Appendix F: Acoustical Assessment Report

Nestlewood Solar
Acoustic Assessment

Clermont and Brown Counties, Ohio

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Prepared for

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ACRONYMS AND ABBREVIATIONS

µPa	micropascals
ANSI	American National Standards Institute
Cadna-A	Computer-Aided Noise Abatement Program
dB	decibel
dBA	A-weighted decibel
EPRI	Electrical Power Research Institute
gen-tie	electric generation tie
Hz	Hertz
ISO	International Organization for Standardization
kV	kilovolt
L_{eq}	equivalent sound level
L_p	sound pressure levels
L_W	sound power level
LT	long-term
ML	Monitoring Location
NIST	National Institute of Standards and Technology
OPSB	Ohio Power Siting Board
POI	point of interconnection
the Project	Nestlewood Solar, an 80-megawatt solar photovoltaic facility
the Project Area	an approximately 610-acre property in Clermont and Brown Counties on which Nestlewood Solar is proposed
ST	short-term
Tetra Tech	Tetra Tech, Inc.
USEPA	United States Environmental Protection Agency
W	watt

1.0 INTRODUCTION

Nestlewood Solar I LLC is proposing to construct and operate Nestlewood Solar (the Project) located in Clermont and Brown Counties, Ohio. The Project is a new 80 megawatt solar photovoltaic facility consisting of solar panel generators, inverters, distribution transformers, a Project substation and utility switchyard with a transformer (as well as a short generation tie [gen-tie] to the existing electric line), access roads, electrical collector cables, and pyranometers within an area of approximately 610 acres (the Project Area).

To characterize the existing acoustic environment within the Project Area, Tetra Tech, Inc. (Tetra Tech) completed a baseline sound survey. In addition, although solar facilities are inherently quiet, an acoustic modeling analysis was conducted to review operational sound levels resulting from the Project and compliance was assessed at nearby noise sensitive areas (i.e., occupied residences) relative to the Ohio Power Siting Board (OPSB) noise requirements (see Section 2.0 of this report). The results of the baseline sound survey and modeling analysis are documented in this Acoustic Assessment report.

1.1 Project Area

The Project Area encompasses approximately 610 acres in Clermont and Brown counties, in southwestern Ohio. The topography of the Project Area is characterized as level to gently sloping. The Project Area primarily consists of agricultural land, characterized by fairly flat topography with elevations ranging between 908 and 951 feet above mean sea level. Existing electric transmission lines cross the Project Area, with areas of wooded vegetation and local roadways also present within the Project Area. All Project components, including the point of interconnection (POI) to the existing grid, will be located within the Project Area.

Areas of wooded vegetation, local roadways, and low-density residential development (widely scattered) occur throughout the Project Area. A single residence is located within the Project Area along Vandament Road. The closest off-site residences are located adjacent to the Project Area’s southern boundary, along Oak Corner Road. Residences are also located across Leonard Road, Liming Lake Road, and Bethel Maple Road. Figure 1 presents the location of the Project Area evaluated in this assessment, as well as the ambient noise monitoring locations (MLs).

1.2 Acoustic Terminology

Airborne sound is described as the rapid fluctuation or oscillation of air pressure above and below atmospheric pressure, creating a sound wave. Sound is characterized by properties of the sound waves (i.e., frequency, wavelength, period, amplitude, and velocity). Noise is defined as unwanted sound. A sound source is defined by a sound power level (L_W), which is independent of any external factors. The acoustic sound power is the rate at which acoustical energy is radiated outward and is expressed in units of watts (W). Sound energy travels in the form of a wave, a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure. A sound pressure level (L_P) is a measure of this fluctuation and can be directly determined with a microphone or calculated from information about the source sound power level and the surrounding environment through predictive acoustic modeling. While the sound power of a source is strictly a function of the total amount of acoustic energy being radiated by the source, the sound pressure levels produced by a source are a function of the distance from the source and the effective radiating area or physical size of the source. In general, the magnitude of a source’s sound power level is always considerably higher than the observed sound pressure level near a source due to the fact that the acoustic energy is being radiated in various directions.

Sound levels are presented on a logarithmic scale to account for the large pressure response range of the human ear, and are expressed in units of decibels (dB). A dB is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Conversely, sound power is commonly referenced to 1 picowatt, which is one trillionth of a watt. Broadband sound includes sound energy summed across the frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum is often completed to determine tonal characteristics. The unit of frequency is Hertz (Hz), which corresponds to the rate in cycles per second that sound pressure waves are generated. Typically, a sound frequency analysis examines 11 octave (or 33⅓ octave) bands ranging from 20 Hz (low) to 20,000 Hz (high). This range encompasses the entire human audible frequency range. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system. Sound exposure in acoustic assessments is commonly measured and calculated as A-weighted dB (dBA).

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (L_{eq}). The equivalent sound level has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is widely used in acoustic assessments, including in OPSB review.

Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1; note that normal conversation at a distance of three to five feet typically ranges from 60 to 70 dBA. Table 2 provides additional reference information on acoustic terminology.

Table 1. Sound Pressure Levels and Relative Loudness of Typical Noise Sources and Soundscapes

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (perception of different sound levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-hp siren (100 feet)	130		32 times as loud
Loud rock concert near stage or jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)	90		2 times as loud
Garbage disposal, food blender (2 feet), or Pneumatic drill (50 feet)	80	Loud	Reference loudness
Vacuum cleaner (10 feet)	70		1/2 as loud
Passenger car at 65 miles per hour (25 feet)	65	Moderate	
Large store air-conditioning unit (20 feet)	60		1/4 as loud
Light auto traffic (100 feet)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room or bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 feet)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Adapted from: Beranek 1988; United States Environmental Protection Agency (USEPA) 1971a.

Table 2. Acoustic Terms and Definitions

Term	Definition
Noise	Typically defined as unwanted sound. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (L_P)	Pressure fluctuations in a medium. Sound pressure is measured in decibels referenced to 20 µPa, the approximate threshold of human perception to sound at 1,000 Hz.
Sound Power Level (L_W)	The total acoustic power of a noise source measured in decibels referenced to picowatts (one trillionth of a watt). Noise specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity, and atmospheric conditions.
Octave Bands	The audible range of humans spans from 20 to 20,000 Hz and is typically divided into center frequencies ranging from 31 to 8,000 Hz for noise modeling evaluations.
Broadband Sound	Noise which covers a wide range of frequencies within the audible spectrum, i.e., 200 to 2,000 Hz.
Masking	Interference in the perception of one sound by the presence of another sound. At elevated wind speeds, leaf rustle and noise made by the wind itself can mask wind turbine sound levels, which remain relatively constant.
Frequency (Hz)	The rate of oscillation of a sound, measured in units of Hz or kilohertz. One hundred Hz is a rate of one hundred times (or cycles) per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate. For comparative purposes, the lowest note on a full range piano is approximately 32 Hz and middle C is 261 Hz.

Note: Compiled by Tetra Tech from multiple technical and engineering resources.

2.0 NOISE REGULATIONS AND GUIDELINES

No noise rules or regulations exist at the state level in Ohio, other than those recently established by the OPSB. The OPSB has established requirements for addressing both construction and operational noise, as well as specific guidelines for acceptable sound level increases alternative energy facilities. There are no noise requirements at the county or local levels.

The OPSB requirements include:

- A description of the noise-sensitive areas within 1 mile of the Project Area (as required in 4906-4-08(A)(3)(c)); provided in Section 1.1 of this report;
- Results of a preconstruction background noise study of the Project Area that includes measurements taken under both day and nighttime conditions (as required in 4906-4-08(A)(3)(e)); provided in Section 3.0 of this report;
- Construction noise levels at the nearest property boundary (as required in 4906-4-08(A)(3)(a)); provided in Section 5.0 of this report;
- Operational noise levels at the nearest property boundary (as required in 4906-4-08(A)(3)(b)) and at noise-sensitive areas (as required in 4906-4-08(A)(3)(c)); provided in Section 4.4 of this report, with consideration for broadband, tonal and low-frequency noise; and
- Equipment and procedures to mitigate the effects of noise emissions, as applicable, as required in 4906-4-08(A)(3)(d); provided in Section 5.0 for construction impacts and Section 4.4 for operational impacts, respectively.

The OPSB considerd the appropriateness of sounds levels on a case-by-case basis, but has established guidance for wind energy facilities (Section 4906-4-09(F)) that can be generally applied that identifies acceptable sound levels at non-participating properties as 5 dBA over ambient nighttime $_{\mathrm{Leq}}$ conditions. Because the Project equipment will only operate during the day, the 5 dBA over ambient metric is being used with the daytime ambient measurements. A complaint resolution process is required to be established for responding to potential noise issues that may arise; the Project's Complaint Resolution Procedure is outlined in Appendix A. This guidance also includes limitations on potentially noisy construction activities from 7:00 a.m. to 7:00 p.m., with impact sound such as pile driving limited to between 10:00 a.m. and 5:00 p.m.

3.0 EXISTING ACOUSTIC CONDITIONS

Tetra Tech conducted a series of ambient sound level measurements to characterize the existing acoustic environment in the vicinity of the Project Area during the daytime period. The section summarizes the methodology used by Tetra Tech to conduct the sound survey and describes the measurement locations.

3.1 Field Methodology

To document the existing conditions, baseline sound level measurements were performed on October 3 and 4, 2018. Weather conditions were conducive for the collection of accurate sound data. The measurement locations were selected to be representative of the surroundings of potential receptors nearest to the proposed Project Area in the principal geographical directions. The ambient sound survey included both automated, an unattended long-term (LT) measurement that extended over the measurement period, as well as short-term (ST) measurements in the presence of an acoustics expert for a minimum duration of 30 minutes. The ST measurements were made during both daytime (11:30 a.m. to 3:00 p.m.) and nighttime (10:30 p.m. to 1:00 a.m.) periods at noise sensitive areas. The long-term measurement was conduct on the Project site collecting data from 11:30 am on October 3 to 11:30 am on October 4, 2018.

Ambient sound level measurements were conducted using a Larson Davis Model 831 precision integrating sound-level analyzer that meets the requirements of American National Standards Institute (ANSI) Standards for Type 1 instruments. This instrument has an operating range of 5 to 140 dB and an overall frequency range of 8 to 20,000 Hz.

The Larson Davis 831 sound level analyzer is designed for service as a long-term environmental sound level data logger measuring the A-weighted sound level. Each analyzer used was enclosed in a weatherproof case and equipped with a self-contained microphone tripod. During the measurements, the microphone and windscreen were tripod-mounted at an approximate height of 1.5 to 1.7 m (4.9 to 5.6 feet) above grade. The sound level meter was calibrated at the beginning and end of the measurement period using a Larson Davis Model CAL200 acoustic calibrator following procedures that are traceable to the National Institute of Standards and Technology (NIST). Table 3 lists the measurement equipment employed during the survey. The analyzers were programmed to sample and store A-weighted and octave band sound level data, including equivalent (L_{eq}) sound levels.

Table 3. Measurement Equipment

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	831
Preamplifier	Larson Davis	PRM902
Microphone	PCB	377B02
Environmental Protection Kit	Larson Davis	EPS2116
Calibrator	Larson Davis	CAL200

3.2 Monitoring Locations

Three short term, attended sound measurements were performed at public locations near residential properties proximate to the Project Area. The monitoring locations (ML-1 through ML-3) were selected to represent ambient conditions at land uses in the vicinity of the Project Area.

A description of each of the three ST MLs and the LT ML, as well as resulting measurements, are provided below.

3.2.1 Monitoring Location 1

ML-1 is located along Vandament Road and is within the Project Area. This location was selected to represent the residences located along the northern portion of the Project Area. Vandament Road is a winding single-lane paved road bordered primarily by agricultural areas.

During the daytime measurements, ML-1 was generally fairly quiet with some contribution from distance traffic along Leonard Road as well as noise from wildlife. There was little to no traffic along Vandament Road, nor any other noticeable sound sources. Nighttime measurements were fairly consistent with the daytime measurements; however, traffic along Leonard Road appeared to be decreased.

3.2.2 Monitoring Location 2

ML-2 is located along the Project's boundary line adjacent to Leonard Road. This location represents a residential neighborhood located directly across Leonard Road.

During the daytime measurement period, noise generated by traffic on Leonard Road was dominant. No other noise sources were documented during the daytime measurement period. During the nighttime measurements the traffic along Leonard Road decreased resulting in lower noise levels.

3.2.3 Monitoring Location 3

ML-3 is located along the Project's western boundary line adjacent to Bethel Maple Road. This location represents a residential neighborhood located along Bethel Maple Road.

During the daytime measurement period, frequent traffic noise was observed on Bethel Maple Road. No other noise sources were documented during the daytime measurement period. During the nighttime measurements the traffic along Bethel Maple Road decreased resulting in lower noise levels.

3.2.4 Long-Term Monitoring Location 1

The LT noise monitoring location was placed within the Project Area, at the site of the proposed substation located at the corner of Bethel Maple Road and Leonard Road. Light traffic was observed along both roadways during the deployment and retrival of the noise monitoring equipment. No other noise sources were documented in the vicinity of the LT noise monitoring location.

3.3 Baseline Sound Survey Results

Table 4 provides a summary of the measured ambient sound levels observed at each of the monitoring locations for both the daytime and nighttime L_{eq} as well as the coordinates for each monitoring location. The monitoring locations are also mapped on Figure 1.

Table 4. Baseline Sound Survey Results, L_{eq} (dBA)

Monitoring Location	Coordinates (Universal Transverse Mercator Zone 16S) Easting (m)	Northing (m)	Time Period	Measured Sound Level (L_{eq}, dBA)
ML-1	757468	4312471	Day	39
			Night	38
ML-2	758181	4312627	Day	45
			Night	40
ML-3	755063	4312255	Day	52
			Night	43
LT-1	756389	4311078	Day	43[1]
			Night	38[1]

[1]Averaged over the monitoring period.

Ambient sound levels did exhibit typical diurnal patterns. Daytime L_{eq} sound levels at the measurement locations ranged from a low of 39 dBA at ML-1 to a high of 52 dBA at ML-3. Nighttime sound levels ranged from a low of 38 dBA at ML-1 and LT-1 to 43 dBA at ML-3.

Table 5 presents the hourly sound level data collected during the 24-hour long-term monitoring measurement from October 3 through October 4, 2018.

Table 5. Hourly Long-Term Measurement Results

Military Time	L_{eq} (dBA)
11:00 (October 3)	36
12:00 (October 3)	46
13:00 (October 3)	46
14:00 (October 3)	40
15:00 (October 3)	45
16:00 (October 3)	43
17:00 (October 3)	41
18:00 (October 3)	42
19:00 (October 3)	45
20:00 (October 3)	41
21:00 (October 3)	42
22:00 (October 3)	39
23:00 (October 3)	39
0:00 (October 4)	39

1:00 (October 4)	39
2:00 (October 4)	38
3:00 (October 4)	39
4:00 (October 4)	39
5:00 (October 4)	39
6:00 (October 4)	39
7:00 (October 4)	39
8:00 (October 4)	39
9:00 (October 4)	42
10:00 (October 4)	42
11:00 (October 4)	44

The daytime noise levels ranged from 36 dBA to 45 dBA and the nighttime noise levels ranged from 38 dBA to 39 dBA. The hourly data collected during the 24-hour sound monitoring study showed relative consistency with the ST measurements.

4.0 OPERATIONAL NOISE

This section describes the model utilized for the assessment; input assumptions used to calculate noise levels due to the Project's normal operation; a conceptual noise mitigation strategy, and the results of the noise impact analysis.

4.1 Noise Prediction Model

The Cadna-A® computer noise model was used to calculate sound pressure levels from the operation of the Project equipment in the vicinity of the Project Area. An industry standard, Cadna-A® was developed by DataKustik GmbH to provide an estimate of sound levels at distances from sources of known emission. It is used by acousticians and acoustic engineers due to the capability to accurately describe noise emission and propagation from complex facilities consisting of various equipment types like the Project and in most cases yields conservative results of operational noise levels in the surrounding community.

The current International Organization for Standardization (ISO) standard for outdoor sound propagation, ISO 9613 Part 2 – "Attenuation of Sound during Propagation Outdoors," was used within Cadna-A® (ISO 1996). The method described in this standard calculates sound attenuation under weather conditions that are favorable for sound propagation, such as for downwind propagation or atmospheric inversion, conditions which are typically considered worst-case. The calculation of sound propagation from source to receiver locations consists of full octave band sound frequency algorithms, which incorporate the following physical effects:

- Geometric spreading wave divergence;
- Reflection from surfaces;
- Atmospheric absorption at 10 degrees Celsius and 70 percent relative humidity;
- Screening by topography and obstacles;
- The effects of terrain features including relative elevations of noise sources;
- Sound power levels from stationary and mobile sources;
- The locations of noise-sensitive land use types;
- Intervening objects including buildings and barrier walls, to the extent included in the design;
- Ground effects due to areas of pavement and unpaved ground;
- Sound power at multiple frequencies;
- Source directivity factors;
- Multiple noise sources and source type (point, area, and/or line); and
- Averaging predicted sound levels over a given time period.

Cadna-A allows for three basic types of sound sources to be introduced into the model: point, line, and area sources. Each noise-radiating element was modeled based on its noise emission pattern. Point sources were programmed for concentrated small dimension sources such as track motors that radiate sound hemispherically. Larger dimensional sources such as the transformers and inverters were modeled as area sources.

Offsite topography was obtained using the publically available United States Geological Survey digital elevation data. A default ground attenuation factor of 0.5 was assumed for offsite sound propagation over acoustically “mixed” ground. A ground attenuation factor of 0.0 for a reflective surface was assumed for paved onsite areas.

The output from Cadna-A® includes tabular sound level results at selected receiver locations and colored noise contour maps (isopleths) that show areas of equal and similar sound levels.

4.2 Input To The Noise Prediction Model

The Project’s general arrangement was reviewed and directly imported into the acoustic model so that on-site equipment could be easily identified; buildings and structures could be added; and sound emission data could be assigned to sources as appropriate. Presumed locations within the potential layout area shown in Figure 2 were assigned for the primary noise souces (the inverters, transformers, and track motors). As previously noted, this equipment is expected to operation during the daytime period only.

Reference sound power levels input to Cadna-A were provided by equipment manufacturers, based on information contained in reference documents or developed using empirical methods. The source levels used in the predictive modeling are based on estimated sound power levels that are generally deemed to be conservative. The projected operational noise levels are based on client-supplied sound power level data for the major sources of equipment. Table 6 summarizes the equipment sound power level data used as inputs to the initial modeling analysis.

Table 6. Modeled Octave Band Sound Power Level (L_P) for Major Pieces of the Project Layout

Sound Source	Sound Power Level (L_P) by Octave Band Frequency dBA									Broadband Level
	31.5	63	125	250	500	1k	2k	4k	8k	dBA
Distribution Transformer	34	54	66	68	74	71	67	62	53	77
Inverter Bank	72	80	87	88	87	84	79	72	65	93
Substation Transformer	87	93	95	90	90	84	79	74	67	99
Tracker Motors	40	40	44	48	52	52	48	44	40	57

4.3 Noise Prediction Model Results

Broadband (dBA) sound pressure levels were calculated for expected normal Project operation assuming that all components identified previously are operating continuously and concurrently at the representative manufacturer-rated sound. The Project equipment is expected to operate during the daytime period only. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of reception. Sound contour plots displaying broadband (dBA) sound levels presented as color-coded isopleths are provided in Figure 3. The noise contours are graphical representations of the cumulative noise associated with full operation of the equipment and show how operational noise would be distributed over the surrounding area within a 1-mile radius of the Project Area. The contour lines shown are analogous to elevation contours on a topographic map, i.e., the noise contours are continuous lines of equal noise level around some source, or sources, of noise. Figure 3 also shows the ambient sound monitoring locations, representative of proximate noise sensitive land uses, that were used to assess potential noise impacts on a cumulative basis.

Table 7 shows the projected sound levels resulting from full, normal operation of the Project at the MLs. The table also provides the total predicted net increase in sound energy at each of the four MLs, which are representative of areas surrounding the Project Area in each of the principal geographical directions.

Table 7. Acoustic Modeling Results Summary

Monitoring Location	Daytime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA	Net Increase in Sound Level, dBA
ML-1	39	42	44	5
ML-2	45	45	48	3
ML-3	52	36	52	0
LT-1	43	42[1]	46	3

[1]Project sound level calculated at nearest residence located approximately 190 feet southeast of the substation boundary line.

Normal Project operations will only occur during the daytime operations, and the major noise-producing equipment will not operate during the nighttime period. As shown in Table 11 the operation of the Project will results in a 5 dB or less increase to the existing ambient noise level, is not expected to be intrusive, and will comply with the OPSB noise requirements.

4.4 Gen-Tie Line Noise Analysis

The Project will incorporate a gen-tie line that would be constructed to connect the Project's output to the electrical grid to Duke Energy's existing South Bethel – Brown 69 kV transmission line.

When a subtransmission line is in operation, an electric field is generated in the air surrounding the conductors, forming a corona. The corona results from the partial breakdown of the electrical insulating properties of the air surrounding the conductors. When the intensity of the electric field at the surface of the conductor exceeds the insulating strength of the surrounding air, a corona discharge occurs at the conductor surface, representing a small dissipation of heat and energy. Some of the energy may dissipate in the form of small local pressure changes that result in audible noise or in radio or television interference. Audible noise generated by corona discharge is characterized as a hissing or crackling sound that may be accompanied by a 120-Hz hum. Slight irregularities or water droplets on the conductor and/or insulator surface accentuate the electric field strength near the conductor surface, thereby making corona discharge and the associated audible noise more likely. Therefore, audible noise from subtransmission lines is generally a foul-weather phenomenon that results from wetting of the conductor. However, during fair weather, insects and dust on the conductors can also serve as sources of corona discharge.

The Electric Power Research Institute (EPRI) has conducted several studies of corona effects (EPRI 1978 and 1987). The typical noise levels for transmission lines with wet conductors are shown in Table 8.

Table 8. Transmission and Subtransmission Line Voltage and Audible Noise Levels

Line Voltage (kV)	Audible Noise Level Directly Below the Conductor (dBA)
138	34
240	40
360	51

As shown in Table 12, the audible noise associated with transmission and subtransmission lines decreases as the line voltage decreases; the audible noise associated with the 240-kV line is lower than 40 dBA and the audible noise associated with the 115-kV line is lower than 34 dBA. The Project gen-tie line is proposed to be 34.5 kV, which will result in noise levels well below 34 dBA at the nearest sensitive receptors. Based on the measured noise levels the overall increase from the 34.5 kV gen-tie line will result in a less than 1 dB increase to the existing ambient noise level, which will be unlikely to be perceptible and will comply with the OPSB noise requirements.

5.0 CONSTRUCTION NOISE

Acoustic emission levels for activities associated with Project construction were based upon typical ranges of energy equivalent noise levels at construction sites, as documented by the USEPA (USEPA 1971b) and the USEPA's "Construction Noise Control Technology Initiatives" (USEPA 1980). The USEPA methodology distinguishes between type of construction and construction phase.

Using those energy equivalent noise levels (L_{eq}) as input to a basic propagation model, construction noise levels were calculated at the nearest non-participating residential structure and at the furthest non-participating residential structure.

The basic model assumed spherical wave divergence from a point source located at the acoustic center of a turbine location. Furthermore, the model conservatively assumed that all pieces of construction equipment associated with an activity would operate simultaneously for the duration of that activity. An additional level of conservatism was built into the construction noise model by excluding potential shielding effects due to intervening structures and buildings along the propagation path from the site to receiver locations.

Construction activities associated with the Project also have the potential for localized noise on a temporary basis as construction activities progress through certain locations within the Project Area. Construction activities the Project can be generally divided into five phases:

1. Site preparation, grading, preparation of staging areas, and on-site access routes;
2. Array foundation installation, conductor installation, and construction of control building;
3. Solar panel assembly and constructing electrical components;
4. Inverter pad construction, substation installation, cabling and terminations, and Gen-Tie construction; and
5. Array and interconnection commissioning, revegetation, and construction of waste removal and recycling.

Note that these activities would occur sequentially for discrete array groupings, with the potential for overlap. In addition to the solar arrays, construction activities will also occur for supporting infrastructure. The electrical collector lines are likely to be completed while each respective solar array is being constructed; other Project-related elements, such as the operations and maintenance building, would occur independently and then be complete.

Based on sound propagation calculations, construction sound levels are predicted to range from 72 to 85 dBA at the MLs. Periodically, sound levels may be higher or lower than those presented in Table 7; however, the overall sound levels should generally be lower due to excess attenuation and the trend toward quieter construction equipment in the intervening decades since these data were developed. As shown in Table 9, the highest projected sound level from construction-related activity is expected to occur at ML-2, during activities associated with the solar panel assembly and constructing electrical components.

Table 9. Projected Construction Noise Levels by Phase (dBA)

Construction Phase	USEPA Construction Noise Level 50 feet	ML-1	ML-2	ML-3	LT-1[1]
Phase 1	87	77	81	80	76
Phase 2	86	76	80	79	74
Phase 3	91	80	85	84	79
Phase 4	89	79	83	82	78
Phase 5	82	72	76	75	70

[1]Construction sound levels calculated at nearest residence located approximately 190 feet southeast of the substation boundary line.

Construction of the Project will occur over a relatively brief period (approximately 10 months). Since construction machines operate intermittently, and the types of machines in use at the Project Area change with the phase of construction, noise emitted during construction will be mobile and highly variable, making it challenging to control. The construction management protocols will include the following noise mitigation measures to minimize noise impacts:

- Maintain all construction tools and equipment in good operating order according to manufacturers' specifications;
- Limit use of major excavating and earth moving machinery to daytime hours;
- To the extent practicable, schedule construction activity during normal working hours on weekdays when higher sound levels are typically present, and are found acceptable. Some limited activities, such as concrete pours, will be required to occur continuously until completion;
- Equip any internal combustion engine used for any purpose on the job or related to the job with a properly operating muffler that is free from rust, holes, and leaks;
- For construction devices that utilize internal combustion engines, ensure the engine's housing doors are kept closed, and install noise-insulating material mounted on the engine housing consistent with manufacturers' guidelines, if possible;
- Limit possible evening shift work to low noise activities such as welding, wire pulling and other similar activities, together with appropriate material handling equipment; and
- Utilize a Complaint Resolution Procedure to address any noise complaints received from residents.

As noted, reasonable efforts will be made to minimize the impact of noise resulting from construction activities at proximate noise sensitive areas through the use of noise mitigation. Because of the temporary nature of the construction noise, no adverse or long-term effects are expected.

6.0 CONCLUSIONS

The construction of the Project has been organized into five phases. Based on sound propagation calculations, construction sound levels are predicted to range from 72 to 85 dBA at the MLs. Periodically, sound levels may be higher or lower; however, the overall sound levels should generally lower due to excess attenuation and the trend toward quieter construction equipment in the intervening decades since these data were developed. The highest projected sound level from construction-related activity is expected to occur at ML-2, during activities associated with the solar panel assembly and constructing electrical compoents. Reasonable efforts will be made to minimize the impact of noise resulting from construction activities at proximate noise sensitive areas through the use of noise mitigation. Based on the temporary nature of the construction noise, no adverse or long-term effects are expected from Project construction.

Normal Project operations will only occur during the daytime operations, and the major noise-producing equipment will not operate during the nighttime period. Project operation will results in a 5-dB or less increase to the existing ambient noise level even at the residential location within the Project Area, and less in other locations, thus complying with OPSB noise guidance.

The Project gen-tie line is proposed to be 34.5 kV, which will result in noise levels below 34 dBA at the nearest sensitive receptors. Based on the measured noise levels, the overall increase from the 34.5-kV gen-tie line will result in a less than 1-dB increase to the existing ambient noise level, which will comply with the OPSB noise requirements.

7.0 REFERENCES

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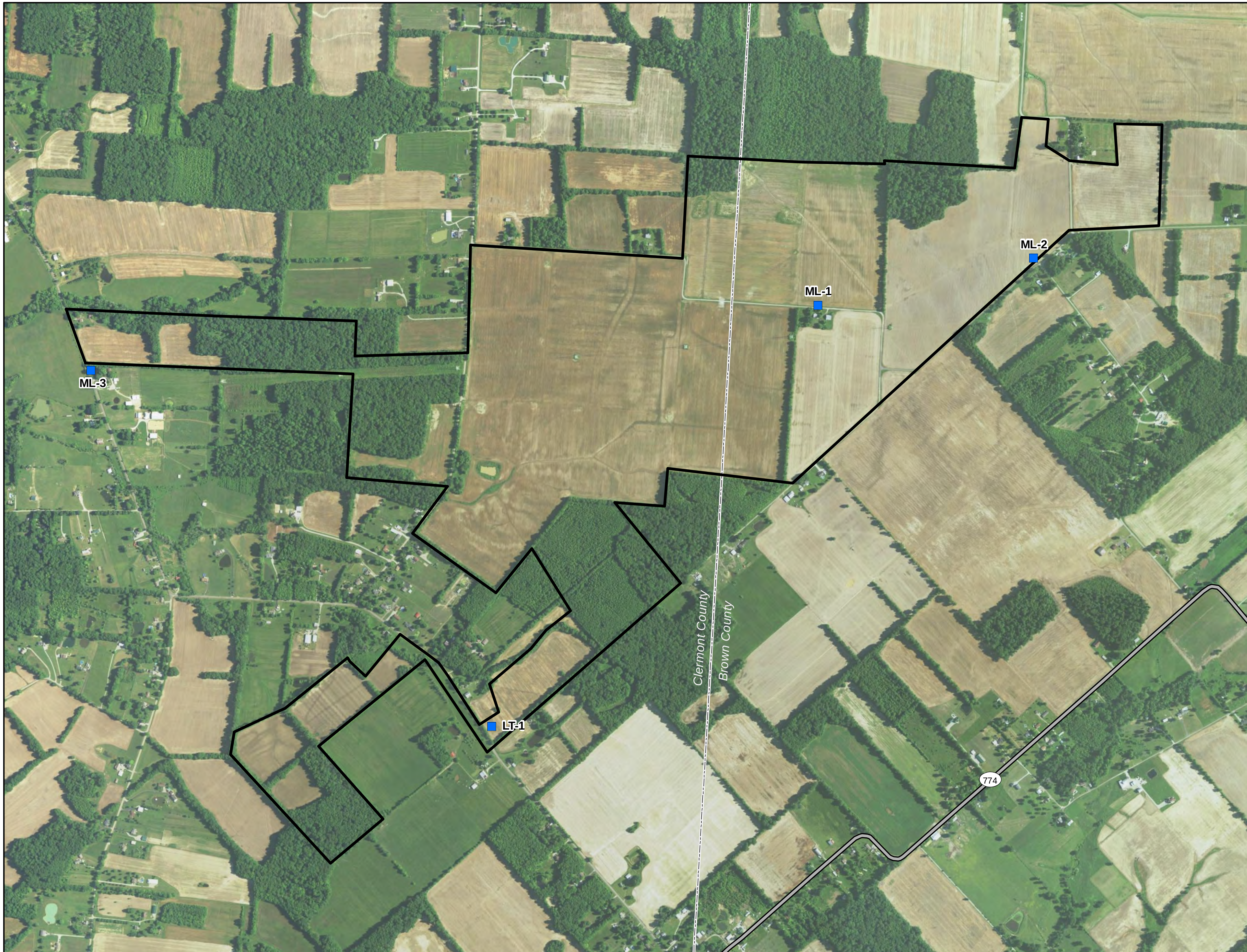
Figures

Figure 1
Project Location and Measurement Locations

Nestlewood Solar
Brown and Clermont Counties, Ohio



Project Area
Measurement Location

N

0 1,000 2,000
Feet
1:12,000

Source: NAIP (2017)

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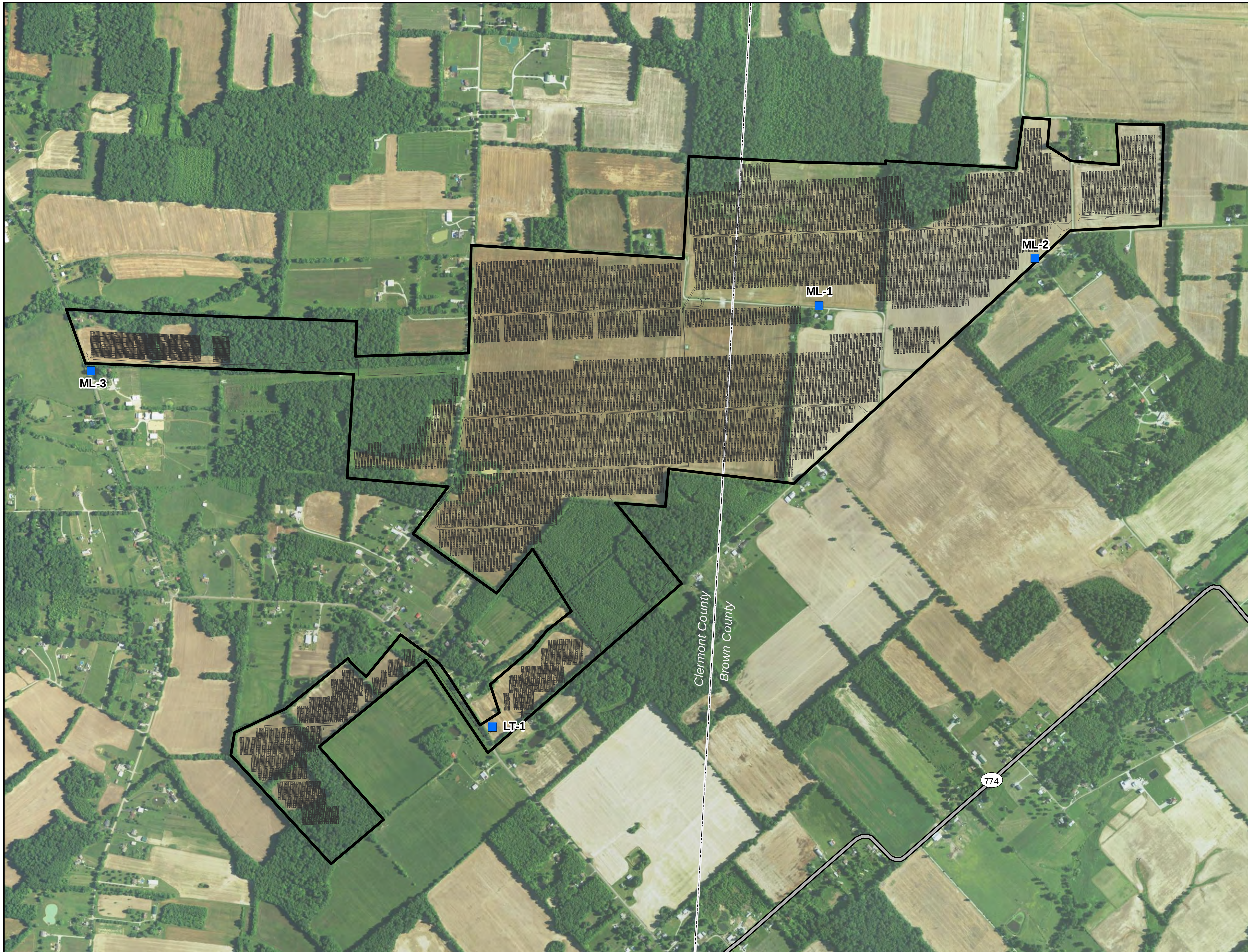
Figure 2
Project Equipment Layout

Nestlewood Solar
Brown and Clermont Counties, Ohio



Project Area
Measurement Location

N
0 1,000 2,000
Feet
1:12,000

Source: NAIP (2017)

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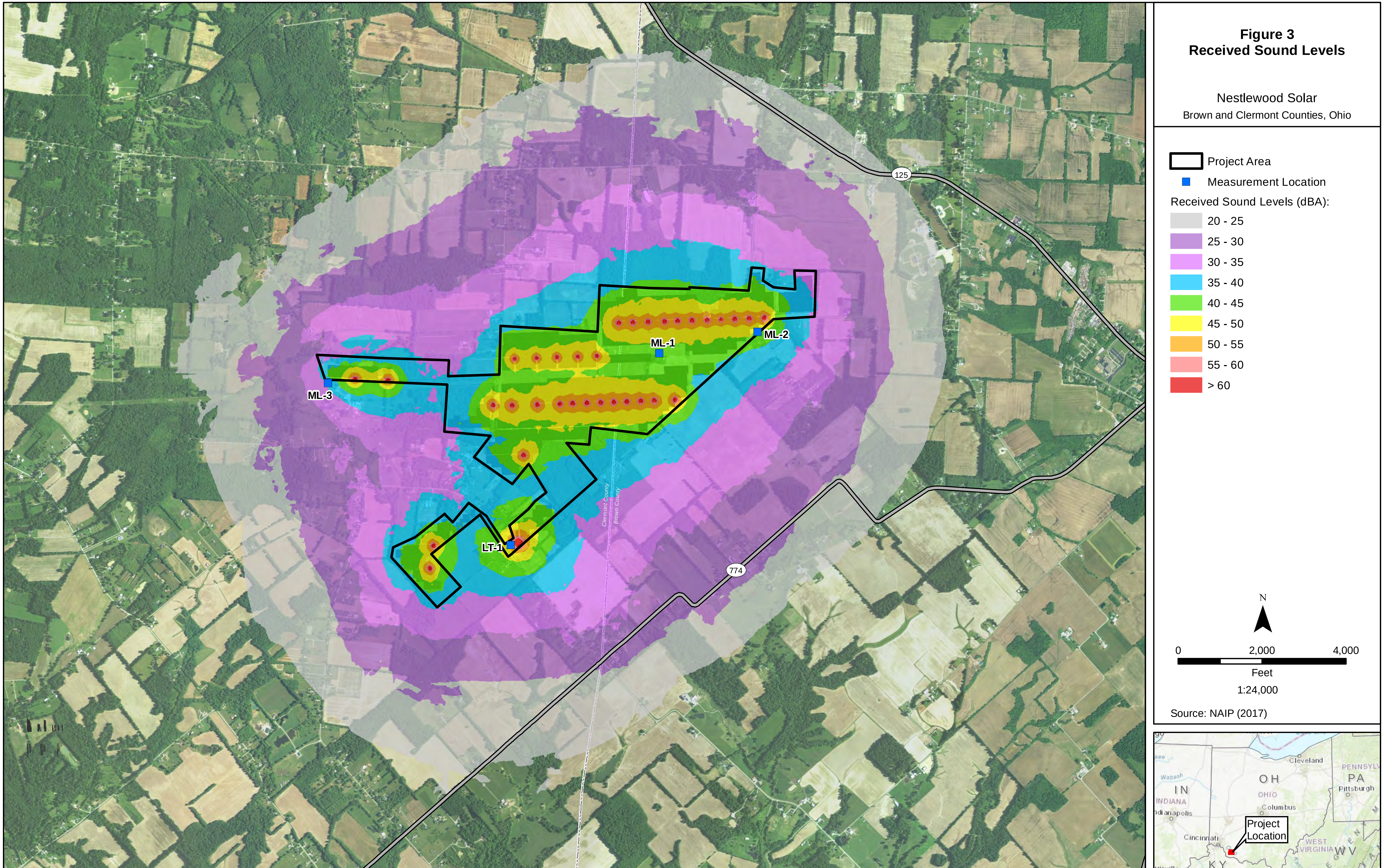
Figure 3
Received Sound Levels
Nestlewood Solar
Brown and Clermont Counties, Ohio
Project Area
Measurement Location
Received Sound Levels (dBA):
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
> 60
N
0
2,000
4,000
Feet
1:24,000
Source: NAIP (2017)
ML-1
ML-2
ML-3
LT-1
125
774
Clermont County
Brown County
Project Location
OH
IN
PA
KY
WV
Cleveland
Pittsburgh
Columbus
Cincinnati
Indianapolis
Frankfort
R:\PROJECTS\NESTLEWOOD_SOLAR_6526\NOISE\MAPS\Figure_3_Sound_Levels.mxd

Appendix A

Complaint Resolution Procedure

Nestlewood Solar Complaint Resolution Program

1. INTRODUCTION

Nestlewood Solar I LLC (Nestlewood Solar) has developed a complaint resolution program for implementation during the construction of the Project to provide an effective process for identification and resolution of concerns voiced by members of the community.

Nestlewood Solar is committed to complying with requirements established through the Ohio Power Siting Board and other regulatory processes, and to establishing an accessible process for community members to voice concerns and for those concerns to be addressed as quickly and effectively as possible. Maintaining detailed records of all complaints and resulting actions is an important aspect of the complaint resolution program.

Nestlewood Solar's policy is to take all reasonable necessary actions to rectify legitimate interference or disturbances that are a direct result of the Project.

2. COMPLAINT RESOLUTION PROCEDURE

2.1 Nestlewood Solar Contacts

Nestlewood Solar will establish a toll-free telephone number and will provide that number to the county commissioners, township trustees, emergency responders, schools, and public libraries within the Project Area; that number will also be posted on the Project website. To register a complaint, individuals may either call the telephone number and leave a message or go to the local construction office during regular business hours.

2.2 Notification

In addition to providing the contact information and procedure to the officials and public locations noted above, Nestlewood Solar will maintain a Project contact list for residents and will provide notification to residences located within 1 mile of construction activities that construction is about to commence.

2.3 Complaint Documentation and Follow-Up

Nestlewood Solar will keep a logbook to register every complaint received. The logbook will include pertinent information about the person making the complaint, the issues surrounding the complaint, and the date the complaint was received; an example of a complaint resolution form is attached.

The logbook will also document Nestlewood Solar's recommended resolution, the date agreement was reached on a proposed resolution, and the date when the proposed resolution was implemented. Nestlewood Solar personnel will generate a quarterly report based on the information recorded in the log book about the nature and resolution of all complaints received in that quarter, and file the report with the OPSB on January 31, April 30, July 31, and October 31 of each calendar year or portion thereof during construction.

Individuals who register a complaint with Nestlewood Solar will receive correspondence from Nestlewood Solar no later than 2 business days after registering the complaint. The intent of the initial correspondence is to gather more information to better understand the complaint. Within 30 days of the complaint being logged, Nestlewood Solar will initiate reasonable action to resolve the legitimate interference or disturbance that is a direct result of the Project.

If Nestlewood Solar and the complaining individual cannot agree to a resolution, Nestlewood Solar will provide a summary of the complaint and proposed resolution to the complaining individual so the complaint can be brought to the OPSB.

Nestlewood Solar Complaint Resolution Form

Complaint Log Number: _____________ Complainant's name and address: Phone number/email:
Date complaint received: ______________ Time complaint received: ______________ Date complainant first contacted: ____________
Nature of complaint:
Definition of problem after investigation:
Description of corrective measures taken: Complainant's signature: ____ Date: _____________
This information is certified to be correct: Site Manager's Signature: _______________________________________ Date: _____________

(Attach additional pages and supporting documentation, as required.)