 38 | 37 |
| 228 | 303924 | 273435 | 37 | 36 |
| 229 | 304001 | 273622 | 37 | 36 |
| 230 | 304143 | 273664 | 37 | 36 |
| 231 | 304195 | 273737 | 36 | 35 |
| 232 | 302883 | 273602 | 33 | 32 |
| 233 | 302963 | 273571 | 33 | 32 |
| 234 | 303041 | 273610 | 33 | 32 |
| 235 | 303123 | 273574 | 34 | 33 |
| 236 | 303154 | 273704 | 34 | 33 |
| 237 | 303231 | 273726 | 34 | 33 |
| 238 | 303302 | 273651 | 34 | 33 |
| 239 | 303340 | 273768 | 34 | 33 |
| 240 | 303389 | 273787 | 34 | 33 |
| 241 | 303405 | 273705 | 34 | 33 |
| 242 | 303820 | 273882 | 35 | 34 |
| 243 | 303957 | 274038 | 35 | 34 |
| 244 | 304049 | 274016 | 35 | 34 |
| 245 | 304042 | 274080 | 35 | 34 |
| 246 | 304220 | 274075 | 35 | 34 |
| 247 | 304143 | 274132 | 35 | 34 |
| 248 | 304201 | 274158 | 35 | 34 |
| 249 | 304541 | 274573 | 34 | 33 |
| 250 | 304600 | 275104 | 32 | 31 |
| 251 | 304599 | 275511 | 31 | 30 |
| 252 | 304687 | 275427 | 32 | 31 |
| 253 | 304532 | 275725 | 31 | 30 |
| 254 | 304599 | 275862 | 30 | 29 |
| 255 | 304591 | 276000 | 30 | 29 |
| 256 | 304547 | 276365 | 29 | 28 |
| 257 | 304419 | 276387 | 28 | 28 |
| 258 | 304120 | 276752 | 23 | 22 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] | Y [Northing] | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| | (m) | (m) | | |
| 259 | 302409 | 275040 | 25 | 24 |
| 260 | 302437 | 275088 | 25 | 24 |
| 261 | 302681 | 275703 | 24 | 23 |
| 262 | 302854 | 275844 | 24 | 23 |
| 263 | 302905 | 275947 | 24 | 23 |
| 264 | 302991 | 275941 | 24 | 23 |
| 265 | 302810 | 276114 | 23 | 22 |
| 266 | 303094 | 276100 | 23 | 22 |
| 267 | 303029 | 276302 | 23 | 22 |
| 268 | 303095 | 276380 | 23 | 22 |
| 269 | 303253 | 276495 | 23 | 22 |
| 270 | 303589 | 276361 | 23 | 22 |
| 271 | 303455 | 276611 | 23 | 22 |
| 272 | 303736 | 276689 | 23 | 22 |
| 273 | 303372 | 276829 | 22 | 21 |
| 274 | 303416 | 277120 | 24 | 23 |
| 275 | 303476 | 277071 | 23 | 22 |
| 276 | 303508 | 277092 | 23 | 22 |
| 277 | 303541 | 277259 | 24 | 23 |
| 278 | 302211 | 275001 | 25 | 24 |
| 279 | 301774 | 275328 | 26 | 25 |
| 280 | 301844 | 275482 | 25 | 24 |
| 281 | 301933 | 275539 | 25 | 24 |
| 282 | 301974 | 275643 | 26 | 25 |
| 283 | 301991 | 275676 | 26 | 25 |
| 284 | 302040 | 275788 | 26 | 25 |
| 285 | 302079 | 275857 | 26 | 25 |
| 286 | 302115 | 276021 | 26 | 25 |
| 287 | 302194 | 276144 | 26 | 25 |
| 288 | 302227 | 276210 | 26 | 25 |
| 289 | 302262 | 276323 | 26 | 25 |
| 290 | 302258 | 276441 | 25 | 24 |
| 291 | 302198 | 276398 | 25 | 24 |
| 292 | 302322 | 276511 | 25 | 24 |
| 293 | 302360 | 276632 | 26 | 25 |
| 294 | 302338 | 276659 | 26 | 25 |
| 295 | 302407 | 276881 | 24 | 23 |
| 296 | 302471 | 276932 | 24 | 23 |
| 297 | 302675 | 276977 | 26 | 25 |
| 298 | 302705 | 277227 | 25 | 24 |
| 299 | 302674 | 277357 | 25 | 24 |
| 300 | 302691 | 277496 | 25 | 24 |
| 301 | 302603 | 277817 | 24 | 23 |

**Table A-1**
Predicted Sound Level Modeling Results
GE 2.3-116

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 302 | 302590 | 277890 | 24 | 23 |
| 303 | 302569 | 277975 | 24 | 23 |
| 304 | 302505 | 278040 | 24 | 23 |
| 305 | 302579 | 278128 | 24 | 23 |
| 306 | 302581 | 278186 | 24 | 23 |
| 307 | 302592 | 278348 | 23 | 22 |
| 308 | 302463 | 278388 | 23 | 22 |
| 309 | 302584 | 278477 | 23 | 22 |
| 310 | 302515 | 278554 | 23 | 22 |
| 311 | 302576 | 278510 | 23 | 22 |
| 312 | 302603 | 278548 | 23 | 22 |
| 313 | 302357 | 279197 | 21 | 20 |
| 314 | 302582 | 278609 | 23 | 22 |
| 315 | 302422 | 279117 | 21 | 20 |
| 316 | 302523 | 279171 | 21 | 20 |
| 317 | 301843 | 279138 | 21 | 20 |
| 318 | 302583 | 278977 | 22 | 21 |
| 319 | 302860 | 279182 | 22 | 21 |
| 320 | 302983 | 279111 | 22 | 21 |
| 321 | 303089 | 279177 | 22 | 21 |
| 322 | 303218 | 279089 | 22 | 21 |
| 323 | 303319 | 279132 | 22 | 21 |
| 324 | 303398 | 279119 | 22 | 21 |
| 325 | 303511 | 279192 | 22 | 21 |
| 326 | 304044 | 278408 | 24 | 23 |
| 327 | 304095 | 278243 | 24 | 23 |
| 328 | 304026 | 278056 | 25 | 24 |
| 329 | 303777 | 277805 | 25 | 24 |
| 330 | 303671 | 277642 | 25 | 24 |
| 331 | 303768 | 277573 | 24 | 23 |
| 332 | 303792 | 277727 | 25 | 24 |
| 333 | 305587 | 270835 | 48 | 47 |
| 334 | 303506 | 268153 | 46 | 45 |
| 335 | 303739 | 267052 | 48 | 47 |

Appendix B

# Vestas V110-2.2 Sound Level Modeling Results

**Table B-1**

Predicted Sound Level Modeling Results

Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 1 | 302816 | 265915 | 46 | 45 |
| 2 | 303062 | 265009 | 44 | 43 |
| 3 | 305191 | 265773 | 43 | 42 |
| 4 | 302077 | 267473 | 47 | 46 |
| 5 | 303317 | 270713 | 38 | 37 |
| 6 | 306562 | 273118 | 43 | 42 |
| 7 | 306428 | 273119 | 43 | 42 |
| 8 | 306290 | 273124 | 44 | 43 |
| 9 | 306043 | 273124 | 45 | 43 |
| 10 | 305504 | 273134 | 44 | 43 |
| 11 | 304572 | 271425 | 43 | 42 |
| 12 | 304504 | 271850 | 43 | 42 |
| 13 | 304445 | 272016 | 44 | 43 |
| 14 | 304388 | 272119 | 44 | 43 |
| 15 | 304351 | 272270 | 44 | 43 |
| 16 | 304271 | 272458 | 43 | 41 |
| 17 | 304269 | 272595 | 42 | 41 |
| 18 | 304110 | 272442 | 41 | 40 |
| 19 | 304044 | 272792 | 39 | 38 |
| 20 | 304035 | 272914 | 39 | 38 |
| 21 | 304005 | 272998 | 38 | 37 |
| 22 | 304070 | 273082 | 38 | 37 |
| 23 | 304326 | 273049 | 40 | 39 |
| 24 | 304647 | 273058 | 42 | 41 |
| 25 | 304795 | 273071 | 43 | 42 |
| 26 | 305272 | 273037 | 44 | 43 |
| 27 | 305479 | 273038 | 45 | 44 |
| 28 | 305780 | 273057 | 45 | 44 |
| 29 | 306159 | 273007 | 46 | 45 |
| 30 | 307052 | 272474 | 48 | 47 |
| 31 | 306568 | 264695 | 38 | 37 |
| 32 | 307872 | 265954 | 44 | 43 |
| 33 | 307785 | 266589 | 45 | 44 |
| 34 | 307687 | 266902 | 42 | 40 |
| 35 | 307651 | 267057 | 41 | 39 |
| 36 | 307631 | 267162 | 40 | 39 |
| 37 | 307630 | 267259 | 39 | 38 |
| 38 | 307500 | 267618 | 40 | 39 |
| 39 | 307676 | 267861 | 39 | 38 |
| 40 | 307620 | 267705 | 40 | 39 |
| 41 | 307768 | 268373 | 38 | 37 |
| 42 | 307726 | 268473 | 38 | 37 |
| 43 | 307695 | 268697 | 38 | 37 |

**Table B-1**

Predicted Sound Level Modeling Results

Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 44 | 307607 | 268996 | 39 | 38 |
| 45 | 307636 | 268987 | 39 | 38 |
| 46 | 307607 | 269078 | 40 | 39 |
| 47 | 307551 | 269187 | 40 | 39 |
| 48 | 307113 | 270181 | 42 | 41 |
| 49 | 301431 | 266088 | 44 | 42 |
| 50 | 301447 | 266087 | 44 | 43 |
| 51 | 301464 | 266086 | 44 | 43 |
| 52 | 301481 | 266086 | 44 | 43 |
| 53 | 301496 | 266085 | 44 | 43 |
| 54 | 301513 | 266086 | 44 | 43 |
| 55 | 301551 | 265937 | 42 | 41 |
| 56 | 301651 | 265829 | 41 | 40 |
| 57 | 301718 | 265666 | 39 | 38 |
| 58 | 301760 | 265559 | 38 | 37 |
| 59 | 301810 | 265444 | 37 | 36 |
| 60 | 301946 | 265227 | 36 | 35 |
| 61 | 302184 | 265032 | 36 | 35 |
| 62 | 302333 | 264927 | 36 | 34 |
| 63 | 303060 | 264346 | 35 | 34 |
| 64 | 304610 | 263870 | 41 | 40 |
| 65 | 303931 | 263816 | 40 | 39 |
| 66 | 303770 | 263877 | 41 | 39 |
| 67 | 303465 | 264022 | 39 | 38 |
| 68 | 304652 | 264176 | 45 | 43 |
| 69 | 301317 | 266111 | 43 | 42 |
| 70 | 301319 | 266170 | 44 | 43 |
| 71 | 301159 | 266760 | 45 | 44 |
| 72 | 301208 | 266825 | 46 | 45 |
| 73 | 301095 | 267065 | 44 | 43 |
| 74 | 301096 | 267157 | 44 | 43 |
| 75 | 301171 | 267530 | 45 | 43 |
| 76 | 301060 | 267617 | 44 | 42 |
| 77 | 301086 | 267702 | 44 | 43 |
| 78 | 301107 | 267760 | 45 | 43 |
| 79 | 301021 | 269276 | 35 | 34 |
| 80 | 302247 | 270408 | 33 | 32 |
| 81 | 302198 | 270448 | 33 | 32 |
| 82 | 302160 | 270303 | 34 | 33 |
| 83 | 302179 | 270025 | 35 | 34 |
| 84 | 302284 | 270129 | 35 | 34 |
| 85 | 302268 | 269916 | 36 | 35 |
| 86 | 302233 | 269840 | 36 | 35 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 87 | 303169 | 270580 | 37 | 36 |
| 88 | 303225 | 270805 | 37 | 36 |
| 89 | 303238 | 270896 | 36 | 35 |
| 90 | 303247 | 271357 | 35 | 34 |
| 91 | 303250 | 271126 | 36 | 35 |
| 92 | 303287 | 271050 | 36 | 35 |
| 93 | 303566 | 271315 | 38 | 37 |
| 94 | 306679 | 270496 | 45 | 44 |
| 95 | 306857 | 270363 | 44 | 42 |
| 96 | 305663 | 265233 | 41 | 40 |
| 97 | 305360 | 265532 | 43 | 42 |
| 98 | 304548 | 265897 | 45 | 44 |
| 99 | 304552 | 265741 | 45 | 43 |
| 100 | 303305 | 264670 | 43 | 42 |
| 101 | 302659 | 265073 | 37 | 36 |
| 102 | 302424 | 265823 | 43 | 42 |
| 103 | 302293 | 266227 | 45 | 44 |
| 104 | 302212 | 267996 | 44 | 43 |
| 105 | 302181 | 269216 | 38 | 37 |
| 106 | 306140 | 268101 | 46 | 44 |
| 107 | 303467 | 271303 | 37 | 36 |
| 108 | 303636 | 271373 | 38 | 37 |
| 109 | 303830 | 271290 | 39 | 38 |
| 110 | 304018 | 271217 | 41 | 40 |
| 111 | 304327 | 271230 | 42 | 41 |
| 112 | 304195 | 271180 | 42 | 41 |
| 113 | 304282 | 271175 | 42 | 41 |
| 114 | 304554 | 271050 | 44 | 43 |
| 115 | 305124 | 271012 | 48 | 47 |
| 116 | 305317 | 270961 | 48 | 48 |
| 117 | 305299 | 271032 | 49 | 49 |
| 118 | 306219 | 270653 | 46 | 45 |
| 119 | 306294 | 270529 | 46 | 45 |
| 120 | 306635 | 270468 | 45 | 44 |
| 121 | 305217 | 265751 | 43 | 42 |
| 122 | 305294 | 265773 | 44 | 43 |
| 123 | 305376 | 265881 | 45 | 44 |
| 124 | 304860 | 266004 | 44 | 43 |
| 125 | 304920 | 265937 | 43 | 42 |
| 126 | 305040 | 266024 | 44 | 43 |
| 127 | 305001 | 266065 | 44 | 43 |
| 128 | 304540 | 266678 | 47 | 46 |
| 129 | 304612 | 266708 | 46 | 45 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 130 | 304624 | 266261 | 45 | 44 |
| 131 | 304563 | 266547 | 47 | 46 |
| 132 | 304560 | 266330 | 46 | 45 |
| 133 | 304201 | 266060 | 47 | 46 |
| 134 | 304553 | 265710 | 45 | 44 |
| 135 | 304540 | 265268 | 46 | 45 |
| 136 | 304543 | 264872 | 47 | 46 |
| 137 | 304616 | 264818 | 47 | 45 |
| 138 | 303744 | 264614 | 47 | 46 |
| 139 | 303625 | 264756 | 47 | 46 |
| 140 | 302600 | 265208 | 41 | 40 |
| 141 | 302531 | 265801 | 44 | 43 |
| 142 | 302390 | 265923 | 43 | 42 |
| 143 | 302307 | 266133 | 44 | 43 |
| 144 | 302265 | 266270 | 45 | 44 |
| 145 | 302360 | 266507 | 46 | 45 |
| 146 | 302130 | 266778 | 48 | 47 |
| 147 | 302387 | 267035 | 47 | 46 |
| 148 | 302243 | 268037 | 44 | 43 |
| 149 | 302170 | 268433 | 42 | 41 |
| 150 | 302230 | 269033 | 39 | 37 |
| 151 | 302179 | 269113 | 38 | 37 |
| 152 | 302266 | 269257 | 38 | 37 |
| 153 | 302179 | 269629 | 36 | 35 |
| 154 | 302182 | 269727 | 36 | 35 |
| 155 | 302498 | 269739 | 37 | 36 |
| 156 | 302621 | 269512 | 38 | 37 |
| 157 | 302678 | 269533 | 38 | 37 |
| 158 | 302789 | 269383 | 39 | 38 |
| 159 | 303018 | 268964 | 41 | 40 |
| 160 | 303099 | 268975 | 41 | 40 |
| 161 | 303425 | 268424 | 44 | 43 |
| 162 | 303853 | 267847 | 47 | 46 |
| 163 | 303895 | 267899 | 47 | 46 |
| 164 | 303835 | 267563 | 48 | 47 |
| 165 | 304226 | 267300 | 46 | 45 |
| 166 | 304458 | 267026 | 46 | 45 |
| 167 | 304634 | 267265 | 46 | 45 |
| 168 | 304790 | 267568 | 47 | 46 |
| 169 | 304905 | 267711 | 48 | 47 |
| 170 | 306789 | 268162 | 45 | 44 |
| 171 | 306695 | 268166 | 46 | 45 |
| 172 | 306134 | 268292 | 45 | 43 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 173 | 305966 | 268095 | 45 | 44 |
| 174 | 305827 | 268168 | 44 | 43 |
| 175 | 305647 | 268181 | 45 | 43 |
| 176 | 307391 | 264688 | 36 | 35 |
| 177 | 307293 | 265060 | 39 | 38 |
| 178 | 307067 | 265261 | 41 | 40 |
| 179 | 307146 | 265153 | 40 | 39 |
| 180 | 307223 | 265239 | 40 | 39 |
| 181 | 306927 | 265751 | 45 | 44 |
| 182 | 306887 | 265867 | 46 | 45 |
| 183 | 306826 | 265976 | 47 | 46 |
| 184 | 306568 | 266269 | 49 | 48 |
| 185 | 306372 | 266516 | 50 | 49 |
| 186 | 306260 | 266797 | 49 | 48 |
| 187 | 306195 | 267114 | 48 | 47 |
| 188 | 306052 | 267381 | 48 | 47 |
| 189 | 305900 | 267559 | 48 | 47 |
| 190 | 305931 | 267524 | 48 | 47 |
| 191 | 305710 | 267647 | 48 | 47 |
| 192 | 305811 | 267625 | 48 | 47 |
| 193 | 305735 | 267726 | 47 | 46 |
| 194 | 305520 | 267811 | 47 | 46 |
| 195 | 305569 | 267820 | 47 | 46 |
| 196 | 305441 | 267956 | 46 | 45 |
| 197 | 305246 | 268115 | 46 | 45 |
| 198 | 305326 | 268206 | 45 | 44 |
| 199 | 305057 | 268405 | 46 | 45 |
| 200 | 304987 | 268424 | 47 | 46 |
| 201 | 305010 | 268492 | 46 | 45 |
| 202 | 305096 | 268476 | 46 | 44 |
| 203 | 304909 | 268664 | 46 | 45 |
| 204 | 304773 | 268939 | 46 | 45 |
| 205 | 304832 | 268934 | 46 | 45 |
| 206 | 304742 | 269119 | 46 | 45 |
| 207 | 304117 | 269810 | 45 | 44 |
| 208 | 304248 | 269765 | 45 | 44 |
| 209 | 304371 | 269567 | 47 | 45 |
| 210 | 304405 | 269501 | 47 | 46 |
| 211 | 304558 | 269436 | 47 | 45 |
| 212 | 304491 | 269521 | 47 | 45 |
| 213 | 304369 | 269714 | 46 | 45 |
| 214 | 304276 | 269887 | 45 | 44 |
| 215 | 303681 | 270366 | 40 | 39 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 216 | 304110 | 273182 | 38 | 37 |
| 217 | 304010 | 273223 | 37 | 36 |
| 218 | 303987 | 273122 | 37 | 36 |
| 219 | 304167 | 273070 | 39 | 38 |
| 220 | 304326 | 273176 | 39 | 38 |
| 221 | 304425 | 273164 | 40 | 39 |
| 222 | 304956 | 273123 | 43 | 42 |
| 223 | 305118 | 273130 | 43 | 42 |
| 224 | 305198 | 273188 | 43 | 42 |
| 225 | 303630 | 273247 | 35 | 34 |
| 226 | 303679 | 273355 | 35 | 34 |
| 227 | 304080 | 273406 | 37 | 36 |
| 228 | 303924 | 273435 | 36 | 35 |
| 229 | 304001 | 273622 | 35 | 34 |
| 230 | 304143 | 273664 | 35 | 34 |
| 231 | 304195 | 273737 | 35 | 34 |
| 232 | 302883 | 273602 | 31 | 30 |
| 233 | 302963 | 273571 | 31 | 30 |
| 234 | 303041 | 273610 | 32 | 30 |
| 235 | 303123 | 273574 | 32 | 31 |
| 236 | 303154 | 273704 | 32 | 31 |
| 237 | 303231 | 273726 | 32 | 31 |
| 238 | 303302 | 273651 | 32 | 31 |
| 239 | 303340 | 273768 | 32 | 31 |
| 240 | 303389 | 273787 | 32 | 31 |
| 241 | 303405 | 273705 | 33 | 32 |
| 242 | 303820 | 273882 | 34 | 32 |
| 243 | 303957 | 274038 | 33 | 32 |
| 244 | 304049 | 274016 | 34 | 33 |
| 245 | 304042 | 274080 | 33 | 32 |
| 246 | 304220 | 274075 | 34 | 33 |
| 247 | 304143 | 274132 | 34 | 32 |
| 248 | 304201 | 274158 | 34 | 32 |
| 249 | 304541 | 274573 | 32 | 31 |
| 250 | 304600 | 275104 | 30 | 29 |
| 251 | 304599 | 275511 | 29 | 28 |
| 252 | 304687 | 275427 | 29 | 28 |
| 253 | 304532 | 275725 | 28 | 27 |
| 254 | 304599 | 275862 | 28 | 27 |
| 255 | 304591 | 276000 | 28 | 27 |
| 256 | 304547 | 276365 | 27 | 25 |
| 257 | 304419 | 276387 | 26 | 25 |
| 258 | 304120 | 276752 | 20 | 19 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 259 | 302409 | 275040 | 23 | 22 |
| 260 | 302437 | 275088 | 23 | 22 |
| 261 | 302681 | 275703 | 22 | 20 |
| 262 | 302854 | 275844 | 21 | 20 |
| 263 | 302905 | 275947 | 21 | 20 |
| 264 | 302991 | 275941 | 21 | 20 |
| 265 | 302810 | 276114 | 21 | 20 |
| 266 | 303094 | 276100 | 21 | 20 |
| 267 | 303029 | 276302 | 21 | 19 |
| 268 | 303095 | 276380 | 20 | 19 |
| 269 | 303253 | 276495 | 20 | 19 |
| 270 | 303589 | 276361 | 21 | 20 |
| 271 | 303455 | 276611 | 20 | 19 |
| 272 | 303736 | 276689 | 20 | 19 |
| 273 | 303372 | 276829 | 20 | 19 |
| 274 | 303416 | 277120 | 21 | 20 |
| 275 | 303476 | 277071 | 20 | 19 |
| 276 | 303508 | 277092 | 20 | 19 |
| 277 | 303541 | 277259 | 22 | 20 |
| 278 | 302211 | 275001 | 22 | 21 |
| 279 | 301774 | 275328 | 23 | 22 |
| 280 | 301844 | 275482 | 23 | 22 |
| 281 | 301933 | 275539 | 23 | 22 |
| 282 | 301974 | 275643 | 24 | 23 |
| 283 | 301991 | 275676 | 24 | 23 |
| 284 | 302040 | 275788 | 23 | 22 |
| 285 | 302079 | 275857 | 23 | 22 |
| 286 | 302115 | 276021 | 23 | 22 |
| 287 | 302194 | 276144 | 23 | 22 |
| 288 | 302227 | 276210 | 23 | 22 |
| 289 | 302262 | 276323 | 23 | 22 |
| 290 | 302258 | 276441 | 23 | 22 |
| 291 | 302198 | 276398 | 23 | 22 |
| 292 | 302322 | 276511 | 23 | 22 |
| 293 | 302360 | 276632 | 23 | 22 |
| 294 | 302338 | 276659 | 23 | 22 |
| 295 | 302407 | 276881 | 22 | 21 |
| 296 | 302471 | 276932 | 21 | 20 |
| 297 | 302675 | 276977 | 23 | 22 |
| 298 | 302705 | 277227 | 23 | 21 |
| 299 | 302674 | 277357 | 23 | 21 |
| 300 | 302691 | 277496 | 22 | 21 |
| 301 | 302603 | 277817 | 22 | 20 |

**Table B-1**
Predicted Sound Level Modeling Results
Vestas V110-2.2

| Receptor ID | X [Easting] (m) | Y [Northing] (m) | $L_{10}$ Sound Level (dBA) | $L_{eq}$ Sound Level (dBA) |
|---|---|---|---|---|
| 302 | 302590 | 277890 | 21 | 20 |
| 303 | 302569 | 277975 | 21 | 20 |
| 304 | 302505 | 278040 | 21 | 20 |
| 305 | 302579 | 278128 | 21 | 20 |
| 306 | 302581 | 278186 | 21 | 20 |
| 307 | 302592 | 278348 | 20 | 19 |
| 308 | 302463 | 278388 | 20 | 19 |
| 309 | 302584 | 278477 | 20 | 19 |
| 310 | 302515 | 278554 | 20 | 19 |
| 311 | 302576 | 278510 | 20 | 19 |
| 312 | 302603 | 278548 | 20 | 19 |
| 313 | 302357 | 279197 | 18 | 17 |
| 314 | 302582 | 278609 | 20 | 19 |
| 315 | 302422 | 279117 | 18 | 17 |
| 316 | 302523 | 279171 | 18 | 17 |
| 317 | 301843 | 279138 | 18 | 17 |
| 318 | 302583 | 278977 | 19 | 18 |
| 319 | 302860 | 279182 | 19 | 18 |
| 320 | 302983 | 279111 | 19 | 18 |
| 321 | 303089 | 279177 | 19 | 18 |
| 322 | 303218 | 279089 | 19 | 18 |
| 323 | 303319 | 279132 | 19 | 18 |
| 324 | 303398 | 279119 | 19 | 18 |
| 325 | 303511 | 279192 | 19 | 18 |
| 326 | 304044 | 278408 | 21 | 20 |
| 327 | 304095 | 278243 | 21 | 20 |
| 328 | 304026 | 278056 | 22 | 21 |
| 329 | 303777 | 277805 | 22 | 21 |
| 330 | 303671 | 277642 | 22 | 21 |
| 331 | 303768 | 277573 | 22 | 21 |
| 332 | 303792 | 277727 | 22 | 21 |
| 333 | 305587 | 270835 | 47 | 46 |
| 334 | 303506 | 268153 | 46 | 45 |
| 335 | 303739 | 267052 | 47 | 46 |