URBAN SOLUTION GROUP

Noise Impact Assessment

Litchfield Solar Project
Litchfield County, CT

Prepared for:

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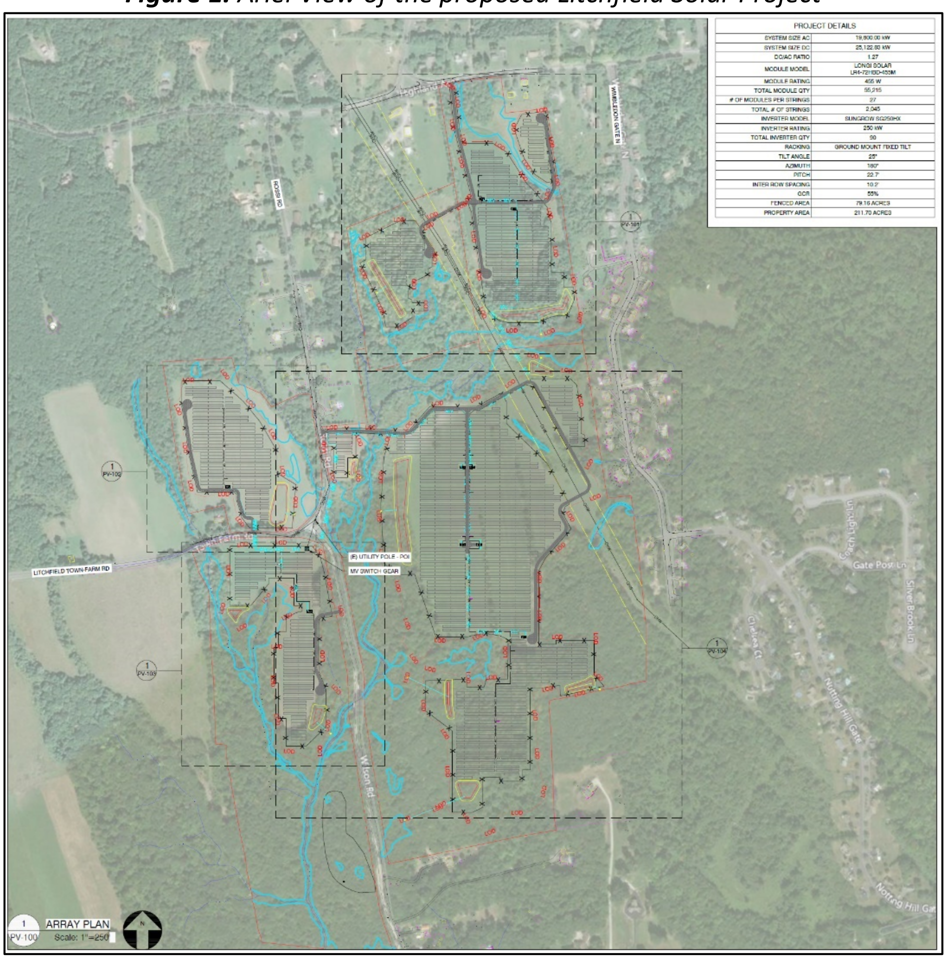
1. Executive Summary

Urban Solution Group, LLC (Urban) was commissioned to prepare a Noise Impact Assessment (NIA) report for the proposed Litchfield Solar Project to be operated by Silicon Ranch Corporation (SRC). SRC is proposing to install ground-based solar panels accompanied with ninety (90) power invertors and nine (9) transformers at the Litchfield Solar Project located in Litchfield County, Connecticut. The purpose of this report was to assess predicted environmental noise impact from the proposed operations on the surrounding environment. The results of this assessment will compare the predicted levels of the Litchfield Solar Project to the permissible noise level limits allowed by the Connecticut Department of Energy and Environmental Protection (CTDEEP) for residential areas.

Location Coordinates:	41.794157°N, 73.168028°W
Regulation Noise Target:	CTDEEP – Zone A – Daytime dBA Limit

Figure 1. *Ariel View of the proposed Litchfield Solar Project*



(Executive Summary Continued)

This assessment modeled 35 receivers for the surrounding residences located around the proposed Litchfield Solar Project. Sound sources are assumed to operate only during the day when electricity is produced by the solar panels. The results of the NIA indicate predicted noise levels for the proposed operations are expected to comply with the daytime permissible noise levels of 55 dBA for residential areas set by CTDEEP. Receiver R24 is expected to be the most impacted receiver with a noise level of 44.1 dBA from the operations. Below is a summary of the results for all 35 receivers.

Predicted Sound Levels – SRC Litchfield Solar Project

Receptor	Sound Level (dBA)	Permissible Sound Level (dBA)	Predicted to meet Compliance
R1	38.0	55.0	Yes
R2	37.4	55.0	Yes
R3	34.7	55.0	Yes
R4	35.5	55.0	Yes
R5	34.9	55.0	Yes
R6	33.4	55.0	Yes
R7	33.8	55.0	Yes
R8	33.6	55.0	Yes
R9	34.3	55.0	Yes
R10	37.5	55.0	Yes
R11	37.1	55.0	Yes
R12	35.4	55.0	Yes
R13	36.1	55.0	Yes
R14	37.7	55.0	Yes
R15	35.5	55.0	Yes
R16	32.5	55.0	Yes
R17	30.5	55.0	Yes
R18	29.2	55.0	Yes
R19	27.0	55.0	Yes
R20	26.3	55.0	Yes
R21	35.5	55.0	Yes
R22	34.9	55.0	Yes
R23	35.6	55.0	Yes
R24	44.1	55.0	Yes
R25	43.5	55.0	Yes
R26	41.8	55.0	Yes
R27	40.4	55.0	Yes
R28	42.4	55.0	Yes
R29	40.8	55.0	Yes
R30	38.4	55.0	Yes
R31	38.9	55.0	Yes
R32	36.4	55.0	Yes
R33	35.2	55.0	Yes
R34	37.3	55.0	Yes
R35	38.2	55.0	Yes

2. Regulations and Noise Standards Summary

The maximum permissible noise levels described in this report are governed by Connecticut Department of Energy and Environmental Protection Agency (CTDEEP) and are found in Connecticut General Statutes and Regulations of Connecticut State Agencies Sections 22a-69-1 through 22a-69-7.4 [1]. In Section 22a-69-3.5, for residential zones (Class A Zone), CTDEEP states, "No person in a Class A Noise Zone shall emit noise exceeding the levels stated" in Table 1.

Section 22a-69-3.5 outlines maximum permissible noise levels for each zone:

The below table provides the noise limits described in Sections 22a-69-3.5 and is provided for reference:

Table 1. *CTDEEP Zone and Designated Noise limits*

ZONE	Daytime (7:00 a.m. – 10:00 p.m.)	Nighttime (10:00 p.m. – 7:00 a.m.)
Zone A	55 dB(A)	45 dB(A)
Zone B	55 dB(A)	45 dB(A)
Zone C	61 dB(A)	51 dB(A)

3. Methodology and Approach

This NIA was conducted using three-dimensional computer noise modeling software. All models and predicted noise levels generated for this report were developed with Predictor V2020 software using the ISO 9613-1/2 standard [2]. This ISO standard is ±3 dBA for distances of 328 feet (100 meters) to 3280 feet (1,000 meters). The algorithms used in the software are based on methods and theory that are accepted in the acoustics community. Actual field measurements may vary from modeled noise levels due to environmental factors and other noise sources. Table 2 lists the conditions used in the model.

Table 2. *Conditions used in Predictor V2020 software*

Parameter	Modeled Input
Temperature	65°F
Topography	USGS TNM – 3.3 feet (1 meter) Resolution
Wind Velocity	2.2 to 11.2 mph – ISO 9613 uses a slight downwind condition from each noise source to each receiver.
Wind Direction	From the noise source to the receiver points
Relative Humidity	70%
Ground Absorption	0.0 for water bodies and roads 0.5 for everywhere else

The solar project is assumed to be operating only during the daytime, since the facility will produce little to no energy during the nighttime. During the nighttime, there is little to no irradiance, meaning the noise emitted by the equipment is significantly reduced. The predicted noise levels generated in this report are from daytime operations while the facility is producing maximum electrical power from the Litchfield Solar Project. Pre-existing sound sources such as those from animals, weather, road traffic, and all other ambient sounds are not included in the noise model. Actual field measurements may vary from modeled noise levels due to environmental factors and other noise sources.

The Sound Power Levels (PWL) used in the model were determined for the significant noise sources through manufacturer's data and theoretical calculations. The Litchfield Solar Project will house 90 invertors and nine (9) transformers. PWL for the 250 kW inverter was obtained from manufacturer data and noise tests for the 250 kW inverter [3]. Sound data for the 3750 kVA transformer was calculated based on reference sound data for the transformer [4] and methods used in the ANSI IEEE C57.12.90 standard [5]. Table 3 below shows the calculated PWL for the 3750 kVA transformer and 250 kW inverter used in the model.

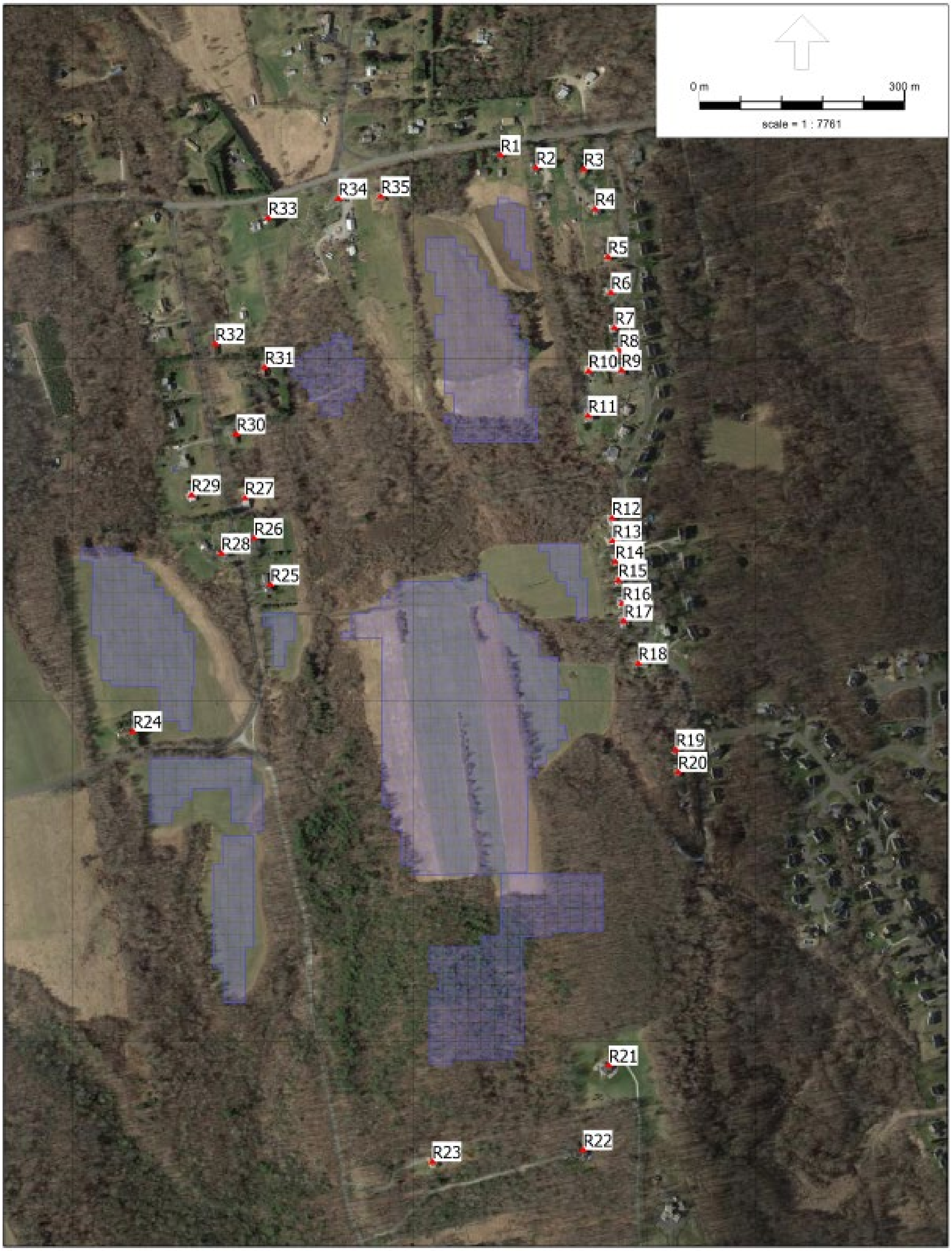
Table 3. *Source Octave Band Sound Power Levels (PWL)*

Source	Linear Octave Band Center Frequency (dB)									Overall (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
3750 kVA Transformer	65.1	71.1	73.1	68.1	68.1	62.1	57.1	52.1	45.1	68.5
250 kW Inverter	79.5	76.3	75.6	81.5	80.1	78.8	73.8	68.6	61.9	82.7

4. Site Information

The proposed Litchfield Solar Project will be located in a residential area near Torrington, CT. The coordinates for the location are 41.794157°N, 73.168028°W. Noise receptor points were located at 35 of the closest residences around the solar project. Figure 2 below shows key receptor points and an aerial of the proposed Litchfield Solar Project. Noise levels at these receptor points must be below 55 dBA noise levels. The blue shaded areas in the image below represent the areas where the solar panels will be placed along with noise emitting equipment.

***Figure 2**. Key Receiver Locations for the Litchfield Solar Project*



5. Noise Modeling Results

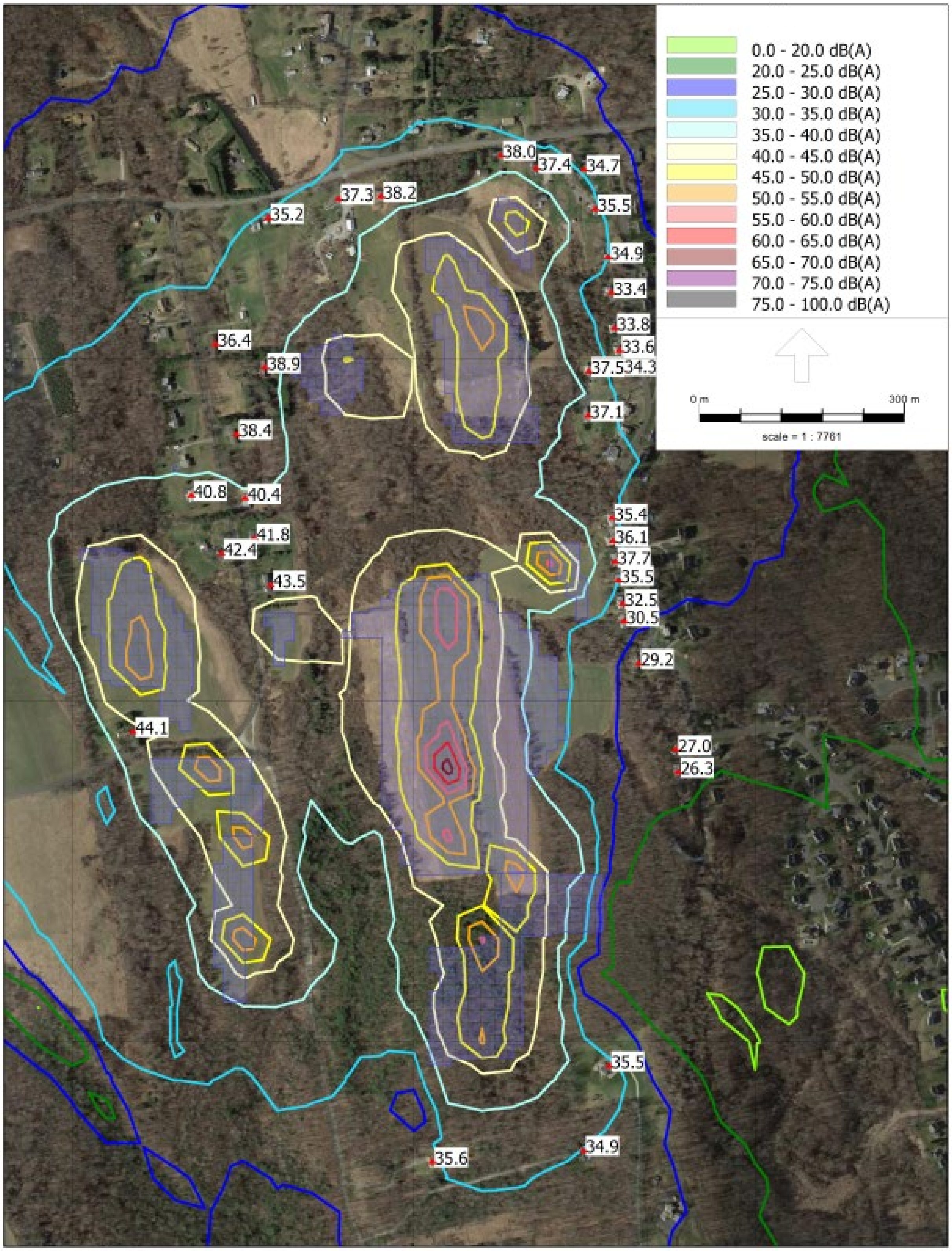
Predicted sound levels from the proposed Litchfield Solar Project, when it's producing maximum electrical power, were calculated using Predictor V2020 software. Predicted noise levels for each receiver are listed in Table 4. The receptor locations in the tables correspond to the locations identified in Figure 2. Predicted noise levels for nearby residences range from 26.6 dBA to 44.1 dBA, with all of the receivers predicted to be below the maximum permissible noise level of 55 dBA set by CTDEEP. Receiver R24 is to be the most impacted receiver, with a noise level of 44.1 dBA. The predictive impact assessment demonstrates that noise mitigation measures are not required to achieve compliance.

The results for the noise modeling are shown as noise contour maps. Figure 3 shows the noise contour map results for the Litchfield Solar Project. The contours are provided in 5 dB increments with the color scale indicating the sound level of each color. The predicted levels only include sound levels from the Litchfield Solar Project and do not include ambient noise or noise contribution from other sources outside of the expected operations. Actual field measurements may vary to predicted levels due to varying noise sources outside of the solar project.

Table 4. *Sound Levels from the SRC Litchfield Solar Project during Maximum Electrical Power Output*

Receptor	Sound Level (dBA)	Permissible Sound Level (dBA)	Predicted to meet Compliance
R1	38.0	55.0	Yes
R2	37.4	55.0	Yes
R3	34.7	55.0	Yes
R4	35.5	55.0	Yes
R5	34.9	55.0	Yes
R6	33.4	55.0	Yes
R7	33.8	55.0	Yes
R8	33.6	55.0	Yes
R9	34.3	55.0	Yes
R10	37.5	55.0	Yes
R11	37.1	55.0	Yes
R12	35.4	55.0	Yes
R13	36.1	55.0	Yes
R14	37.7	55.0	Yes
R15	35.5	55.0	Yes
R16	32.5	55.0	Yes
R17	30.5	55.0	Yes
R18	29.2	55.0	Yes
R19	27.0	55.0	Yes
R20	26.3	55.0	Yes
R21	35.5	55.0	Yes
R22	34.9	55.0	Yes
R23	35.6	55.0	Yes
R24	44.1	55.0	Yes
R25	43.5	55.0	Yes
R26	41.8	55.0	Yes
R27	40.4	55.0	Yes
R28	42.4	55.0	Yes
R29	40.8	55.0	Yes
R30	38.4	55.0	Yes
R31	38.9	55.0	Yes
R32	36.4	55.0	Yes
R33	35.2	55.0	Yes
R34	37.3	55.0	Yes
R35	38.2	55.0	Yes

Figure 3. *Expected Sound Levels of the Litchfield Solar Project at Maximum Power Output*



6. Conclusion

The results of the noise modeling indicate that noise levels generated by the SRC's proposed Litchfield Solar Project is predicted to comply with daytime permissible noise levels of 55 dBA for residential areas required by CTDEEP. The impact assessment demonstrates that noise mitigation measures are not required, as the proposed operations are expected to be in compliance.

7. Notations

The services provided for this project were performed in accordance with generally accepted professional consulting services. No warranty, expressed or implied, is made or intended by rendition for these consulting services or by furnishing oral or written reports of the findings made. Urban Solution Group generated this report for the exclusive use by Silicon Ranch Corporation.

8. References

[1] Connecticut General Statutes and Regulations of Connecticut State Agencies. Sections 22a-69-1 to 22a-69-7.4.

[2] International Standard. (n.d.). ISO 9613 Acoustics - Attenuation of sound during propagation outdoors.

[3] Sungrow Power Supply Co., Ltd. (2020). Noise Test Report: SG250HX Three Phase Grid-connected PV Inverter.

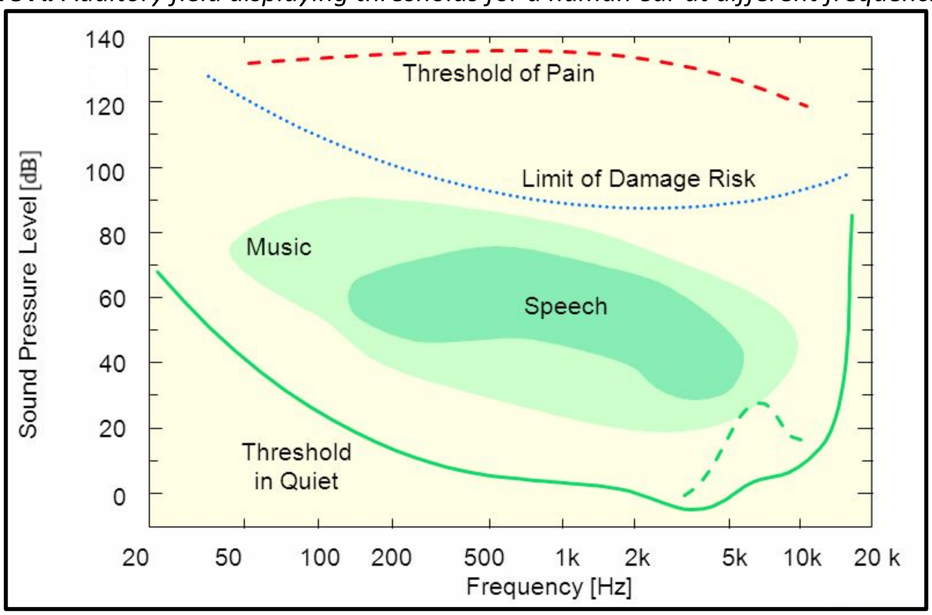
[4] Cooper Power Systems. (2008). Audible Sound Level Test: 3750 KVA, Wound Core, Natural Air Cooled, 15712 Nominal Gauss Three Phase Substation Transformer.

[5] American National Standards Institute, ANSI. IEEE C57.12.90 (2015). Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

Appendix 1 – Sound Fundamentals

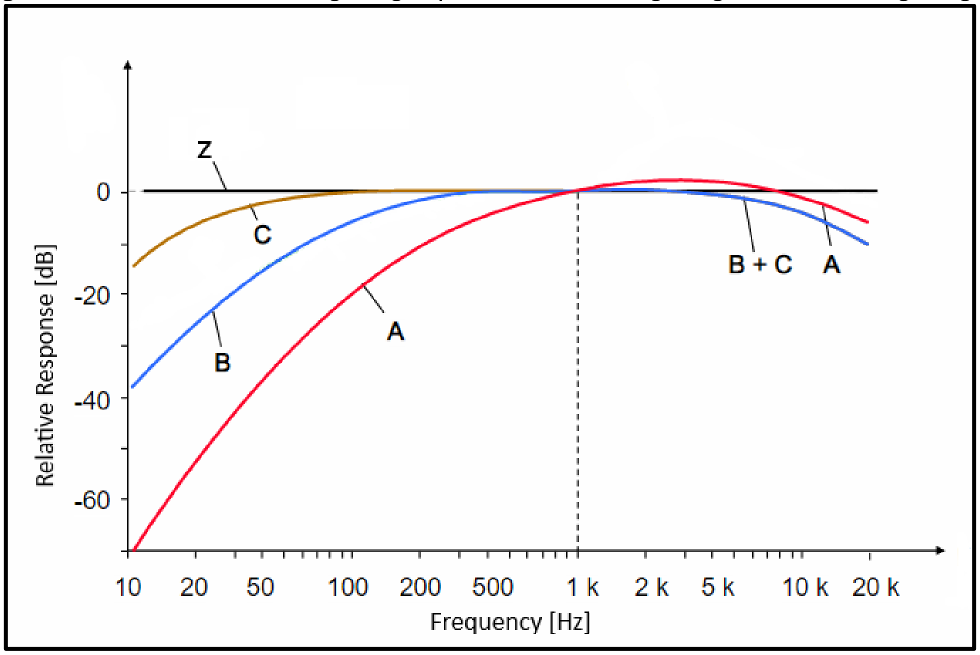
Sound is a series of vibrations transmitted through the air, or other medium, and can be heard when they are processed by the human ear. There are two important properties that describe sound; frequency and amplitude. Frequency is determined by the rate of movement and is measured in cycles per second, which is known as Hertz (Hz). A healthy human ear can hear 20 Hz – 20,000 Hz (Figure A). The sensation associated with frequency is commonly referred to as the pitch of a sound. High frequencies produce a higher pitch and vice versa. The amplitude of a sound is determined by the maximum displacement of air molecules produced by the vibrations. These displacements lead to pressure fluctuations in air, which are expressed in decibels (dB). Decibels are a logarithmic ratio of sound pressure over the standard threshold of hearing. The more energy a sound has, the larger the pressure fluctuations, resulting in a louder sound.

Figure A. *Auditory field displaying thresholds for a human ear at different frequencies [1]*



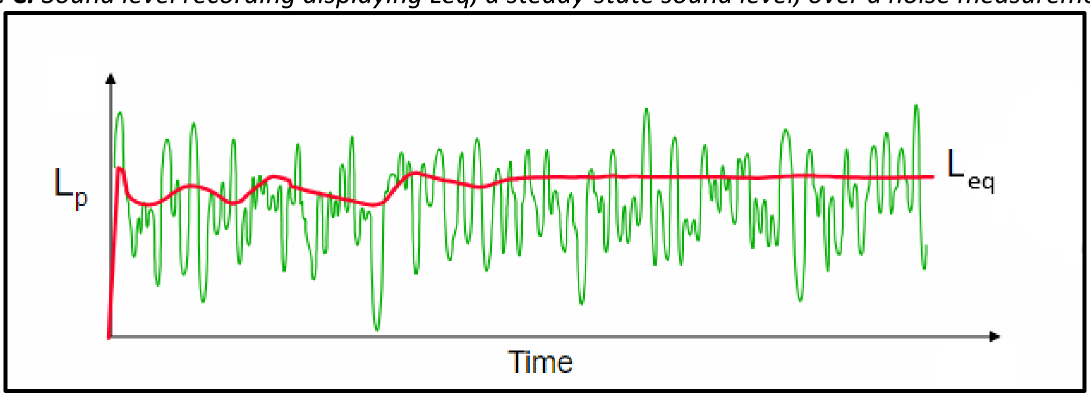
Frequency weightings are applied to measurements to provide a better match between measured results and human perception. Each weighting, in relation to their frequency components, allows for a consistent measurement of the different type of noise sources. A-weighted decibel sound pressure levels (dBA) are measurements recorded from a sound level meter measuring sounds similar to the response of the ear (Figure B). While C-weighted (dBC) measurements are for low-frequency components.

Figure B. *Common sound weightings up to 20 kHz, Z-weighting means no weighting [1]*



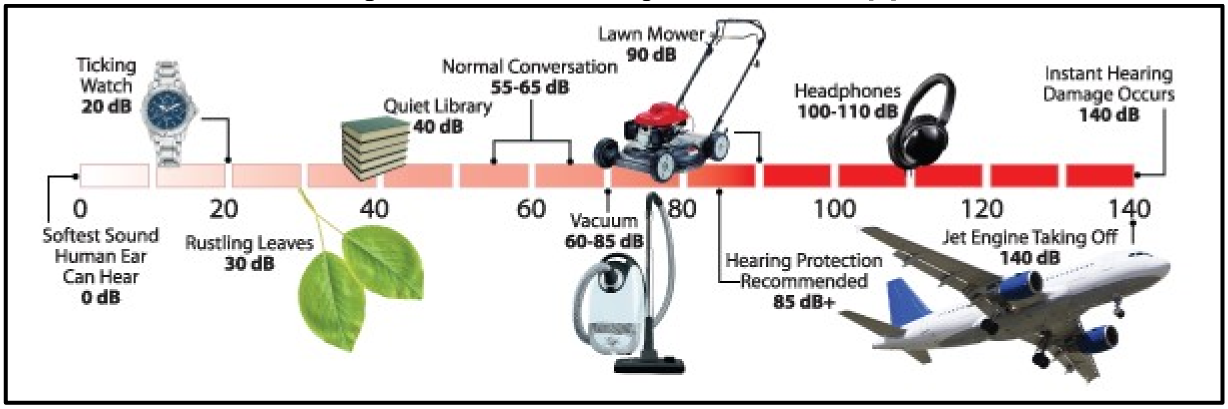
Each measurement has an exponential time factor. Slow time weighting is the most common for environmental noise measurements and will be used for these measurements. For recording over long periods of time, the sound level meter records each weighted decibel reading with an equivalent, or average, continuous sound level reading (Leq). Leq represents the same energy as the actual time varying sound signal (Figure C). LAeq refers to the equivalent continuous sound level for an A-weighted measurement.

Figure C. *Sound level recording displaying Leq, a steady-state sound level, over a noise measurement [1]*



Environmental noise is a combination of various noise sources. These sources may include; vehicle traffic, aircraft flyovers, wind, weather disturbances, commercial or industrial activities, and other short-term events. These sources create “background noise”. Background noise varies throughout the day, generally following the cycle of human activity. Figure D presents typical A-weighted (dBA) sound levels for multiple sources of sound.

Figure D. *Common A-weighted sound levels [2]*



Appendix 2 – Glossary

Ambient Noise

All noises that exist in an area and are not related to facility. Ambient noise includes sound from other industrial noise not subject to this directive, transportation sources, animals and nature.

Average Sound Level

See Energy Equivalent Sound Level.

A-weighted sound level

The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear.

Calibration

A procedure used for the adjustment of a sound level meter using a reference source of a known sound pressure level and frequency. Calibration must take place before and after the sound level measurements.

Day Night Sound Level (Ldn)

Is the average noise level over a 24-hour period. The noise between the hours of 22:00 and 07:00 is artificially increased by 10 dB. The nighttime noise is weighted to consider the decrease in community background noise.

Daytime Average Sound Level

The time-averaged A-weighted sound level measured between the daytime hours, which are usually 7:00 am to 7:00 pm (7:00 am to 9:00 pm for Weld County Code).

Decibel (dB)

A unit of measure of sound pressure that compresses a large range of numbers into a more meaningful scale. The basic unit of measurement for sound levels.

dBA

The decibel (dB) sound pressure level filtered through the A filtering network to approximate human hearing response. See dB and A-weighted Sound Level.

Energy Equivalent Sound Level (L_{eq})

The Leq is a single-number average, sound level that represents cumulative acoustical energy as measured over a specified time interval.

Facility

Any operation used in exploration, processing, development and transportation of energy resources.

Frequency
The number of oscillations per second for a sound wave.

Impulse Noise
Unwanted, instantaneous sharp sounds that create sudden impulses of pressure similar to gunfire and explosions.

Noise Reduction
The difference in sound pressure level between two points

Ldn
See Day night sound level.

L_{eq}
See Energy Equivalent Sound Level.

Noise
Generally understood as unwanted sound.

Noise Impact Assessment (NIA)
Identifies the expected sound level emanating from operations and receptor points are placed in locations related to compliance. It also identifies what the permissible sound level is and how it was calculated.

Noise Reduction Coefficient (NRC)
A single number rating of the sound absorption properties for a material. An NRC value of zero indicates the material is purely reflective. An NRC value of one indicates perfect absorption.

Octave
A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. The octave band has a center frequency that is double the center frequency of the octave band preceding it.

Point Source
A source that radiates sound from a single point. Generally used to model equipment when looking at the sound impact over a large area.

Receiver
A person or piece of equipment that is affected by noise.

Sound
A series of vibrations transmitted through the air, or other medium, and can be heard when they are processed by the human ear.

Sound Level Meter (SLM)

An instrument that contains a microphone and filter used to measure sound levels, using standard frequency-weightings and exponentially weighted time averaging.

Sound Power Level

A physical measurement of the amount of power a sound source radiates into the surrounding air. It is the rate at which sound energy is emitted, or received, per unit time.

Sound Transmission Class (STC)

An integer rating that measures how well a barrier or building partition attenuates sound. Indicates how well a barrier is at stopping sound from transmitting through it.

1/3 Octave

The 1/3 octave band analysis provides a finer breakdown of sound distribution as a function of frequency.