

MEMORANDUM

To: Mr. Adam Furman
S·POWER
Sustainable Power Group

From: John Crawford, P.E. (MN), PTOE
Justin Sebens, EIT

Date: May 7, 2018

Subject: Spotsylvania Solar Energy Center Project
Noise Study

Introduction

Kimley-Horn and Associates has been contracted by S·POWER to complete a noise analysis for the proposed Spotsylvania Solar Energy Center Project, located in western Spotsylvania County, Virginia.

Figure 1 provides the current site plan for the proposed development. The purpose of this report is to provide information about anticipated sound-generating activities for both construction, and for long-term operation of the proposed site.

The entire project consists of three sites (Site A, Site B, and Site C), which will ultimately include 6,350+/- acres of total land with 3,500+/- acres being developed, and will generate 500 megawatts.

This report identifies 5 specific areas of analysis:

- 1) Near the Fawn Lake community
- 2) North of W. Catharpin Road near Danville Drive.
- 3) Post Oak Road southeast of W. Catharpin Road
- 4) South of W. Catharpin Road on/near Danville Drive
- 5) North of Post Oak Road, southeast of Gabriel Court

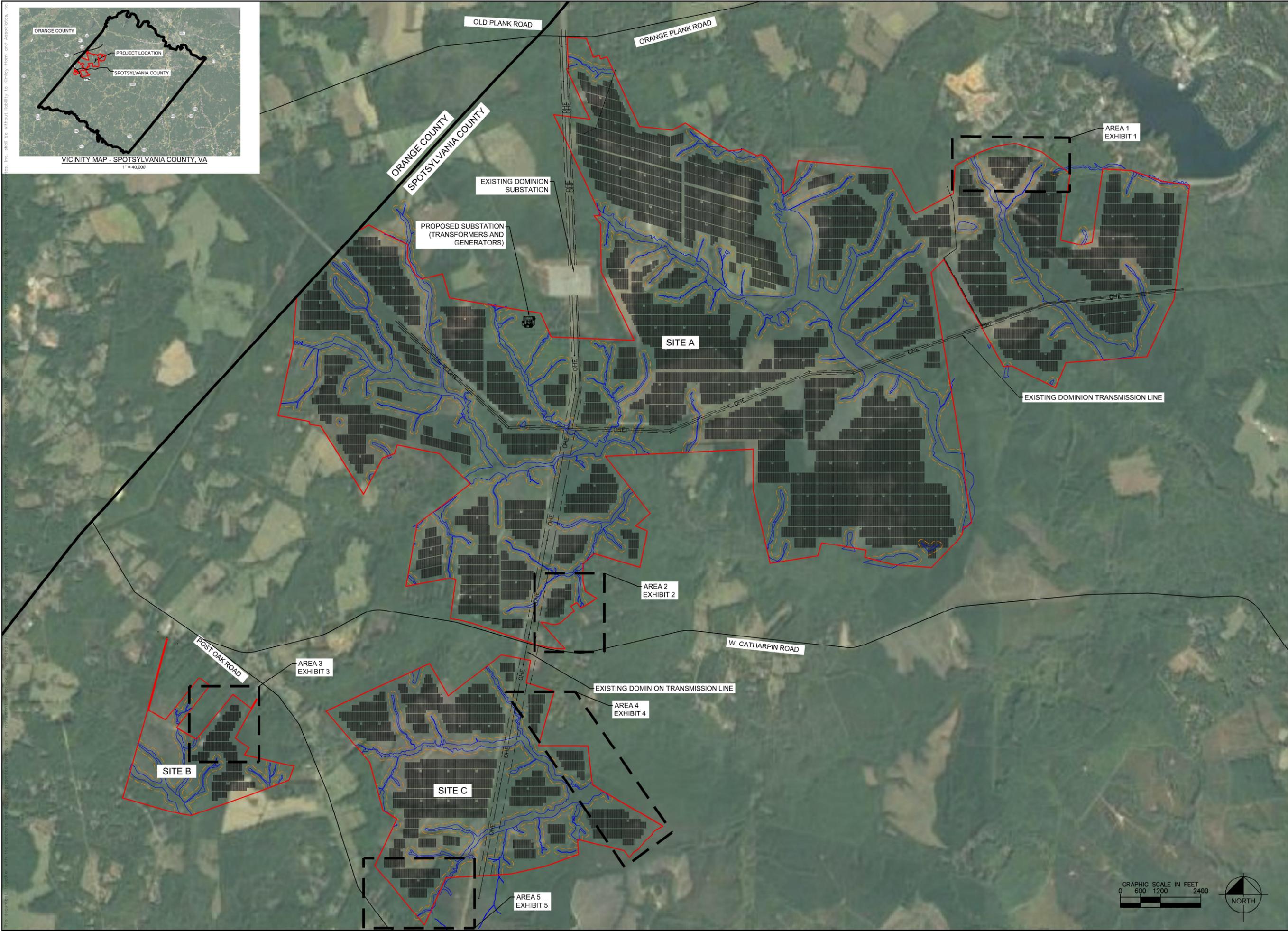
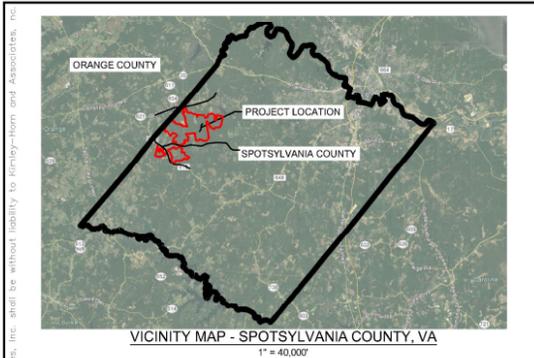
To assist with understanding of sound from the project, this report provides general background information about how sound levels dissipate over distance, and how sound levels change depending on the number of pieces of equipment, and the duration of time those pieces of equipment may be in operation. We are also providing a **summary of relevant portions of the Spotsylvania County Noise Ordinance**. In addition, we are providing **background information about the project's noise sources, including their intensity, duration, and location during both construction and long-term operation.**

Background

Noise is defined as any unwanted sound. Sound travels in a wave motion and produces a sound pressure level, which is commonly measured in decibels (dB). A logarithm of the ratio of a sound energy level relative to a reference sound energy can be used to represent a decibel. The way the average person hears sounds causes different weights to be adjusted on high- and low-pitched sound. These adjusted sound levels are measured in "A-weighted decibels" (dBA). A sound increase of 3 dBA is hardly noticeable, a 5 dBA increase is clearly perceived by the human ear, and a 10 dBA increase is twice as

loud. For instance, if there is an increase in the sound level by 3 dBA due to sound source doubling, it is barely perceptible by humans. When there is a 10 dBA increase in sound, or the source energy has increased 10-fold, the source is perceived as twice as loud. **Figure 2** provides a rough comparison of the sound levels of some common sound sources.

There are many factors that contribute to the loudness of sound, including the topography of the area, the number of sound sources, and intensity of the sound source. Another important factor is the distance the receptor is from the source of the sound. As the distance from the source increases, the sound level decreases. Doubling the distance from a point source over hard ground (such as pavement or water) will reduce the sound level by 6 dBA. Doubling the distance over soft ground (such as vegetated or grassy ground) will result in a decrease in the sound level of 7.5 dBA.



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APPROVAL

KHA PROJECT	116626000
DATE	3/14/2018
SCALE	AS SHOWN
DESIGNED BY	JRB
DRAWN BY	JRB
CHECKED BY	SMM

OVERALL PROJECT MAP

SPOTSYLVANIA SOLAR
 ENERGY CENTER
 PREPARED FOR
S-POWER
 SPOTSYLVANIA COUNTY VIRGINIA

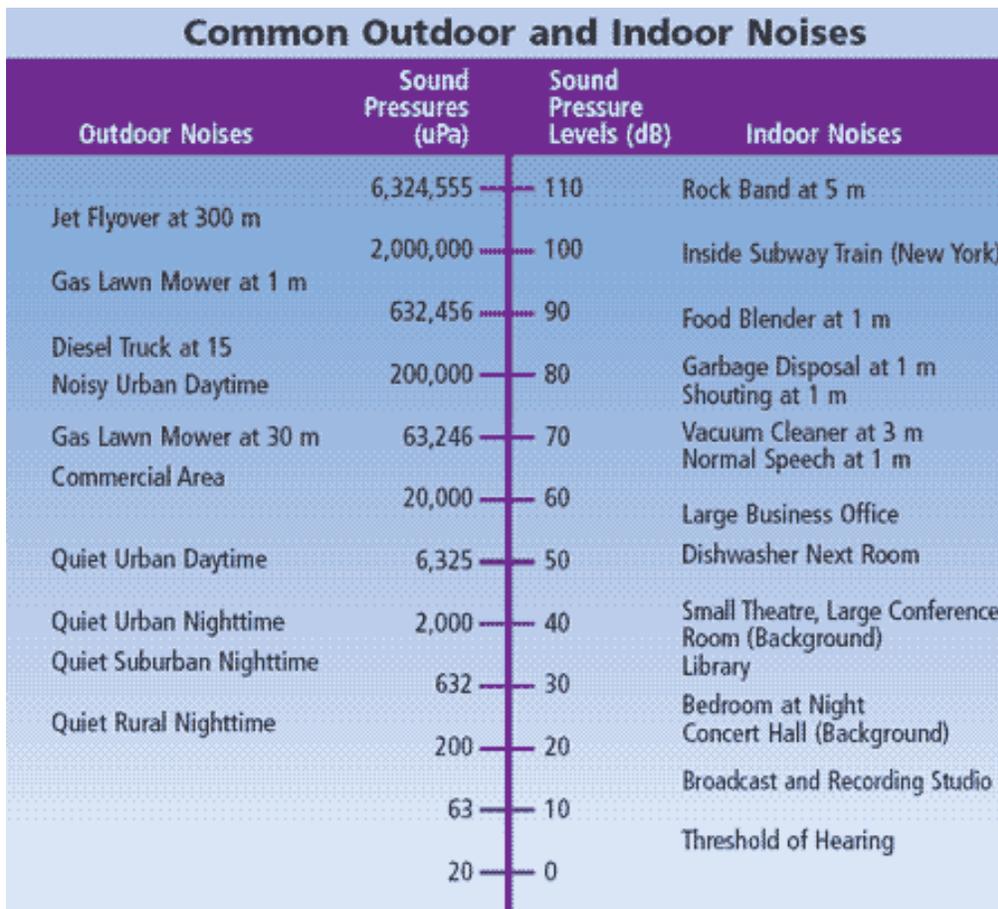


Figure 2: Decibel Levels of Common Noise Sources
 Source: "Living With Noise" Federal Highway Administration
<https://www.fhwa.dot.gov/publications/publicroads/03jul/06.cfm>

Noise levels used in this report include L_{eq} noise levels. L_{eq} is the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq}(h)$ being the hourly value of L_{eq} . In effect, it's analogous to the "average" sound level over a given period of time. L_{eq} is a commonly used metric for noise standards and ordinances, as is the case for Spotsylvania County.

Spotsylvania County Noise Ordinance

Spotsylvania County's noise ordinance defines the maximum allowable sound levels within ordinance *Section 14-51 – Maximum permissible sound levels generally*. The ordinance defines two time of day sound level limits, one for daytime (6:00 AM – 10:00 PM) and one for nighttime (10:00 PM – 6:00 AM). The daytime maximum sound level for residential areas is 65 dBA L_{eq} and the nighttime is 60 dBA L_{eq} .

Section 14-52. (a) (1) of the County's noise ordinance specifies that construction noise is exempt from maximum noise levels, provided the activity is during the daytime:

“Noise emitted from activities related to the construction, repair, maintenance, remodeling or demolition, grading or other improvement of real property, which noise is customarily emitted from such activities.”

Construction Noise

Construction of the property will include site preparation, installation of photovoltaic (PV) panels, and testing.

Some sound generating activities will include site clearing, grading, and installation of the mounting and steel pier support structures. The pier support structures will include pneumatically driven H-pile steel beams.

The installation of the H-pile steel beams will require the use of up to 15 Vermeer PD10 Pile Drivers during construction in the immediate vicinity of each area analyzed. Approximately 50 acres will take approximately 3 to 4 days to complete the installation of the H-pile steel beams. **Exhibit 1** through **Exhibit 5** show these areas, and depicts the area of adjacent construction, along with the location of the PV panels planned for installation. The pile driver locations depict a worst-case distribution of pile drivers.

Two types of pile drivers are planned for use during installation of the solar panels. The equipment has been documented to produce noise levels of 105 and 114 dBA at the operator’s ear. These pile drivers are similar Vermeer pile drivers with different engines. The equipment with 105 dBA at the operator’s ear is outfitted with a Yanmar engine. The equipment with 114 dBA at the operator’s ear is outfitted with a Deutz engine. The location of the noise source to the operator’s ear is approximately 4 feet. Using logarithmic calculation, as described above in the *Background* section of this document, noise levels from a point source decrease by approximately 6 dBA each time the distance is doubled.

Based on the provided noise level from the equipment manufacturer, noise levels can then be calculated at any distance, assuming no ground attenuation. The resultant equivalent noise levels from one PD10 pile driver with source noise levels of 105 dBA (at the operator’s ear):

- 83 decibels at 50 feet from one machine
- 77 decibels at 100 feet from one machine
- 71 decibels at 200 feet from one machine
- 65 decibels at 400 feet from one machine

The resultant equivalent noise levels from one PD10 pile driver with source noise levels of 114 dBA (at the operator’s ear):

- 92 decibels at 50 feet from one machine
- 86 decibels at 100 feet from one machine
- 80 decibels at 200 feet from one machine
- 74 decibels at 400 feet from one machine

Note that the differing pile drivers were assumed to be spaced in an alternating fashion. Therefore, if an area has four pile drivers, two will be pile drivers with Yanmar engines, and two will be pile drivers with Deutz engines.

Another calculation to be done is to combine the noise from multiple machines. As described above in the *Background* section of this document, noise levels increase by approximately 3 dBA when the source is doubled.

Using the logarithmic calculations for multiple sources, dissipation over distance, and the equipment distribution as shown on **Exhibits 3-7**, noise levels at nearby residential areas nearest the construction area have been calculated.

For all of the following locations, noise levels are expected to range between approximately 68 and 80 L_{eq} dBA at the closest residential properties.

Noise levels of 70 dBA are equivalent to a gas lawn mower at 30 meters (approximately 100 feet). This noise level is also sometimes described as the level at which people need to begin to raise their voices to carry a normal conversation. Noise levels of 80 dBA are equivalent to a noisy urban environment. This report demonstrates a potential worst-case scenario, and pile-driving equipment locations were chosen to demonstrate this worst-case. Note that this worst-case condition, with the equipment operating close to the residences, does not include ground attenuation or existing ground cover (trees/foliage), which will likely result in noise levels that could be as much as 5 dBA lower than what is reported.

This situation will likely last no more than 4 working days in the immediate vicinity of residential properties, after which, noise from pile-driving operation will be much lower as distance increases between the nearby homes and pile-drivers.

Area 1, near the Fawn Lake Community

For the three residential areas, listed west to east, the resultant L_{eq} is 70.1, 68.6, and 67.3 dBA.

Note that this worst-case condition does not include the proposed earth berm at the property boundary. It is very likely that noise levels will be lower due to the effects of trees, and the proposed earth berm. Noise levels will likely be up to 5 decibels lower than described above due to these factors. **Exhibit 1** depicts the noise sources and resulting sound levels in the area.

Area 2, North of W. Catharpin Road near Danville Drive.

Noise levels at properties adjacent to the construction area will experience L_{eq} noise levels ranging from 72.8 (north of the construction area) to 80.3 dBA (south and east of the construction area). **Exhibit 2** depicts the noise sources and resulting sound levels in the area. Note that this area near these residences is approximately 14 acres, which will take less than 3 days to construct.

Area 3, Post Oak Road southeast of W. Catharpin Road

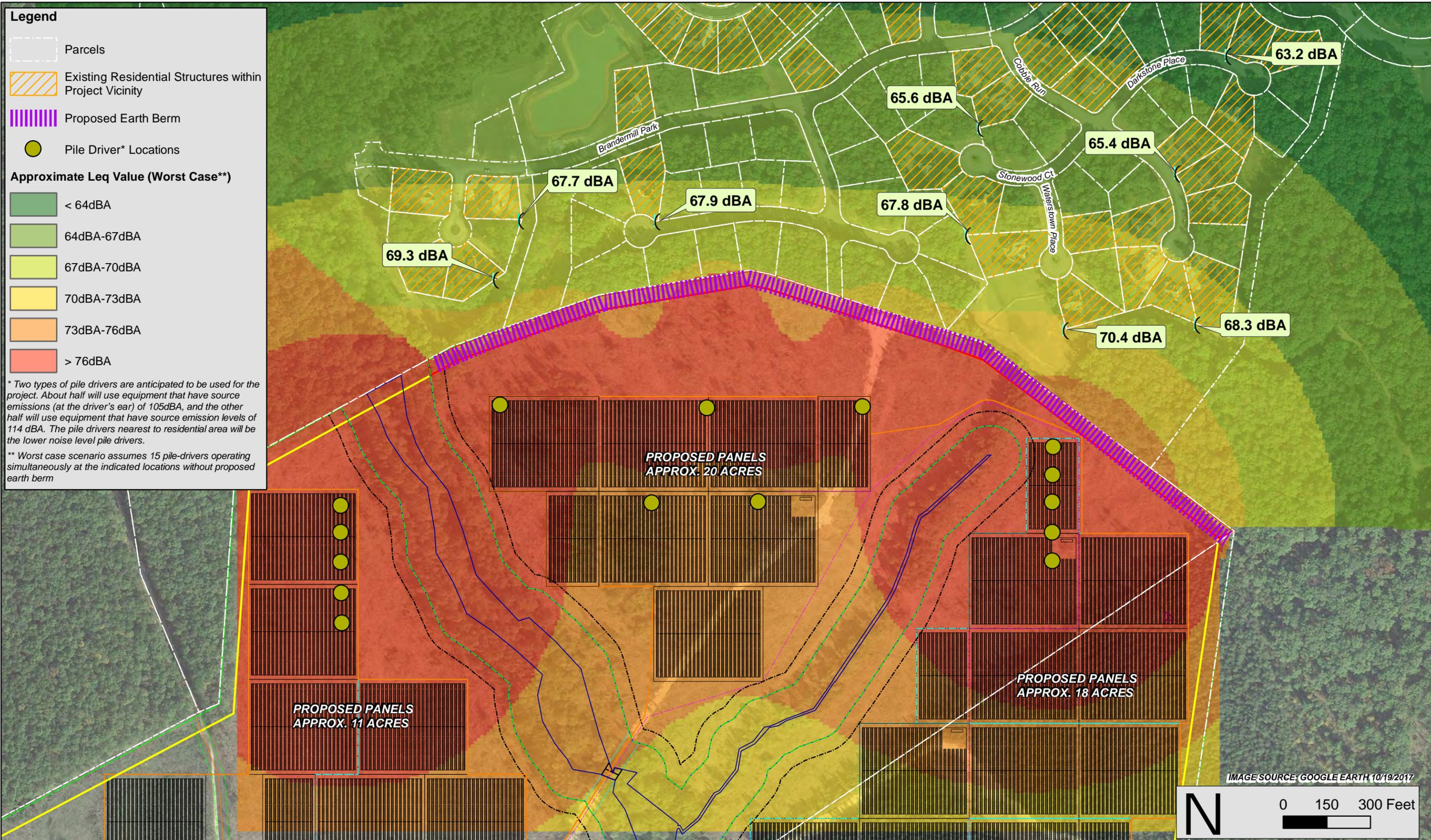
Noise levels at properties adjacent to the construction area will experience L_{eq} noise levels ranging from 72.6 to 78.1 dBA. **Exhibit 3** depicts the noise sources and resulting sound levels in the area. Note that this area near these residences is approximately 22 acres, which will take less than 3 days to construct.

Area 4, South of W. Catharpin Road on/near Danville Drive

Noise levels at properties adjacent to the construction area will experience L_{eq} noise levels ranging from 71.4 to 77.3 dBA. **Exhibit 4** depicts the noise sources and resulting sound levels in the area. Note that this area near these residences is approximately 36 acres, which will take less than 3 days to construct.

Area 5, North of Post Oak Road, southeast of Gabriel Court

Noise levels at properties adjacent to the construction area will experience L_{eq} noise levels ranging from 70.1 to 72.6 dBA. **Exhibit 5** depicts the noise sources and resulting sound levels in the area. Note that this area near these residences is approximately 30 acres, which will take less than 3 days to construct.



NOTE: This exhibit shows a panel area of about 50 acres. For each 50 acre area, it will take around 3-4 days to install the H-pile steel beams.

Legend

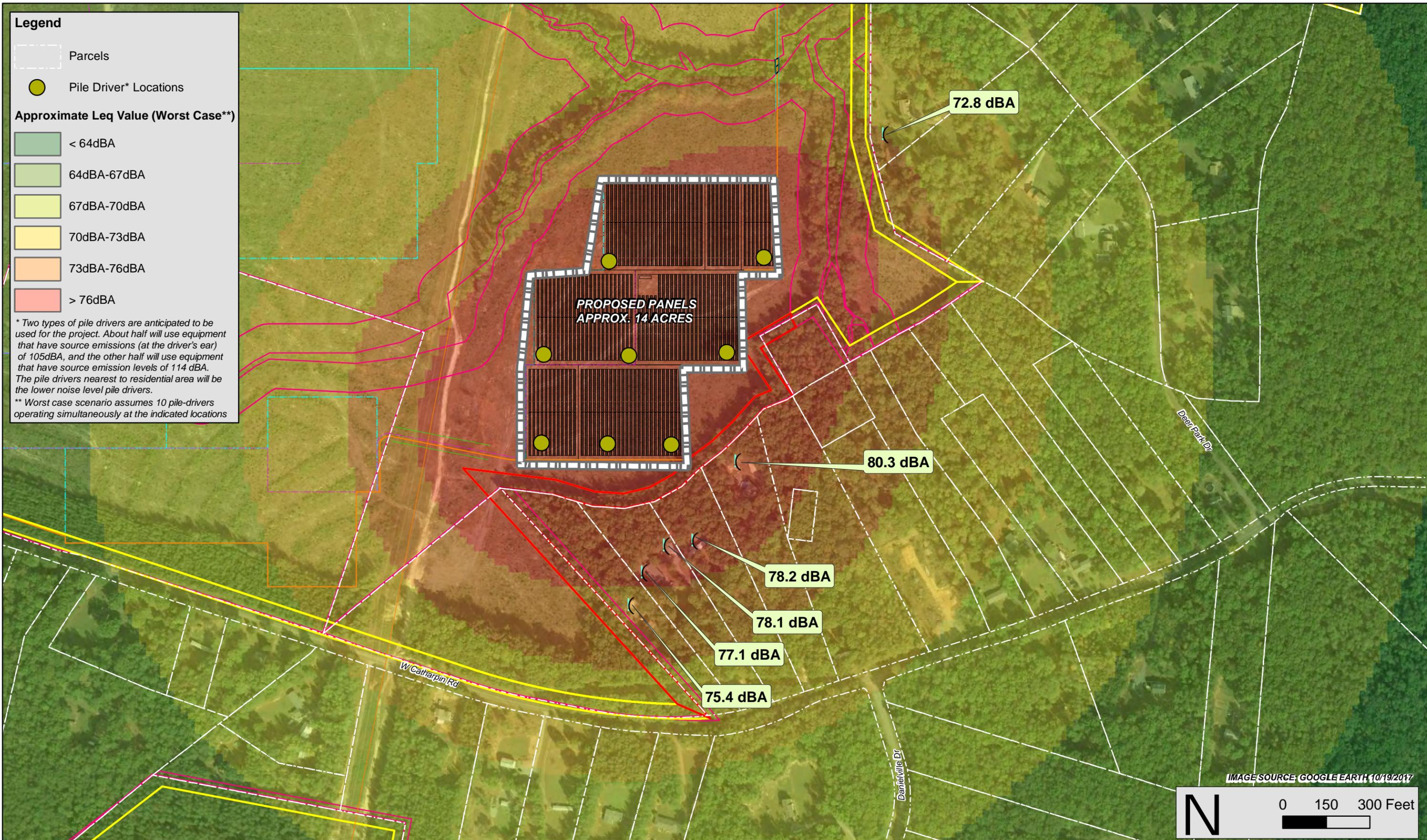
- Parcels
- Pile Driver* Locations

Approximate Leq Value (Worst Case)**

- < 64dBA
- 64dBA-67dBA
- 67dBA-70dBA
- 70dBA-73dBA
- 73dBA-76dBA
- > 76dBA

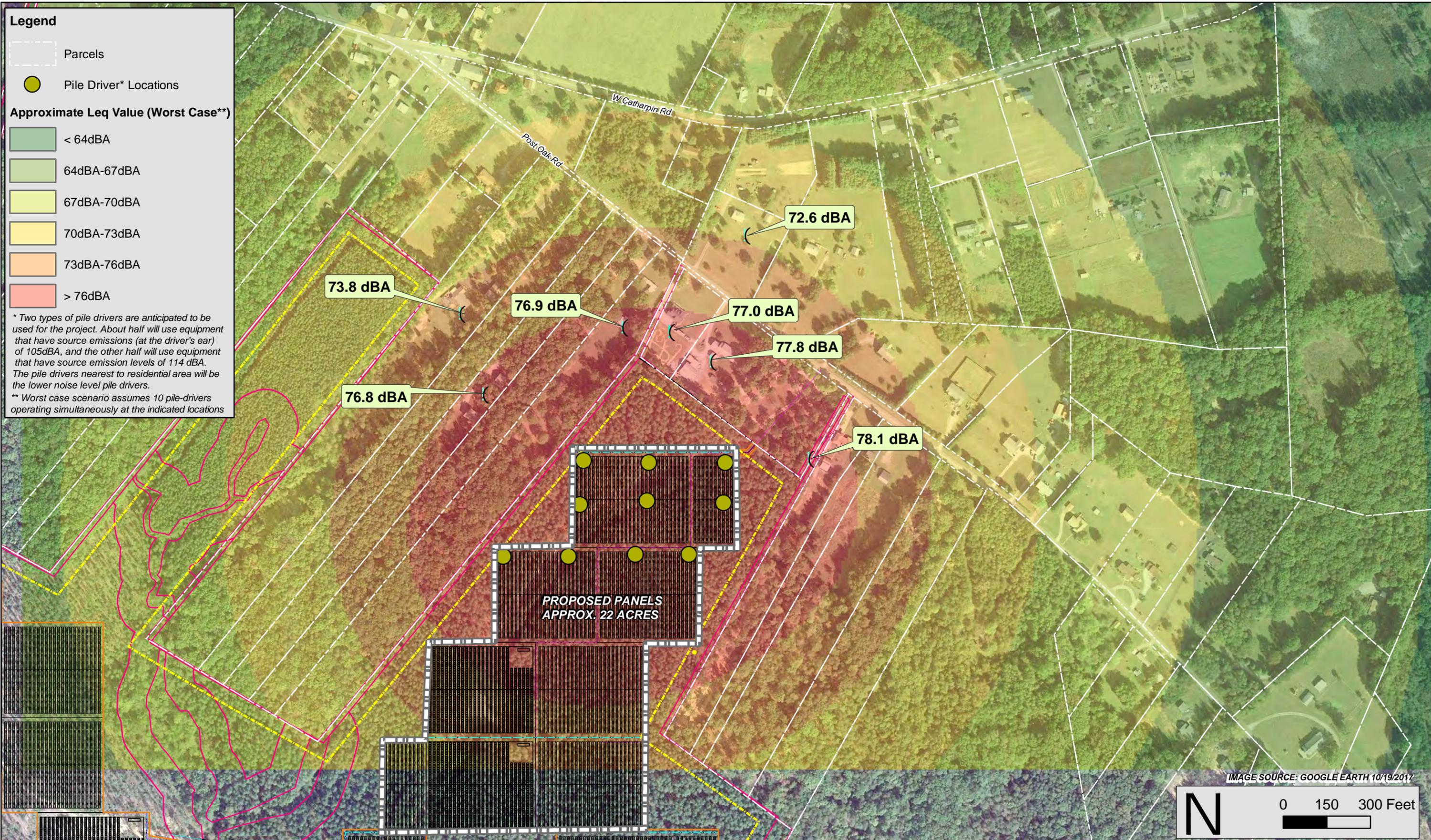
* Two types of pile drivers are anticipated to be used for the project. About half will use equipment that have source emissions (at the driver's ear) of 105dBA, and the other half will use equipment that have source emission levels of 114 dBA. The pile drivers nearest to residential area will be the lower noise level pile drivers.

** Worst case scenario assumes 10 pile-drivers operating simultaneously at the indicated locations



NOTE: For each 50 acre area, it will take around 3-4 days to install the H-pile steel beams.

WORST CASE PILE-DRIVING NOISE SCENARIO EXHIBIT 2



NOTE: For each 50 acre area, it will take around 3-4 days to install the H-pile steel beams.

Legend

- Parcels
- Pile Driver* Locations

Approximate Leq Value (Worst Case)**

- < 64dBA
- 64dBA-67dBA
- 67dBA-70dBA
- 70dBA-73dBA
- 73dBA-76dBA
- > 76dBA

* Two types of pile drivers are anticipated to be used for the project. About half will use equipment that have source emissions (at the driver's ear) of 105dBA, and the other half will use equipment that have source emission levels of 114 dBA. The pile drivers nearest to residential area will be the lower noise level pile drivers.

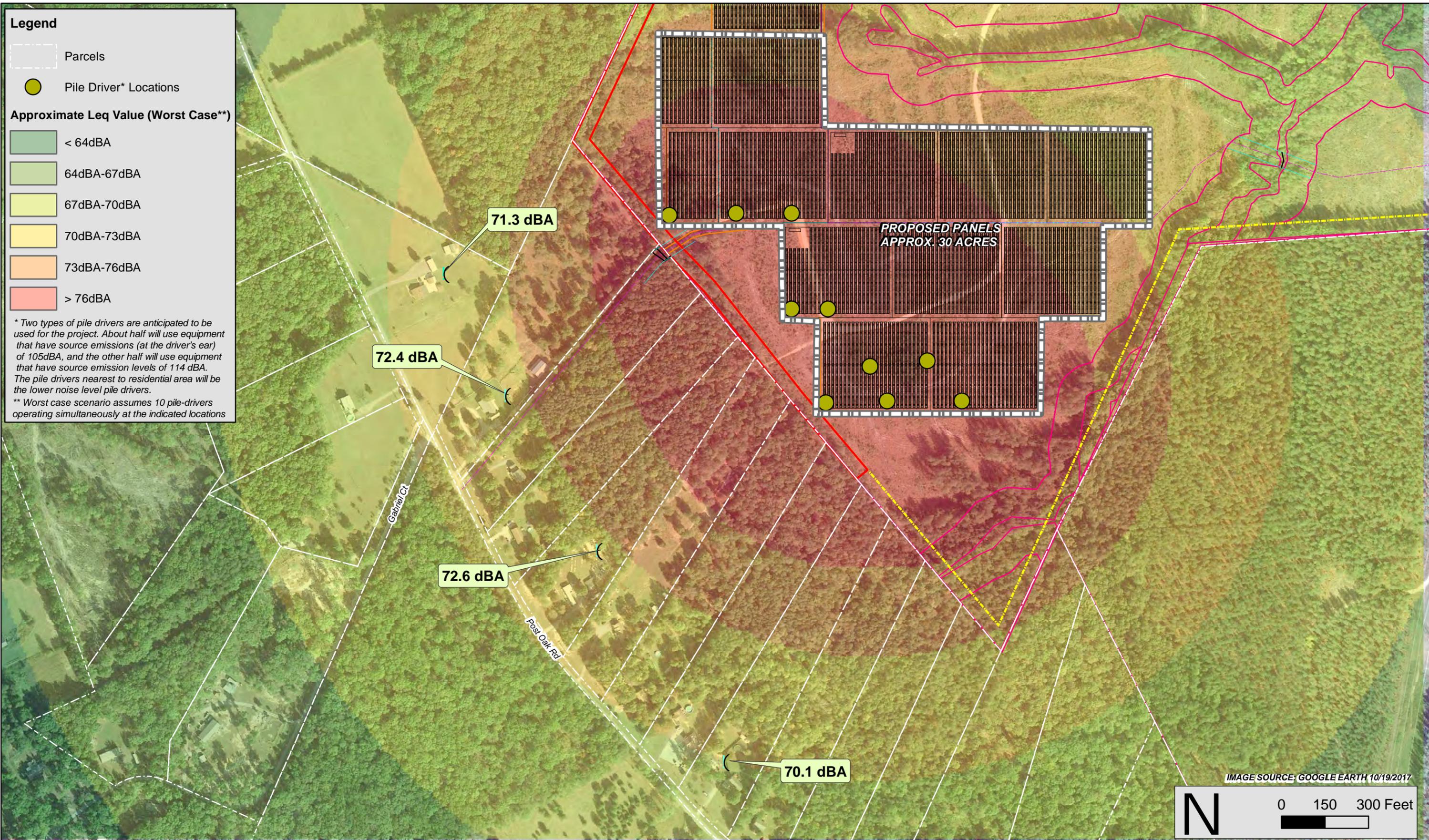
** Worst case scenario assumes 10 pile-drivers operating simultaneously at the indicated locations



IMAGE SOURCE: GOOGLE EARTH; 10/19/2017



NOTE: For each 50 acre area, it will take around 3-4 days to install the H-pile steel beams.



Long-term project operation noise

A number of noise-generating items will be included in the permanent operations of the project. The project will include tracker motors, inverters, transformers, and backup generators.

Tracker Motors:

The tracker motors have noise levels of approximately 53 dBA. The low level of noise from these motors is below the residential standard, even immediately adjacent to the tracker motors. Noise levels will be substantially lower at the property boundary.

Inverters:

The inverters have a source emission level of 79 dBA at 50 feet from the source. The inverter nearest to the property line near the Fawn Lake neighborhood is 680 feet away. At this distance, the highest possible noise level, without consideration of the earthen berm, will be approximately 56 decibels. The earthen berm, and ground effects between the inverter and the property line will likely lower this noise by at least 5 decibels.

Transformer:

The proposed transformer has a source emission level of 84 dBA when measured at the place of manufacture. The nearest property line adjacent to a transformer is approximately 325 feet. The noise level at this property line is anticipated to be approximately 46 dBA L_{eq} , which is well below the County's ordinance level of 65 dBA L_{eq} during the daytime, and 60 dBA L_{eq} during the nighttime.

Backup Generator:

The nearest property line adjacent to a backup generator is approximately 325 feet. The worst case noise level at this property line is anticipated to be 63 dBA L_{eq} , which is below the Spotsylvania County ordinance level of 65 dBA L_{eq} during the daytime.

The property line nearest to the Fawn Lake neighborhood is approximately 14,000 feet from the nearest backup generator. The noise level from the backup generator at this property line will not be detectible.

Summary and Conclusion

The Spotsylvania County noise ordinance states that construction activities are exempt from the maximum permissible noise level for ordinary construction activities between the daytime hours of 6am to 10pm. Noise levels at the nearest residential areas may be as high as 80.3 dBA L_{eq} , and may last as long as 4 days, during the daytime only. Noise levels will be slightly lower than what is reported in this document due to existing trees, foliage, as well as the proposed earth berm near the Fawn Lake Community.

During the permanent operation of the project, with low noise levels from the operating equipment, a proposed earthen berm near the Fawn Lake Community, and existing trees and vegetation, noise levels will be below the Spotsylvania County noise ordinance maximum permissible noise levels.