



**MERJENT**

# **BOWMAN WIND SOUND MODELING**

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## 1.0 EXECUTIVE SUMMARY

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The Bowman Wind Farm project (the “Project”) is an up to 208.7 MW nameplate capacity wind power generation facility proposed in Bowman County, North Dakota.

The Project is subject to a Bowman County wind turbine noise standard of 45 dBA  $L_{eq}$  within 100 feet of any non-participating residence (absent a variance), and a North Dakota Public Service Commission (NDPSC) turbine noise standard of 45 dBA within 100 feet of an inhabited residence or a community building (absent a waiver). To assess the noise impacts of the Project, RSG has conducted sound propagation modeling of the planned turbine layout. The 45 dBA standard is also applied to sound generated by battery storage and substation components of the Project. We used the internationally accepted sound propagation modeling methodology, ISO 9613-2, with parameters developed specific to wind turbines.

The modeling results show that Project sound levels are at or below 44 dBA  $L_{eq}$  within 100 feet of non-participating residences and community buildings assuming concurrent and continuous operation of all Project components. One pending participating residence has a modeled sound level of 47 dBA  $L_{eq}$ . This residence is currently in the process of executing administrative documents for a participation agreement. Should this landowner not sign, Turbine 41 would not be constructed and sound levels within 100 feet of this residence would be 44 dBA  $L_{eq}$ .

Modeled Project generated operational sound levels do not exceed the applicable noise standards.

## 2.0 INTRODUCTION

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The Bowman Wind Farm Project is an up to 208.7 MW nameplate capacity wind power generation facility proposed in Bowman County, North Dakota. RSG conducted sound propagation modeling for the proposed turbine array to assess compliance with the applicable sound level requirements.

Included in this report are:

1. A Project description,
2. An overview of ordinances and standards that apply to the Project,
3. A description of sound propagation modeling procedures,
4. Sound propagation modeling results, and
5. Conclusions.

A primer on acoustical terminology is provided in Appendix A.

Acoustical issues specific to wind turbine noise are described in Appendix B.

## 3.0 PROJECT DESCRIPTION

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A Project area map is shown in Figure 1. The Project is located about 5 miles (8 km) west of the City of Bowman. Land within the Project area is rural and is primarily used for agriculture with some residences interspersed. The terrain is relatively flat.

The Project is modeled using General Electric (GE) 2.82 MW wind turbines with 127-meter rotor diameters, 89-meter hub heights, and fitted with low-noise trailing edges (LNTE). Other turbine models and hub heights are also being considered. Up to 74 wind turbines will be constructed. The preliminary locations for 86 turbine (74 primary and 12 alternative) sites are included in the modeling in this report. A single 222 MVA transformer at the collector substation connects the turbine array to the electric grid.

The Project also proposes a battery energy storage system (BESS) facility. This facility stores energy generated by the Project primarily during off-peak demand periods and releases that energy primarily during peak demand periods. The 400 MWh BESS includes batteries, cooling equipment, inverters, and transformers. It is proposed to be located on a fifteen-acre parcel just south of the Project substation.

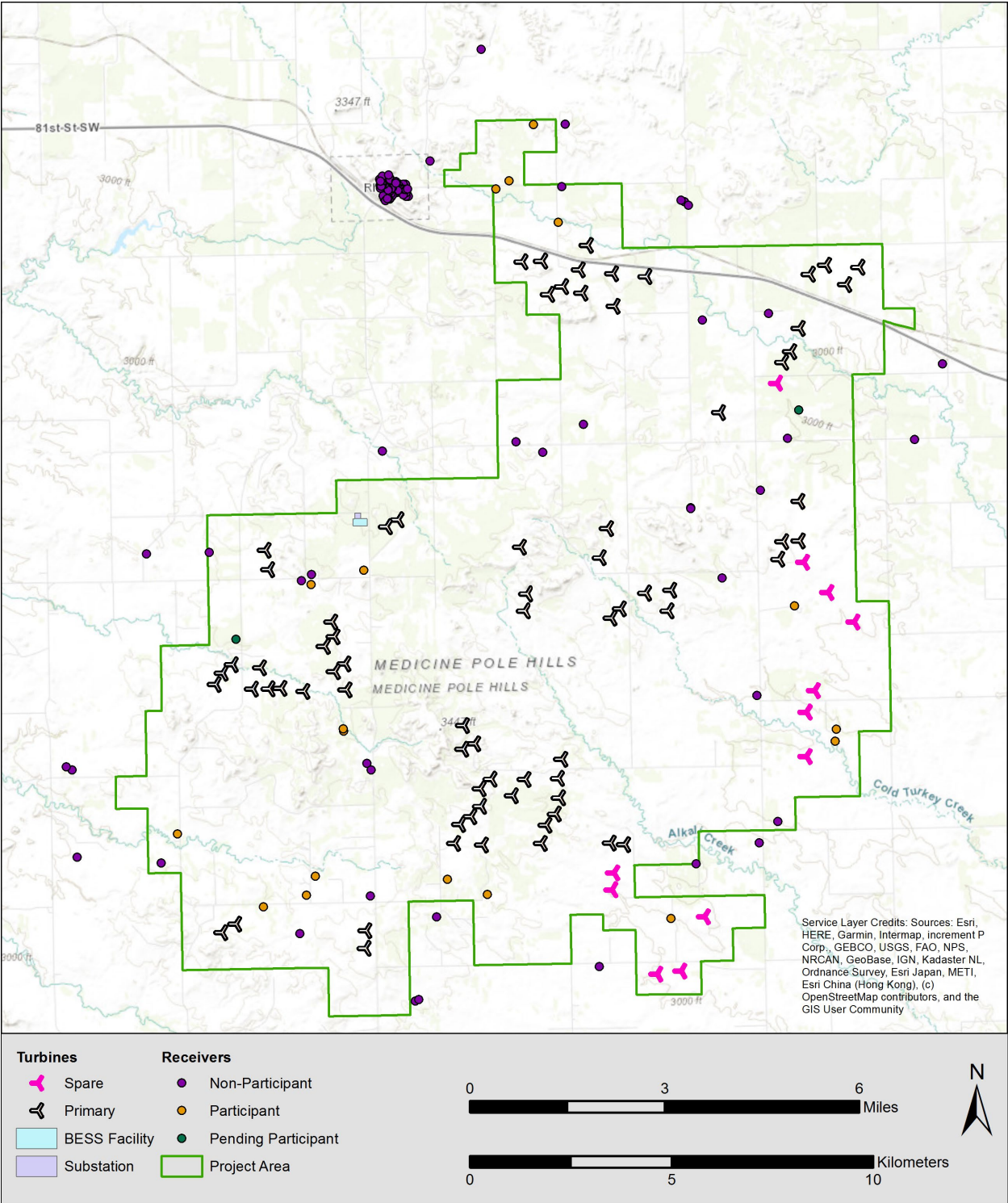


FIGURE 1: BOWMAN WIND FARM – PROJECT AREA MAP

## 4.0 NOISE STANDARDS & GUIDELINES

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There are no Federal noise regulations applicable to the Project.

The State of North Dakota has adopted regulations through the North Dakota Public Service Commission (PSC) for the noise emitted from wind energy facilities under NDAC Section 69-06-08-01(4). The regulation states that noise produced by wind turbines shall not exceed 45 dBA within 100 feet of an inhabited residence or community building. The regulation allows for the criteria to be waived in writing by the owner of the occupied residence or the community building.

Bowman County has a wind energy facility ordinance in Section 6.11 of its Zoning Ordinance. The code states that “sound levels of wind turbines within one-hundred (100) feet of any non-participating residence will not exceed 45 dBA  $L_{eq}$ . Construction noise or reasonable and necessary maintenance activities are allowed to exceed the sound limit except between the hours of 10 PM to 6 AM local time. This sound standard does not apply to participating dwellings.”

## 5.0 SOUND PROPAGATION MODELING

### 5.1 PROCEDURES

Modeling for the Project was performed in accordance with the standard ISO 9613-2, “Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation.”

The ISO standard states,

This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level ... under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation ... or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The model takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain. The acoustical modeling software used here was CadnaA® Version 2020 from Datakustik GmbH. CadnaA® is a widely accepted acoustical propagation modeling tool, used by many noise control professionals in the United States and internationally.

ISO 9613-2 also assumes downwind sound propagation between every source and every receiver. Consequently, all wind directions, including the prevailing wind directions, are taken into account. The Project area was modeled with a ground factor of  $G=0.5$ . Otherwise, no reflections (such as due to buildings) were considered. Shielding by structures and foliage attenuation were likewise not considered. Atmospheric absorption was based on 10°C and 70% relative humidity and source contributions were considered up to 10,000 meters (6.2 miles) from each receiver. Turbines were modeled with the manufacturer specified apparent sound power. All turbine data used is the most recent available from the manufacturer. The model was laid over the USGS Digital Terrain Model to give accurate elevations throughout.

Sound levels were modeled within 100 feet in all directions from each of 140 residences and seven community buildings located in the area. All receivers were modeled at a 4-meter (13 foot) height. Locations of these receivers are shown in Appendix D.

To account for sound power and propagation uncertainty, +2 dB was added to the modeling results.

Results calculated with these parameters represent the highest one-hour equivalent sound level ( $L_{eq(1h)}$ ) that will be emitted by the Project. As such, the results are likely to overestimate typical sound levels from the Project.

## 5.2 SOUND SOURCES

### Wind Turbines

The 86 wind turbine locations, including 74 primary and 12 alternative locations, shown in Figure 1 were included in the sound propagation model. The wind turbine assumed was the GE 2.82-127 LNTE, although other models are currently being considered. If a different wind turbine is selected, revised sound modeling will be produced for that model. Details of the wind turbine modeled are found in Appendix C.

### Project Transformer

The proposed 34.5 kV to 230 kV 222 MVA 1050 kV BIL collector substation transformer will be located in the western portion of the Project area (see Figure 1).

The sound emissions data used for modeling is from the NEMA TR 1 standard (“Transformers, Step Voltage Regulators, and Reactors, NEMA TR 1-2013”), with spectral information taken from a transformer test performed by RSG for a similarly sized transformer.

The transformer will have cooling fans. Cooling fan operation is usually a function of electric load and ambient air temperature. As a conservative assumption, we model the transformer with fans on. The fans-off cooling mode is specified by NEMA TR 1 as having sound pressure levels that are 3 dB lower.

### Battery Energy Storage System

The proposed battery energy storage system (BESS) facility would be located in the western portion of the site, immediately south of the substation (see Figure 1).

The 400 MWh BESS facility would include 90 Powin battery containers, 90 inverters, and 90 4.2-MVA transformers. Each container would utilize two heating ventilation air conditioners (HVAC) for a total of 180 HVAC units.

The HVAC unit assumed was the Marvair 6-ton Vertical Mount Air Conditioner, with a specified sound pressure level of 60 dBA at 50 feet, equivalent to a sound power level of 94.7 dBA. Spectral information was taken from a HVAC unit test performed by RSG for a similarly sized Marvair unit.

Sound emissions data for similarly sized inverters and transformers was used. The BESS inverters were each assumed to generate a sound power level of 92 dBA and the transformers were each assumed to generate a sound power level of 84 dBA.

## 5.3 RESULTS

### Maximum Hourly $L_{eq}$

Modeling results are shown in Table 1 and Figure 2. This analysis assumes a credible worst-case scenario with all primary and spare turbines and all substation and BESS equipment operating simultaneously under their loudest mode and without taking into account shielding or foliage attenuation.

As shown in Table 1 and Figure 2, all non-participating land uses are modeled to be below the 45 dBA  $L_{eq}$  criteria. One residence, R-148, has a modeled sound level of 47 dBA  $L_{eq}$ . This residence is a pending participant and currently in the process of executing administrative documents for a participation agreement. Should this landowner not sign, Turbine 41 would not be constructed and sound levels within 100 feet of this residence would be 44 dBA  $L_{eq}$ . Detailed information for each receiver is provided in Appendix D.

**TABLE 1: MODEL RESULTS SUMMARY ( $L_{eq-1h}$ )**

| Land Use                                  | Average | Maximum | Minimum | $\geq 45$ dBA |
|-------------------------------------------|---------|---------|---------|---------------|
| All (147)                                 | 30 dBA  | 47dBA   | 19 dBA  | 1%            |
| Participating Residence (20) <sup>1</sup> | 40 dBA  | 47 dBA  | 32 dBA  | 5%            |
| Non-Participating Residence (120)         | 28 dBA  | 44 dBA  | 19 dBA  | 0%            |
| Community Buildings (7)                   | 27 dBA  | 41 dBA  | 24 dBA  | 0%            |

<sup>1</sup> Two residences considered 'Participating' are in the process of executing administrative documents for a participation agreement. This includes R-38, which has a modeled sound level of 42 dBA and would be below the 45 dBA  $L_{eq}$  criteria for non-participating residences and R-148, which has a modeled sound level of 47 dBA and would be above the criteria for non-participating residences. Should the landowner at R-148 not sign, Turbine 41 would not be constructed and the modeled sound level at R-148 would be 44 dBA  $L_{eq}$ .

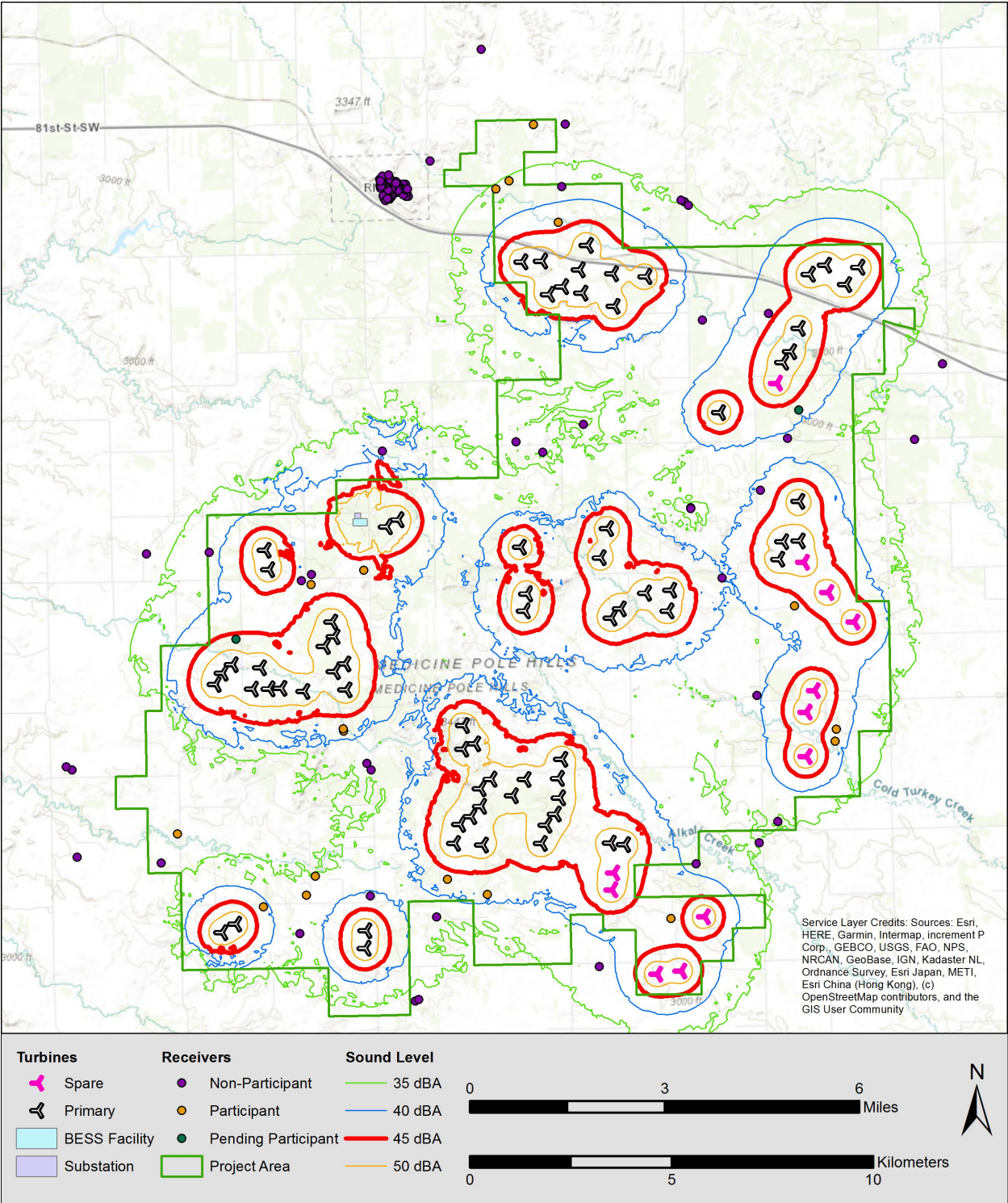


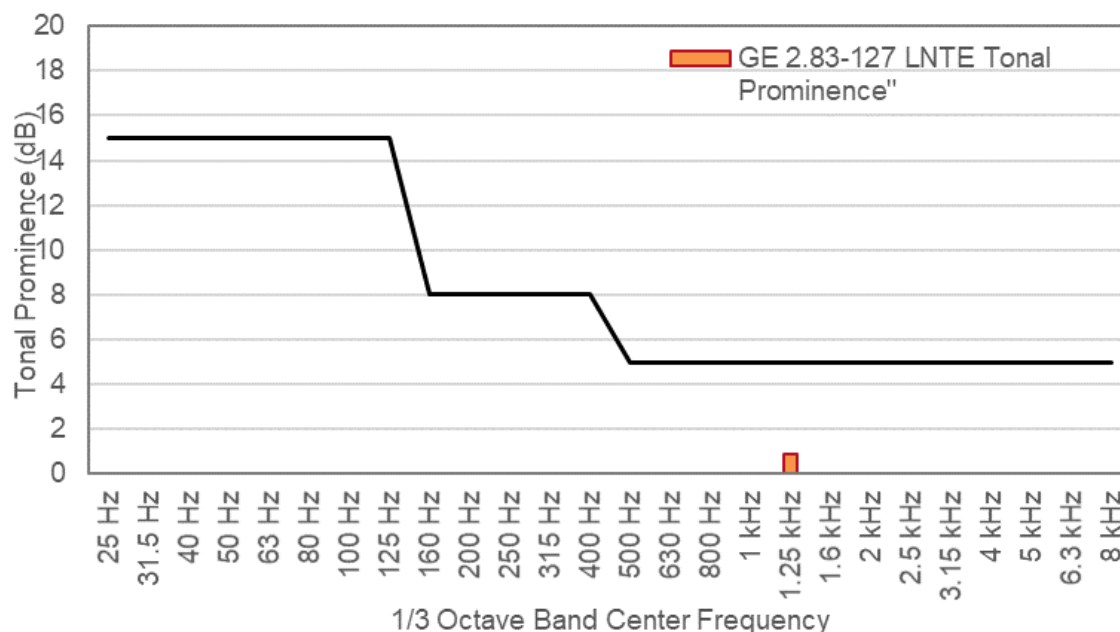
FIGURE 2: SOUND PROPAGATION MODELING RESULTS

## Long-Term Project Sound Levels

The modeling results shown in Table 1, Figure 2, and Appendix D are calculated a worst-case short term (1-hour) equivalent average sound level with all Project components (primary and alternative) operating continuously and simultaneously under a single worst-case meteorological condition. However, in real-life a variety of meteorological conditions will occur, and each turbine will only operate at maximum sound power for a portion of the time. The actual sound level at a receiver will depend on variations in atmospheric stability, wind speed, wind direction, and other parameters that change hourly, as well as the operational utilization of each turbine. Differences between  $L_{eq(1h)}$  and annual average sound levels due to changes in meteorology are on the order of 5 to 15 dBA, depending on the configuration of the receiver relative to the turbines.<sup>2</sup> Therefore, a receiver that is modeled to have a highest hour 44 dBA  $L_{eq(1h)}$  exposure will have an annual average sound level of 29 to 39 dBA.

## Tonality

Figure 3 shows the tonal prominence of the GE 2.82-127 LNTE turbine compared with the ANSI S12.9 Part 4 tonality criteria. This indicates that sound power spectrum of the wind turbine does not have a tonal prominence.



**FIGURE 3: REPORTED 1/3 OCTAVE BAND TONAL PROMINENCE COMPARED TO ANSI S12.9 PART 4 TONALITY CRITERIA**

Tones are generated by transformers but are often masked when cooling fans are operating. In addition, as one moves away from the substation, the sound is further masked by background sound (including the wind turbines). Under ANSI S12.9 Part 4, if tonal sounds are present, 5 dB

<sup>2</sup> Kaliski, et al, 2010, "Calculating annualized sound levels for a wind farm," Proceedings of Acoustical Society of America/NOISE-CON 2010, 159<sup>th</sup> Meeting, Baltimore, Maryland, April 2010.

is added to the tonal sound as a penalty. The maximum sound level from the Project substation and BESS facility transformers is 31 dBA  $L_{eq}$ . Assuming it is tonal sound and not masked, adding 5 dB would bring the transformer sound to 36 dBA  $L_{eq}$ . Thus, even with a tonal penalty, the substation and BESS facility sound would meet the Project noise criteria.

## 6.0 CONCLUSIONS

RSG performed sound propagation modeling of the proposed Project. The Project will be capable of generating up to 208.7 MW. The modeled array consists of 86 (74 primary and 12 alternate) GE 2.82-127 LNTE wind turbines on an 89-meter tower, though other hub heights and turbine models are being considered. The Project also proposes a 222 MVA transformer at the collector substation to connect the turbine array to the electric grid and a BESS facility.

Sound propagation modeling was performed ISO 9613-2, implemented in the Cadna/A modeling package. The Project model used parameters have been shown to represent conservatively accurate  $L_{eq(1h)}$  sound levels.

The results of the modeling show that Project generated sound levels would be 44 dBA  $L_{eq(1h)}$  or less within 100 feet of all non-participating residences and all community buildings. Modeled Project generated operational sound levels do not exceed 45 dBA  $L_{eq}$  within 100 feet of any non-participating residence or community building. One pending participant has a modeled sound level of 47 dBA  $L_{eq}$ . This residence is currently in the process of executing administrative documents for a participation agreement. Should this landowner not sign, Turbine 41 would not be constructed and sound levels within 100 feet of this residence would be 44 dBA  $L_{eq}$ .



## APPENDIX A. PRIMER ON SOUND

### ***Expressing Sound in Decibel Levels***

Normal human hearing is sensitive to sound fluctuations over an enormous range of pressures, from about 20 micropascals (the “threshold of audibility”) to about 20 pascals (the “threshold of pain”).<sup>3</sup> This factor of one million in sound pressure difference is challenging to convey in engineering units. Instead, sound pressure is converted to sound “levels” in units of “decibels” (dB, named after Alexander Graham Bell). Once a measured sound is converted to dB, it is denoted as a level with the letter “L” (such as “L<sub>eq</sub>”).

The conversion from sound pressure in pascals to sound level in dB is a four-step process. First, the sound wave’s measured amplitude is squared and the mean is taken. Second, a ratio is taken between the mean square sound pressure and the square of the threshold of audibility (20 micropascals) at 1 kHz. Third, using the logarithm function, the ratio is converted to factors of 10. The final result is multiplied by 10 to give the decibel level. By this decibel scale, sound levels range from 0 dB at the threshold of audibility to 120 dB at the threshold of pain.

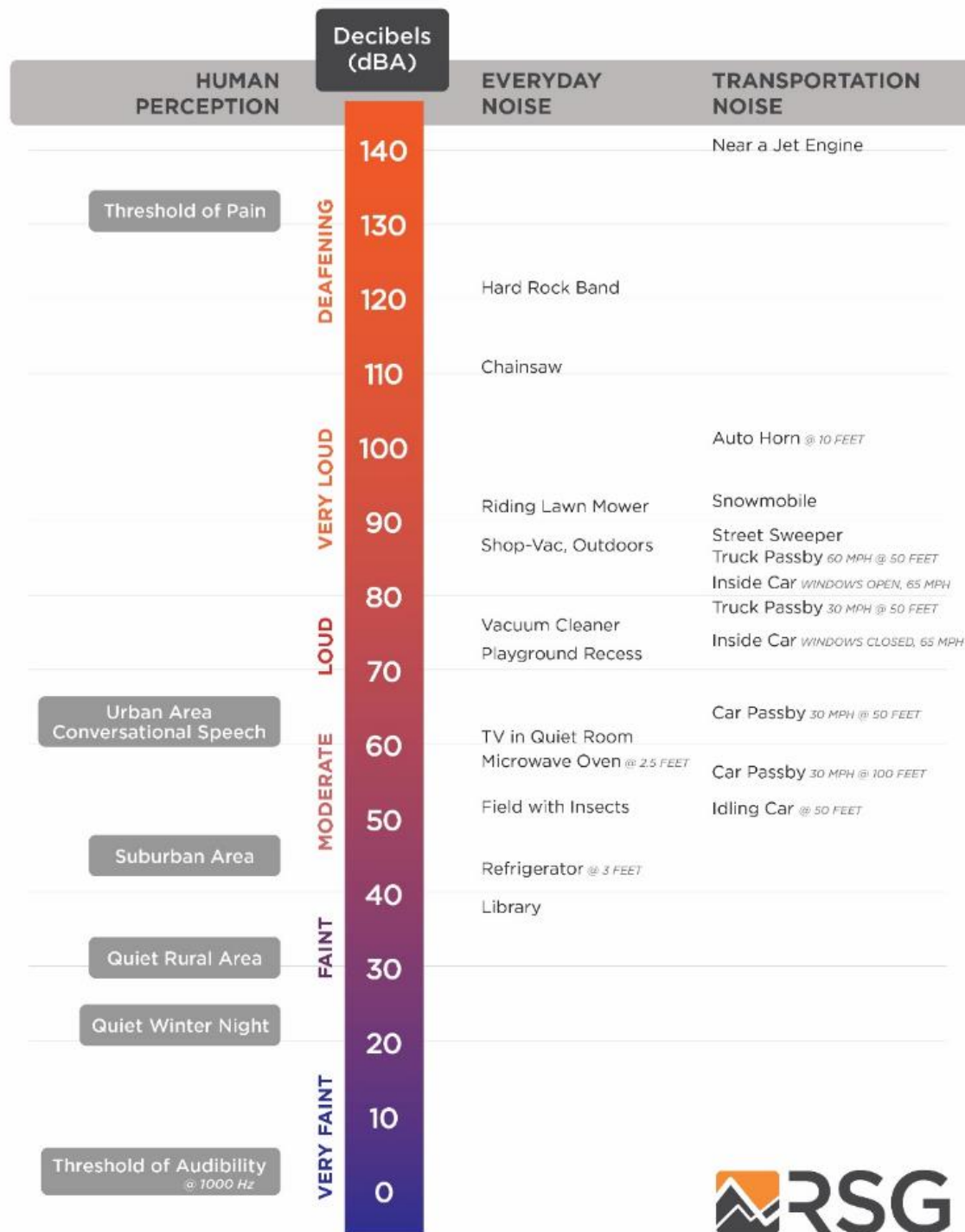
Typical sound sources, and their sound pressure levels, are listed on the scale in Figure 4. Typical ambient nighttime sound levels around wind turbine locations, in the absence of wind turbines, is shown in Figure 5.

### ***Human Response to Sound Levels: Apparent Loudness***

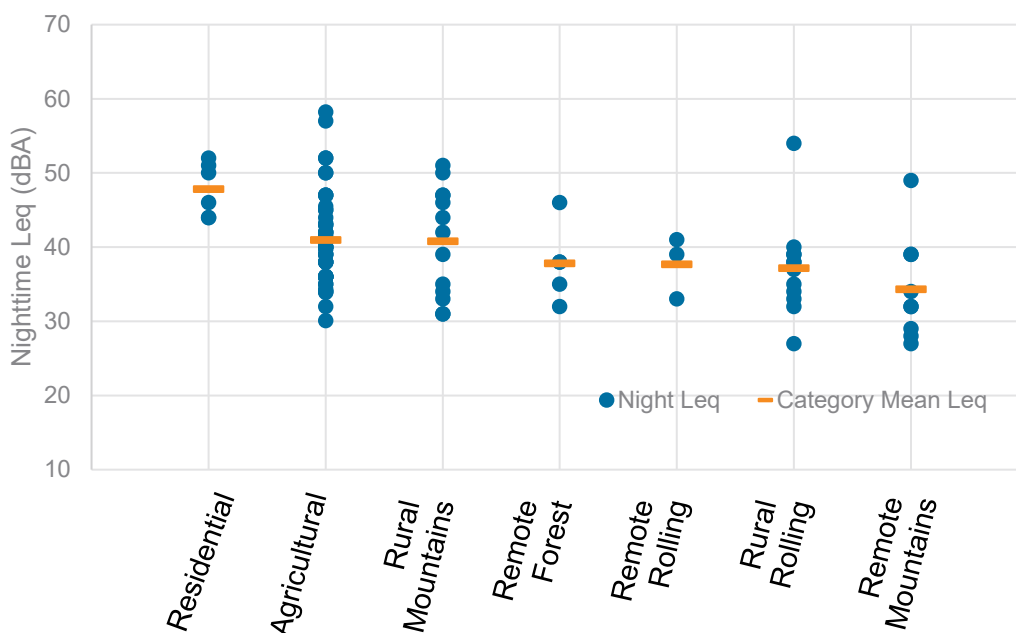
For every 20 dB increase in sound level, the sound pressure increases by a *factor* of 10; the sound *level* range from 0 dB to 120 dB covers 6 factors of 10, or one million, in sound *pressure*. However, for an increase of 10 dB in sound *level* as measured by a meter, humans perceive an approximate doubling of apparent loudness: to the human ear, a sound level of 70 dB sounds about “twice as loud” as a sound level of 60 dB. Smaller changes in sound level, less than 3 dB up or down, are generally not perceptible.

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<sup>3</sup> The pascal is a measure of pressure in the metric system. In Imperial units, they are themselves very small: one pascal is only 145 millionths of a pound per square inch (psi). The sound pressure at the threshold of audibility is only 3 one-billionths of one psi: at the threshold of pain, it is about 3 one-thousandths of one psi.



**FIGURE 4: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES**



**FIGURE 5: BACKGROUND NIGHTTIME  $L_{eq}$  AT 102 LOCATIONS AT POTENTIAL WIND TURBINE SITES ACROSS THE U.S. BY LAND USE CATEGORY<sup>4</sup>**

### ***Frequency Spectrum of Sound***

The “frequency” of a sound is the rate at which it fluctuates in time, expressed in Hertz (Hz), or cycles per second. Very few sounds occur at only one frequency: most sound contains energy at many different frequencies, and it can be broken down into different frequency divisions, or bands. These bands are similar to musical pitches, from low tones to high tones. The most common division is the standard octave band. An octave is the range of frequencies whose upper frequency limit is twice its lower frequency limit, exactly like an octave in music. An octave band is identified by its center frequency: each successive band’s center frequency is twice as high (one octave) as the previous band. For example, the 500 Hz octave band includes all sound whose frequencies range between 354 Hz (Hertz, or cycles per second) and 707 Hz. The next band is centered at 1,000 Hz with a range between 707 Hz and 1,414 Hz. The range of human hearing is divided into 10 standard octave bands: 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz, 8,000 Hz, and 16,000 Hz. For analyses that require finer frequency detail, each octave-band can be subdivided. A commonly-used subdivision creates three smaller bands within each octave band, or so-called 1/3-octave bands.

### ***Human Response to Frequency: Weighting of Sound Levels***

The human ear is not equally sensitive to sounds of all frequencies. Sounds at some frequencies seem louder than others, despite having the same decibel level as measured by a sound level meter. In particular, human hearing is much more sensitive to medium pitches (from about 500 Hz to about 4,000 Hz) than to very low or very high pitches. For example, a tone measuring 80 dB at 500 Hz (a medium pitch) sounds quite a bit louder than a tone measuring

<sup>4</sup> From Kaliski, K., Bastasch, M., and O’Neal, R., “Regulating and Predicting Wind Turbine Sound in the U.S.,” Proceedings of InterNoise2018, Institute of Noise Control Engineering, 2018

80 dB at 60 Hz (a very low pitch). The frequency response of normal human hearing ranges from 20 Hz to 20,000 Hz. Below 20 Hz, pitch perception is greatly reduced and sound may be “felt” as much as “heard”. Frequencies below 20 Hz are known as “infrasound”. Likewise, above 20,000 Hz, sound can no longer be heard by humans; this is known as “ultrasound”. As humans age, they tend to lose the ability to hear higher frequencies first; many adults do not hear very well above about 16,000 Hz. Most natural and man-made sound occurs in the range from about 40 Hz to about 4,000 Hz. Some insects and birdsongs reach to about 8,000 Hz.

To adjust measured sound pressure levels so that they mimic human hearing response, sound level meters apply filters, known as “frequency weightings”, to the signals. There are several defined weighting scales, including “A”, “B”, “C”, “D”, “G”, and “Z”. The most common weighting scale used in environmental noise analysis and regulation is A-weighting. This weighting represents the sensitivity of the human ear to sounds of low to moderate level. It attenuates sounds with frequencies below 1000 Hz and above 4000 Hz; it amplifies very slightly sounds between 1000 Hz and 4000 Hz, where the human ear is particularly sensitive. The C-weighting scale is sometimes used to describe louder sounds. The B- and D- scales are seldom used. All of these frequency weighting scales are normalized to the average human hearing response at 1000 Hz: at this frequency, the filters neither attenuate nor amplify. G-weighting is a standardized weighting used to evaluate infrasound.

When a reported sound level has been filtered using a frequency weighting, the letter is appended to “dB”. For example, sound with A-weighting is usually denoted “dBA” or “dB(A)”. When no filtering is applied, the level is denoted “dB” or “dBZ”. The letter is also appended as a subscript to the level indicator “L”, for example “L<sub>A</sub>” for A-weighted levels.

### ***Equivalent Continuous Sound Level - $L_{eq}$***

One straightforward, common way of describing sound levels is in terms of the Continuous Equivalent Sound Level, or  $L_{eq}$ . The  $L_{eq}$  is the average sound pressure level over a defined period of time, such as one hour or one day.  $L_{eq}$  is the most commonly used descriptor in noise standards and regulations.  $L_{eq}$  is representative of the overall sound to which a person is exposed. Because of the logarithmic calculation of decibels,  $L_{eq}$  tends to favor higher sound levels: loud and infrequent sources have a larger impact on the resulting average sound level than quieter but more frequent sounds.

## APPENDIX B. WIND TURBINE ACOUSTICS

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### Sources of Sound Generation by Wind Turbines

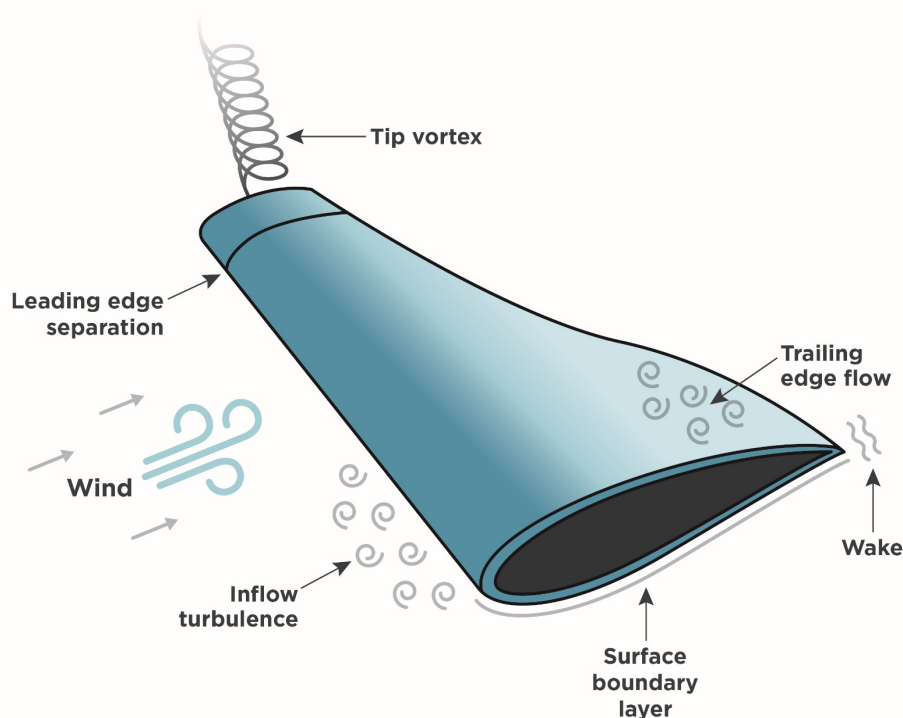
Wind turbines generate two principal types of noise: aerodynamic noise, produced from the flow of air around the blades, and mechanical noise, produced from mechanical and electrical components within the nacelle.

Aerodynamic noise is the primary source of noise associated with wind turbines. These acoustic emissions can be either tonal or broad band. Tonal noise occurs at discrete frequencies, whereas broadband noise is distributed with little peaking across the frequency spectrum.

While unusual, tonal noise can also originate from unstable air flows over holes, slits, or blunt trailing edges on blades. Most modern wind turbines have upwind rotors designed to prevent blade impulsive noise. Therefore, the majority of audible aerodynamic noise from wind turbines is broadband at the middle frequencies, roughly between 200 Hz and 1,000 Hz.

Wind turbines emit aerodynamic broadband noise as the spinning blades interact with atmospheric turbulence and as air flows along their surfaces. This produces a characteristic “whooshing” sound through several mechanisms (Figure 6):

- Inflow turbulence noise occurs when the rotor blades encounter atmospheric turbulence as they pass through the air. Uneven pressure on a rotor blade causes variations in the local angle of attack, which affects the lift and drag forces, causing aerodynamic loading fluctuations. This generates noise that varies across a wide range of frequencies but is most significant at frequencies below 500 Hz.
- Trailing edge noise is produced as boundary-layer turbulence as the air passes into the wake, or trailing edge, of the blade. This noise is distributed across a wide frequency range but is most notable at high frequencies between 700 Hz and 2 kHz.
- Tip vortex noise occurs when tip turbulence interacts with the surface of the blade tip. While this is audible near the turbine, it tends to be a small component of the overall noise further away.
- Stall or separation noise occurs due to the interaction of turbulence with the blade surface.

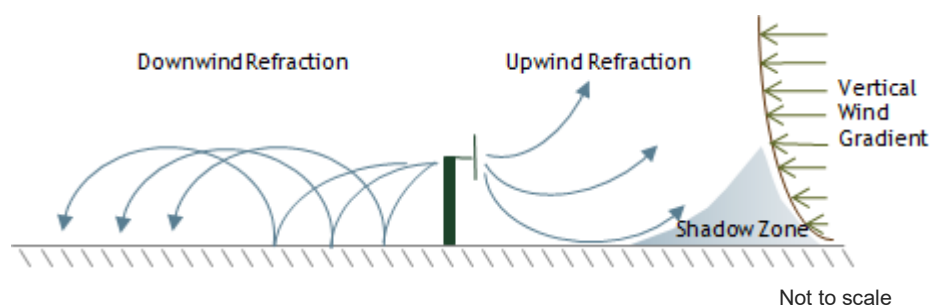


**FIGURE 6: AIRFLOW AROUND A ROTOR BLADE**

Mechanical sound from machinery inside the nacelle tends to be tonal in nature but can also have a broadband component. Potential sources of mechanical noise include the gearbox, generator, yaw drives, cooling fans, and auxiliary equipment. These components are housed within the nacelle, whose surfaces, if untreated, radiate the resulting noise. However modern wind turbines have nacelles that are designed to reduce internal noise, and rarely is the mechanical noise a significant portion of the total noise from a wind turbine.

## Meteorology

Meteorological conditions can significantly affect sound propagation. The two most important conditions to consider are wind shear and temperature lapse. Wind shear is the difference in wind speeds by elevation and temperature lapse rate is the temperature gradient by elevation. In conditions with high wind shear (large wind speed gradient), sound levels upwind from the source tend to decrease and sound levels downwind tend to increase due to the refraction, or bending, of the sound (Figure 7).



**FIGURE 7: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)**

With temperature lapse, when ground surface temperatures are higher than those aloft, sound will tend to refract upwards, leading to lower sound levels near the ground. The opposite is true when ground temperatures are lower than those aloft (an inversion condition).

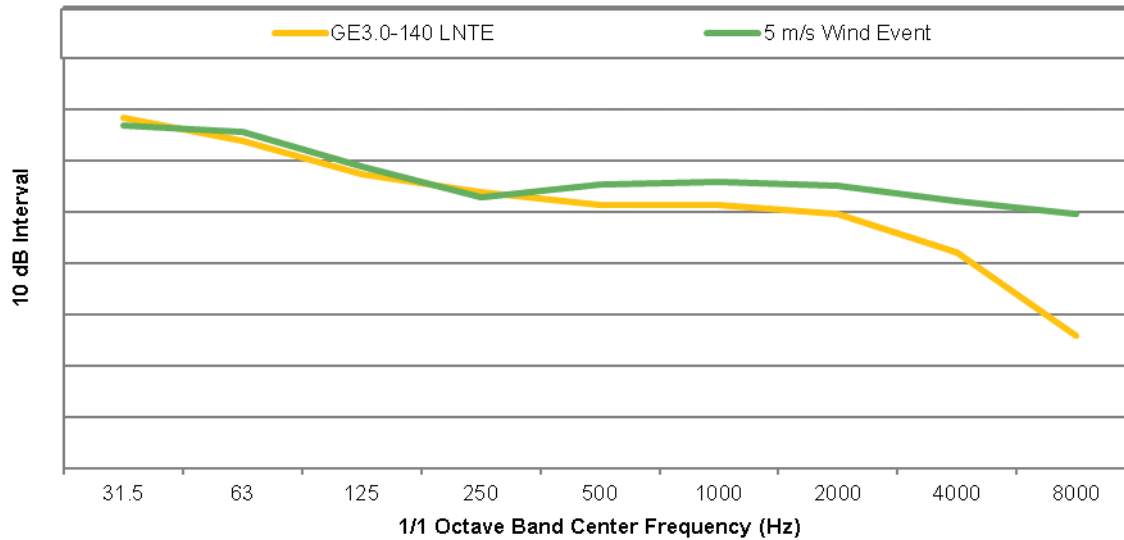
High winds and high solar radiation can create turbulence which tends to break up and dissipate sound energy. Highly stable atmospheres, which tend to occur on clear nights with low ground-level wind speeds, tend to minimize atmospheric turbulence and are generally more favorable to downwind propagation.

In general terms, sound propagates along the ground best under stable conditions with a strong temperature inversion. This tends to occur during the night and is characterized by low ground-level winds. As a result, worst-case conditions for wind turbines tend to occur downwind under moderate nighttime temperature inversions. Therefore, this is the default condition for modeling wind turbine sound.

## Masking

As mentioned above, sound levels from wind turbines are a function of wind speed. Background sound is also a function of wind speed, i.e., the stronger the winds, the louder the resulting background sound. This effect is amplified in areas covered by trees and other vegetation.

The sound from a wind turbine can often be masked by wind noise at downwind receivers because the frequency spectrum from wind is similar to the frequency spectrum from a wind turbine. Figure 8 compares the shape of the sound spectrum measured during a 5 m/s wind event to that of the GE 3.0-140 LNTE wind turbine. As shown, the shapes of the spectra are similar at lower frequencies. At higher frequencies, the sounds from the masking wind noise are higher than the wind turbine. As a result, the masking of turbine noise occurs at higher wind speeds for some meteorological conditions. Masking will occur most, when ground wind speeds are relatively high, creating wind-caused noise such as wind blowing through the trees and interaction of wind with structures.



**FIGURE 8: COMPARISON OF NORMALIZED FREQUENCY SPECTRA MEASURED FROM A 5 M/S WIND EVENT AND THE SOUND POWER SPECTRA FROM THE GE 3.0-140 LNTE<sup>5</sup>**

It is important to note that while winds may be blowing at turbine height, there may be little to no wind at ground level. This is especially true during strong wind gradients (high wind shear), which mostly occur at night. This can also occur on the leeward side of ridges where the ridge blocks the wind.

<sup>5</sup> The purpose of this Figure is to show the shapes to two spectra relative to one another and not the actual sound level of the two sources of sound. The level of each source was normalized independently.

APPENDIX C. SOURCE INFORMATION

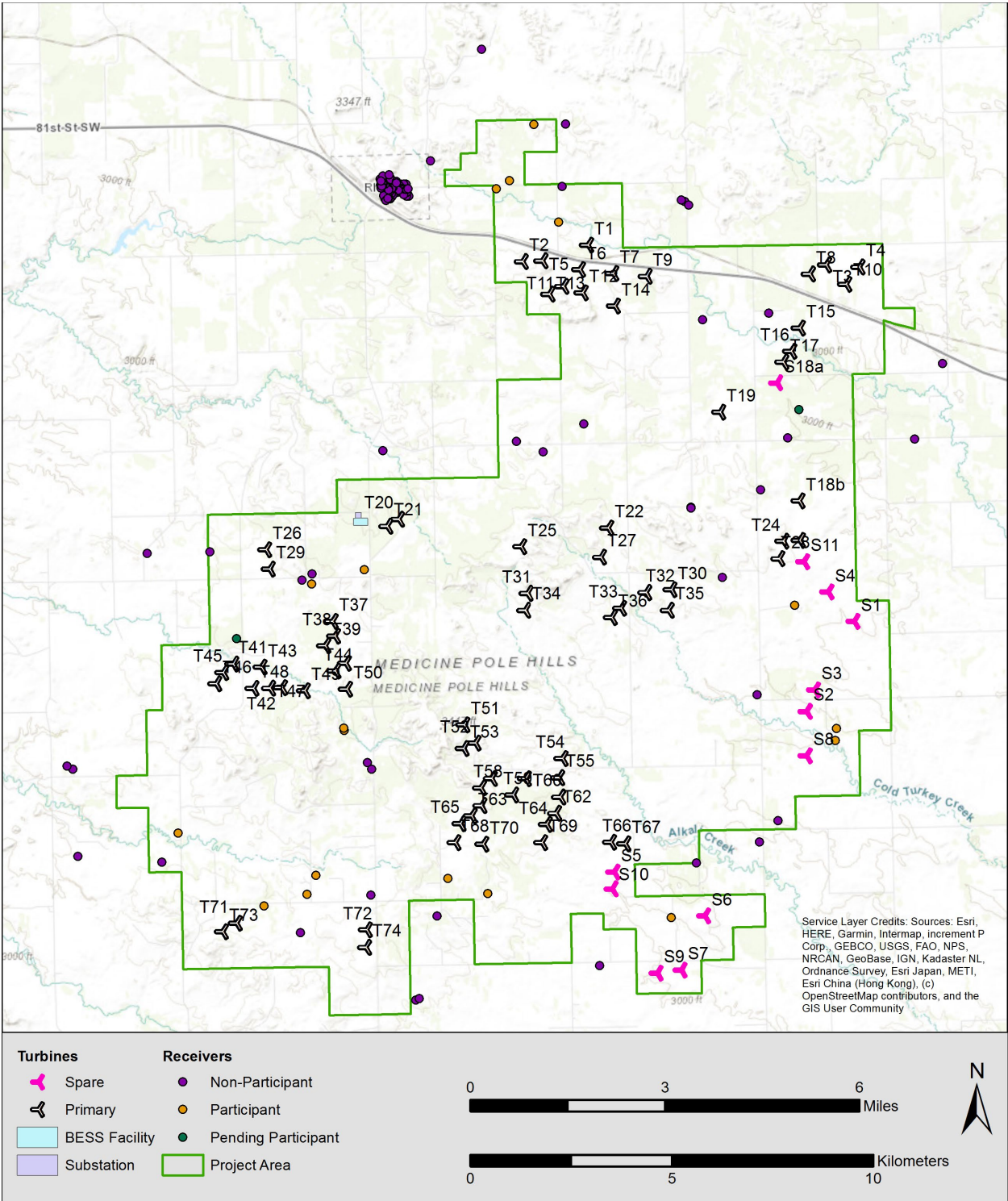


FIGURE 9: WIND TURBINE LOCATION MAP

**TABLE 2: NOISE SOURCE INFORMATION TABLE**

| ID   | Type                        | Sound<br>Power<br>Level (dBA) | Hub Height<br>(m) | Coordinates<br>(UTM NAD83 Z13N) |         |       |
|------|-----------------------------|-------------------------------|-------------------|---------------------------------|---------|-------|
|      |                             |                               |                   | X (m)                           | Y (m)   | Z (m) |
| T1   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607880                          | 5118354 | 1059  |
| T2   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 613689                          | 5112222 | 1031  |
| T3   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 610844                          | 5110516 | 1032  |
| T4   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600532                          | 5108578 | 1040  |
| T5   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606984                          | 5105936 | 1047  |
| T6   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606238                          | 5104714 | 1047  |
| T7   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614268                          | 5106908 | 999   |
| T8   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609496                          | 5104030 | 1019  |
| T9   | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614202                          | 5111718 | 1032  |
| T10  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609507                          | 5118052 | 1037  |
| T11  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614094                          | 5117507 | 1009  |
| T12  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 613884                          | 5116934 | 1007  |
| T13  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 613688                          | 5116670 | 1019  |
| T14  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 612115                          | 5115426 | 1026  |
| T15  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614088                          | 5113222 | 1011  |
| T16  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 604150                          | 5112776 | 1072  |
| T17  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 603861                          | 5112601 | 1071  |
| T18b | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609338                          | 5112554 | 1069  |
| T19  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614099                          | 5112243 | 1023  |
| T20  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607180                          | 5112089 | 1117  |
| T21  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600850                          | 5112020 | 1046  |
| T22  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609163                          | 5111833 | 1050  |
| T23  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 613587                          | 5111791 | 1040  |
| T24  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600938                          | 5111538 | 1062  |
| T25  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 610910                          | 5111022 | 1047  |
| T26  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 610283                          | 5110961 | 1049  |
| T27  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607343                          | 5110935 | 1077  |
| T28  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609659                          | 5110563 | 1043  |
| T29  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607283                          | 5110522 | 1062  |
| T30  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609429                          | 5110338 | 1029  |
| T31  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602506                          | 5110240 | 1055  |
| T32  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602562                          | 5109873 | 1062  |
| T33  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602325                          | 5109633 | 1056  |
| T34  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602827                          | 5109198 | 1066  |
| T35  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602573                          | 5109005 | 1063  |
| T36  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 599788                          | 5108975 | 1037  |

| ID  | Type                        | Sound<br>Power<br>Level (dBA) | Hub Height<br>(m) | Coordinates<br>(UTM NAD83 Z13N) |         |       |
|-----|-----------------------------|-------------------------------|-------------------|---------------------------------|---------|-------|
|     |                             |                               |                   | X (m)                           | Y (m)   | Z (m) |
| T37 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 601244                          | 5108593 | 1056  |
| T38 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 599617                          | 5108695 | 1044  |
| T39 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600946                          | 5108585 | 1046  |
| T40 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 601812                          | 5108523 | 1048  |
| T41 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 602860                          | 5108557 | 1055  |
| T42 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 605772                          | 5107673 | 1069  |
| T43 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606053                          | 5107219 | 1067  |
| T44 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 605751                          | 5107087 | 1091  |
| T45 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608210                          | 5106838 | 1039  |
| T46 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608119                          | 5106370 | 1037  |
| T47 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606453                          | 5106347 | 1063  |
| T48 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607300                          | 5106342 | 1043  |
| T49 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606179                          | 5106110 | 1084  |
| T50 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608148                          | 5105887 | 1037  |
| T51 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 606191                          | 5105679 | 1074  |
| T52 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608046                          | 5105484 | 1040  |
| T53 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 605949                          | 5105422 | 1057  |
| T54 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 605669                          | 5105224 | 1051  |
| T55 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607819                          | 5105203 | 1038  |
| T56 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609408                          | 5104768 | 1017  |
| T57 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 605545                          | 5104754 | 1048  |
| T58 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607697                          | 5104754 | 1043  |
| T59 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609766                          | 5104726 | 1017  |
| T60 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600122                          | 5102755 | 1052  |
| T61 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 603350                          | 5102590 | 1076  |
| T62 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 599775                          | 5102549 | 1067  |
| T63 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 603331                          | 5102160 | 1076  |
| T64 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600036                          | 5109180 | 1037  |
| T65 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 600738                          | 5109102 | 1040  |
| T66 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614803                          | 5110965 | 1013  |
| T67 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 615448                          | 5110235 | 1003  |
| T68 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614475                          | 5108543 | 1014  |
| T69 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614268                          | 5108014 | 998   |
| T70 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609445                          | 5103616 | 1008  |
| T71 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 611745                          | 5102937 | 1016  |
| T72 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 611156                          | 5101598 | 998   |
| T73 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 610565                          | 5101517 | 1004  |
| T74 | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 613543                          | 5116151 | 1019  |
| S1  | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608840                          | 5119564 | 1031  |

| ID               | Type                        | Sound<br>Power<br>Level (dBA) | Hub Height<br>(m) | Coordinates<br>(UTM NAD83 Z13N) |         |       |
|------------------|-----------------------------|-------------------------------|-------------------|---------------------------------|---------|-------|
|                  |                             |                               |                   | X (m)                           | Y (m)   | Z (m) |
| S2               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 615575                          | 5119024 | 1021  |
| S3               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608643                          | 5118955 | 1043  |
| S4               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 609469                          | 5118868 | 1039  |
| S5               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614344                          | 5118851 | 1020  |
| S6               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 610290                          | 5118792 | 1039  |
| S7               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 615253                          | 5118591 | 1026  |
| S8               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608227                          | 5118542 | 1053  |
| S9               | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 608710                          | 5118383 | 1052  |
| S10              | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607711                          | 5119179 | 1056  |
| S11              | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 607222                          | 5119163 | 1061  |
| S18a             | GE 2.82 - 127 LNTE-Enhanced | 111                           | 89                | 614751                          | 5119077 | 1023  |
| Substation Trans | 222 MVA Transformer ONAF2   | 112                           | 2.5               | 603163                          | 5112872 | 974   |
| BESS Trans1      | 4.2 MVA Transformer ONAF2   | 84                            | 2.5               | 603298                          | 5112631 | 976   |
| BESS Trans2      | 4.2 MVA Transformer ONAF3   | 84                            | 2.5               | 603298                          | 5112649 | 976   |
| BESS Trans3      | 4.2 MVA Transformer ONAF4   | 84                            | 2.5               | 603298                          | 5112667 | 976   |
| BESS Trans4      | 4.2 MVA Transformer ONAF5   | 84                            | 2.5               | 603298                          | 5112685 | 976   |
| BESS Trans5      | 4.2 MVA Transformer ONAF6   | 84                            | 2.5               | 603298                          | 5112703 | 975   |
| BESS Trans6      | 4.2 MVA Transformer ONAF7   | 84                            | 2.5               | 603298                          | 5112721 | 975   |
| BESS Trans7      | 4.2 MVA Transformer ONAF8   | 84                            | 2.5               | 603298                          | 5112739 | 974   |
| BESS Trans8      | 4.2 MVA Transformer ONAF9   | 84                            | 2.5               | 603298                          | 5112757 | 974   |
| BESS Trans9      | 4.2 MVA Transformer ONAF10  | 84                            | 2.5               | 603298                          | 5112775 | 974   |
| BESS Trans10     | 4.2 MVA Transformer ONAF11  | 84                            | 2.5               | 603308                          | 5112631 | 976   |
| BESS Trans11     | 4.2 MVA Transformer ONAF12  | 84                            | 2.5               | 603308                          | 5112649 | 976   |
| BESS Trans12     | 4.2 MVA Transformer ONAF13  | 84                            | 2.5               | 603308                          | 5112667 | 976   |
| BESS Trans13     | 4.2 MVA Transformer ONAF14  | 84                            | 2.5               | 603308                          | 5112685 | 975   |
| BESS Trans14     | 4.2 MVA Transformer ONAF15  | 84                            | 2.5               | 603308                          | 5112703 | 975   |
| BESS Trans15     | 4.2 MVA Transformer ONAF16  | 84                            | 2.5               | 603308                          | 5112721 | 975   |
| BESS Trans16     | 4.2 MVA Transformer ONAF17  | 84                            | 2.5               | 603308                          | 5112739 | 974   |
| BESS Trans17     | 4.2 MVA Transformer ONAF18  | 84                            | 2.5               | 603308                          | 5112757 | 973   |
| BESS Trans18     | 4.2 MVA Transformer ONAF19  | 84                            | 2.5               | 603308                          | 5112775 | 973   |
| BESS Trans19     | 4.2 MVA Transformer ONAF20  | 84                            | 2.5               | 603318                          | 5112631 | 976   |
| BESS Trans20     | 4.2 MVA Transformer ONAF21  | 84                            | 2.5               | 603318                          | 5112649 | 976   |
| BESS Trans21     | 4.2 MVA Transformer ONAF22  | 84                            | 2.5               | 603318                          | 5112667 | 976   |
| BESS Trans22     | 4.2 MVA Transformer ONAF23  | 84                            | 2.5               | 603318                          | 5112685 | 975   |
| BESS Trans23     | 4.2 MVA Transformer ONAF24  | 84                            | 2.5               | 603318                          | 5112703 | 975   |
| BESS Trans24     | 4.2 MVA Transformer ONAF25  | 84                            | 2.5               | 603318                          | 5112721 | 974   |
| BESS Trans25     | 4.2 MVA Transformer ONAF26  | 84                            | 2.5               | 603318                          | 5112739 | 974   |
| BESS Trans26     | 4.2 MVA Transformer ONAF27  | 84                            | 2.5               | 603318                          | 5112757 | 973   |
| BESS Trans27     | 4.2 MVA Transformer ONAF28  | 84                            | 2.5               | 603318                          | 5112775 | 973   |

| ID              | Type                       | Sound<br>Power<br>Level (dBA) | Hub Height<br>(m) | Coordinates<br>(UTM NAD83 Z13N) |         |       |
|-----------------|----------------------------|-------------------------------|-------------------|---------------------------------|---------|-------|
|                 |                            |                               |                   | X (m)                           | Y (m)   | Z (m) |
| BESS Trans28    | 4.2 MVA Transformer ONAF29 | 84                            | 2.5               | 603328                          | 5112631 | 976   |
| BESS Trans29    | 4.2 MVA Transformer ONAF30 | 84                            | 2.5               | 603328                          | 5112649 | 976   |
| BESS Trans30    | 4.2 MVA Transformer ONAF31 | 84                            | 2.5               | 603328                          | 5112667 | 975   |
| BESS Trans31    | 4.2 MVA Transformer ONAF32 | 84                            | 2.5               | 603328                          | 5112685 | 975   |
| BESS Trans32    | 4.2 MVA Transformer ONAF33 | 84                            | 2.5               | 603328                          | 5112703 | 975   |
| BESS Trans33    | 4.2 MVA Transformer ONAF34 | 84                            | 2.5               | 603328                          | 5112721 | 974   |
| BESS Trans34    | 4.2 MVA Transformer ONAF35 | 84                            | 2.5               | 603328                          | 5112739 | 974   |
| BESS Trans35    | 4.2 MVA Transformer ONAF36 | 84                            | 2.5               | 603328                          | 5112757 | 973   |
| BESS Trans36    | 4.2 MVA Transformer ONAF37 | 84                            | 2.5               | 603328                          | 5112775 | 973   |
| BESS Trans37    | 4.2 MVA Transformer ONAF38 | 84                            | 2.5               | 603338                          | 5112631 | 975   |
| BESS Trans38    | 4.2 MVA Transformer ONAF39 | 84                            | 2.5               | 603338                          | 5112649 | 975   |
| BESS Trans39    | 4.2 MVA Transformer ONAF40 | 84                            | 2.5               | 603338                          | 5112667 | 975   |
| BESS Trans40    | 4.2 MVA Transformer ONAF41 | 84                            | 2.5               | 603338                          | 5112685 | 975   |
| BESS Trans41    | 4.2 MVA Transformer ONAF42 | 84                            | 2.5               | 603338                          | 5112703 | 974   |
| BESS Inverter42 | SMA Inverter               | 92                            | 2.5               | 603338                          | 5112721 | 974   |
| BESS Inverter43 | SMA Inverter               | 92                            | 2.5               | 603338                          | 5112739 | 973   |
| BESS Inverter44 | SMA Inverter               | 92                            | 2.5               | 603338                          | 5112757 | 973   |
| BESS Inverter45 | SMA Inverter               | 92                            | 2.5               | 603338                          | 5112775 | 973   |
| BESS Inverter46 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112631 | 975   |
| BESS Inverter47 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112649 | 975   |
| BESS Inverter48 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112667 | 975   |
| BESS Inverter49 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112685 | 975   |
| BESS Inverter50 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112703 | 974   |
| BESS Inverter51 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112721 | 974   |
| BESS Inverter52 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112739 | 973   |
| BESS Inverter53 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112757 | 973   |
| BESS Inverter54 | SMA Inverter               | 92                            | 2.5               | 603348                          | 5112775 | 973   |
| BESS Inverter55 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112631 | 975   |
| BESS Inverter56 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112649 | 975   |
| BESS Inverter57 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112667 | 975   |
| BESS Inverter58 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112685 | 974   |
| BESS Inverter59 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112703 | 974   |
| BESS Inverter60 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112721 | 973   |
| BESS Inverter61 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112739 | 973   |
| BESS Inverter62 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112757 | 972   |
| BESS Inverter63 | SMA Inverter               | 92                            | 2.5               | 603358                          | 5112775 | 972   |
| BESS Inverter64 | SMA Inverter               | 92                            | 2.5               | 603368                          | 5112631 | 974   |
| BESS Inverter65 | SMA Inverter               | 92                            | 2.5               | 603368                          | 5112649 | 974   |
| BESS Inverter66 | SMA Inverter               | 92                            | 2.5               | 603368                          | 5112667 | 974   |

| ID              | Type         | Sound<br>Power<br>Level (dBA) | Hub Height<br>(m) | Coordinates<br>(UTM NAD83 Z13N) |         |       |
|-----------------|--------------|-------------------------------|-------------------|---------------------------------|---------|-------|
|                 |              |                               |                   | X (m)                           | Y (m)   | Z (m) |
| BESS Inverter67 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112685 | 974   |
| BESS Inverter68 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112703 | 974   |
| BESS Inverter69 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112721 | 973   |
| BESS Inverter70 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112739 | 973   |
| BESS Inverter71 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112757 | 972   |
| BESS Inverter72 | SMA Inverter | 92                            | 2.5               | 603368                          | 5112775 | 972   |
| BESS Inverter73 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112631 | 974   |
| BESS Inverter74 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112649 | 974   |
| BESS Inverter75 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112667 | 974   |
| BESS Inverter76 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112685 | 974   |
| BESS Inverter77 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112703 | 973   |
| BESS Inverter78 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112721 | 973   |
| BESS Inverter79 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112739 | 973   |
| BESS Inverter80 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112757 | 972   |
| BESS Inverter81 | SMA Inverter | 92                            | 2.5               | 603378                          | 5112775 | 972   |
| BESS Inverter82 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112631 | 974   |
| BESS Inverter83 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112649 | 974   |
| BESS Inverter84 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112667 | 973   |
| BESS Inverter85 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112685 | 973   |
| BESS Inverter86 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112703 | 973   |
| BESS Inverter87 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112721 | 973   |
| BESS Inverter88 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112739 | 972   |
| BESS Inverter89 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112757 | 972   |
| BESS Inverter90 | SMA Inverter | 92                            | 2.5               | 603388                          | 5112775 | 972   |

APPENDIX D. RECEIVER LEVEL RESULTS

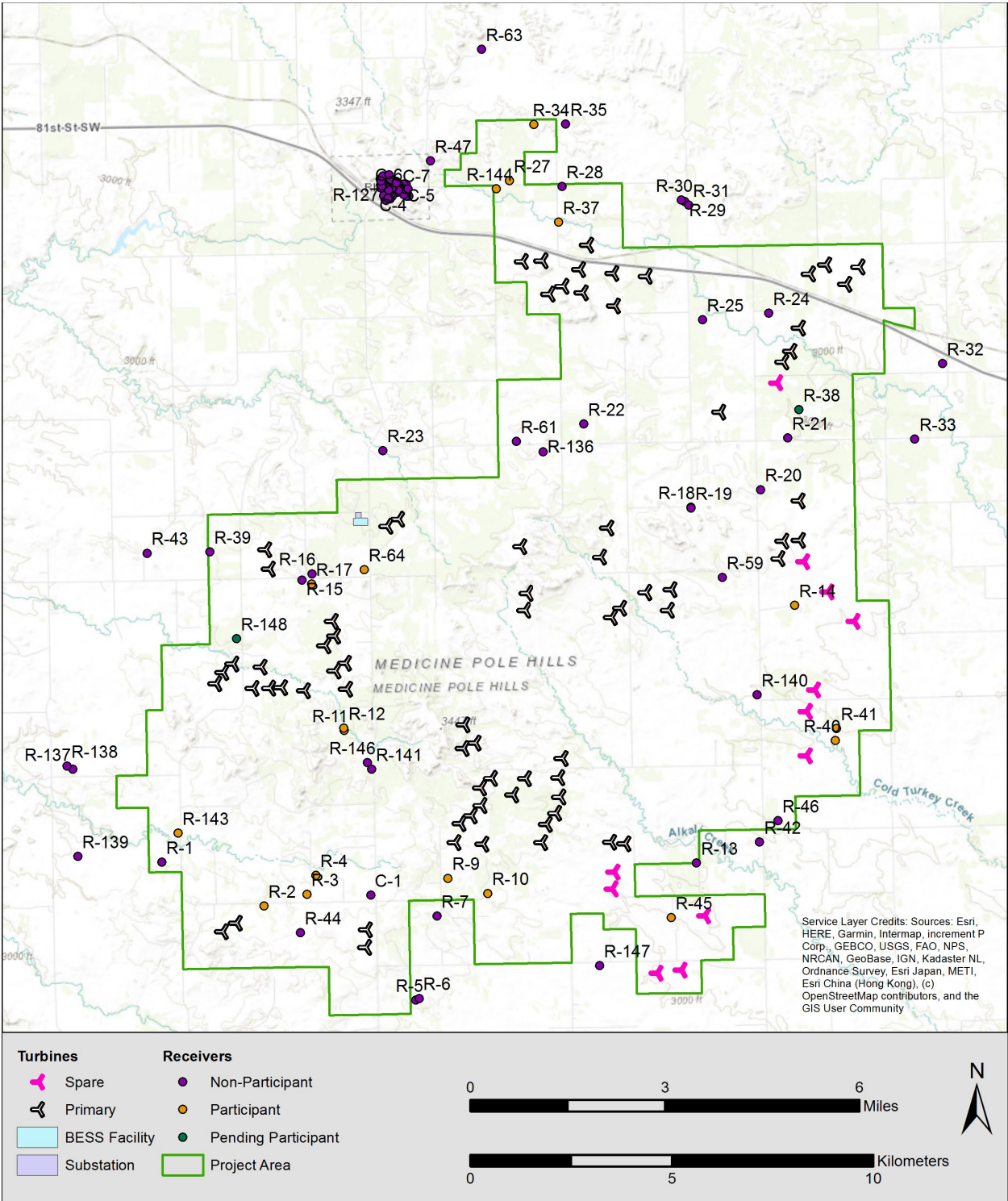


FIGURE 10: RECEIVER MAP

TABLE 3: RECEPTOR SOUND LEVEL RESULTS AND COORDINATES

| Receptor | Land Use                         | Overall Sound Level (dBA) | Coordinates (UTM Zone 13N, NAD 83) |         |       |
|----------|----------------------------------|---------------------------|------------------------------------|---------|-------|
|          |                                  |                           | X (m)                              | Y (m)   | Z (m) |
| R-1      | Residential Non-Participant      | 32                        | 598290                             | 5104261 | 941   |
| R-2      | Residential Participant          | 41                        | 600826                             | 5103183 | 956   |
| R-3      | Residential Participant          | 37                        | 601891                             | 5103470 | 959   |
| R-4      | Residential Participant          | 36                        | 602113                             | 5103942 | 953   |
| R-5      | Residential Non-Participant      | 34                        | 604593                             | 5100844 | 960   |
| R-6      | Residential Non-Participant      | 35                        | 604671                             | 5100890 | 959   |
| R-7      | Residential Non-Participant      | 39                        | 605115                             | 5102927 | 974   |
| R-9      | Residential Participant          | 43                        | 605382                             | 5103866 | 969   |
| R-10     | Residential Participant          | 41                        | 606371                             | 5103492 | 952   |
| R-11     | Residential Participant          | 42                        | 602810                             | 5107530 | 977   |
| R-12     | Residential Participant          | 42                        | 602807                             | 5107585 | 976   |
| R-13     | Residential Non-Participant      | 39                        | 611554                             | 5104249 | 921   |
| R-14     | Residential Participant          | 44                        | 613992                             | 5110632 | 929   |
| R-15     | Residential Non-Participant      | 44                        | 601761                             | 5111255 | 975   |
| R-16     | Residential Non-Participant      | 43                        | 602011                             | 5111415 | 974   |
| R-17     | Residential Participant          | 43                        | 602001                             | 5111159 | 969   |
| R-18     | Residential Non-Participant      | 35                        | 611420                             | 5113066 | 960   |
| R-19     | Residential Non-Participant      | 35                        | 611415                             | 5113039 | 961   |
| R-20     | Residential Non-Participant      | 42                        | 613145                             | 5113499 | 949   |
| R-21     | Residential Non-Participant      | 40                        | 613815                             | 5114783 | 920   |
| R-22     | Residential Non-Participant      | 36                        | 608753                             | 5115123 | 962   |
| R-23     | Residential Non-Participant      | 38                        | 603772                             | 5114469 | 962   |
| R-24     | Residential Non-Participant      | 44                        | 613349                             | 5117872 | 930   |
| R-25     | Residential Non-Participant      | 39                        | 611703                             | 5117712 | 935   |
| R-27     | Residential Participant          | 36                        | 606912                             | 5121157 | 964   |
| R-28     | Residential Non-Participant      | 38                        | 608220                             | 5121018 | 955   |
| R-29     | Residential Non-Participant      | 35                        | 611264                             | 5120638 | 944   |
| R-30     | Residential Non-Participant      | 35                        | 611177                             | 5120682 | 945   |
| R-31     | Residential Non-Participant      | 36                        | 611358                             | 5120554 | 944   |
| R-32     | Residential Non-Participant      | 33                        | 617660                             | 5116624 | 914   |
| R-33     | Residential Non-Participant      | 33                        | 616971                             | 5114750 | 909   |
| R-34     | Residential Participant          | 32                        | 607517                             | 5122547 | 981   |
| R-35     | Residential Non-Participant      | 32                        | 608309                             | 5122556 | 981   |
| R-37     | Residential Participant          | 44                        | 608128                             | 5120127 | 952   |
| R-38     | Pending Participant <sup>6</sup> | 42                        | 614096                             | 5115483 | 928   |
| R-39     | Residential Non-Participant      | 39                        | 599477                             | 5111956 | 947   |
| R-40     | Residential Participant          | 43                        | 614996                             | 5107279 | 914   |
| R-41     | Residential Participant          | 43                        | 615024                             | 5107579 | 916   |

<sup>6</sup> This residence is a pending participant and currently in the process of executing administrative documents for a participation agreement.

| Receptor | Land Use                    | Overall<br>Sound Level<br>(dBA) | Coordinates (UTM Zone 13N, NAD 83) |         |       |
|----------|-----------------------------|---------------------------------|------------------------------------|---------|-------|
|          |                             |                                 | X (m)                              | Y (m)   | Z (m) |
| R-42     | Residential Non-Participant | 35                              | 613120                             | 5104763 | 915   |
| R-43     | Residential Non-Participant | 34                              | 597921                             | 5111924 | 945   |
| R-44     | Residential Non-Participant | 37                              | 601725                             | 5102516 | 964   |
| R-45     | Residential Participant     | 43                              | 610922                             | 5102894 | 914   |
| R-46     | Residential Non-Participant | 36                              | 613577                             | 5105297 | 920   |
| R-47     | Residential Non-Participant | 30                              | 604953                             | 5121651 | 987   |
| R-48     | Residential Non-Participant | 25                              | 604367                             | 5120914 | 984   |
| R-49     | Residential Non-Participant | 25                              | 604349                             | 5121071 | 983   |
| R-50     | Residential Non-Participant | 24                              | 604213                             | 5121073 | 983   |
| R-51     | Residential Non-Participant | 25                              | 604364                             | 5120814 | 987   |
| R-52     | Residential Non-Participant | 25                              | 604381                             | 5120816 | 987   |
| R-53     | Residential Non-Participant | 25                              | 604397                             | 5120815 | 987   |
| R-54     | Residential Non-Participant | 25                              | 604420                             | 5120774 | 990   |
| R-55     | Residential Non-Participant | 25                              | 604361                             | 5120776 | 988   |
| R-56     | Residential Non-Participant | 25                              | 604001                             | 5120773 | 980   |
| R-57     | Residential Non-Participant | 25                              | 603960                             | 5120722 | 979   |
| R-58     | Residential Non-Participant | 24                              | 604134                             | 5120870 | 981   |
| R-59     | Residential Non-Participant | 41                              | 612193                             | 5111321 | 944   |
| R-61     | Residential Non-Participant | 35                              | 607087                             | 5114694 | 977   |
| R-63     | Residential Non-Participant | 19                              | 606220                             | 5124417 | 948   |
| R-64     | Residential Participant     | 44                              | 603312                             | 5111520 | 998   |
| R-65     | Residential Non-Participant | 24                              | 604294                             | 5121067 | 982   |
| R-66     | Residential Non-Participant | 24                              | 604181                             | 5121033 | 982   |
| R-67     | Residential Non-Participant | 24                              | 604130                             | 5121044 | 983   |
| R-68     | Residential Non-Participant | 25                              | 604063                             | 5121124 | 986   |
| R-69     | Residential Non-Participant | 24                              | 604085                             | 5121076 | 984   |
| R-71     | Residential Non-Participant | 25                              | 604363                             | 5120859 | 987   |
| R-72     | Residential Non-Participant | 25                              | 604296                             | 5120816 | 986   |
| R-73     | Residential Non-Participant | 25                              | 604356                             | 5120934 | 984   |
| R-74     | Residential Non-Participant | 25                              | 604400                             | 5120958 | 983   |
| R-75     | Residential Non-Participant | 25                              | 604023                             | 5121081 | 985   |
| R-76     | Residential Non-Participant | 25                              | 604000                             | 5121062 | 984   |
| R-77     | Residential Non-Participant | 25                              | 603977                             | 5121074 | 985   |
| R-78     | Residential Non-Participant | 25                              | 603985                             | 5121117 | 986   |
| R-79     | Residential Non-Participant | 30                              | 603852                             | 5121246 | 997   |
| R-80     | Residential Non-Participant | 25                              | 603893                             | 5121202 | 992   |
| R-81     | Residential Non-Participant | 25                              | 603857                             | 5121057 | 984   |
| R-82     | Residential Non-Participant | 25                              | 603891                             | 5121094 | 986   |
| R-83     | Residential Non-Participant | 25                              | 603938                             | 5121037 | 983   |
| R-84     | Residential Non-Participant | 25                              | 603999                             | 5121036 | 983   |
| R-85     | Residential Non-Participant | 25                              | 603923                             | 5121129 | 988   |

| Receptor | Land Use                    | Overall<br>Sound Level<br>(dBA) | Coordinates (UTM Zone 13N, NAD 83) |         |       |
|----------|-----------------------------|---------------------------------|------------------------------------|---------|-------|
|          |                             |                                 | X (m)                              | Y (m)   | Z (m) |
| R-86     | Residential Non-Participant | 24                              | 603926                             | 5121162 | 989   |
| R-87     | Residential Non-Participant | 25                              | 603828                             | 5121192 | 990   |
| R-88     | Residential Non-Participant | 25                              | 603880                             | 5120787 | 973   |
| R-89     | Residential Non-Participant | 25                              | 603960                             | 5120800 | 977   |
| R-90     | Residential Non-Participant | 25                              | 603923                             | 5120769 | 974   |
| R-91     | Residential Non-Participant | 25                              | 603954                             | 5120712 | 978   |
| R-92     | Residential Non-Participant | 25                              | 603980                             | 5120748 | 980   |
| R-93     | Residential Non-Participant | 24                              | 604023                             | 5120801 | 981   |
| R-94     | Residential Non-Participant | 25                              | 603982                             | 5120828 | 978   |
| R-95     | Residential Non-Participant | 25                              | 603901                             | 5120811 | 974   |
| R-96     | Residential Non-Participant | 25                              | 603834                             | 5120824 | 974   |
| R-97     | Residential Non-Participant | 25                              | 603824                             | 5120713 | 973   |
| R-98     | Residential Non-Participant | 25                              | 603807                             | 5120783 | 974   |
| R-99     | Residential Non-Participant | 25                              | 603853                             | 5120738 | 973   |
| R-100    | Residential Non-Participant | 25                              | 603834                             | 5120759 | 973   |
| R-101    | Residential Non-Participant | 25                              | 603863                             | 5120860 | 976   |
| R-102    | Residential Non-Participant | 25                              | 603876                             | 5120870 | 977   |
| R-103    | Residential Non-Participant | 25                              | 603865                             | 5120963 | 980   |
| R-104    | Residential Non-Participant | 25                              | 603886                             | 5120919 | 979   |
| R-105    | Residential Non-Participant | 25                              | 603970                             | 5120920 | 979   |
| R-106    | Residential Non-Participant | 25                              | 604022                             | 5120990 | 981   |
| R-107    | Residential Non-Participant | 25                              | 603996                             | 5120964 | 980   |
| R-108    | Residential Non-Participant | 25                              | 603880                             | 5120970 | 980   |
| R-109    | Residential Non-Participant | 25                              | 603915                             | 5120745 | 974   |
| R-110    | Residential Non-Participant | 25                              | 603882                             | 5120705 | 973   |
| R-111    | Residential Non-Participant | 25                              | 603872                             | 5120733 | 973   |
| R-112    | Residential Non-Participant | 25                              | 603787                             | 5120787 | 975   |
| R-113    | Residential Non-Participant | 25                              | 603916                             | 5120958 | 980   |
| R-114    | Residential Non-Participant | 25                              | 603916                             | 5120924 | 979   |
| R-115    | Residential Non-Participant | 25                              | 603718                             | 5121051 | 985   |
| R-116    | Residential Non-Participant | 25                              | 603729                             | 5121065 | 985   |
| R-117    | Residential Non-Participant | 25                              | 603764                             | 5121112 | 987   |
| R-118    | Residential Non-Participant | 25                              | 603810                             | 5121098 | 987   |
| R-119    | Residential Non-Participant | 25                              | 603826                             | 5121076 | 985   |
| R-120    | Residential Non-Participant | 25                              | 603776                             | 5121056 | 985   |
| R-121    | Residential Non-Participant | 25                              | 603747                             | 5121085 | 986   |
| R-122    | Residential Non-Participant | 25                              | 603729                             | 5120979 | 983   |
| R-123    | Residential Non-Participant | 25                              | 603743                             | 5121020 | 983   |
| R-124    | Residential Non-Participant | 28                              | 603707                             | 5121202 | 995   |
| R-125    | Residential Non-Participant | 24                              | 603811                             | 5121164 | 988   |
| R-126    | Residential Non-Participant | 29                              | 603770                             | 5121271 | 1000  |

| Receptor | Land Use                         | Overall<br>Sound Level<br>(dBA) | Coordinates (UTM Zone 13N, NAD 83) |         |       |
|----------|----------------------------------|---------------------------------|------------------------------------|---------|-------|
|          |                                  |                                 | X (m)                              | Y (m)   | Z (m) |
| R-127    | Residential Non-Participant      | 25                              | 603722                             | 5121151 | 989   |
| R-128    | Residential Non-Participant      | 25                              | 603963                             | 5121214 | 992   |
| R-129    | Residential Non-Participant      | 24                              | 603947                             | 5121164 | 989   |
| R-130    | Residential Non-Participant      | 24                              | 603966                             | 5121186 | 990   |
| R-131    | Residential Non-Participant      | 29                              | 603926                             | 5121303 | 1004  |
| R-132    | Residential Non-Participant      | 24                              | 604108                             | 5121142 | 986   |
| R-133    | Residential Non-Participant      | 24                              | 604110                             | 5121100 | 985   |
| R-134    | Residential Non-Participant      | 25                              | 603853                             | 5120666 | 973   |
| R-135    | Residential Non-Participant      | 25                              | 603894                             | 5120716 | 974   |
| R-136    | Residential Non-Participant      | 35                              | 607753                             | 5114434 | 972   |
| R-137    | Residential Non-Participant      | 29                              | 596075                             | 5106566 | 937   |
| R-138    | Residential Non-Participant      | 29                              | 595936                             | 5106648 | 944   |
| R-139    | Residential Non-Participant      | 29                              | 596205                             | 5104411 | 925   |
| R-140    | Residential Non-Participant      | 40                              | 613058                             | 5108413 | 918   |
| R-141    | Residential Non-Participant      | 36                              | 603495                             | 5106574 | 989   |
| R-143    | Residential Participant          | 32                              | 598695                             | 5104987 | 932   |
| R-144    | Residential Participant          | 36                              | 606584                             | 5120958 | 962   |
| R-146    | Residential Non-Participant      | 38                              | 603386                             | 5106732 | 999   |
| R-147    | Residential Non-Participant      | 38                              | 609152                             | 5101701 | 928   |
| R-148    | Pending Participant <sup>7</sup> | 47                              | 600142                             | 5109806 | 952   |
| C-1      | Church                           | 41                              | 603470                             | 5103451 | 974   |
| C-2      | School                           | 25                              | 604273                             | 5120933 | 983   |
| C-3      | School                           | 25                              | 604275                             | 5120888 | 984   |
| C-4      | School                           | 25                              | 604206                             | 5120889 | 982   |
| C-5      | School                           | 25                              | 604269                             | 5120952 | 983   |
| C-6      | School                           | 25                              | 604306                             | 5120948 | 984   |
| C-7      | School                           | 24                              | 604161                             | 5120915 | 981   |

<sup>7</sup> This residence is a pending participant and currently in the process of executing administrative documents for a participation agreement. Should this landowner not sign, Turbine 41 would not be constructed and the resulting sound level would be 44 dBA  $L_{eq}$ .



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