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TECHNICAL REPORT

Title: Existing Conditions Background Sound Surveys and Sound Emissions Assessment

Project: Mohawk Solar
Location: Canajoharie, NY
Prepared For: Mohawk Solar, LLC
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Revision: B
Issue Date: April 30, 2019
Reference No: TM-2096-013119-B

Attachments: **Table T-2096-021419-A** Source Sound Level Calculations
Inverter Data Sheet
SSU Data Sheet
Plot 1 Project Sound Emissions Contours

1.0 Introduction

A study has been carried out for Mohawk Solar, LLC to evaluate the sound emissions from the proposed Mohawk Solar Energy Facility located southwest of Canajoharie in Montgomery County, NY in order to identify and quantitatively evaluate any possible community issues associated with the sound emissions from the project. Compared to other types of power generation facilities, potential sound impacts from a photovoltaic solar energy project are relatively few, relatively mild and, moreover, have the unusual characteristic of only occurring during the daylight hours when sound is much less likely to be an issue in the first place. In this case, any possible concerns about sound emissions are largely confined to the step-up transformer in the new collector substation, some small low voltage transformers within the various solar fields and some short-lived activities during construction.

In an effort to methodically evaluate the potential impact from the project, field surveys were carried out during both winter and summer conditions to establish the current levels of background sound at the nearest residence to the proposed substation and in the general site area so that projections of future project sound can be evaluated within an appropriate context. This report summarizes the findings from those field surveys and discusses the potential sound impacts associated with the project.

1.1 Executive Summary

Two seasonal field surveys of the existing ambient sound levels near the proposed substation and in the general site vicinity of the Mohawk Solar Project have been carried out to establish the baseline environmental conditions. The survey results indicate that the sound levels in the area are extremely quiet with an average daytime L90 sound level of only 29 dBA during winter conditions and 25 dBA during the summer after ANS-weighting was applied to eliminate some high frequency natural sounds observed during that survey. No existing tones were found. In general, these low background levels indicate that the environment will not provide any significant masking of the project's sound emissions.

The sound power level of the step-up transformer associated with the proposed substation was calculated from its expected maximum MVA rating of 110 and its far field sound pressure level frequency spectrum has been mathematically projected to the nearest residence to evaluate any potential sound impact using the Modified Composite Sound Rating (MCNR) methodology. This approach compares the frequency spectra of the existing background level to that of the proposed project to essentially gauge its audibility relative to the natural environmental sound level. Additional adjustments are made for such factors as time of day, tonal content and the community attitude towards to the project. The result of this analysis, which considers the very low existing ambient, is that no adverse reaction is expected from the proposed substation at the closest residence - and at all more distant receptor locations.

Beyond the substation, there will some sound from the small string inverters mounted on the panel racks and a number of small medium/low voltage transformers (SSU's) distributed throughout the solar fields; however, the sound pressure levels from both of these components are minimal, in the 53 to 65 dBA range at 1 m, which essentially makes them negligible (less than 30 dBA) with respect to residences hundreds of feet away. Consequently, no adverse community sound impact is anticipated from this equipment.

In contrast to other forms of power generation, the sound emissions during the construction of this photovoltaic project are expected to be dramatically lower in magnitude and duration. However, some unavoidable disturbance is possible when the mounting posts are driven in, but this activity will be fairly short-lived in any particular location. Some local sound will be generated during the construction of the operations and maintenance building, but it will be generally similar in nature and duration to the construction of a residential home. Other sounds from trenching and road building will also be brief and will progress from place to place avoiding prolonged exposure at any specific location.

In general, the potential sound impacts from all aspects of the project are expected to extremely minimal.

2.0 Existing Conditions Sound Surveys

In order to quantitatively evaluate the potential sound impact of the substation transformer and a number of smaller low voltage transformers distributed throughout the project area, sound monitoring equipment was set up to measure existing environmental sound levels in the site area under both winter and summer conditions for later comparison to the predicted sound levels from the project. The winter survey was carried out over a 6 day period from January 24th to 30th 2018 and the summertime survey was conducted over 8 days from June 28th to July 7th 2018. Continuously recording frequency analyzers were used in general accordance with ANSI S12.9-R2013 "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-term, Wide-Area Sound".

2.1 Measurement Locations

The overall site plan on the following page shows the leased land parcels (orange), proposed panel arrays (gray), nearby residences (black), and the three background sound monitoring locations. These positions were chosen to evaluate existing environmental sound levels at the nearest residence to the substation and at two other general locations representative of the overall site vicinity. The exact monitoring locations are described in further detail in the following sections.

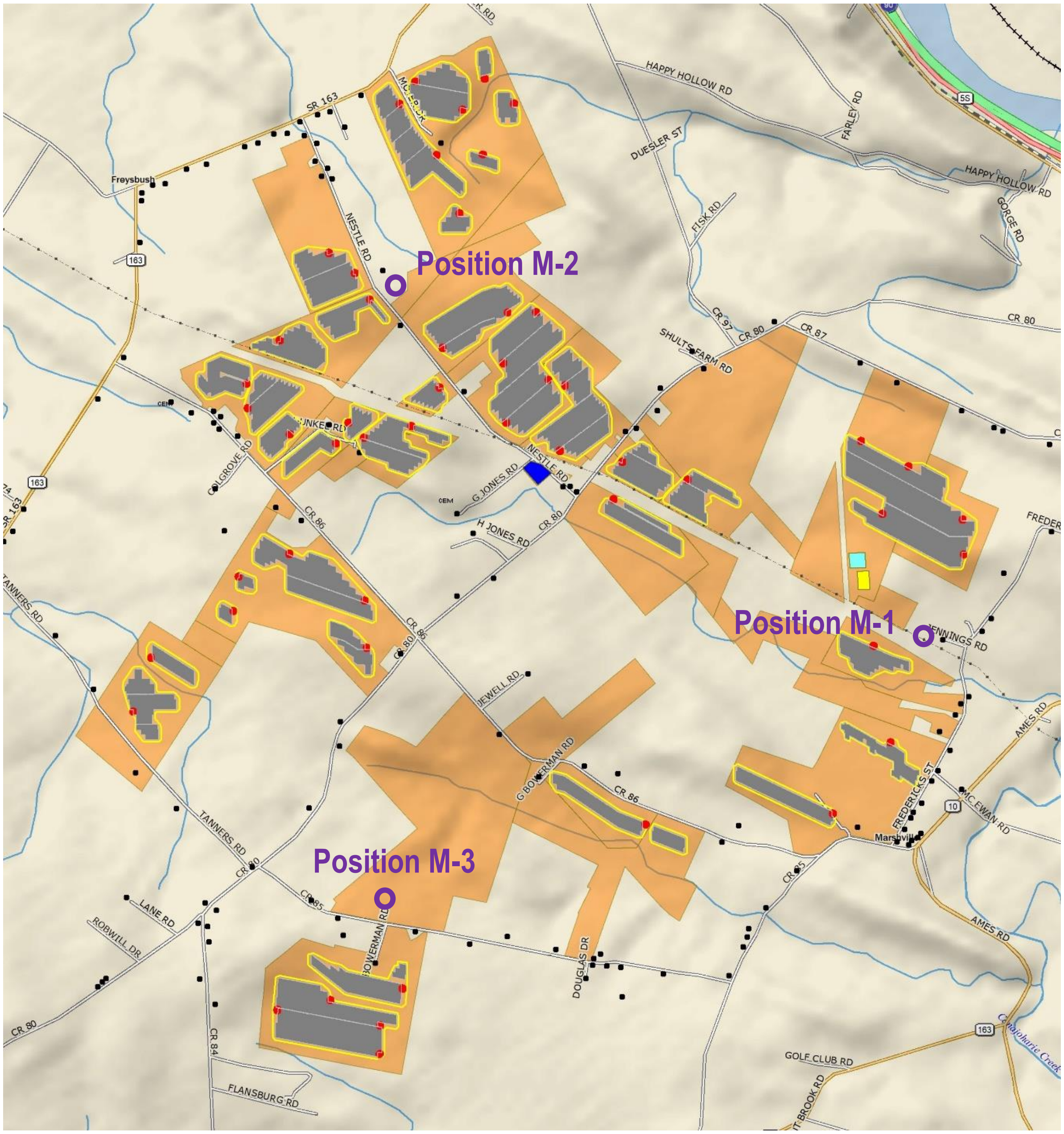

Figure 2.1.1
Overall Site Vicinity Showing the Ambient Sound Measurement Positions

2.1.1 Position M-1

The substation location is shown in the aerial below along with the location of background sound monitoring Position M-1 representing the nearest residence to the substation.

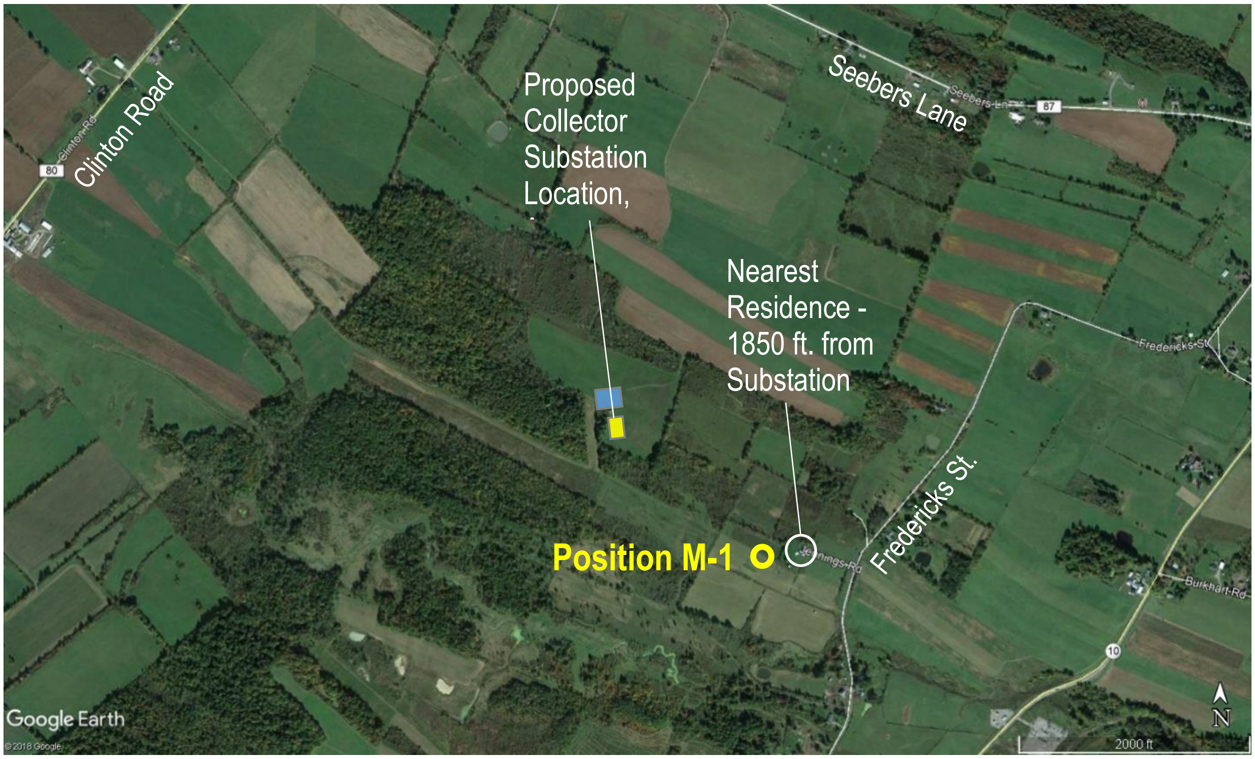

Figure 2.1.1.1
Substation Vicinity Showing Measurement Position M-1 Near the Closest Residence

As illustrated in Figure 2.1.1.2, a frequency analyzer, along with a back-up unit, were set up as continuous sound monitors at a position on the edge of the existing transmission line right-of-way 300 feet west of the house.

Figure 2.1.1.2
Sound Monitoring Equipment Looking E towards the House
(behind the pine trees)

2.1.2 Position M-2

Position M-2 was located in an open field off Nestle Road in the northeastern part of the site.

Figure 2.1.2.1
Measurement Position M-2

The measurement equipment is shown in the following photograph taken during the winter survey.

Figure 2.1.2.2
Sound Monitoring Equipment Looking NW towards the Nearest House

2.1.3 Position M-3

Position M-3 was set up in the southern part of the site area at a location in another field approximately 370 ft. north of Dygert Road near its intersection with Bowerman Road.

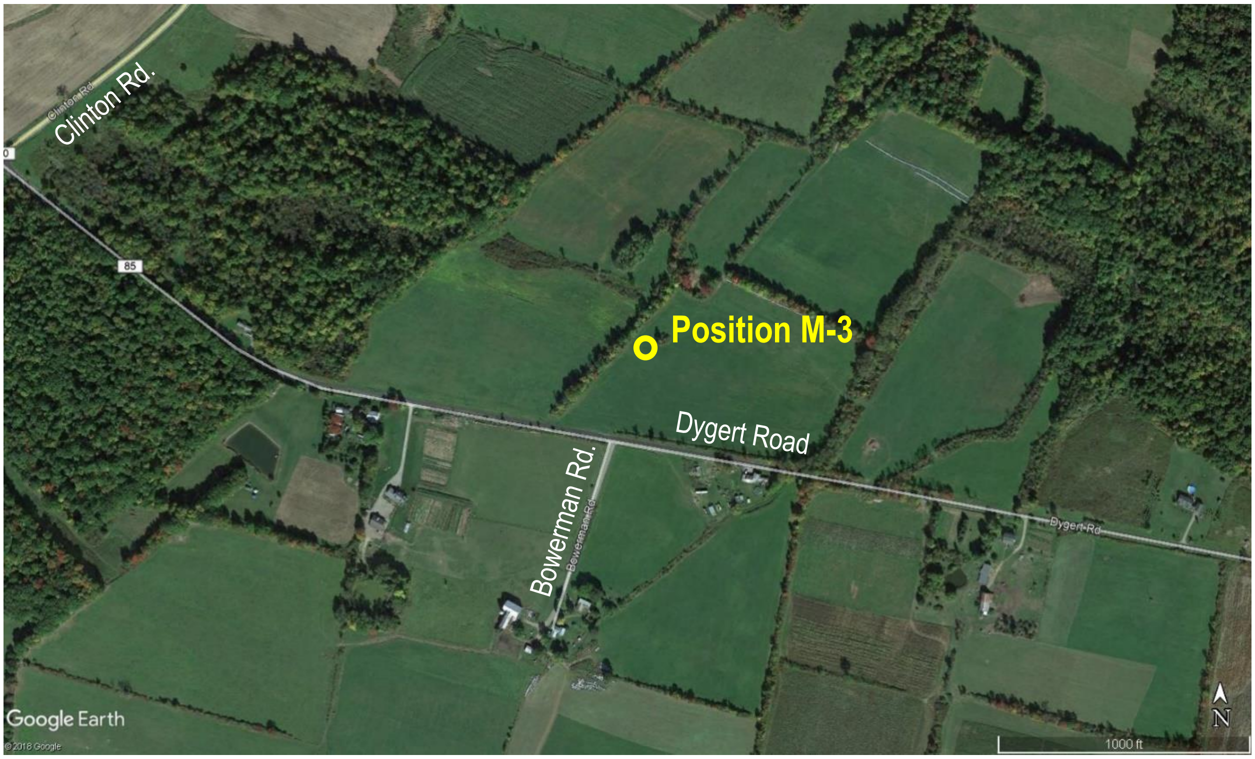

Figure 2.1.3.1
Measurement Position M-3

Figure 2.1.3.2
Sound Monitoring Equipment Looking SE towards Dygert Road

2.2 Survey Equipment and Survey Methodology

Norsonic N-140, ANSI S1.4-1983(R2006) Type 1 precision, 1/3 octave band frequency analyzers were used as the primary instruments for the survey at all positions along with a Rion Model NL-22, ANSI Type 2, environmental sound monitor at Position M-1 for redundancy. Because all of the primary instruments worked perfectly, none of the data collected from the back-up instrument were needed or used in the analysis. Each instrument was field calibrated with a Brüel and Kjær Type 4230, ANSI S1.40-1984(R1990) Type 1 calibrator at the beginning and end of the survey and all the primary meters exhibited a drift within a +/- 0.2 dB range. Weather-treated 7 in. diameter windscreens were used to minimize self-generated distortion from wind on the primary instruments. The microphones were fixed to temporary posts at a height of 1.2 m above local grade in open areas removed from any reflective vertical surfaces.

A variety of statistical sound levels, such as the minimum, average, maximum, etc. were measured in 10 minute increments over each survey period; however, the parameter of primary relevance and importance to this kind of survey is the “residual” or L90 percentile level, which is the sound level exceeded 90% of the time over each measurement period. Put another way, this level captures the quietest (not necessarily consecutive) 1 minute of each 10 minute interval making it a conservative measure of the near-minimum background sound level.

2.3 Survey Conditions

The weather conditions during the winter survey period were generally favorable in the sense there was no precipitation and the wind speeds were generally moderate, except on the first day of the test when gusty conditions were present.

There was also a lack a precipitation during the summer survey but there were several periods of moderately high winds on 6/30, 7/2 and 7/3. All data collected during the windy periods in both surveys was deleted from the analysis and averaging calculations.

3.0 Survey Results

3.1 Winter Survey

The winter survey results, in terms of the residual (L90(10 min.)) sound levels at all three positions are plotted below.

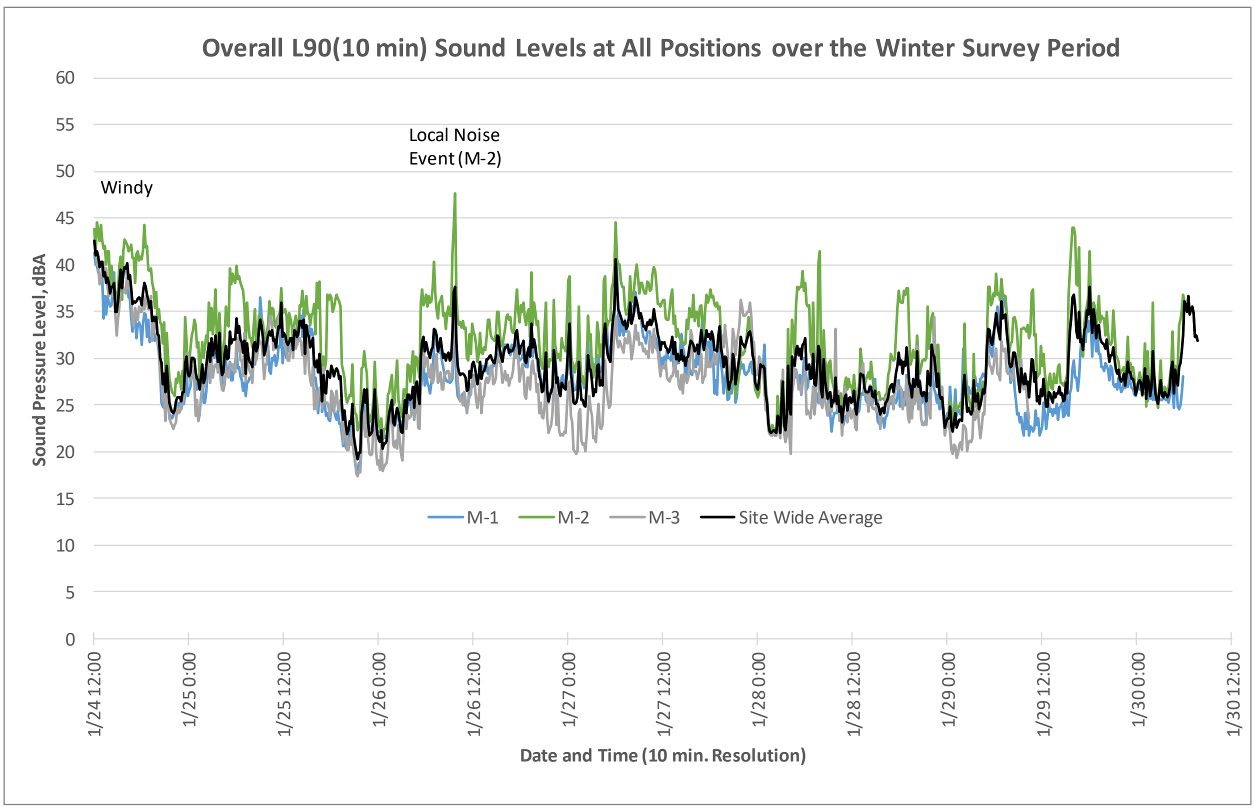

Figure 3.1.1

What these results generally show is that this environment is extremely quiet with sound levels typically in the 20 to 35 dBA range. Slightly higher, but still relatively low sound levels (only about 40 dBA), were measured during the windy conditions that existed on the first day of the survey. These data were omitted from the analysis.

Because the project and its associated substation will only be active during the day when the sun is out, the baseline background sound level of relevance is the average daytime L90 sound level. At the time of the winter survey the daylight hours were approximately 7 a.m. to 5 p.m. The overall average A-weighted daytime sound level during this period, excluding the windy period on the first day and the local noise event on Jan. 26, was a very low 28 dBA. The average octave band frequency content of the adjusted daytime level is tabulated below.

Table 3.1.1
Average Measured Daytime L90 Background Sound Level (7 a.m. to 5 p.m.) – Winter Survey

Octave Band Center Frequency, Hz									**dBA**
31.5	63	125	250	500	1k	2k	4k	8k	
43	42	36	27	23	21	15	15	15	**28**

These full octave band levels were derived from the measured 1/3 octave band spectra recorded over the survey period. The average daytime L90 1/3 octave band spectrum adjusted for wind and local noise events, specifically at Position M-1, is plotted below. The smooth character of this spectrum indicates that there are no pre-existing tonal sounds in the vicinity of the substation as defined in ISO 1996:2 Annex K, nor are there any high frequency natural sounds that might warrant correction per ANSI/ASA S12.100[1].

[1] ANSI/ASA S12.100-2014, *Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas*, 2014.

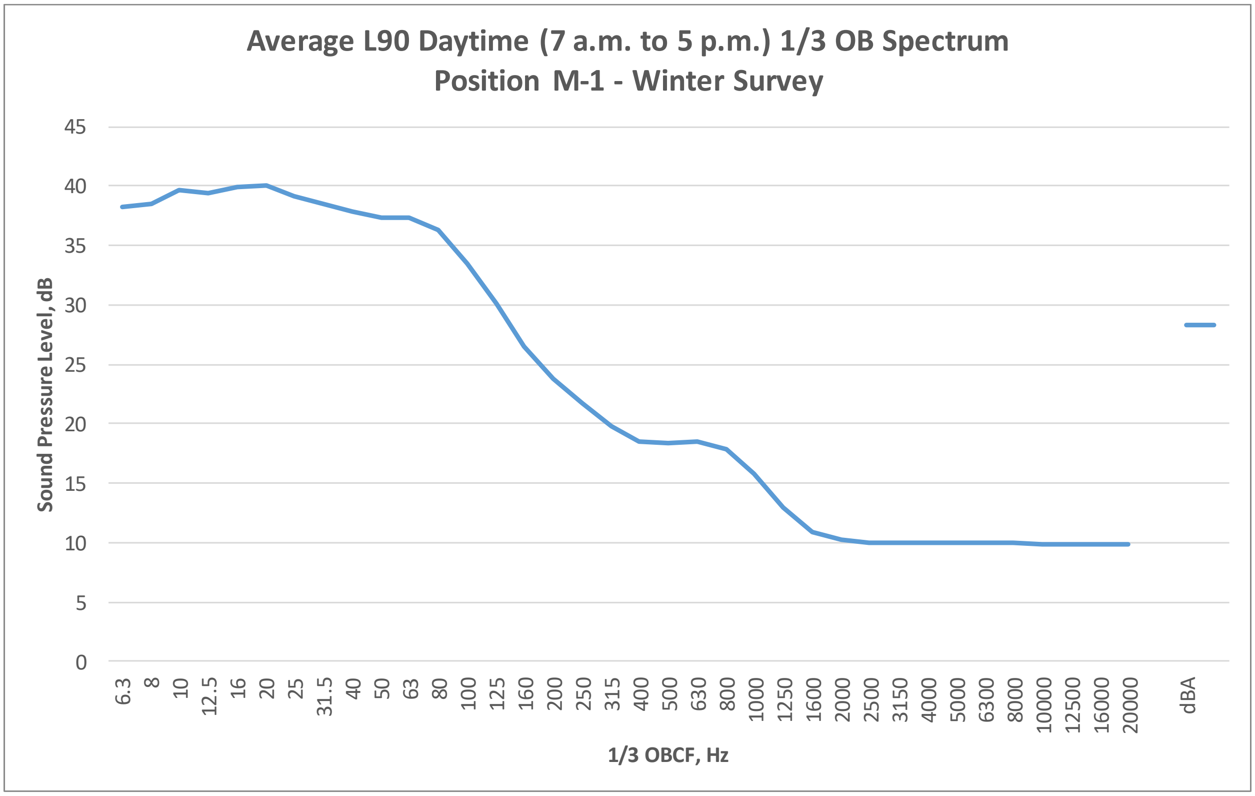

Figure 3.1.2

3.2 Summer Survey

The summer survey results, in terms of the residual (L90(10 min.)) sound levels at all three positions are plotted below.

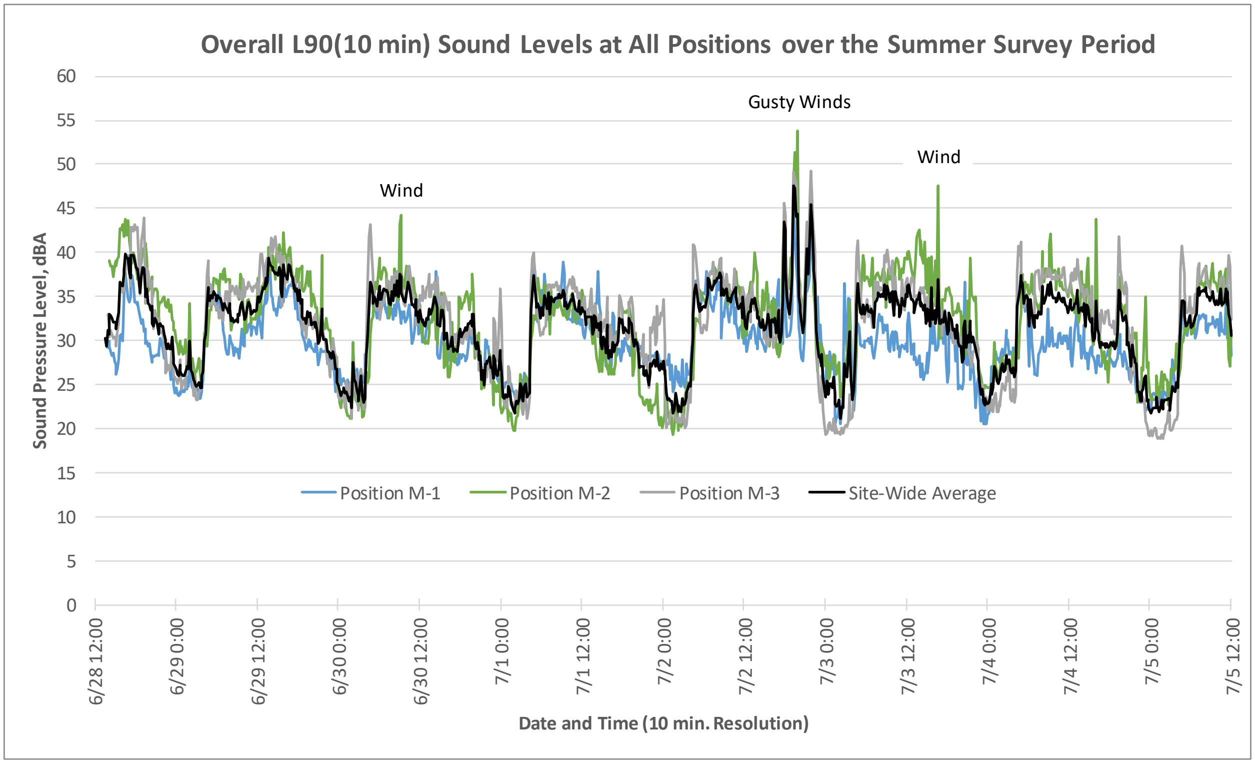

Figure 3.2.1

The summer results generally exhibit a clearer diurnal pattern than was found in the winter survey characterized by an abrupt increase in sound around 4:45 a.m. every morning off the nighttime lows of about 22 dBA. Since, this increase occurs simultaneously at all three monitoring positions, it may be attributed to traffic rather than local contamination from dairy farm activities, for example.

At the time of the summer survey the daylight hours were approximately 5:30 a.m. to 8:30 p.m. The overall average A-weighted daytime sound level during this period, omitting all data collected during the windy periods, was 32 dBA, which is still very low and only marginally higher than the winter result due to a slight increase in high frequency sound associated with a summertime insect activity. The average as-measured octave band frequency content of the daytime level is tabulated below.

Table 3.2.1
Average Measured Daytime L90 Background Sound Level (5:30 a.m. to 8:30 p.m.) – Summer Survey, **As-Measured**

Octave Band Center Frequency, Hz									dBA
31.5	63	125	250	500	1k	2k	4k	8k	
40	37	31	23	23	22	20	20	17	**32**

The average daytime L90 1/3 octave band spectrum specifically at Position M-1, exclusive of windy periods, is plotted below. The smooth character of this spectrum indicates that there are no pre-existing tonal sounds in the vicinity of the substation, with the possible exception of extreme high frequency insect sounds around 16,000 Hz.

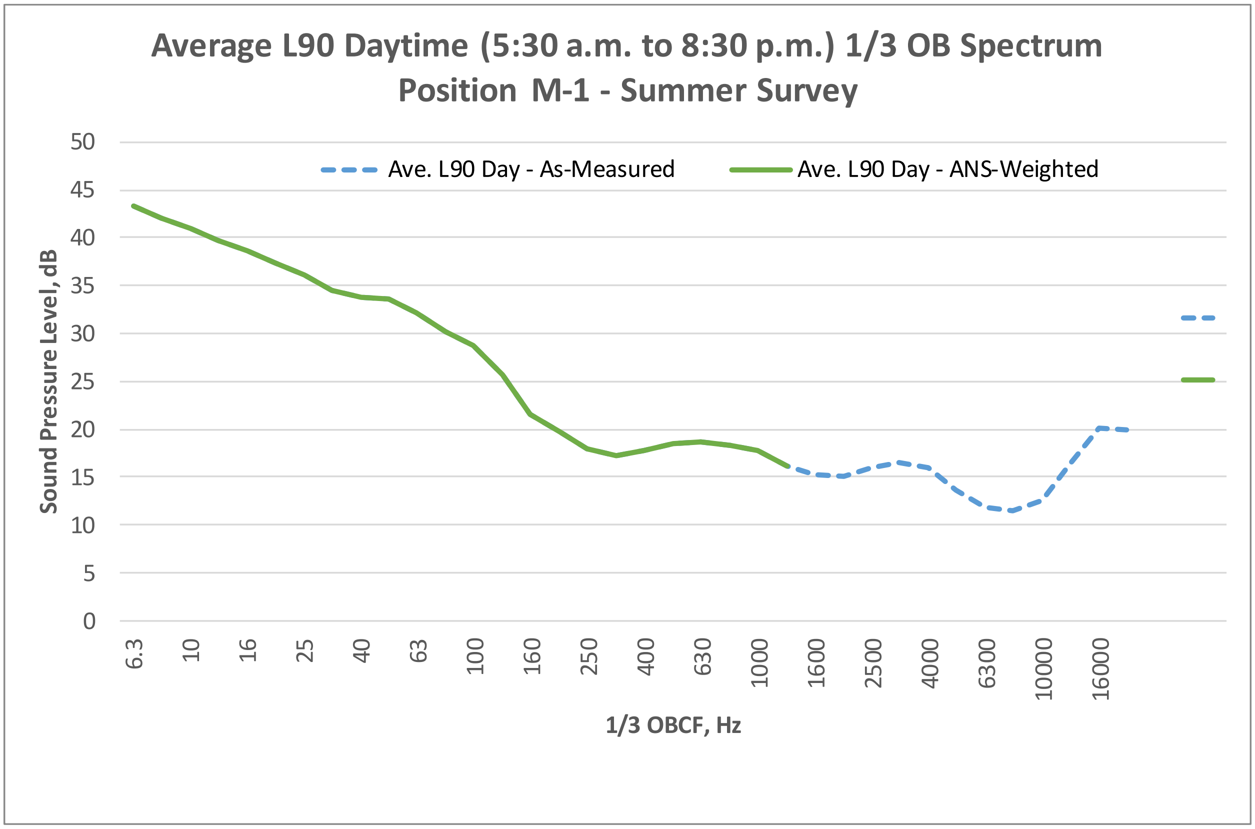

Figure 3.2.2

In order to eliminate any possible impact on the overall A-weighted sound level from this seasonal high frequency natural sound (HFNS), the average daytime L90 spectrum was corrected in accordance with ANSI S12.100-2014[2]. This process involves the elimination of all data above 1000 Hz and the logarithmic re-summation of the A-weighted spectrum to derive the ANS-weighted sound level; or the A-weighed sound level representative of a noise sensitive, quiet residential area. This mathematical adjustment leads to an overall ANS-weighted sound level of 25 dBA, which will be used for design purposes.

[2] ibid.

Table 3.2.2
Average Measured Daytime L90 Background Sound Level (5:30 a.m. to 8:30 p.m.) – Summer Survey, ANS-Weighted **Design Level**

Octave Band Center Frequency, Hz									dBANS
31.5	63	125	250	500	1k	2k	4k	8k	
40	37	31	23	23	22	-	-	-	**25**

4.0 Sound Emissions from the Substation

4.1 Transformer Sound Level

The only sound source of any potential consequence in the new substation is the main step-up transformer. The input sound power level for this transformer has been conservatively estimated in octave bands in **Table T-2096-021419-A** based on the unit's maximum expected MegaVolt Ampere (MVA) rating of 110 using empirically derived algorithms from the "Electric Power Plant Environmental Noise Guide[3]" published by the Edison Electric Institute (EEI). Numerous transformers over a wide range of sizes and manufacturers were measured in the EEI study to develop a formulaic relationship between the MVA rating and sound power. The precise transformer model, rating and manufacturer for this project have not yet been finalized, but the best estimate at this time is for a 110 MVA unit.

The algorithm predicts a near field sound pressure level of 80 dBA; however, the current supplier reports that the actual maximum sound level with the radiator fans on is 75 dBA. Consequently, the calculated sound pressure level appears to be conservative by about 5 dBA. Nevertheless, the resulting sound power level of 99 dBA re 1 pW based on the calculated near field of 80 dBA will be used for modeling purposes without adjustment.

Table 4.1.1
Design 110 MVA Transformer Sound Power Level (Lw) Spectrum

OBCF, Hz	31.5	63	125	250	500	1k	2k	4k	8k	**dBA**
Lw, dB re 1 pW	96	102	104	99	99	93	88	83	76	**99**

[3] "Electric Power Plant Environmental Noise Guide", Prepared by Bolt Beranek and Newman for the Edison Electric Institute, 2nd Ed., 1984.

4.2 Sound Propagation Calculations

Based on the sound power level spectrum above, the octave band sound emissions from the substation have been calculated in **Table T-2096-021419-A** at the nearest potentially sensitive residence in strict accordance with ISO 9613-2 *Acoustics –Attenuation of Sound during Propagation Outdoors*[4].

In this instance, a mid-range, somewhat conservative ground absorption coefficient (Ag from ISO 9613-2) of 0.5 (on a scale of 0 to 1) has been used to represent the site vicinity, which generally consists of open fields and intermittent wooded areas. Normally, such terrain would be considered more acoustically absorptive and would warrant a higher coefficient than 0.5. There are no major undulations in the topography near the substation site so a flat plane is assumed along with ISO “standard day” conditions (10 deg. C/70% RH).

4.3 Analysis of Substation Sound Levels at the Nearest Residence

The nearest residence to the proposed new substation is illustrated in Figure 4.3.1 and designated as Design Point 1.

[4] *Acoustics – Attenuation of Sound during Propagation Outdoors*, Part 2, “A General Method of Calculation,” ISO 9613-2, International Organization for Standardization, Geneva, Switzerland, 1996.

Figure 4.3.1
Substation Vicinity Showing Distance to Nearest Residence

The overall A-weighted sound level from the proposed substation transformer at this design point is calculated at an extremely quiet, and probably inaudible, 32 dBA, which, in absolute terms, is well below any existing disturbance threshold for daytime exposure, such as the latest WHO (2018) environmental noise guidelines[5], which range from 45 to 54 dBA during the day depending on the type of source. Moreover, it is important to note that the sound power level used in this prediction, as discussed in Section 4.1 above, is apparently conservative/high by 5 dBA, since the manufacturer's measured near field is 5 dBA lower than the EEI algorithm prediction.

However, because transformer sound is characterized by hums and tones, its frequency content is generally of more importance than its overall magnitude. An assessment approach that uses the frequency spectrum of the source and the background to evaluate potentially intrusive noise and predict community reaction is the Modified Composite Noise Rating, or MCNR, method.

The first step in the evaluation process is to plot the octave band frequency spectrum of the predicted project-only sound level at points of interest against a set of curves that generally map the perceptibility of the sound as a function of frequency. Figure 4.3.2 below shows the predicted

[5] World Health Organization, Regional Office for Europe, *Environmental Noise Guidelines for the European Region*, 2018.

project sound level spectra at DP-1. A lower-case initial classification letter, applicable to the regions between each curve, is assigned according to the highest region that the spectrum touches.

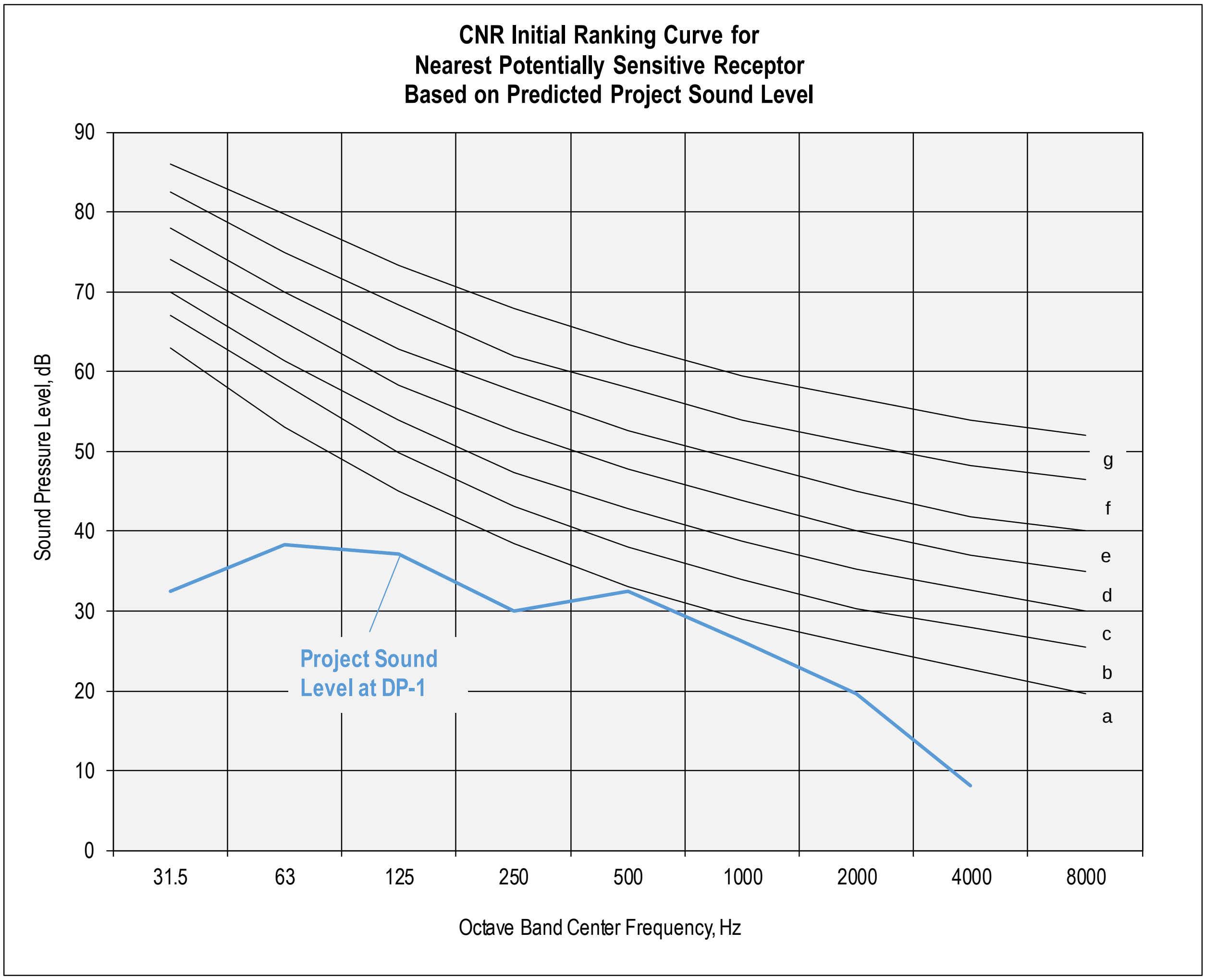

Figure 4.3.2

The initial ranking for this design point is “**a**”.

Starting from this baseline rating classification a series of corrections and adjustments are made to estimate the final classification, which, in turn, gives an indication of the potential community reaction.

The first principal correction is for background masking sound. A second chart of curves is used to determine how well or how poorly the background sound level frequency spectrum would act to mask the project sound level. The highest region intercepted determines the correction factor. Figure 4.3.3 plots the average daytime L90 sound level measured over both the winter and summer surveys at this location, using only the surviving octave bands after ANS-weighting for the summer result.

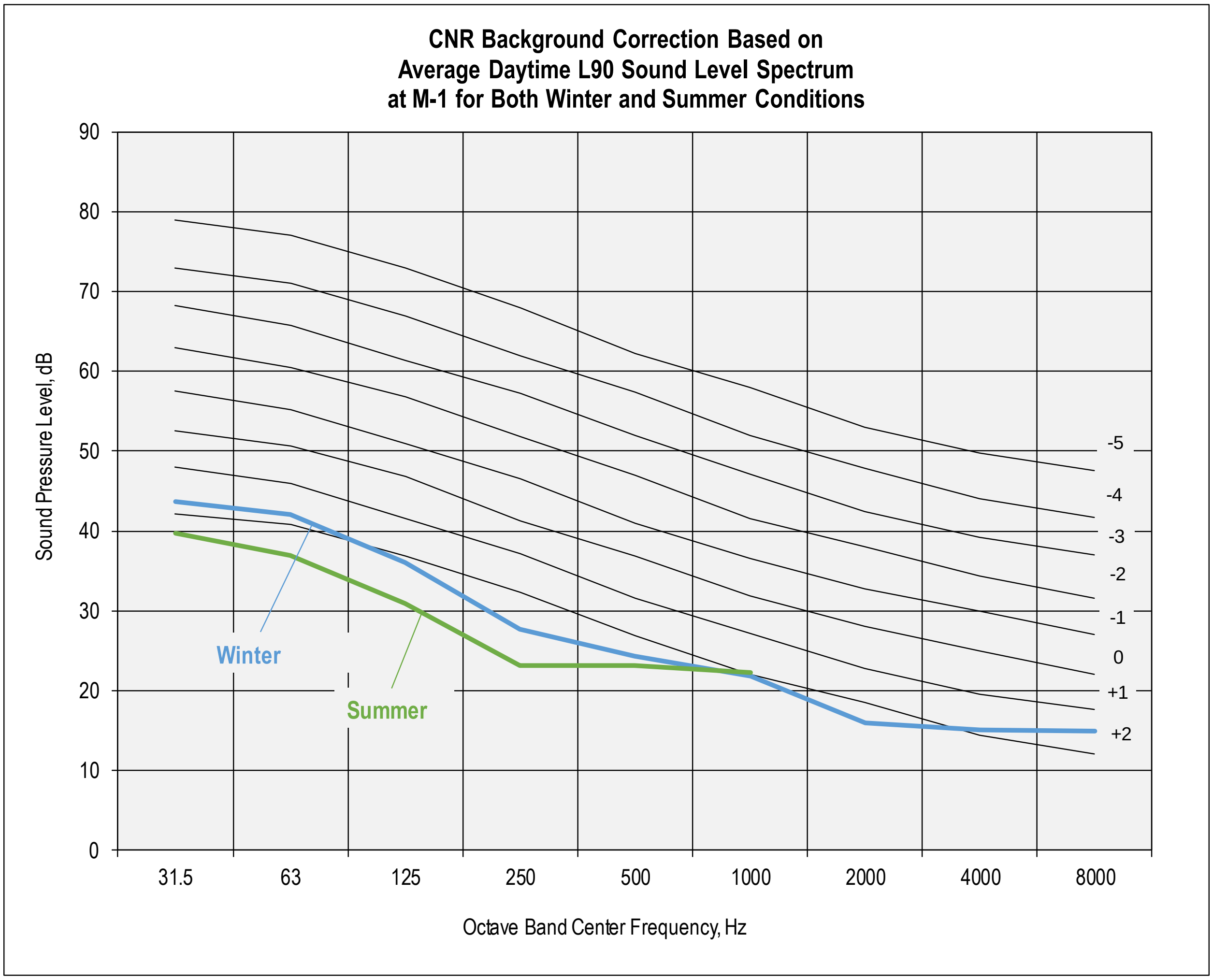

Figure 4.3.3

This chart indicates that the very low background sound level in this area results in a correction of **+2** for both summer and winter conditions.

The remaining corrections to the baseline MCNR rating relate to the temporal nature of the new sound source, its character and the general attitude of observers.

The temporal correction accounts for the duration of the ostensibly intruding sound; i.e. when it occurs (during the day or night) and whether it changes with the seasons. Since the project is only active when the sun is shining, a correction of **-1** for daytime only operation would apply.

Next, a character correction takes into consideration the fact that sounds that contain any kind of tone, impulse or excessive low frequency content are more apt to be considered objectionable than a broadband sound of the same magnitude. In this case, transformers are tonal sound sources, but only at fairly short distances up to about 500 to 700 ft. Since the receptor distance of relevance here is nearly three times that limit at 1850 feet, all the initial tonal character will have dropped out of the signal. Consequently, a tonal penalty would not be realistically applicable in this situation, making this correction **0**.

The final correction factor, ranging from -1 to +1, is associated with previous exposure and attitude as delineated in the following table.

Table 4.3.3.1
MCNR Correction Factors Related to Receptor Attitude

MCNR Correction Factor	Previous Exposure and Attitude
-1	Considerable previous exposure and/or good community relations
0	Some previous exposure and good community relations
+1	No previous exposure or some previous exposure and poor community relations

The general community attitude towards this project is not known but there is no reason to believe that community relations are poor; consequently, the fairest interpretation of this factor seems to be a neutral rating of **0**, despite the fact there has been no previous exposure.

The final MCNR classification for a specific receptor location is determined by applying the net correction to the baseline letter grade. For example, a baseline rating of “c” with a net correction of -1 would result in a final rating of “B”, or one letter below the starting value. In this case the corrections and final ratings for the key design point are summarized below.

Table 4.3.3
Summary of MCNR Correction Factors and Final Ratings

Correction	**DP-1 Winter**	**DP-1 Summer**
Initial Rating based on Model Prediction	**a**	**a**
Background Correction	+2	+2
Temporal/Seasonal Correction	-1	-1
Character Correction	0	0
Exposure and Attitude	0	0
Net Correction	**+1**	**+1**
Final Rating	**B**	**B**

The nominal meaning of these final ratings is given in the chart below.

Table 4.3.4
Final MCNR Ratings and Predicted Reactions

Final MCNR Rating	**Significance**
A	No Reaction
B	No Reaction
C	No Reaction to Sporadic Complaints
D	Sporadic Complaints
E	Widespread Complaints or Single Threat of Legal Action
F	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
G	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
H	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
I	Vigorous Action

The rating of **B** indicates that “no reaction” is anticipated at the nearest potentially sensitive receptor and, by extension, at all more distant receptors, making it unnecessary to tabulate or specifically quantify those levels.

5.0 Sound Emissions from Other Sources

With the possible exception of substations, photovoltaic power projects generate very little environmental sound during normal operation. The only other sound sources of any potential significance are the electrical inverters used to convert locally generated DC current into AC power that is then routed to the substation through underground collector cables. In many cases, this power conversion is accomplished by a small number of fairly large inverters placed on concrete pads within each panel array area. In this case, however, the DC to AC conversion will be implemented by many small string inverters (SMA Sunny Highpower Peak3, data sheet attached), which are essentially small electrical boxes attached to each panel rack. These small-scale inverters then feed AC power to medium/low voltage transformers, called secondary skid units (SSU's), that in turn relay the power to the collector substation.

The sound level produced by the string inverters is not precisely known but is given by the manufacturer as less than 65 dBA at 1 m, which is a similar in magnitude to a normal conversation. Consequently, these components may be neglected as significant sound sources with the potential to affect off site residents hundreds of feet, or more, away.

The SSU transformers are also relatively small and are estimated by the manufacturer, ABB, to generate a near field sound level of only 53 dBA, which may also be considered a negligible sound source. Nevertheless, because the locations of these units appear on the current site plan and because the octave band sound power level can be conservatively estimated from the transformer's 2 MVA rating, their sound emissions have been conservatively calculated in Table T-2096-021419-A. The site-wide sound contours have subsequently been mapped out to 30 dBA in **Plot 1** using Cadna/A® software assuming a mid-range ground absorption coefficient of 0.5. The SSU's are indicated as red dots in the plot and the substation transformer is also included. Even the extremely low 30 dBA sound level contour is so close to each SSU that the individual contour lines can only be seen in the enlarged inset. In no case does the 30 dBA contour reach any homes in the area, whether participating or not, so no adverse impact is anticipated from this equipment. At the nearest non-participating residence to any SSU (DP-5), which is about 360 feet away from a group of three units, a negligible sound level of 26 dBA is predicted. The nearest participant is about 240 feet from a single unit and also has a predicted project sound level of 26 dBA. Such levels would be inconsequential, and most likely inaudible, so no adverse impact is anticipated at any residence regardless of participation status.

During normal operation the facility does not require an operator or any full-time staff, so there clearly wouldn't be any sound impacts from traffic. The site would only be occasionally visited by maintenance personnel.

6.0 Sound Emissions during Construction

In contrast to other forms of power generation, the construction phase of a solar energy facility is remarkably short and the activities that generate any significant sound are few. Where a fossil or wind project would require extensive earthworks and the pouring of massive concrete foundations, a solar plant only involves the installation of the mounting posts for the panel racks. Concrete foundations are not used for the panel arrays. There are two basic methods of erecting the posts:

pile driving or rotating screw bases. If the posts are driven in, it is essentially a small-scale pile driving operation that produces a repetitive, metallic pounding sound, which will be clearly audible for some distance and could cause some unavoidable disturbance. On the other hand, this activity is short-lived and would proceed fairly quickly, only occurring for a period of days to a couple of weeks in any one locality. If the posts are screwed in there might be some local sound from the driving apparatus; however, any community impact is likely to be minimal.

In terms of the more traditional construction phases, the table below gives some representative sound levels from construction equipment at 50 feet[6]. These sound levels might be temporarily produced very close to where the work is occurring.

Table 6.0.1
Typical Construction Equipment Sound Levels per FHWA by Phase

Equipment Description	Typ. Sound Level at 50 ft., dBA	Est. Maximum Total Level at 50 ft. (Property Boundary) per Phase, dBA[1]
Blasting		
n/a		n/a
Earthmoving Road Construction and Electrical Line Trenching		
Dozer	85	85
Front End Loader	80	
Grader	85	
Backhoe	80	
Support Post Installation		
Vermeer PD10 Pile Driver[2]	84	84 (Impulsive for Driven Posts)
Drill Rig Truck	84	84 (Broadband for Screwed Posts)
Truck Traffic Material Delivery		
Flatbed Truck	84	84
Erection Panel Installation		
Mobile Crane	85	85

Note 1: Not all vehicles are likely to be in simultaneous operation. Maximum level represents the highest level realistically likely at any given time.
Note 2: Based on manufacturer's information.

As indicated in the table, no blasting is anticipated for the project. Additionally, there is no need for concrete pouring throughout the solar fields. The base slabs for the SSU's, if needed, will

[6] U. S. Dept. of Transportation, Federal Highway Administration, *Roadway Construction Noise Model User's Guide*, Table 1, Jan. 2006.

likely be precast and dropped in place. Concrete pouring is only likely for the transformer base in the substation. A concrete pump truck typically generates a sound level of about 82 dBA at 50 feet[7], or the boundary of the substation. At the nearest house (Design Point 1) 1850 feet away this sound level would decrease to around 45 dBA and occur only intermittently during the day; most likely only for a day or two.

Construction of the operations and maintenance building located on the south side of Nestle Road near its intersection with County Road 80 will also produce some sound. This sound is likely to be similar in character and duration to the construction of a residence or farm out-building and will be audible from time to time at the nearest houses roughly 500 feet away to the east.

7.0 Conclusions

Two seasonal field surveys of the existing ambient sound levels near the proposed substation and in the general site vicinity of the Mohawk Solar Project have been carried out to establish the baseline environmental conditions. The survey results indicate that the sound levels in the area are extremely quiet with an average daytime L90 sound level of only 29 dBA during winter conditions and 25 dBA during the summer after ANS-weighting was applied to eliminate some high frequency natural sounds observed during that survey. No existing tones were found. In general, these low background levels indicate that the environment will not provide any significant masking of the project's sound emissions.

The sound power level of the step-up transformer associated with the proposed substation was calculated from its expected maximum MVA rating of 110 and its far field sound pressure level frequency spectrum has been mathematically projected to the nearest residence to evaluate any potential sound impact using the Modified Composite Noise Rating (MCNR) methodology. This approach compares the frequency spectra of the existing background level to that of the proposed project to essentially gauge its audibility relative to the natural environmental sound level. Additional adjustments are made for such factors as time of day, tonal content and the community attitude towards to the project. The result of this analysis, which considers the very low existing ambient, is that no adverse reaction is expected from the proposed substation at the closest residence - and at all more distant receptor locations.

Beyond the substation, there will some sound from the small string inverters mounted on the panel racks and a number of small medium/low voltage transformers (SSU's) distributed throughout the solar fields; however, the sound pressure levels from both of these components are minimal, in the 53 to 65 dBA range at 1 m, which essentially makes them negligible (less than 30 dBA) with respect to residences hundreds of feet away. Consequently, no adverse community sound impact is anticipated from this equipment.

[7] Ibid.

In contrast to other forms of power generation, the sound emissions during the construction of this photovoltaic project are expected to be dramatically lower in magnitude and duration. However, some unavoidable disturbance is possible when the mounting posts are driven in, but this activity will be fairly short-lived in any particular location. Some local sound will be generated during the construction of the operations and maintenance building, but it will be generally similar in nature and duration to the construction of a residential home or farm building. Other sounds from trenching and road building will also be brief and will progress from place to place avoiding prolonged exposure at any specific location.

In general, the potential sound impacts from all aspects of the project are expected to extremely minimal.

END OF REPORT TEXT

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

Table: **T-2096-021419-A**
Title: **Substation Transformer and SSU Sound Power Level Deriviations**
Project: **Mohawk Solar**
Revision: **A**
Date: **4/12/19**

Descriptor			Octave Band Center Frequency, Hz 31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
1. Main Step Up Transformer in Collector Substation													
A. Sound Power Level Estimate Based on Max MVA Rating													
Maximum Expected MVA Rating	**110**	MVA										99	
Standard NEMA Rating		NEMA = 55 +12 log (MVA), per EEI Guide*										79	
Size Factor (10 log s) Based on MVA												19	
Frequency Adjustment Factors			-3	3	5	0	0	-6	-11	-16	-23		
Near Field Lp Based on NEMA Rating			76	82	84	79	79	73	68	63	56	**80**	
Max NF Lp with Radiator Fans On per OEM*												**75**	
Nom. Lw = NEMA Rating + 10 log s			**96**	**102**	**104**	**99**	**99**	**93**	**88**	**83**	**76**	**99**	
* Lw Apparently Conservative by at Least 5 dBA													

* Edison Electric Institute, "Electric Power Plant Environmental Noise Guide", 2nd Ed., BBN, 1984.

B. Calculated Sound Pressure at Nearest Residence, DP-1			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
Path Attenuation:													
Source Receiver Distance	**564**	m		**1850** ft.									
Hemispherical Distance Loss, m	564		-63	-63	-63	-63	-63	-63	-63	-63	-63		
Air Absorption (10°C / 70%RH), m	564		0	0	0	-1	-1	-2	-5	-11	-29		
Anomalous Attenuation, m	0		0	0	0	0	0	0	0	0	0		
Number of Sources	1		0	0	0	0	0	0	0	0	0		
Ground Attenuation per ISO 9613-2	Ag = 0.5		0	0	-3	-5	-2	-1	0	0	0		
Sum of Path Attenuation:			-63	-63	-66	-69	-66	-66	-68	-74	-92		
Calc. Receptor Lp			**32**	**38**	**37**	**30**	**32**	**26**	**20**	**8**	**-17**	**32**	

2. Secondary Skid Units (SSU's) Medium to Low Voltage Transformers			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
A. Sound Power Level Estimate Based on Max MVA Rating													
Maximum Expected MVA Rating	**2**	MVA										73	
Standard NEMA Rating		NEMA = 55 +12 log (MVA), per EEI Guide*										59	
Size Factor (10 log s) Based on MVA												15	
Frequency Adjustment Factors			-3	3	5	0	0	-6	-11	-16	-23		
Near Field Lp Based on NEMA Rating			56	62	64	59	59	53	48	43	36	**59**	
Max NF Lp per ABB*												**53**	
Nom. Lw = NEMA Rating + 10 log s			**70**	**76**	**78**	**73**	**73**	**67**	**62**	**57**	**50**	**74**	
* Lw Apparently Conservative by at Least 6 dBA													

* Edison Electric Institute, "Electric Power Plant Environmental Noise Guide", 2nd Ed., BBN, 1984.

Notes:
Lp = Sound Pressure Level, dB re 20 μPa
Lw = Sound Power Level, dB re 1 pW

SHP 125-US-20 / SHP 150-US-20

Cost effective

- Modular architecture reduces BOS and maximizes system uptime
- Compact design and high power density maximize transportation and logistical efficiency

Maximum flexibility

- Scalable 1,500 VDC building block with best-in-class performance
- Flexible architecture creates scalability while maximizing land usage

Simple install, commissioning

- Ergonomic handling and simple connections enable quick installation
- Centralized commissioning and control with SMA Data Manager

Highly innovative

- SMA Smart Connected reduces O&M costs and simplifies field-service
- Powered by award winning ennexOS cross sector energy management platform

SUNNY HIGHPOWER PEAK3 125-US / 150-US

A superior modular solution for utility power plants

The new Sunny Highpower PEAK3 is SMA's latest addition to a comprehensive portfolio of utility solutions. This 1,500 VDC inverter offers high power density in a modular architecture that achieves a cost-optimized solution for utility-scale PV integrators. With fast, simple installation and commissioning, the Sunny Highpower PEAK3 is accelerating the path to energization. SMA has also brought its field-proven Smart Connected technology to the PEAK3, which simplifies O&M and contributes to lower lifetime service costs. The PEAK3 utility system solution is powered by the ennexOS cross sector energy management platform, 2018 winner of the Intersolar smarter E AWARD.

Technical Data *	Sunny Highpower PEAK3 125-US	Sunny Highpower PEAK3 150-US
Input (DC)		
Maximum array power	187500 Wp STC	225000 Wp STC
Maximum system voltage	1500 VDC	
MPP voltage range	710 V ... 1425 V	855 V ... 1425 V
MPP trackers	1	
Maximum operating input current	180 A	
Maximum input short-circuit current	325 A	
Output (AC)		
Nominal AC power	125000 W	150000 W
Maximum apparent power	125000 VA	150000 VA
Output phases / line connections	3 / 3-PE	
Nominal AC voltage	480 V	600 V
Compatible transformer winding configuration	Wye-grounded	
Maximum output current	151 A	
Rated grid frequency	60 Hz	
Grid frequency / range	50 Hz, 60 Hz / -6 Hz ... +6 Hz	
Power factor at rated power / adjustable displacement	1 / 0.0 leading ... 0.0 lagging	
Harmonics (THD)	<3%	
Efficiency		
CEC efficiency (preliminary)	98.5 %	98.5 %
Protection and safety features		
Ground fault monitoring: Riso / Differential current	● / ●	
DC reverse polarity protection	●	
AC short circuit protection	●	
Monitored surge protection (Type 2): DC / AC	● / ●	
Protection class / overvoltage category (as per UL 840)	I / IV	
General data		
Device dimensions (W / H / D)	770 / 830 / 444 mm (30.3 / 32.7 / 17.5 in.)	
Device weight	85 kg (185 lbs)	
Operating temperature range	-25°C ... +60°C (-13°F ... +140°F)	
Storage temperature range	-40°C ... +70°C (-40°F ... +158°F)	
Audible noise emission (full power @ 1m and 25°C)	< 65 dB(A)	
Internal consumption at night	< 5 W	
Topology	Transformerless	
Cooling concept	OptiCool (forced convection, variable speed fans)	
Enclosure protection rating	Type 4X (as per UL 50E)	
Maximum permissible relative humidity (non-condensing)	100%	
Additional information		
Mounting	Rack mount	
DC connection	Terminal lugs - up to 600 kcmil CU/AL	
AC connection	Screw terminals - up to 300 kcmil CU/AL	
LED indicators (Status/Fault/Communication)	●	
SMA Speedwire (Ethernet network interface)	● (2 x RJ45 ports)	
Data protocols: SMA Modbus / SunSpec Modbus / Webconnect	● / ● / ●	
OptiTrac Global Peak (shade tolerant MPP tracking)	●	
PID Mitigation Solution	○	
Integrated Plant Control / Q on Demand 24/7	● / ●	
Off-grid capable / SMA Fuel Save Controller compatible	● / ●	
SMA Smart Connected (proactive monitoring and service)	●	
Certifications (pending as of June 2018)		
Certifications and approvals	UL 1741, UL 1998, IEEE 1547, CAN/CSA-C22.2 No.62109	
FCC compliance	FCC Part 15, Class A	
Grid interconnection standards	UL 1741 SA - CA Rule 21, HECO Rule 14H, PRC-024-02	
Advanced grid support capabilities	L/HFRT, L/HVRT, Volt-VAr, Volt-Watt, Frequency-Watt, Ramp Rate Control, Fixed Power Factor	
Warranty		
Standard	5 years	
Optional extensions	10 / 15 / 20 years	
Type designation	SHP 125-US-20	SHP 150-US-20

* Preliminary data as of June 2018 ● Standard features ○ Optional features

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SMA America, LLC

Technical data sheet

Secondary Skid Unit (SSU)
Solar Power Collection application

Secondary Skid Unit (SSU)

A Secondary Skid Unit (SSU) is an assembly comprising of MV switchgear and a transformer packaged for power collection in solar generating plants. The SSU is the power collection unit which converts the solar energy generated by the solar panels into a usable grid voltage. The SSU is a plug-and-play solution usually installed as close to the solar strings as possible, enabling solar power to be easily and rapidly connected to the electrical grid.

Features

- Simple and quick installation – pre-test units at the factory, drop in place and connect cables
- Pre-engineered products to reduce time to quote and supply, while reducing risks
- Engineered for efficient cooling in order to extend the life of the equipment
- All ABB designs are green to support the environment
- No exposed live parts, more safe for operator and personnel
- SCADA ready
- All equipment contained in the solar modules are type tested according to their relevant standards
- Easy access to equipment for visual inspection and service
- Open-air cooling for maximum efficiency
- Compact and easily transportable
- Economic solution
- Locking system for MV compartment to prevent unauthorized entry

Transformer

The SSU is designed and manufactured to be installed with liquid filled or dry type transformers. The transformer can be provided with alarm and trip contacts for temperature and gas pressure.

Medium voltage

The SSU can be provided with different options of medium voltage switchgear from ABB's SF6 or air insulated switchgear portfolio. The MV switchgear can be provided with SF6 gas alarm, switch position contacts, plug-in MV surge arresters or auto reclosing functions.

Low voltage

The low voltage protection is included in the inverter equipment. LV cables are directly connected to the transformer LV bushing.

Smart Grid

- Smart grid ready for easy connection to any SCADA system through any standard communication protocols
- Remote Terminal Unit (RTU) to monitor the SSU and store data for operation, maintenance and fault analysis
- Local and remote monitoring commands available
- Smart grid compatibility provides supervision and operation of substations from a central office by utilizing end user communication and infrastructure and ABB Station automation device

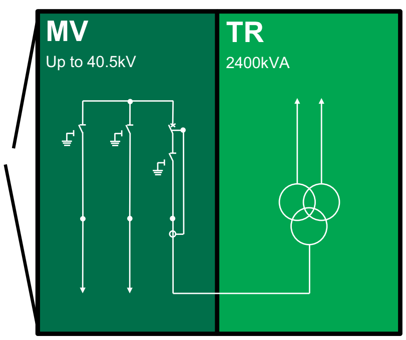
Pre-engineered solution technical data

Pre-designed solutions are available for optimized designs and quicker delivery. Power ratings are aligned with the most common inverter power ratings. The solutions are equipped with medium voltage switchgear SafeRing CCV configuration (cable loop with breaker and relay protection). The transformer includes standard integrated protection for pressure and gas (RIS). Product datasheets are available with an overview of other options available. Pre-designed solutions for Power Collection are shown below:

Style number	SSU-S-1510-0CCV-4000	SSU-S-2410-0CCV-3000	SSU-S-2410-0CCV-4000	SSU-S-2410-0CCV-2000
Enclosure type	Skid	Skid	Skid	Skid
Overall parameters				
Length x Width x Height, mm	3400 x 2550 x 2800	3400 x 2550 x 2800	3400 x 2550 x 2800	3400 x 2550 x 2800
Approximate weight (metric tons)	8	9.5	9	9
MV switchgear				
Switchgear type	SafeRing CCV	SafeRing CCV	SafeRing CCV	SafeRing CCV
Protection Relay	REJ603	REJ603	REJ603	REJ603
Transformer				
Transformer type	oil immersed	oil immersed	oil immersed	oil immersed
Power rating, kVA	1500	2400	2400	2400
LV Voltage level, V	300 to 400	300 to 400	300 to 400	300 to 400
MV Voltage level, kV max	13.8	40.5	13.8	24
Standard protection	RIS	RIS	RIS	RIS

1VPD110001A0331 Rev A January 2016

Single line diagram/layout (without inverter)



General technical data

Nominal output voltage range	6 kV to 40.5 kV
Ambient temperature range	-25 °C to +40 °C
Relative humidity, non-condensing	95%
Max altitude above sea level w/out derating	1000m
Corrosion class (ISO 12944-2)	C5M
IP rating	IP44

For more information please contact:

E-Mail: get.ph@ph.abb.com

www.abb.com/mediumvoltage
www.abb.com/medium-voltage/by-customer-segment/solar

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Project:		Description:	Legend:
Mohawk Solar		**Plot 1**	Residence
Prepared for:			Project Property
Avangrid Renewables		**Predicted Sound Contours (dBA) of Facility in Full Operation Plotted to 30 dBA**	30 dBA Contour
Date: April 12, 2019	Drawing #: MO-Rev-B-1-1		