September 20, 2024

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Subject: ***Big Timber Solar Farm LLC – Sound Study***
Kane County, Illinois

Executive Summary

The purpose of this technical memorandum is to summarize the evaluated sound levels associated with the operational equipment that will be located at the proposed Big Timber Solar Farm LLC Solar Site in Kane County, IL. The proposed solar photovoltaic project site is less than a mile west of Gilberts, approximately 1.5 miles southeast of Huntley, and 2.5 miles east of Hampshire. The site is generally located south of Higgins Road (IL Route 72), east of Big Timber Road (County Road 21), and southwest of Jane Addams Memorial Tollway (I-90). Additionally, Union Pacific (UP) railroad tracks are located approximately 1 mile east of the project site. The solar site will be located on agricultural land with residences north, west, and south of the project area. The location of the proposed Big Timber Solar Farm LLC Solar Site is shown in **Figure 1**.

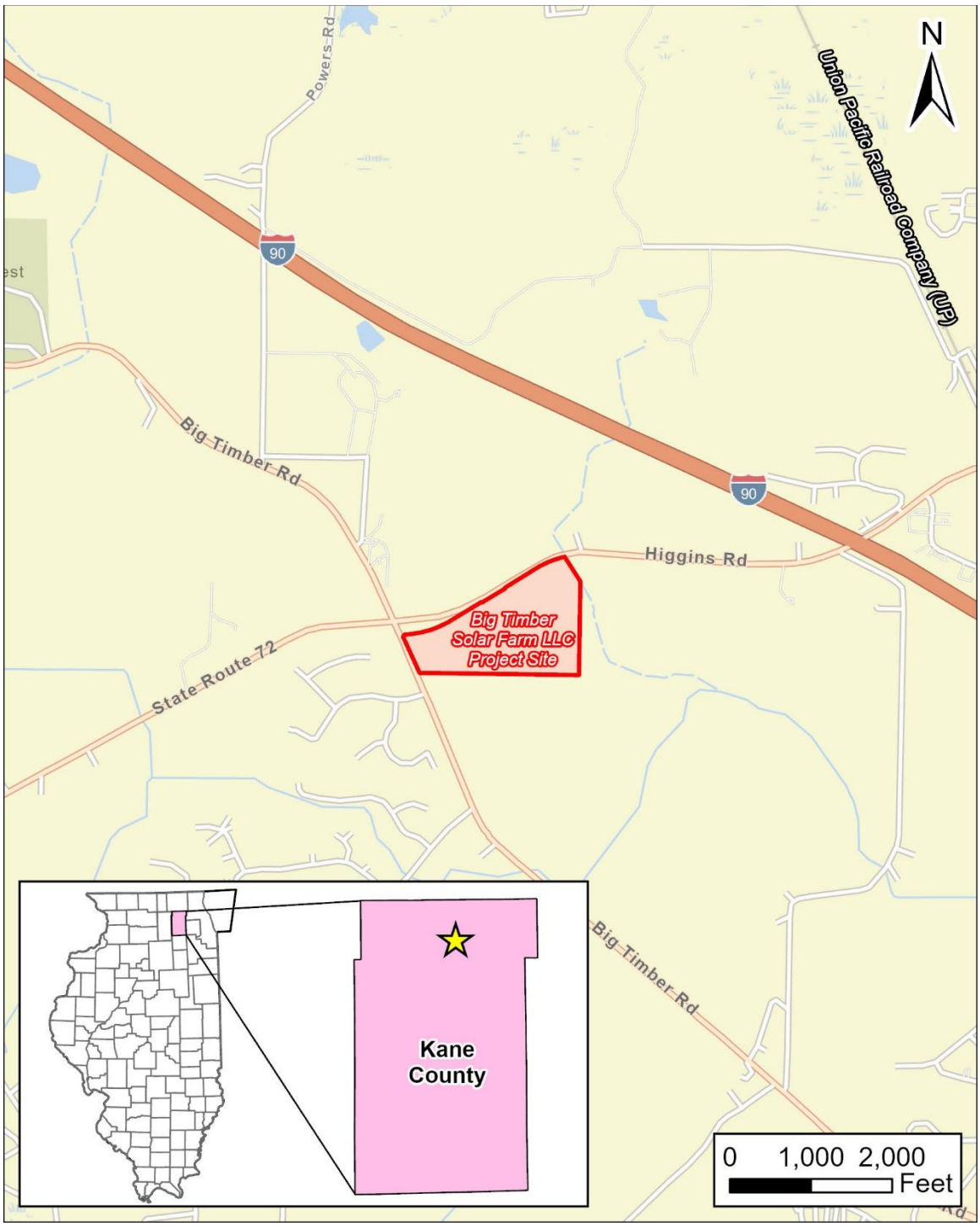
Analysis Findings

- *The solar photovoltaic project will be located on agricultural land with residential land uses north, west, and south of the project area. The Illinois Pollution Control Board (IPCB) noise regulations are based on allowable octave band sound pressure levels that vary depending on the category of land the noise is generated from and the category of land the noise is received at. Modeled operational octave band sound pressure levels at surrounding Class A property boundaries (i.e., residences) are anticipated to remain below the limits established by IPCB; therefore, noise mitigation is not recommended at this time.*

Project Description

The proposed Big Timber Solar Farm LLC Solar Site will be developed on an approximately 47-acre parcel of agricultural land within an unincorporated portion of Kane County, IL. The solar site will consist of solar arrays throughout the project area with two (2) equipment pads located near the southern edge of the site, containing up to forty (40) string inverters, with twenty (20) string inverters on each equipment pad, one (1) 3,500 kilo-volt-ampere (kVA) transformer, and one (1) 2,000 kVA transformer.

Figure 1: Site Location and Vicinity



Characteristics of Noise

Noise is generally defined as unwanted sound. It is emitted from many natural and man-made sources. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level. Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. The intensities of each frequency add together to generate sound. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all of the frequencies of a sound according to a weighting system. It has been found that the A-weighted decibel [dB(A)] filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response of the human ear.

The degree of disturbance from exposure to unwanted sound – noise – depends upon three factors:

1. The amount, nature, and duration of the intruding noise
2. The relationship between the intruding noise and the existing sound environment; and
3. The situation in which the disturbing noise is heard

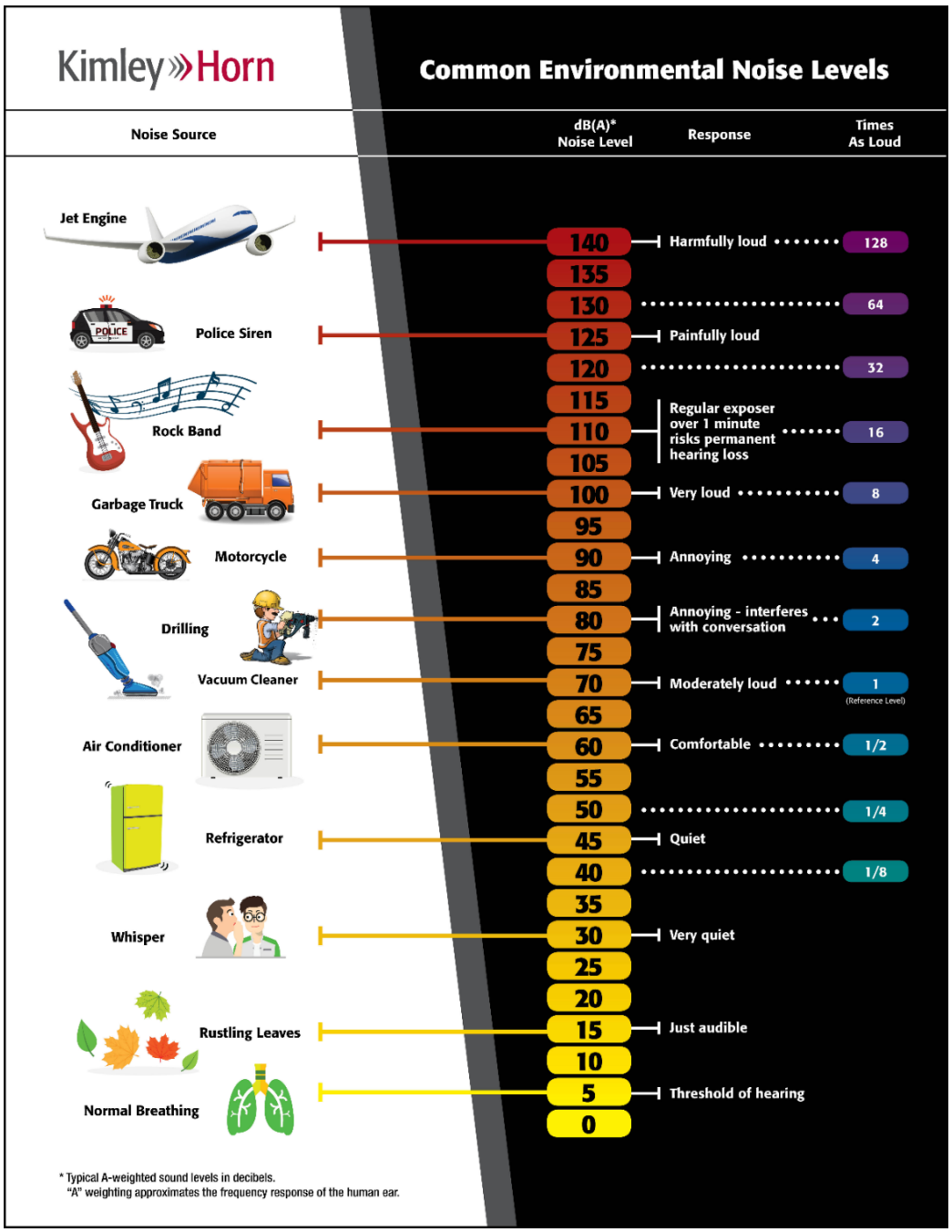
In considering the first of these factors, it is important to note that individuals have varying sensitivity to noise. Loud noises bother some people more than other people, and some individuals become increasingly upset if an unwanted noise persists. The time patterns and durations of noise(s) also affect perception as to whether or not it is offensive. For example, noises that occur during nighttime (sleeping) hours are typically considered to be more offensive than the same noises in the daytime.

With regard to the second factor, individuals tend to judge the annoyance of an unwanted noise in terms of its relationship to noise from other sources (background noise). A car horn blowing at night when background noise levels are low would generally be more objectionable than one blowing in the afternoon when background noise levels are typically higher. The response to noise stimulus is analogous to the response to turning on an interior light. During the daytime an illuminated bulb simply adds to the ambient light, but when eyes are conditioned to the dark of night, a suddenly illuminated bulb can be temporarily blinding.

The third factor – situational noise – is related to the interference of noise with activities of individuals. In a 60 dB(A) environment such as is commonly found in a large business office, normal conversation would be possible, while sleep might be difficult. Loud noises may easily interrupt activities that require a quiet setting for greater mental concentration or rest; however, the same loud noises may not interrupt activities requiring less mental focus or tranquility.

As shown in **Figure 2**, most individuals are exposed to fairly high noise levels from many sources on a regular basis. To perceive sounds of greatly varying pressure levels, human hearing has a non-linear sensitivity to sound pressure exposure. Doubling the sound pressure results in a three decibel change in the noise level; however, variations of three decibels [3 dB(A)] or less are commonly considered “barely perceptible” to normal human hearing. A five decibel [5 dB(A)] change is more readily noticeable. A ten-fold increase in the sound pressure level correlates to a 10 decibel [10 dB(A)] noise level increase; however, it is judged by most people as only sounding “twice as loud”.

Figure 2: Common Noise Levels



Over time, individuals tend to accept the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent use of exterior and interior spaces and has been theorized to pose health risks.

Local Regulations

The Big Timber Solar Farm LLC Solar Site is in Kane County, IL. Chapter 25, Article 5, Section 25-5-4-9 of the Kane County Code of Ordinances states that "noise levels from Commercial Solar Energy Facilities shall be in compliance with applicable Illinois Pollution Control Board (IPCB) regulations."

The IPCB noise regulations are based on allowable octave band sound pressure levels during daytime and nighttime hours. According to Title 35 (Environmental Protection), Subtitle H (Noise), Chapter I (Pollution Control Board), Part 901 (Sound Emission Standards and Limitations for Property Line-Noise Sources), a facility operating in an agricultural field (Class C Land) cannot cause an exceedance of sound levels at any point within a residential land use (Class A Land) during daytime hours as shown in **Table 1**.

Table 1: Maximum Allowable Sound Emitted to Class A Land During Daytime Hours

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	**75**	72	72
63	**74**	71	71
125	**69**	65	65
250	**64**	57	57
500	**58**	51	51
1000	**52**	45	45
2000	**47**	39	39
4000	**43**	34	34
8000	**40**	32	32

The IPCB has also established the allowable octave band sound pressure levels for nighttime hours shown in **Table 2**. However, these values are not applicable to the proposed solar site as it will not be operational during nighttime hours. These values are included for reference purposes only.

Table 2: Maximum Allowable Sound Emitted to Class A Land During Nighttime Hours

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	**69**	63	63
63	**67**	61	61
125	**62**	55	55
250	**54**	47	47
500	**47**	40	40
1000	**41**	35	35
2000	**36**	30	30
4000	**32**	25	25
8000	**32**	25	25

Noise Analysis

Sound levels from the proposed Big Timber Solar Farm LLC Solar Site were evaluated using SoundPLAN. This program computes predicted sound levels at noise-sensitive areas through a series of adjustments to reference sound levels. SoundPLAN also accounts for topography, groundcover type, and intervening structures. Sound levels generated from string inverters are anticipated to be the main source of sound from the proposed solar photovoltaic project site.

It should be noted that noise from surrounding roadways was not modeled in this analysis although Higgins Road, Big Timber Road, I-90, and other roadways are anticipated to contribute to the ambient noise environment throughout the entire day. Furthermore, per the Federal Railroad Administration Crossing Inventory, approximately one (1) train pass-by event is anticipated to occur during the daytime along the UP railroad tracks and will contribute to the ambient noise environment.

String Inverters

Photovoltaic (PV) inverter equipment generates steady, unvarying sound that can create issues when located near noise-sensitive areas. It was assumed that forty (40) PV string inverters would be located on two (2) equipment pads near the southern edge of the solar site. Based on noise emission levels provided for the Chint Power Systems (CPS) SCH100/125KTL-DO/US-600 string inverter equipment, a reference sound level of 65 dB(A) at 1 meter for each string inverter was used. **Table 3** shows the octave band emission levels for a typical string inverter used for reference. The sound from the simultaneous operation of the string inverters was calculated using SoundPLAN.

Table 3: Sound Emissions for String Inverter

Octave Band Center Frequency	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Frequency Sound Level	58	57	59	59	66	57	56	56	51

Sound generated by the string inverters is not anticipated to significantly contribute to the existing environmental sound levels surrounding the site. Also, sound generated by the string inverters is expected to be mitigated by providing offsets between the equipment and surrounding noise-sensitive land uses as well as by the physical presence of the solar arrays, which are anticipated to shield and disperse some of the sound generated by the inverters.

Transformers

Transformer equipment generates steady, unvarying noise that can create issues when located near noise-sensitive uses. It was assumed that one (1) 3,500 kVA transformer and one (1) 2,000 kVA transformer would be located within the proposed solar site. Based on the National Electrical Manufacturers Association (NEMA) average decibel ratings for a 3,500 kVA transformer and a 2,600 kVA transformer, a reference sound level of 64 dB(A) at 1 meter and 63 dB(A) at 1 meter, respectively, for the transformers were used. **Tables 4 and 5** show the octave band emission levels

for the proposed transformers. The sound from the operation of the transformers was calculated using SoundPLAN.

Table 4: Sound Emissions for the 3,500 kVA Transformer

Octave Band Center Frequency	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Frequency Sound Level	21.5	40.8	52.8	55.3	60.8	58.0	54.2	49.0	39.9

Table 5: Sound Emissions for the 2,000 kVA Transformer

Octave Band Center Frequency	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Frequency Sound Level	18.5	37.8	49.8	52.3	57.8	55.0	51.2	46.0	36.9

Sound generated by the transformers is not anticipated to significantly contribute to the existing environmental sound levels surrounding the site.

Results

The SoundPLAN-predicted maximum operational sound levels at the surrounding noise-sensitive land uses are anticipated to remain near or below approximately 34 dB(A), which is below the maximum permissible equivalent sound level established in the IPCB regulations for daytime hours. Since the SoundPLAN-predicted maximum octave band noise levels at surrounding Class A properties are not anticipated to exceed the applicable limits established by IPCB, noise mitigation measures do not need to be included in the project design at this time. See **Table 6** below. The anticipated operational sound contours are shown in **Figure 3**.

Table 6: Predicted Maximum Octave Band Sound Emissions at Class A Properties

Octave Band Center Frequency	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Maximum Octave Band SPLs from Equipment	2.2	16.4	25.7	15.3	9.0	23.7	30.1	27.9	6.9

Figure 3: Operational Sound Contours

Conclusions

The proposed solar photovoltaic project site is less than a mile west of Gilberts, approximately 1.5 miles southeast of Huntley, and 2.5 miles east of Hampshire. The site is generally located south of Higgins Road (IL Route 72), east of Big Timber Road (County Road 21), and southwest of Jane Addams Memorial Tollway (I-90). Additionally, Union Pacific (UP) railroad tracks are located approximately 1 mile east of the project site.

After modeling and analyzing the anticipated operational sound levels throughout the proposed solar site, it was determined that noise mitigation measures are not needed at this time since the anticipated operational sound levels will remain below the IPCB allowable noise levels at the surrounding Class A land uses during daytime hours.