Appendix D Rev.1

Updated Preliminary Noise Compliance Assessment Report

Three Waters Wind Farm, LLC
Docket No. IP-7002/WS-19-576
February 10, 2020

PUBLIC DOCUMENT – NONPUBLIC DATA HAS BEEN EXCISED

RSG
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THREE WATERS WIND FARM, LLC

THREE WATERS WIND PROJECT

Updated Preliminary Noise Compliance Assessment | February 4, 2020

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Three Waters Wind Farm, LLC
THREE WATERS WIND PROJECT

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Three Waters Wind Farm, LLC submitted a Certificate of Need (CN) and Site Permit Application (SPA) to the Minnesota Public Utilities Commission (PUC) to build a wind power generation facility in Jackson County, Minnesota. The Three Waters Wind Project (Project) will involve the construction of up to 71 wind turbines in Minnesota for a rating of up to 201 MW in Minnesota. The Project will also involve additional wind turbines in Osceola and Dickinson Counties in Iowa. The turbines will be installed in an area southwest of Lakefield between and in the vicinity of Interstate 90 (I-90) and the Iowa Border with additional turbines south of the Iowa Border within four miles of the border. From east to west, the Project area in Minnesota lies between 440th Avenue and 320th Avenue.

RSG completed a preliminary noise compliance assessment on October 3, 2019 which was submitted as part of the September 30, 2019 SPA filing. This is an updated version of that report which includes updated sound propagation model results. The updated modeling results reflect changes in the wind turbine options that were made to address initial Minnesota PUC and Department of Commerce comments as part of the completeness determination of the CN and SPA documents in December 2019.

Included in this updated report are:

- A description of the Project;
- A discussion of applicable sound level standards;
- A discussion of sound issues that are particular to wind farms;
- Background sound level monitoring procedure and results;
- Sound propagation modeling procedures and results; and
- Conclusions.

Appendix A includes a primer on the science of sound, including descriptions of some of the acoustical terms used in this report.

The only sections of this report that have been updated include:

- Section 1.0 – Introduction;
- Section 6.0 – Sound Propagation Modeling;
- Section 7.0 – Conclusions;
- Appendix B – Model Input Data; and
- Appendix C – Receiver Information.

2.0 PROJECT DESCRIPTION

The overall Three Waters Wind Project will be located in Jackson County, Minnesota, and Osceola and Dickinson Counties in Iowa. The northern extent of the Project area is generally I-90, although one proposed turbine lies north of I-90. The southern extent of the Project in Minnesota is the Iowa border, but the Project extends into Iowa by up to 5.6 kilometers (3.5 miles). The eastern extent of the Project area is 440th Avenue in Minnesota and 190th Avenue in Iowa. The western extent is 350th Avenue north of Round Lake, 320th Avenue south of Round Lake, and White Avenue in Iowa.

The Project is designed to included up to 71 primary wind turbines in Minnesota and additional wind turbines in Iowa, but this assessment addresses a total of 79 turbines in Minnesota and 49 turbines in Iowa, accounting for all primary and alternate locations. The current turbine model under consideration and modeled in this report is the GE 2.82-127 (2.82 MW) with a hub height of 89 meters (292 feet).

The area around the Project is composed primarily of agricultural land uses (primarily corn and soybean with some livestock operations) with farm residences. Terrain in the area is mostly flat. Round Lake (the lake) is located west of the Project and is approximately 2.4 kilometers (1.5 mile) from the closest proposed turbine. Round Lake (the city) is located a little further west and is approximately 3.2 kilometers (2 miles) from the nearest proposed turbine.

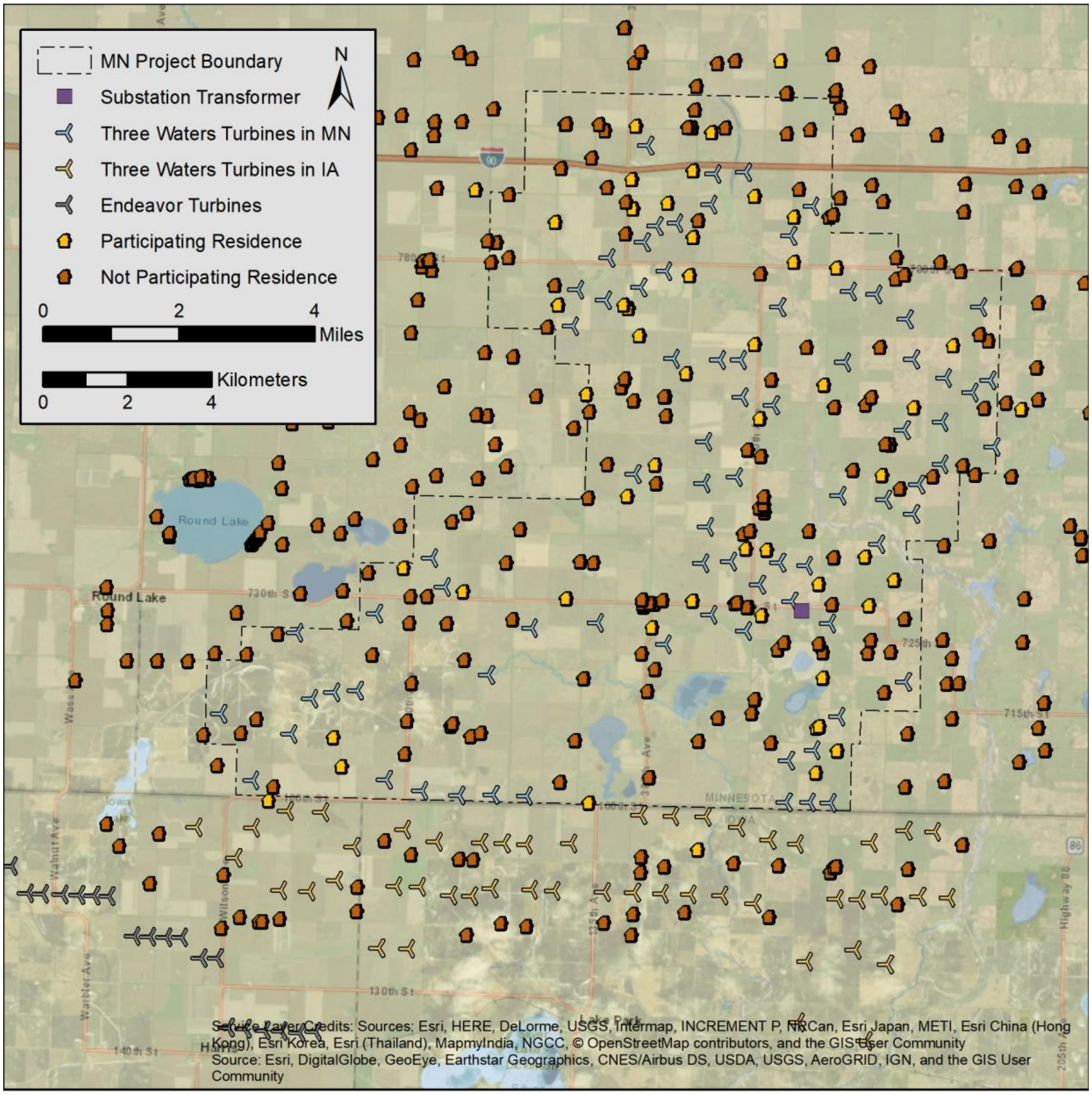

FIGURE 1: PROJECT SITE MAP

3.0 SOUND LEVEL STANDARDS & GUIDELINES

3.1 LOCAL STANDARDS

Jackson County addresses noise from wind turbines in Section 734.6 of the Jackson County Zoning Ordinance, which states:

> *Noise is regulated by the Minnesota Pollution Control Agency under Chapter 7030. These rules establish the maximum night and daytime noise levels that effectively limit wind turbine noise to 50-dB (A) at farm residences. In addition the County may impose limits relative to impulsive and pure tone noises.*

3.2 STATE STANDARDS

Minnesota Statute §116.07 charges the Pollution Control Agency with adopting noise standards. These standards are set in Minnesota Rules Chapter 7030, for which a wind power project must demonstrate it will comply with to receive a site permit from the PUC. The rule provides daytime and nighttime[1] sound level limits (Table 1) for a variety of land uses, which are grouped into three categories identified by a Noise Area Classification (NAC). The sensitive land uses around the Project are primarily within NAC 1 which includes residences including farmhouses and contain the most restrictive sound limits.

TABLE 1: SOUND LEVEL LIMITS (dBA) FROM MN RULES 7030.0040

NOISE AREA CLASSIFICATION	DAYTIME		NIGHTTIME	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

The Rule says that the limits are for the "…preservation of public health and welfare" and that they are "…consistent with speech, sleep, annoyance, and hearing conservation requirements…", but that they "…do not, by themselves, identify the limiting levels of impulsive noise[2] needed for the preservation of public health and welfare."

[1] MN Rules 7030.0020 define daytime as 7:00 a.m. to 10:00 p.m. and nighttime as 10:00 p.m. to 7:00 a.m.
[2] Impulsive noise is defined in Minnesota Rules Chapter 7030.0020. Typical, wind turbine sound at the distance of a residential receiver is not considered impulsive.

4.0 WIND TURBINE ACOUSTICS – SPECIAL CONSIDERATIONS

4.1 SOURCES OF SOUND GENERATION BY WIND TURBINES

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

Aerodynamic sound is the primary source of sound associated with wind turbines. These acoustic emissions can be either tonal or broadband. Tonal sound occurs at discrete frequencies, whereas broadband sound is distributed with little peaking across the frequency spectrum. While unusual, tonal sound can also originate from unstable air flows over holes, slits, or blunt trailing edges on blades. The majority of audible aerodynamic sound from wind turbines is broadband at the middle frequencies, roughly between 200 Hz and 1,000 Hz.

Wind turbines emit aerodynamic broadband sound as the rotating blades interact with atmospheric turbulence and as air flows along their surfaces. This produces a characteristic “whooshing” sound through several mechanisms (Figure 2):

- Inflow turbulence sound 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 sound that varies across a wide range of frequencies but is most significant at frequencies below 500 Hz.
- Trailing edge sound is produced as boundary-layer turbulence as the air passes into the wake, or trailing edge, of the blade. This sound is distributed across a wide frequency range but is most notable at high frequencies between 700 Hz and 2 kHz.
- Tip vortex sound 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 sound further away.
- Stall or separation sound occurs due to the interaction of turbulence with the blade surface.

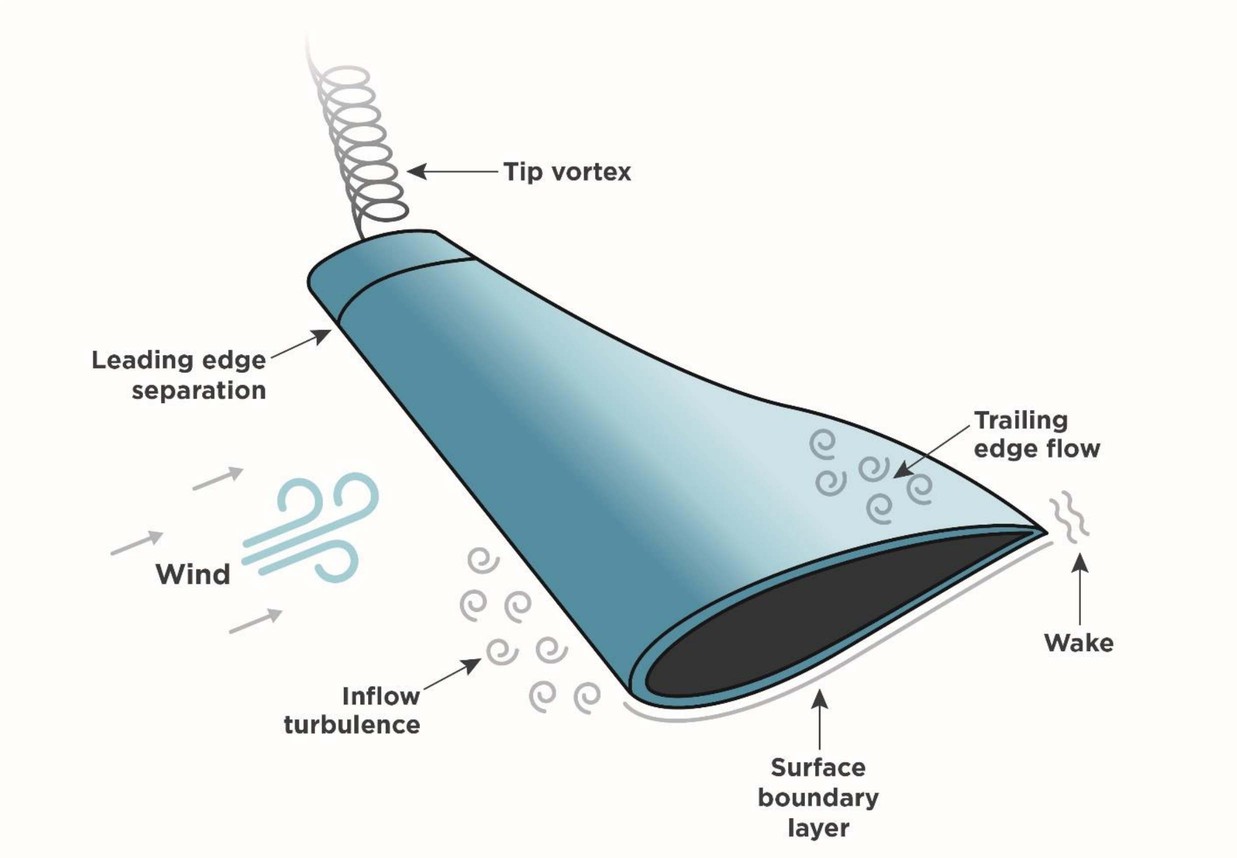

FIGURE 2: AIRFLOW AROUND A ROTOR BLADE

Mechanical sound from machinery inside the nacelle tends to be tonal in nature but can also have a broadband component. Potential sources of mechanical sound 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 sound. However modern wind turbines have nacelles that are designed to reduce the transmission of internal sound, and rarely is this a significant portion of the total wind turbine sound.

4.2 AMPLITUDE MODULATION

Amplitude modulation (AM) is a fluctuation in sound level that occurs at the blade passage frequency. There is no consistent definition how much of a sound level fluctuation is necessary for blade swish to be considered AM. Fluctuations in individual 1/3 octave bands are typically greater. Fluctuations in individual 1/3 octave bands can sometimes synchronize and desynchronize over periods, leading to increases and decreases in magnitude of the A-weighted fluctuations. Similarly, in wind farms with multiple turbines, fluctuations can synchronize and desynchronize, leading to variations in amplitude modulation depth.[3] Most

[3] McCunney, Robert, et al. "Wind Turbines and Health: A Critical Review of the Scientific Literature." *Journal of Occupational and Environmental Medicine.* 56(11) November 2014: pp. e108-e130.

amplitude modulation is in the mid-frequencies and most overall A-weighted AM is less than 4.5 dB in depth.[4]

There are many confirmed and hypothesized causes of amplitude modulation including: blade passage in front of the tower, blade tip sound emission directivity, wind shear, inflow turbulence, transient blade stall, and turbine blade yaw error. It has recently been noted that although wind shear can contribute to the extent of amplitude modulation, wind shear does not contribute to the existence of amplitude modulation in and of itself. Instead, there needs to be detachment of airflow from the blades for wind shear to contribute to amplitude modulation.[5] While factors like the blade passing in front of the tower are intrinsic to wind turbine design, other factors vary with turbine design, local meteorology, topography, and turbine layout. Mountainous areas, for example, are more likely to have turbulent airflow, less likely to have high wind shear, and less likely to have turbine layouts that allow for blade passage synchronization for multiple turbines. Amplitude modulation extent varies with the relative location of a receptor to the turbine. Amplitude Modulation is usually experienced most when the receptor is between 45 and 60 degrees from the downwind or upwind position and is experienced least directly with the receptor directly upwind or downwind of the turbines.

4.3 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 3).

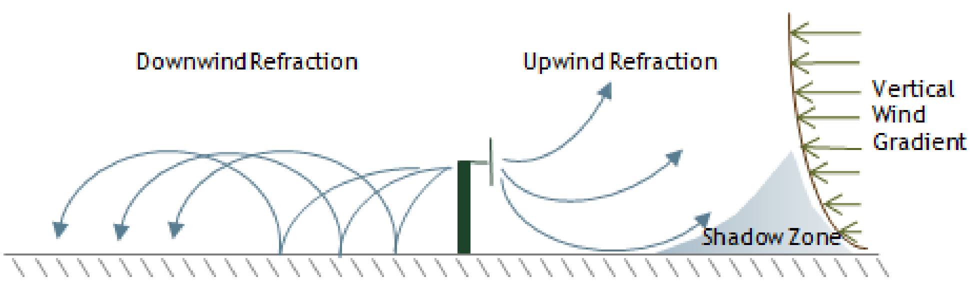

FIGURE 3: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)

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).

[4] RSG, et al., “Massachusetts Study on Wind Turbine Acoustics,” Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016

[5] “Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect.” *RenewableUK.* December 2013.

High winds and/or 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.

4.4 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 sound at downwind receptors because the frequency spectrum from wind is very similar to the frequency spectrum from a wind turbine. Figure 4 compares the shape of the sound spectrum measured during a 5 m/s wind event at the Project site to that of a GE 2.82-127 wind turbine. As shown, the shapes of the spectra are very similar. At higher frequencies, the sounds from the masking wind sound are higher than the wind turbine. As a result, the masking of turbine sound occurs at higher wind speeds for some meteorological conditions. Masking will occur most, when ground wind speeds are relatively high, creating wind-caused sound such as wind blowing through the trees and interaction of wind with structures.

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.

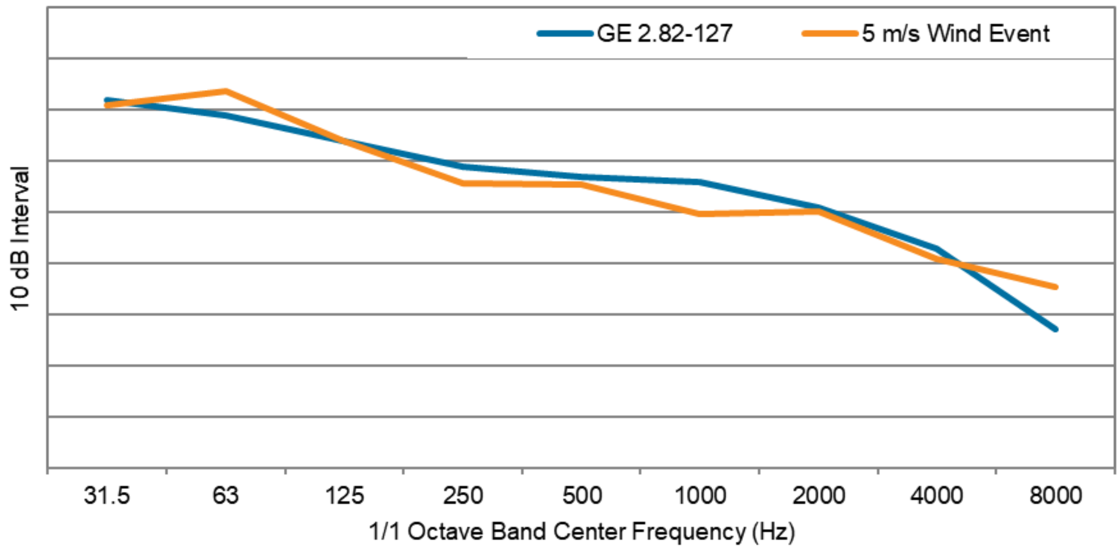

FIGURE 4: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM THE WIND AND THE GE 2.82-127[6]

4.5 INFRASOUND AND LOW FREQUENCY SOUND

Infrasound is sound pressure fluctuations at frequencies below about 20 Hz. Sound below this frequency is only audible at very high magnitudes. Low frequency sound is in the audible range of human hearing, that is, above 20 Hz, but below 100 to 200 Hz depending on the definition.

Low frequency aerodynamic tonal sound is typically associated with downwind rotors on horizontal axis wind turbines. In this configuration, the rotor plane is behind the tower relative to the oncoming wind. As the turbine blades rotate, each blade crosses behind the tower's aerodynamic wake and experiences brief load fluctuations. This causes short, low-frequency pulses or thumping sounds. Large modern wind turbines are "upwind", where the rotor plane is upwind of the tower. As a result, this type of low frequency sound is at a much lower magnitude with upwind turbines than downwind turbines, well below established infrasonic hearing thresholds.

Figure 5 shows the sound levels 350 meters (1,148 feet) from a wind turbine when the wind turbine was operating (T-on) and shut down (T-off) for wind speeds at hub height greater than 9 m/s. Measurements were made over approximately two weeks.[7] The red 90 dBG line is shown here as the ISO 7196:1995 perceptibility threshold. As shown, the wind turbines generated measurable infrasound, but at least 20 dB below audibility thresholds.

[6] 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.
[7] RSG, et al., "Massachusetts Study on Wind Turbine Acoustics," Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016 – Graphic from RSG presentation to MassDEP WNTAG, March, 2016

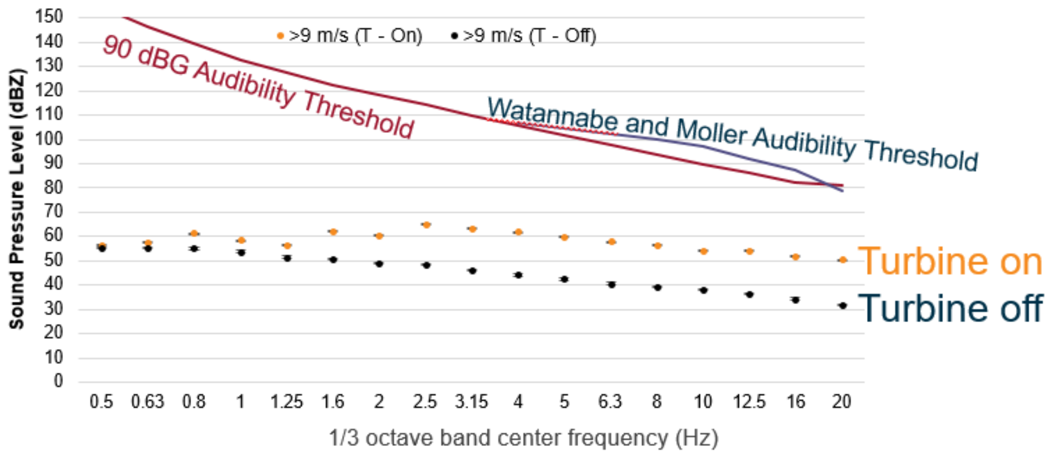

FIGURE 5: INFRASOUND FROM A WIND TURBINE AT 350 METERS (1,148 FEET) COMPARED WITH PERCEPTION THESHOLDS

Low frequency sound is primarily generated by the generator and mechanical components. Much of the mechanical sound has been reduced in modern wind turbines through improved sound insulation at the hub. Low frequency sound can also be generated by the blades at higher wind speeds when the inflow air is very turbulent. However, at these wind speeds, low frequency sound from the wind turbine blades is often masked by wind sound at the downwind receptors.

Finally, low frequency sound is absorbed less by the atmosphere and ground than higher frequency sound. Our modeling takes into account frequency-specific ground attenuation and atmospheric absorption factors that takes this into account.

4.6 USE OF SOUND LEVEL WEIGHTING NETWORKS FOR WIND TURBINE SOUND

The human ear is not equally sensitive to sound pressure levels at all frequencies and magnitudes. Some frequencies, despite being the same decibel level (that is, magnitude), seem louder than others. For example, a 500 Hz tone at 80 dB will sound louder than a 63 Hz tone at the same level. In addition, the relative loudness of these tones will change with magnitude. For example, the perceived difference in loudness between those two tones is less when both are at 110 dB than when they are at 40 dB.

To account for the difference in the perceived loudness of a sound by frequency and magnitude, acousticians apply frequency weightings to sound levels. The most common weighting scale used in environmental noise analysis is the “A-weighting”, which represents the sensitivity of the human ear at lower sound pressure levels. The A-weighting is the most appropriate weighting when overall sound pressure levels are relatively low (up to about 70 dBA). The A-weighting de-emphasizes sounds at lower and very high frequencies, since the human ear is insensitive to sound at these frequencies at low magnitude. The A-weighting is indicated by “dBA” or “dB(A)”.

At higher sound pressure levels (greater than approximately 70 dBA), a different weighting must be used since human hearing sensitivity does not change as much with frequency. The “C-weighting” mimics the sensitivity of the human ear for these moderate to higher sound levels (greater than approximately 70 dBA, which is higher ground-based sound levels produced by wind power projects). C-weighted sound levels are indicated by “dBC” or “dB(C)”.

The “Z-weighting” does not emphasize or de-emphasize sound at any frequency. “Z” weighted sound levels are sometimes labeled as “Flat” or “Linear”. The difference is that the “Z-weighting” is defined as being unweighted in a specific range, whereas “Flat” or “Linear” indicate that no weighting has been used. Z-weighting or unweighted levels are typically used when reporting sound levels at individual octave bands.

The most appropriate weighting for wind turbine sound is A-weighting, for two reasons. The first is that sound pressure levels due to wind turbine sound are typically in the appropriate range for the A-weighting at typical receiver distances (50 dBA or less). The second is that various studies of wind turbine acoustics have shown that the potential effects of wind turbine noise on people are correlated with A-weighted sound level (i.e. Pedersen et al, 2008[8]) as well as to the perceived loudness of wind turbine sound.[9,10] Other researchers found that 51% of the energy making up a C-weighted measurement of wind turbine sound is not audible. Thus, it is more difficult to relate the level of C-weighted sound to human perception. That is, two sounds may be perceived exactly alike, but there could be significant variations in the C-weighted sound level depending on the content of inaudible sound in each.[4]

[8] Pedersen, Eja and Waye, Kerstin. “Perception and annoyance due to wind turbine noise - a dose-response relation.” Journal of the Acoustical Society of America. 116(6). pp. 3460-3470.
[9] Yokoyama S., et al. “Perception of low frequency components in wind turbine noise.” Noise Control Engr. J. 62(5) 2014
[10] Yokoyama et al. “Loudness evaluation of general environmental noise containing low frequency components.” Proceedings of InterNoise2013, 2013

5.0 SOUND LEVEL MONITORING

5.1 MONITORING PROCEDURES

Background sound level monitoring was conducted throughout the Project area to quantify the existing sound levels, including the nighttime L_{50}, and to identify existing sources of sound. Monitoring locations were selected per the guidance provided in the Department of Commerce's "Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report," October 2012 and after the release of the July 2019 guidance, by the same name, RSG confirmed that the monitor locations still fit the guidance. The guidance recommends a minimum of three locations within the Project area. For this Project there were a total of five onsite and two offsite monitor locations. The guidance also recommends that one monitor location be in proximity to the worst-case modeled receptor. Based on the preliminary layout for the Project, Monitor C was selected being representative of the worst-case modeled area. A map of all the monitor locations is provided in Figure 6, and each monitor location is described further in Section 5.2.

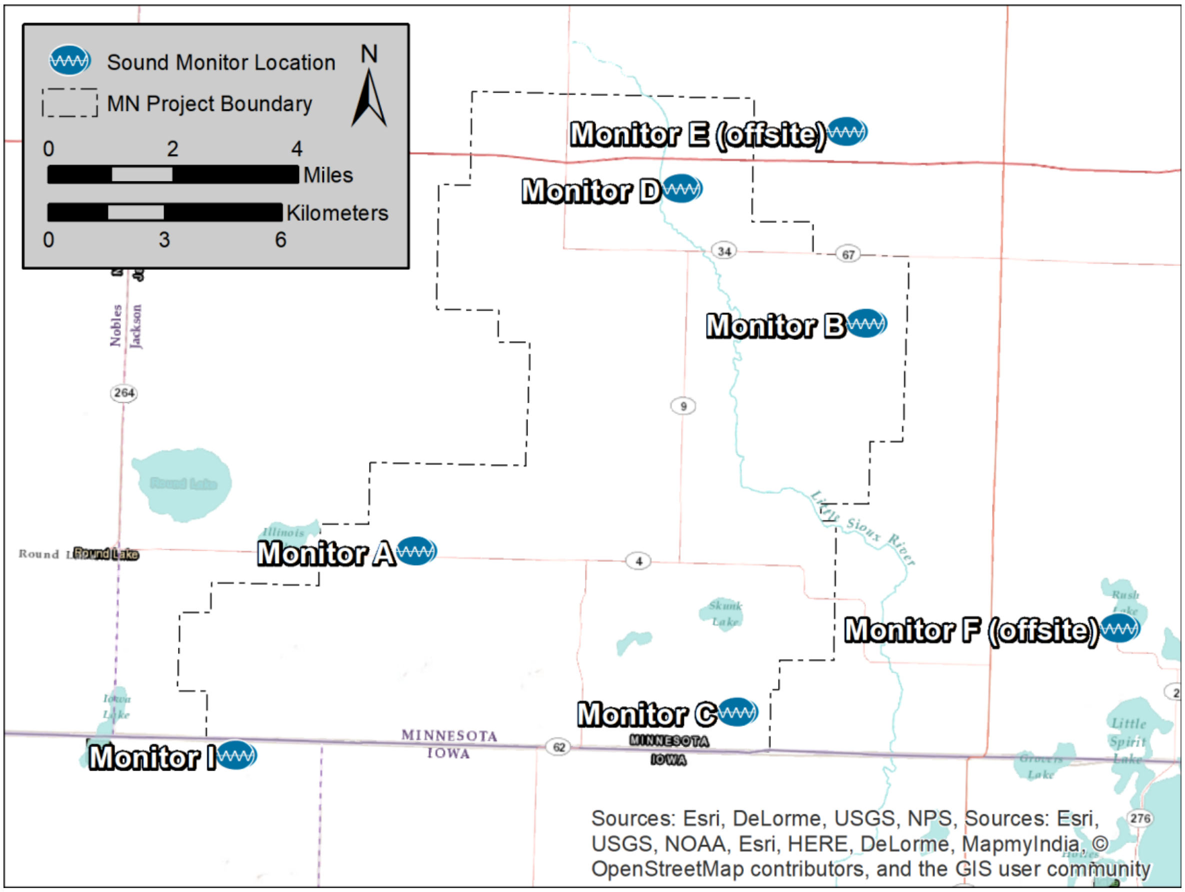

FIGURE 6: MAP OF BACKGROUND SOUND MONITOR LOCATIONS

Equipment

Background sound level monitoring was performed with ANSI/IEC Class 1 Cesva SC310 and Cirrus CR:171B sound level meters with a minimum frequency range of 20 Hz to 10 kHz. Meters were set to log, at a minimum, 1/3 octave band sound levels once each second for the entire measurement period. Sound level meter microphones were mounted on wooden stakes at a height of approximately 1.5 meters (5 feet) and covered with 180 mm (7 inch) windscreens to minimize the impact of wind-caused distortion on measurements. The sound level meters were connected to Edirol audio recorders, recording audio data at a minimum resolution of 96 kbps in .mp3 format. Before and after the measurement periods, the meters were calibrated with a B&K 4231 calibrator. The monitoring equipment meets LWECS Guidance.

A list of the equipment used at each monitor is shown in Table 2. At each site, an ONSET anemometer was located at microphone height. At Monitor B and Monitor C, a wind direction sensor was also included in the setup. The offsite Monitor E location also logged temperature and relative humidity. Wind data was logged at a rate of once each minute and regional precipitation periods were collected from KMJQ in Jackson, MN.

TABLE 2: SOUND MONITOR EQUIPMENT SPECIFICATIONS BY SITE

Monitor Location	Sound Level Meter	1/3 Octave Band Frequency Range	Audio Recorder	Weather Station
Monitor A	Cirrus CR: 171B	6.3 Hz-20 kHz	Edirol R-09HR	ONSET HOBO Wind Speed Sensor
Monitor B	Cesva SC310	10 Hz - 20kHz	Edirol R-05	ONSET HOBO Wind Speed Sensor and Directional Sensors
Monitor C	Cesva SC310	10 Hz - 20kHz	Edirol R-09HR	ONSET HOBO Wind Speed and Direction Sensors
Monitor D	Cesva SC310	10 Hz - 20kHz	Edirol R-05	ONSET HOBO Wind Speed Sensor
Monitor I[11]	Cesva SC310	10 Hz - 20kHz	Edirol R-05	ONSET HOBO Wind Speed Sensor
Offsite E	Cesva SC310	20 Hz - 10kHz	Edirol R-05	ONSET HOBO Wind Speed, Temperature, and Humidity,Sensors
Offsite F	Cirrus CR: 171B	6.3 Hz-20 kHz	Edirol R-05	ONSET HOBO Wind Speed Sensor

Data Processing

For each period A-, C-, and Z-weighted equivalent average sound levels (L_{EQ}) were calculated. For A- and C-weighted sound levels, the L_{10}, L_{50}, and L_{90} statistical sound levels were also calculated.

A second set of data was also generated with periods removed from the data that either contained anomalous sound events or periods with conditions that could lead to false sound level readings.

Periods that were removed from the sound level data included:

[11] Monitors A through D and Offsite E and F were located in Minnesota. Monitor I was denoted with an “I” because it was located in Iowa. There were no Monitors G and H.

- Wind speeds above 11 mph (5 m/s),
- Precipitation and thunderstorm events, and
- Personnel and animal interaction with equipment.

5.2 MONITOR LOCATION DESCRIPTIONS

Monitor A

Monitor A was located adjacent to an annual vegetable garden at an unoccupied homestead on the western side of the Project area. The monitor was located 110 meters (360 feet) north of 730th Street and 1.2 kilometers (3/4 mile) east of 350th Avenue on a parcel that is 5 kilometers (3.1 miles) east of Round Lake and 8.5 kilometers (5.3 miles) east of the City of Round Lake, MN. Like other homes in the area, the homestead is surrounded by large cultivated fields. A picture of the monitor setup is provided in Figure 7, and a map of the surrounding area is shown in Figure 8.

FIGURE 7: PICTURE OF THE MONITORING SETUP AT MONITOR A

FIGURE 8: AERIAL VIEW OF MONITOR A AND THE SURROUNDING AREA

Monitor B

Monitor B was located on the outskirts of a homestead in the northeastern quadrant of the Project area. The monitor, located between an agricultural field and a line of trees, was placed 160 meters (525 feet) south of 770th Street and 205 meters (670 feet) west of 430th Ave. Interstate 90 is 4.1 kilometers (2.5 miles) north of the monitoring location. The surrounding parcels and fields were actively growing corn and soybeans. Additionally, a hog house is located 455 meters (1,500 feet) to the northwest of the monitoring location. The parcel is located about 8 kilometers (5 miles) south of the town of Lakefield, MN. A picture of the monitor setup is provided in Figure 9, and a map of the surrounding area is shown in Figure 10.

FIGURE 9: PICTURE OF THE MONITORING SETUP AT MONITOR B

FIGURE 10: AERIAL VIEW OF MONITOR B AND THE SURROUNDING AREA

Monitor C

Monitor C was located within an arboreal windbreak on the north side of a homestead and working farm complex in the southeastern quadrant of the Project area. The monitor was located 600 meters (2,150 feet) south of 710th Street and 75 meters (250 feet) west of 440th Avenue, the latter of which appeared to mostly be an access drive for this residence/farm operation. This location is one kilometer north of the Iowa/Minnesota border and 7.6 kilometers (4.75 miles) northeast of Lake Park, IA. The surrounding areas are typical of the area, almost entirely fields in agricultural production with scattered homesteads surrounded by trees to the north and west. A picture of the monitor setup is provided in Figure 11, and a map of the surrounding area is shown in Figure 12.

FIGURE 11: PICTURE OF THE MONITORING SETUP AT MONITOR C

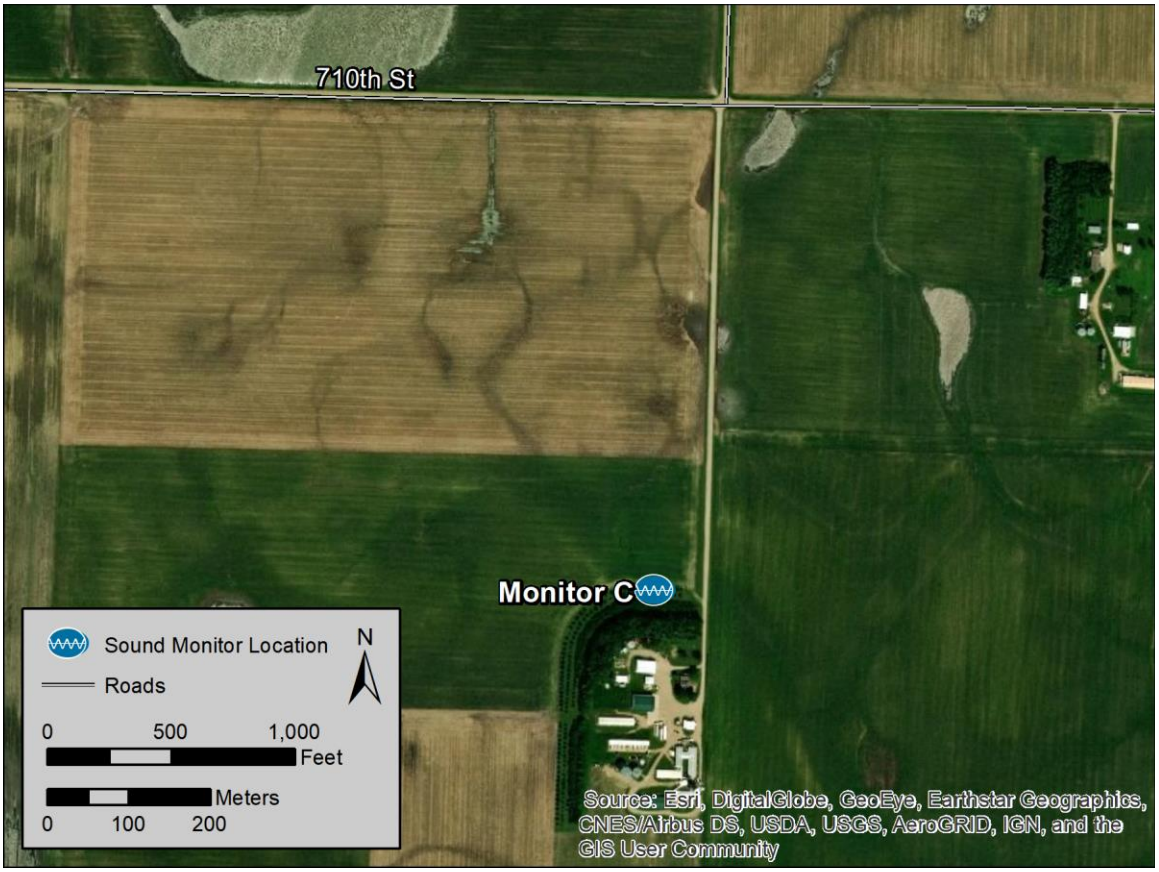

FIGURE 12: AERIAL VIEW OF MONITOR C AND THE SURROUNDING AREA

Monitor D

Monitor D, in the northernmost section of the Project, was located adjacent to a garden at a homestead. On the north side of the parcel were several paddocks of sheep. The monitor was 12 meters (40 feet) north of 790th Street, 265 meters west of 400th Avenue, and 725 meters (2,375 feet) south of Interstate 90. The parcel is 9.5 kilometers (5.9 miles) southwest of the Town of Lakefield, MN and 23 kilometers (14.4 miles) west of Worthington, MN. A map of the surrounding area is shown in Figure 13, and a picture of the monitor setup is provided in Figure 14.

FIGURE 13: PICTURE OF THE MONITORING SETUP AT MONITOR D

FIGURE 14: AERIAL VIEW OF MONITOR D AND THE SURROUNDING AREA

Monitor E (Offsite)

Monitor E was located in an arboreal wind break between the barn and the road on a parcel north of the Project area. The parcel is located outside of the Project boundary. The monitor was placed 30 meters (100 feet) south of 800th Street and 800 meters (2,625 feet) north of Interstate 90. The surrounding parcels are comprised of agricultural fields in production with homesteads dispersed throughout. The parcel is 5 km (3.1 miles) southwest of Lakefield, MN, and 18.5 kilometers (11.6 miles) west of Jackson, MN. A picture of the monitor setup is provided in Figure 15, and a map of the surrounding area is shown in Figure 16.

FIGURE 15: PICTURE OF THE MONITORING SETUP AT OFFSITE MONITOR E

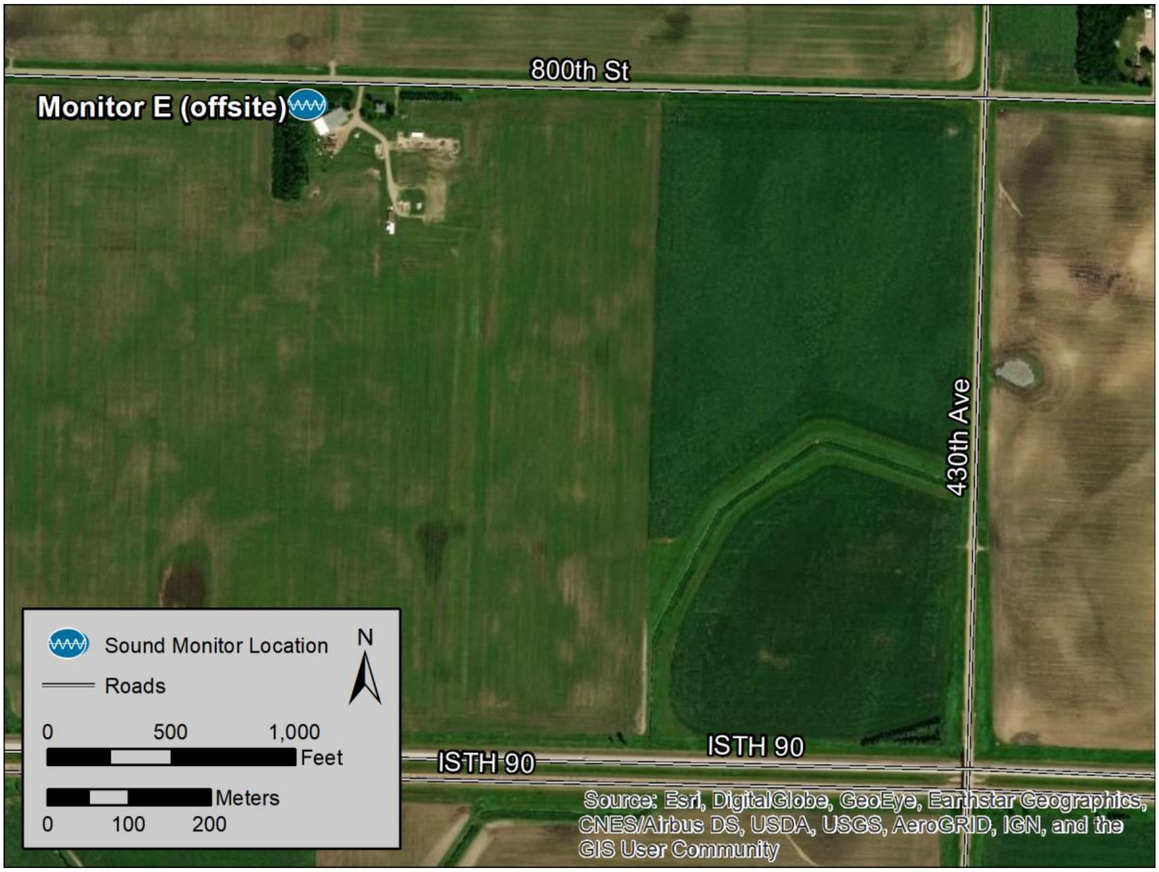

FIGURE 16: AERIAL VIEW OF OFFSITE MONITOR E AND THE SURROUNDING AREA

Monitor F (Offsite)

Monitor F was located on the fence line between two agricultural fields to the east of the Project. Rush Lake bordered the parcels to the north, whose closest point is 160 meters (525 feet) north of the sound monitoring locations. The closest homestead to the monitoring location is 275 meters (900 feet) to the northwest. The monitor was placed 800 meters (2,625 feet) east of 465th Avenue and was 210 meters (690 feet) north-northeast of a ninety-degree bend in 720th Street. Loon Lake, which is used for recreation, is located 2.1 kilometers (1.3 miles) directly east of the monitoring location. A picture of the monitor setup is provided in Figure 17, and a map of the surrounding area is shown in Figure 18.

FIGURE 17: PICTURE OF THE MONITORING SETUP AT OFFSITE MONITOR F

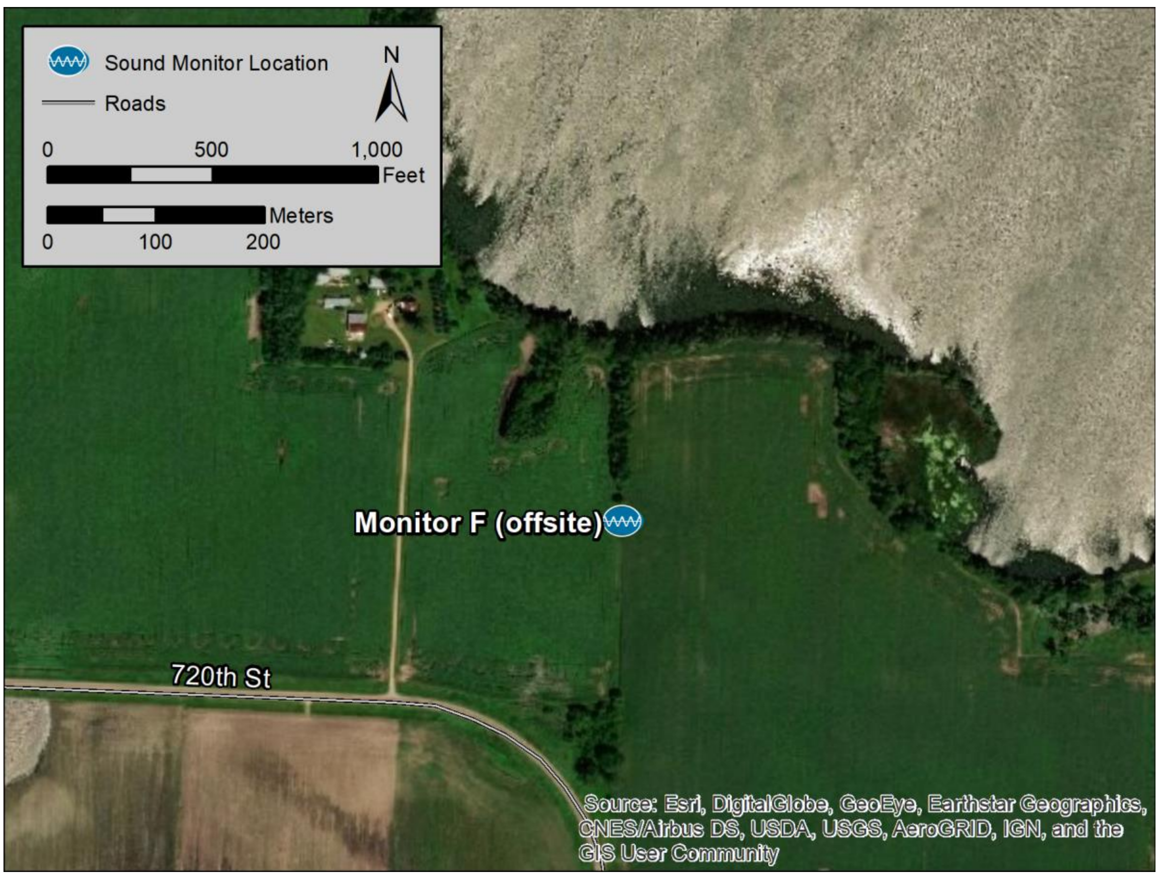

FIGURE 18: AERIAL VIEW OF OFFSITE MONITOR F AND THE SURROUNDING AREA

Monitor I

Monitor I was located on a homestead in Iowa that contained some farming infrastructure at the southern end of the Project. The monitor was placed 60 meters (198 feet) south of 700th street, which is also the Minnesota/Iowa border. The monitoring location is 950 meters (3,117 feet) east of Wilson Avenue. The surrounding landscape is dominated by agricultural fields. The closest town, Round Lake, MN, is located 5.75 kilometers (3.57 miles) north of the parcel. A picture of the monitor setup is provided in Figure 19, and a map of the surrounding area is shown in Figure 20.

FIGURE 19: PICTURE OF THE MONITORING SETUP AT MONITOR I

FIGURE 20: AERIAL VIEW OF MONITOR I AND THE SURROUNDING AREA

5.3 MONITORING RESULTS

For each monitor site, sound level time-history monitoring results are presented in a single chart in this report section. Each chart contains hourly sound levels, gust wind speed measured adjacent to each microphone, "hub height" average wind speed, precipitation events, and indications of data exclusions in conformance with LWECS Guidance. Points on the sound level graph represent data summarized for a single one-hour interval. The top portion of the chart displays A-weighted sound levels, the middle portion presents C-weighted levels, and the bottom portion shows wind speeds and times when there were data exclusions. All portions of the chart indicate day/night by shading: night is defined as 22:00 to 07:00 and shaded in grey.

The specific sound level metrics reported are L_{EQ}, L_{90}, L_{50}, and L_{10}. Equivalent continuous sound levels (L_{EQ}) are the energy-average level over one hour. Tenth-percentile sound levels (L_{90}) are the statistical value above which 90% of the sound levels occurred during one hour. Fiftieth-percentile sound levels (L_{50}) represent the median sound level of that one-hour period. Ninetieth-percentile sound levels (L_{10}) are the statistical value above which 10% of the sound levels occurred during one hour. Data that were excluded from processing (e.g., due to high wind and rain periods) are included in the graphs but shown in lighter colors. Furthermore, rectangular markers on the lower portion of the chart indicate periods for which data was excluded and designate if the period was eliminated as a result of rain, wind gusts over 11 mph, or anomalous events.

Sound level data and wind gust data presented in the charts are those measured at each corresponding site. Wind data from the monitoring location, measured at the microphone height of 1.5 meters (5 feet), are presented as the maximum gust speed occurring at any time over a 10-minute interval; they are not averaged. The average 10-minute hub height wind speed extrapolated from the Project met-tower closest to the monitoring location is also displayed on the chart. Lastly, regional one-hour precipitation totals, as reported by KMJQ, are plotted with respect to the secondary axis on the right-hand side of the chart. Note that the precipitation may not line up exactly with precipitation exclusions because the airport is between 19 and 38 kilometers (11.8 and 23.6 miles) from the monitoring locations.

Lastly, one-third octave band statistical sound level results are also presented for periods when a representative wind speed (9 m/s) existed at a representative hub height of 89 meters (292 feet). This condition reflects the experienced wind conditions that would result in turbines producing near maximum sound power (9 m/s wind speed or greater). This condition reflects wind conditions that would result in turbines producing maximum sound power. Only periods with this representative wind speed were used for the unweighted statistical one-third octave band metrics in the figures, providing a baseline for direct comparison with post-construction measurements. Each vertical orange and grey bar shows the Lower 10th, median, and Upper 10th percentile L_{90}, L_{50}, and L_{10}) sound level for a single 1/3 octave band. The top of the orange bar is the Upper 10th percentile sound pressure level, the white dot is the median, and the bottom of the grey bar is the lower 10th percentile sound level. The entire length of the bar indicates the middle 80th percentile of sound pressure levels. The blue dots indicate the equivalent average sound pressure level (L_{EQ}) for that 1/3 octave band. At the far right of the chart are the A-, C-, and Z-weighted overall levels.

Results Summary

Exclusion Periods

Periods were excluded at each monitor through both manual identification and automated processing. Manual processing included the review of spectrograms created from the measured one-second one-third octave band data, accompanied by audio recordings made through the sound level meter's microphone. In this way, typical sources and anomalous events were identified.

Exact rain periods were manually identified from the spectrogram to ensure that data during rain events at each monitor were excluded. Automated processing of wind speed permitted the identification of gusts above 5 m/s (11.2 mph) on a one-minute basis. That is, if a gust within a specific one-minute period was measured above 5 m/s (11.2 mph), then that whole minute was eliminated.

A summary of each monitor's total runtime and the amount of time excluded from the reported sound levels for rain, wind, and anomalous events are shown in Table 3.

TABLE 3: SUMMARY OF EXCLUSION PERIODS AT EACH MONITOR

Location	Run-Time	Exclusion Statistics							
		Rain		Wind		Anomalies		Total	
	(hr)	(hr)	(%)	(hr)	(%)	(hr)	(%)	(hr)	(%)
A	189	23.0	12.2	17.9	9.5	3.8	0.5	44.7	23.6
B	178	20.9	11.8	4.0	2.2	2.7	1.5	27.6	15.5
C	191	21.8	11.4	0.9	0.5	10.5	5.5	33.2	17.4
D	177	21.2	12.0	9.1	5.1	9.3	5.3	39.6	22.4
I	194	24.2	12.5	6.8	3.5	3.9	2.0	34.9	18.0
Offsite E	172	22.8	13.3	1.5	0.8	5.3	3.1	29.6	17.2
Offsite F	189	24.3	12.8	24.0	12.7	5.9	3.1	54.3	28.7

Overall Sound Levels

The A-weighted sound levels are listed for all seven sites in Table 4, and the C-weighted sound levels are listed Table 5. The reported levels represent all valid periods, that is, all periods that were not excluded due to weather or anomalous activity, as discussed in the previous section. In both tables, the equivalent continuous levels (L_{EQ}) at night are less than (or equal to) daytime levels at all sites, which is typical and indicate the influence of human activity on the measured sound levels during the day. For some locations, the large difference between L_{EQ} and 10th-percentile levels (L_{90}) indicate that the soundscapes are often dominated by transient or intermittent sounds (such as aircraft overflights or passing automobiles).

TABLE 4: PRECONSTRUCTION MONITORING SUMMARY (A-WEIGHTED RESULTS)

Location	Sound Levels (dBA)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Onsite A	42	26	34	44	43	30	37	45	42	25	31	43
Onsite B	41	27	32	41	41	29	34	42	39	25	29	38
Onsite C	41	30	36	43	41	31	37	44	40	29	35	42
Onsite D	44	29	40	47	45	36	41	47	43	27	34	46
Onsite I	43	26	38	46	44	31	40	46	43	23	33	46
Onsite Average	*43*	*28*	*37*	*45*	*43*	*32*	*38*	*45*	*41*	*26*	*33*	*44*
Offsite E	46	29	38	46	46	31	39	46	45	28	37	46
Offsite F	39	27	32	38	41	28	33	40	36	26	31	37

TABLE 5: PRECONSTRUCTION MONITORING SUMMARY (C-WEIGHTED RESULTS)

Location	Sound Levels (dBC)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Onsite A	55	46	50	56	56	46	50	58	53	46	49	54
Onsite B	51	45	48	52	51	46	49	53	49	44	47	51
Onsite C	54	48	51	54	55	47	51	55	51	49	51	52
Onsite D	56	48	53	59	58	50	54	60	54	47	51	56
Onsite I	55	44	50	56	55	44	50	57	53	43	50	55
Onsite Average	*54*	*46*	*51*	*56*	*56*	*47*	*51*	*57*	*52*	*46*	*50*	*54*
Offsite E	57	47	52	57	58	49	53	58	54	46	50	56
Offsite F	52	43	48	54	53	44	49	56	50	42	46	53

Meteorology

Local meteorological data was collected from anemometers alongside the monitors, Project met-towers, and the Jackson Municipal Airport ASOS station (KMJQ). According to the temperature sensor at Monitor E, local temperatures ranged from 13.8°C to 33.5°C (57°F to 92°F) during the monitoring period. According to KMJQ, significant precipitation events took place on the morning of June 27th and the afternoon/evening of July 1st. Both were accompanied by thunder, which were all excluded as rain events and not included in the data analysis with the aid of spectrograms and audio recordings. A summary of the 1.5-meter (5-foot) wind speeds measured at each monitoring location over the deployment period at each site is provided in Table 6.

TABLE 6: SUMMARY OF MEASURED 1.5-METER (5-FOOT) WIND SPEEDS

Location	Measured 1.5-meter Wind (mph)			
	10-min Wind Speed		10-min Gust Speed	
	Average	Maximum	Average	Maximum
Onsite A	2.3	16.8	6.2	32.7
Onsite B	0.8	9.9	3.5	18.0
Onsite C	0.5	7.8	2.9	18.0
Onsite D	2.1	12.4	5.1	20.3
Onsite I	2.5	11.5	5.6	20.3
Offsite E	1.7	9.5	3.7	16.3
Offsite F	2.8	12.2	7.1	20.3

Monitor A

Monitoring results for Monitor A are presented in Figure 21.

The primary noise sources at this location were car passes (though it was not an especially busy road), biogenic sounds (birds especially), aircraft overflights, and wind rustling through trees and grass. The location exhibited a diurnal pattern, though not as strongly as other locations. All A-weighted sound level metrics plotted dropped below 30 dBA nightly. The quietest nighttime periods often dropped down to about 25 dBA. It also had the second greatest amount of wind exclusions during the monitor period. Note that this monitor suffered an equipment failure in the early afternoon of July 2nd: a lawn mower ran over the microphone cable and the acoustic signal was lost. Fortunately, this incident occurred a couple hours prior to the end of the monitoring period and had already been deployed for seven full days prior to the failure.

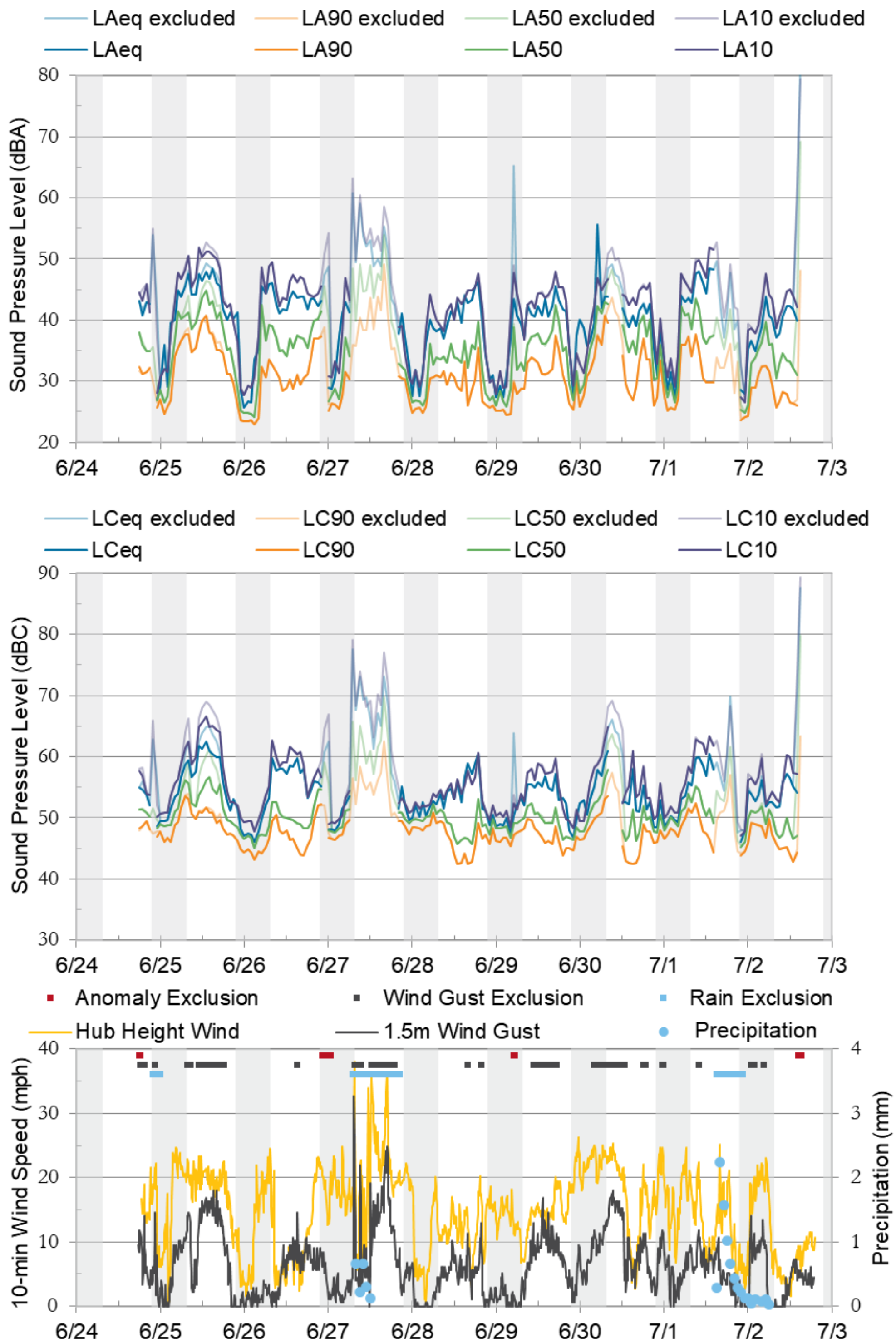

FIGURE 21: PRE-CONSTRUCTION MONITORING RESULTS AT LOCATION A

Monitor B

Monitoring results for Monitor B are presented in Figure 22.

The soundscape at this location was characterized by birds, wind noise (when not strong enough to be excluded), and occasional aircraft at altitude. Exclusions were triggered by nearby equipment and birds interacting with the microphone. Fans from the nearby hog farm were audible but did not have a significant impact on sound levels due to being nearly half a kilometer away. This location had the second lowest overall sound levels, an overall nighttime L_{50} of 29 dBA.

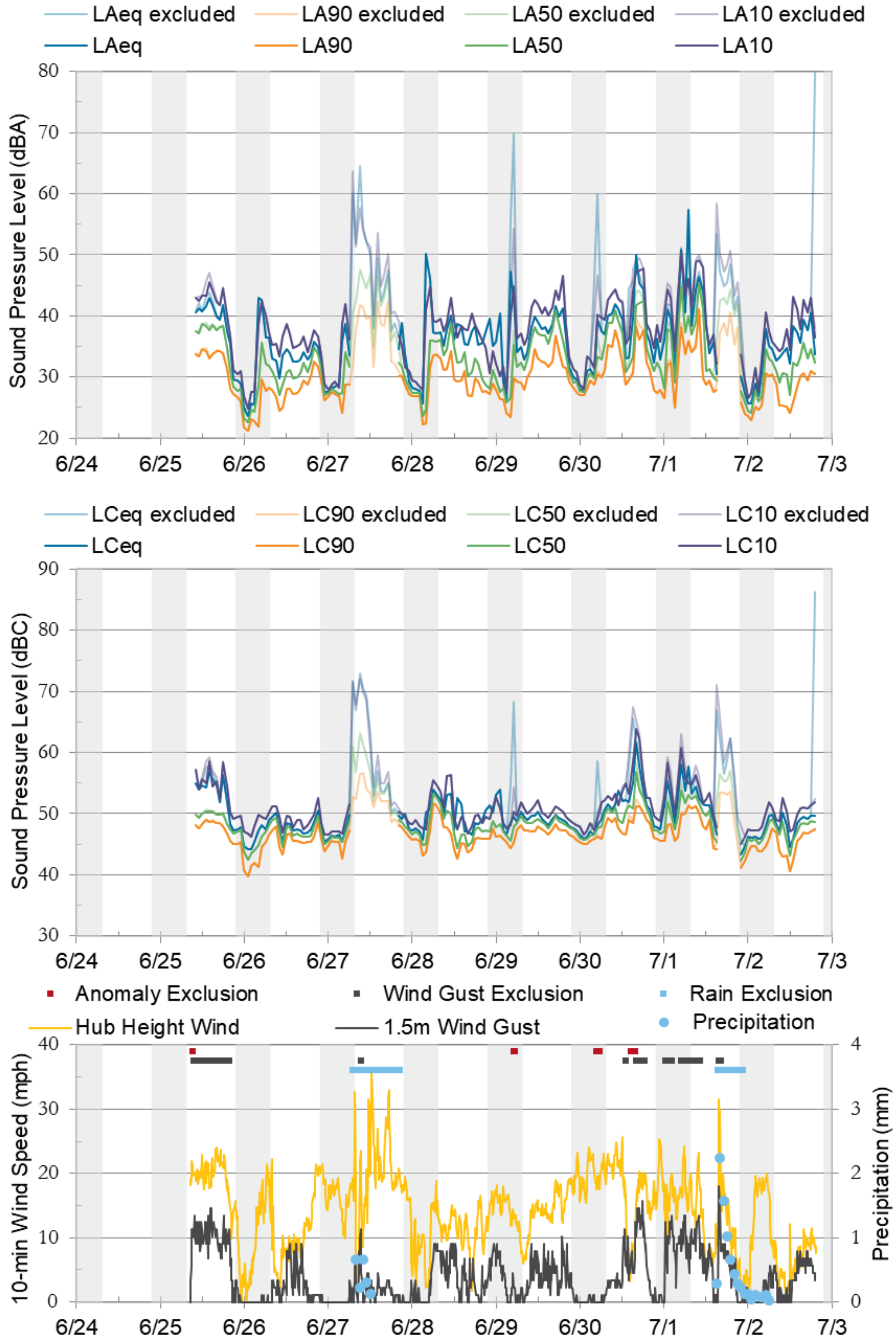

FIGURE 22: PRECONSTRUCTION MONITORING RESULTS AT MONITOR B

Monitor C

Monitoring results for Monitor C are presented in Figure 23.

The soundscape at this location was characterized by distant farm equipment, bird sounds, large truck passbys, wind through vegetation, and occasional aircraft fly overs. Some anomalous events that were excluded at this location included agricultural machinery operating very close to the monitor. The homestead was also the site of a farming operation that included trucks coming and going, livestock, and distant stationary agricultural equipment. Throughout much of the monitoring period, the constant stationary agricultural equipment was present and audible, resulting in this location having the highest nighttime L_{50} of 35 dBA.

Figure 24 presents the statistical sound levels for Monitor C during periods when nearby turbines would be operating at maximum sound power output (for the representative wind speed of 9 m/s at 89 meter hub height). The slight increase in the 63 Hz one-third octave band was due to the stationary agricultural equipment mentioned above. The 125 Hz L_{EQ} 1/3 octave band that was higher than the L10 was due to infrequent heavy truck passbys on the homestead/farm access road. The large sound level ranges at higher frequencies is indicative of nearby insect activity.

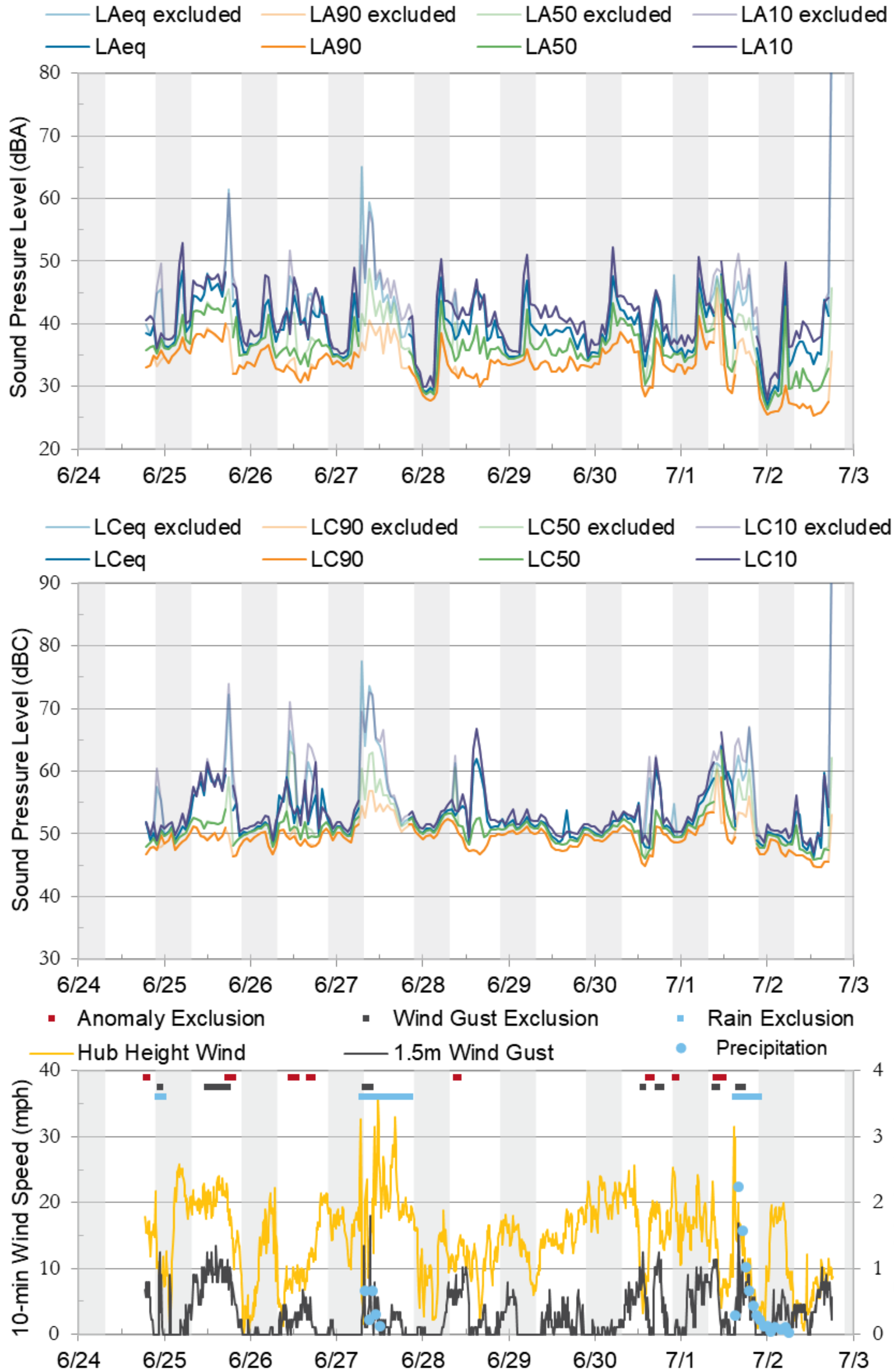

FIGURE 23: PRECONSTRUCTION MONITORING RESULTS AT MONITOR C

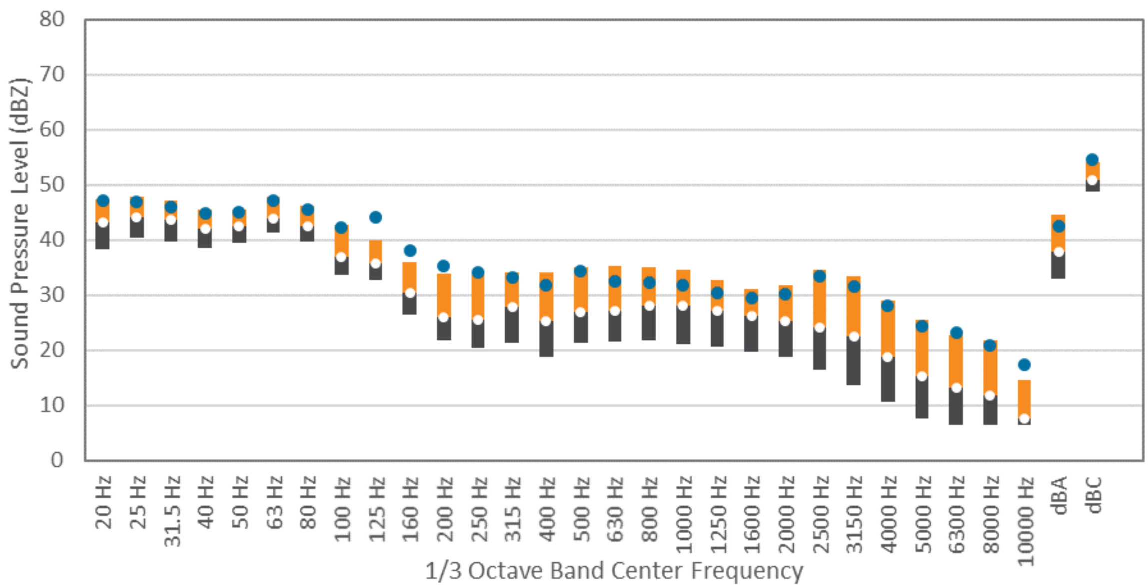

FIGURE 24: MONITOR C – 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS (FOR PERIODS WITH A 9 m/s WIND SPEED AT 89-METER (292-FOOT) HEIGHT)

Monitor D

Monitoring results for Monitor D are presented in Figure 25.

The soundscape at this location consisted of bird sounds, wind, and occasional distant dog and sheep sounds. Several exclusions were made, including for lawn mowing and other vehicles close to the meter. The sound level pattern at the monitor was diurnal, revealing substantial swings in daytime and nighttime sound levels that were a function of anthropogenic activity (mostly vehicle traffic). It had the second highest overall (L_{50}) sound levels of all monitoring locations: 41 dBA during the day and 34 dBA at night, likely owing to its proximity to Interstate 90. Additionally, it had the highest L_{10} values of any location, which could be the result of truck traffic on Interstate 90 and 790th Street.

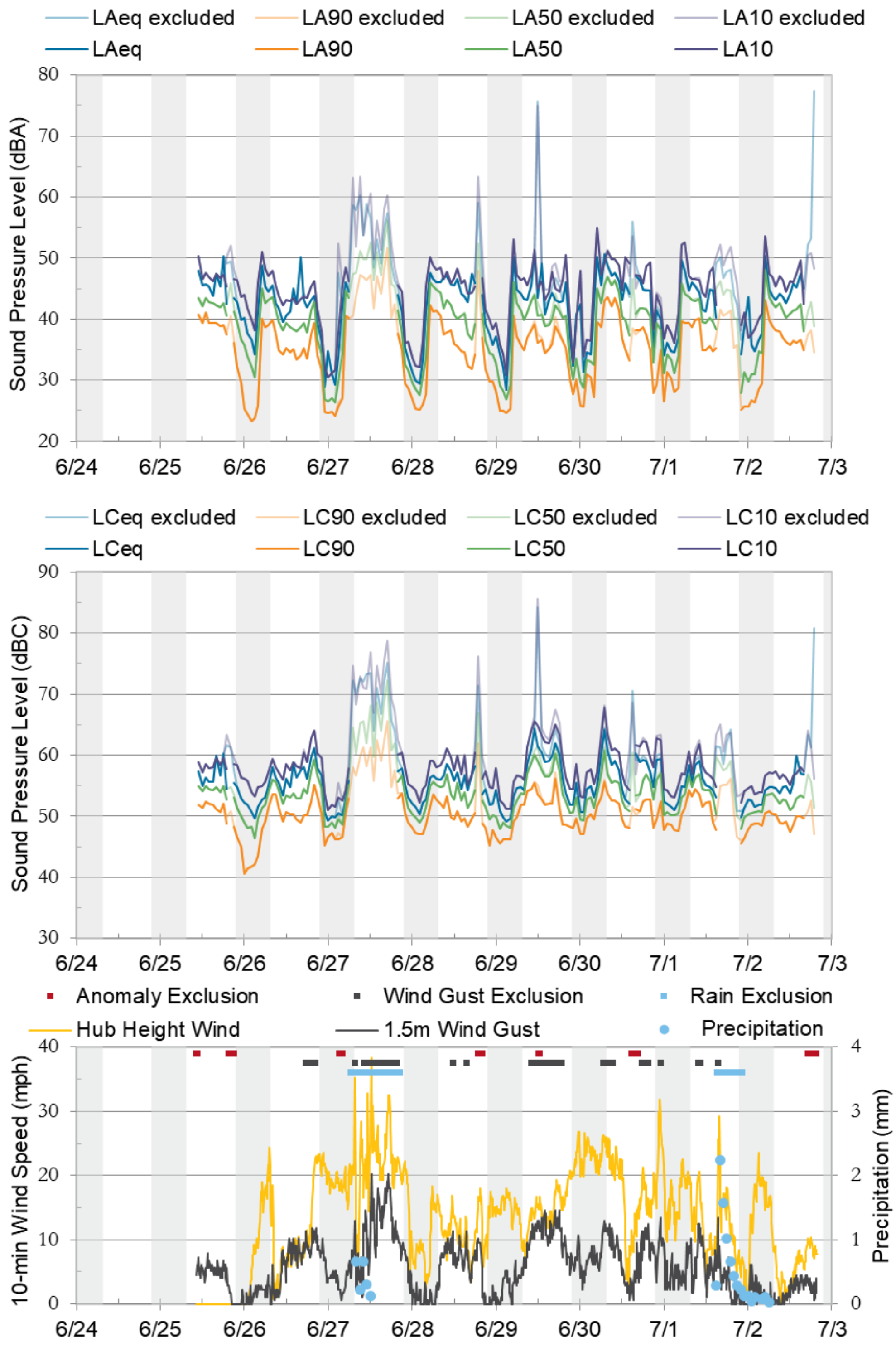

FIGURE 25: PRECONSTRUCTION MONITORING RESULTS AT MONITOR D

Monitor I

Monitoring results for Monitor I are presented in Figure 26.

Sound at this location was characterized by occasional car passbys, bird noise, leaf rustle, a cycling air conditioner, and occasional aircraft overflights at altitude. Sound levels when the homestead was being mowed were excluded from the data analysis on June 26th and July 2nd.

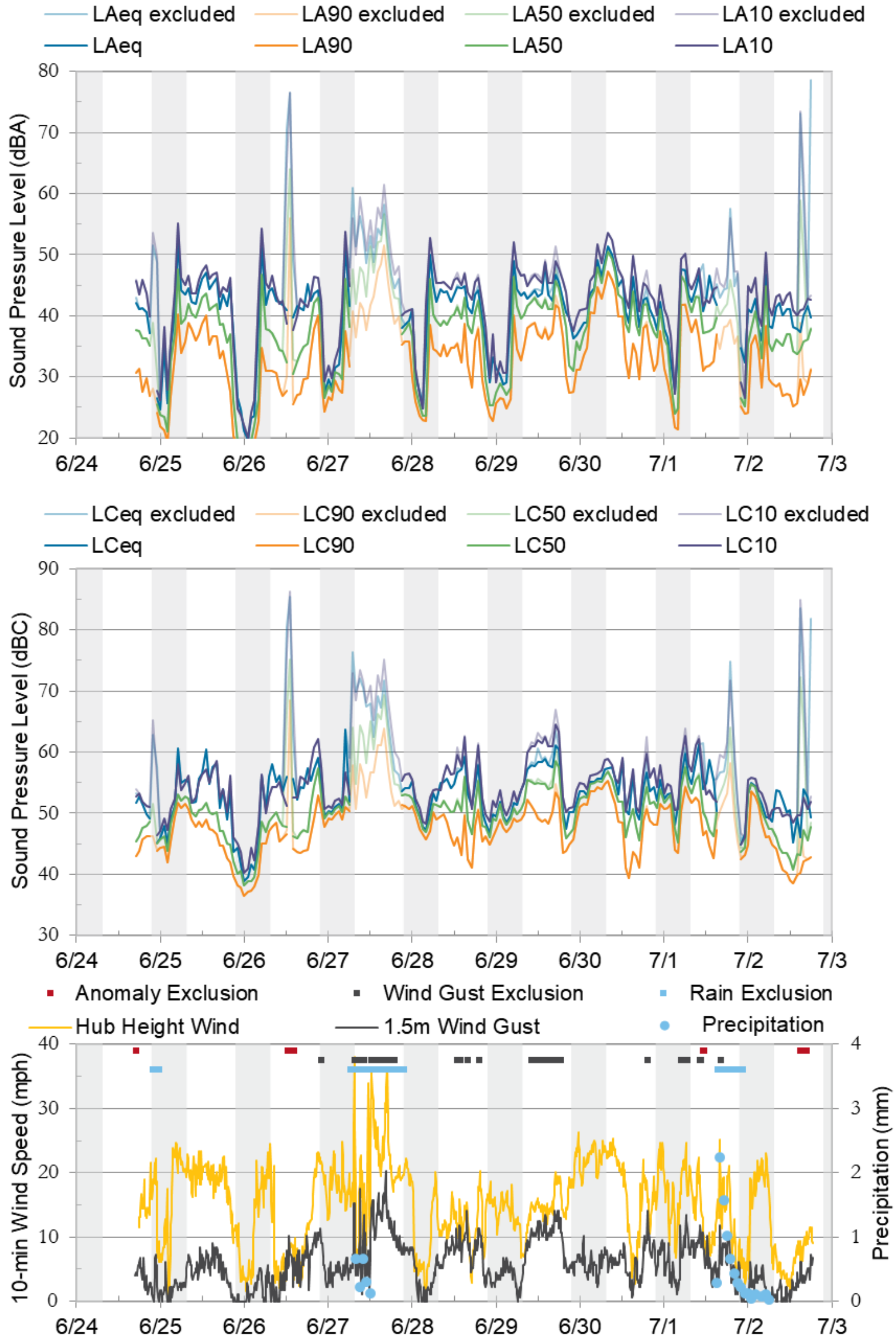

FIGURE 26: PRECONSTRUCTION MONITORING RESULTS FOR MONITOR I

Monitor E (Offsite)

Monitoring results for the Offsite E Monitor are presented in Figure 27.

Sound at this location was characterized by occasional car passes, biogenic noise (especially birds), and noise from Interstate 90 at approximately one-half mile away. This location had the highest overall sound levels (46 dBA and 57 dBC), likely due to the proximity of the interstate. Additionally, it exhibited the least diurnal pattern for the same reason.

The statistical levels for a representative wind speed (9 m/s) at a representative hub height (89 meters) are presented in Figure 28. Elevated L_{EQ} values centered on 160 Hz are likely due to heavy truck passbys on the interstate. The large variation in sound levels around 3,150 Hz was a result of variation in bird activity during the periods with representative hub height wind speeds of 9 m/s.

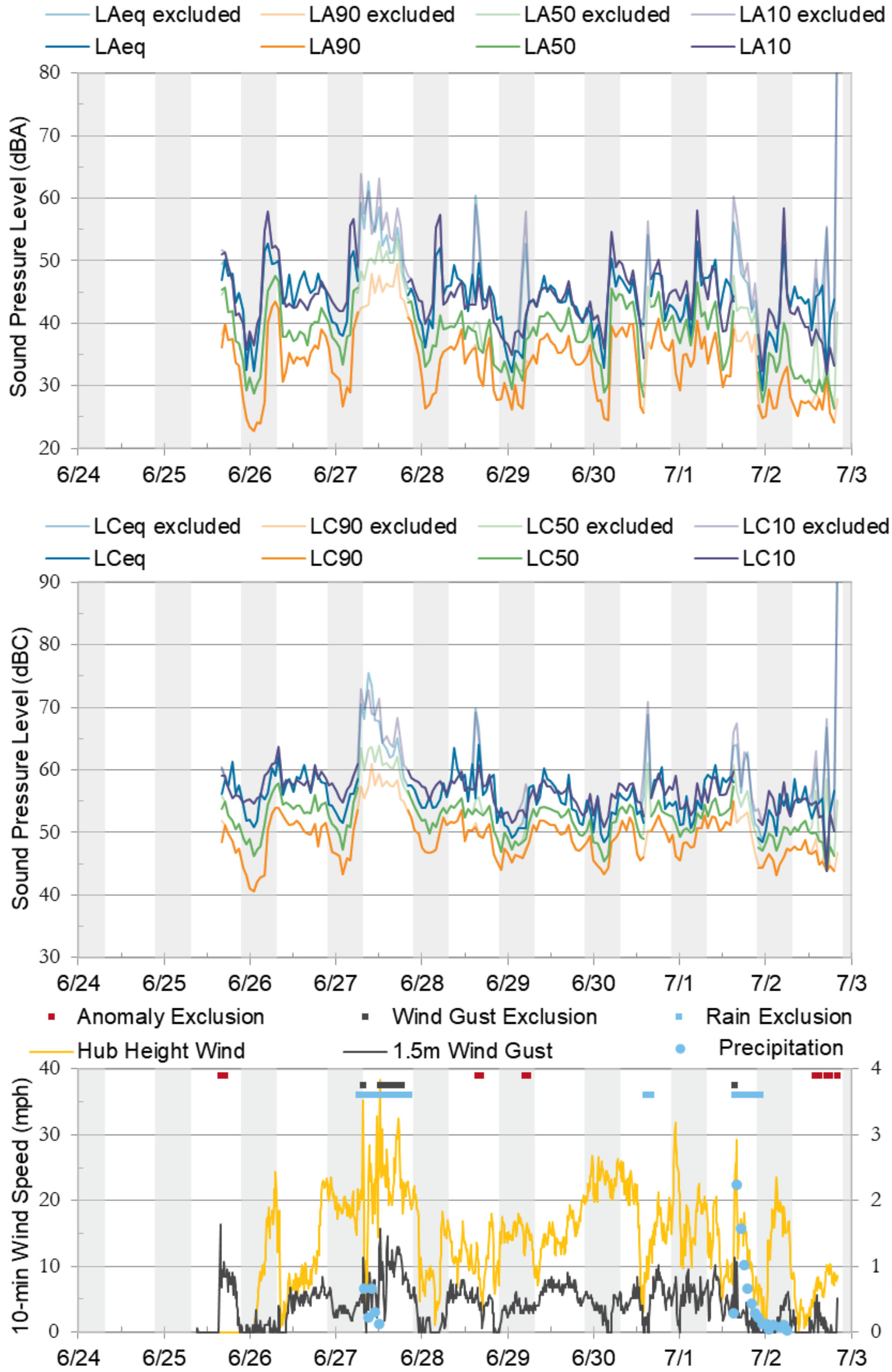

FIGURE 27: PRECONSTRUCTION MONITORING RESULTS OF THE OFFSITE E MONITOR

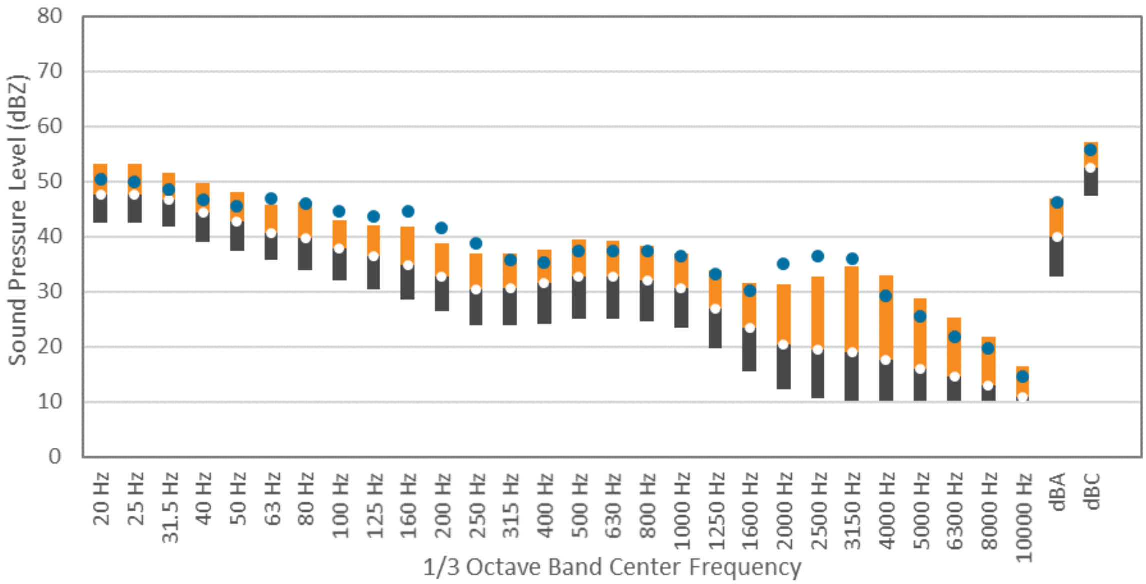

FIGURE 28: OFFSITE E MONITOR – 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS (FOR PERIODS WITH A 9 m/s WIND SPEED AT 89-METER (292-FOOT) HEIGHT)

Monitor F (Offsite)

Monitoring results for the Offsite F Monitor are presented in Figure 29.

The soundscape at this location was influenced by anthropogenic sources (especially birds), wind, cruising altitude aircraft, and distant agricultural equipment. Items excluded from the dataset included close-proximity agricultural activity and bird interaction with the microphone. It had the lowest overall sound levels (39 dBA and 52 dBC) of any location. This was likely due to not being directly adjacent to a homestead or agricultural operation.

Figure 30 presents the overall statistical levels for periods when the representative wind speed of 9 m/s was estimated to be blowing at 89 meters above ground level. The high L_{EQ} values around 4000 Hz are the result of nearby bird activity.

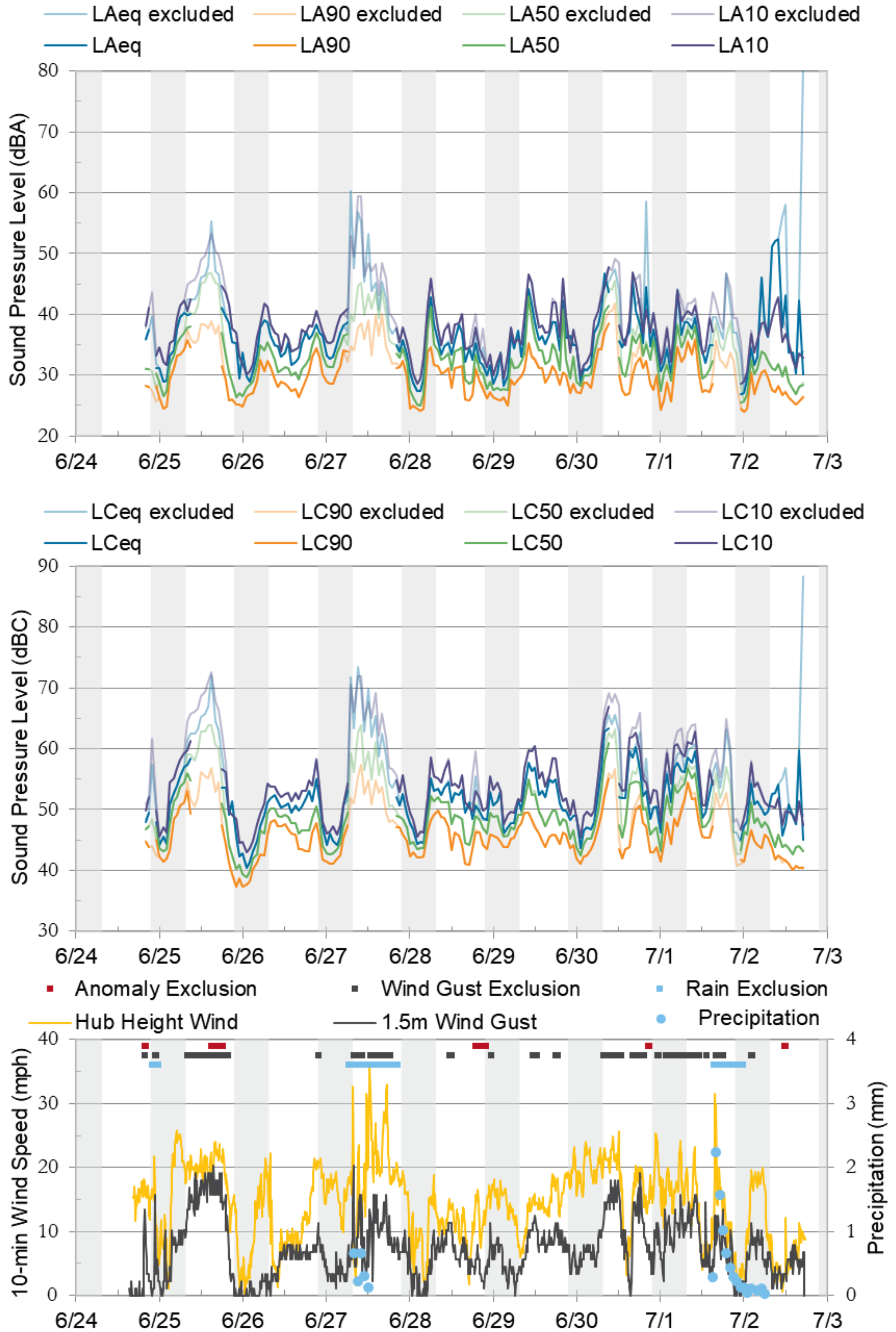

FIGURE 29: PRECONSTRUCTION MONITORING RESULTS FOR THE OFFSITE F MONITOR

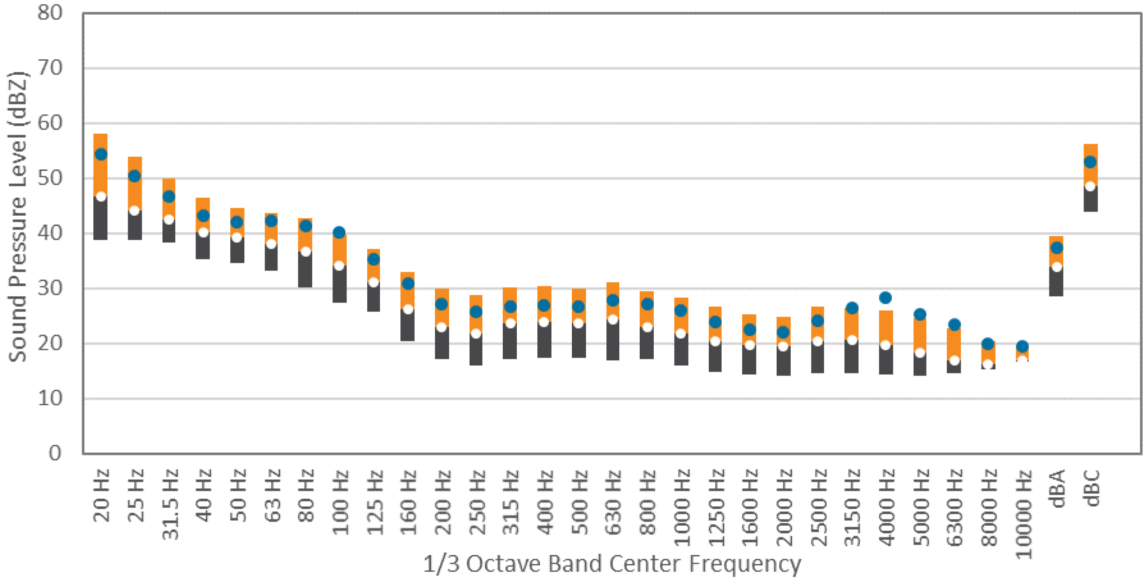

FIGURE 30: OFFSITE MONITOR F - 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS (FOR PERIODS WITH A 9 m/s WIND SPEED AT 89-METER (292-FOOT) HEIGHT)

6.0 SOUND PROPAGATION MODELING

6.1 MODELING PROCEDURE

Modeling for the Project was 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, 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.

Model input parameters are listed in Appendix B including the modeled sound power spectra for each turbine model.

For this analysis, we utilized a ground absorption factor of G=0.7, which is appropriate for comparing modeled results to the L_{50} metric used in the state standard, particularly when summing model results with the monitored L_{50} levels[12]. A 2-dB uncertainty factor was added to the turbine sound power per typical manufacturer warranty confidence interval specifications.

Two distinct receiver heights are included in the analysis; different receiver heights result in different sound levels as a result of source proximity, relative exposure, and ground absorption factor sensitivity. For this model, residences are modeled as discrete receivers at 4 meters (13 feet) above ground level. Using a 4 meter receiver height is more conservative than lower heights. For example, modeled sound levels at a height of 4 meters are 1.6 dB higher, on average, than model results at a height of 1.5 meters. Use of 4 meter receiver height is also

[12] Generally accepted wind turbine modeling procedure calls for a ground absorption factor of G = 0.5, with a 2 dB uncertainty factor added to the manufacturer's guaranteed levels, to predict a maximum $L_{EQ(1-hr)}$. In this case, the Minnesota state limit utilizes an L_{50} metric instead of maximum $L_{EQ(1-hr)}$, which means a ground factor of G=0.7 can be used.

supported by post-construction monitoring at a number of projects[13]. A total of 343 Minnesota residences were modeled, at locations within 3.2 kilometers (2 miles) of the Project. In addition, a total of 37 Iowa residences were modeled, at locations within 3.2 kilometers (2 miles) of the Minnesota-Iowa border. The grid, represented in the results map by sound pressure level contours, is calculated at a height of 1.5 meters (5 feet), to represent one's average listening height when standing outside.

A search distance up to 10,000 meters (6.2 miles) allows for the contributions of distant turbines to be considered at receivers. The contribution of distant turbines will depend on the geometry and geography of the Project.

The model included the all of the primary and alternate Project turbine locations in Minnesota and Iowa with select turbines utilizing low-noise trailing edge blades (LNTE) and noise reduced operations (NRO). The turbines using LNTE and NRO are noted in Appendix B. The model also included the sound emissions from 26 turbines at NextEra's Endeavor Wind Farm in Osceola County, Iowa southwest of the proposed Project.

6.2 MODELING RESULTS

Overall A-weighted Model Results

Modeling results are shown in Figure 31. Results are presented as contour lines representing 5-dB increments of calculated A-weighted sound pressure levels. Appendix C provides a list of the calculated sound pressure levels at each receiver in tabular format and a map showing all receiver identification numbers for reference in the appendix table.

A summary of the sound propagation model results is presented in Table 7. All modeled residences are projected to have sound levels below 50 dBA, the lowest sound limit under Minnesota Rules Chapter 7030. The highest modeled sound level (L_{50}) at a residence is 47 dBA, and the average sound level (L_{50}) across all residences is 38 dBA.

TABLE 7: MODEL RESULTS SUMMARY

Statistical Metric	Modeled Turbine-Only Sound Level (dBA) by Residence Classification		
	All Residences	Participating Residences	Non-Participating Residences
Average L50	38	44	37
Maximum L50	47	47	47
Minimum L50	24	31	24

[13] Kaliski, et. al., Regulating and predicting wind turbine sound in the U.S., Inter-Noise 2018.

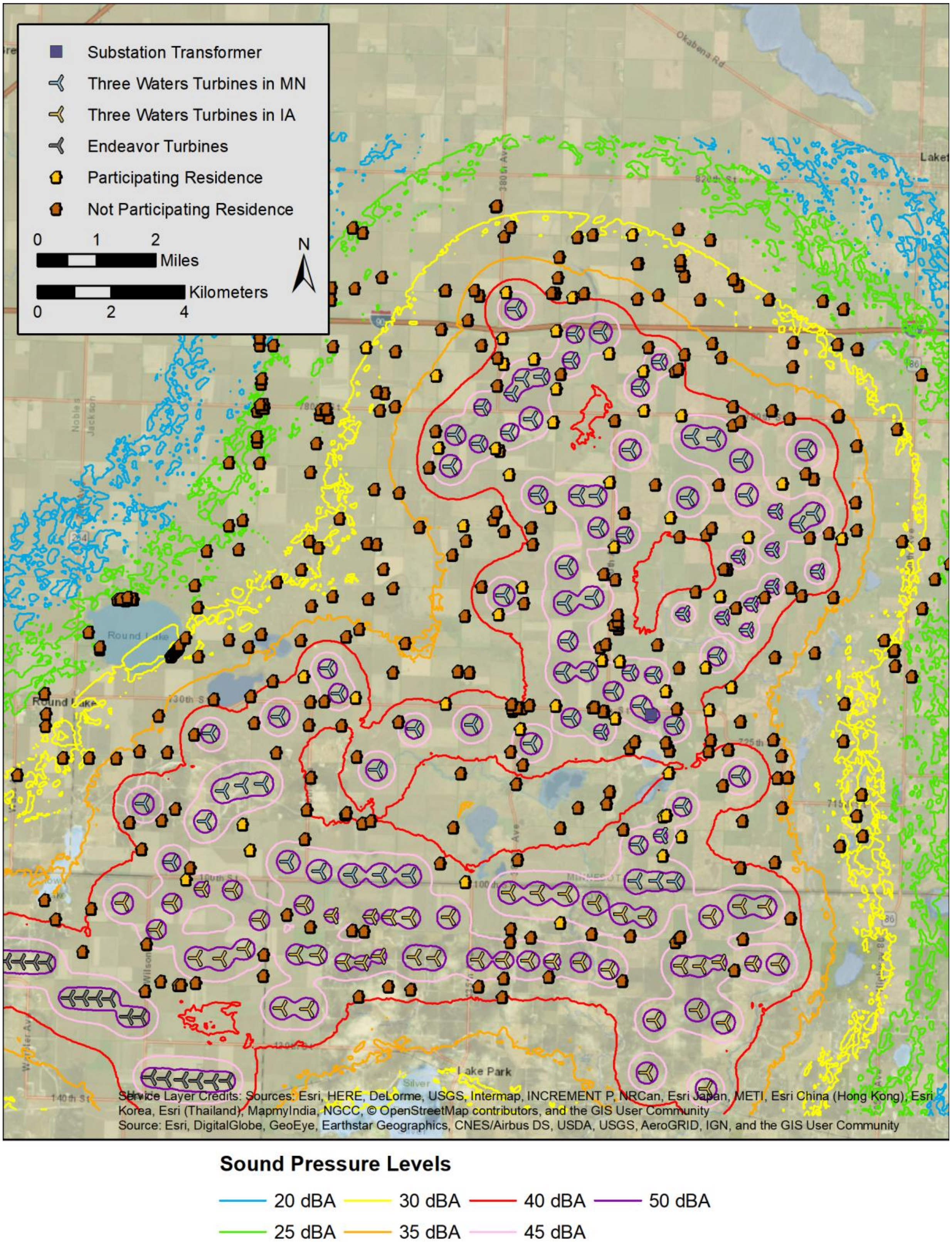

FIGURE 31: SOUND PROPAGATION MODEL RESULTS

Model Results Added to Background L_{50}

To assess compliance with state noise regulations, the model results must be summed (logarithmically)[14] with the monitored overall nighttime L_{50} results to determine the projected cumulative sound level (L_{50}) that could occur when the Project is operating. This analysis is presented in Table 8 for each monitor location. As shown in the Table, the model results summed with the overall nighttime L_{50} for each background monitor location are less than 50 dBA.

TABLE 8: MODEL RESULTS (dBA) SUMMED WITH MONITORED BACKGROUND SOUND LEVELS (L_{50}, dBA)

Scenario/Metric	Monitor Location				
	Monitor A	Monitor B	Monitor C	Monitor D	Monitor I
Monitored Overall Nighttime L_{50} Background Sound Level	31	29	35	34	33
Modeled Turbine-Only Sound Level	45	43	46	44	47
Total Sound (L_{50}) of Background & Modeled Turbine Sound Levels	45	43	46	44	47

The background L_{50} does and will vary from hour to hour, as shown in the monitor results in Section 5.0. The average overall nighttime L_{50} across all the monitor sites was 33 dBA, but there were some nighttime hours during the monitoring period when the L_{50} was above 40 dBA and as high as 48 dBA for a few hours. Thus, in Appendix C, the model results are summed with a range of potential background L_{50} values ranging from 30 dBA to 45 dBA in 5 dB increments.

[14] $L_{p1,2} = 10 \times \log_{10}\left(10^{L_{p1}/10} + 10^{L_{p2}/10}\right)$

7.0 CONCLUSIONS

The Three Waters Wind Project is a proposed wind power generation facility in Jackson County, Minnesota. The facility will include up to 71 wind turbines in Minnesota for a rating of up to 201 MW in Minnesota. The facility will also include additional wind turbines in Iowa. For the CN and SPA, RSG performed a preliminary noise compliance assessment of the Project based on the preliminary turbine layout including both the primary and alternate turbine locations.

Conclusions of the assessment are as follows:

1. Background sound levels vary around the Project site during the day but are generally consistent across the area at night. The overall nighttime L_{50} across the Project area ranged from 29 dBA at Monitor B to 35 dBA at Monitor C. The average overall nighttime L_{50} across the site was 33 dBA. During the day, the overall L50 across the Project area ranged from 34 at Monitor B to 41 at Monitor D with an average overall daytime L_{50} of 38 dBA.
2. Minimum 1-hour nighttime L_{50}s were between 19 and 28 dBA across the Project area, while maximum 1-hour nighttime L_{50}s were between 42 and 48 dBA.
3. State noise regulations require that wind power generation facilities show compliance with a nighttime limit of 50 dBA (L_{50}) and a daytime limit of 60 dBA (L_{50}) at residences.
4. Sound propagation modeling was performed in accordance with ISO 9613-2 at a total of 380 discrete receivers (343 in Minnesota within 2 miles of the Project, 37 in Iowa within 2 miles of the state border) with spectral ground attenuation and a ground factor of G=0.7. These modeling parameters are meant to represent the L_{50} of the proposed facility.
5. Modeling was completed for the anticipated turbine model, the GE 2.82-127 with a hub height of 89 meters. Select turbines are modeled with LNTE and NRO. The turbines using LNTE and NRO are noted in Appendix B.
6. Projected sound levels from the Project, including all primary and alternate turbine locations in Minnesota and Iowa, in combination with modeled sound levels from the Endeavor Wind Farm in Osceola, Iowa are less than 50 dBA at all residences with the highest projected sound level (L_{50}) at a residence of 47 dBA. The average sound level (L_{50}) across all modeled residences is 38 dBA.
7. When added to the overall nighttime L_{50} from monitored locations, sound levels remain below 50 dBA, but the background L_{50} does and will vary from hour to hour, as shown in the monitor results.

APPENDIX A. ACOUSTICS PRIMER

Expressing Sound in Decibel Levels

The varying air pressure that constitutes sound can be characterized in many different ways. The human ear is the basis for the metrics that are used in acoustics. 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").[15] 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".

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). 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 32.

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.

[15] 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 32: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES

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 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, sound pressure fluctuations are not "heard", but sometimes can be "felt". This is 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. 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". 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_A” for A-weighted levels.

Time Response of Sound Level Meters

Because sound levels can vary greatly from one moment to the next, the time over which sound is measured can influence the value of the levels reported. Often, sound is measured in real time, as it fluctuates. In this case, acousticians apply a so-called “time response” to the sound level meter, and this time response is often part of regulations for measuring sound. If the sound level is varying slowly, over a few seconds, “Slow” time response is applied, with a time constant of one second. If the sound level is varying quickly (for example, if brief events are mixed into the overall sound), “Fast” time response can be applied, with a time constant of one-eighth of a second.[16] The time response setting for a sound level measurement is indicated with the subscript “S” for Slow and “F” for Fast: L_S or L_F. A sound level meter set to Fast time response will indicate higher sound levels than one set to Slow time response when brief events are mixed into the overall sound, because it can respond more quickly.

In some cases, the maximum sound level that can be generated by a source is of concern. Likewise, the minimum sound level occurring during a monitoring period may be required. To measure these, the sound level meter can be set to capture and hold the highest and lowest levels measured during a given monitoring period. This is represented by the subscript “max”, denoted as “L_{max}”. One can define a “max” level with Fast response L_{Fmax} (1/8-second time constant), Slow time response L_{Smax} (1-second time constant), or Continuous Equivalent level over a specified time period L_{EQmax}.

Accounting for Changes in Sound Over Time

A sound level meter’s time response settings are useful for continuous monitoring. However, they are less useful in summarizing sound levels over longer periods. To do so, acousticians apply simple statistics to the measured sound levels, resulting in a set of defined types of sound level related to averages over time. An example is shown in Figure 33. The sound level at each instant of time is the grey trace going from left to right. Over the total time it was measured (1 hour in the figure), the sound energy spends certain fractions of time near various levels, ranging from the minimum (about 27 dB in the figure) to the maximum (about 65 dB in the figure). The simplest descriptor is the average sound level, known as the Equivalent Continuous Sound Level. Statistical levels are used to determine for what percentage of time the sound is louder than any given level. These levels are described in the following sections.

Equivalent Continuous Sound Level - Leq

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

[16] There is a third time response defined by standards, the “Impulse” response. This response was defined to enable use of older, analog meters when measuring very brief sounds; it is no longer in common use.

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. For example, in Figure 33, even though the sound levels spends most of the time near about 34 dBA, the L_{EQ} is 41 dBA, having been "inflated" by the maximum level of 65 dBA and other occasional spikes over the course of the hour.

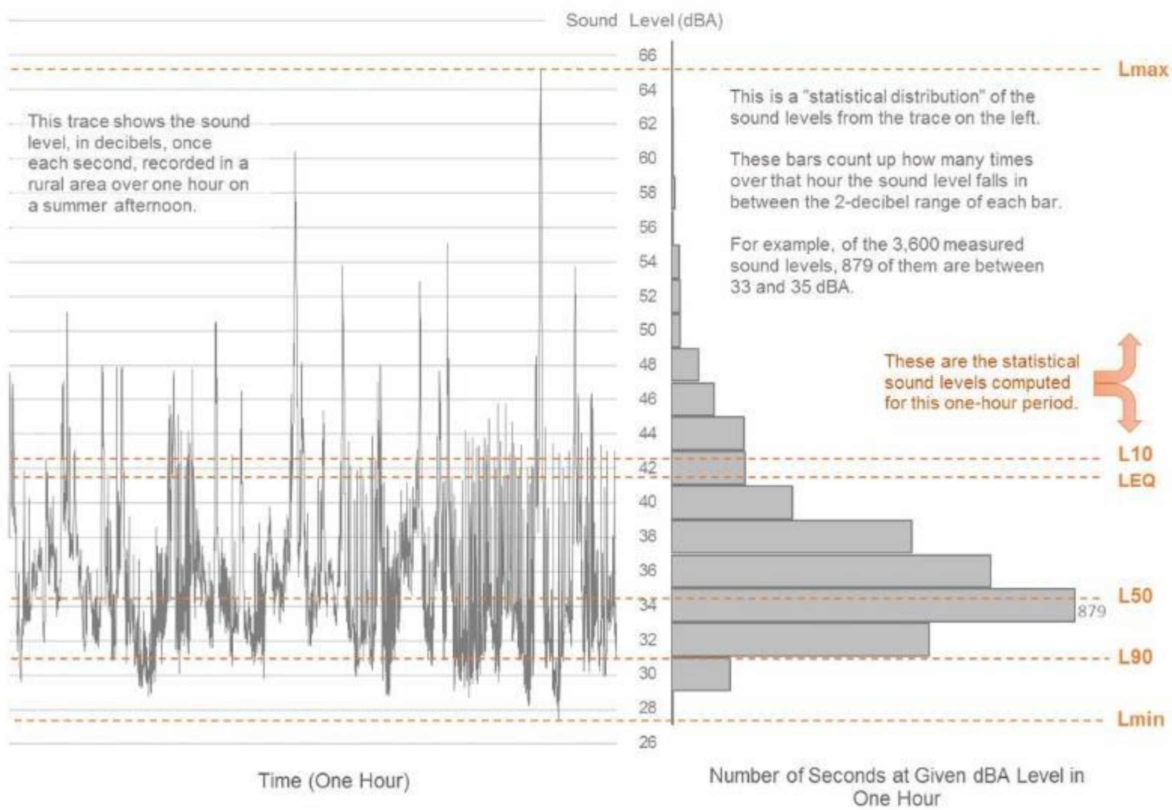

FIGURE 33: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME

Percentile Sound Levels – Ln

Percentile sound levels describe the statistical distribution of sound levels over time. "L_N" is the level above which the sound spends "N" percent of the time. For example, L_{90} (sometimes called the "residual base level") is the sound level exceeded 90% of the time: the sound is louder than L_{90} most of the time. L_{10} is the sound level that is exceeded only 10% of the time. L_{50} (the "median level") is exceeded 50% of the time: half of the time the sound is louder than L_{50}, and half the time it is quieter than L_{50}. Note that L_{50} (median) and L_{EQ} (mean) are not always the same, for reasons described in the previous section.

L_{90} is often a good representation of the "ambient sound" in an area. This is the sound that persists for longer periods, and below which the overall sound level seldom falls. It tends to filter out other short-term environmental sounds that aren't part of the source being investigated. L_{10}

represents the higher, but less frequent, sound levels. These could include such events as barking dogs, vehicles driving by and aircraft flying overhead, gusts of wind, and work operations. L_{90} represents the background sound that is present when these event sounds are excluded.

Note that if one sound source is very constant and dominates the soundscape in an area, all of the descriptive sound levels mentioned here tend toward the same value. It is when the sound is varying widely from one moment to the next that the statistical descriptors are useful.

APPENDIX B. MODEL INPUT DATA

TABLE 9: SOUND PROPAGATION MODELING PARAMETERS

PARAMETER	SETTING
Ground Absorption	Spectral for all sources, Mixed Ground (G=0.7)
Atmospheric Attenuation	Based on 10 Degrees Celsius, 70% Relative Humidity
Reflections	None
Receiver Height	4 meters for residences, 1.5 meters for grid
Search Distance	10,000 meters

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NOTE: Some proprietary information in Table 10 & 11 below have been excluded. The sound power levels of some turbines are considered proprietary information but may be provided under a proper protective agreement.

TABLE 10: TURBINE HUB HEIGHT AND 1/1 OCTAVE BAND MODELED TURBINE SPECTRA (dBZ UNLESS OTHERWISE INDICATED)

SOUND SOURCE	HUB HEIGHT	1/1 OCTAVE BAND CENTER FREQUENCY (HZ)									SUM (dBA)	SUM (dBZ)
		31.5	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*		
GE 2.82-127	89 m	122	119	114	109	107	106	101	93	77	110.0	123.9
GE 2.82-127 LNTE[17]	89 m	122	119	113	101	104	104	102	94	78	108.5	123.7
GE 2.82-127 LNTE w/NRO[18]	89 m											
GE 2.82-127 LNTE w/NRO	89 m											
GE 2.82-127 LNTE w/NRO	89 m											
GE 2.82-127 LNTE w/NRO	89 m											
Clipper C96	80 m											

TABLE 11: MODELED TURBINE SOUND POWER LEVELS & LOCATIONS[19]

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
2	MN	GE 2.82-127	112	89	313703	4834648
4	MN	GE 2.82-127	112	89	311924	4830366
5	MN	GE 2.82-127 LNTE	110.5	89	312052	4831232

[17] LNTE: Low Noise Trailing Edges
[18] NRO: Noise Reduced Operations
[19] A map showing the location of the turbines by Turbine ID is provided in Figure 34 after this Table.

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
6	MN	GE 2.82-127 LNTE & NRO		89	312708	4830978
7	MN	GE 2.82-127 LNTE & NRO		89	313609	4832347
8	MN	GE 2.82-127 LNTE	110.5	89	313911	4832743
9	MN	GE 2.82-127 LNTE & NRO		89	314397	4832807
A10	MN	GE 2.82-127 LNTE & NRO		89	315208	4833245
11	MN	GE 2.82-127	112	89	316038	4834018
13	MN	GE 2.82-127 LNTE & NRO		89	317094	4832503
14	MN	GE 2.82-127 LNTE	110.5	89	314314	4829597
A15	MN	GE 2.82-127 LNTE & NRO		89	320126	4826609
16	MN	GE 2.82-127 LNTE	110.5	89	315416	4829572
17	MN	GE 2.82-127 LNTE	110.5	89	315915	4829569
19	MN	GE 2.82-127	112	89	318515	4831182
20	MN	GE 2.82-127	112	89	319118	4831115
21	MN	GE 2.82-127	112	89	319853	4830528
24	MN	GE 2.82-127 LNTE & NRO		89	316685	4828498
27	MN	GE 2.82-127 LNTE & NRO		89	320691	4827095
28	MN	GE 2.82-127 LNTE & NRO		89	320773	4829144
29	MN	GE 2.82-127 LNTE & NRO		89	321408	4828797
30	MN	GE 2.82-127	112	89	321825	4829087
31	MN	GE 2.82-127 LNTE & NRO		89	318267	4826346
32	MN	GE 2.82-127 LNTE & NRO		89	319347	4826249
33	MN	GE 2.82-127	112	89	307268	4823554
A36	MN	GE 2.82-127 LNTE	110.5	89	308884	4824177
38	MN	GE 2.82-127 LNTE	110.5	89	310947	4823211
42	MN	GE 2.82-127	112	89	312515	4823334
44	MN	GE 2.82-127 LNTE	110.5	89	315129	4825611

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
45	MN	GE 2.82-127	112	89	314130	4822819
47	MN	GE 2.82-127 LNTE & NRO		89	316352	4824237
48	MN	GE 2.82-127 LNTE & NRO		89	316824	4824754
49	MN	GE 2.82-127 LNTE & NRO		89	317470	4824691
51	MN	GE 2.82-127 LNTE	110.5	89	317113	4823842
53	MN	GE 2.82-127 LNTE	110.5	89	318026	4823314
56	MN	GE 2.82-127 LNTE	110.5	89	318243	4821099
58	MN	GE 2.82-127	112	89	319804	4821926
59	MN	GE 2.82-127	112	89	303574	4821177
60	MN	GE 2.82-127	112	89	305251	4820697
63	MN	GE 2.82-127	112	89	306813	4821722
64	MN	GE 2.82-127	112	89	310034	4819247
65	MN	GE 2.82-127	112	89	310832	4819228
66	MN	GE 2.82-127	112	89	321612	4830813
68	MN	GE 2.82-127 LNTE	110.5	89	315010	4824743
69	MN	GE 2.82-127	112	89	309230	4819238
70	MN	GE 2.82-127	112	89	308360	4819346
72	MN	GE 2.82-127 LNTE & NRO		89	317537	4819076
73	MN	GE 2.82-127 LNTE & NRO		89	318035	4819062
74	MN	GE 2.82-127 LNTE & NRO		89	317657	4820313
75	MN	GE 2.82-127	112	89	315086	4827632
76	MN	GE 2.82-127	112	89	315043	4826643
A77	MN	GE 2.82-127	112	89	315808	4826797
78	MN	GE 2.82-127	112	89	319996	4829584
79	MN	GE 2.82-127	112	89	316985	4819074
80	MN	GE 2.82-127 LNTE & NRO		89	312793	4831978
81	MN	GE 2.82-127 LNTE & NRO		89	317035	4820064
82	MN	GE 2.82-127 LNTE & NRO		89	321927	4827502
A83	MN	GE 2.82-127 LNTE & NRO		89	316033	4823137

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
86	MN	GE 2.82-127 LNTE & NRO		89	320691	4828100
87	MN	GE 2.82-127 LNTE & NRO		89	313527	4831285
88	MN	GE 2.82-127 LNTE & NRO		89	304343	4819594
89	MN	GE 2.82-127	112	89	306260	4821682
90	MN	GE 2.82-127	112	89	307503	4819605
91	MN	GE 2.82-127 LNTE & NRO		89	320008	4825910
92	MN	GE 2.82-127 LNTE & NRO		89	315675	4824786
93	MN	GE 2.82-127 LNTE	110.5	89	315948	4828687
94	MN	GE 2.82-127	112	89	316824	4830816
95	MN	GE 2.82-127	112	89	305739	4821530
96	MN	GE 2.82-127	112	89	314138	4831664
97	MN	GE 2.82-127 LNTE	110.5	89	308586	4824871
98	MN	GE 2.82-127	112	89	318388	4829506
A2	MN	GE 2.82-127 LNTE	110.5	89	305390	4823091
A9	MN	GE 2.82-127 LNTE & NRO		89	315303	4833970
95M	MN	GE 2.82-127 LNTE & NRO		89	317622	4833211
97M	MN	GE 2.82-127	112	89	313389	4826857
99M	MN	GE 2.82-127	112	89	309925	4822098
96M	MN	GE 2.82-127 LNTE & NRO		89	319782	4827905
98M	MN	GE 2.82-127 LNTE	110.5	89	315208	4823518
A53	MN	GE 2.82-127 LNTE	110.5	89	319187	4825195
1	IA	GE 2.82-127	112.0	89	303000	4818475
3	IA	GE 2.82-127 LNTE	110.5	89	304352	4818472
4	IA	GE 2.82-127 LNTE & NRO		89	305167	4818859
5	IA	GE 2.82-127 LNTE	110.5	89	306000	4818834
6	IA	GE 2.82-127 LNTE	110.5	89	306740	4818019
7	IA	GE 2.82-127 LNTE & NRO		89	307940	4818421

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
9	IA	GE 2.82-127 LNTE & NRO		89	310292	4818090
10	IA	GE 2.82-127 LNTE	110.5	89	310820	4818075
11	IA	GE 2.82-127	112.0	89	311881	4818093
12	IA	GE 2.82-127	112.0	89	313529	4818766
13	IA	GE 2.82-127	112.0	89	314301	4818745
14	IA	GE 2.82-127	112.0	89	315066	4818724
18	IA	GE 2.82-127	112.0	89	319008	4818104
19	IA	GE 2.82-127	112.0	89	319825	4818394
20	IA	GE 2.82-127	112.0	89	320513	4818376
21	IA	GE 2.82-127 LNTE	110.5	89	303926	4817752
22	IA	GE 2.82-127	112.0	89	305004	4816976
23	IA	GE 2.82-127	112.0	89	305676	4816957
24	IA	GE 2.82-127 LNTE	110.5	89	307737	4817079
25	IA	GE 2.82-127 LNTE & NRO		89	309540	4816847
26	IA	GE 2.82-127 LNTE & NRO		89	310001	4817025
27	IA	GE 2.82-127	112.0	89	310953	4816998
28	IA	GE 2.82-127 LNTE	110.5	89	315475	4816865
29	IA	GE 2.82-127 LNTE	110.5	89	316245	4816665
31	IA	GE 2.82-127 LNTE	110.5	89	318732	4816757
32	IA	GE 2.82-127 LNTE	110.5	89	306332	4817221
33	IA	GE 2.82-127 LNTE & NRO		89	308305	4817063
34	IA	GE 2.82-127	112.0	89	311485	4816970
35	IA	GE 2.82-127 LNTE & NRO		89	313384	4816922
36	IA	GE 2.82-127 LNTE	110.5	89	314056	4816904
37	IA	GE 2.82-127 LNTE & NRO		89	314710	4816886
A5	IA	GE 2.82-127	112.0	89	312682	4816942
A9	IA	GE 2.82-127 LNTE	110.5	89	318204	4816771
A10	IA	GE 2.82-127 LNTE & NRO		89	319263	4816864

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
A11	IA	GE 2.82-127	112.0	89	307323	4815615
A12	IA	GE 2.82-127	112.0	89	308043	4815594
A13	IA	GE 2.82-127	112.0	89	317476	4815290
A14	IA	GE 2.82-127	112.0	89	317277	4813852
A15	IA	GE 2.82-127	112.0	89	318888	4813412
A16	IA	GE 2.82-127	112.0	89	318630	4815565
A17	IA	GE 2.82-127	112.0	89	319384	4815222
A18	IA	GE 2.82-127 LNTE & NRO		89	320156	4816830
A19	IA	GE 2.82-127	112.0	89	320860	4816808
A20	IA	GE 2.82-127 LNTE & NRO		89	308698	4818135
A21	IA	GE 2.82-127 LNTE & NRO		89	309039	4816861
A23	IA	GE 2.82-127 LNTE & NRO		89	309762	4818105
A24	IA	GE 2.82-127	112.0	89	315873	4818480
A25	IA	GE 2.82-127 LNTE	110.5	89	316591	4818175
A26	IA	GE 2.82-127 LNTE	110.5	89	317261	4818088
Endeavor Wind Farm in IA						
2-1 B	IA	Clipper C96		80	296066	4817468
2-2 B	IA	Clipper C96		80	296440	4817459
2-3 B	IA	Clipper C96		80	296829	4817447
2-4 B	IA	Clipper C96		80	297192	4817436
2-5 B	IA	Clipper C96		80	297587	4817416
2-6 B	IA	Clipper C96		80	297877	4817418
2-7 B	IA	Clipper C96		80	298201	4817438
2-8 B	IA	Clipper C96		80	298616	4817558
2-9 ALT. B	IA	Clipper C96		80	299002	4816916
2-10 B	IA	Clipper C96		80	299354	4816905
2-11 B	IA	Clipper C96		80	299819	4816889
2-12 B	IA	Clipper C96		80	300203	4816875
2-13 B	IA	Clipper C96		80	300568	4816862
2-14 B	IA	Clipper C96		80	300928	4816848
2-16 B	IA	Clipper C96		80	301531	4815896
2-17 B	IA	Clipper C96		80	301902	4815887
2-18 B	IA	Clipper C96		80	302281	4815875
2-19 B	IA	Clipper C96		80	302653	4815864

TURBINE ID	STATE	TURBINE	MODELED SOUND POWER LEVEL (dBA)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)	
					X (m)	Y (m)
2-20 B	IA	Clipper C96		80	303126	4815380
2-21 B	IA	Clipper C96		80	303493	4815371
1-A5 B	IA	Clipper C96		80	303758	4813732
1-A6 B	IA	Clipper C96		80	304156	4813698
1-1 B	IA	Clipper C96		80	304620	4813664
1-2 B	IA	Clipper C96		80	305012	4813638
1-3 B	IA	Clipper C96		80	305439	4813610
1-4 B	IA	Clipper C96		80	305832	4813631

...NONPUBLIC DATA HAS BEEN EXCISED]

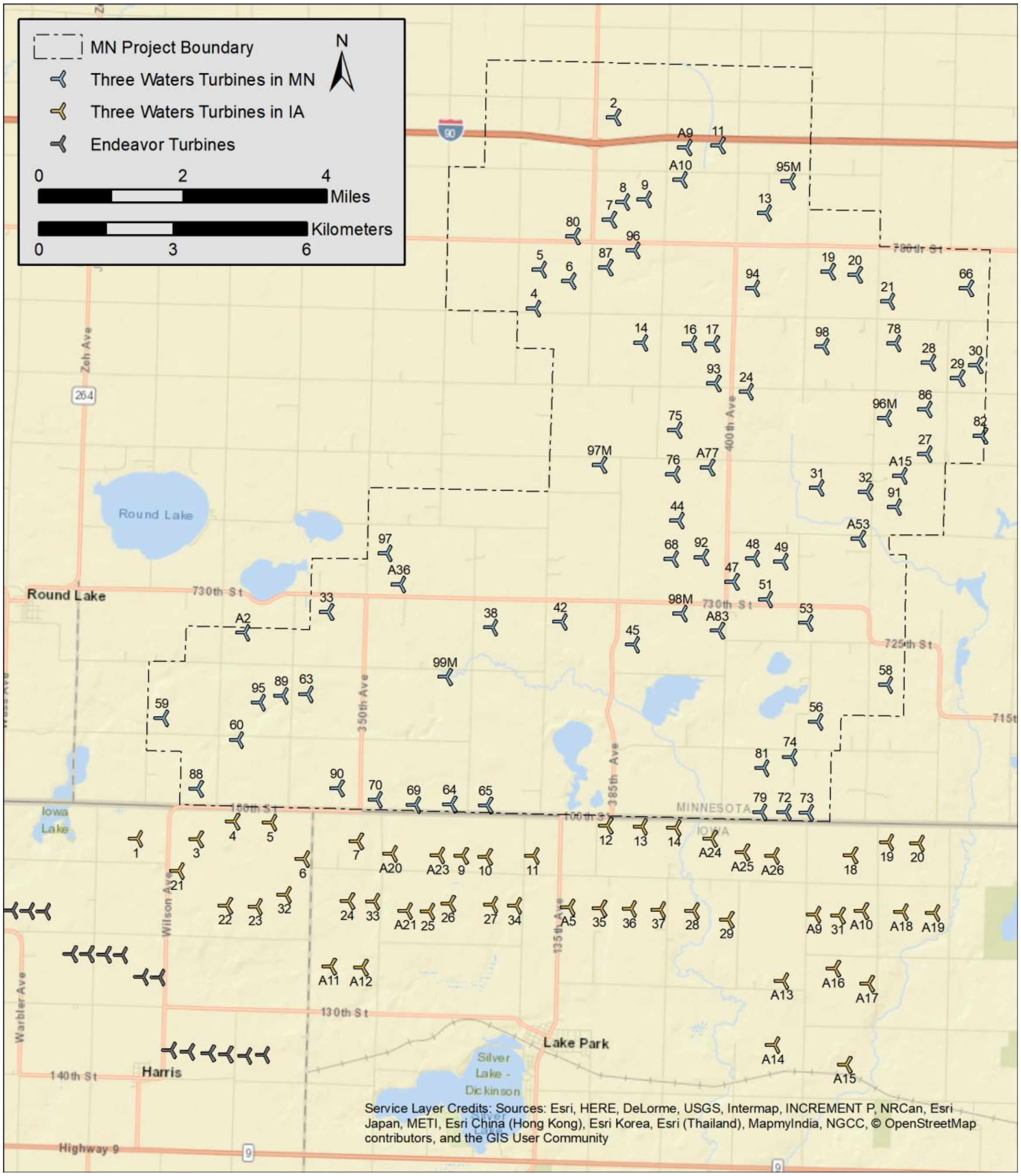
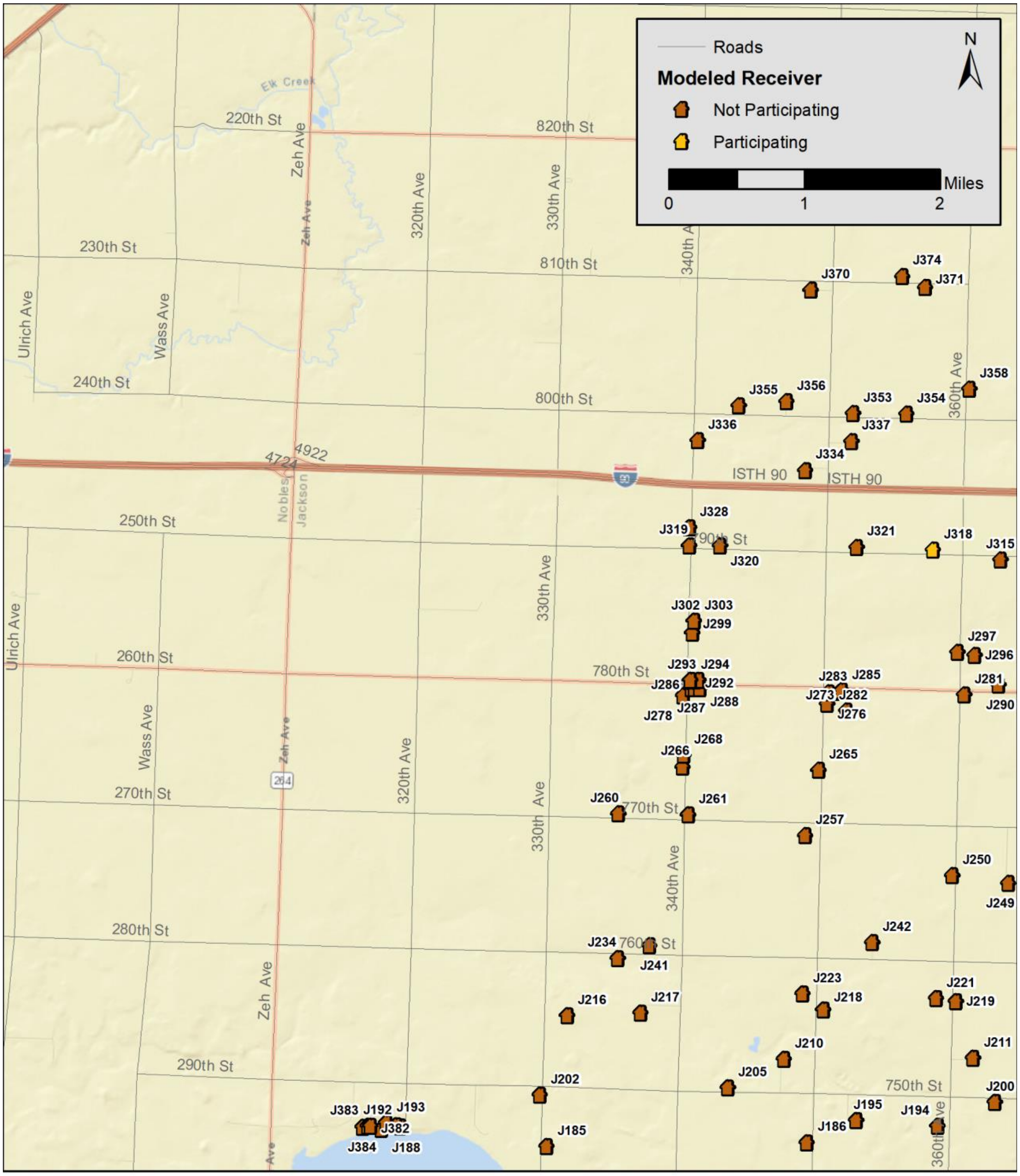


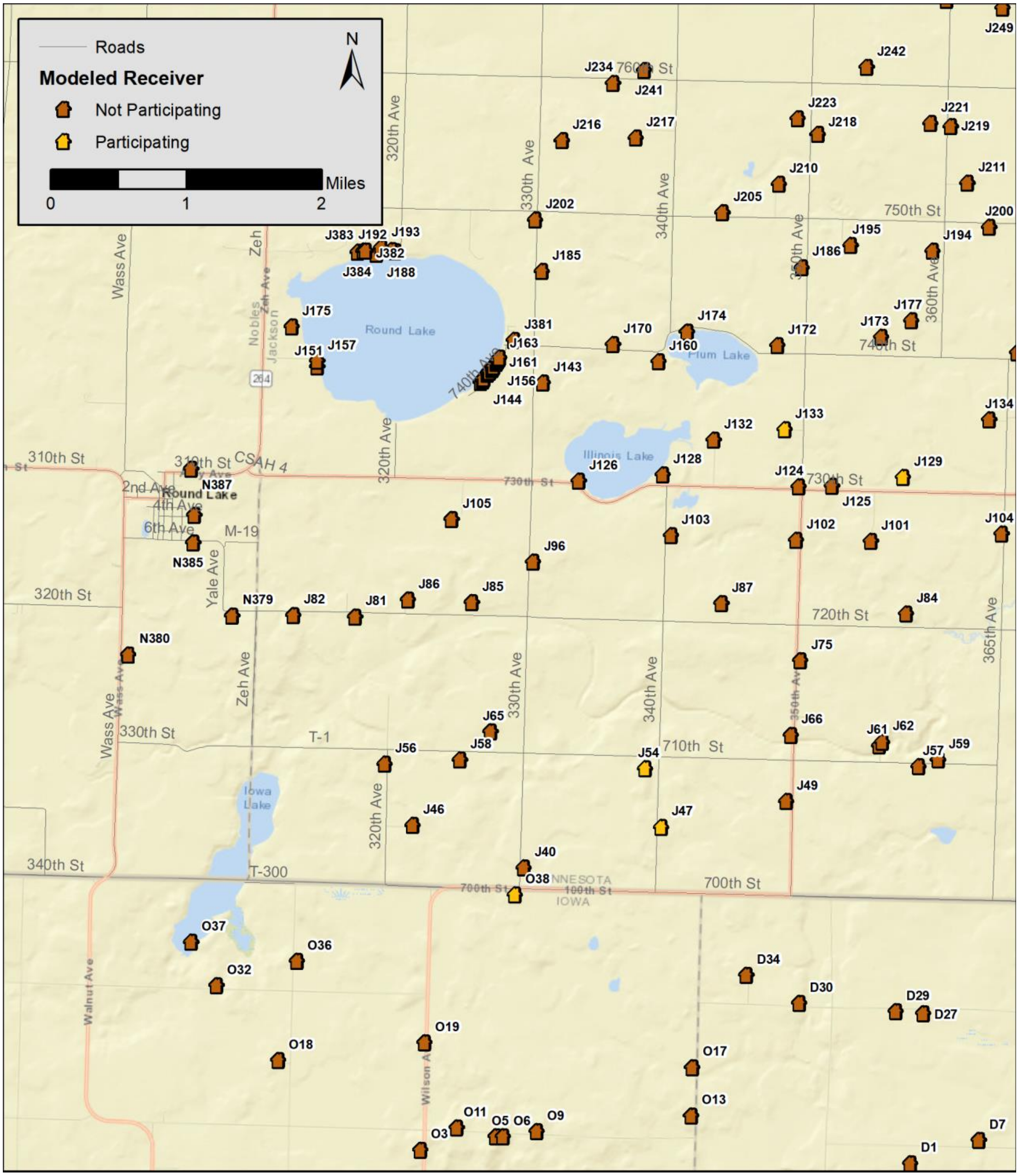
FIGURE 34: MAP OF MODELED TURBINE LOCATIONS BY TURBINE ID

APPENDIX C. RECEIVER INFORMATION



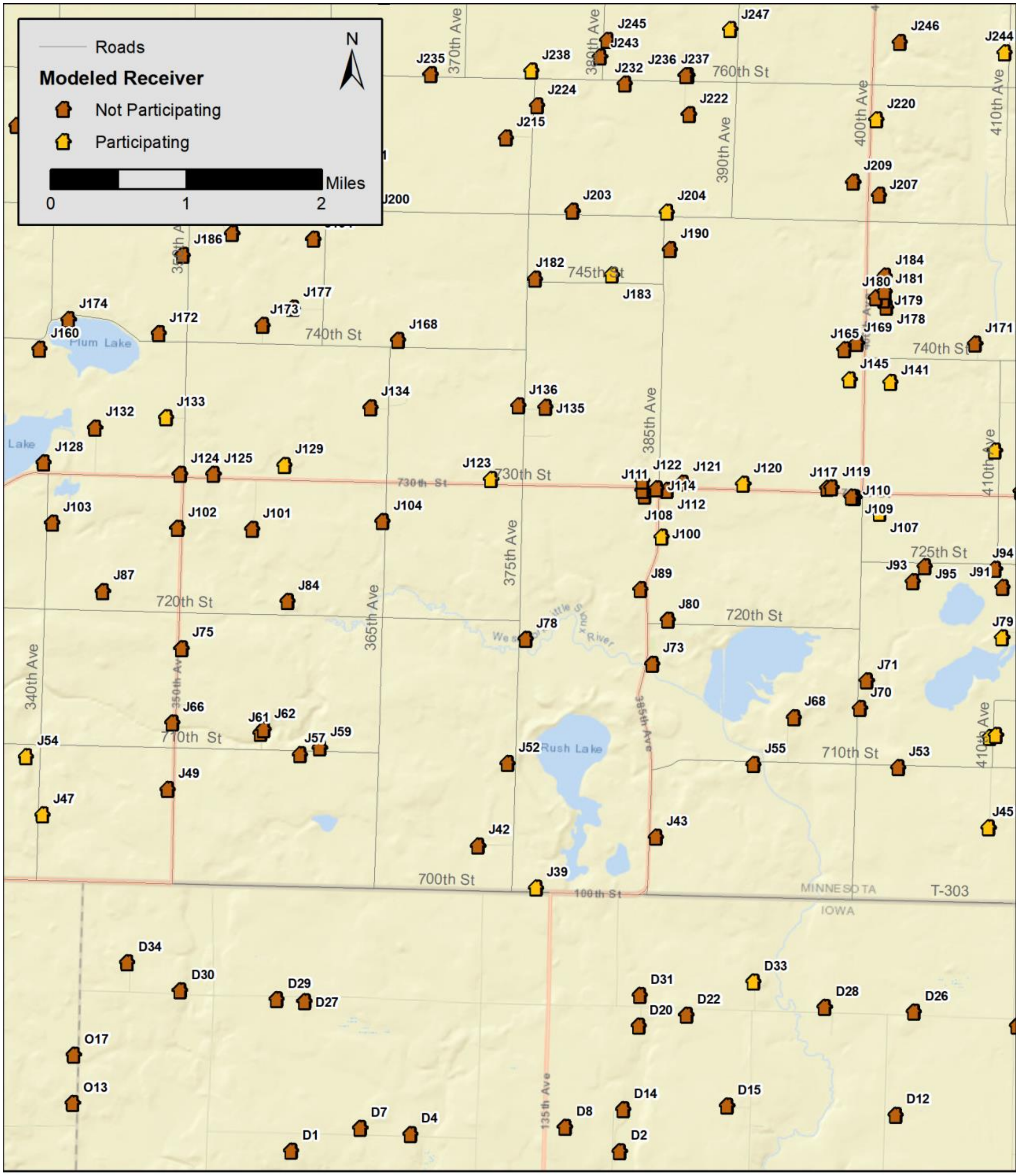
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

FIGURE 35: MAP OF MODELED RECEIVERS - NORTHWEST PROJECT AREA



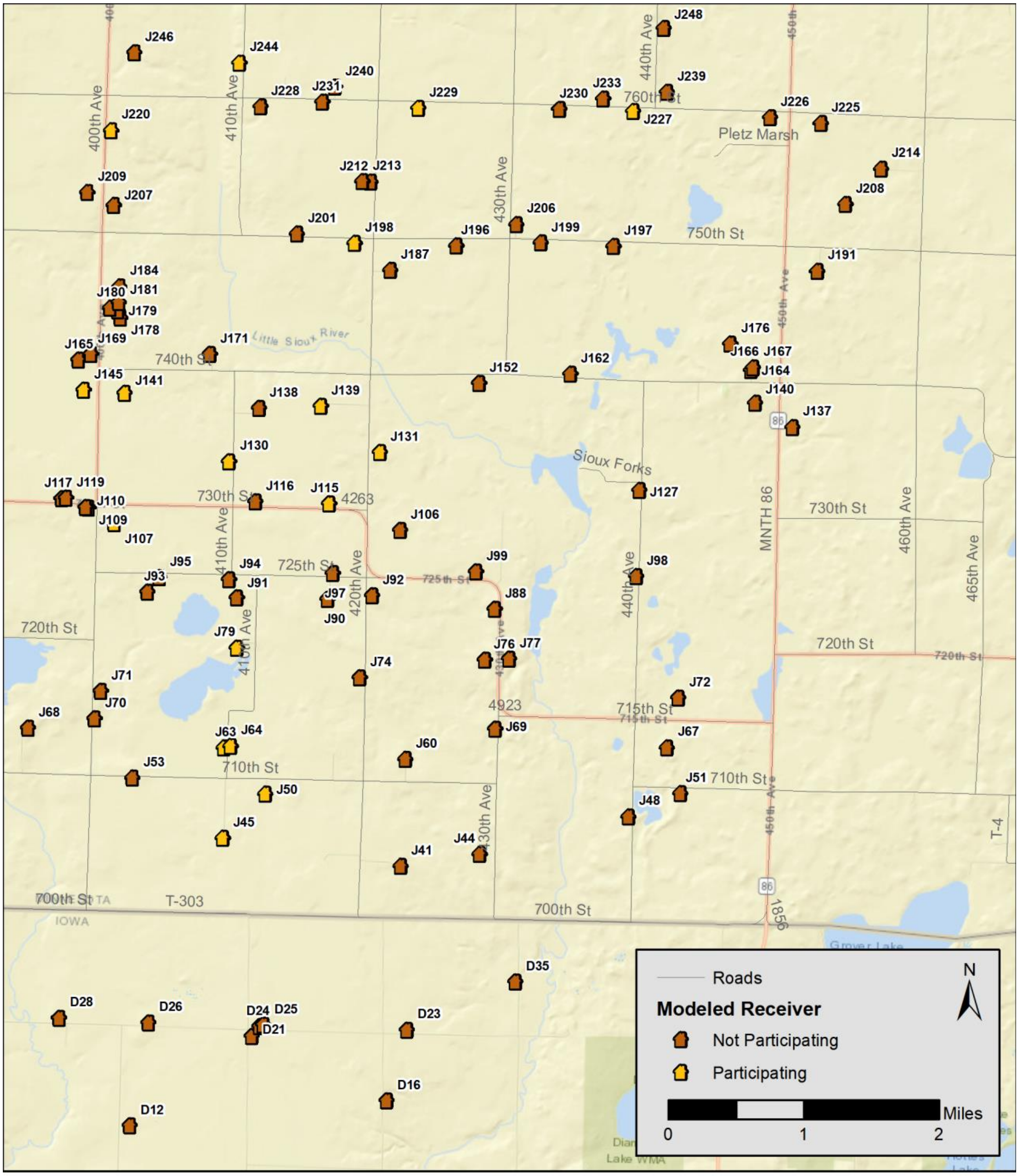
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

FIGURE 36: MAP OF MODELED RECEIVERS - SOUTHWEST PROJECT AREA



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

FIGURE 37: MAP OF MODELED RECEIVERS - SOUTH-CENTRAL PROJECT AREA



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

FIGURE 38: MAP OF MODELED RECEIVERS - SOUTHEAST PROJECT AREA

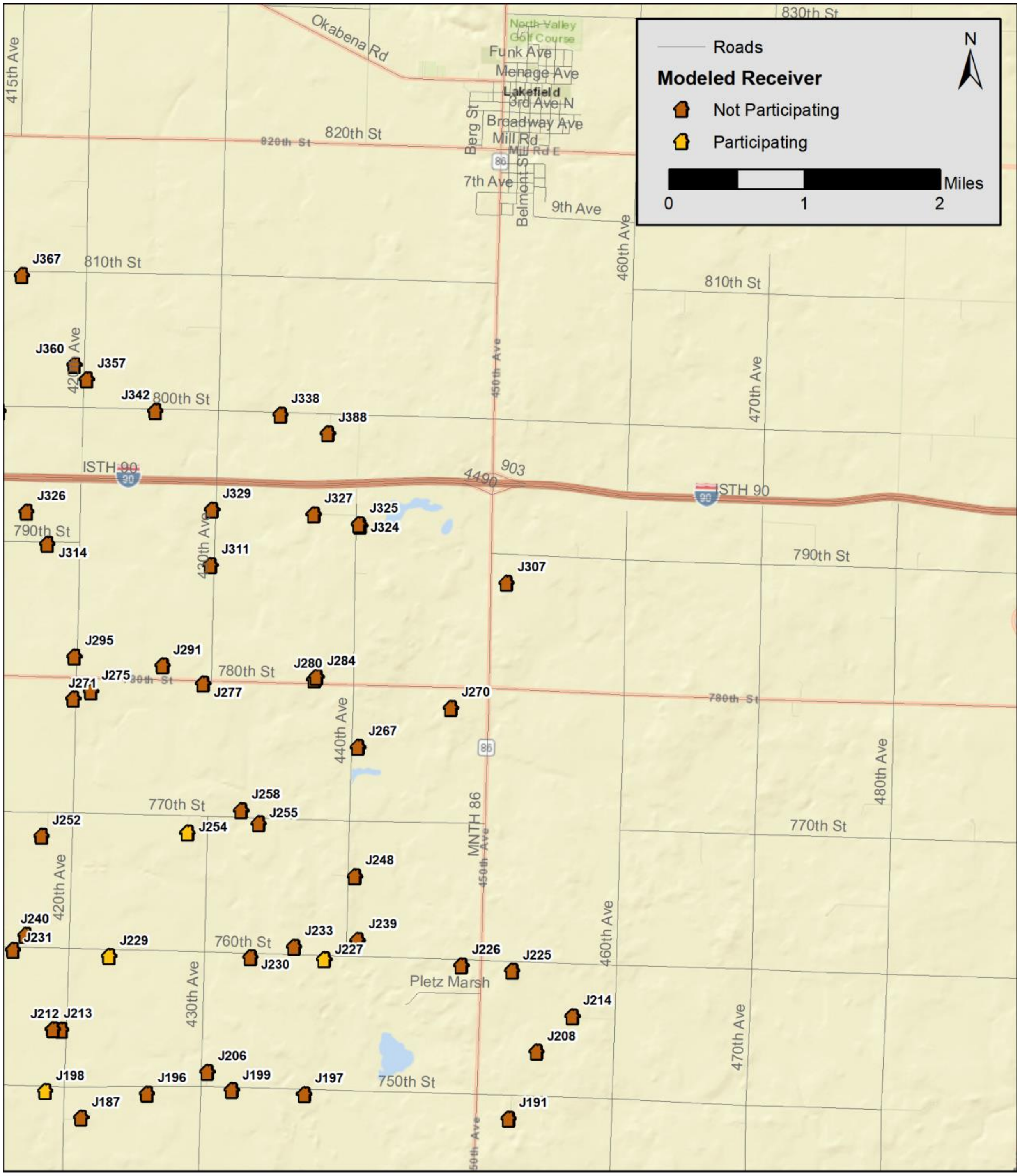


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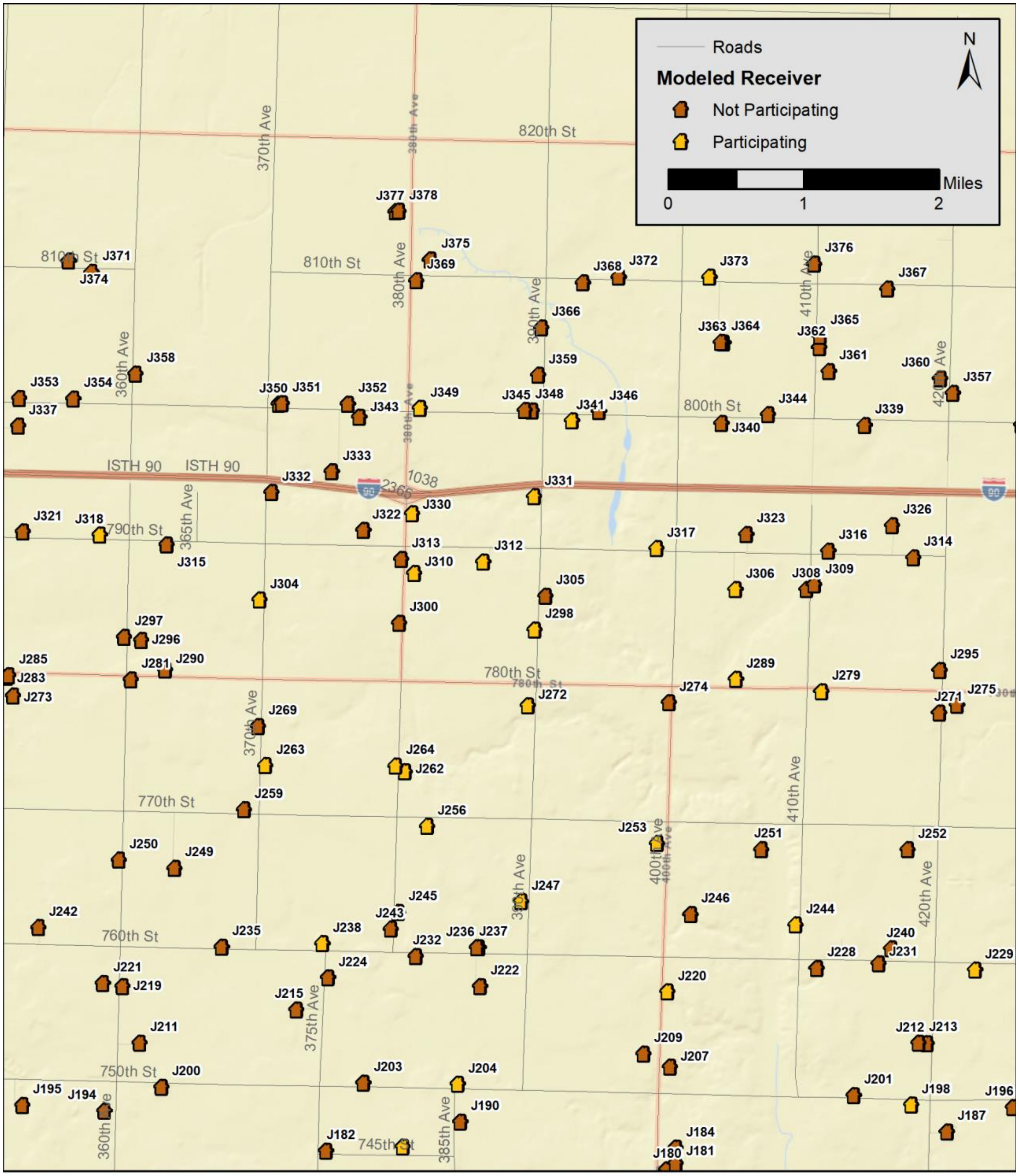
FIGURE 39: MAP OF MODELED RECEIVERS - NORTHEAST PROJECT AREA



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

FIGURE 40: MAP OF MODELED RECEIVERS – NORTH-CENTRAL PROJECT AREA

TABLE 12: MODELED RECEIVER RESULTS, WITH AND WITHOUT BACKGROUND SOUND LEVELS (L_{50})

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J39	44	44	45	45	48	312341	4819054	461
J40	46	46	46	47	49	304846	4819436	473
J41	43	43	44	45	47	319831	4819438	454
J42	44	44	45	45	48	311652	4819556	457
J43	44	44	45	45	48	313768	4819658	455
J44	40	40	41	43	46	320771	4819582	447
J45	47	47	47	48	49	317718	4819771	457
J46	43	43	44	45	47	303525	4819945	475
J47	44	44	45	45	48	306479	4819923	473
J48	33	35	37	41	45	322540	4820027	437
J49	45	45	45	46	48	307963	4820227	469
J50	45	45	45	46	48	318224	4820294	452
J51	31	34	36	41	45	323158	4820303	440
J52	40	40	41	43	46	312006	4820535	464
J53	44	44	45	45	48	316647	4820486	456
J54	45	45	45	46	48	306284	4820616	472
J55	40	40	41	43	46	314928	4820522	453
J56	45	45	45	46	48	303193	4820674	474
J57	42	42	43	44	47	309536	4820642	469
J58	45	45	45	46	48	304083	4820723	470
J59	42	42	43	44	47	309770	4820720	467
J60	40	40	41	43	46	319886	4820710	447
J61	42	42	43	44	47	309068	4820891	467
J62	42	42	43	44	47	309106	4820933	468
J63	46	46	46	47	49	317731	4820844	448
J64	46	46	46	47	49	317807	4820864	449
J65	45	45	45	46	48	304449	4821052	469
J66	42	42	43	44	47	308021	4821014	464
J67	31	34	36	41	45	322997	4820848	443
J68	40	40	41	43	46	315405	4821079	455
J69	38	39	40	42	46	320955	4821066	441

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J70	39	40	40	43	46	316192	4821188	448
J71	39	40	40	43	46	316267	4821515	452
J72	32	34	37	41	45	323133	4821435	436
J73	40	40	41	43	46	313725	4821714	449
J74	46	46	46	47	49	319346	4821678	451
N380	31	34	36	41	45	300147	4821969	476
J75	41	41	42	44	46	308133	4821899	470
J76	40	40	41	43	46	320829	4821884	440
J77	38	39	40	42	46	321122	4821901	440
J78	40	40	41	43	46	312217	4822007	450
J79	42	42	43	44	47	317881	4822028	450
J80	45	45	45	46	48	313908	4822235	454
N379	32	34	37	41	45	301378	4822432	475
J81	38	39	40	42	46	302838	4822419	470
J82	35	36	38	41	45	302105	4822438	478
J84	45	45	45	46	48	309387	4822455	462
J85	40	40	41	43	46	304224	4822588	471
J86	38	39	40	42	46	303467	4822619	473
J87	44	44	45	45	48	307194	4822577	473
J88	38	39	40	42	46	320947	4822493	437
J89	45	45	45	46	48	313581	4822599	456
J90	41	41	42	44	46	318959	4822609	449
J91	43	43	44	45	47	317885	4822626	450
J92	43	43	44	45	47	319493	4822649	446
J93	42	42	43	44	47	316822	4822694	447
J94	45	45	45	46	48	317792	4822840	450
J95	43	43	44	45	47	316962	4822868	448
J96	46	46	46	47	49	304957	4823068	475
J97	41	41	42	44	46	319025	4822914	449
J98	30	33	36	40	45	322633	4822882	438
J99	38	39	40	42	46	320725	4822934	439
J100	47	47	47	48	49	313834	4823222	453
J101	42	42	43	44	47	308967	4823316	466
J102	43	43	44	45	47	308082	4823328	463

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J103	44	44	45	45	48	306595	4823386	468
J104	46	46	46	47	49	310520	4823405	459
J105	37	38	39	42	46	303989	4823577	470
J106	39	40	40	43	46	319823	4823428	441
J107	46	46	46	47	49	316426	4823508	452
J108	43	43	44	45	47	313629	4823711	454
J109	47	47	47	48	49	316120	4823694	453
J110	47	47	47	48	49	316092	4823697	452
J111	42	42	43	44	47	313604	4823778	454
J112	43	43	44	45	47	313895	4823776	455
J114	42	42	43	44	47	313775	4823796	452
J115	41	41	42	44	46	318983	4823741	442
J116	47	47	47	48	49	318104	4823766	448
J117	46	46	46	47	49	315804	4823802	453
J119	46	46	46	47	49	315852	4823809	453
J120	46	46	46	47	49	314800	4823853	456
J121	43	43	44	45	47	314079	4823866	460
J122	42	42	43	44	47	313605	4823885	457
J123	42	42	43	44	47	311808	4823909	460
J124	44	44	45	45	48	308112	4823966	466
J125	47	47	47	48	49	308507	4823968	467
J126	40	40	41	43	46	305494	4824033	465
J127	33	35	37	41	45	322667	4823905	435
J128	41	41	42	44	46	306494	4824105	463
J129	46	46	46	47	49	309353	4824076	461
J130	46	46	46	47	49	317793	4824244	447
J131	41	41	42	44	46	319582	4824352	438
J132	41	41	42	44	46	307100	4824520	469
J133	44	44	45	45	48	307944	4824640	469
J134	38	39	40	42	46	310376	4824760	465
J135	39	40	40	43	46	312453	4824763	463
J136	39	40	40	43	46	312132	4824783	462
J137	29	33	36	40	45	324485	4824652	437
J138	43	43	44	45	47	318150	4824875	445

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J139	47	47	47	48	49	318884	4824900	443
J140	29	33	36	40	45	324041	4824940	443
J141	47	47	47	48	49	316551	4825057	450
J142	33	35	37	41	45	304329	4825202	470
J143	34	35	38	41	45	305070	4825199	471
J144	32	34	37	41	45	304354	4825225	471
J145	47	47	47	48	49	316065	4825090	450
J146	32	34	37	41	45	304366	4825250	471
J147	31	34	36	41	45	304410	4825302	472
J148	31	34	36	41	45	304427	4825322	472
J149	32	34	37	41	45	304437	4825327	472
J150	32	34	37	41	45	304466	4825357	471
J151	30	33	36	40	45	302387	4825387	471
J152	39	40	40	43	46	320765	4825175	439
J153	33	35	37	41	45	304470	4825376	471
J155	33	35	37	41	45	304487	4825386	472
J156	32	34	37	41	45	304520	4825430	471
J157	29	33	36	40	45	302388	4825455	471
J158	32	34	37	41	45	304531	4825456	471
J159	32	34	37	41	45	304538	4825465	470
J160	35	36	38	41	45	306444	4825452	468
J161	31	34	36	41	45	304545	4825478	469
J162	35	36	38	41	45	321846	4825287	434
J163	32	34	37	41	45	304552	4825493	469
J164	31	34	36	41	45	323994	4825329	446
J165	45	45	45	46	48	316003	4825448	452
J166	31	34	36	41	45	324019	4825362	446
J167	31	34	36	41	45	324019	4825362	446
J168	37	38	39	42	46	310705	4825557	458
J169	44	44	45	45	48	316153	4825520	452
J170	34	35	38	41	45	305905	4825652	472
J171	42	42	43	44	47	317561	4825517	439
J172	39	40	40	43	46	307859	4825639	467
J381	32	34	37	41	45	304724	4825701	471

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J173	39	40	40	43	46	309090	4825738	464
J174	34	35	38	41	45	306787	4825804	465
J175	29	33	36	40	45	302088	4825863	476
J176	32	34	37	41	45	323750	4825643	444
J177	37	38	39	42	46	309451	4825939	464
J178	43	43	44	45	47	316504	4825953	447
J179	43	43	44	45	47	316471	4826037	449
J180	44	44	45	45	48	316378	4826066	448
J181	43	43	44	45	47	316487	4826138	447
J182	39	40	40	43	46	312329	4826290	458
J183	46	46	46	47	49	313245	4826338	456
J184	44	44	45	45	48	316487	4826323	447
J185	31	34	36	41	45	305057	4826524	473
J186	35	36	38	41	45	308146	4826569	467
J187	46	46	46	47	49	319710	4826519	443
J188	28	32	36	40	45	303093	4826727	469
J384	28	32	36	40	45	302870	4826749	472
J189	28	32	36	40	45	303313	4826755	474
J383	28	32	36	40	45	302936	4826761	472
J382	28	32	36	40	45	302963	4826764	472
J190	46	46	46	47	49	313930	4826636	454
J191	30	33	36	40	45	324784	4826508	448
J192	28	32	36	40	45	303269	4826769	473
J193	27	32	36	40	45	303148	4826800	470
J194	34	35	38	41	45	309700	4826763	458
J195	34	35	38	41	45	308726	4826831	464
J196	47	47	47	48	49	320494	4826806	440
J197	39	40	40	43	46	322361	4826798	435
J198	43	43	44	45	47	319285	4826836	442
J199	41	41	42	44	46	321498	4826844	438
J200	35	36	38	41	45	310374	4827047	456
J201	42	42	43	44	47	318601	4826950	443
J202	29	33	36	40	45	304977	4827135	469
J203	44	44	45	45	48	312773	4827095	456

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J204	46	46	46	47	49	313898	4827085	454
J205	32	34	37	41	45	307208	4827219	470
J206	43	43	44	45	47	321206	4827063	438
J207	44	44	45	45	48	316420	4827288	446
J208	30	33	36	40	45	325115	4827302	452
J209	46	46	46	47	49	316107	4827442	447
J210	32	34	37	41	45	307875	4827561	462
J211	34	35	38	41	45	310117	4827570	456
J212	44	44	45	45	48	319474	4827566	443
J213	43	43	44	45	47	319373	4827570	443
J214	29	33	36	40	45	325541	4827722	452
J215	37	38	39	42	46	311983	4827964	453
J216	27	32	36	40	45	305299	4828075	472
J217	29	33	36	40	45	306173	4828109	468
J218	32	34	37	41	45	308339	4828148	465
J219	34	35	38	41	45	309915	4828246	457
J220	47	47	47	48	49	316388	4828178	446
J221	33	35	37	41	45	309678	4828281	459
J222	42	42	43	44	47	314163	4828243	453
J223	32	34	37	41	45	308096	4828334	464
J224	38	39	40	42	46	312353	4828346	455
J225	31	34	36	41	45	324828	4828264	457
J226	33	35	37	41	45	324222	4828329	443
J227	41	41	42	44	46	322596	4828401	436
J228	41	41	42	44	46	318167	4828459	441
J229	44	44	45	45	48	320044	4828440	440
J230	47	47	47	48	49	321717	4828426	438
J231	42	42	43	44	47	318898	4828515	445
J232	40	40	41	43	46	313397	4828603	453
J233	45	45	45	46	48	322238	4828551	439
J234	27	32	36	40	45	305902	4828758	461
J235	36	37	39	41	46	311089	4828714	454
J236	43	43	44	45	47	314145	4828704	451
J237	42	42	43	44	47	314125	4828707	451

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J238	38	39	40	42	46	312288	4828756	452
J239	39	40	40	43	46	322992	4828631	437
J240	43	43	44	45	47	319047	4828691	445
J241	28	32	36	40	45	306274	4828907	463
J242	32	34	37	41	45	308918	4828944	461
J243	40	40	41	43	46	313102	4828925	453
J244	44	44	45	45	48	317913	4828977	439
J245	40	40	41	43	46	313188	4829125	454
J246	45	45	45	46	48	316668	4829101	443
J247	47	47	47	48	49	314651	4829254	457
J248	40	40	41	43	46	322958	4829389	440
J249	37	38	39	42	46	310533	4829647	456
J250	34	35	38	41	45	309869	4829744	460
J251	44	44	45	45	48	317504	4829873	441
J252	46	46	46	47	49	319241	4829867	443
J253	47	47	47	48	49	316264	4829942	452
J254	45	45	45	46	48	320975	4829904	444
J255	44	44	45	45	48	321816	4830017	438
J256	43	43	44	45	47	313536	4830150	459
J257	30	33	36	40	45	308123	4830214	463
J258	45	45	45	46	48	321605	4830172	439
J259	45	45	45	46	48	311355	4830342	455
J260	27	32	36	40	45	305908	4830474	465
J261	28	32	36	40	45	306739	4830465	462
J262	46	46	46	47	49	313271	4830793	454
J263	47	47	47	48	49	311613	4830867	455
J264	47	47	47	48	49	313159	4830866	452
J265	30	33	36	40	45	308286	4830992	460
J266	26	31	36	40	45	306671	4831034	463
J267	38	39	40	42	46	322997	4830922	440
J268	27	32	36	40	45	306681	4831171	462
J269	45	45	45	46	48	311523	4831331	454
J270	32	34	37	41	45	324096	4831388	449
J271	46	46	46	47	49	319617	4831495	443

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J272	46	46	46	47	49	314729	4831576	447
J273	31	34	36	41	45	308611	4831698	458
J274	43	43	44	45	47	316406	4831613	449
J275	44	44	45	45	48	319827	4831583	443
J276	28	32	36	40	45	308386	4831779	455
J277	41	41	42	44	46	321158	4831673	440
J278	27	32	36	40	45	306677	4831874	460
J279	46	46	46	47	49	318217	4831748	445
J280	38	39	40	42	46	322480	4831726	447
J281	34	35	38	41	45	310013	4831886	458
J282	29	33	36	40	45	308402	4831915	456
J283	30	33	36	40	45	308534	4831916	456
J284	38	39	40	42	46	322503	4831755	447
J285	30	33	36	40	45	308556	4831936	456
J286	24	31	35	40	45	306775	4831962	459
J287	26	31	36	40	45	306814	4831962	460
J288	27	32	36	40	45	306875	4831965	459
J289	44	44	45	45	48	317203	4831893	443
J290	36	37	39	41	46	310422	4832003	457
J291	40	40	41	43	46	320676	4831889	442
J292	26	31	36	40	45	306814	4832055	459
J293	26	31	36	40	45	306853	4832058	458
J294	26	31	36	40	45	306764	4832061	459
J295	42	42	43	44	47	319626	4831998	446
J296	34	35	38	41	45	310137	4832354	451
J297	33	35	37	41	45	309933	4832394	452
J298	46	46	46	47	49	314809	4832481	449
J299	26	31	36	40	45	306784	4832622	458
J300	46	46	46	47	49	313199	4832559	453
J302	24	31	35	40	45	306806	4832763	457
J303	24	31	35	40	45	306806	4832763	457
J304	38	39	40	42	46	311543	4832836	453
J305	47	47	47	48	49	314938	4832879	447
J306	47	47	47	48	49	317194	4832961	444

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J307	28	32	36	40	45	324761	4832872	448
J308	44	44	45	45	48	318041	4832961	442
J309	43	43	44	45	47	318137	4833013	444
J310	44	44	45	45	48	313379	4833149	451
J311	34	35	38	41	45	321245	4833083	441
J312	46	46	46	47	49	314202	4833289	450
J313	43	43	44	45	47	313223	4833320	451
J314	37	38	39	42	46	319311	4833336	439
J315	33	35	37	41	45	310441	4833492	452
J316	41	41	42	44	46	318299	4833418	440
J317	45	45	45	46	48	316261	4833447	446
J318	31	34	36	41	45	309645	4833608	453
J319	25	31	35	40	45	306749	4833660	454
J320	26	31	36	40	45	307114	4833659	457
J321	29	33	36	40	45	308733	4833642	452
J322	40	40	41	43	46	312775	4833661	449
J323	44	44	45	45	48	317326	4833614	443
J324	30	33	36	40	45	323020	4833550	446
J325	30	33	36	40	45	323008	4833567	447
J326	36	37	39	41	46	319062	4833719	439
J327	30	33	36	40	45	322470	4833686	446
J328	25	31	35	40	45	306748	4833875	458
J329	33	35	37	41	45	321260	4833740	441
J330	43	43	44	45	47	313357	4833858	448
J331	45	45	45	46	48	314806	4834061	440
J332	34	35	38	41	45	311682	4834110	449
J333	38	39	40	42	46	312402	4834357	445
J334	27	32	36	40	45	308126	4834554	452
J336	24	31	35	40	45	306846	4834908	452
J337	26	31	36	40	45	308676	4834899	450
J338	30	33	36	40	45	322075	4834869	443
J339	34	35	38	41	45	318730	4834910	440
J340	38	39	40	42	46	317030	4834932	445
J341	41	41	42	44	46	315255	4834964	443

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J342	32	34	37	41	45	320593	4834911	443
J343	39	40	40	43	46	312729	4835005	448
J344	36	37	39	41	46	317585	4835036	444
J345	40	40	41	43	46	314779	4835079	445
J346	40	40	41	43	46	315574	4835073	444
J348	40	40	41	43	46	314692	4835088	445
J349	46	46	46	47	49	313447	4835110	445
J350	33	35	37	41	45	311773	4835158	449
J351	34	35	38	41	45	311809	4835167	449
J352	38	39	40	42	46	312588	4835161	448
J353	27	32	36	40	45	308691	4835228	448
J354	28	32	36	40	45	309327	4835224	448
J355	24	31	35	40	45	307337	4835322	452
J356	26	31	36	40	45	307904	4835370	451
J357	32	34	37	41	45	319778	4835290	442
J358	29	33	36	40	45	310072	4835521	451
J359	38	39	40	42	46	314851	4835504	442
J360	32	34	37	41	45	319630	4835463	442
J361	33	35	37	41	45	318307	4835551	442
J362	33	35	37	41	45	318195	4835835	442
J363	34	35	38	41	45	317056	4835889	445
J364	34	35	38	41	45	317023	4835894	445
J365	31	34	36	41	45	318199	4835969	442
J366	35	36	38	41	45	314891	4836067	441
J367	30	33	36	40	45	319006	4836530	441
J368	33	35	37	41	45	315383	4836605	441
J369	33	35	37	41	45	313404	4836630	445
J370	24	31	35	40	45	308191	4836698	450
J371	27	32	36	40	45	309547	4836728	450
J372	31	34	36	41	45	315807	4836673	441
J373	32	34	37	41	45	316885	4836669	439
J374	26	31	36	40	45	309276	4836860	450
J375	32	34	37	41	45	313573	4836874	444
J376	31	34	36	41	45	318132	4836825	442

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
J377	30	33	36	40	45	313158	4837446	444
J378	30	33	36	40	45	313193	4837452	444
N385	31	34	36	41	45	300916	4823298	476
N386	30	33	36	40	45	300927	4823625	475
N387	30	33	36	40	45	300891	4824176	480
J388	30	33	36	40	45	322637	4834650	447
D1	43	43	44	45	47	309434	4815927	468
D2	41	41	42	44	46	313337	4815925	448
O3	45	45	45	46	48	303618	4816088	478
D4	44	44	45	45	48	310848	4816129	464
O5	44	44	45	45	48	304513	4816243	479
O6	44	44	45	45	48	304597	4816244	474
D7	43	43	44	45	47	310251	4816201	462
D8	45	45	45	46	48	312690	4816212	461
O9	46	46	46	47	49	304996	4816305	478
O11	44	44	45	45	48	304049	4816348	483
D12	46	46	46	47	49	316613	4816356	451
O13	45	45	45	46	48	306834	4816494	471
D14	46	46	46	47	49	313378	4816421	455
D15	47	47	47	48	49	314610	4816467	461
D16	47	47	47	48	49	319666	4816652	448
O17	47	47	47	48	49	306849	4817068	468
O18	43	43	44	45	47	301926	4817150	482
O19	47	47	47	48	49	303665	4817358	481
D20	47	47	47	48	49	313561	4817415	456
D21	46	46	46	47	49	318060	4817414	457
D22	46	46	46	47	49	314129	4817544	458
D23	46	46	46	47	49	319904	4817494	449
D24	46	46	46	47	49	318152	4817534	458
D25	46	46	46	47	49	318200	4817552	458
D26	47	47	47	48	49	316834	4817580	454
D27	47	47	47	48	49	309593	4817705	468
D28	46	46	46	47	49	315773	4817635	450
D29	46	46	46	47	49	309262	4817730	468

RECEIVER ID	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL (dBA)	COMBINED BACKGROUND AND MODELED SOUND PRESSURE LEVEL (L_{50}, dBA)				COORDINATES (UTM NAD83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
		30 dBA Background	*35 dBA Background*	*40 dBA Background*	*45 dBA Background*	X (m)	Y (m)	
D30	47	47	47	48	49	308116	4817831	473
D31	45	45	45	46	48	313576	4817777	459
O32	41	41	42	44	46	301194	4818039	476
D33	46	46	46	47	49	314926	4817940	455
D34	47	47	47	48	49	307486	4818163	475
D35	44	44	45	45	48	321195	4818063	434
O36	43	43	44	45	47	302151	4818329	475
O37	38	39	40	42	46	300892	4818556	466
O38	47	47	47	48	49	304738	4819118	478

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