# SOUTH RIPLEY SOLAR PROJECT NOISE IMPACT ASSESSMENT

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ConnectGen

**Report Title**:

South Ripley Solar Project Noise Impact Assessment


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**Report Prepared for**:

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# 1.0 INTRODUCTION

This report is a Project Noise Impact Assessment ("PNIA") of the proposed South Ripley Solar Energy Center (the "Project") as part of its permit application under Chapter XVIII Title 19 of New York Codes, Rules, and Regulations (NYCRR), Part 900 (also known as Section 94-c).[1]

The project will be located in the town of Ripley in Chautauqua County, New York. The area around the project is primarily farmland with some forested and residential areas. The Project is proposed as a 270 MW solar facility with supporting infrastructure that may include approximately 20 MW of energy storage.

This PNIA evaluates the sound generated by the Project and was conducted as part of the Section 94-c permitting process and in accordance with its regulations.

The PNIA includes:

1. A description of the Project.
2. A discussion of sound level limit standards and guidelines applicable to the Project.
3. Sound level monitoring procedures.
4. Sound monitoring results from monitoring conducted within the Project area.
5. Sound propagation modeling procedures.
6. Sound propagation modeling results.
7. A discussion and analysis of construction noise and its mitigation.
8. Conclusions.

A primer and glossary discussing terms found in this report are in Appendix E and Appendix F, respectively.

[1] This study was prepared by Mr. Kenneth Kaliski of Resource Systems Group, Inc. (RSG). Mr. Kaliski is Board Certified through the Institute of Noise Control Engineering, a Professional Engineer (licenses in Vermont, New Hampshire, Illinois, Michigan, and Massachusetts) and is a member of the Acoustical Society of America. RSG is a member of the National Council of Acoustical Consultants. Mr. Kaliski has 35 years of experience at RSG. He has substantial experience with noise from renewable energy facilities and is the co-author of "An overview of sound from commercial photovoltaic facilities," Proceedings of Noise-Con 2020, New Orleans, Louisiana.

# 2.0 STANDARDS, GUIDELINES, AND PROJECT DESIGN GOALS

This section describes the noise regulations that apply to the Project and any additional sound level design goals. Local standards are discussed first, followed by Section 94-c standards, and international guidelines referenced in Section 94-c.

## 2.1 TOWN NOISE STANDARD

The Town of Ripley Zoning Document (February 9, 2017) requires a "noise level study" for permit submission but does not provide quantitative noise standards:

> ***Section 620 "Solar and Wind Systems***
> *Solar Panels may be considered accessory "structures" and they do present peculiar safety hazards and challenges (agricultural or otherwise) for First Responders and Fire Departments. They are subject to site plan and other specific review, NYS constitution article XIV and NYS SEQR refer. Minimum requisites for submission and County referral are:*
> 1. *Draft sketch of installation including boundary lines.*
> 2. *Reflectivity and noise level studies.*
> 3. *Certification of limitation to allowable 110% farm use*

On May 18, 2021, the Town Board of Ripley introduced a potential amendment to the Town of Ripley's Zoning Law which included an update to the current noise requirements for solar energy projects. A public hearing to take public input has been scheduled on June 28, 2021 and the amendment has been sent to the Chautauqua County Office of Planning and Economic Development for review. The proposed amendment is as follows:

> *"Noise: Once in operation, sound pressure level at the exterior of any residence or non-participating property line, expressed in terms of dBA Leq-8hr, shall not exceed existing background ambient noise, expressed in dBA Leq-8hr as measured by a qualified acoustician, by more than 6dB."*

The language has not yet been adopted by the Town and thus does not govern siting of solar energy facilities at the time of this study.

## 2.2 STATE REGULATIONS

The Project is evaluated by New York State under Chapter XVIII, Title 19 of NYCRR Part 900, and noise is evaluated specifically under the State of New York Office of Renewable Energy Siting, Part 900-2.8, Exhibit 7, also called "Section 94-c".

For solar facilities, the regulation specifies a maximum exterior noise limit of 45 dBA $L_{8h}$ at the outside of any existing non-participating residence and 55 dBA $L_{8h}$ at the outside of any existing participating residence. Noise from collector substation equipment is limited to 40 dBA $L_{1h}$ at existing nonparticipating residences. Audible prominent tones are given a +5 dBA penalty at residences. The tonal penalty applies only at residences, not at residential property lines. The standards are as measured outside the home or building housing the sensitive land use (residence, seasonal residence, school, hospital, etc.) and would not apply to areas that have transient uses such as camps, driveways, trails, farm fields, and parking areas.[2]

The regulations also specify a standard of 55 dBA $L_{8h}$ at any portion of a nonparticipating property except NYS-regulated wetlands and utility rights-of-way.

A radius of evaluation, modeling standards, input parameters, and assumptions are also given in the regulations, as well as evaluation procedures for prominent tones, ambient pre-construction baseline conditions, modeling of future noise levels, and reasonable noise abatement measures for operational and construction activities. Relevant excerpts from the regulation can be found in Appendix A.

## 2.3 WORLD HEALTH ORGANIZATION

The United Nation's World Health Organization (WHO) has published "Guidelines for Community Noise" (1999) which uses research on the health impacts of noise to develop guideline sound levels for communities. The foreword of the report states, "The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments."

The WHO long-term guideline to protect against hearing impairment is 70 dBA $L_{24h}$ over a lifetime exposure, and higher for occupational or recreational exposure. For short-term protection against hearing impairment due to impulsive sound the guideline is 120 dB-peak for children and 140 dB-peak for adults. Section 94-c requires comparison with these thresholds for construction and blasting.

## 2.4 SOUND THRESHOLDS FOR SOUTH RIPLEY SOLAR

A summary of the design goals, regulatory limits, and proposed assessment thresholds are shown in Table 1.

[2] Seasonal homes have operating septic systems or running water whereas "camps" do not. Seasonal homes are considered sensitive receptors, but camps are not.

**TABLE 1: PROJECT DESIGN GOALS AND REGULATORY LIMITS**

| To Address | Guideline or Regulation |
|---|---|
| Section 94-c regulations – residences exterior | Nonparticipating: 45 dBA $L_{8h}$ |
| | Participating: 55 dBA $L_{8h}$ |
| Section 94-c regulations – residential property lines | Nonparticipating: 55 dBA $L_{8h}$ |
| Section 94-c regulation – from substation noise | 40 dBA $L_{1h}$ for nonparticipating residences |
| WHO 1999 hearing impairment guidelines [per Section 94-c, Exhibit 7(m)(1)] | 120 dB-peak for children |
| | 140 dB-peak for adults |
| | 70 dBA $L_{24h}$ |
| ANSI S12.9 Part 4 tonal penalty [per Section 94-c, Exhibit 7(b)(2)(ii)] | 5 dB penalty for audible prominent tones at sensitive receptors |

# 3.0 PROJECT DESCRIPTION

## 3.1 PROJECT AREA

The Project area is immediately to the east of the Pennsylvania and New York border, south of Interstate 90 and north of Interstate 86. State Route 64 and State Route 303 run northwest to southeast through the project. The Project is situated between the towns of North East, PA and Sherman, NY, located about 6 km (3.75 miles) from each town. The major geographical features in the area, which is a mixture of open agricultural land and forests, include Lake Erie (10 km to the north) and the Twentymile Creek valley, which runs to the north side of the Project. A high-voltage power line right-of-way cuts through the western side of the Project from southwest to northeast. A railroad parallels NY-20 about 5 km (3 miles) north of the Project area. A regional map of the Project area is shown in Figure 1.

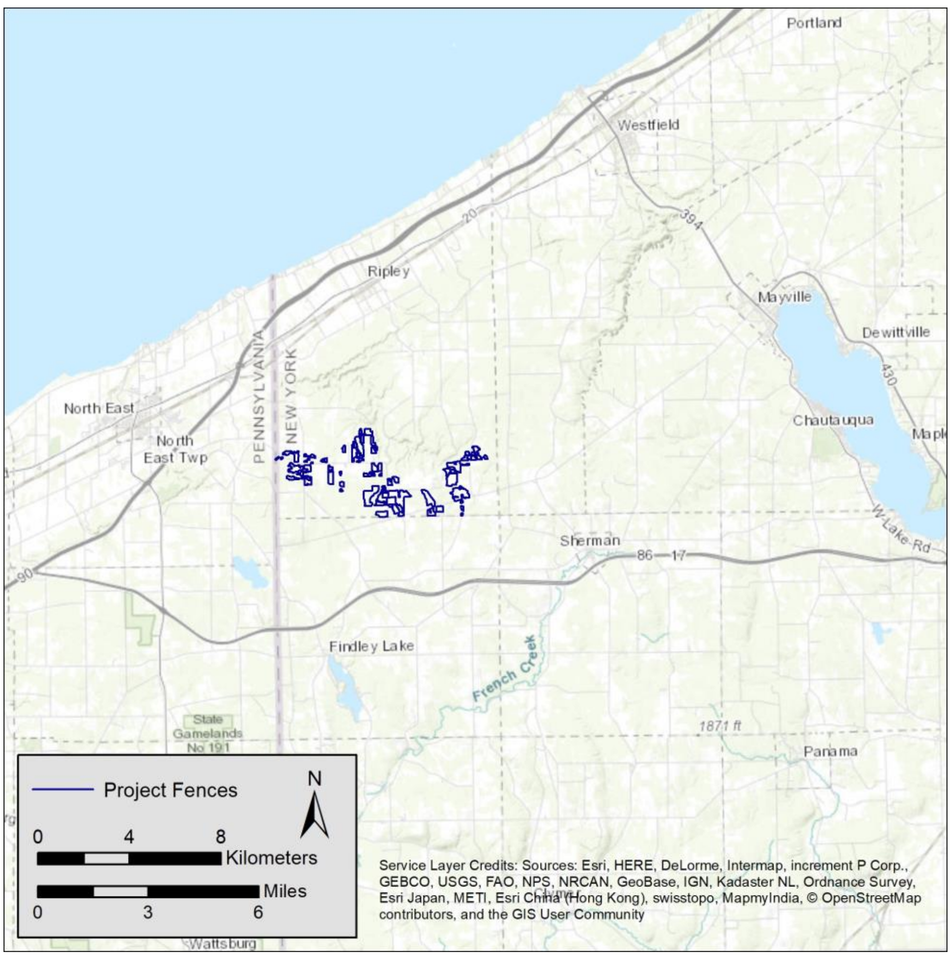


**FIGURE 1. REGIONAL MAP**

Land within the project boundary is primarily forested and open land. The open areas in the region are dominated by homestead plots and agriculture, including working farms and livestock agriculture. Rural residential homesteads are located throughout the region, mostly occupying cleared land and old farm fields. Seasonal hobby activities such as snowmobiling, operation of off-road ATV's, hunting, fishing, and gardening are widespread. Livestock agriculture is predominant, that is, raising of cattle for milk and beef. Beef and milk operations include cornfields and hayfields for livestock feed, open fields for grazing, milking barns, and the operation of farm equipment on local roads and throughout the fields.

## 3.2 PROJECT ELEMENTS

The primary operational sound sources include:

- A high-voltage substation transformer rated at 285 MVA, 825 kV BIL, and steps up power to the distribution grid voltage of 230 kV. The transformer will have sound emissions that are guaranteed by the manufacturer to be at least 10 dB below that allowed by the NEMA TR-1 standard.
- 2,232 string inverters rated between 1 and 3 MVA. The inverters will have a temperature-controlled cooling fan that will operate mostly during hotter weather and high loads.
- 137 medium voltage transformers ("MVT"). These transformers will not have cooling fans.
- 20 MW of energy storage. The energy storage facility will include 42 battery energy storage (BESS) units and seven power conversion system (PCS) units. The energy storage units are typically charged during the day and discharge during the evening. Cooling fans on the battery storage units are temperature controlled and would operate as a function of ambient temperature and charge/discharge loading. The discharge is rated at a four-hour duration.

The solar panels are fixed-tilt. There are no trackers. Thus, outside of the MVTs and inverters, there are no sound generating sources within the arrays.

Daytime operations could include all sources operating – potentially at their maximum capacity simultaneously. The energy storage system typically discharges during the evening (4 pm to 10 pm), but it could discharge at any time of the day or night as conditions dictate. During the night, the inverters may operate for VAR control, the MVTs are energized, and the substation transformer would be energized, but without cooling fans operating.

Electricity from all the solar arrays will come together through underground collection lines into a proposed substation located on the south side of NE Sherman Rd, adjacent to the Pennsylvania border. The nearest residence to the proposed substation is approximately 150 meters (500 ft) to northwest, on the opposite side of NE Sherman Rd

A map of the Project area showing modeled receptors, and Project elements is provided in Figure 2.

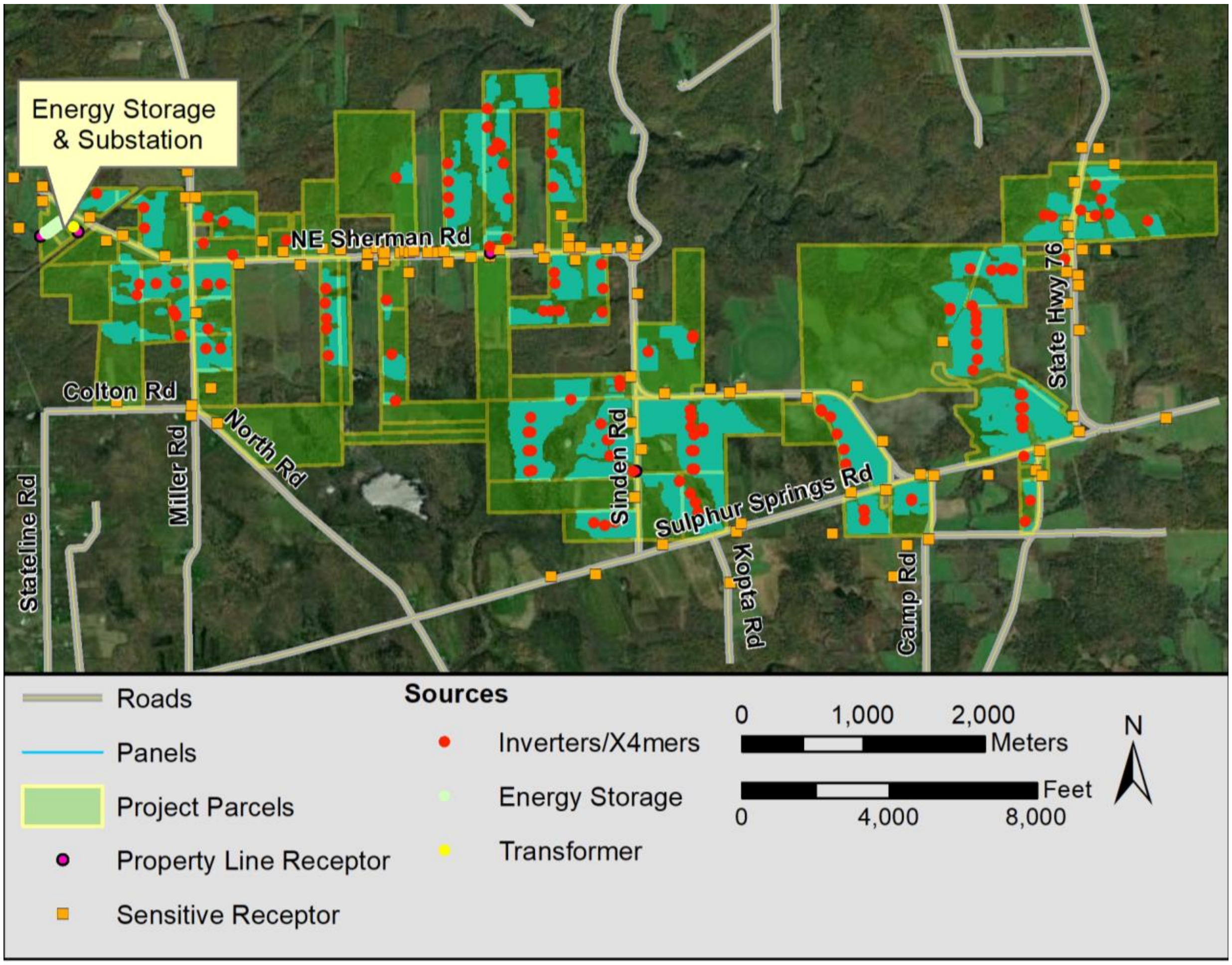


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**FIGURE 2: PROJECT SITE MAP**

# 4.0 AMBIENT PRE-CONSTRUCTION SOUND LEVEL MONITORING

A detailed monitoring program was developed to assess the ambient pre-construction sound levels for the variety of soundscapes that exist within the Project area. The Project area contains working farms and farmland, rural homesteads, and local roads. Monitoring sites were distributed throughout the Project area to be as representative as possible of the broader local soundscapes that exist in the immediate area.

## 4.1 REPRESENTATIVE MONITOR LOCATIONS

Six monitoring locations, distributed within the Project boundary, were selected as representative of the different ambient soundscapes in the area. The representative areas included rural residential, farming, low and high traffic roads, and remote areas.

The six selected monitoring locations that represent these areas are referred to by the nearest road or feature: “CR 64,” “Miller Road,” “Substation,” “CR 303,” “Sulphur Springs Road,” and “Meeder Road.” The monitoring locations are listed in Table 2, which indicates the defining characteristics of each location. The geographical distribution of the sites is shown on the map in the next section in Figure 3. Each of the sites is discussed further below.

**TABLE 2: MONITORING LOCATION CHARACTERISTICS**

| Site Name | Rural Residential | Active Farm | Low Traffic | Truck Traffic | High Traffic | Remote Area |
|---|---|---|---|---|---|---|
| CR 64 | X | X | | X | X | |
| Miller Road | | | X | | | |
| Substation | X | | | X | X | |
| CR 303 | | | X | | | X |
| Sulphur Springs Road | | | X | | | X |
| Meeder Road | X | X | | X | X | |

## 4.2 SCOPE OF MONITORING

Long-term sound level monitoring was carried out at the six sites in the winter, from March 4 to 12, 2020, and the summer, from July 9 to July 16, 2020. Monitoring locations, distributed throughout the project area, are shown in Figure 3.

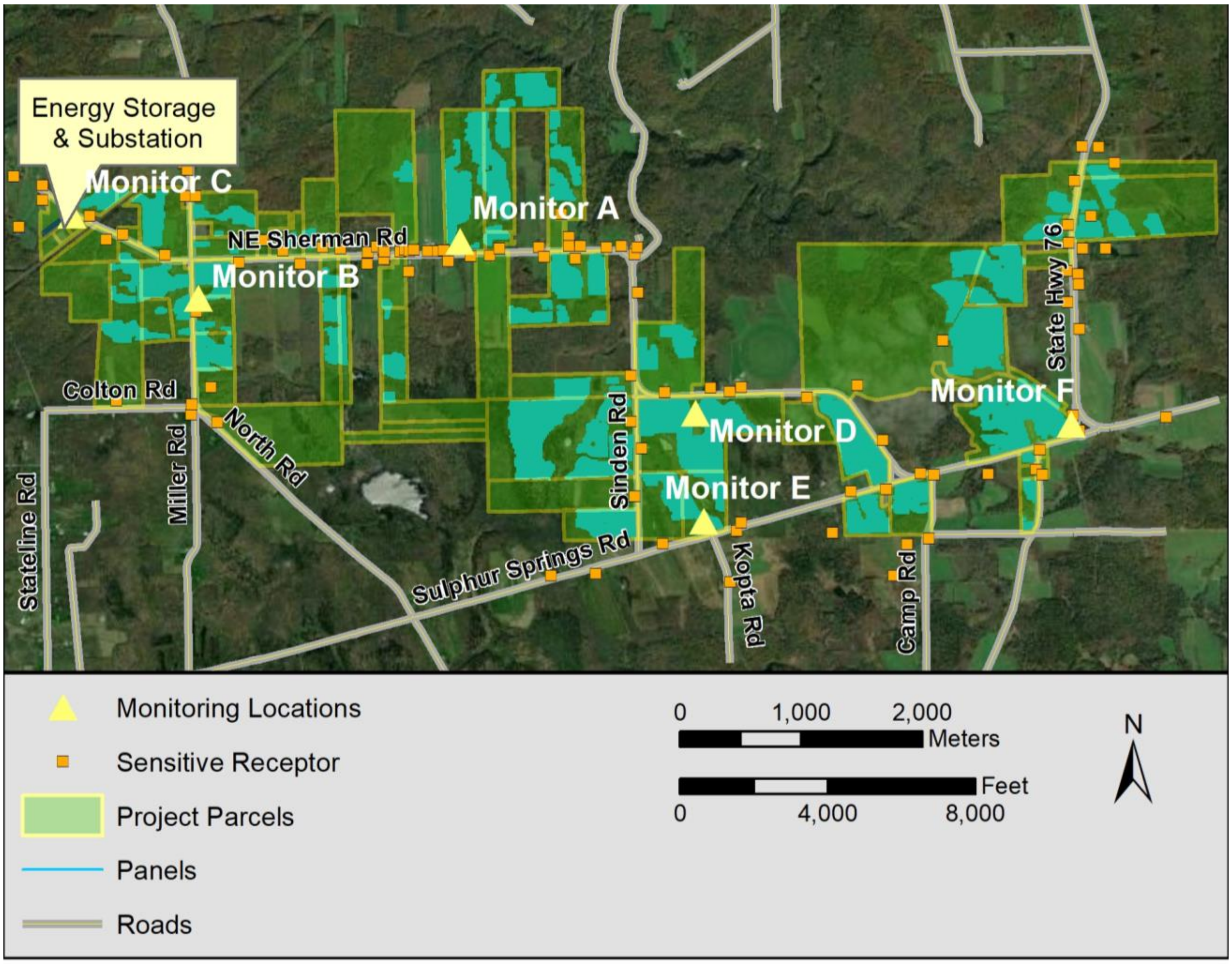


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**FIGURE 3: OVERVIEW OF MONITORING LOCATIONS**

## 4.3 METHODOLOGY

Sound level data were collected with ANSI/IEC Class 1 sound level meters that continuously logged overall and 1/3-octave band sound levels once each second. Three models of sound level meters were utilized, as shown in Table 3.

Each sound level meter microphone was mounted on a wooden stake at a height of approximately 1.2 m (4 ft.) and protected by an ACO-Pacific hydrophobic windscreen (170 mm (7 in.) diameter). Audio signals from each microphone were recorded continuously throughout the monitoring period to allow for sound source identification. The Svantek meter was set to record digital audio internally, and the Cesva meters were connected to Roland R-05 or R-09HR digital sound recorders for source identification by audio. All sound level meters were calibrated before and after monitoring periods, with either a Cesva CB-5, Larson Davis CAL200, or Brüel and Kjær 4231 calibrator, emitting a 94 dB tone at 1 kHz.

Wind speeds were logged at each monitoring site. Precipitation and air temperature were logged at Meeder Road. Although the ASOS station at Erie International Airport (ERI) is physically closer, the overall meteorology from the ASOS station at the Chautauqua County-Jamestown Airport was found to have a more accurate representation of the site.

**TABLE 3: SOUND LEVEL METERS AT EACH SITE**

| Monitor Location | Summer | Winter | Coordinates UTM NAD83 Z18N | |
|---|---|---|---|---|
| | | | X (m) | Y (m) |
| CR 64 | Cesva SC-310 | Cesva SC-310 | 605,687 | 4,672,311 |
| Miller Road | Cesva SC-310 | Svantek SV979 | 603,529 | 4,671,838 |
| Substation | Svantek SV979 | Svantek SV979 | 602,484 | 4,672,527 |
| CR 303 | Cesva SC-310 | Cirrus CR:171 | 607,637 | 4,670,893 |
| Sulphur Springs Road | Cesva SC-310 | Cirrus CR:171 | 607,702 | 4,669,999 |
| Meeder Road | Svantek SV979 | Svantek SV979 | 610,740 | 4,670,800 |

## 4.4 DATA ANALYSIS

One-second sound level data from each monitor were averaged into 10-minute periods and summarized over the entire monitoring period. Data were excluded from the averaging under the following conditions:

- Wind gust speeds above 5 m/s (11 mph)
- Temperatures below -18° C (0° F)
- Extreme values of relative humidity (equipment specification dependent)
- Precipitation in the form of rain, sleet, or ice
- Thunder
- Anomalous sounds that were out of character for the area being monitored, including nearby chainsaws, lawn equipment, and nearby farm equipment
- Seasonal sound sources such as harvesting equipment, lawn mowers, and snow removal equipment, and
- During microphone calibration.

Particularly during summer monitoring, biogenic sounds including insects, amphibians, and birds were present. These seasonal sounds were filtered out of the reported sound levels using the "ANS" frequency-weighting network when tonal bird and insect sound was found.[3] This effectively removes the high-frequency portion of biogenic sound.

## 4.5 FORMAT OF MONITORING RESULTS

Over 4,000 hours of sound level data were collected for this project. This section describes how the background sound level results are presented for each monitor over both seasons of monitoring. Following the site descriptions, the actual results are presented.

For each monitoring location, results are presented as graphs of sound level and maximum wind gust speed as a function of time throughout the monitoring period in Section 5. For each monitor site, results are presented as graphs of sound level, temperature and gust wind speed

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[3] Sounds considered tonal that get the ANS weight applied are those for which a prominent discrete high frequency (>1.25 kHz) tone is found using either of the two methods:

1. If a 1/3 octave band exceeds the neighboring 1/3 octave band on either side by more than 5 dB (as in ANSI S12.9 Part 4 Annex C), or
2. If a 1/3 octave band exceeds the average of the two neighboring lower and two neighboring upper 1/3 octave bands on each side by more than 5 dB.

The latter method is used to capture complex bird harmonic sounds that would not be considered tonal under the first method.

as a function of time throughout the monitoring period. Each plot runs from Monday through Sunday.

Each point on the graph represents data summarized for a single 10-minute interval. Equivalent continuous sound levels ($L_{eq}$) are the energy-average sound level over 10 minutes. The tenth-percentile sound level ($L_{90}$) is the sound level that is exceeded 90% of the time during each 10-minute period. Sound levels data for the winter is presented as overall A-weighted data sound levels, while summer sound levels are provided with ANS-weighting that removes tonal biogenic noise.

Processed data represent sound levels for those periods for which data have been excluded, as explained in Section 4.3. The reason for exclusion of data at a particular 10-minute interval (i.e., low temperature, wind gusts, relative humidity, or anomalous activity) is indicated in the lower portion of each figure. Sound level data during the excluded periods are shown in lighter shade for the $L_{eq}$ and $L_{90}$. Note that daylight savings occurred during the monitoring period and thus there is no data between 2 AM and 3 AM on Sunday, March 8th.

Wind data from each site are presented as average wind speed and gust wind speed. The 10-minute average wind speed data are averaged for all observations in the 10-minute interval. The gust speed is the maximum gust occurring at any time during the 10-minute interval; these are not averaged. All data provided in this report is reported in local time, which observes daylight savings time. Winter monitoring was in EST (GMT+5) while summer monitoring occurred in observance of Daylight Savings Time - EDT (GMT +4)

# 5.0 SOUND LEVEL MONITORING RESULTS

Sound level monitoring at each site is detailed in this section. The location of each site is described, followed by sound level results from the winter and summer monitoring periods.

## 5.1 MONITOR A: COUNTY ROAD 64

The "CR 64" monitor was located at along an access road to upland fields along County Road 64 (also referred to as NE Sherman Road) in Ripley, New York. The parcel is surrounded by rural residential plots, farm fields, forest, an active beef operation (250 meters (820 feet) to the west), and a winery (500 meters (1,640 feet) to the southwest). A perpetual stream runs about 65 meters to the southeast of the monitor location. The site is located on the map in Figure 4. Figure 5 shows the installed monitor adjacent to a telephone pole alongside the parcel's access road in winter and summer conditions, respectively.


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**FIGURE 4: COUNTRY ROAD 64 MONITOR LOCATION MAP**

**FIGURE 5: PHOTOGRAPH OF THE CR 64 MONITOR SITE IN WINTER, LOOKING EAST AND IN SUMMER, LOOKING SOUTHWEST**

## Monitoring Results Description

### *Winter*

Long-term winter sound level results are plotted as time history plots in Figure 6 alongside the average and gust wind speed measured adjacent to the microphone, period exclusions, and regional humidity. Sound levels at the monitor generally fluctuated diurnally, with higher sound levels during the day that were mostly caused by intermittent high-speed traffic on CR 64. Trains were present throughout day and night with clearly audible train horns. A stationary siren from the firehouse sounded daily at 5pm (except on Sundays). Sirens found at other times were removed from the averaging as anomalous events. Other contributing sources of sound were aircraft overflights (at least one per hour during the day and about one every two hours at night), dogs barking, nighttime mammal activity (including domestic dogs), birds (including crows), tractors and small equipment operating in the distance, truck passbys, and intermittent distant gunfire. An unidentified mammal interacting with the monitor necessitated exclusion on one occasion. The elevated $L_{90}$ sound levels in the afternoons (on 3/5, 3/11, and 3/12) were a result of tractors or 4-wheelers operating on nearby parcels. Plowing activity (both municipal and resident) was removed, as the National Operational Hydrologic Remote Sensing Center recorded snow on the evening of the March 6$^{th}$. The lowest sound levels at the site were driven by the nearby creek, as nighttime levels on nights following precipitation events was slightly higher than other nights (precipitation occurred earlier in the day prior to monitor deployment).

### *Summer*

Long term time history results from the summer monitoring period are provided in Figure 7. Similar to the winter monitoring, the sound levels showed a diurnal pattern that was driven by traffic and human activity during the day. Nighttime $L_{90}$ responded diurnally along with the $L_{eq}$ due to the lack of water running in the nearby creek. A substantial portion of the monitoring period (mostly at night) was excluded due to exceedance of the sound level meter's relative humidity specification. Thunderstorm events were recorded on the first three days of monitoring (July 10$^{th}$ through July 12$^{th}$). Traffic, intermittent farm and outdoor equipment, biogenic noise, and distant trains were the signature sources during the summer.

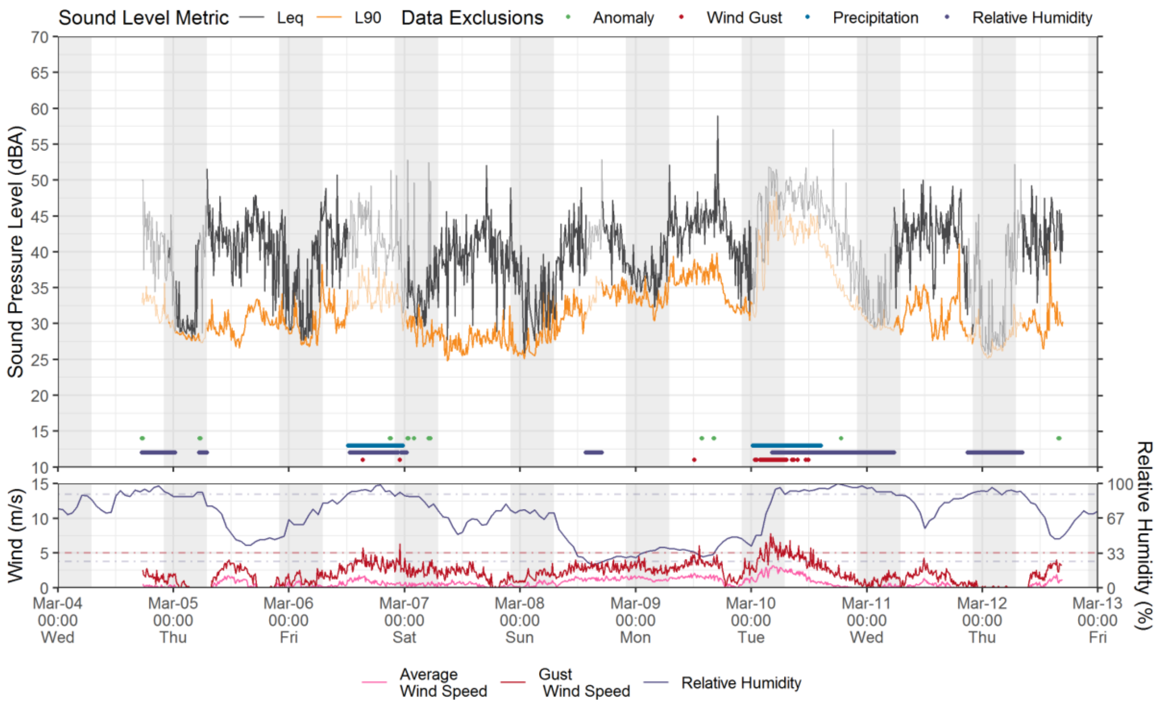


**FIGURE 6: CR 64 MONITOR TIME HISTORY—WINTER—MARCH 04 TO MARCH 13, 2020**

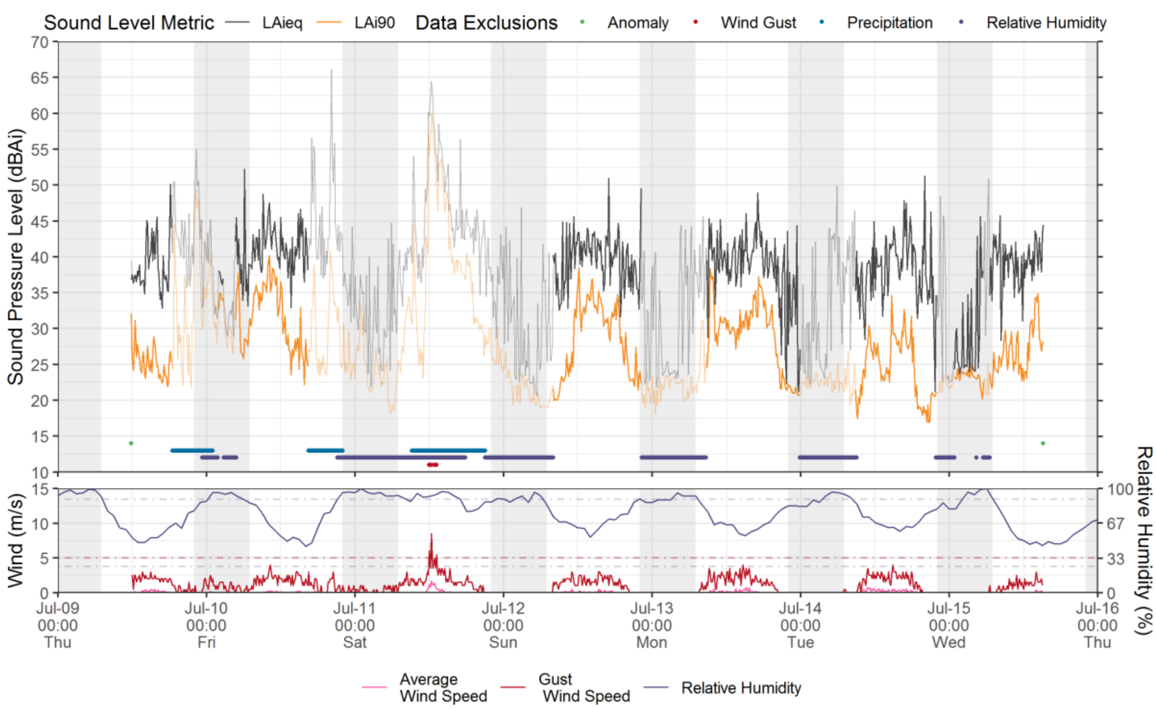


**FIGURE 7: CR 64 MONITOR TIME HISTORY—SUMMER —JULY 09 TO JULY 16, 2020**

## 5.2 MONITOR B: MILLER ROAD

The “Miller Road” monitor was located to the north of a homestead in Ripley, New York in what appeared to be an old vineyard and has since grown back to sparse trees and grass. The monitor was approximately 45 meters (150 feet) east of Miller Road and 100 meters (330 feet) north of the residence. The parcel is surrounded by forests and hayfields. A residential wind turbine was located 110 meters (360 feet) southeast of the monitor.

An aerial view of the monitoring site is shown in Figure 8. Pictures of the monitor installed in winter and summer monitor are provided in Figure 9.


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**FIGURE 8: MILLER ROAD MONITOR LOCATION MAP**

**FIGURE 9: PHOTOGRAPHS OF THE MILLER ROAD MONITOR IN WINTER, LOOKING SOUTHEAST, AND IN SUMMER, LOOKING NORTHEAST**

### *Winter Monitoring*

Long-term winter sound level results are plotted as time history graphs in Figure 10 along with the average and gust wind speed. Sound levels generally followed a diurnal pattern with sound levels higher during the day and lower at night due mostly to anthropogenic activity. Sound levels during the day on weekdays were higher than the weekend due to lighter traffic on the weekdays. The daily fluctuations in sound level were often interrupted during windy periods due to the operation of the nearby residential wind turbine. The lowest sound levels on nights with continuous wind was notably higher than on less windy nights, as a result of the small wind turbine operating nearby. When nights were calm, the fully diurnal pattern due to anthropogenic activity were clear.

Other sounds included the daily stationary siren form the firehouse, a tractor operating at a distance on the property, residents coming and going from the property, distant car and truck passbys on CR 64, infrequent truck and car passbys on Miller Road, commercial aircraft overflights and low-flying small aircraft. Distant trains and train whistles were audible throughout the early mornings and nighttime periods with typically more than ten distant train passbys were each day. As alluded to above, the wind turbine generator on the property was often audible during quiet periods when the wind was blowing aloft.

The two spikes on the last day of monitoring were from a small low flying aircraft, which also occurred on the afternoon of March 8$^{th}$ and the morning of March 9$^{th}$.

### *Summer Monitoring*

The time history results from the summer monitoring in July 2020 at the Miller Road monitor are presented in Figure 11. Sound levels were typically diurnal in response to vehicular traffic and outdoor equipment, though the pattern was interrupted on some occasions with higher apparent sound emissions from a nearby residential turbine. Periods in which the $L_{90}$ and $L_{eq}$ tracked together were indicative of sound emissions from the nearby residential turbine, such as on the overnight from July 10$^{th}$ to 11$^{th}$ and at the beginning of July 15$^{th}$.

Daytime anthropogenic noise was dominated by vehicle passbys on Miller Road with spikes intermittent 10-1minute $L_{eq}$ between 40 and 50 dBA. Several truck passbys in the morning of July 14$^{th}$ caused the highest nighttime sound levels of the period. Distant trains were evident throughout the day and night.

Bird sounds were prevalent surrounding dawn and dusk each day; the contribution of this biogenic noise is mostly removed by the smart-ANS weighting. The 10-minute A-weighted sound level dipped below 20 dBA in the evening on July 14$^{th}$ due to low windspeeds, minimal anthropogenic activity, and no wind turbine operation.

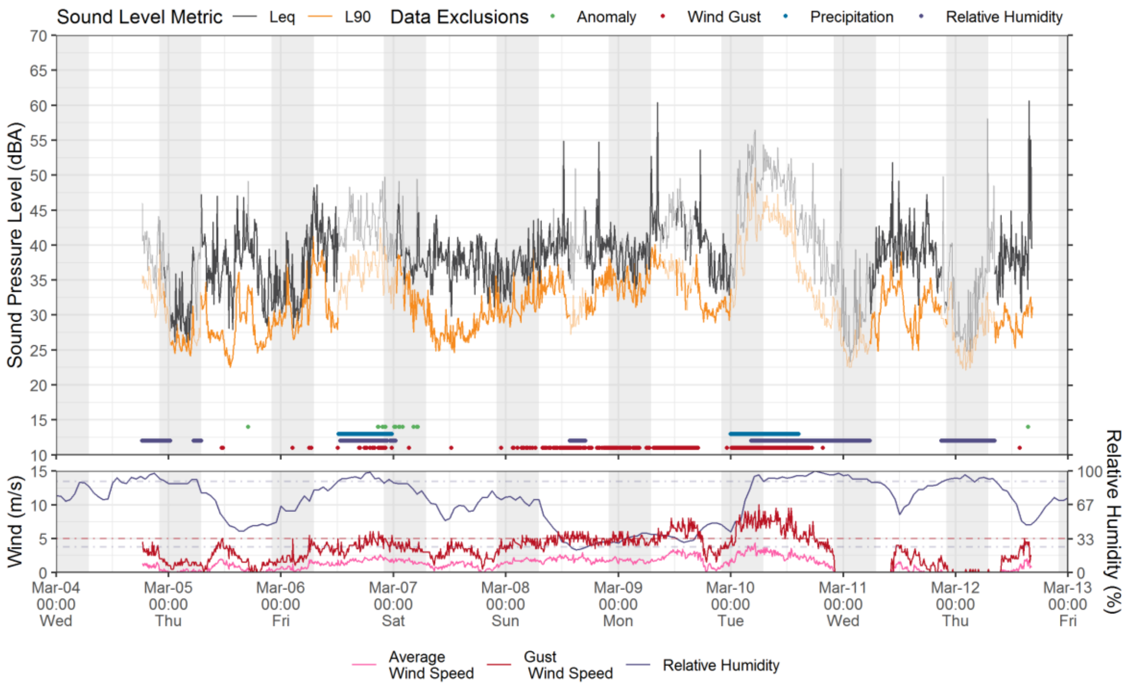


**FIGURE 10: MILLER ROAD MONITOR TIME HISTORY—WINTER —MARCH 02 TO MARCH 09, 2020**

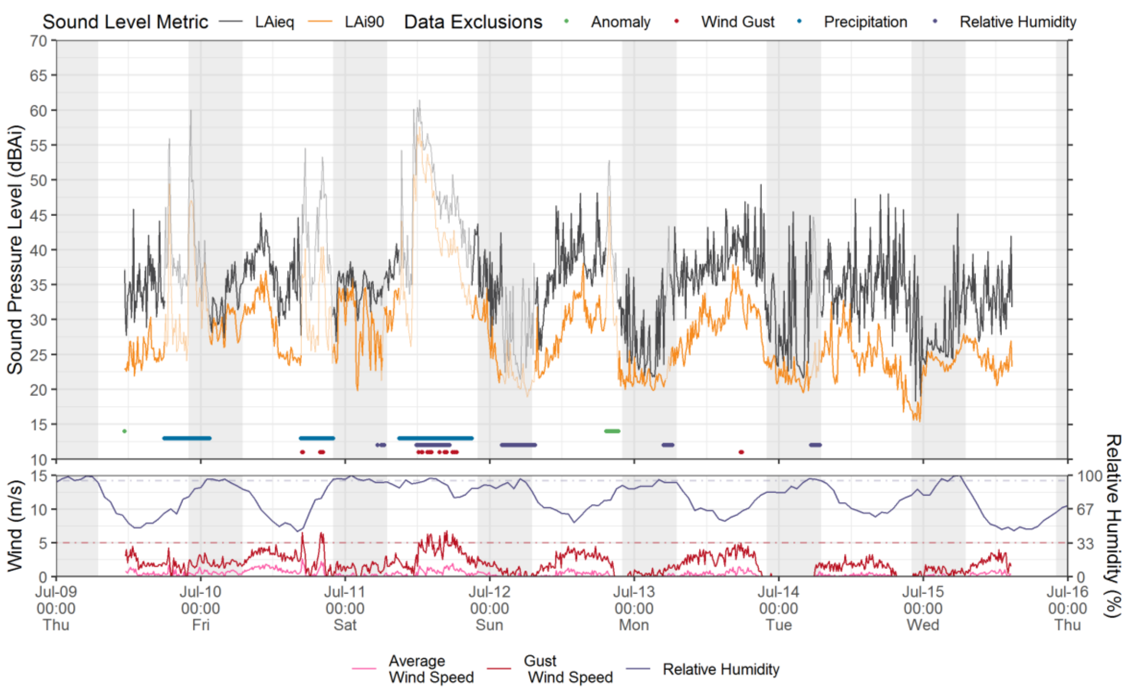


**FIGURE 11: MILLER ROAD MONITOR TIME HISTORY—SUMMER— JULY 09 TO JULY 16, 2020**

## 5.3 MONITOR C: SUBSTATION

The “Substation” monitor was located on an uninhabited parcel 265 meters (870 feet) east of the Pennsylvania state line in Ripley, New York. The monitor was approximately 19 meters (62 feet) from the road and 150 meters (490 feet) northeast of the existing area substation.

The monitor was near a small pond at the low point of a cow pasture and adjacent to three storage containers. Two residences are located across CR 64 (NE Sherman Road), at 85 meters (280 feet) to the north and 140 meters (460 feet) to the east from the monitor.

An aerial view of the site is provided in the map in Figure 12. Figure 13 shows photographs of the monitor installed in winter and summer conditions.

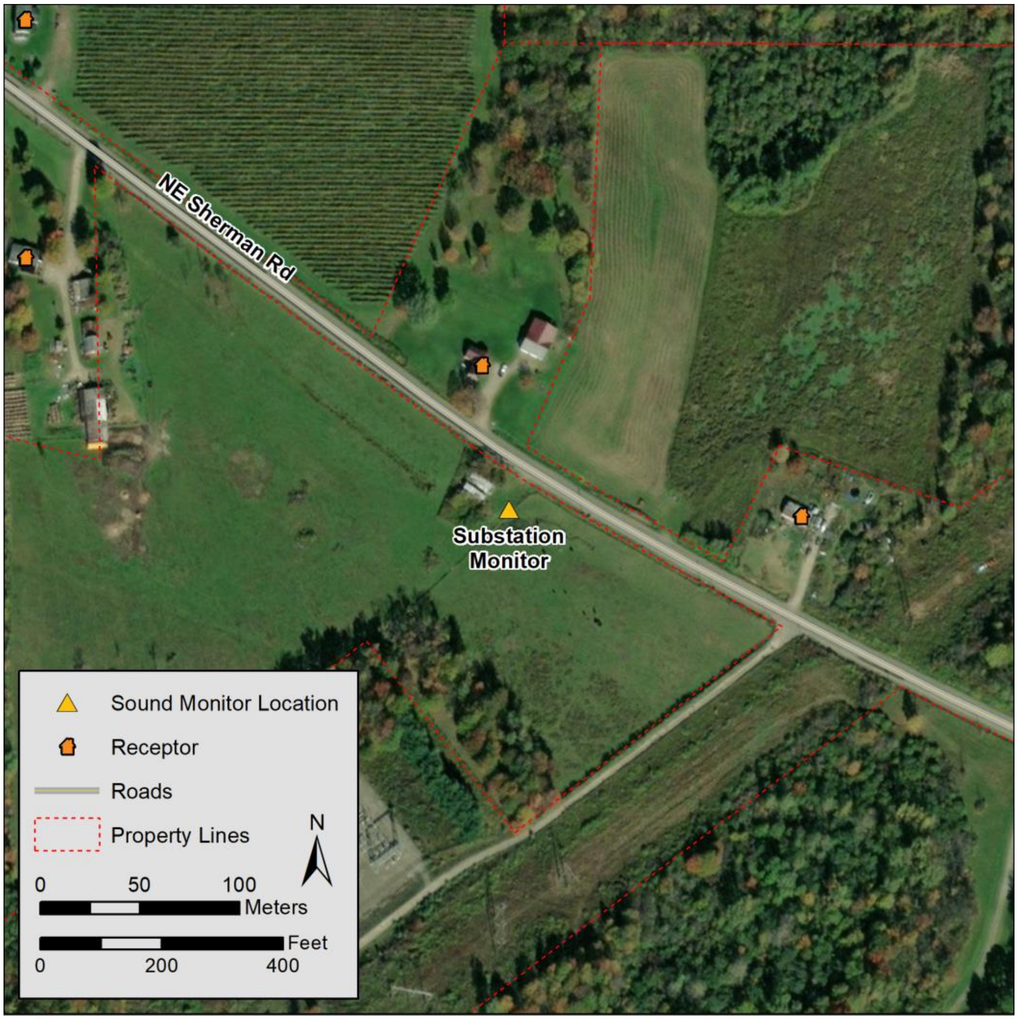


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**FIGURE 12: SUBSTATION MONITOR LOCATION MAP**

**FIGURE 13: PHOTOGRAPH OF THE SUBSTATION MONITOR SITE IN WINTER, LOOKING EAST AND IN SUMMER, LOOKING SOUTH**

### *Winter Monitoring*

Long-term winter sound level results are plotted as time history graphs in Figure 14.CR 64 was the main source of sound throughout the monitoring period; sound levels generally tracked with traffic volumes with a clear diurnal pattern, leading to higher sound levels during the day and lower sound levels at night. Typical sounds observed at the site included high-speed car, truck, and motorcycle passbys on CR 64, distant trains and train whistles, aircraft overflights (commercial and recreational), trickling water, and local sounds.

The spikes around 5 PM on March 8$^{th}$ and in the early afternoon on the last two days of monitoring were caused by motorcycle passbys and idling.

### *Summer Monitoring*

Figure 15 provides the time history results of the summer monitoring period at the CR-64 monitor. The consistent ~10 dB difference between the $L_{90}$ and $L_{eq}$ at the monitor indicates that short duration events dominate the soundscape. For the first couple of days, the short duration events were mostly limited to daytime due to high-speed vehicular traffic on CR 64; ten-minute nighttime $L_{eq}$ were generally below 35 dBA.

After the precipitation during the first three days of monitoring, increased amphibian activity was notable, as the nearby wetland area had been refreshed. After the beginning of the heightened amphibian activity on the morning of July 12$^{th}$, amphibian sound dominated the nighttime soundscape between midnight and noon. The sounds produced by the frogs were broadband from about 300 Hz to 3 kHz and thus the Smart ANS weighting did not completely remove the frog sound. Ten-minute equivalent sound levels at night with the frogs active were around 50 dBA,NS, which was slightly elevated above daytime levels in their absence.

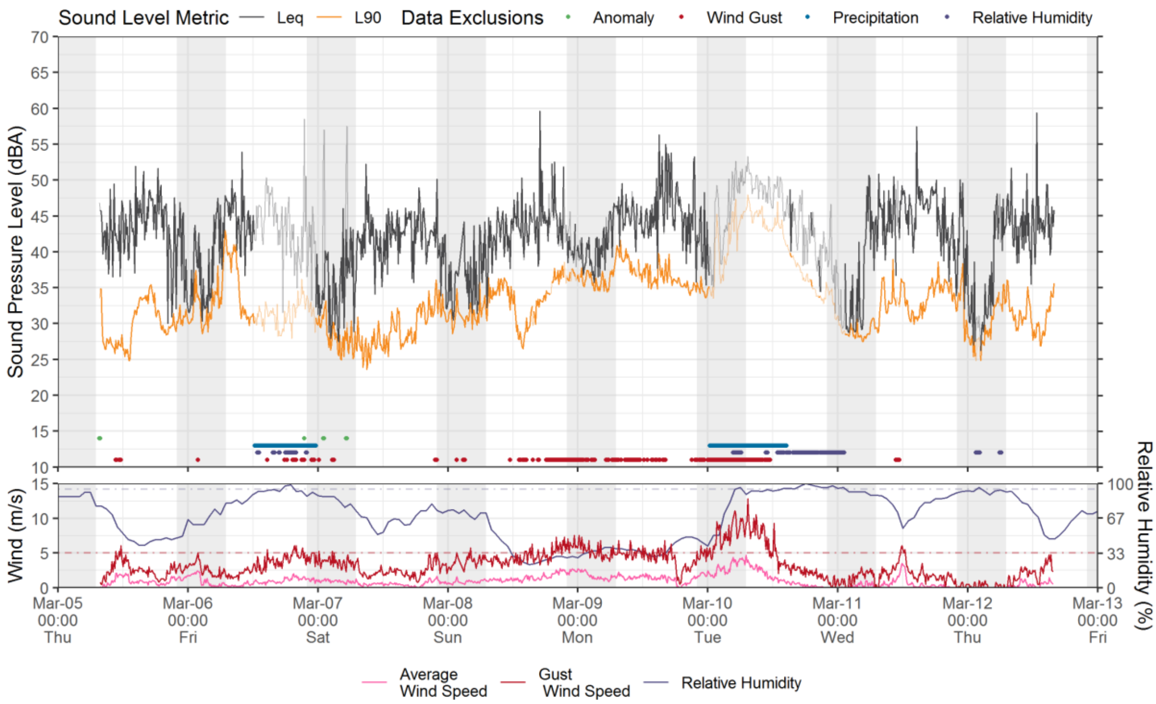


**FIGURE 14: SUBSTATION MONITOR TIME HISTORY—WINTER—MARCH 02 TO MARCH 09, 2020**

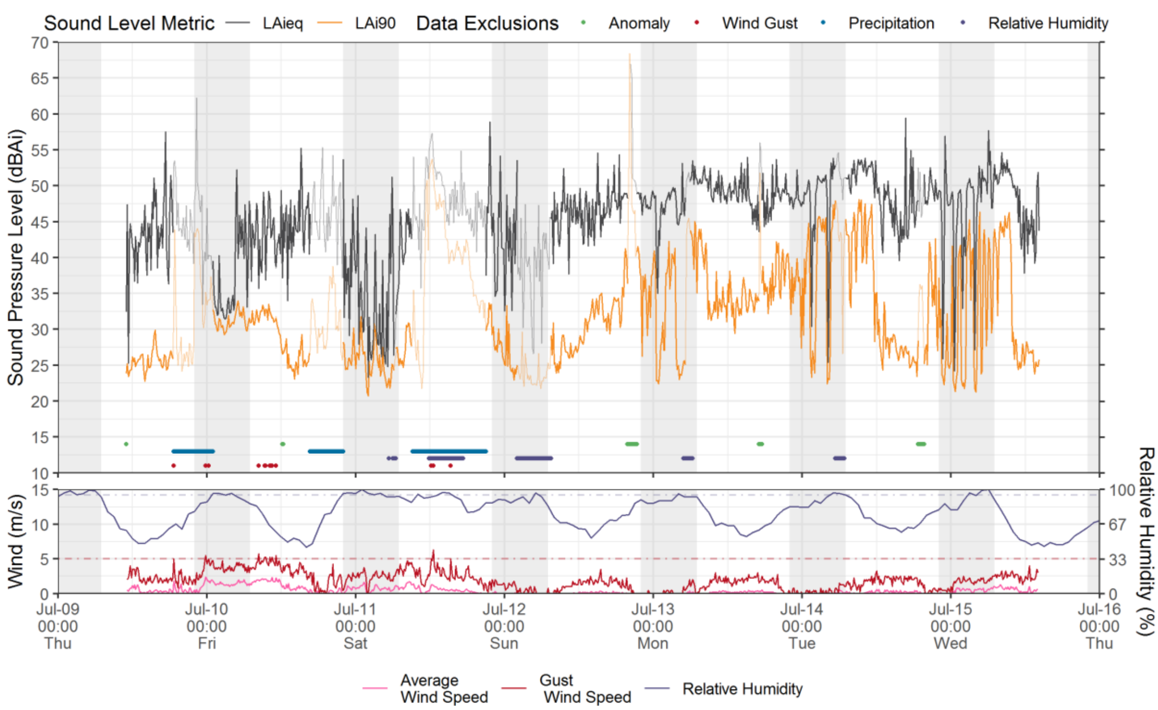


**FIGURE 15: SUBSTATION MONITOR TIME HISTORY—SUMMER—MARCH 02 TO MARCH 09, 2020**

## 5.4 MONITOR D: CR 303

The “CR 303” monitor was located on an uninhabited parcel in Ripley, New York. The monitor location was 145 meters south of CR 303 (NE Sherman Road) and approximately 490 meters (1,610 feet) east across the adjacent agricultural field from Sinden Road. This location is along a private access road in a buffer zone of spruces and grass between agricultural fields and forest. An aerial view of the site is provided in the map in Figure 16. Figure 17 shows the monitor installed in winter and summer conditions.

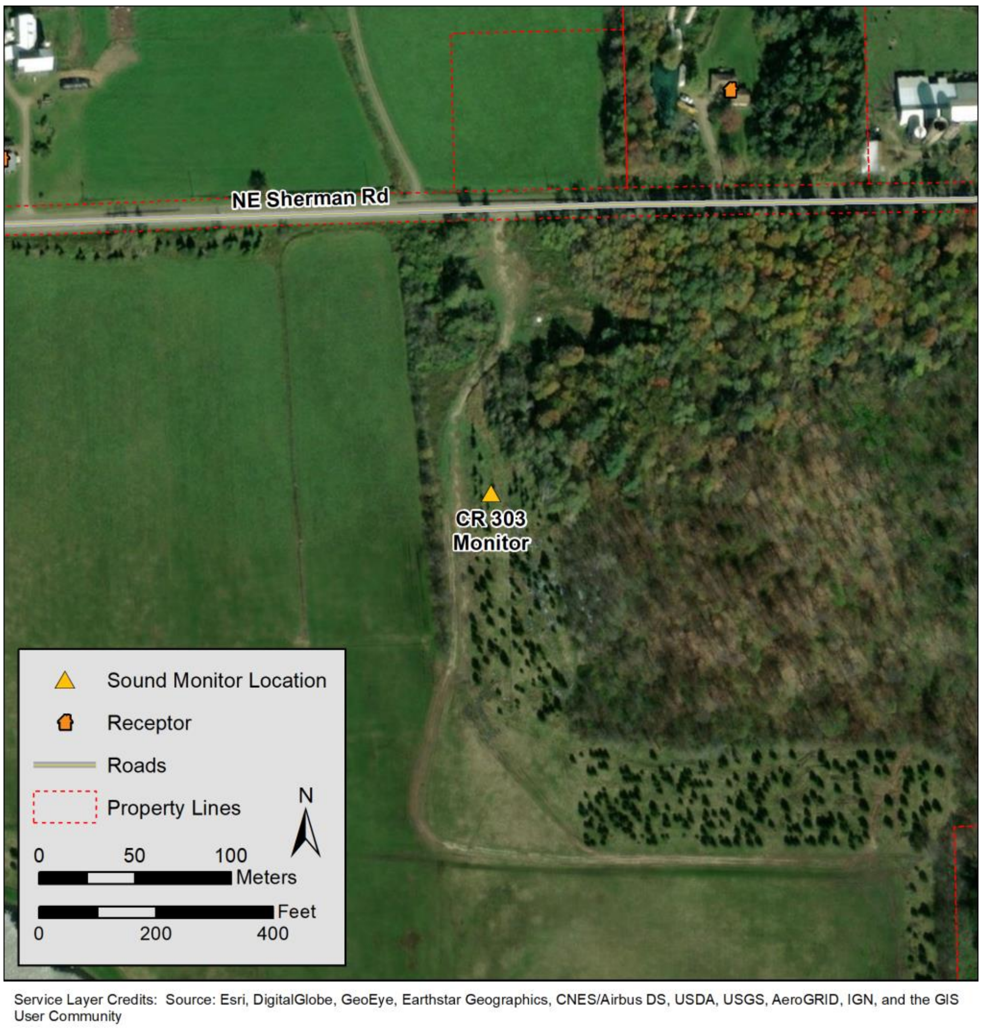


**FIGURE 16: CR 303 MONITOR LOCATION MAP**

**FIGURE 17: PHOTOGRAPH OF THE CR 303 MONITOR SITE IN WINTER AND IN SUMMER**

### *Winter Monitoring*

Time history results from long-term winter sound level monitoring are plotted in Figure 18. The monitoring location was relatively remote in that it was removed from anthropogenic activity. Distant transportation noise sources (e.g., vehicular traffic, trains, and aircraft) and wind through the trees were the main contributors to sound levels. Although bird activity was prevalent, they were mostly absent from the area immediately adjacent to monitor in the sparse spruce edge habitat.

### *Summer Monitoring*

The time history results from summertime monitoring at the CR 303 monitor are provided in Figure 19. A diurnal pattern is evident that corresponds to daytime human activity. The smart-ANS weight mostly removed biogenic sound levels in the morning as a result of the avian dawn chorus. Nighttime sound levels were generally below 30 dBA $L_{eq10min}$. The ANS-weighted $L_{90}$ at night often dropped below 25 dBA. Sound level spikes at night during the last three days of monitoring were related to heavy truck passbys on CR 303.

The highest sound levels on July 12$^{th}$ were a result of agricultural equipment operating nearby for most of the afternoon. After this date, the daytime sound levels generally decreased from typical levels above 40 dBA to an $L_{eq}$ typically below 35 dBA. Similar agricultural equipment was measured each day, starting on July 12$^{th}$, and may have been working further away from the monitor each day.

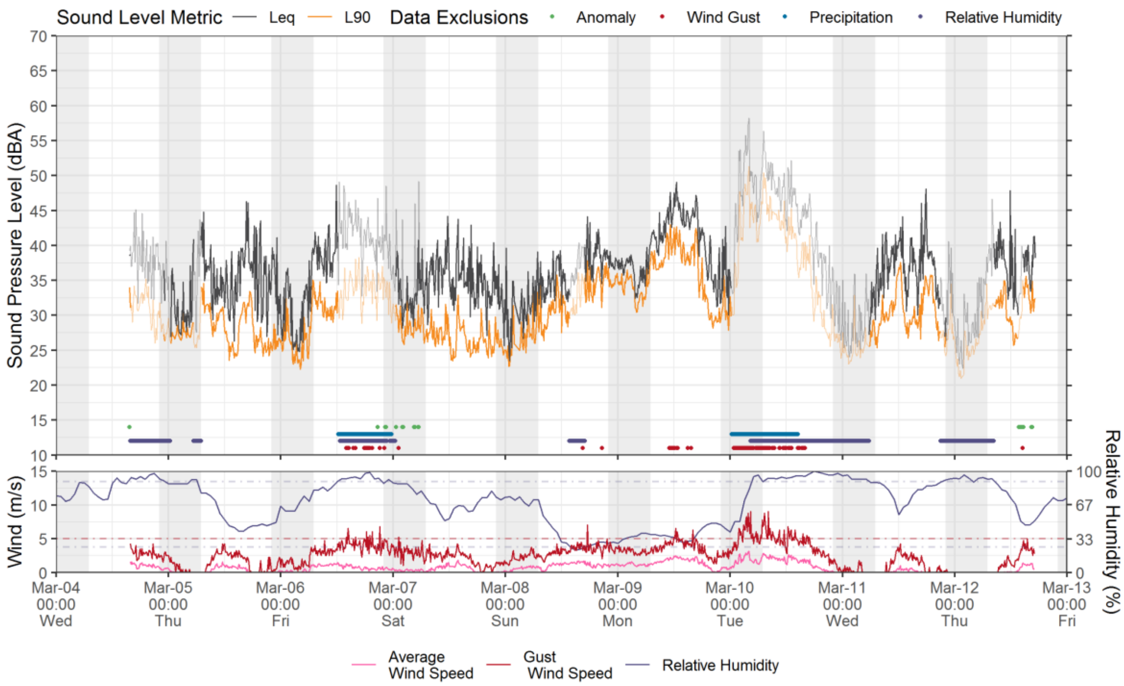


**FIGURE 18: CR 303 MONITOR TIME HISTORY—WINTER—MARCH 04 TO MARCH 13, 2020**

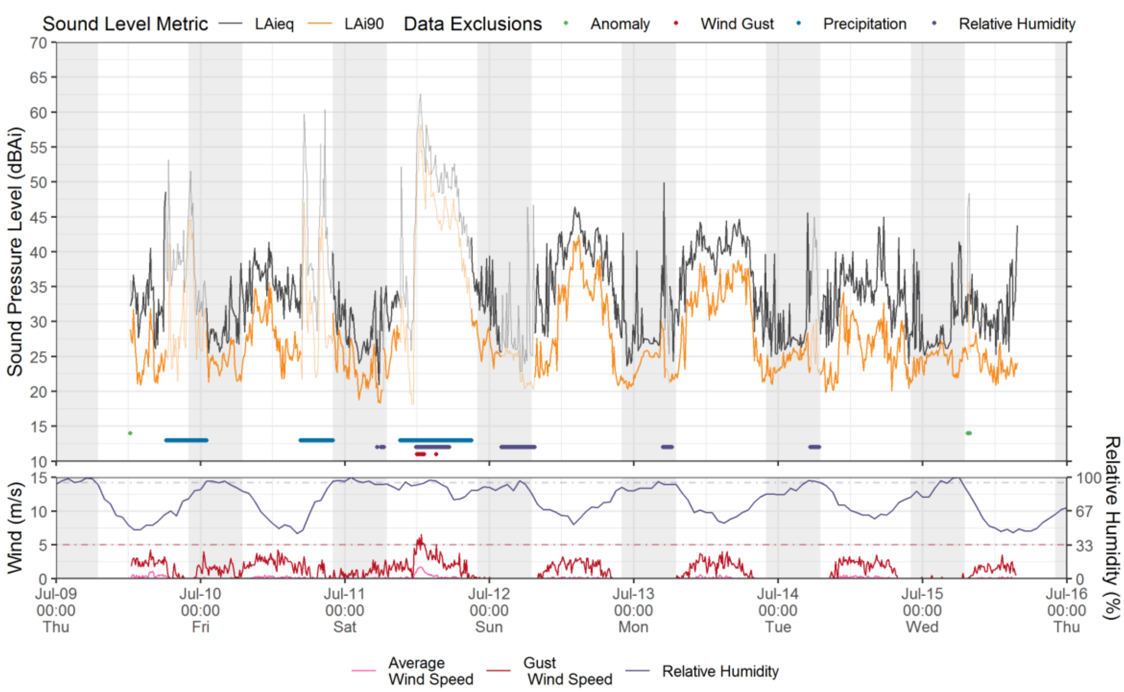


**FIGURE 19: CR 303 MONITOR TIME HISTORY—SUMMER—JULY 09 TO JULY 16, 2020**

## 5.5 MONITOR E: SULPHUR SPRINGS ROAD

The “Sulphur Springs Road” monitor was located along the edge of a remote agricultural field north of Sulphur Springs Road in Ripley, New York. The monitoring location was approximately 125 meters (410 ft) northwest of the intersection of Sulphur Springs Road / Post Road and Kopta Road. The monitor was placed on the edge of a remote field landlocked by forest. The monitor did not have line of sight to any roads and was surrounded by slightly higher terrain.

An aerial view of the site is provided in the map in Figure 20. Figure 21 shows photographs of the monitor installed in winter and summer conditions.


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

**FIGURE 20: SULPHUR SPRINGS ROAD MONITOR LOCATION MAP**

**FIGURE 21: PHOTOGRAPH OF THE SULPHUR SPRINGS ROAD MONITOR SITE IN WINTER, LOOKING EAST AND SUMMER, LOOKING SOUTH**

### *Winter Monitoring*

Time history results from long-term winter sound level monitoring at the Sulphur Springs Road monitor location are plotted in Figure 22. The Sulphur Springs Road monitor was located at the most remote site, as it was separated from anthropogenic activity more than the other monitors. In the distance, trucks, trains and commercial aircraft overflights were the main anthropogenic noise sources. A diurnal pattern was often observed Monday through Friday in which sound levels were a function of anthropogenic activity. The diurnal pattern recorded at the Sulphur Springs Road monitor often consisted of a quieter period between early afternoon and early evening during the week. Otherwise, bird activity was common and dominated by crows.

Around noon on March 6$^{th}$, a three-minute engine brake event raised the sound level at the monitor. The spikes during the day on March 7$^{th}$ and March 11$^{th}$ were aircraft overflights.

### *Summer Monitoring*

The time history results from the summer monitoring period at the Sulphur Springs Road monitor are plotted in Figure 22.The diurnal pattern from anthropogenic activities was pronounced for both the $L_{eq}$ and $L_{90}$. The similarity of the traces of each metric in the plot signifies that the soundscape was comprised of a wide range of distant sounds, such as trains, aircraft overfights, vehicles on area roads. A distant tractor was measured during the day on July 13$^{th}$. The spikes in 10-minute $L_{eq}$ on the mornings of July 13$^{th}$ and July 14$^{th}$ (at about 5 AM) were two truck passbys on nearby roads.

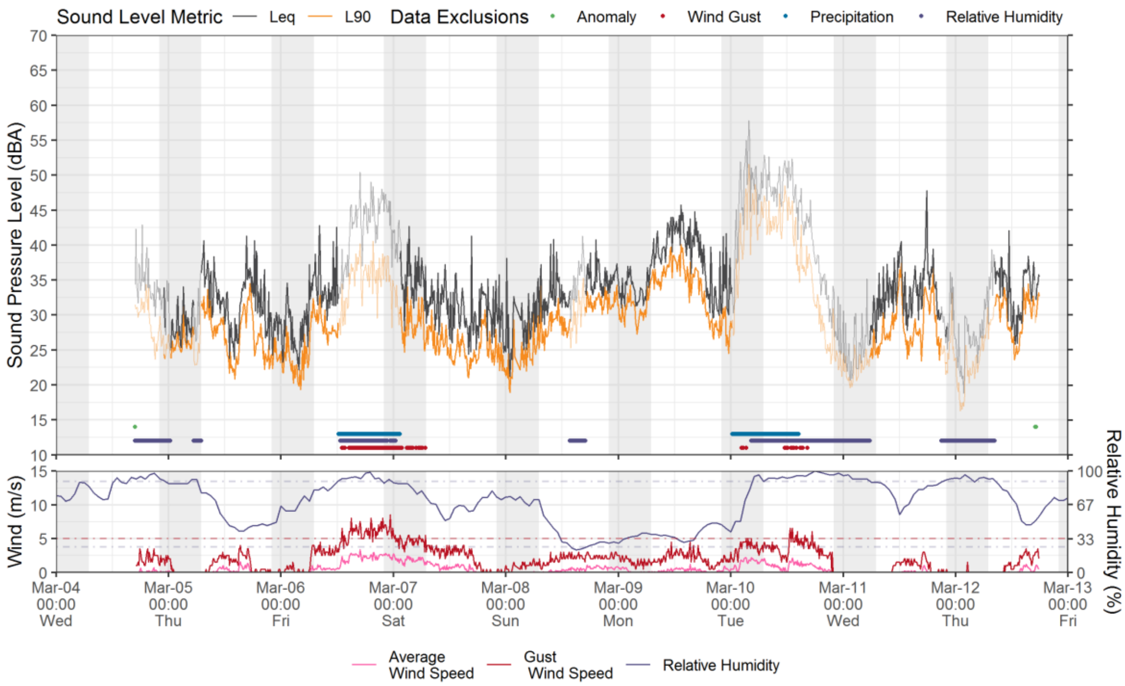


**FIGURE 22: SULPHUR SPRINGS ROAD MONITOR TIME HISTORY—WINTER—MARCH 04 TO MARCH 13, 2020**

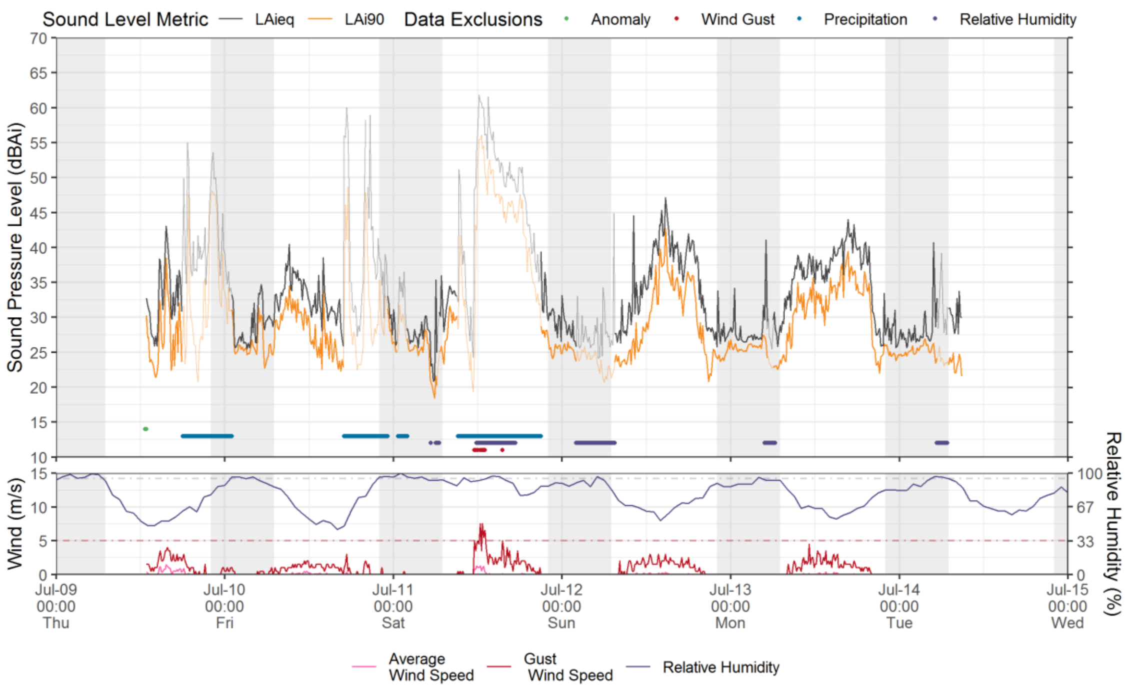


**FIGURE 23: SULPHUR SPRINGS ROAD MONITOR TIME HISTORY—SUMMER—JULY**

## 5.6 MONITOR F: MEEDER ROAD

The “Meeder Road” monitor was attached to a telephone pole in an agricultural field near the intersection of State Highway 76, CR 64 (NE Sherman Road), and Meeder Road in Ripley, New York. The monitor was located about 50 meters (165 feet) west of Meeder Road and 100 meters north of NE Sherman Road. The monitoring location is in a large field with a long line of sight to the west, including the approach of CR 303 and its intersection with CR 622 and Mina Road, which is approximately 340 meters (1,115 feet) to the southwest. One residence is 60 meters (195 feet) to the north of the monitor, and another is 80 meters (260 feet) to the southeast. A large barn is located about 125 meters (410 feet) to the southeast.

An aerial view of the site is provided in the map in Figure 24. Figure 25 shows photographs of the monitor installed in winter and summer conditions.

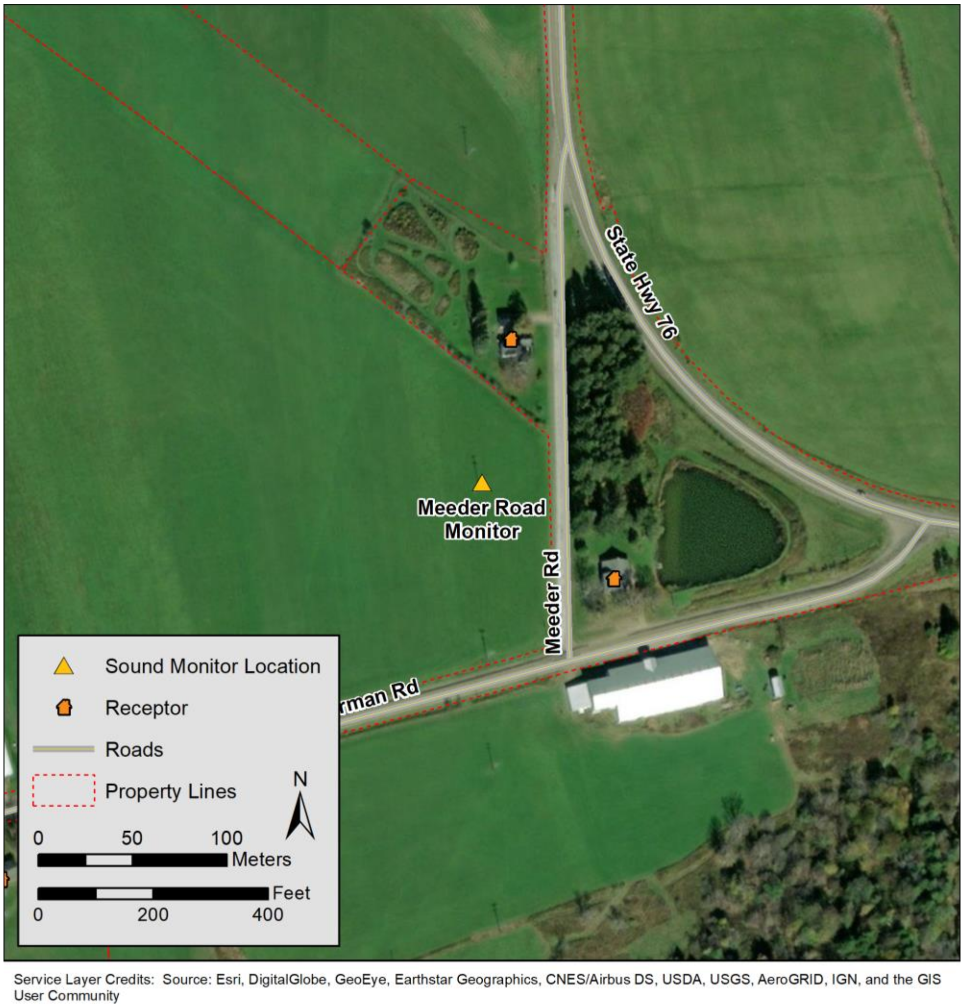


**FIGURE 24: MEEDER ROAD MONITOR LOCATION MAP**

**FIGURE 25: PHOTOGRAPH OF THE MEEDER ROAD MONITOR SITE IN WINTER, LOOKING WEST, AND SUMMER, LOOKING NORTH**

### *Winter Monitoring*

Time history results from winter sound level monitoring at the Meeder Road monitor location are plotted in Figure 26. Vehicular noise was the dominant feature of the soundscape measured, due to the monitor's clear line-of-sight to a long stretch of road and intersection. Vehicles traveling south on NY-76, a high-speed north/south thoroughfare east of the project, utilize Meeder Road to turn onto CR 303 (NE Sherman Road). As such, trucks and vehicles decelerate on Meeder Road, stop at the intersection, and then turn and accelerate, thus prolonging the passby and elevating sound levels.

The soundscape also contained general activities from the surrounding farm buildings and residences, such as sounds from workshops, heating systems, tractors, chainsaws, residents coming and go from their homes nearby, and 20-minute periods of diesel trucks idling. Other sounds included distant train passbys, commercial and recreational aircraft, and birds.

### *Summer Monitoring*

Sound level results from the summer monitoring period at the Meeder Road monitoring location are plotted in Figure 27. The influence of vehicular noise on the soundscape is evident with the difference between the $L_{eq}$ and $L_{90}$, particularly during the day. Spikes in the 10-minute $L_{eq}$ sound levels at night were related to truck traffic. The Meeder Road monitor location was exposed to the highest winds compared to the other locations. Average wind speed was generally correlated with the $L_{90}$.

The lowest 10-minute $L_{90}$ measured at the site was about 21 dBA on the morning of July 11$^{th}$. The highest nighttime $L_{90}$ (about 34 dBA) was recorded near midnight of July 12$^{th}$, after the largest precipitation event of the period. The highest sound level was a result of running water from the pond on the opposite side of Meeder Road.

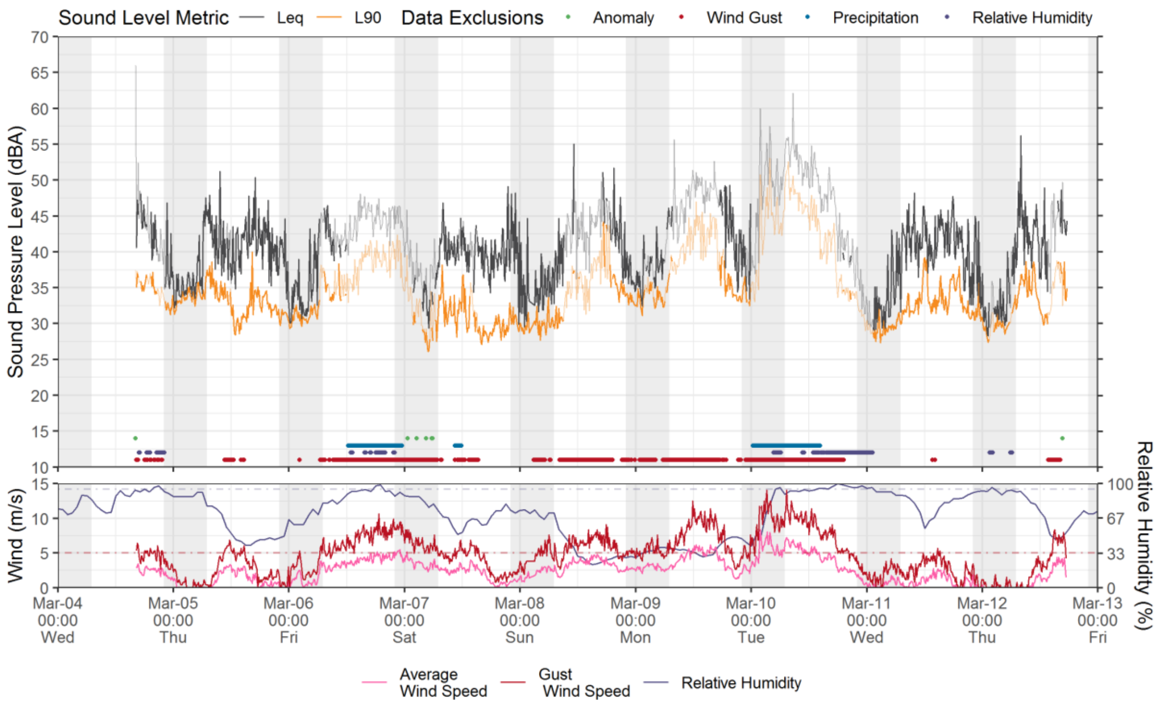


**FIGURE 26: MEEDER ROAD MONITOR TIME HISTORY—WEEK 1—MARCH 02 TO MARCH 09, 2020**

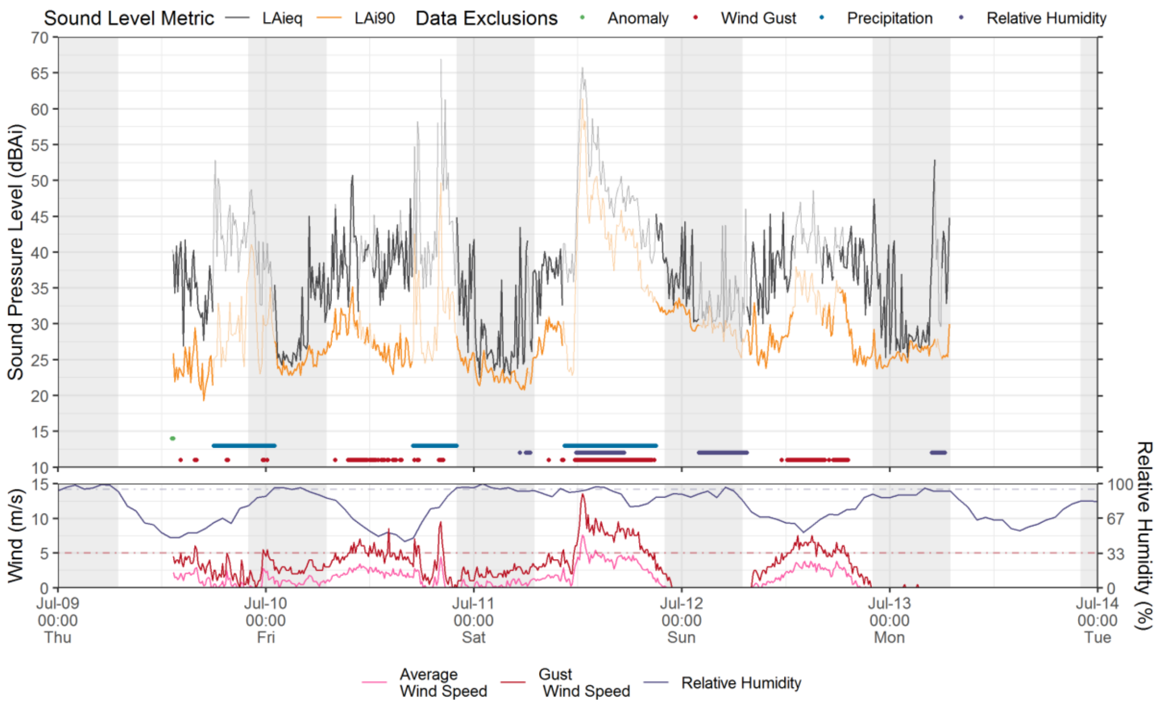


**FIGURE 27: MEEDER ROAD MONITOR TIME HISTORY—SUMMER—JULY 09 TO JULY 14**

# 6.0 OVERALL MONITORING RESULTS

The sound levels over the entire monitoring period are summarized in Tables 4 through 6. The aggregated levels for each period were determined by averaging all valid 1-second periods for the given season; the combined period considered both seasons in the analysis.

The three tables provide results for the winter monitoring period (Table 4), the summer monitoring period (Table 5), and the combined period (Table 6). As noted above, we weighted the sound levels using a “Smart-ANS” filter, which removed high-frequency tonal sound from amphibians, birds, and insects. Differences in the A-weighted and ANS-weighted sound levels in winter were minimal (generally less than 1 dB) but were more significant in summer due to biogenic sound.

Generally, where there is a larger difference between the $L_{eq}$ and $L_{90}$, the soundscape is likely to include transient or intermittent sounds, such as aircraft overflights or passing automobiles, that weight the $L_{eq}$. Sites along roadways saw more traffic during the daytime - events that increase the $L_{eq}$.

During the winter (Table 4), the equivalent continuous levels ($L_{eq}$) at night were generally about 4 or 5 dB less than daytime levels at all sites. The winter nighttime equivalent continuous level ($L_{eq}$) averaged over all six sites is 40 dBA. The lowest winter overall $L_{eq}$ (35 dBA) was measured at the Sulphur Springs monitor. The nighttime winter $L_{90}$ ranged from 24 to 30 dBA between sites; this level was often limited by consistent wind and/or running water.

Overall sound levels for the summertime are shown in Table 5. Most overall equivalent sound levels were around 40 dBA, with the exception of the Substation monitor that was dominated by frog sounds in the second half of the period. Otherwise, the largest consistent difference between daytime and nighttime $L_{eq}$ in the summer was evident at CR 303 and Sulphur Springs Road, as they were the farthest removed from sources of nighttime sound (such as intermittent vehicular traffic). The nighttime $L_{90}$ at each site was under 25 dBA or below. The nighttime levels during the summer were less than winter due to less water running (snow melt began in March and by July the region was encroaching on drought status).

The overall sound levels for the combined period comprising both seasons is provided in Table 6. The overall nighttime $L_{eq}$ was 40 dBA averaged over all six sites for the combined monitoring periods, which is in line with both seasons. With the exception of the substation monitor, most levels were similar between seasons.

**TABLE 4: AMBIENT PRECONSTRUCTION SOUND MONITORING WINTER SUMMARY**

| | Monitoring Location | Sound Level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Overall | | | | Day | | | | Night | | | |
| | | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 |
| Winter | CR 64 | 42 | 41 | 33 | 28 | 43 | 43 | 34 | 28 | 38 | 38 | 32 | 28 |
| | Miller Road | 41 | 41 | 34 | 28 | 42 | 41 | 33 | 27 | 38 | 40 | 34 | 28 |
| | Substation | 44 | 42 | 35 | 29 | 46 | 43 | 35 | 29 | 41 | 40 | 34 | 29 |
| | CR 303 | 38 | 41 | 33 | 27 | 39 | 42 | 33 | 27 | 35 | 38 | 31 | 26 |
| | Sulphur Springs Road | 35 | 38 | 31 | 25 | 36 | 39 | 32 | 26 | 33 | 36 | 30 | 24 |
| | Meeder Road | 41 | 42 | 35 | 30 | 43 | 44 | 36 | 31 | 38 | 38 | 33 | 30 |

**TABLE 5: AMBIENT PRECONSTRUCTION SOUND MONITORING SUMMER SUMMARY**

| | Monitoring Location | Sound Level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Overall | | | | Day | | | | Night | | | |
| | | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 |
| Summer | CR 64 | 41 | 41 | 32 | 24 | 41 | 42 | 33 | 25 | 39 | 38 | 26 | 22 |
| | Miller Road | 38 | 39 | 30 | 23 | 39 | 41 | 32 | 25 | 35 | 36 | 27 | 22 |
| | Substation | 48 | 52 | 39 | 26 | 49 | 52 | 39 | 27 | 48 | 51 | 37 | 25 |
| | CR 303 | 38 | 41 | 29 | 24 | 40 | 43 | 33 | 25 | 33 | 32 | 27 | 23 |
| | Sulphur Springs Road | 37 | 40 | 30 | 25 | 39 | 42 | 34 | 26 | 29 | 31 | 27 | 25 |
| | Meeder Road | 39 | 39 | 29 | 24 | 40 | 41 | 32 | 26 | 37 | 34 | 27 | 24 |

**TABLE 6: AMBIENT PRECONSTRUCTION SOUND MONITORING COMBINED SEASONS SUMMARY**

| | Monitoring Location | Sound Level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Overall | | | | Day | | | | Night | | | |
| | | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 | Leq | L10 | L50 | L90 |
| Combined | CR 64 | 42 | 41 | 33 | 26 | 42 | 42 | 33 | 27 | 38 | 38 | 31 | 26 |
| | Miller Road | 39 | 40 | 32 | 25 | 41 | 41 | 33 | 26 | 36 | 39 | 32 | 24 |
| | Substation | 47 | 49 | 35 | 28 | 47 | 49 | 36 | 28 | 46 | 50 | 34 | 27 |
| | CR 303 | 37 | 40 | 31 | 25 | 39 | 42 | 33 | 26 | 34 | 36 | 28 | 24 |
| | Sulphur Springs Road | 35 | 38 | 31 | 25 | 36 | 40 | 32 | 26 | 32 | 35 | 28 | 24 |
| | Meeder Road | 41 | 42 | 34 | 27 | 42 | 44 | 35 | 29 | 38 | 37 | 32 | 25 |

# 7.0 SOUND PROPAGATION MODELING

## 7.1 PROCEDURES

### ISO 9613-2 & CadnaA

Future Project sound levels during construction and operation of the facility were modeled in accordance with the standard ISO 9613-2, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation," as required under 94-c, 900-2.8(d). 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 assumes downwind sound propagation between every source and every receptor, consequently, all wind directions, including the prevailing wind directions, are taken into account.

For solar facilities, the ISO 9613-2 model is more likely to overestimate sound levels. First, the barrier-effect of the solar panels in blocking sound from interior sources, especially inverters and medium-voltage transformers, is not taken into account in the modeling done for this Project. Second, sound emissions of solar equipment tend to be highest during sunny days. Under these conditions, the sound is refracted upwards, lowering the sound levels measured near the ground. Under the modeling assumptions used in this report, the meteorological conditions are always downward refracting, such as occurs during cloudy days with moderate downwind conditions or a well-developed moderate nighttime temperature inversion.

### Model Assumptions

The project area was primarily modeled with half porous and half hard ground (G=0.5), which is a conservative assumption given that most of the ground is porous (G=1.0). The substation was modeled as G=0.6, where the ground is made up of loose gravel[4], and the energy storage facility was modeled at G=0.0, where the ground is assumed to be concrete. No attenuation due to foliage was included.

In the model, a 1.5-meter (5 foot) receptor height was used for modeling discrete receptors (like homes and worst-case property line points) and contour mapping. The discrete receptors were included if they were, at a minimum, within 1,500 feet of any project noise-generating component, or within the 30 dBA contour line.

Other model input parameters are listed in Appendix B.

Modeled equipment includes the following:

- Array string inverters and MVTs – The 2,176 inverters are scattered throughout the Project. There are approximately six to 20 inverters grouped in a location and are collocated with a single MVT. The inverters convert the DC electricity generated by the solar panels to low-voltage AC power and the transformers the increase the voltage to medium-voltage AC power for transmission to the substation. Each inverter is modeled with a sound power level of 78 dBA. These inverters have fans whose speed is a function of temperature and load. For the modeling in this report, the fans are assumed to operate at 100 percent during all daylight and nighttime hours. Each MVT is modeled at a sound power of 66 dBA.
- Substation Transformers – The substation transformer steps up the medium voltage AC power to the high voltage of the transmission line. The substation transformers are modeled with a sound power of 89 dBA with cooling fans on, which includes 10 dB of attenuation relative to the NEMA TR1 standard.

All equipment were modeled at the manufacturer's published maximum sound power levels. If only the overall A-weighted sound levels were provided by the manufacturer, or a particular equipment model has not yet been selected, octave bands were estimated based on RSG measurements of similar equipment or published spectra.

There are no other solar or wind projects within 3,000 feet of the Project. Thus, cumulative impacts from other nearby projects were not included in the model.

One-third octave band data is not currently available from the equipment manufacturers, so a 5 dB penalty was applied to all sound sources as required by Section 94-c regulations. This includes, the inverters, MVTs, substation transformer, and energy storage. Tonal penalties were

[4] The loose gravel in a substation is highly porous and is intended to drain well. RSG has conducted calibration studies on substation gravel and found that the appropriate ground factor for accurate modeling is 0.6. Note running the substation ground at G=0.5 changes the modeling results at the closest receptor by 0.1 dB and does not affect the conclusions in the report.

not included in the modeled sound power or modeling isolines but are included in later tables where the modeled sound levels are compared to noise standards.

Consistent with Section 94-c regulations for the modeling of solar facilities, no additional uncertainty was added to the modeling results.

Results calculated with these parameters are used to model the eight-hour equivalent average sound level during the day, with all equipment operating at maximum capacity. This also represents a worst-case nighttime condition if the inverters are used for VAR support.

## 7.2 MITIGATION OF OPERATIONAL SOURCES

Mitigation has been incorporated into the model is needed to meet applicable Section 94-c noise standards. The mitigation in the model includes the selection of energy storage equipment with low noise cooling equipment and a specification on the substation transformer sound pressure level of 10 dB minus NEMA TR-1.

## 7.3 TONALITY

An assessment for tonal prominence of the inverters, transformers, and tracking motors was not conducted because 1/3 octave band data is not currently available from the manufacturers.

Project equipment such as transformers are often tonal at integer multiples of the line frequency (60 Hz). Transformers are usually tonal in the 125 Hz, 250 Hz, 315 Hz, 500 Hz, or 630 Hz 1/3 octave bands during the ONAN condition, but not the ONAF condition due to masking from the cooling fans, though some tonal prominence often remains. Inverters sometimes also have tonal prominence at higher frequencies due to fans or filters.

The addition of a 5 dB penalty to all equipment is a conservative assumption as even if the equipment generates tonal sound, the level of tonality is generally reduced at the receiver due to the attenuation of the sound over distance and masking by broadband background sound.

## 7.4 MODEL RESULTS OF OPERATIONAL SOUND

Mitigated short-term sound propagation modeling results are shown in Figures 28 through 34 for the worst-case daytime configuration. Note that the figures do not include the 5 dB tonal penalty. The penalty is applied in the numerical table of the results in Table 7. The number of nonparticipating sensitive receptors at each sound level above 35 dBA is provided in Table 8. All residences in the model are conservatively considered nonparticipating residences, except for one participating seasonal structure that will be moved or removed as part of the Project

**TABLE 7: SUMMARY OF $L_{8H}$ SOUND MODELING RESULTS FOR EACH OPERATING SCENARIO (IN dBA)**

| Receptor Type | Daytime Sound Level – Maximum $L_{8h}$ (dBA) | | | Plus 5 dB tonal penalty Maximum $L_{8h}$ (dBA) | | |
|---|---|---|---|---|---|---|
| | Min. | Max. | Avg. | Min. | Max. | Avg. |
| Residential[5] | 25 | 39 | 33 | 30 | 44 | 38 |
| Residential due to substation transformer[6] | | 34 | | | 39 | |
| Participating Seasonal[7] | | 47 | | | 52 | |
| Property Line[6] | | 52 | | | n/a | |

**TABLE 8: SENSITIVE RECEPTORS AT SOUND LEVELS ABOVE 35 dBA[8]**

| Sound Pressure Level - Maximum $L_{8h}$ (dBA) | Number of Sensitive Receptors | |
|---|---|---|
| | All Sources Operating | +5 dB Tonal Penalty |
| 35 | 10 | 15 |
| 36 | 12 | 13 |
| 37 | 4 | 11 |
| 38 | 6 | 10 |
| 39 | 3 | 6 |
| 40 | 0 | 10 |
| 41 | 0 | 12 |
| 42 | 0 | 4 |
| 43 | 0 | 6 |
| 44 | 0 | 3 |
| 45 | 0 | 0 |

Results show sound levels are at or below 45 dBA $L_{8h}$ at all receptors, meeting the applicable Section 94-c limits for participating and nonparticipating residential receptors. In addition, the substation transformers are at or below 40 dBA $L_{1h}$ at the closest home with a tonal penalty applied in the model. All property line sound levels are at or below the applicable 55 dBA $L_{8h}$ limit. The highest modeled property line sound level of 52 dBA is adjacent to the substation, about 32 meters (100 ft) southeast of the transformer.

[5] Includes all residences – both participating and nonparticipating.
[6] Only the worst-case location is shown.
[7] This is a structure on a participating parcel located relatively close to inverters that will be moved or removed as part of the Project.
[8] This table does not include the one participating seasonal structure that will be moved or removed, modeled at 47 dBA without a tonal penalty and 52 dBA with a tonal penalty.

The results summarized above indicate compliance with all applicable Section 94-c sound level limits.

See Table 20 in Appendix C for A-weighted modeling results for each receptor, and Table 22 in Appendix D for 1/1 octave band modeling results.

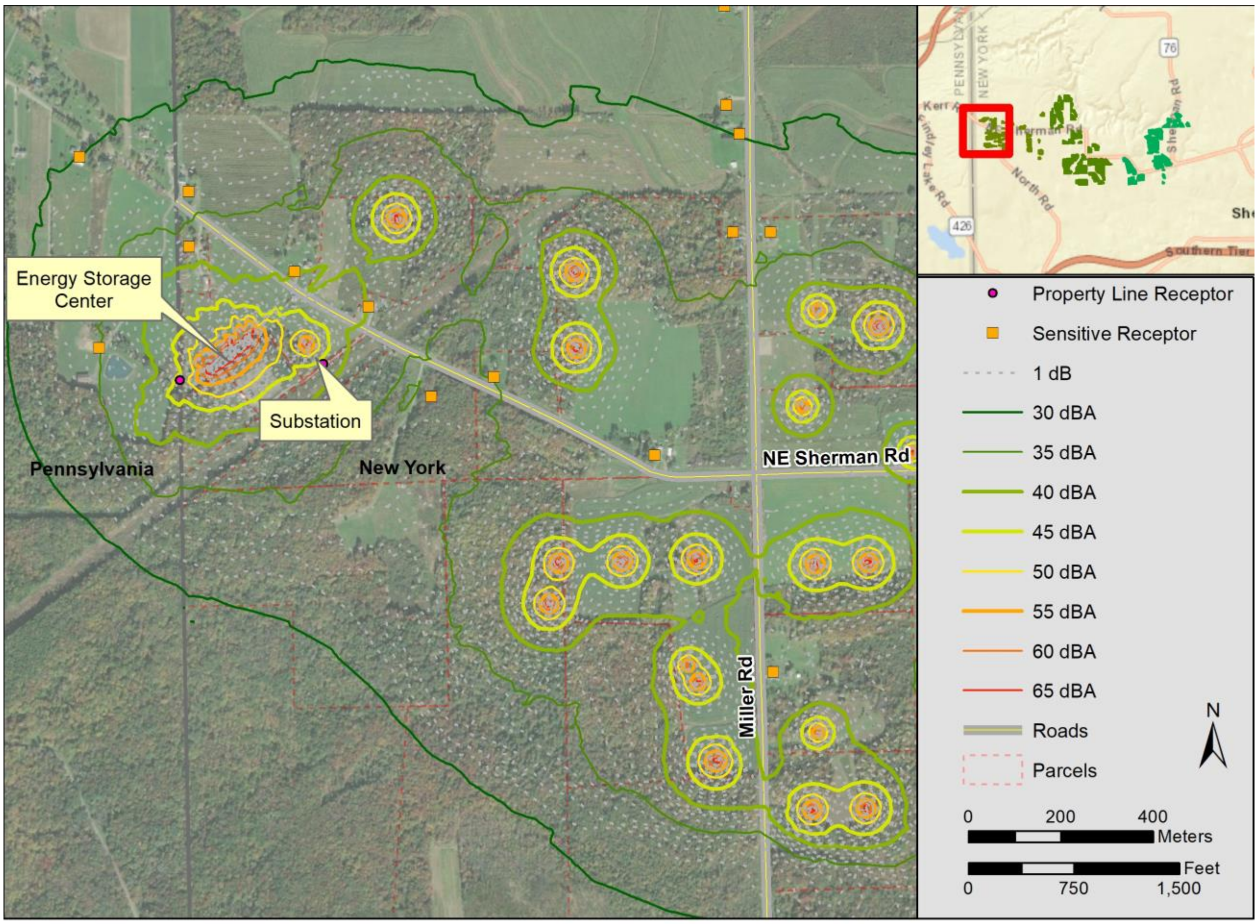


**FIGURE 28: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 1**

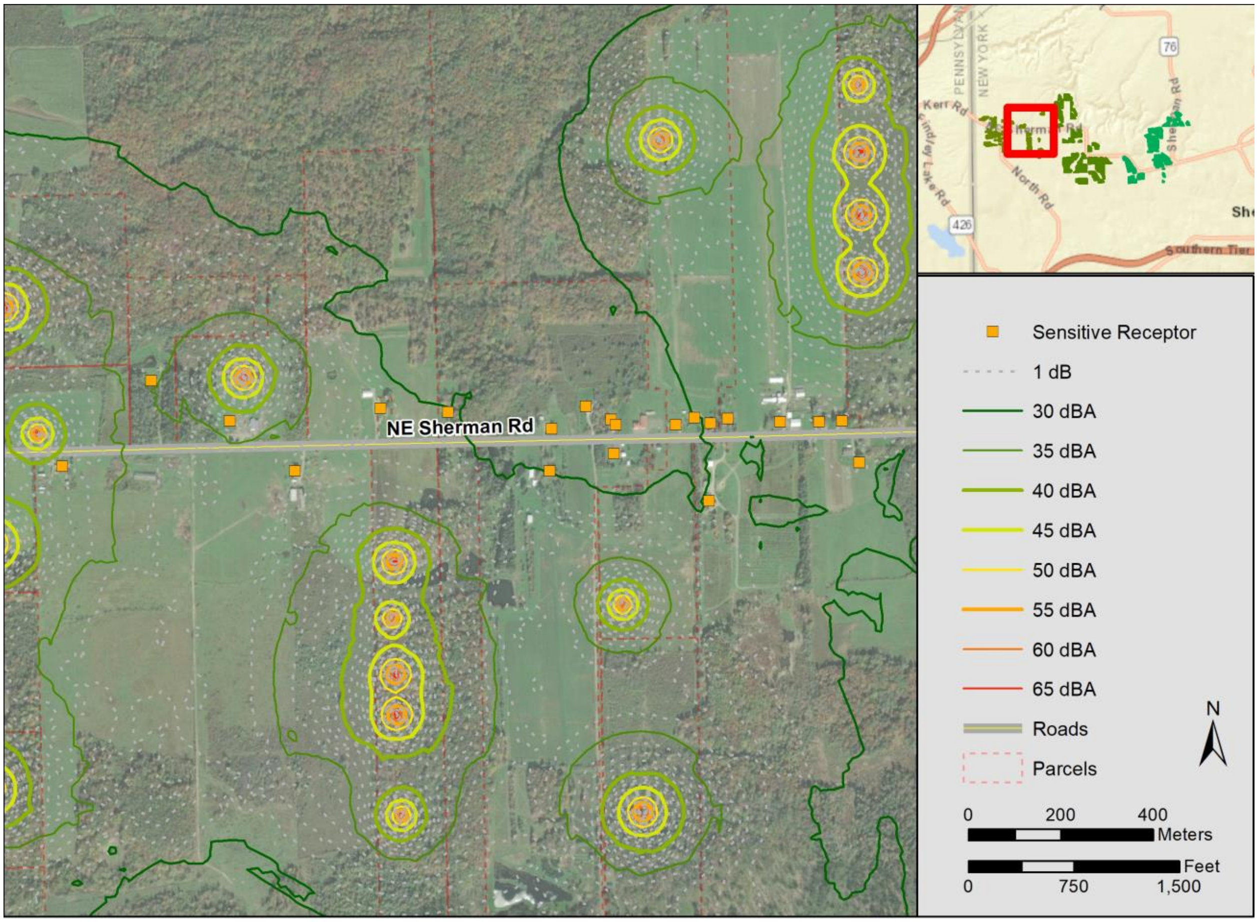


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**FIGURE 29: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 2**

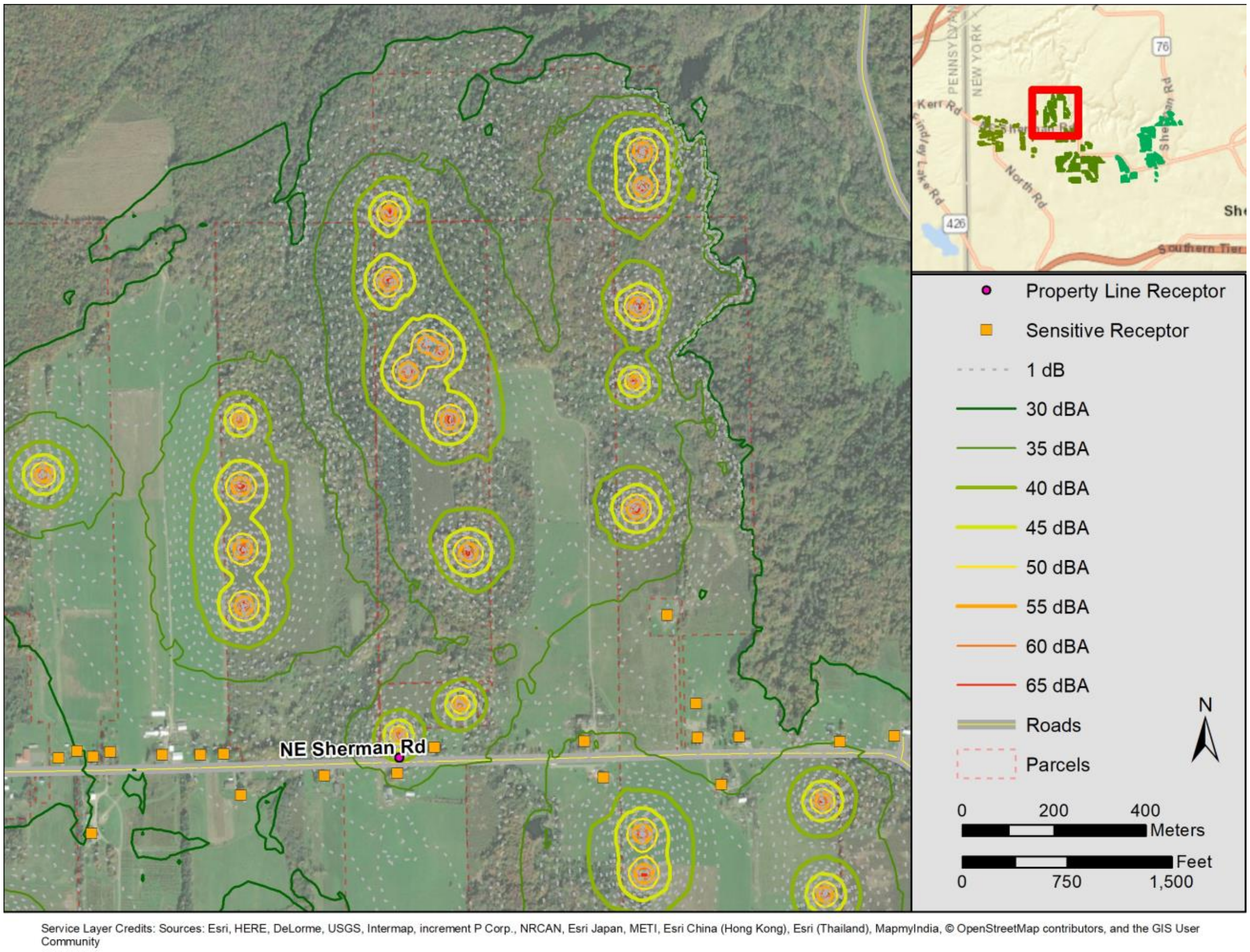


**FIGURE 30: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 3**

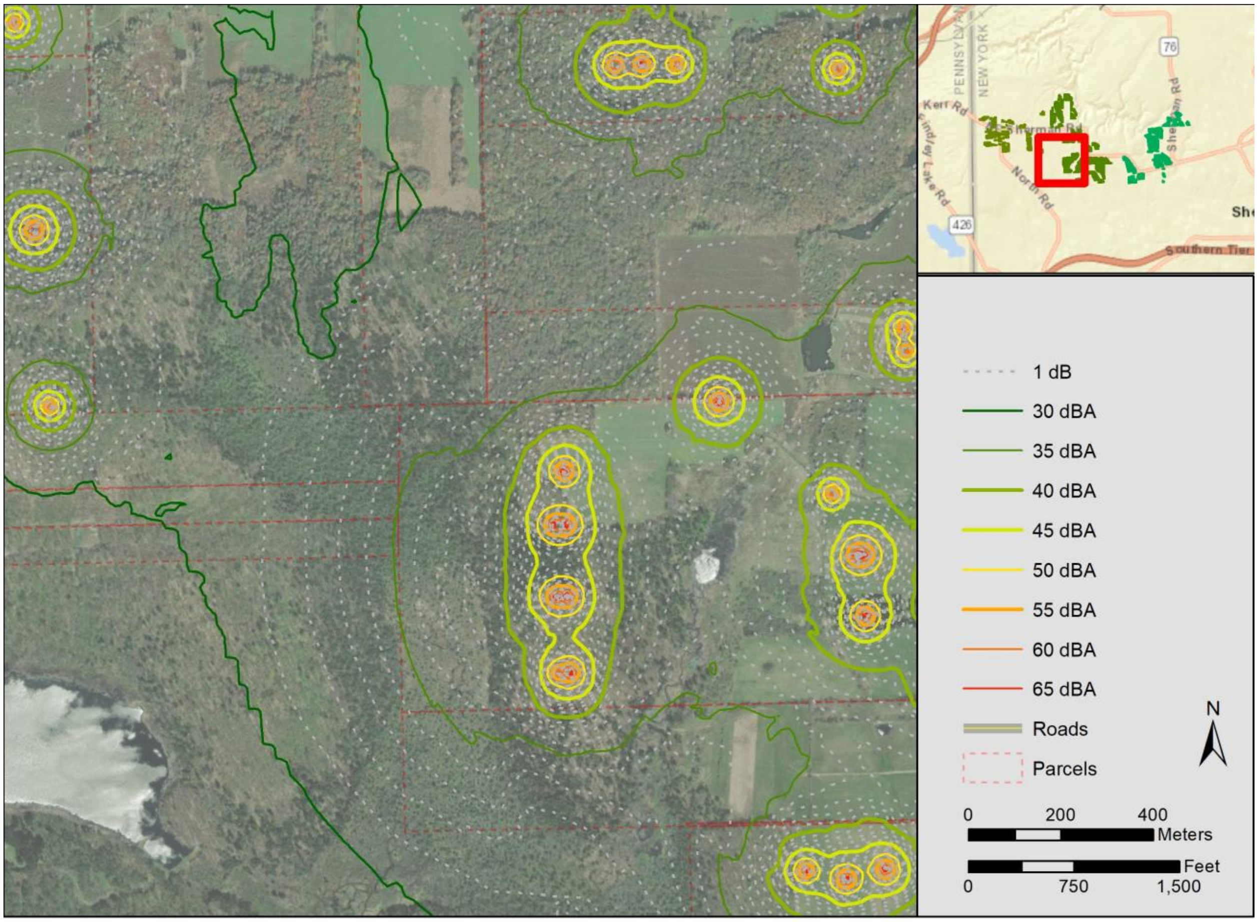


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**FIGURE 31: MITIGATED MAXIMUM L8H SOUND PROPAGATION MODEL RESULTS – MAP 4**

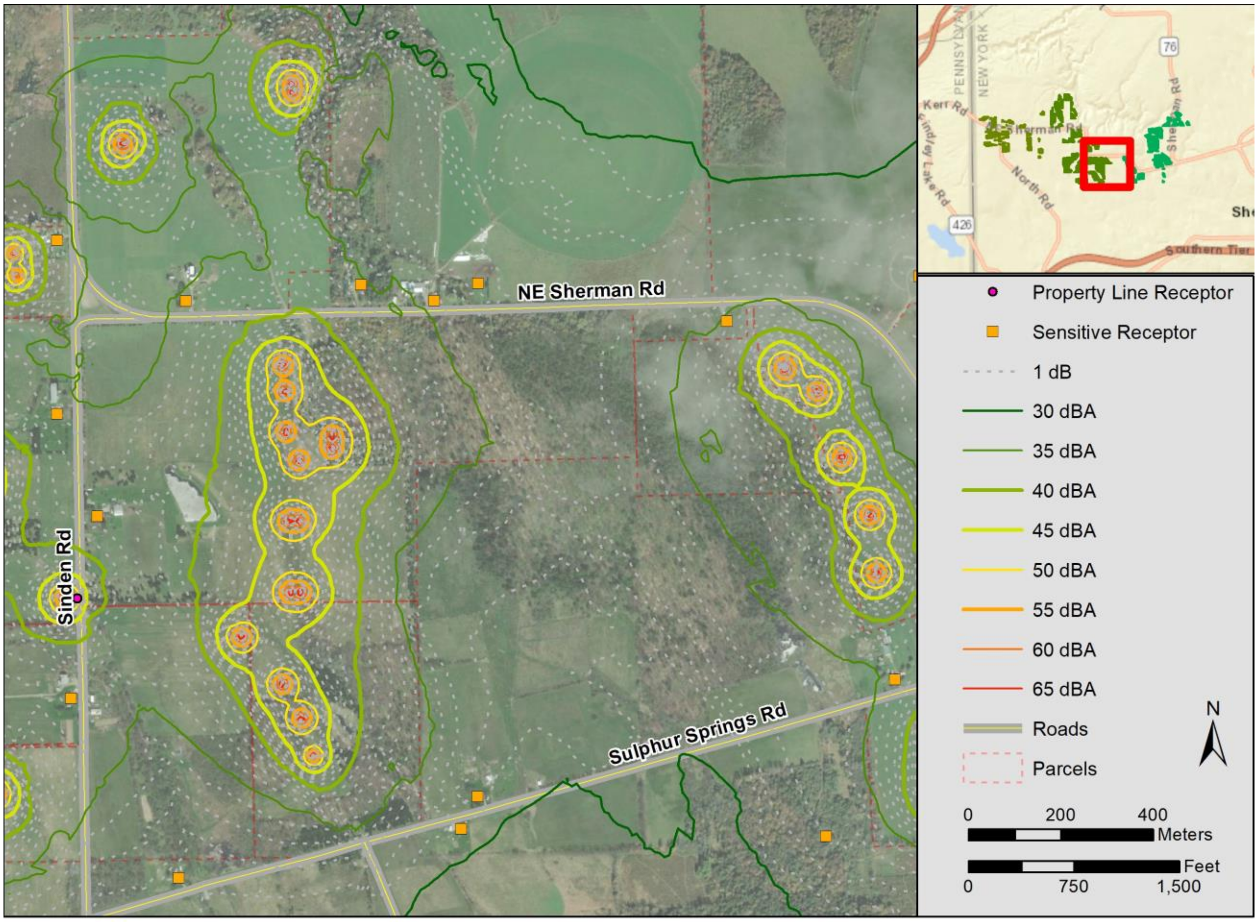
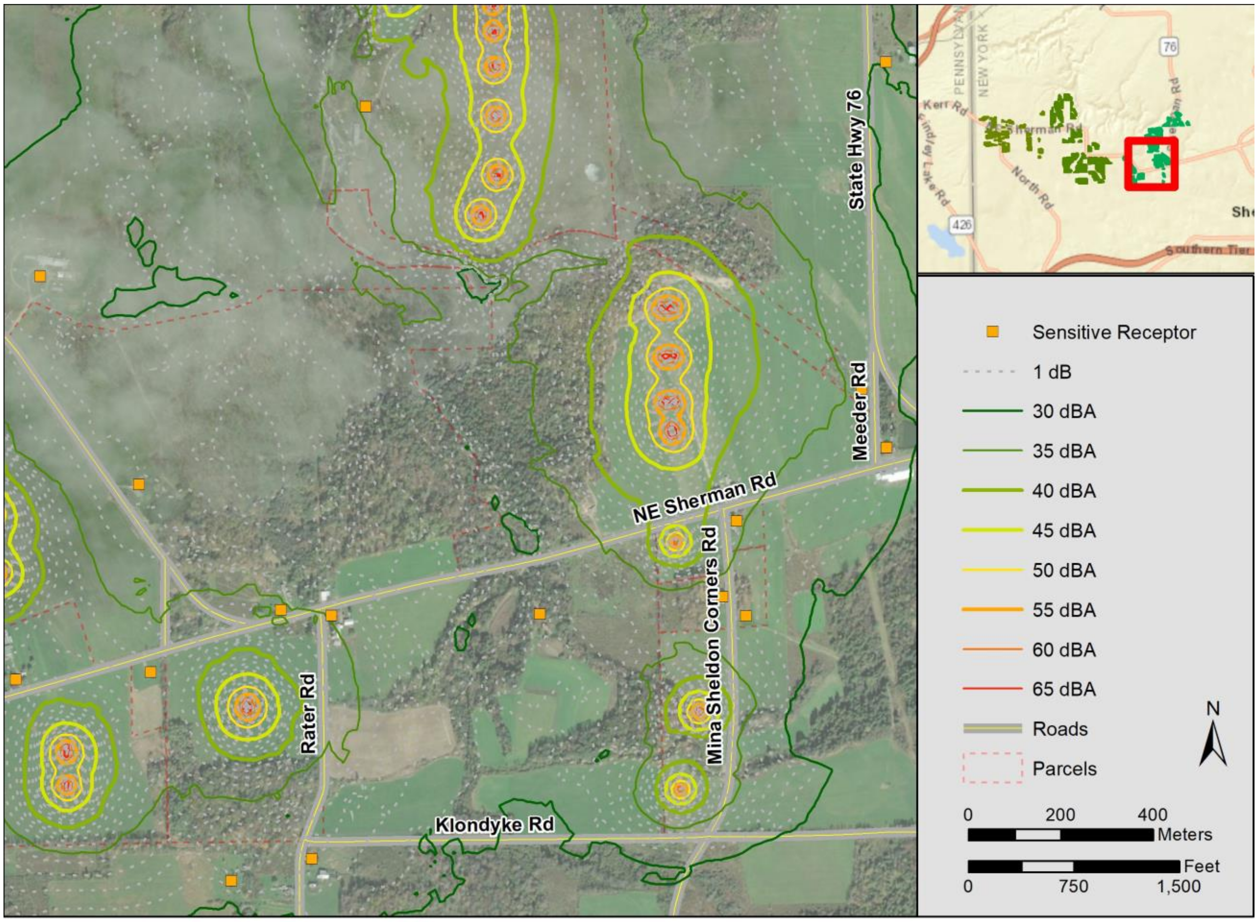



**FIGURE 32: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 5**




Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

**FIGURE 33: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 6**

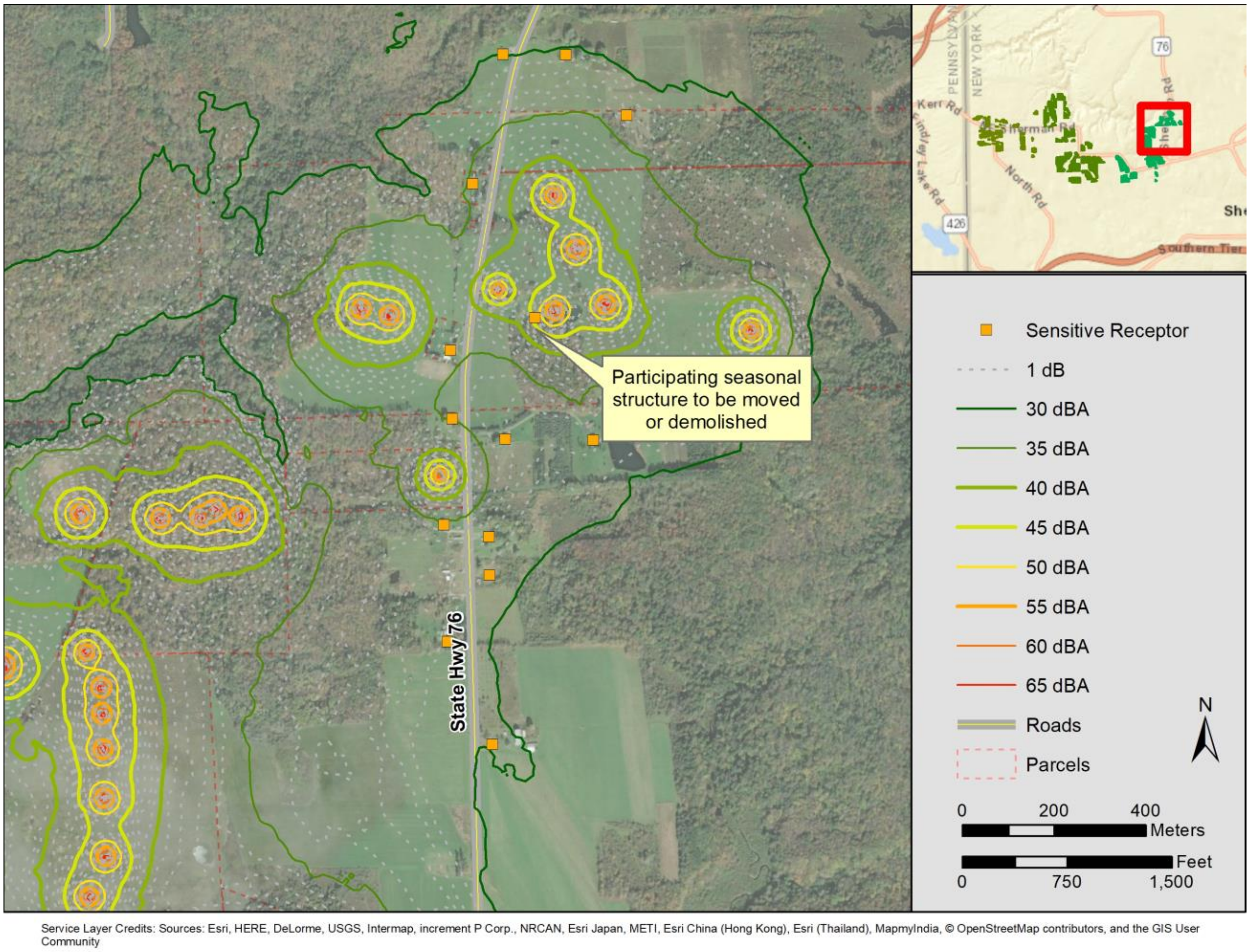



**FIGURE 34: MITIGATED MAXIMUM $L_{8H}$ SOUND PROPAGATION MODEL RESULTS – MAP 7**

## 7.5 CONSTRUCTION NOISE

Construction noise modeling was performed using the same standard and software used to model operational noise, ISO 9613-2 implemented in Datakustik's CadnaA, in accordance with the requirements of Section 94-c. Discrete receptor and grid heights are the same as was used in operational sound propagation modeling for the Project, as described in Section 7.1.

Sound source information was obtained from National Cooperative Highway Research Program (NCHRP) Project 25-49 (September 2018). Modeling procedures generally followed guidelines in the FHWA's Highway Construction Noise Handbook, where appropriate and where data was available.

Construction across the Project site is proposed to take place from 7 AM to 6 PM for approximately 12 to 19 months. While Sunday could be worked, no pile driving would occur on those days.

For construction noise modeling, construction activities were categorized into seven groups: road construction, substation construction, trenching, inverter installation, piling, racking, and boring. For each category, the closest receptors were identified and the worst-case areas around the Project area were modeled assuming the maximum sound emissions of all associated construction equipment operating simultaneously.

## Road Construction

Project road construction would take place from public roads and through the areas proposed for solar arrays to inverter locations and the substation. The primary sources associated with this activity are excavators, dozers, graders, dump trucks, and rollers.

Cumulative model results of all primary road construction sources operating simultaneously near the closest receptor to road construction is provided in Figure 35. The worst-case receptor for road construction is a residence (Receptor ID 38) on the north side of NE Sherman Road. The cumulative modeled sound level at this receptor is 83 dBA. Table 9 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. Road construction typically only takes place for a few days in any given location, so the potential impact to any given receptor is relatively short in duration.

**TABLE 9: MODELED SOURCES FOR ROAD CONSTRUCTION AND MODELED SOUND LEVELS**

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Excavator | 76 | 79 |
| Dozer | 80 | 76 |
| Grader | 78 | 75 |
| Roller | 82 | 72 |
| Dump Truck | 82 | 71 |
| **Cumulative Sound Level at Closest Receptor:** | | **83** |

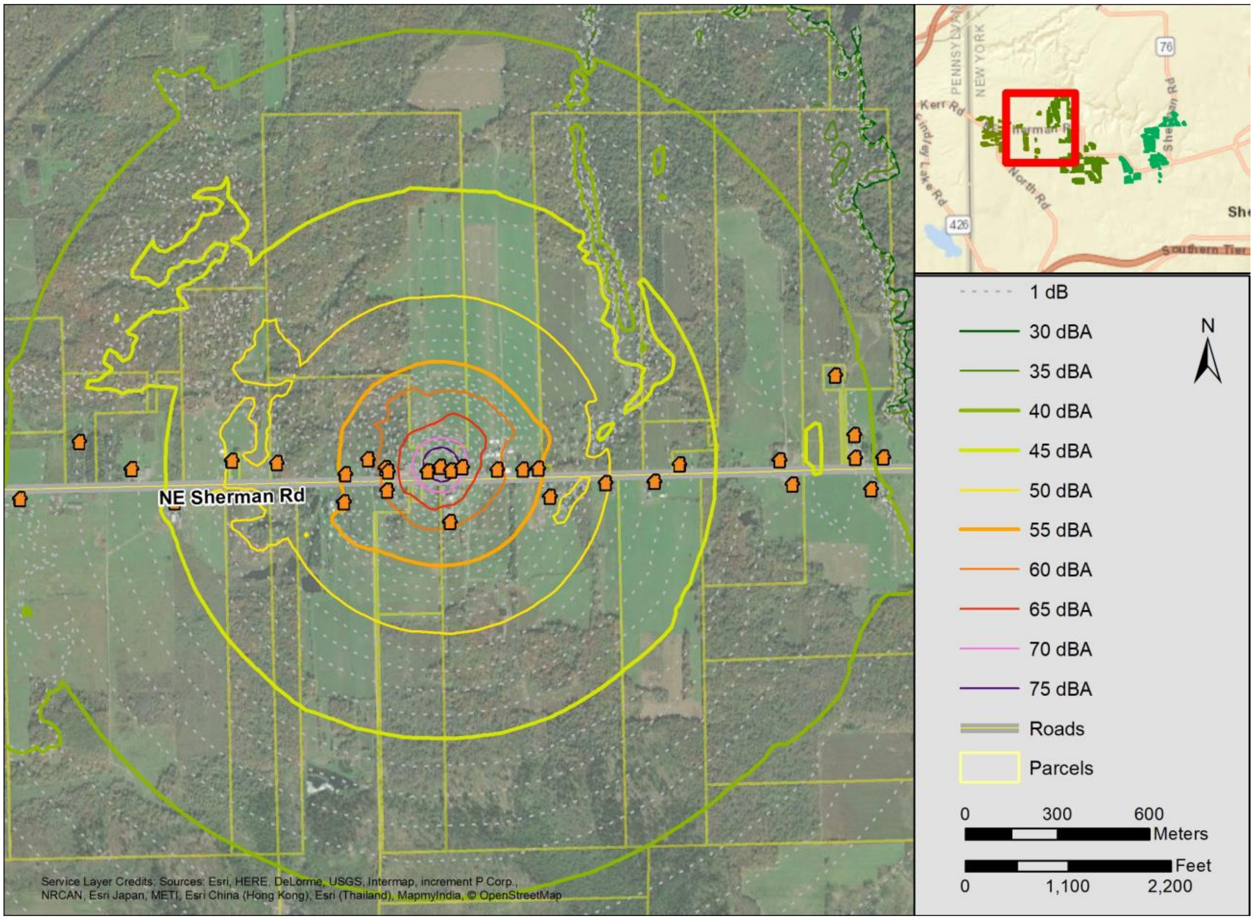



**FIGURE 35: ROAD CONSTRUCTION MODEL RESULTS**

## Substation and Energy Storage Construction

This construction would take place within the substation area shown in Figure 36. The primary sources associated with this activity are excavators, dozers, graders, dump trucks, rollers, concrete mixing trucks, concrete pumper trucks, flatbed trucks, man-lifts, and cranes. Construction of the substation will take approximately 12 months and the energy storage construction will take approximately 15 months.

Cumulative model results of all primary substation construction sources operating simultaneously is provided in Figure 36. The worst-case receptor for substation construction is a residence (Receptor ID 42) northeast of the substation. The cumulative modeled sound level at this receptor is 72 dBA. Table 10 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor.

### TABLE 10: MODELED SOURCES FOR SUBSTATION CONSTRUCTION AND MODELED SOUND LEVELS

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Excavator | 76 | 57 |
| Dozer | 80 | 59 |
| Grader | 78 | 61 |
| Roller | 82 | 65 |
| Dump Truck | 82 | 64 |
| Concrete Mixing Truck | 81 | 62 |
| Concrete Pumper Truck | 84 | 67 |
| Man-lift | 72 | 54 |
| Flatbed Truck | 74 | 51 |
| Crane (2) | 74 | 57 |
| **Cumulative Sound Level at Closest Receptor:** | | **72** |

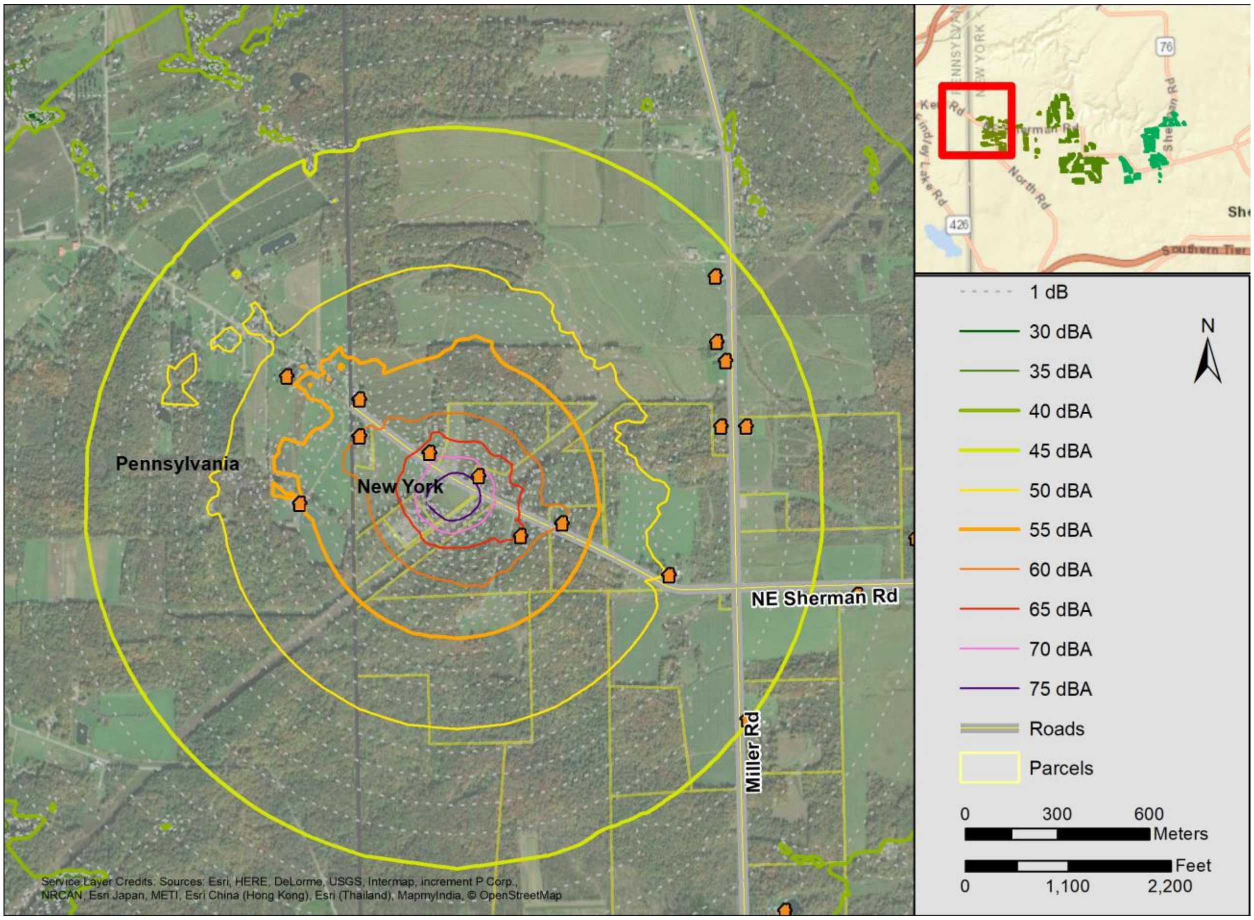



**FIGURE 36: SUBSTATION CONSTRUCTION MODEL RESULTS**

## Trenching

Trenching would take place along the underground collection line routes throughout the Project area. The primary sources associated with this activity are excavators, dozers, rollers, compactors, flatbed trucks, forklifts, and trenchers.

Cumulative model results of all primary trenching sources operating simultaneously near the closest receptor to trenching is provided in Figure 37. The worst-case receptor for trenching is a residence (Receptor ID 38) north of NE Sherman Rd. The cumulative modeled sound level at this receptor is 83 dBA. Table 11 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. Trenching typically only takes place for a few days in any given location, so the potential impact to any given receptor is relatively short in duration.

**TABLE 11: MODELED SOURCES FOR TRENCHING AND MODELED SOUND LEVELS**

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Excavator | 76 | 75 |
| Dozer | 80 | 71 |
| Trencher | 80 | 79 |
| Roller | 82 | 75 |
| Compactor | 75 | 69 |
| Flatbed Truck | 74 | 69 |
| Forklift | 84 | 78 |
| **Cumulative Sound Level at Closest Receptor:** | | **76** |

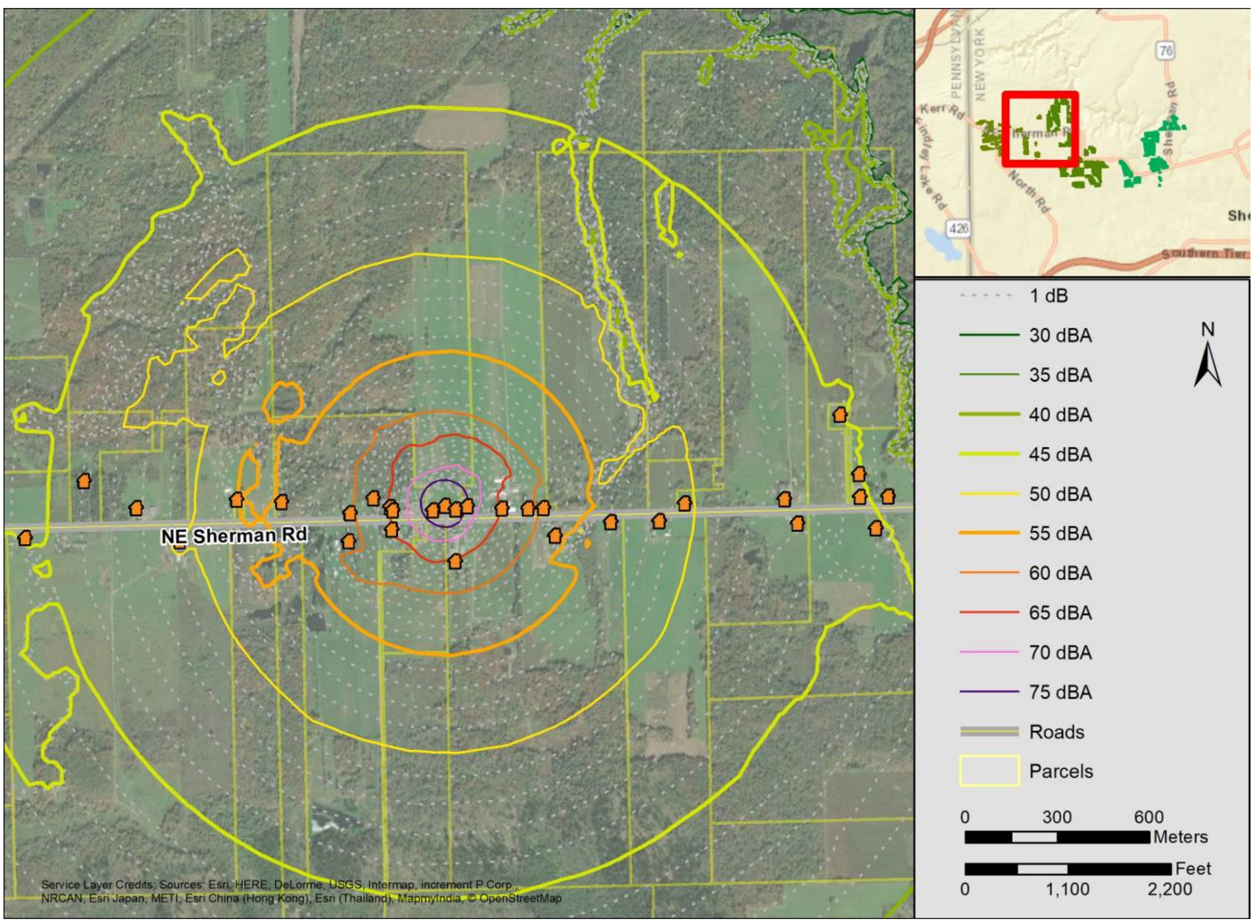



**FIGURE 37: TRENCHING MODEL RESULTS**

## Array Inverter and Transformer Construction

This construction would take place around each inverter pad location throughout the solar arrays shown in Figure 2. The primary sources associated with this activity are excavators, dozers, graders, rollers, dump trucks, concrete mixing trucks, and concrete pumping trucks.

Cumulative model results of all primary inverter construction sources operating simultaneously near the closest receptor to inverter construction is provided in Figure 38. The worst-case receptor for inverter construction is south of NE Sherman Road (Receptor ID 25). The cumulative modeled sound level at this receptor is 72 dBA. Table 12 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. Construction at each inverter pad typically lasts for a few days, so the potential impact to any given receptor is relatively short in duration.

**TABLE 12: MODELED SOURCES FOR INVERTER CONSTRUCTION AND MODELED SOUND LEVELS**

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Excavator | 76 | 59 |
| Dozer | 80 | 63 |
| Grader | 78 | 59 |
| Roller | 82 | 64 |
| Dump Truck | 82 | 62 |
| Concrete Mixing Truck | 81 | 64 |
| Concrete Pumping Truck | 84 | 68 |
| **Cumulative Sound Level at Closest Receptor:** | | **72** |

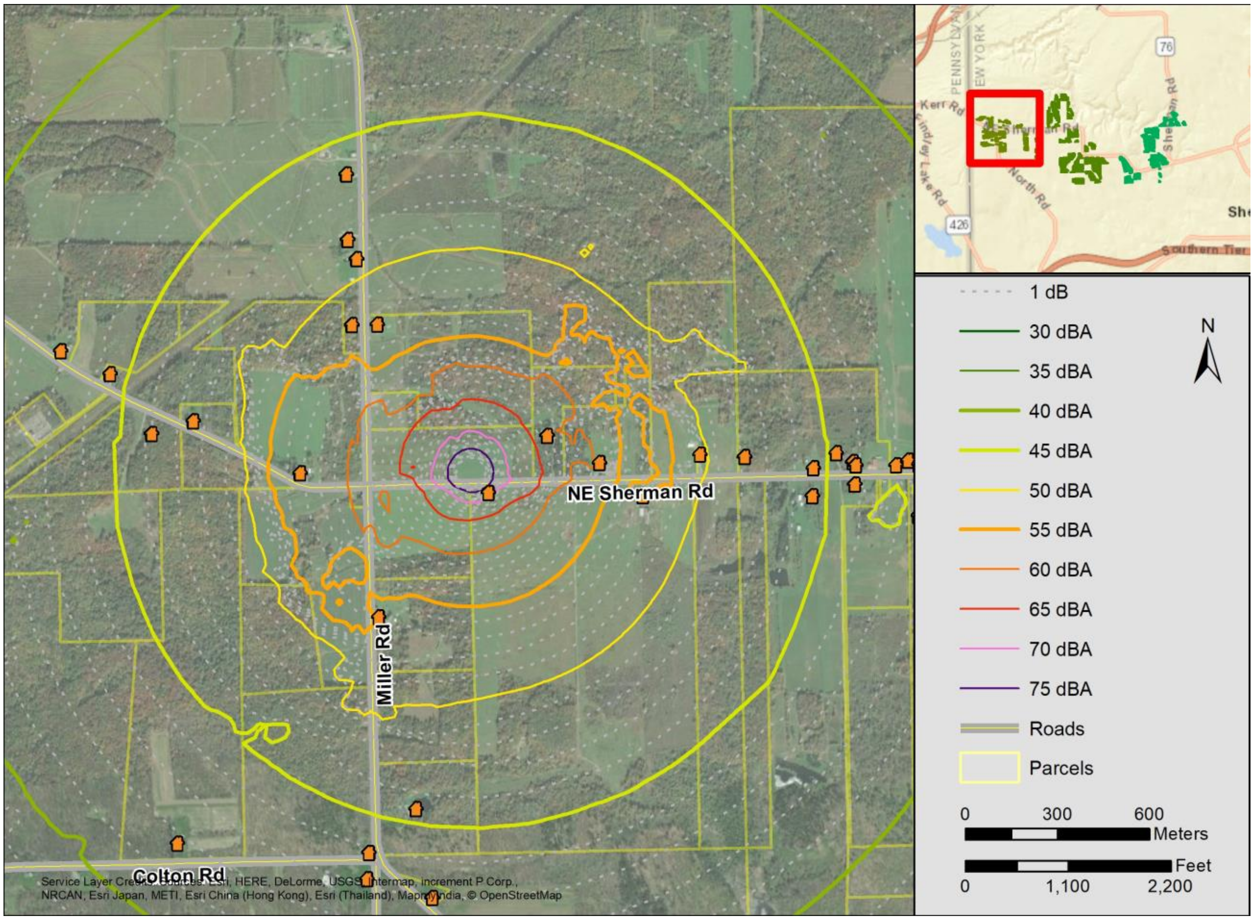



**FIGURE 38: INVERTER CONSTRUCTION MODEL RESULTS**

## Piling

Piling would take place throughout the solar arrays. The primary sources associated with this activity are flatbed trucks, boom trucks, and pile drivers.

Cumulative model results of all primary piling sources operating simultaneously near the closest receptor to piling is provided in Figure 39. The worst-case receptor for piling is at a residence west of State Highway 76 (Receptor ID 92). The cumulative modeled sound level at this receptor is 70 dBA. Table 13 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. If there were two crews in the same area, the sound level would be approximately 70 dBA. Piling typically lasts for a few days in any given location, so the potential impact to any given receptor is relatively short in duration.

TABLE 13: MODELED SOURCES FOR PILING AND MODELED SOUND LEVELS

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Flatbed Truck | 74 | 62 |
| Boom Truck | 72 | 61 |
| Pile Driver | 84 | 68 |
| **Cumulative Sound Level at Closest Receptor:** | | **70** |

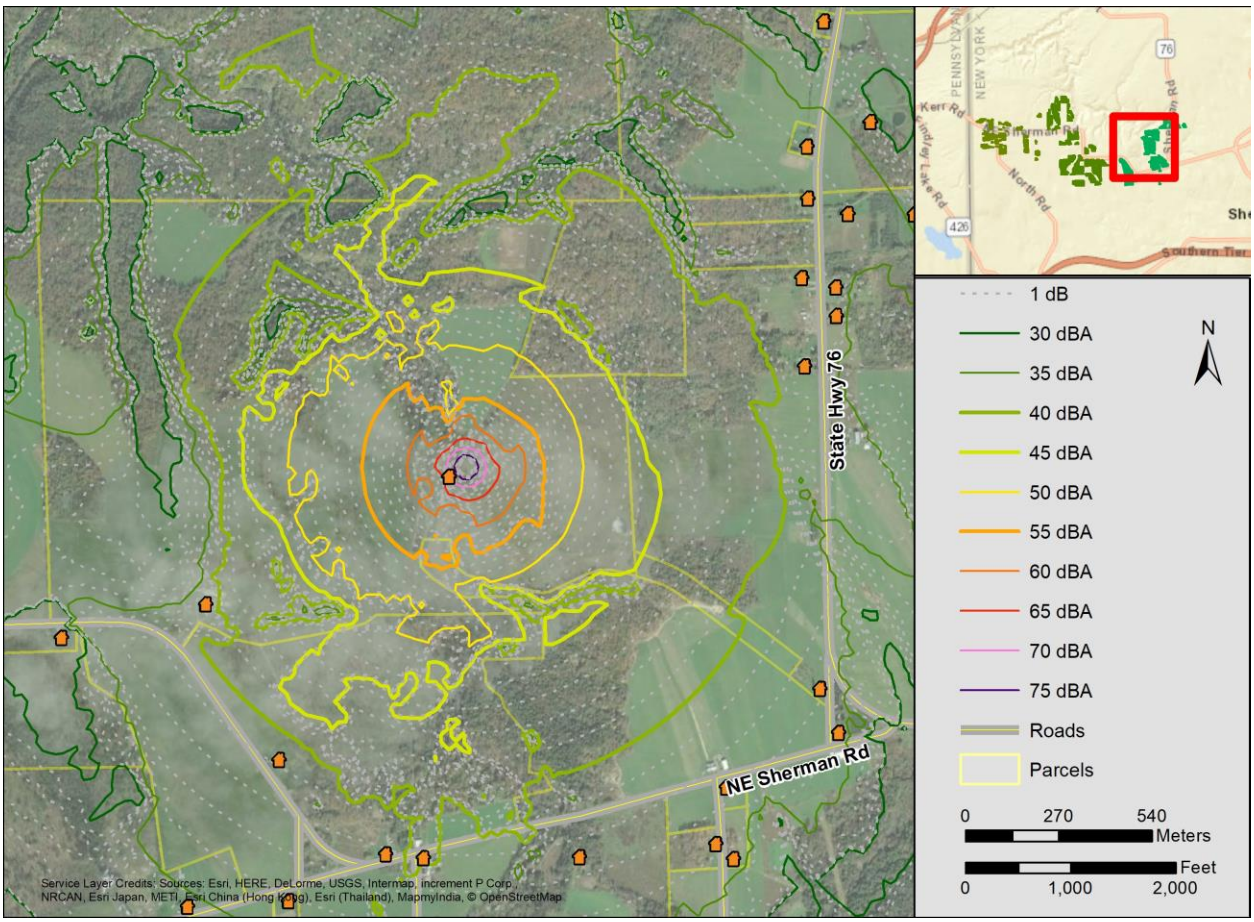



FIGURE 39: PILING MODEL RESULTS

## Racking

Racking would take place throughout the solar arrays. The primary sources associated with this activity are flatbed trucks and forklifts.

Cumulative model results of all primary racking sources with two crews operating simultaneously near the closest receptor to racking is provided in Figure 40. The worst-case receptor for racking is at a residence west of State Highway 76 (Receptor ID 92). The cumulative modeled sound level at this receptor is 78 dBA. Table 14 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. There are two of each source for racking assuming that two teams may be working in the same area at once. Like piling, racking typically lasts for a few days in any given location, so the potential impact to any given receptor is relatively short in duration.

**TABLE 14: MODELED SOURCES FOR RACKING AND MODELED SOUND LEVELS**

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Flatbed Truck 1 | 74 | 63 |
| Forklift 1 | 84 | 75 |
| Flatbed Truck 2 | 74 | 63 |
| Forklift 2 | 84 | 75 |
| **Cumulative Sound Level at Closest Receptor:** | | **78** |

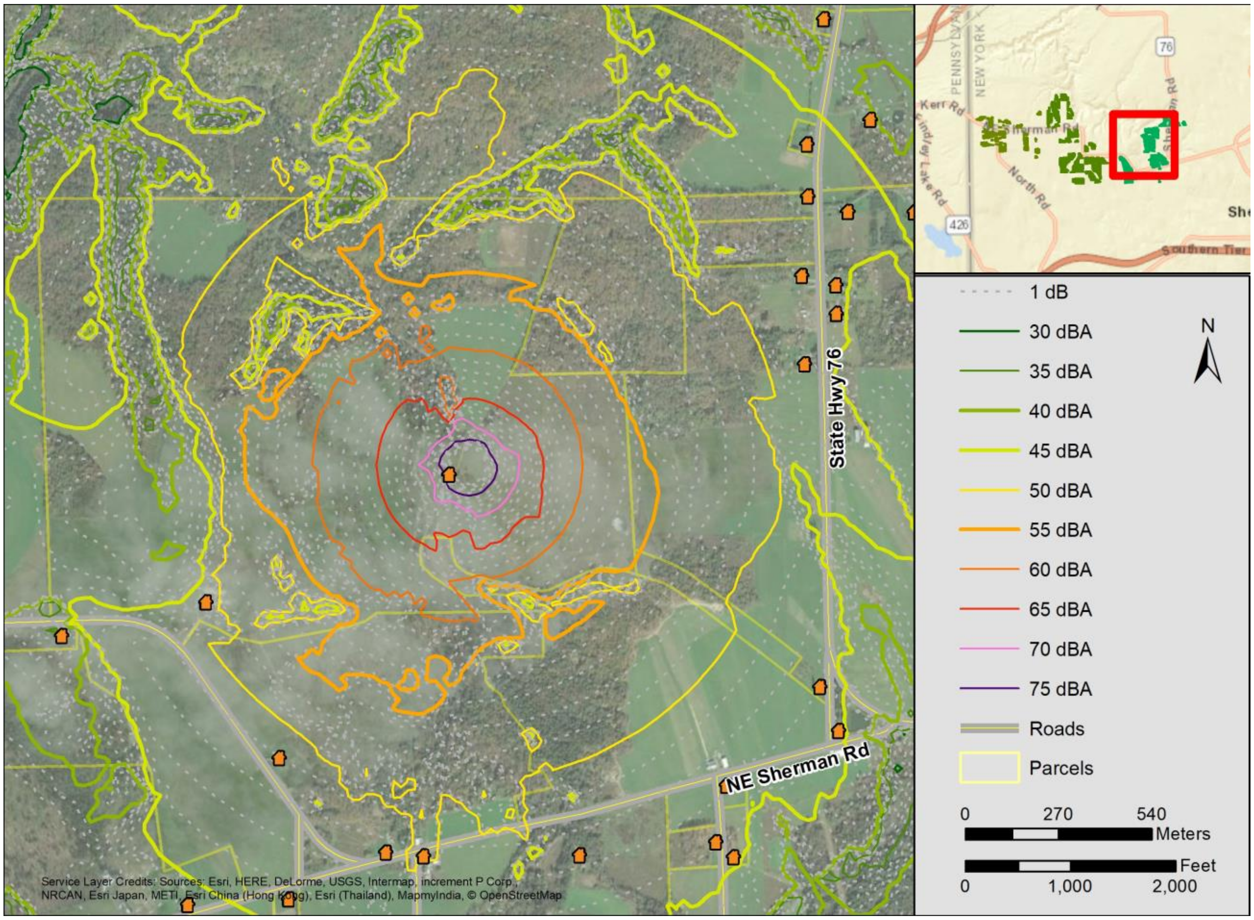



**FIGURE 40: RACKING MODEL RESULTS**

## Boring

Boring would take place on the ends of portions of the underground collection line routes throughout the Project area. The primary source associated with this activity is a horizontal boring machine.

Cumulative model results of all primary boring sources operating simultaneously near the closest receptor to racking is provided in Figure 41. The worst-case receptor for boring is at a residence north of NE Sherman Rd (Receptor ID 38). The cumulative modeled sound level at this receptor is 50 dBA. Table 15 shows the sound level from each source at a distance of 50 feet, and the sound level from each source at the closest receptor. Boring typically lasts for a few days in any given location, so the potential impact to any given receptor is relatively short in duration.

TABLE 15: MODELED SOURCES FOR BORING AND MODELED SOUND LEVELS

| EQUIPMENT | SOUND PRESSURE LEVEL AT 50 FEET (dBA) | SOUND PRESSURE LEVEL AT CLOSEST SENSITIVE RECEPTOR (dBA) |
|---|---|---|
| Boring Machine | 76 | 50 |
| **Cumulative Sound Level at Closest Receptor:** | | **50** |

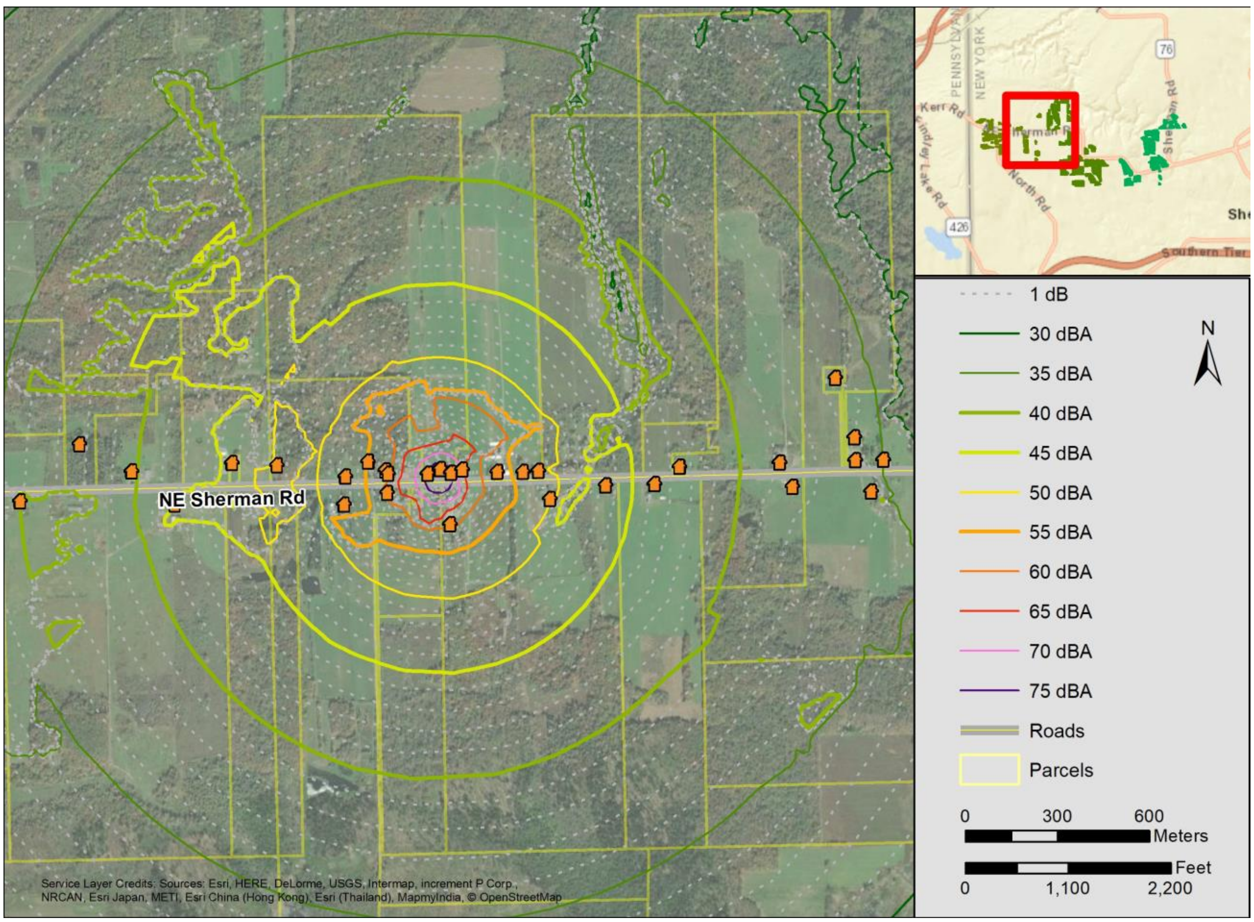



FIGURE 41: BORING MODEL RESULTS

## Construction Best Management Practices

The following best management construction practices are recommended to limit construction hours and reduce construction noise levels at noise sensitive locations.

- Equipment and trucks used for project construction shall utilize property operating mufflers at all times,
- Locate all stationary noise-generating equipment, such as air compressors and portable power generators, a minimum of 200 feet from adjacent residential structures,

- Maintaining equipment and surface irregularities on construction sites to prevent unnecessary noise,
- Locate staging areas and construction material areas a minimum of 200 feet from adjacent residential and classroom structures,
- Prohibit unnecessary idling of internal combustion engines, and
- Requiring contractors to use approved haul routes to minimize noise at residential and other sensitive noise receptor sites.

# 8.0 SUMMARY AND CONCLUSIONS

The South Ripley Solar Project ("Project") is a proposed 270 megawatt (MW) photovoltaic solar power facility with supporting infrastructure in Chautauqua County, New York. In preparation for permitting under Chapter XVIII, Title 19 of New York Codes, Rules, and Regulations, Part 900, also known as "Section 94-c", RSG has prepared a Project Noise Impact Assessment (PNIA).

There are no local or federal noise limits that are applicable to the Project. Section 94-c applies several noise limits for solar power projects, along with requirements for noise study content.

Table 16 shows noise limits that are applicable to the project. As shown in the table, there are no receptors analyzed in this PNIA that exceed any applicable quantitative sound level limits.

**TABLE 16: SOUND LEVEL LIMITS APPLICABLE TO THE PROJECT AND NUMBER OF RECEPTORS EXCEEDING THE LIMITS**

| Sound Level Limit or Threshold | Maximum Sound Level (dBA) (including tonal penalty) | Number of Receptors Exceeding Standard |
|---|---|---|
| 45 dBA $L_{8h}$ at nonparticipating residences | 44 dBA | 0 (0%) |
| 55 dBA $L_{8h}$ at participating residence | 52 dBA[9] | 0 (0%) |
| 55 dBA $L_{8h}$ at nonparticipating property lines | 52 dBA | 0 (0%) |
| 40 dBA $L_{1h}$ at nonparticipating residences from substation noise | 39 dBA | 0 (0%) |

A summary of some key points in this assessment and conclusions of the assessment are as follows:

- Background sound level measurements were performed at six locations throughout the Project area in March and July 2020. Monitor locations were chosen to represent different areas and soundscapes throughout the Project area. Descriptions of each monitor location are found in Section 5.0
- The average ambient preconstruction equivalent sound level across the Project area was 42 dBA during the day and 32 dBA at night. The sound levels and the types of sources that were present during the monitoring period are indicative of a rural area.
- Sound propagation modeling was performed using ISO 9613-2 sound propagation modeling algorithms to calculate projected Project-related construction and operational sound levels at 103 sensitive sound receptors. As a conservative assumption, all participating properties and homes were considered as non-participating for comparison

[9] This participating seasonal structure will be moved or removed as part of the Project.

to noise standards (except for one participating seasonal structure that will be moved or removed as part of the Project).

- The operational sound sources that were included in the sound propagation model included:
  - 2,176 string inverters skids
  - A high-voltage transformer at the substation
  - 137 medium voltage transformers (“MVT”) with no cooling fans, and
  - 20 MW of energy storage.
- Without 1/3 octave band sound emission data available from the equipment manufacturers, all sources were assumed to be tonal with a 5 dB penalty applied for evaluating the projected sound levels against the 94-c sound level limits applied at residences. This is a conservative assumption as tonality is generally reduced at the receiver due to the attenuation of the sound over distance and masking by broadband background sound.
- Modeled Project sound levels ($L_{8h}$) are reported in Section 7.4.
  - The highest sound level at a non-participating residence, including tonal penalties on all modeled sources, is 44 dBA $L_{8h}$. Without the tonal penalty, the highest projected sound level at a non-participating residence is 39 dBA $L_{8h}$. These levels meet Section 94-c limits.
  - The highest projected sound level at a non-participating property line is 52 dBA $L_{8h}$ which occurs at a location adjacent to and southeast of the substation next. All property lines are modeled to meet Section 94-c limits.
  - The substation transformer is expected to be tonal. It is modeled to be 34 dBA $L_{8h}$ or less at all sensitive receptors. Including a 5 dB tonal penalty, the maximum sound level is modelled at 39 dBA, which meets the 40 dBA Section 94-c limit.
- The modeled sound levels are below the WHO criteria for hearing loss (70 dBA $L_{24}$).
- Construction noise was modeled using ISO 9613-2 for a number of construction activities in the areas where they would be conducted closest to receptors. The projected sound level at the most impacted receptors that would occur from each activity is provided below. These sound levels are from construction equipment associated with a specific activity operating simultaneously and will not be consistently experienced by nearby receptors. Impacts will also be of relatively short duration.
  - 70 dBA for road construction,
  - 53 dBA for substation construction,

    - 76 dBA for trenching,
    - 68 dBA for inverter construction
    - 62 dBA for piling,
    - 66 dBA for racking, and
    - 50 dBA for boring.
- The Project has incorporated several noise-mitigating elements into the design, including the use of low-noise equipment in the energy storage facility (relative to other commercially available equipment) and a low-noise substation transformer (NEMA TR-1 minus 10 dB).

Based upon the results from the analysis completed in this report and the information presented in this report, we conclude that the Project will meet the noise limits set in Section 94-c, and the noise reporting requirements of Section 94-c have been met as detailed in Appendix A.

# APPENDIX A. ORES NOISE REGULATIONS

The relevant excerpt from ORES Regulations is found below. Sections only applying to wind power facilities have been removed. Shown within **square brackets** are the sections in this report where specific provisions are found.

§900-2.8 Exhibit 7: Noise and Vibration

Exhibit 7 shall contain:

(a) A study of the noise impacts of the construction and operation of the facility. The name(s) of the preparer(s) of the study and qualifications to perform such analyses shall be stated. If the study is prepared by certified member(s) of a relevant professional society or state, the details of such certification(s) shall be stated. **[Section 1.0]**

(b) Design Goals: The study shall demonstrate that noise levels from noise sources at the facility will comply with the following:

(1) For wind facilities:

…

(2) For solar facilities: **[Table 1, Section 7.4 and Appendix C]**

(i) A maximum noise limit of forty-five (45) dBA Leq (8-hour), at the outside of any existing non-participating residence, and fifty-five (55) dBA Leq (8-hour) at the outside of any existing participating residence; **[Table 1, Section 7.4 and Appendix C]**

(ii) A maximum noise limit of forty (40) dBA Leq (1-hour) at the outside of any existing non- participating residence from the collector substation equipment; **[Table 1 and Section 7.4]**

(iii) Prominent tones are as defined by using the constant level differences listed under ANSI/ASA S12.9-2005/Part 4 Annex C (sounds with tonal content) (see section 900-15.1(a)(1)(iii) of this Part), at the outside of any existing non- participating residence. Should a prominent tone occur, the broadband overall (dBA) noise level at the evaluated non-participating position shall be increased by 5 dBA for evaluation of compliance with subparagraphs (i) and (ii) of this paragraph; and **[Sections 7.3, and 7.4]**

(iv) A maximum noise limit of fifty-five (55) dBA Leq (8-hour), short-term equivalent continuous average sound level from the facility across any portion of a non-participating property except for portions delineated as NYS-regulated wetlands pursuant to section 900-1.3(e) of this Part and utility ROW to be demonstrated with modeled sound contours drawings and discrete sound levels at worst-case locations. No penalties for prominent tones will be added in this assessment. **[Table 1, Section 7.4 and Appendix C]**

(c) Radius of Evaluation: Evaluation of the maximum noise levels to be produced during operation of the facility shall be conducted on a cumulative (if any) and non-cumulative basis for all sensitive receptors within the sound study area, defined as follows:

…

(2) For solar facilities, the evaluation shall include, at a minimum, all sensitive receptors within a one thousand five hundred (1,500) foot radius from any noise source (e.g., substation transformer(s), medium to low voltage transformers, inverters, energy storage) proposed for the facility or within the thirty (30) dBA noise contour, whichever is greater. For the cumulative noise analysis, the evaluation shall include noise from any solar facility and substation existing and proposed by the time of filing the application and any existing sensitive receptors within a three thousand (3,000)- foot radius from any noise source proposed for the facility or within the thirty (30) dBA cumulative noise contour, whichever is greater. **[Section 7.4]**

(d) Modeling standards, input parameters, and assumptions:

(1) For both wind and solar facilities, the evaluation shall use computer noise modeling software that follows the ANSI/ASA S12.62-2012/ISO 9613-2:1996 (MOD) (see section 900-15.1(a)(1)(v) of this Part) or the ISO-9613-2:1996 propagation standards (see section 900-15.1(g)(1)(i) of this Part) with no meteorological correction (Cmet) added. The model shall: **[Section 7.1]**

(i) Set all noise sources operating simultaneously at maximum sound power levels; **[Section 7.1]**

(ii) Use a ground absorption factor of no more than G=0.5 for lands and G=0 for water bodies; **[Section 7.1]**

(iii) Use a temperature of ten (10) degrees Celsius and seventy (70) percent relative humidity; **[Section 7.1]**

(iv) Report, at a minimum, the maximum A-weighted dBA Leq (1-hour or 8-hour) sound pressure levels in a year, and the maximum linear/unweighted/Z dB (Leq 1-hour) sound pressure levels in a year from the thirty-one and a half (31.5) Hz up to the eight thousand (8,000) Hz full-octave band, at all sensitive sound receptors within the radius of evaluation; **[Appendix C and Appendix D]**

(v) Report the maximum A-weighted dBA Leq sound pressure levels in a year (Leq (8-hour)) at the most critically impacted external property boundary lines of the facility site (e.g., non-participating boundary lines); **[Table 7 and Appendix C]**

(vi) Report the information in tabular and spreadsheet compatible format as specified herein and in subdivisions (f)(3) and (q)(2) of this section. A summary of the number of receptors exposed to sound levels greater than thirty-five (35) dBA will also be reported in tabular format grouped in one (1)-dB bins; and **[Table 8]**

(vii) Report noise impacts with sound level contours (specified in subdivision (k) of this section) on the map described in subdivision (h) of this section. **[Section 7.4]**

(2) For wind facilities, the model shall:

…

(3) For solar facilities, the model shall use a one and a half (1.5) meter assessment point above the ground and the addition of an uncertainty factor of zero (0) dBA or greater. **[Section 7.1]**

(e) Evaluation of prominent tones for the design:

(1) For wind and solar facility noise sources: The evaluation shall be conducted by using manufacturer sound information, the ANSI/ASA S12.62-2012/ISO 9613-2:1996 (MOD) (see section 900-15.1(a)(1)(v) of this Part) or the ISO 9613-2:1996 propagation standard (see section 900-15.1(g)(1)(i) of this Part) attenuations (Adiv, Aatm, Agr, and Abar), and the “prominent discrete tone” constant level differences (Kt) specified in ANSI/ASA S12.9-2013/Part 3 Annex B, Section B.1 (see section 900-15.1(a)(1)(ii) of this Part), as follows: fifteen (15) dB in low-frequency one-third-octave bands (from twenty-five (25) up to one hundred twenty-five (125) Hz); eight (8) dB in middle-frequency one-third-octave bands (from one hundred sixty (160) up to four hundred (400) Hz); and five (5) dB in high-frequency one-third-octave bands (from five hundred (500) up to ten thousand (10,000) Hz). **[Section 7.3]**

(2) For substation transformers and other solar facility noise sources (such as inverters/medium to low voltage transformers) where no manufacturer’s information or pre-construction field tests are available, the sounds will be assumed to be tonal and prominent. **[Section 7.3]**

…

(h) A map of the study area showing the location of sensitive sound receptors in relation to the facility (including any related substations), as follows.

(1) The sensitive sound receptors shown shall include all residences, outdoor public facilities and public areas, hospitals, schools, libraries, parks, camps, summer camps, places of worship, cemeteries, any historic resources listed or eligible for listing on the State or National Register of Historic Places, any public (federal, state and local) lands, cabins and hunting camps identified by property tax codes, and any other seasonal residences with septic systems/running water within the Sound Study Area. **[Appendix C]**

(2) All residences shall be included as sensitive sound receptors regardless of participation in the facility (e.g., participating, potentially participating, and non-participating residences) or occupancy (e.g., year-round, seasonal use).

(3) Only properties that have a signed contract with the applicant prior to the date of filing the application shall be identified as "participating." Other properties may be designated either as "non-participating" or "potentially participating." Updates with ID-tax numbers may be filed after the application is filed. **[All receptors designated as non-participating in this study]**

(i) An evaluation of ambient pre-construction baseline noise conditions by using the L90 statistical and the Leq energy-based noise descriptors, and by following the recommendations included in ANSI/ASA S3/SC 1.100-2014-ANSI/ASA S12.100-2014 American National Standard entitled Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas (see section 900-15.1(a)(1)(iv) of this Part). Sound surveys shall be conducted for, at a minimum, a seven (7) day-long period for wind facilities and a four (4) day-long period for solar facilities. **[Section 4.0]**

(j) An evaluation of future noise levels during construction of the facility including predicted A- weighted/dBA sound levels using computer noise modeling as follows: **[Section 7.5]**

(1) The model shall use the ANSI/ASA S12.62-2012/ISO 9613-2:1996 (MOD) (see section 900- 15.1(a)(1)(v) of this Part) or the ISO-9613-2:1996 propagation standard (see section 900- 15.1(g)(1)(i) of this Part) for the main phases of construction, and from activities at any proposed batch plant area/laydown area; **[Section 7.5]**

(2) The model shall include, at a minimum, all noise sources and construction sites that may operate simultaneously to meet the proposed construction schedule for the most critical timeframes of each phase; **[Section 7.5]**

(3) For wind and solar facilities, the operational modeling requirements included in subdivisions (d)(1)(i) through (d)(1)(iii), and (d)(3) of this section shall be used for modeling of construction noise; and **[Section 7.5]**

(4) Sound impacts shall be reported with sound level contours (specified in subdivision (k) of this section) on the map described in subdivision (h) of this section and sound levels at the most critically impacted receptors in tabular format (as specified in subdivision (q)(2) of this section). **[Section 7.5]**

(k) Sound Levels in Graphical Format:

(1) The application shall include legible sound contours rendered above the map specified in subdivision (h) of this section. **[Section 7.4]**

(2) Sound contours shall include all sensitive sound receptors and boundary lines (differentiating participating and non-participating) and all noise sources (e.g., wind turbines for wind facilities, substation(s), transformers, HVAC equipment, energy storage systems and emergency generators for wind and solar facilities; and inverters and medium to low voltage transformers for solar). **[Section 7.4]**

(3) Sound contours shall be rendered at a minimum, until the thirty (30) dBA noise contour is reached, in one (1)-dBA steps, with sound contours multiples of five (5) dBA differentiated. **[Section 7.4]**

(4) Full-size hard copy maps (22" x 34") in 1:12,000 scale shall be submitted. **[Provided separately, model result maps in this report are also produced at an 1:12,000 scale]**

(l) A tabular comparison between maximum sound impacts and any design goals, noise limits, and local requirements for the facility, and the degree of compliance at all sensitive sound receptors and at the most impacted non-participating boundary lines within the facility site. **[Section 8.0]**

(m) An evaluation as to whether any of the following potential community noise impacts will occur:

(1) Hearing loss for the public, as addressed by the World Health Organization (WHO) Guidelines for Community Noise published in 1999 (see section 900-15.1(d)(1)(i) of this Part). The requirements for the public are not to exceed an average sound level of seventy (70) dBA from operation of the facility **[Section 8.0]** and one hundred twenty (120) dB-peak for children and one hundred forty (140) dB-peak for adults for impulsive sound levels (e.g., construction blasting).

(2) The potential for structural damage from some construction activities (e.g., blasting, pile driving, excavation, horizontal directional drilling or rock hammering,

if any) to produce any cracks, settlements, or structural damage on any existing proximal buildings, including any residences, historical buildings, and public or private infrastructure.

(n) An identification and evaluation of reasonable noise abatement measures for construction activities. **[Section 7.5]**

(o) An identification and evaluation of noise abatement measures for the design and operation of the facility to comply with the design limits set forth in subdivision (b) of this section. **[Section 7.4 and 7.2]**

(1) For wind facilities:

…

(2) For solar facilities: If noise mitigation measures are necessary for the design, those mitigation measures shall be implemented no later than the start date of operations.

(p) The software input parameters, assumptions, and associated data used for the computer modeling shall be provided as follows:

(1) GIS files used for the computer noise modeling, including noise source and receptor locations and heights, topography, final grading, boundary lines, and participating status shall be delivered by digital means;

(2) Computer noise modeling files shall be submitted by digital/electronic means;

(3) Site plan and elevation details of substations, as related to the location of all relevant noise sources (e.g., transformers, emergency generator, HVAC equipment, and energy storage systems, if any); specifications, any identified mitigations, and appropriate clearances for sound walls, barriers, mufflers, silencers, and enclosures, if any.

…

(5) For solar facilities, the application shall contain:

(i) The locations of all noise sources (e.g., substation transformer(s), medium to low voltage transformers, inverters, energy storage system, HVAC equipment, emergency generators, if any) identified with GIS coordinates and GIS files. **[Table 18]**

(ii) Sound information from the manufacturers for all noise sources as listed above, and any other relevant noise sources. **[Table 19]**

(q) Miscellaneous:

(1) The application shall include a glossary of terminology, definitions, abbreviations and references mentioned in the application. **[Appendix F]**

(2) Information shall be reported in tabular, spreadsheet compatible or graphical format as follows:

(i) Data reported in tabular format shall be clearly identified to include headers and summary footer rows. Headers shall include identification of the information contained on each column, such as noise descriptors (e.g., Leq, L90, etc.); weighting (dBA, linear, dB, dBZ) duration of evaluation (e.g., 1-hour, 8-hour), time of the day (day time, nighttime); whether the value is a maximum or average value and the corresponding time frame of evaluation (e.g., maximum 8-h-Leq-nighttime in a year, etc.);

(ii) Titles shall identify whether the tabular or graphical information correspond to the "unmitigated" or "mitigated" results, if any mitigation measures are evaluated, and “cumulative” or “non-cumulative” for cumulative noise assessments;

(iii) Columns or rows with results related to a specific design goal, noise limit or local requirement, shall identify the requirement to which the information relates;

(iv) Tables shall be sorted by sound impacts or rows at the bottom summarizing the results to report maximum and minimum values of the information contained in the columns. For this purpose, sound receptors shall be separated in different tables according to their use (e.g., participating residences, non-participating residences, non-participating boundary lines, schools, parks, cemeteries, historic places, etc.); and

(v) The application shall report estimates of the absolute number of sensitive sound receptors that will be exposed to noise levels that exceed any design goal or noise limit (in total as well as grouped in one (1)-dB bins). **[Table 8 and Table 16]**

# APPENDIX B. MODEL INPUT DATA

### TABLE 17: MODEL PARAMETER SETTINGS

| Model Parameter | Setting |
|---|---|
| Atmospheric Absorption | Based on 10°C and 70% RH |
| Foliage | None |
| Ground Absorption | ISO 9613-2 spectral and G=0.5, except substation (G=0.6) and energy storage facility (G=0.0) |
| Receiver Height | 1.5 meters for sound level isolines and discrete receptors |
| Search Radius | 2,000 meters from each source |

### TABLE 18: OPERATIONAL SOURCE INPUT DATA[10]

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Inverter | 91 | 2 | 606471 | 4673473 | 387 |
| Array Inverter | 91 | 2 | 608683 | 4670919 | 494 |
| Array Inverter | 91 | 2 | 606462 | 4673212 | 410 |
| Array Inverter | 91 | 2 | 603082 | 4672433 | 468 |
| Array Inverter | 91 | 2 | 605125 | 4671386 | 449 |
| Array Inverter | 91 | 2 | 605595 | 4672818 | 428 |
| Array Inverter | 91 | 2 | 606457 | 4672770 | 428 |
| Array Inverter | 91 | 2 | 610521 | 4672538 | 468 |
| Array Inverter | 91 | 2 | 606091 | 4672675 | 422 |
| Array Inverter | 91 | 2 | 607245 | 4671408 | 462 |
| Array Inverter | 91 | 2 | 606610 | 4671013 | 450 |
| Array Inverter | 91 | 2 | 610992 | 4672668 | 474 |
| Array Inverter | 91 | 2 | 602691 | 4672715 | 458 |
| Array Inverter | 89 | 2 | 606798 | 4669994 | 457 |
| Array Inverter | 91 | 2 | 603599 | 4671964 | 455 |
| Array Inverter | 91 | 2 | 603737 | 4672481 | 447 |

[10] Each "Array Inverter" point source represents a group of string inverters. While each inverter has the same sound power, the total sound power for the point source in the model is a function of how many string inverters are in the group. The calculation is ***Total Point Source Lw = 78 dBA + 10 Log (n),*** where n is the number of string inverters in the group.

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Inverter | 91 | 2 | 604588 | 4671684 | 448 |
| Array Inverter | 91 | 2 | 606924 | 4670680 | 460 |
| Array Inverter | 91 | 2 | 611056 | 4672548 | 477 |
| Array Inverter | 91 | 2 | 603043 | 4671967 | 471 |
| Array Inverter | 91 | 2 | 603181 | 4671971 | 469 |
| Array Inverter | 91 | 2 | 603342 | 4671975 | 463 |
| Array Inverter | 91 | 2 | 603593 | 4671432 | 472 |
| Array Inverter | 91 | 2 | 606971 | 4669997 | 468 |
| Array Inverter | 91 | 2 | 607700 | 4670775 | 476 |
| Array Inverter | 91 | 2 | 607608 | 4670435 | 475 |
| Array Inverter | 91 | 2 | 608752 | 4670872 | 497 |
| Array Inverter | 91 | 2 | 608880 | 4670477 | 477 |
| Array Inverter | 91 | 2 | 608866 | 4670603 | 485 |
| Array Inverter | 91 | 2 | 608805 | 4670728 | 492 |
| Array Inverter | 91 | 2 | 606050 | 4672965 | 412 |
| Array Inverter | 91 | 2 | 605916 | 4673267 | 405 |
| Array Inverter | 86 | 2 | 606453 | 4673049 | 417 |
| Array Inverter | 91 | 2 | 606286 | 4670425 | 452 |
| Array Inverter | 91 | 2 | 610203 | 4672099 | 458 |
| Array Inverter | 91 | 2 | 606886 | 4669976 | 465 |
| Array Inverter | 86 | 2 | 609030 | 4670099 | 472 |
| Array Inverter | 91 | 2 | 609031 | 4670085 | 472 |
| Array Inverter | 91 | 2 | 603714 | 4671968 | 452 |
| Array Inverter | 91 | 2 | 603077 | 4672598 | 465 |
| Array Inverter | 91 | 2 | 606471 | 4672061 | 443 |
| Array Inverter | 91 | 2 | 610345 | 4670781 | 459 |
| Array Inverter | 91 | 2 | 609423 | 4670180 | 454 |
| Array Inverter | 86 | 2 | 603324 | 4671745 | 473 |
| Array Inverter | 91 | 2 | 603710 | 4671435 | 467 |
| Array Inverter | 91 | 2 | 605598 | 4672682 | 432 |
| Array Inverter | 91 | 2 | 605601 | 4672558 | 439 |
| Array Inverter | 91 | 2 | 606281 | 4670590 | 451 |
| Array Inverter | 91 | 2 | 606256 | 4670589 | 451 |
| Array Inverter | 91 | 2 | 606274 | 4670862 | 456 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Inverter | 91 | 2 | 606277 | 4670745 | 454 |
| Array Inverter | 91 | 2 | 606252 | 4670745 | 453 |
| Array Inverter | 91 | 2 | 607634 | 4670162 | 472 |
| Array Inverter | 91 | 2 | 607632 | 4670435 | 476 |
| Array Inverter | 91 | 2 | 607627 | 4670722 | 476 |
| Array Inverter | 91 | 2 | 607597 | 4670872 | 476 |
| Array Inverter | 91 | 2 | 607604 | 4670590 | 477 |
| Array Inverter | 91 | 2 | 607628 | 4670591 | 479 |
| Array Inverter | 91 | 2 | 607600 | 4670784 | 476 |
| Array Inverter | 91 | 2 | 607593 | 4670928 | 475 |
| Array Inverter | 91 | 2 | 610329 | 4670847 | 460 |
| Array Inverter | 91 | 2 | 609961 | 4671470 | 445 |
| Array Inverter | 91 | 2 | 610344 | 4670790 | 459 |
| Array Inverter | 91 | 2 | 606475 | 4671973 | 443 |
| Array Inverter | 86 | 2 | 603376 | 4671537 | 478 |
| Array Inverter | 91 | 2 | 603022 | 4671878 | 473 |
| Array Inverter | 91 | 2 | 609958 | 4671576 | 445 |
| Array Inverter | 91 | 2 | 609956 | 4671654 | 446 |
| Array Inverter | 91 | 2 | 609954 | 4671712 | 447 |
| Array Inverter | 91 | 2 | 607592 | 4670236 | 473 |
| Array Inverter | 91 | 2 | 610944 | 4672534 | 479 |
| Array Inverter | 91 | 2 | 606909 | 4670680 | 460 |
| Array Inverter | 91 | 2 | 606927 | 4670547 | 457 |
| Array Inverter | 91 | 2 | 607119 | 4670422 | 462 |
| Array Inverter | 91 | 2 | 609908 | 4672091 | 443 |
| Array Inverter | 91 | 2 | 610258 | 4672086 | 461 |
| Array Inverter | 91 | 2 | 610349 | 4670848 | 461 |
| Array Inverter | 91 | 2 | 610326 | 4670946 | 459 |
| Array Inverter | 91 | 2 | 610346 | 4670947 | 458 |
| Array Inverter | 91 | 2 | 610323 | 4671053 | 454 |
| Array Inverter | 91 | 2 | 610343 | 4671054 | 454 |
| Array Inverter | 89 | 2 | 609742 | 4671749 | 430 |
| Array Inverter | 91 | 2 | 609965 | 4671343 | 444 |
| Array Inverter | 91 | 2 | 610584 | 4672524 | 473 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Inverter | 91 | 2 | 610171 | 4672083 | 457 |
| Array Inverter | 91 | 2 | 610084 | 4672081 | 452 |
| Array Inverter | 91 | 2 | 609929 | 4671254 | 439 |
| Array Inverter | 91 | 2 | 609423 | 4670192 | 454 |
| Array Inverter | 91 | 2 | 607700 | 4670747 | 477 |
| Array Inverter | 91 | 2 | 605960 | 4673069 | 410 |
| Array Inverter | 86 | 2 | 607659 | 4670080 | 473 |
| Array Inverter | 91 | 2 | 604591 | 4671596 | 449 |
| Array Inverter | 89 | 2 | 603345 | 4671709 | 474 |
| Array Inverter | 89 | 2 | 604259 | 4672329 | 444 |
| Array Inverter | 89 | 2 | 604585 | 4671929 | 444 |
| Array Inverter | 89 | 2 | 605163 | 4672845 | 428 |
| Array Inverter | 89 | 2 | 606028 | 4673114 | 408 |
| Array Inverter | 89 | 2 | 609922 | 4671788 | 446 |
| Array Inverter | 89 | 2 | 611374 | 4672491 | 478 |
| Array Inverter | 89 | 2 | 606442 | 4671746 | 447 |
| Array Inverter | 86 | 2 | 603604 | 4672515 | 448 |
| Array Inverter | 89 | 2 | 610941 | 4672785 | 472 |
| Array Inverter | 89 | 2 | 606864 | 4672133 | 452 |
| Array Inverter | 91 | 2 | 609741 | 4671764 | 430 |
| Array Inverter | 89 | 2 | 610403 | 4670177 | 442 |
| Array Inverter | 89 | 2 | 606870 | 4671929 | 454 |
| Array Inverter | 89 | 2 | 607614 | 4671521 | 467 |
| Array Inverter | 89 | 2 | 607613 | 4671541 | 467 |
| Array Inverter | 86 | 2 | 606074 | 4672344 | 421 |
| Array Inverter | 89 | 2 | 605999 | 4673130 | 405 |
| Array Inverter | 89 | 2 | 605918 | 4673416 | 401 |
| Array Inverter | 89 | 2 | 602689 | 4672724 | 457 |
| Array Inverter | 89 | 2 | 606384 | 4671744 | 446 |
| Array Inverter | 91 | 2 | 603387 | 4671538 | 478 |
| Array Inverter | 86 | 2 | 603572 | 4672306 | 448 |
| Array Inverter | 86 | 2 | 606517 | 4671746 | 447 |
| Array Inverter | 86 | 2 | 605081 | 4671836 | 446 |
| Array Inverter | 86 | 2 | 606868 | 4671736 | 454 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Inverter | 86 | 2 | 610352 | 4670545 | 460 |
| Array Inverter | 86 | 2 | 603812 | 4672207 | 446 |
| Array Inverter | 86 | 2 | 604601 | 4671378 | 449 |
| Array Inverter | 91 | 2 | 609031 | 4670016 | 473 |
| Array Inverter | 86 | 2 | 605158 | 4671003 | 447 |
| Array Inverter | 86 | 2 | 610363 | 4670007 | 436 |
| Array Inverter | 86 | 2 | 608680 | 4670929 | 494 |
| Array Inverter | 86 | 2 | 610694 | 4672175 | 472 |
| Array Inverter | 86 | 2 | 606856 | 4670813 | 455 |
| Array Inverter | 86 | 2 | 607009 | 4671172 | 454 |
| Array Inverter | 86 | 2 | 604581 | 4671806 | 445 |
| Array Inverter | 86 | 2 | 606261 | 4670424 | 451 |
| Array Inverter | 91 | 2 | 606471 | 4673551 | 386 |
| Array Inverter | 86 | 2 | 603605 | 4671599 | 466 |
| Array Inverter | 91 | 2 | 607504 | 4670338 | 474 |
| Array Inverter | 86 | 2 | 610820 | 4672580 | 481 |
| Array Inverter | 86 | 2 | 605939 | 4672276 | 430 |
| Array Inverter | 86 | 2 | 607016 | 4671124 | 454 |
| Array Inverter | 86 | 2 | 605592 | 4672965 | 424 |
| Array Transformer | 66 | 1.5 | 603081 | 4672433 | 468 |
| Array Transformer | 66 | 1.5 | 603383 | 4671537 | 478 |
| Array Transformer | 66 | 1.5 | 603344 | 4671709 | 474 |
| Array Transformer | 66 | 1.5 | 603571 | 4672306 | 448 |
| Array Transformer | 66 | 1.5 | 604255 | 4672328 | 443 |
| Array Transformer | 66 | 1.5 | 604583 | 4671929 | 444 |
| Array Transformer | 66 | 1.5 | 606513 | 4671746 | 446 |
| Array Transformer | 66 | 1.5 | 605080 | 4671836 | 446 |
| Array Transformer | 66 | 1.5 | 605124 | 4671386 | 449 |
| Array Transformer | 66 | 1.5 | 605592 | 4672818 | 427 |
| Array Transformer | 66 | 1.5 | 606456 | 4672770 | 428 |
| Array Transformer | 66 | 1.5 | 605160 | 4672845 | 428 |
| Array Transformer | 66 | 1.5 | 606027 | 4673114 | 407 |
| Array Transformer | 66 | 1.5 | 610520 | 4672538 | 468 |
| Array Transformer | 66 | 1.5 | 606090 | 4672675 | 422 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Transformer | 66 | 1.5 | 607244 | 4671408 | 461 |
| Array Transformer | 66 | 1.5 | 606609 | 4671013 | 450 |
| Array Transformer | 66 | 1.5 | 606865 | 4671735 | 454 |
| Array Transformer | 66 | 1.5 | 609921 | 4671788 | 446 |
| Array Transformer | 66 | 1.5 | 610991 | 4672668 | 473 |
| Array Transformer | 66 | 1.5 | 602688 | 4672715 | 457 |
| Array Transformer | 66 | 1.5 | 606797 | 4669994 | 457 |
| Array Transformer | 66 | 1.5 | 610350 | 4670545 | 460 |
| Array Transformer | 66 | 1.5 | 603598 | 4671964 | 455 |
| Array Transformer | 66 | 1.5 | 603732 | 4672483 | 447 |
| Array Transformer | 66 | 1.5 | 604586 | 4671684 | 447 |
| Array Transformer | 66 | 1.5 | 606922 | 4670680 | 460 |
| Array Transformer | 66 | 1.5 | 611373 | 4672491 | 477 |
| Array Transformer | 66 | 1.5 | 611055 | 4672548 | 477 |
| Array Transformer | 66 | 1.5 | 603811 | 4672207 | 446 |
| Array Transformer | 66 | 1.5 | 603042 | 4671967 | 470 |
| Array Transformer | 66 | 1.5 | 603180 | 4671971 | 469 |
| Array Transformer | 66 | 1.5 | 603341 | 4671975 | 462 |
| Array Transformer | 66 | 1.5 | 603592 | 4671432 | 471 |
| Array Transformer | 66 | 1.5 | 604600 | 4671378 | 449 |
| Array Transformer | 66 | 1.5 | 606437 | 4671746 | 446 |
| Array Transformer | 66 | 1.5 | 606970 | 4669997 | 468 |
| Array Transformer | 66 | 1.5 | 607699 | 4670775 | 476 |
| Array Transformer | 66 | 1.5 | 607607 | 4670435 | 475 |
| Array Transformer | 66 | 1.5 | 608751 | 4670872 | 497 |
| Array Transformer | 66 | 1.5 | 608878 | 4670477 | 476 |
| Array Transformer | 66 | 1.5 | 608864 | 4670603 | 484 |
| Array Transformer | 66 | 1.5 | 608803 | 4670728 | 491 |
| Array Transformer | 66 | 1.5 | 609030 | 4670016 | 472 |
| Array Transformer | 66 | 1.5 | 606049 | 4672965 | 411 |
| Array Transformer | 66 | 1.5 | 605915 | 4673267 | 405 |
| Array Transformer | 66 | 1.5 | 606470 | 4673473 | 386 |
| Array Transformer | 66 | 1.5 | 606450 | 4673049 | 417 |
| Array Transformer | 66 | 1.5 | 606285 | 4670425 | 452 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Transformer | 66 | 1.5 | 610202 | 4672099 | 457 |
| Array Transformer | 66 | 1.5 | 606885 | 4669976 | 464 |
| Array Transformer | 66 | 1.5 | 609027 | 4670098 | 472 |
| Array Transformer | 66 | 1.5 | 609030 | 4670085 | 472 |
| Array Transformer | 66 | 1.5 | 603604 | 4672519 | 447 |
| Array Transformer | 66 | 1.5 | 603713 | 4671968 | 452 |
| Array Transformer | 66 | 1.5 | 603076 | 4672598 | 464 |
| Array Transformer | 66 | 1.5 | 610940 | 4672785 | 471 |
| Array Transformer | 66 | 1.5 | 605154 | 4671003 | 447 |
| Array Transformer | 66 | 1.5 | 606862 | 4672133 | 452 |
| Array Transformer | 66 | 1.5 | 606469 | 4672061 | 443 |
| Array Transformer | 66 | 1.5 | 609739 | 4671764 | 430 |
| Array Transformer | 66 | 1.5 | 610343 | 4670781 | 458 |
| Array Transformer | 66 | 1.5 | 610402 | 4670177 | 441 |
| Array Transformer | 66 | 1.5 | 610361 | 4670007 | 435 |
| Array Transformer | 66 | 1.5 | 609422 | 4670180 | 453 |
| Array Transformer | 66 | 1.5 | 608680 | 4670919 | 493 |
| Array Transformer | 66 | 1.5 | 608676 | 4670929 | 493 |
| Array Transformer | 66 | 1.5 | 610689 | 4672174 | 472 |
| Array Transformer | 66 | 1.5 | 606855 | 4670813 | 455 |
| Array Transformer | 66 | 1.5 | 607007 | 4671172 | 454 |
| Array Transformer | 66 | 1.5 | 603321 | 4671745 | 473 |
| Array Transformer | 66 | 1.5 | 603709 | 4671435 | 466 |
| Array Transformer | 66 | 1.5 | 604578 | 4671806 | 445 |
| Array Transformer | 66 | 1.5 | 605596 | 4672682 | 432 |
| Array Transformer | 66 | 1.5 | 605599 | 4672558 | 438 |
| Array Transformer | 66 | 1.5 | 606260 | 4670424 | 451 |
| Array Transformer | 66 | 1.5 | 606280 | 4670590 | 451 |
| Array Transformer | 66 | 1.5 | 606255 | 4670589 | 450 |
| Array Transformer | 66 | 1.5 | 606273 | 4670862 | 456 |
| Array Transformer | 66 | 1.5 | 606276 | 4670745 | 453 |
| Array Transformer | 66 | 1.5 | 606251 | 4670745 | 452 |
| Array Transformer | 66 | 1.5 | 607633 | 4670162 | 472 |
| Array Transformer | 66 | 1.5 | 607631 | 4670435 | 475 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Transformer | 66 | 1.5 | 607626 | 4670722 | 476 |
| Array Transformer | 66 | 1.5 | 607596 | 4670872 | 475 |
| Array Transformer | 66 | 1.5 | 607603 | 4670590 | 476 |
| Array Transformer | 66 | 1.5 | 607627 | 4670591 | 478 |
| Array Transformer | 66 | 1.5 | 607599 | 4670784 | 476 |
| Array Transformer | 66 | 1.5 | 607592 | 4670928 | 474 |
| Array Transformer | 66 | 1.5 | 610328 | 4670847 | 459 |
| Array Transformer | 66 | 1.5 | 609960 | 4671470 | 444 |
| Array Transformer | 66 | 1.5 | 610343 | 4670790 | 458 |
| Array Transformer | 66 | 1.5 | 606470 | 4673551 | 385 |
| Array Transformer | 66 | 1.5 | 606867 | 4671928 | 454 |
| Array Transformer | 66 | 1.5 | 606473 | 4671973 | 442 |
| Array Transformer | 66 | 1.5 | 603372 | 4671537 | 478 |
| Array Transformer | 66 | 1.5 | 603021 | 4671878 | 472 |
| Array Transformer | 66 | 1.5 | 603604 | 4671599 | 466 |
| Array Transformer | 66 | 1.5 | 607613 | 4671521 | 467 |
| Array Transformer | 66 | 1.5 | 607612 | 4671541 | 467 |
| Array Transformer | 66 | 1.5 | 609957 | 4671576 | 444 |
| Array Transformer | 66 | 1.5 | 609955 | 4671654 | 446 |
| Array Transformer | 66 | 1.5 | 609953 | 4671712 | 447 |
| Array Transformer | 66 | 1.5 | 607591 | 4670236 | 473 |
| Array Transformer | 66 | 1.5 | 607503 | 4670338 | 473 |
| Array Transformer | 66 | 1.5 | 610819 | 4672580 | 481 |
| Array Transformer | 66 | 1.5 | 610943 | 4672534 | 479 |
| Array Transformer | 66 | 1.5 | 606907 | 4670680 | 459 |
| Array Transformer | 66 | 1.5 | 606926 | 4670547 | 456 |
| Array Transformer | 66 | 1.5 | 607118 | 4670422 | 462 |
| Array Transformer | 66 | 1.5 | 609907 | 4672091 | 443 |
| Array Transformer | 66 | 1.5 | 610257 | 4672086 | 460 |
| Array Transformer | 66 | 1.5 | 610348 | 4670848 | 460 |
| Array Transformer | 66 | 1.5 | 610325 | 4670946 | 458 |
| Array Transformer | 66 | 1.5 | 610345 | 4670947 | 458 |
| Array Transformer | 66 | 1.5 | 610322 | 4671053 | 454 |
| Array Transformer | 66 | 1.5 | 610342 | 4671054 | 454 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Array Transformer | 66 | 1.5 | 609739 | 4671750 | 429 |
| Array Transformer | 66 | 1.5 | 609964 | 4671343 | 443 |
| Array Transformer | 66 | 1.5 | 606072 | 4672344 | 421 |
| Array Transformer | 66 | 1.5 | 605934 | 4672276 | 429 |
| Array Transformer | 66 | 1.5 | 610583 | 4672524 | 473 |
| Array Transformer | 66 | 1.5 | 607015 | 4671124 | 454 |
| Array Transformer | 66 | 1.5 | 610170 | 4672083 | 456 |
| Array Transformer | 66 | 1.5 | 610083 | 4672081 | 452 |
| Array Transformer | 66 | 1.5 | 609928 | 4671254 | 438 |
| Array Transformer | 66 | 1.5 | 609422 | 4670192 | 453 |
| Array Transformer | 66 | 1.5 | 605998 | 4673130 | 404 |
| Array Transformer | 66 | 1.5 | 606460 | 4673212 | 410 |
| Array Transformer | 66 | 1.5 | 605917 | 4673416 | 400 |
| Array Transformer | 66 | 1.5 | 605587 | 4672965 | 424 |
| Array Transformer | 66 | 1.5 | 602688 | 4672724 | 457 |
| Array Transformer | 66 | 1.5 | 606379 | 4671744 | 445 |
| Array Transformer | 66 | 1.5 | 607699 | 4670747 | 476 |
| Array Transformer | 66 | 1.5 | 605959 | 4673069 | 409 |
| Array Transformer | 66 | 1.5 | 607658 | 4670080 | 473 |
| Array Transformer | 66 | 1.5 | 604588 | 4671596 | 448 |
| Substation Transformer | 89 | 1.75 | 602496 | 4672441 | 457 |
| Battery Storage Device | 78 | 2 | 602263 | 4672397 | 451 |
| Battery Storage Device | 78 | 2 | 602273 | 4672384 | 452 |
| Battery Storage Device | 78 | 2 | 602279 | 4672388 | 452 |
| Battery Storage Device | 78 | 2 | 602284 | 4672392 | 452 |
| Battery Storage Device | 78 | 2 | 602290 | 4672397 | 452 |
| Battery Storage Device | 78 | 2 | 602296 | 4672401 | 452 |
| Battery Storage Device | 78 | 2 | 602299 | 4672406 | 452 |
| Battery Storage Device | 78 | 2 | 602268 | 4672402 | 451 |
| Battery Storage Device | 78 | 2 | 602274 | 4672406 | 451 |
| Battery Storage Device | 78 | 2 | 602280 | 4672410 | 451 |
| Battery Storage Device | 78 | 2 | 602285 | 4672415 | 451 |
| Battery Storage Device | 78 | 2 | 602291 | 4672417 | 452 |
| Battery Storage Device | 78 | 2 | 602295 | 4672411 | 452 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Battery Storage Device | 78 | 2 | 602313 | 4672416 | 452 |
| Battery Storage Device | 78 | 2 | 602309 | 4672422 | 452 |
| Battery Storage Device | 78 | 2 | 602304 | 4672427 | 452 |
| Battery Storage Device | 78 | 2 | 602308 | 4672432 | 451 |
| Battery Storage Device | 78 | 2 | 602318 | 4672419 | 452 |
| Battery Storage Device | 78 | 2 | 602322 | 4672423 | 452 |
| Battery Storage Device | 78 | 2 | 602318 | 4672429 | 452 |
| Battery Storage Device | 78 | 2 | 602313 | 4672434 | 452 |
| Battery Storage Device | 78 | 2 | 602327 | 4672445 | 452 |
| Battery Storage Device | 78 | 2 | 602331 | 4672439 | 452 |
| Battery Storage Device | 78 | 2 | 602336 | 4672433 | 452 |
| Battery Storage Device | 78 | 2 | 602341 | 4672436 | 452 |
| Battery Storage Device | 78 | 2 | 602330 | 4672449 | 452 |
| Battery Storage Device | 78 | 2 | 602336 | 4672452 | 452 |
| Battery Storage Device | 78 | 2 | 602340 | 4672446 | 452 |
| Battery Storage Device | 78 | 2 | 602345 | 4672440 | 452 |
| Battery Storage Device | 78 | 2 | 602358 | 4672451 | 453 |
| Battery Storage Device | 78 | 2 | 602354 | 4672457 | 452 |
| Battery Storage Device | 78 | 2 | 602349 | 4672462 | 452 |
| Battery Storage Device | 78 | 2 | 602353 | 4672467 | 452 |
| Battery Storage Device | 78 | 2 | 602363 | 4672454 | 453 |
| Battery Storage Device | 78 | 2 | 602367 | 4672458 | 453 |
| Battery Storage Device | 78 | 2 | 602363 | 4672464 | 452 |
| Battery Storage Device | 78 | 2 | 602359 | 4672469 | 452 |
| Battery Storage Device | 78 | 2 | 602372 | 4672480 | 452 |
| Battery Storage Device | 78 | 2 | 602376 | 4672474 | 452 |
| Battery Storage Device | 78 | 2 | 602381 | 4672468 | 453 |
| Battery Storage Device | 78 | 2 | 602386 | 4672471 | 453 |
| Battery Storage Device | 78 | 2 | 602375 | 4672484 | 452 |
| Storage Inverters | 92 | 2 | 602288 | 4672387 | 453 |
| Storage Inverters | 92 | 2 | 602302 | 4672397 | 453 |
| Storage Inverters | 92 | 2 | 602315 | 4672408 | 453 |
| Storage Inverters | 92 | 2 | 602329 | 4672419 | 453 |
| Storage Inverters | 92 | 2 | 602343 | 4672429 | 453 |

| Source | Modeled Sound Power Level (dBA) | Relative Height (m) | Coordinates (UTM NAD83 Z18N) | | Modeled Absolute Height (m) |
|---|---|---|---|---|---|
| | Day | | X (m) | Y (m) | |
| Storage Inverters | 92 | 2 | 602356 | 4672440 | 453 |
| Storage Inverters | 92 | 2 | 602370 | 4672450 | 453 |

## TABLE 19: OPERATIONAL SOURCE SOUND POWER LEVEL SPECTRA

| Source | 1/1 Octave Band Sound Power (dBZ) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz | Sum (dBA) | Sum (dBZ) |
| Substation Transformer ONAF | 36 | 52 | 81 | 79 | 84 | 83 | 81 | 74 | 64 | 89 | 98 |
| Battery Energy Storage System (BESS) | 57 | 62 | 74 | 75 | 65 | 65 | 59 | 53 | 48 | 78 | 98 |
| Storage Inverters (PCS) | 81 | 80 | 84 | 81 | 86 | 76 | 75 | 71 | 74 | 92 | 96 |
| Array Transformer | 23 | 41 | 54 | 57 | 62 | 60 | 55 | 51 | 45 | 66 | 74 |
| Array Inverter | 81 | 78 | 76 | 84 | 76 | 70 | 65 | 60 | 53 | 78 | 87 |

# APPENDIX C. RECEPTOR INFORMATION & MODEL RESULTS

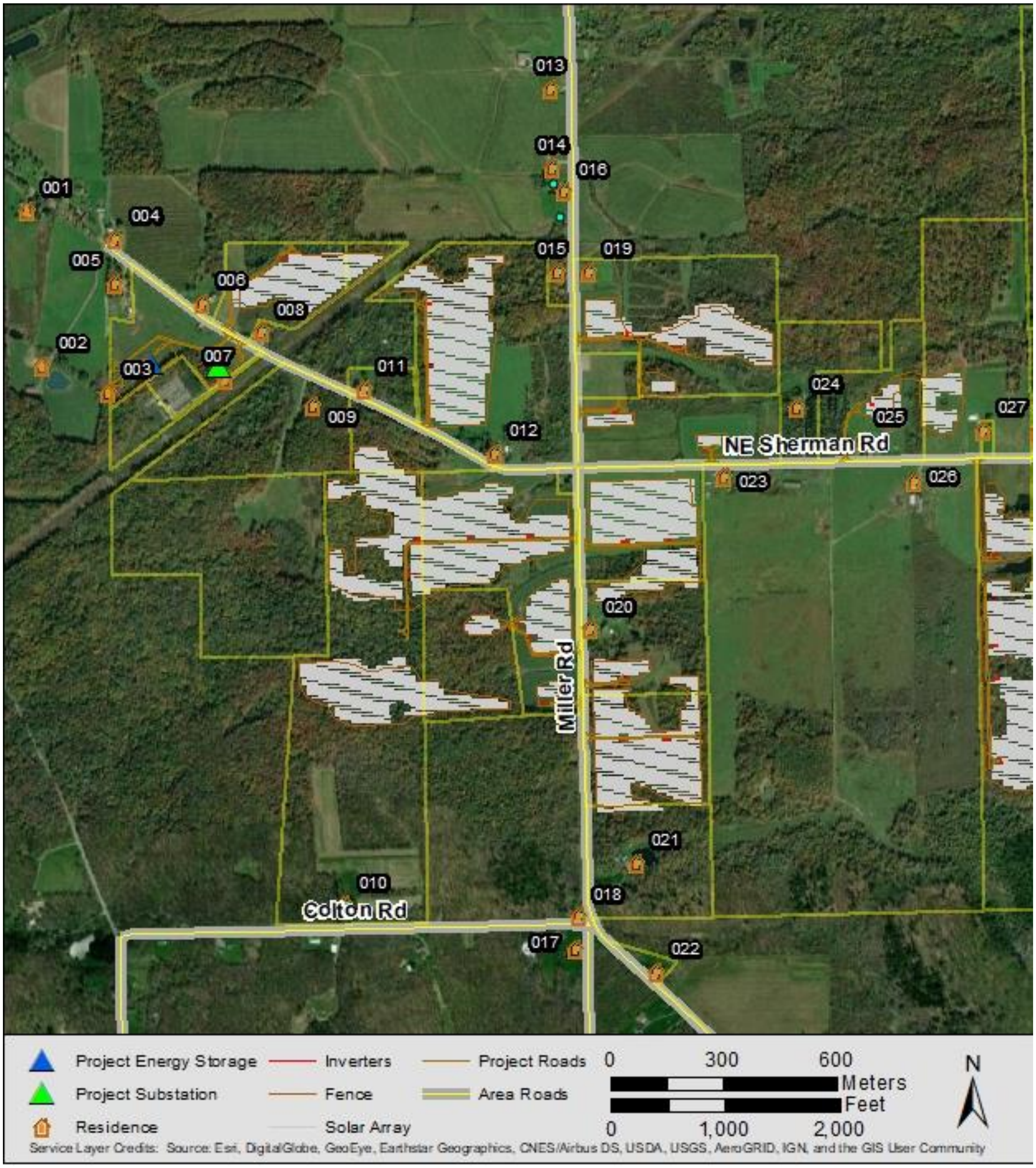



**FIGURE 42: MAP OF MODELED RECEPTORS – WEST AREA**

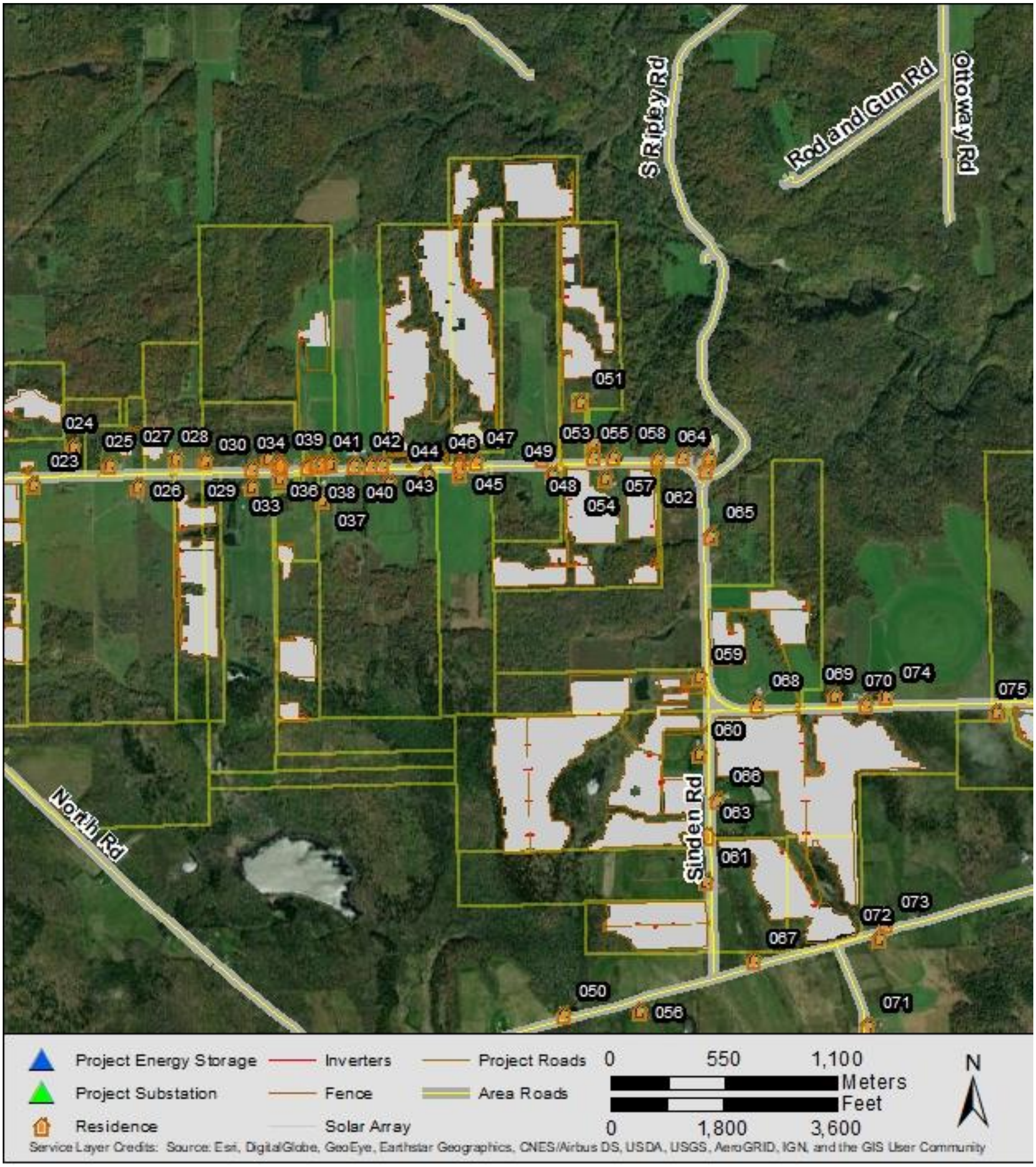



**FIGURE 43: MAP OF MODELED RECEPTORS – CENTRAL AREA**

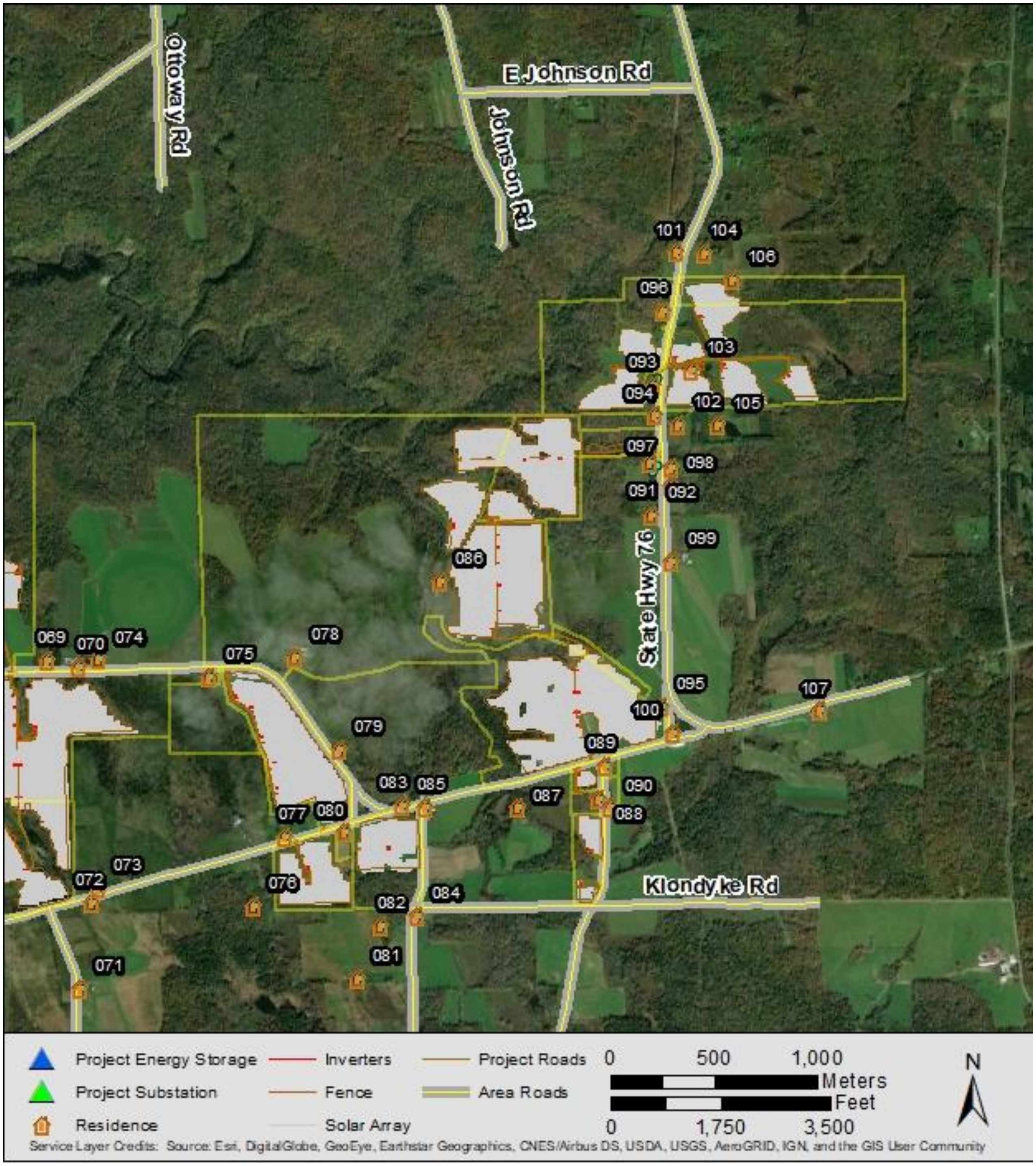



**FIGURE 44: MAP OF MODELED RECEPTORS – EAST AREA**

## TABLE 20: RECEIVER LOCATIONS AND MODELING RESULTS

| Receptor ID | Type | Sound Pressure Level - $L_{8h}$ (dBA) | Relative Height (m) | Coordinates (UTM NAD 83 Z18N) | | |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | Z (m) |
| 1 | Residence | 30 | 1.5 | 602004 | 4672848 | 440 |
| 2 | Residence | 35 | 1.5 | 602046 | 4672434 | 446 |
| 4 | Residence | 34 | 1.5 | 602241 | 4672773 | 444 |
| 5 | Residence | 37 | 1.5 | 602241 | 4672653 | 447 |
| 6 | Residence | 39 | 1.5 | 602470 | 4672599 | 454 |
| 8 | Residence | 39 | 1.5 | 602631 | 4672523 | 458 |
| 9 | Residence | 35 | 1.5 | 602767 | 4672328 | 466 |
| 10 | Residence | 26 | 1.5 | 602851 | 4670994 | 481 |
| 11 | Residence | 35 | 1.5 | 602903 | 4672370 | 467 |
| 12 | Residence | 37 | 1.5 | 603251 | 4672201 | 462 |
| 13 | Residence | 27 | 1.5 | 603402 | 4673175 | 437 |
| 14 | Residence | 29 | 1.5 | 603407 | 4672961 | 438 |
| 15 | Residence | 33 | 1.5 | 603421 | 4672684 | 448 |
| 16 | Residence | 30 | 1.5 | 603436 | 4672898 | 441 |
| 17 | Residence | 27 | 1.5 | 603470 | 4670878 | 472 |
| 18 | Residence | 28 | 1.5 | 603475 | 4670963 | 468 |
| 19 | Residence | 32 | 1.5 | 603503 | 4672684 | 446 |
| 20 | Residence | 39 | 1.5 | 603508 | 4671730 | 467 |
| 21 | Residence | 31 | 1.5 | 603630 | 4671106 | 471 |
| 22 | Residence | 27 | 1.5 | 603683 | 4670816 | 468 |
| 23 | Residence | 38 | 1.5 | 603866 | 4672136 | 448 |
| 24 | Residence | 35 | 1.5 | 604058 | 4672322 | 442 |
| 25 | Residence | 38 | 1.5 | 604229 | 4672234 | 445 |
| 26 | Residence | 34 | 1.5 | 604370 | 4672126 | 446 |
| 27 | Residence | 32 | 1.5 | 604556 | 4672262 | 446 |
| 28 | Residence | 31 | 1.5 | 604703 | 4672254 | 444 |
| 29 | Residence | 30 | 1.5 | 604923 | 4672126 | 442 |
| 30 | Residence | 29 | 1.5 | 604927 | 4672218 | 437 |
| 31 | Residence | 29 | 1.5 | 605001 | 4672266 | 439 |
| 32 | Residence | 30 | 1.5 | 605057 | 4672237 | 441 |
| 33 | Residence | 30 | 1.5 | 605063 | 4672164 | 443 |
| 34 | Residence | 30 | 1.5 | 605066 | 4672227 | 441 |
| 35 | Residence | 30 | 1.5 | 605196 | 4672226 | 442 |
| 36 | Residence | 30 | 1.5 | 605237 | 4672242 | 443 |

| Receptor ID | Type | Sound Pressure Level - $L_{8h}$ (dBA) | Relative Height (m) | Coordinates (UTM NAD 83 Z18N) | | |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | Z (m) |
| 37 | Residence | 30 | 1.5 | 605269 | 4672061 | 445 |
| 38 | Residence | 30 | 1.5 | 605271 | 4672229 | 443 |
| 39 | Residence | 30 | 1.5 | 605309 | 4672240 | 442 |
| 40 | Residence | 31 | 1.5 | 605423 | 4672233 | 440 |
| 41 | Residence | 31 | 1.5 | 605507 | 4672233 | 439 |
| 42 | Residence | 31 | 1.5 | 605557 | 4672235 | 437 |
| 43 | Residence | 31 | 1.5 | 605595 | 4672144 | 437 |
| 44 | Residence | 33 | 1.5 | 605777 | 4672188 | 430 |
| 45 | Residence | 37 | 1.5 | 605936 | 4672192 | 431 |
| 47 | Residence | 38 | 1.5 | 606018 | 4672250 | 430 |
| 48 | Residence | 36 | 1.5 | 606344 | 4672263 | 440 |
| 49 | Residence | 38 | 1.5 | 606387 | 4672184 | 439 |
| 50 | Residence | 29 | 1.5 | 606444 | 4669554 | 442 |
| 51 | Residence | 34 | 1.5 | 606526 | 4672539 | 443 |
| 52 | Residence | 32 | 1.5 | 606588 | 4672345 | 448 |
| 53 | Residence | 34 | 1.5 | 606591 | 4672271 | 453 |
| 54 | Residence | 35 | 1.5 | 606643 | 4672169 | 457 |
| 55 | Residence | 32 | 1.5 | 606683 | 4672273 | 449 |
| 56 | Residence | 31 | 1.5 | 606812 | 4669570 | 468 |
| 57 | Residence | 35 | 1.5 | 606902 | 4672262 | 448 |
| 58 | Residence | 31 | 1.5 | 607022 | 4672274 | 447 |
| 59 | Residence | 37 | 1.5 | 607103 | 4671200 | 464 |
| 60 | Residence | 36 | 1.5 | 607103 | 4670822 | 471 |
| 61 | Residence | 36 | 1.5 | 607133 | 4670205 | 481 |
| 62 | Residence | 30 | 1.5 | 607134 | 4672206 | 443 |
| 64 | Residence | 30 | 1.5 | 607155 | 4672261 | 444 |
| 65 | Residence | 33 | 1.5 | 607160 | 4671887 | 453 |
| 66 | Residence | 38 | 1.5 | 607190 | 4670600 | 468 |
| 67 | Residence | 32 | 1.5 | 607367 | 4669815 | 470 |
| 68 | Residence | 36 | 1.5 | 607382 | 4671067 | 484 |
| 69 | Residence | 36 | 1.5 | 607762 | 4671103 | 471 |
| 70 | Residence | 35 | 1.5 | 607920 | 4671069 | 473 |
| 71 | Residence | 28 | 1.5 | 607925 | 4669500 | 475 |
| 72 | Residence | 31 | 1.5 | 607980 | 4669921 | 467 |
| 73 | Residence | 31 | 1.5 | 608015 | 4669991 | 470 |

| Receptor ID | Type | Sound Pressure Level - $L_{8h}$ (dBA) | Relative Height (m) | Coordinates (UTM NAD 83 Z18N) | | |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | Z (m) |
| 74 | Residence | 33 | 1.5 | 608017 | 4671106 | 474 |
| 75 | Residence | 36 | 1.5 | 608556 | 4671024 | 482 |
| 77 | Residence | 38 | 1.5 | 608921 | 4670245 | 473 |
| 78 | Residence | 32 | 1.5 | 608973 | 4671122 | 479 |
| 79 | Residence | 33 | 1.5 | 609187 | 4670669 | 472 |
| 80 | Residence | 36 | 1.5 | 609213 | 4670261 | 465 |
| 81 | Residence | 28 | 1.5 | 609277 | 4669553 | 455 |
| 82 | Residence | 32 | 1.5 | 609387 | 4669808 | 454 |
| 83 | Residence | 36 | 1.5 | 609495 | 4670396 | 447 |
| 84 | Residence | 33 | 1.5 | 609563 | 4669857 | 451 |
| 85 | Residence | 35 | 1.5 | 609606 | 4670385 | 442 |
| 86 | Residence | 36 | 1.5 | 609679 | 4671490 | 420 |
| 87 | Residence | 32 | 1.5 | 610057 | 4670388 | 436 |
| 88 | Residence | 34 | 1.5 | 610453 | 4670426 | 463 |
| 89 | Residence | 36 | 1.5 | 610485 | 4670590 | 462 |
| 90 | Residence | 33 | 1.5 | 610504 | 4670383 | 460 |
| 91 | Residence | 35 | 1.5 | 610702 | 4672067 | 473 |
| 92 | Residence | 31 | 1.5 | 610710 | 4671811 | 474 |
| 93 | Residence | 36 | 1.5 | 610717 | 4672448 | 478 |
| 94 | Residence | 35 | 1.5 | 610721 | 4672298 | 475 |
| 95 | Residence | 33 | 1.5 | 610755 | 4670877 | 470 |
| 96 | Residence | 36 | 1.5 | 610766 | 4672811 | 472 |
| 97 | Residence | 32 | 1.5 | 610801 | 4672040 | 473 |
| 98 | Residence | 31 | 1.5 | 610803 | 4671957 | 472 |
| 99 | Residence | 30 | 1.5 | 610808 | 4671586 | 477 |
| 100 | Residence | 32 | 1.5 | 610810 | 4670749 | 468 |
| 101 | Residence | 30 | 1.5 | 610831 | 4673094 | 476 |
| 102 | Residence | 33 | 1.5 | 610836 | 4672253 | 476 |
| 104 | Residence | 31 | 1.5 | 610969 | 4673093 | 483 |
| 105 | Residence | 32 | 1.5 | 611028 | 4672251 | 480 |
| 107 | Residence | 25 | 1.5 | 611528 | 4670857 | 472 |
| 76 | Seasonal Structure | 33 | 1.5 | 608771 | 4669905 | 461 |
| 103 | Seasonal Structure | 47 | 1.5 | 610902 | 4672519 | 484 |

| Receptor ID | Type | Sound Pressure Level - $L_{8h}$ (dBA) | Relative Height (m) | Coordinates (UTM NAD 83 Z18N) | | |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | Z (m) |
| 106 | Seasonal Structure | 34 | 1.5 | 611102 | 4672960 | 483 |
| **Average** | | 33 | | | | |
| **Minimum** | | 25 | | | | |
| **Maximum** | | 39 | | | | |
| | | | | | | |

## TABLE 21: PROPERTY LINE RECEIVER LOCATIONS AND MODELING RESULTS

| Receptor ID | Type | Sound Pressure Level (dBA) - Maximum $L_{8h}$ Day | Relative Height (m) | Coordinates (UTM NAD 83 Z18N) | | |
|---|---|---|---|---|---|---|
| | | | | X (m) | Y (m) | Z (m) |
| 3 | Property Line | 47 | 1.5 | 602221 | 4672364 | 450 |
| 7 | Property Line | 43 | 1.5 | 602532 | 4672398 | 458 |
| 46 | Property Line | 41 | 1.5 | 605941 | 4672227 | 430 |
| 63 | Property Line | 52 | 1.5 | 607146 | 4670422 | 463 |

# APPENDIX D. 1/1 OCTAVE BAND MODEL RESULTS

### TABLE 22: MITIGATED DAYTIME 1/1 OCTAVE BAND SOUND PROPAGATION MODELING RESULTS

| Receptor ID | Type | 1/1 Octave Band Sound Pressure Level (dBZ), Maximum $L_{8h}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 1 | Residence | 45 | 38 | 38 | 33 | 29 | 22 | 15 | 8 | 0 |
| 2 | Residence | 50 | 41 | 43 | 37 | 34 | 25 | 22 | 23 | 0 |
| 3 | Property Line | 60 | 52 | 53 | 45 | 44 | 37 | 35 | 41 | 28 |
| 4 | Residence | 51 | 43 | 43 | 36 | 32 | 25 | 21 | 18 | 0 |
| 5 | Residence | 51 | 43 | 45 | 39 | 36 | 28 | 25 | 27 | 0 |
| 6 | Residence | 55 | 47 | 48 | 41 | 37 | 32 | 28 | 27 | 3 |
| 7 | Property Line | 52 | 44 | 49 | 42 | 41 | 39 | 34 | 32 | 15 |
| 8 | Residence | 49 | 41 | 43 | 40 | 38 | 31 | 28 | 27 | 0 |
| 9 | Residence | 46 | 39 | 41 | 38 | 33 | 27 | 22 | 17 | 0 |
| 10 | Residence | 34 | 29 | 28 | 32 | 24 | 15 | 5 | 0 | 0 |
| 11 | Residence | 44 | 38 | 38 | 40 | 33 | 27 | 23 | 14 | 0 |
| 12 | Residence | 45 | 42 | 37 | 41 | 35 | 29 | 23 | 11 | 0 |
| 13 | Residence | 37 | 33 | 29 | 33 | 26 | 19 | 10 | 0 | 0 |
| 14 | Residence | 38 | 34 | 30 | 35 | 28 | 21 | 13 | 0 | 0 |
| 15 | Residence | 40 | 37 | 33 | 38 | 32 | 26 | 20 | 6 | 0 |
| 16 | Residence | 37 | 32 | 31 | 35 | 28 | 21 | 13 | 0 | 0 |
| 17 | Residence | 36 | 31 | 28 | 34 | 25 | 17 | 7 | 0 | 0 |
| 18 | Residence | 35 | 31 | 29 | 34 | 26 | 17 | 8 | 0 | 0 |
| 19 | Residence | 38 | 34 | 32 | 38 | 30 | 23 | 18 | 7 | 0 |
| 20 | Residence | 46 | 43 | 38 | 43 | 37 | 32 | 27 | 16 | 0 |
| 21 | Residence | 37 | 33 | 30 | 37 | 29 | 21 | 13 | 0 | 0 |
| 22 | Residence | 37 | 33 | 28 | 33 | 25 | 17 | 7 | 0 | 0 |
| 23 | Residence | 46 | 43 | 37 | 42 | 36 | 32 | 26 | 17 | 1 |
| 24 | Residence | 43 | 40 | 34 | 39 | 33 | 28 | 22 | 11 | 0 |
| 25 | Residence | 46 | 43 | 38 | 41 | 36 | 32 | 26 | 19 | 3 |
| 26 | Residence | 42 | 39 | 33 | 38 | 32 | 27 | 20 | 9 | 0 |
| 27 | Residence | 41 | 38 | 31 | 37 | 31 | 25 | 17 | 2 | 0 |
| 28 | Residence | 40 | 37 | 30 | 36 | 29 | 23 | 14 | 0 | 0 |
| 29 | Residence | 36 | 33 | 29 | 36 | 28 | 20 | 11 | 0 | 0 |

| Receptor ID | Type | 1/1 Octave Band Sound Pressure Level (dBZ), Maximum $L_{8h}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 30 | Residence | 35 | 31 | 29 | 36 | 27 | 19 | 10 | 0 | 0 |
| 31 | Residence | 36 | 32 | 29 | 36 | 27 | 19 | 10 | 0 | 0 |
| 32 | Residence | 37 | 33 | 29 | 36 | 27 | 20 | 10 | 0 | 0 |
| 33 | Residence | 37 | 34 | 29 | 36 | 28 | 20 | 10 | 0 | 0 |
| 34 | Residence | 37 | 33 | 29 | 36 | 28 | 20 | 10 | 0 | 0 |
| 35 | Residence | 37 | 34 | 29 | 36 | 28 | 20 | 10 | 0 | 0 |
| 36 | Residence | 36 | 32 | 29 | 36 | 28 | 20 | 10 | 0 | 0 |
| 37 | Residence | 37 | 33 | 29 | 36 | 28 | 21 | 13 | 0 | 0 |
| 38 | Residence | 37 | 34 | 29 | 36 | 28 | 20 | 11 | 0 | 0 |
| 39 | Residence | 38 | 34 | 30 | 36 | 28 | 21 | 12 | 0 | 0 |
| 40 | Residence | 36 | 32 | 30 | 37 | 28 | 20 | 12 | 0 | 0 |
| 41 | Residence | 36 | 33 | 30 | 37 | 29 | 22 | 13 | 0 | 0 |
| 42 | Residence | 39 | 36 | 31 | 37 | 29 | 22 | 14 | 0 | 0 |
| 43 | Residence | 39 | 36 | 30 | 37 | 29 | 23 | 14 | 0 | 0 |
| 44 | Residence | 39 | 36 | 32 | 38 | 31 | 25 | 19 | 8 | 0 |
| 45 | Residence | 43 | 40 | 36 | 41 | 35 | 30 | 25 | 17 | 3 |
| 46 | Property Line | 48 | 44 | 40 | 45 | 39 | 34 | 30 | 23 | 12 |
| 47 | Residence | 44 | 40 | 36 | 42 | 35 | 30 | 26 | 18 | 4 |
| 48 | Residence | 44 | 41 | 35 | 40 | 34 | 29 | 23 | 11 | 0 |
| 49 | Residence | 47 | 43 | 38 | 41 | 36 | 32 | 26 | 17 | 0 |
| 50 | Residence | 39 | 36 | 29 | 34 | 27 | 22 | 13 | 0 | 0 |
| 51 | Residence | 40 | 36 | 33 | 39 | 32 | 25 | 19 | 7 | 0 |
| 52 | Residence | 37 | 33 | 31 | 38 | 30 | 22 | 14 | 0 | 0 |
| 53 | Residence | 39 | 36 | 32 | 39 | 32 | 24 | 17 | 4 | 0 |
| 54 | Residence | 40 | 37 | 33 | 40 | 33 | 26 | 19 | 8 | 0 |
| 55 | Residence | 37 | 34 | 31 | 38 | 29 | 22 | 16 | 6 | 0 |
| 56 | Residence | 38 | 35 | 30 | 36 | 29 | 23 | 16 | 0 | 0 |
| 57 | Residence | 38 | 35 | 32 | 39 | 33 | 27 | 22 | 13 | 0 |
| 58 | Residence | 36 | 33 | 30 | 37 | 29 | 22 | 16 | 7 | 0 |
| 59 | Residence | 41 | 38 | 35 | 42 | 35 | 30 | 24 | 16 | 1 |
| 60 | Residence | 41 | 38 | 35 | 42 | 35 | 28 | 21 | 11 | 0 |
| 61 | Residence | 42 | 38 | 34 | 41 | 34 | 28 | 21 | 8 | 0 |
| 62 | Residence | 35 | 32 | 29 | 36 | 28 | 20 | 13 | 0 | 0 |
| 63 | Property Line | 57 | 54 | 50 | 56 | 49 | 44 | 40 | 34 | 25 |
| 64 | Residence | 35 | 31 | 29 | 36 | 27 | 19 | 11 | 0 | 0 |

| Receptor ID | Type | 1/1 Octave Band Sound Pressure Level (dBZ), Maximum $L_{8h}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 65 | Residence | 41 | 38 | 33 | 38 | 31 | 26 | 19 | 6 | 0 |
| 66 | Residence | 45 | 41 | 37 | 42 | 36 | 30 | 24 | 14 | 0 |
| 67 | Residence | 36 | 33 | 30 | 38 | 30 | 22 | 15 | 0 | 0 |
| 68 | Residence | 42 | 38 | 34 | 41 | 34 | 27 | 20 | 6 | 0 |
| 69 | Residence | 40 | 37 | 33 | 41 | 33 | 27 | 22 | 9 | 0 |
| 70 | Residence | 43 | 39 | 34 | 40 | 33 | 27 | 20 | 6 | 0 |
| 71 | Residence | 36 | 33 | 27 | 34 | 26 | 18 | 7 | 0 | 0 |
| 72 | Residence | 36 | 32 | 30 | 37 | 29 | 21 | 13 | 0 | 0 |
| 73 | Residence | 37 | 34 | 30 | 37 | 29 | 22 | 14 | 0 | 0 |
| 74 | Residence | 42 | 38 | 32 | 39 | 31 | 25 | 18 | 1 | 0 |
| 75 | Residence | 40 | 36 | 33 | 41 | 33 | 27 | 23 | 14 | 0 |
| 76 | Seasonal Structure | 42 | 39 | 32 | 38 | 31 | 26 | 19 | 7 | 0 |
| 77 | Residence | 46 | 43 | 37 | 41 | 36 | 31 | 26 | 16 | 0 |
| 78 | Residence | 37 | 33 | 31 | 38 | 30 | 22 | 16 | 2 | 0 |
| 79 | Residence | 41 | 37 | 32 | 39 | 31 | 25 | 17 | 1 | 0 |
| 80 | Residence | 43 | 40 | 35 | 41 | 35 | 29 | 23 | 12 | 0 |
| 81 | Residence | 33 | 30 | 27 | 34 | 26 | 18 | 8 | 0 | 0 |
| 82 | Residence | 40 | 37 | 31 | 37 | 30 | 24 | 16 | 1 | 0 |
| 83 | Residence | 45 | 42 | 36 | 40 | 34 | 30 | 24 | 13 | 0 |
| 84 | Residence | 43 | 40 | 32 | 37 | 31 | 26 | 20 | 5 | 0 |
| 85 | Residence | 44 | 41 | 34 | 39 | 33 | 28 | 22 | 10 | 0 |
| 86 | Residence | 41 | 38 | 34 | 41 | 34 | 28 | 23 | 11 | 0 |
| 87 | Residence | 40 | 37 | 31 | 38 | 31 | 24 | 17 | 1 | 0 |
| 88 | Residence | 39 | 36 | 32 | 39 | 32 | 25 | 19 | 8 | 0 |
| 89 | Residence | 39 | 36 | 34 | 41 | 34 | 28 | 23 | 13 | 0 |
| 90 | Residence | 37 | 33 | 31 | 38 | 31 | 23 | 16 | 4 | 0 |
| 91 | Residence | 38 | 35 | 32 | 40 | 32 | 27 | 21 | 13 | 0 |
| 92 | Residence | 36 | 32 | 30 | 37 | 29 | 21 | 12 | 0 | 0 |
| 93 | Residence | 40 | 37 | 34 | 42 | 34 | 28 | 24 | 15 | 0 |
| 94 | Residence | 42 | 39 | 35 | 40 | 33 | 27 | 22 | 13 | 0 |
| 95 | Residence | 36 | 33 | 31 | 38 | 31 | 24 | 18 | 3 | 0 |
| 96 | Residence | 40 | 38 | 35 | 40 | 34 | 28 | 23 | 12 | 0 |
| 97 | Residence | 36 | 33 | 30 | 38 | 30 | 23 | 17 | 7 | 0 |
| 98 | Residence | 35 | 32 | 30 | 37 | 29 | 21 | 13 | 0 | 0 |
| 99 | Residence | 38 | 34 | 29 | 36 | 28 | 21 | 11 | 0 | 0 |

| Receptor ID | Type | 1/1 Octave Band Sound Pressure Level (dBZ), Maximum $L_{8h}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
| 100 | Residence | 36 | 33 | 30 | 37 | 30 | 23 | 16 | 0 | 0 |
| 101 | Residence | 37 | 34 | 29 | 36 | 28 | 22 | 14 | 0 | 0 |
| 102 | Residence | 40 | 37 | 33 | 38 | 31 | 25 | 20 | 10 | 0 |
| 103 | Seasonal Structure | 49 | 46 | 43 | 51 | 45 | 39 | 35 | 28 | 17 |
| 104 | Residence | 38 | 34 | 29 | 36 | 28 | 22 | 16 | 1 | 0 |
| 105 | Residence | 36 | 33 | 31 | 38 | 30 | 23 | 16 | 3 | 0 |
| 106 | Seasonal Structure | 43 | 39 | 33 | 38 | 32 | 27 | 21 | 9 | 0 |
| 107 | Residence | 31 | 28 | 24 | 31 | 22 | 13 | 0 | 0 | 0 |

# APPENDIX E. 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").[11] 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 45.

## 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.

---

[11] 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.

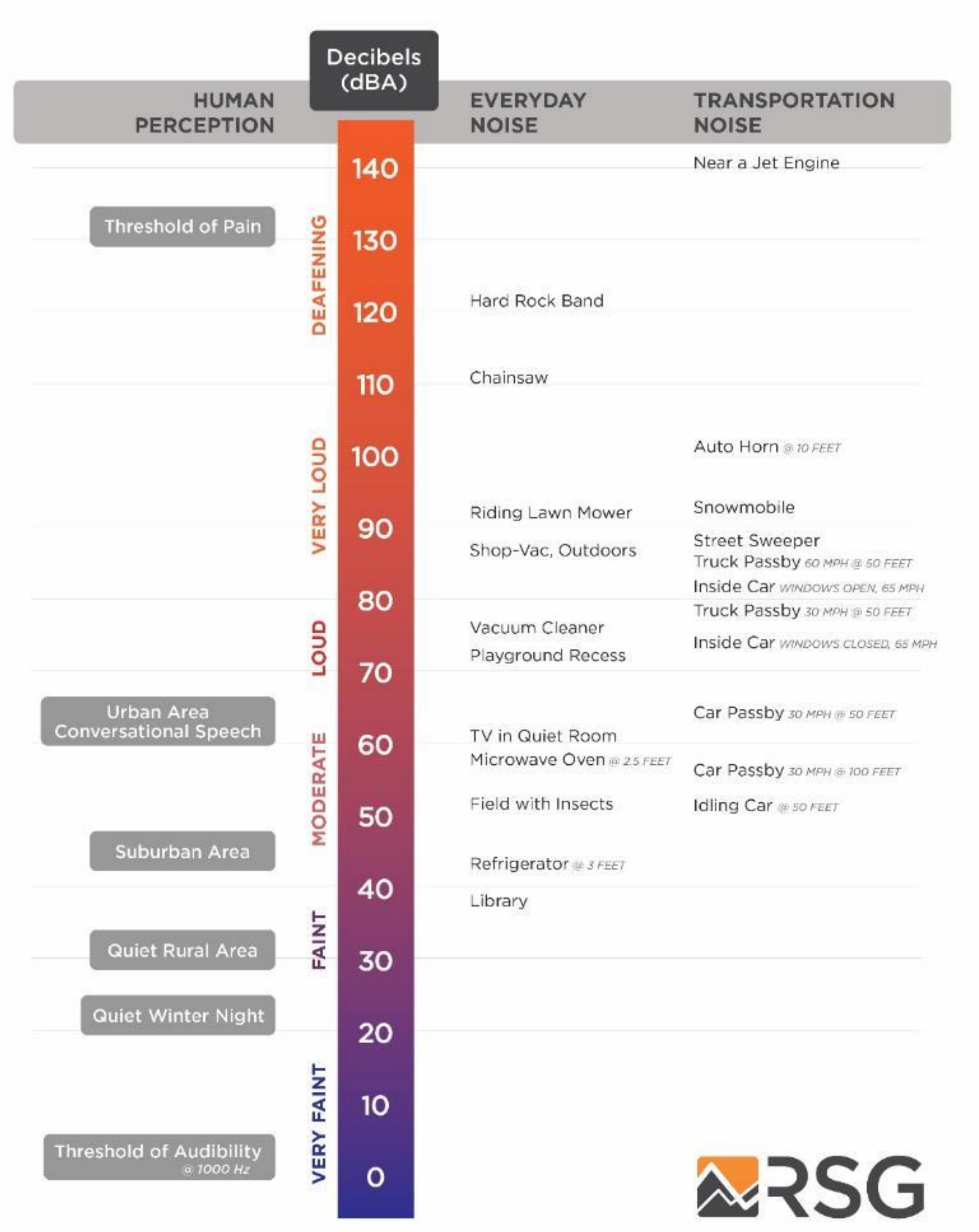



**FIGURE 45: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES**

## 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. G-weighting is a standardized weighting used to evaluate infrasound.

When a reported sound level has been filtered using a frequency weighting, the letter is appended to “dB”. For example, sound with A-weighting is usually denoted “dBA”. 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.[12] 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 $L_{eq,max}$.

## 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 46. 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

[12] 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.

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.

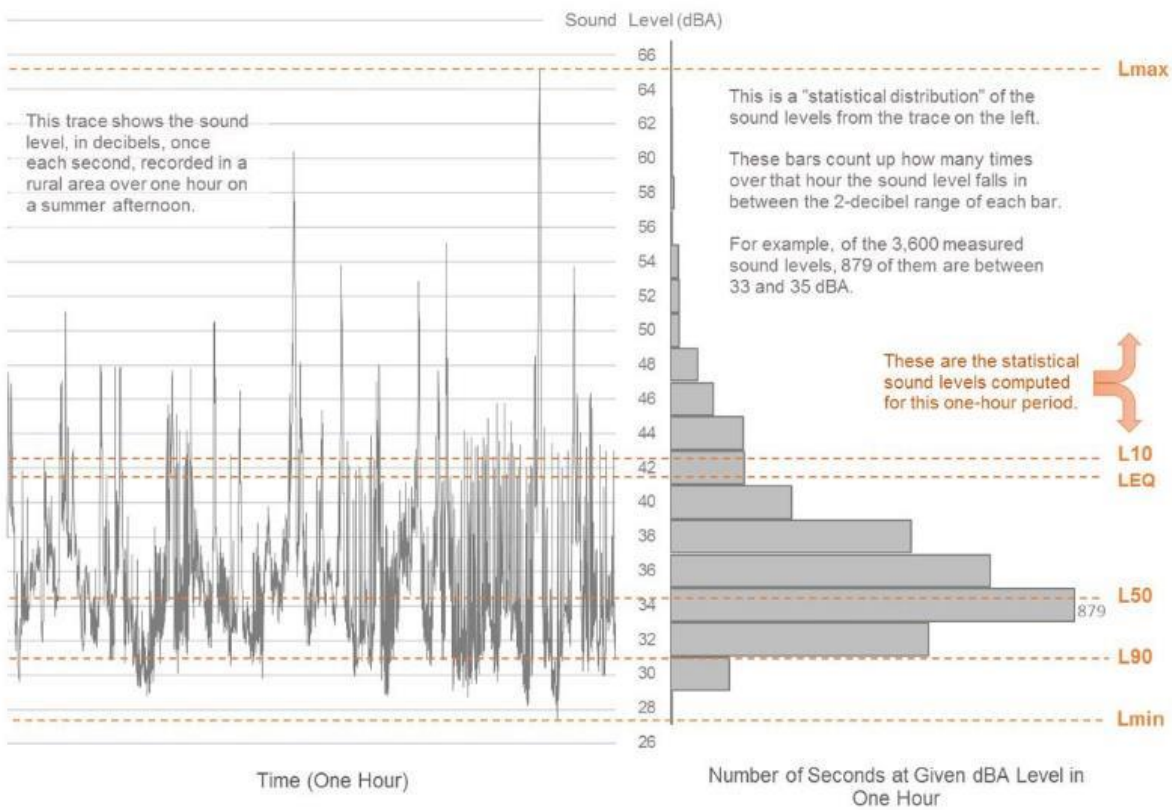



**FIGURE 46: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME**

### *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 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 46, even though the sound levels spend 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.

### *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 , and half the time it is quieter than . Note that (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 F. ACOUSTICS GLOSSARY

Definitions of acoustical term or general scientific terms are included here if not explained within the body of the report.

A-Weighting — The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.

Ambient — The "all-encompassing sound at a given place, usually a composite of sounds from many sources near and far." (ANSI S1.1)

ANSI — American National Standards Institute

Audible — For the purposes of this report, able to be heard by ontologically normal healthy young adults (18 to 25 years), according to ISO 389-7 (see Figure 47).

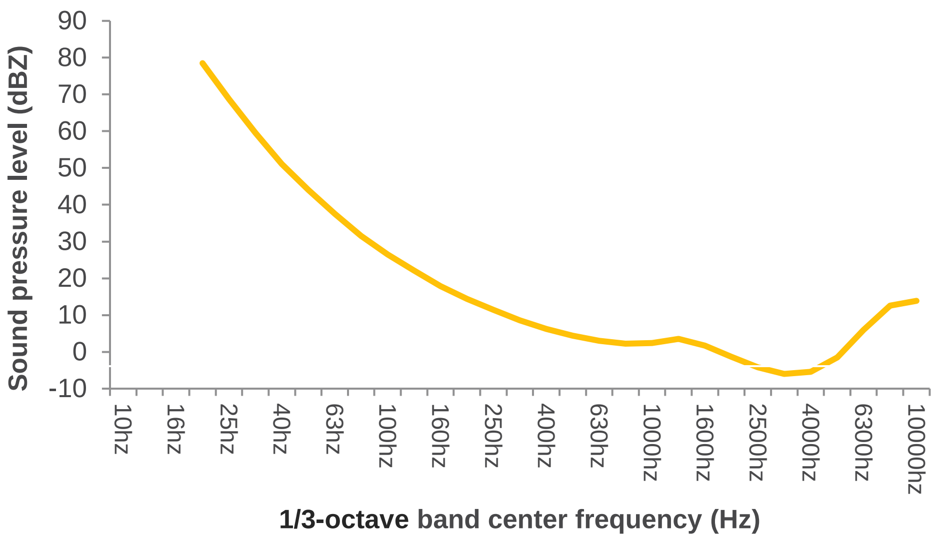



**FIGURE 47: ISO 387-7 AUDIBILITY CURVE IN A FREE FIELD**

Background Sound Level – the sound level in absence of the source of interest.

Biogenic — Produced of brought about by living organisms

Broadband Sound – Sound with a broad spectral distribution, with no tones, such as white noise, static, and airflow.

dBA — A-Weighted decibels (see A-Weighting, Decibel)

Decibel, dB — A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.

Frequency — In acoustics, the number of times in a second one cycle of a waveform passes a fixed space. The perceived pitch of a sound is proportional to its frequency. The relationship between wavelength and frequency is dependent on the speed of sound.

$$f = \frac{c}{\lambda}$$

where λ is wavelength, c is the speed of sound, and f is frequency. The typical hearing range for young healthy individuals is roughly between frequencies of 20 Hz (1 Hertz is one cycle per second) and 20,000 Hz (also designated as 20 kHz, where 1 kHz is one thousand cycles per second).

| | |
|---|---|
| G | The proportion of ground that is considered porous, as defined under ISO 9613-2. For example, G = 1 represents all porous ground, G = 0 represents all hard ground, and G = 0.5 represents half-porous and half-hard ground. |
| Geophonic | Naturally occurring sound produced by a habitat, excluding sounds made by living organisms. |
| Infrasound | Sound that is of such low frequency that it is not readily audible by humans at nominal levels – generally considered to be below 20 Hz (Figure 47) |
| ISO | The International Organization for Standards |
| ISO 9613 | The International Standards Organization Standard ISO 9613, “Acoustics – Attenuation of sound during propagation outdoors”. The standard is used to predict how sound propagates outdoors. It is currently the standard used by most noise control engineers in the U.S. to predict sound levels in communities. Part 1 of the standard estimates atmospheric attenuation, and Part 2 uses the results from Part 1 with sound emissions from the source and propagation path factors to estimate sound levels at some distance from the source. |
| $L_{1h}$ | The average A-weighted sound pressure level, in decibels, during a period of 1-hour. |
| $L_{8h}$ | The average A-weighted sound pressure level, in decibels, during a period of 8-hours. |
| $L_F$ | Fast-response sound level, where the exponential response time is set to 125 ms. A sound level meter set to fast-response is relatively faster to respond to rapidly changing sound levels. It can be expressed as an instantaneous level, in a percentile, or in a statistic such as a one-second $L_{Fmax}$, for example. (See “sound level meter response”) |
| $L_{Fmax\ (1\text{-}sec)}$ | The A-weighted, fast-response maximum sound level, as measured over a one-second period, in decibels. |
| $L_{eq}$ | Equivalent average sound level. The average of the mean square sound *pressure* over an entire monitoring period and expressed as a decibel: $Leq_T = 10 * log_{10}\left(\frac{1}{T}\int_{\theta}^{T} p_A^2(t)dt \Big/ p_{ref}^2\right)$ where $p_A^2$ is the squared instantaneous weighted sound pressure signal, as a function of elapsed time t, $p_{ref}$ is the reference pressure of 20 µPa, and T is the stated time interval. The reference pressure of 20 µPa is used for all measurements in this document. The monitoring period, T, can be for any defined length of time. It could be one second ($L_{eq\ 1\text{-}sec}$), one hour ($L_{1h}$), eight hours ($L_{8h}$), or 24 hours ($L_{24h}$). Because $L_{eq}$ is a logarithmic function of the average pressure, loud and |

infrequent sounds have a greater effect on the resulting $L_{eq}$ than quieter and more frequent sounds.

$L_n$ — See "$n^{th}$ percentile"

$L_p$ — See "Sound Pressure Level"

$L_S$ — Slow response sound level, where the exponential response time is set to 1.0 second. This is a relatively slower response time to Fast and results in a longer rise and fall time in the displayed sound level. The five-second instantaneous A-weighted $L_S$ is the metric currently used by MassDEP for compliance monitoring. $L_S$ is often used in local sound regulations as it tends to filter short-term contamination by responding more slowly to rapidly changing sound levels, and is easier to read on a sound level meter display. (See "sound level meter response")

Lw — See "Sound Power Level"

Low Frequency Sound – Sound with frequency content between 20 Hz and 200 Hz.

Measured — An observed quantity. In this report, we differentiate between measured values, for example, those that are logged by a sound level meter, and modeled values, such as those that are predicted by a sound propagation model.

m/s — Velocity in meters per second

Mph — Velocity in miles per hour

ms — Milliseconds; one thousandth of a second

MVA — The apparent electrical power rating. The product of the voltage and current (in amperes).

MVT — Medium voltage transformer

$n^{th}$ Percentile — In statistics, the value which represents the highest $n^{th}$ percent of a series of values. For example, in 100 measurements sorted from high to low, the $10^{th}$ percentile would be the $90^{th}$ measurement down from the top. That is, 10 percent of the observations fall below that value. In acoustics, the $n^{th}$ percentile level is the level exceeded n percent of the time, which is the opposite of the statistical definition. Thus, the acoustic $L_{90}$ represents the statistical $10^{th}$ percentile level. In this document, if we use "$n^{th}$ percentile" it will refer to the statistical definition, and if we use "L*n*", it refers to the acoustical definition. $L_{50}$ is the median sound level.

NYCRR — New York Codes, Rules, and Regulations

Octave bands - A band of frequencies whose lower frequency limit is one half of its upper frequency limit. An octave-band is identified by its center frequency. As an example, the 500 Hz octave band is the range which includes frequencies between 360 Hz and 720 Hz. An octave higher would be twice this. That is, it would be centered at 1,000 Hz with a range between 720 and 1,440 Hz. The range of human hearing is divided into 10 standardized octave-bands: 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz. For analyses that require even further frequency detail, each octave-band divided into equal parts, such as 1/3-octave-bands.

ONAF — Oil Natural Air Forced, Under ONAF conditions, the air of a transformer is circulated using fans.

ONAN Oil Natural Air Natural, Under ONAN conditions, the oil and air of a transformer are circulated without the use of fans, resulting in quieter operation of the transformer.

PNIA Project Noise Impact Assessment

Section 94c Chapter XVIII Title 19 Part 900 of New York Codes, Rules, and Regulations

Site The entire area of a project and its surroundings.

Sound [Pressure] Level – the sound pressure level as measured in decibels:

$$\text{Lp (in dB)} = 10log_{10}\left(\frac{p}{p_{ref}}\right)^2$$

where p is the sound pressure in Pascals and $p_{ref}$ is the reference sound pressure of 20 µPa. All sound pressure levels shown in this document use this $p_{ref}$.

Sound level meter response – The rate at which a sound level meter display can change related to a change in actual sound level. Sound levels vary over time. In fact, the variation is so fast, that one would not be reliably able to read the level on a sound level meter. For that reason, the displayed sound level is damped in time, to make it readable.

There are three standard time responses available on most sound level meters: Slow, Fast, and Impulse (see “Ls”, “Lf”, and” Li”, respectively). Fast response has a time constant of 125 ms. This response is similar to the response of the human ear. The Slow response has a time constant of 1 second. This is often used in environmental noise measurement because its slow rise and fall time eliminates very short spikes in noise that are not related to the measurement. The Impulse response has a very fast rise time of 35 ms and a slow decay time of 1.5 seconds. It is rarely used in environmental noise measurements, but can be used with other metrics to evaluate the impulsivity of a sound event.

Fast, slow, and impulse sound levels cannot be averaged over time, since they are not representative of the actual sound level over time. They are simply applied to the actual sound level to slow the meter reading. A true energy average can be calculated using the $L_{eq}$ metric, which is independent of the sound level meter response setting (see “$L_{eq}$”).

Sound Power Level – The level of sound power (sound generation) of a source, independent of environmental factors, measured in decibels:

$$\text{Lw (in dB)} = 10log_{10}\left(\frac{w}{w_{ref}}\right)^2$$

where w is the sound power measured in Watts and $w_{ref}$ is the reference sound power of $10^{-12}$ Watts. A simple way of thinking about the difference between sound pressure and sound power is by the analogy of a light bulb: the sound pressure is similar to the lumens of light measured in a certain place under specific conditions, while the sound power would be equivalent to the wattage rating of the bulb, which does not change.

Sound Propagation - The spreading of sound from the sound source through the environment.

Spectrum The components of a sound broken down into individual frequencies or frequency bands.

Tonal Sound - Sound where narrow frequency band(s) are pronounced, such as in alarms, sirens, squeals, and horns.

Unattended Monitoring – Sound monitoring where a sound level meter and associated equipment is left unattended for some length of time. Sound recordings may be taken along with the logged sound levels to aid in identification of different sources of sound.

VAR Control Reactive power management through power distribution systems.

WHO The United Nation’s World Health Organization.