APPENDIX I
SOUND SURVEY ANALYSIS AND REPORT

DRAFT
SOUND SURVEY AND ANALYSIS REPORT

Janus Solar Project

Colusa County, California

August 1, 2021

RWE Solar Development, LLC

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ACRONYMS AND ABBREVIATIONS

μPa	microPascal
CEQA	California Environmental Quality Act
dB	decibel
dBA	A-weighted decibel
dBL	unweighted (linear) decibel
FTA	Federal Transit Authority
Hz	hertz
in/sec	inch per second
ISO	International Organization for Standardization
Ldn	Day-night average sound level
Leq	equivalent sound level
LP	sound pressure level
kV	kilovolt
ML	monitoring location
NSA	Noise Sensitive Area
PG&E	Pacific Gas and Electric
PPV	Peak-Particle-Velocity
Project	Janus Solar Project
Tetra Tech	Tetra Tech, Inc.
USEPA	United States Environmental Protection Agency
VdB	vibration decibel

1.0 OVERVIEW

Tetra Tech, Inc. (Tetra Tech) has prepared this noise impact assessment for the proposed Janus Solar Project (Project) to support a California Environmental Quality Act (CEQA) evaluation. The Project is proposed on approximately 1,024 acres of land located approximately 6.5 miles southwest of the city of Williams within Colusa County. The Project consists of constructing and operating a photovoltaic solar electric generating facility and energy storage system and associated infrastructure that would produce up to 80 megawatts of power at the Point of Interconnection. The Project would include the construction of solar arrays, an electrical substation and electrical interconnection facilities, an energy storage system and other necessary infrastructure.

1.1 PROJECT SETTING

The Project site is on three parcels of private land that total approximately 1,024 acres and is currently operated as a cattle ranch. To avoid environmental constraints, approximately 768 acres of the 1,024-acre site would be used for the Project. The Project site is surrounded by rural residential, agricultural fields, and undeveloped land. The nearest residential property lines are located directly adjacent to the southern Project boundary and the northwestern Project boundary, while a mixed residential/agricultural property line is located directly adjacent to the northern Project boundary.

Spring Valley Road runs through the Project site from north to south. The generation tie line follows Spring Valley Road north to Walnut Drive at which point it follows Walnut Drive to Pacific Gas and Electric's (PG&E's) Cortina Substation. The nearest community to the Project site is the city of Williams, which is located approximately 6.5 miles northeast. Figure 1 provides an overview of the Project site as well as the surrounding area.

1.2 ACOUSTIC METRICS AND TERMINOLOGY

All sounds originate with a source, whether it is a human voice, motor vehicles on a roadway, or a combustion turbine. Energy is required to produce sound and this sound energy is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear. A sound source is defined by a sound power level (abbreviated "LW"), which is independent of any external factors. By definition, sound power is the rate at which acoustical energy is radiated outward and is expressed in units of watts.

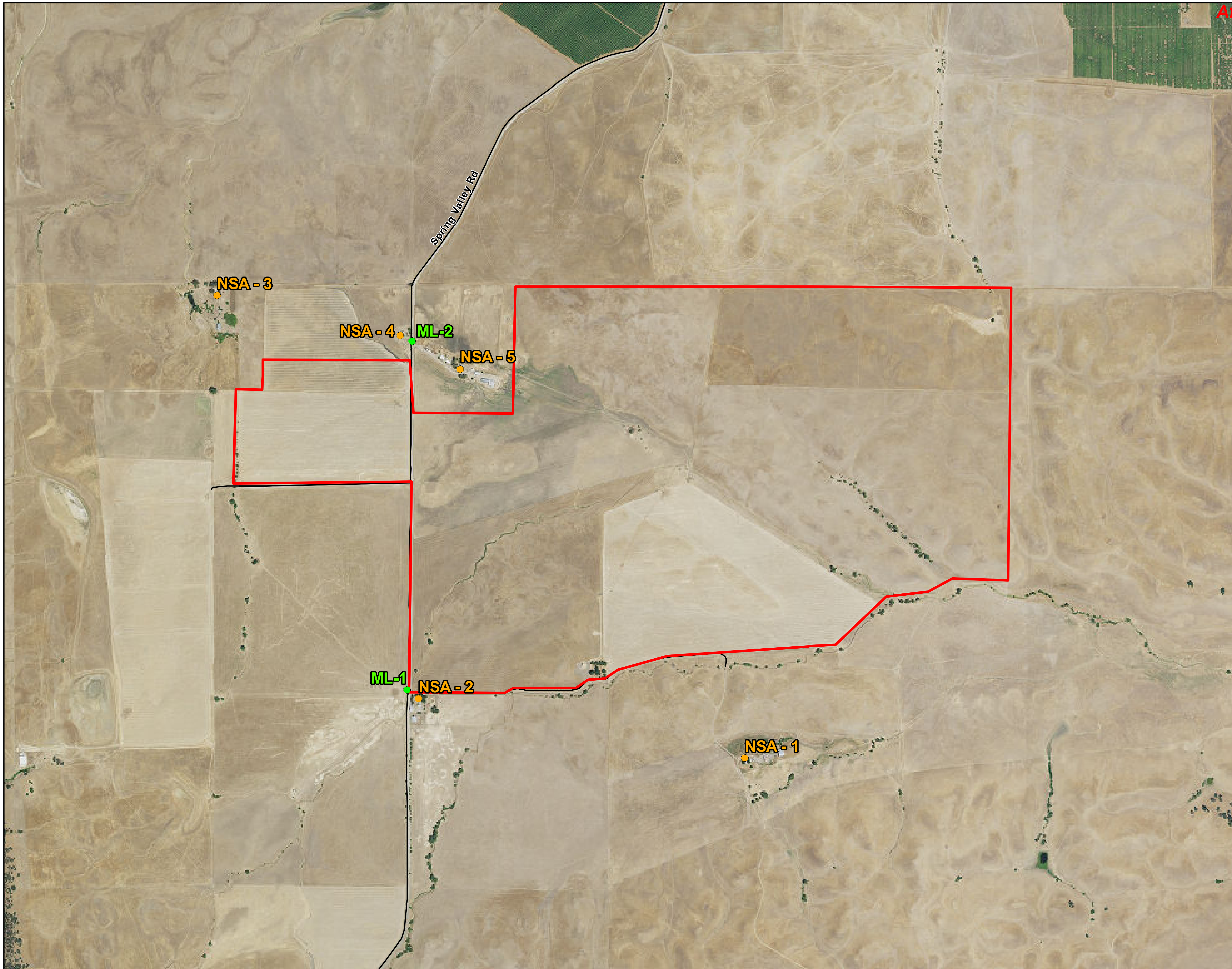
A source sound power level cannot be measured directly. It is calculated from measurements of sound intensity or sound pressure at a given distance from the source outside the acoustic and geometric near-field. A sound pressure level (abbreviated "L_P") is a measure of the sound wave fluctuation at a given receiver location and can be obtained through the use of a microphone or calculated from information about the source sound power level and the surrounding environment. The sound pressure level in decibels (dB) is the logarithm of the ratio of the sound pressure of the source to the reference sound pressure of 20 microPascals (μPa), multiplied by 20. The range of sound pressures that can be detected by a person with normal hearing is very wide, ranging from about 20 μPa for very faint sounds at the threshold of hearing, to nearly 10 million μPa for extremely loud sounds such as a jet during take-off at a distance of 300 feet.

Janus Solar Project

Colusa County, CA

Noise Report

Figure 1: Project Location



- Project Area
- Noise Monitoring Location
- Noise Sensitive Receptor

N

0 0.25 0.5 Miles

Scale is 1:15,000 when printed at 11"x17"

NOT FOR CONSTRUCTION

Broadband sound includes sound energy summed across the entire audible frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum can be completed to determine tonal characteristics. The unit of frequency is hertz (Hz), measuring the cycles per second of the sound pressure waves. Typically, the frequency analysis examines 11 octave bands ranging from 16 Hz (low) to 16,000 Hz (high). Since the human ear does not perceive every frequency with equal loudness, spectrally-varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and is represented in A-Weighted Decibel (dBA).

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (L_{eq}). The L_{eq} has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is widely used in acoustic assessments in the State of California. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1. Table 2 presents additional reference information on terminology used in the report.

Table 1. Sound Pressure Levels (L_P) and Relative Loudness of Typical Noise Sources and Acoustic Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
Vacuum cleaner (10 feet)	70	Moderate
Passenger car at 65 miles per hour (25 feet)	65	
Large store air-conditioning unit (20 feet)	60	
Light auto traffic (100 feet)	50	Quiet
Quiet rural residential area with no activity	45	
Bedroom or quiet living room; Bird calls	40	Faint
Typical wilderness area	35	
Quiet library, soft whisper (15 feet)	30	Very quiet
Wilderness with no wind or animal activity	25	Extremely quiet
High-quality recording studio	20	
Acoustic test chamber	10	Just audible
	0	Threshold of hearing

Adapted from: Kurze and Beranek (1988) and USEPA (1971)

Table 2. Acoustic Terms and Definitions

Term	Definition
Noise	Typically defined as unwanted sound. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (L_P)	Pressure fluctuations in a medium. Sound pressure is measured in dB referenced to 20 μPa, the approximate threshold of human perception to sound at 1,000 Hz.
Sound Power Level (L_W)	The total acoustic power of a noise source measured in dB referenced to picowatts (one trillionth of a watt). Noise specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.

Term	Definition
Equivalent Sound Level (L_{eq})	The L_{eq} is the continuous equivalent sound level, defined as the single sound pressure level that, if constant over the stated measurement period, would contain the same sound energy as the actual monitored sound that is fluctuating in level over the measurement period.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Unweighted (Linear) Decibels (dBL)	Unweighted sound levels are referred to as linear. Linear decibels are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear are presented as dBL in this report.
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity, and atmospheric conditions.

1.3 VIBRATION METRICS AND TERMINOLOGY

Vibration is an oscillatory motion that is described in terms of displacement, velocity, or acceleration. Velocity is the most common descriptor used when evaluating human perception or structural damage. Velocity represents the instantaneous speed of movement and more accurately describes the response of humans, buildings, and equipment to vibrations.

Peak-Particle-Velocity (PPV) and root mean square velocity are typical metrics used to describe vibration levels in units of inches per second in the United States. However, to evaluate annoyance to humans, the vibration dB (VdB) notation is commonly used. The decibel notation acts to compress the range of numbers required to describe vibration. In the United States, the accepted velocity reference for converting to dB is 1×10^{-6} inches per second. The abbreviation "VdB" is used for vibration dB to reduce the potential for confusion with sound decibels.

In contrast to airborne noise, ground-borne vibration is not an everyday occurrence for humans. The background vibration velocity levels within residential areas are usually 50 VdB or lower, which is well below the human perception threshold of approximately 65 VdB. However, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. For a significant impact to occur, vibration levels must exceed 72 VdB during frequent events, 75 VdB for occasional events, and 80 VdB during infrequent events (FTA 2006). Outdoor sources that generate perceptible ground-borne vibrations are typically construction equipment, steel-wheeled trains, and traffic on rough roadways. Table 3 provides common vibration sources as well as human and structural response to ground-borne vibrations.

Table 3. Typical Levels of Ground-Borne Vibration

Human/Structural Response	PPV (in/sec)	Velocity Level (VdB)*	Typical sources (50 feet from source)
Threshold, Minor Cosmetic Damage, Fragile Buildings	0.4	100	Blasting from Construction Projects
	0.17-0.2	92-94	Heavy Tracked Construction Equipment
Difficulty with Tasks, Such as Reading a Computer Screen	0.125	90	
	0.074	85	Commuter Rail, Upper Range

Human/Structural Response	PPV (in/sec)	Velocity Level (VdB)*	Typical sources (50 feet from source)
Residential Annoyance, Infrequent Events	0.04	80	Rapid Transit, Upper Range
	0.013	75	Commuter Rail, Typical
	0.023	72	Bus or Truck Bump Over
Residential Annoyance, Frequent Events	0.013	70	Rapid Transit, Typical
Approximate Threshold of Human Perception	0.007	65	
	0.005	62	Bus or Truck, Typical
	0.0013	50	Typical Background Vibration Levels

*RMS Vibration Velocity in VdB reference to 10^{-6} inches/second
Source: FTA (2006)

The degree of annoyance cannot always be explained by the magnitude of the vibrations alone. Phenomena, such as ground-borne noise and rattling, visual effects (e.g., movement of hanging objects), and time of day, all influence the response of individuals. The American National Standards Institute and the International Organization for Standardization (ISO) have developed criteria for evaluation of human exposure to vibrations. The recommendations of these standards and other studies evaluating human response to vibrations have been incorporated into the Federal Transit Administration's (FTA) Transit Noise and Vibration Impact Assessment Manual (May 2006). The criteria within this manual are used to assess noise and vibration impacts from transit operations.

1.4 SENSITIVE RECEPTORS

Human response to noise varies considerably from one individual to another. Effects of noise at various levels can include interference with sleep, concentration, and communication, and can cause physiological and psychological stress and hearing loss. Given these effects, some land uses are considered more sensitive to ambient noise levels than others. In general, residences, schools, hotels, hospitals, and nursing homes are considered to be the most sensitive to noise. These locations are referred to as noise sensitive areas (NSAs). Places such as churches, libraries, and cemeteries, where people tend to pray, study, and/or contemplate also are NSAs. Commercial and industrial uses are considered the least noise-sensitive. As shown in Figure 1, there are multiple residences near the Project site (NSA 1-5). NSA-5 is the residence of the landowner participating in the Project, such that NSA-5 is not considered a sensitive receptor

1.5 NOISE AND VIBRATION LEVEL REQUIREMENT AND GUIDELINES

Potential noise impacts associated with the Project were evaluated with respect to the applicable noise requirements prescribed by CEQA, the Colusa County General Plan (2012), and the Colusa County Code. Details regarding each set of requirements are provided below.

1.5.1 California Environmental Quality Act

CEQA requires that significant environmental impacts be identified and that such impacts be eliminated or mitigated to the extent feasible. Appendix G of the CEQA Statutes and Guidelines (State Clearing House, Office of Planning and Research and the Natural Resources Agency 2016) sets forth a series of suggested thresholds for determining a potentially significant impact. Under the thresholds suggested in Appendix G, the proposed Project could be considered to have significant noise and vibration impacts if it results in one or more of the following:

a) Generation of substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards?

b) Generation of excessive groundborne vibration or groundborne noise level?

c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan had not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

The CEQA Statutes and Guidelines Appendix G thresholds for items (c) and (d) do not define the term “substantial”; however, the Colusa County General Plan Noise Element states that an increase in ambient noise levels by more than 3 dB would be considered significant, as discussed below.

1.5.2 Colusa County General Plan

The Colusa County General Plan includes a Noise Element with noise policies to manage sources of noise and protect noise sensitive land uses. This Noise Element contains goals, objectives, policies, and action items that seek to reduce community exposure to excessive noise levels through the establishment of noise level standards for a variety of land uses. The Noise Element contains the following policies to address noise.

Policy N 1-1 New proposed stationary noise sources shall not result in noise levels that exceed the standards of Table N-1, as measured immediately within the property line of lands designated for noise-sensitive uses.

Policy N 1-2 Ensure that noise sources do not interfere with sleep by applying an interior maximum noise level criterion (L_{max}) of 45 dBA in sleeping areas, for sensitive receptors.

Policy N 1-6 Require new land use development proposals to address potential stationary and mobile noise impacts and land use incompatibilities from aircraft noise, train travel, and truck travel.

Policy N 1-12 Where noise mitigation measures are required to achieve the standards of Tables N-1 or N-2, the emphasis of such measures shall be placed upon site planning and project design. The use of noise barriers shall be considered a means of achieving the noise standards only after all other practical design-related noise mitigation measures have been considered and integrated into the project. Landscaped berms shall be considered as a preferred mitigation option over sound walls.

Policy N 1-13 An acoustical analysis shall be prepared and submitted to the County according to the requirements of Table N-3 when:

- Noise sensitive land uses are proposed in areas exposed to existing or projected noise levels exceeding the Table N-1 (stationary) or Table N-2 (mobile) noise level standards.
- A proposed project has the potential to create new noise levels exceeding the noise level standards of Table N-1 or Table N-2.

Policy N 1-15 As part of the review of new development projects, consider vibration impacts and require mitigation to reduce any significant adverse impacts to the maximum extent feasible and practical.

Policy N 1-16 In making a determination of impact under the California Environmental Quality Act (CEQA), a significant impact will occur if the project results in an exceedance of the noise level standards contained in the Noise Element, or the project will result in an increase in ambient noise levels by more than 3 dB.

Policy N 1-17 Require use of site design measures, such as the use of building design and orientation, buffer space, use of berms, and noise attenuation measures applied to the noise source, to reduce impacts to the maximum extent feasible and practical before mitigating noise impacts through use of sound walls. The use of sound walls or noise barriers to attenuate noise from existing noise sources is discouraged, but may be allowed if the wall is architecturally incorporated into the project design, blends into the natural landscape, and does not adversely affect significant public view corridors.

Action N 1-J: As part of the project review and approval process, require that all acoustical studies be prepared in accordance with Table N-3.

Action N 1-K: As part of the project review and approval process, require construction projects and new development anticipated to generate a significant amount of ground borne vibration to ensure acceptable interior vibration levels at nearby noise-sensitive uses based on Federal Transit Administration criteria.

The tables in the Noise Element referred to as Table N-1 and Table N-3 are shown below as Table 4 and Table 5, respectively.

Table 4. Exterior and Interior Noise Level Performance Standards for Projects Affected by or Including Non-transportation Noise Sources

Type of Use	Interior Noise Level Standard	Exterior Noise Level, Leq[1]	
		Day Time (7 A.M. to 10 P.M.)	Nighttime (10 P.M. to 7 A.M.)
All sensitive land uses	45 dB L_{max}	55 dB	45 dB
New residential affected by existing seasonal agricultural noise	40 dB L_{dn}	N/A	N/A

[1] Exterior noise level standard to be applied at the property line of the receiving land use or at a designated outdoor activity area (at the discretion of the Planning Director) of the new development. For mixed-use type projects, the exterior noise level standard may be waived (at the discretion of the Planning Director) if the project does not include a designated activity area and mitigation of property line noise is not practical. In this case, the interior standard would still apply.

Each of the exterior noise levels specified above shall be lowered by five dB for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises (e.g., humming sounds, outdoor speaker systems). These noise level standards do not apply to residential units established in conjunction with industrial or commercial uses (e.g., caretaker dwellings).

The County can impose noise level standards that are more restrictive than those specified above based upon determination of existing low ambient noise levels.

Notes:

Fixed noise sources which are typically of concern include, but are not limited to the following:

Air Compressors
Blowers
Boilers
Cooling Towers/Evaporative Condensers
Conveyor Systems
Cutting Equipment
Drill Rigs
Emergency Generators
HVAC Systems
Fans
Gas or Diesel Motors
Gas Wells
Generators
Grinders
Heavy Equipment
Lift Stations
Outdoor Speakers
Pile Drivers
Pump Stations
Rice Dryers
Steam Turbines
Steam Valves
Transformers
Welders

The types of uses which may typically produce the noise sources described above include but are not limited to: various industrial and agricultural facilities, trucking operations, tire shops, auto maintenance shops, metal fabricating shops, shopping centers, drive-up windows, car washes, loading docks, public works projects, batch plants, bottling and canning plants, recycling centers, electric generating stations, race tracks, landfills, sand and gravel operations, and athletic fields

Source: Colusa County General Plan 2012

Table 5. Requirements For an Acoustical Analysis

An acoustical analysis prepared pursuant to the Noise Element shall:
A. Be the financial responsibility of the applicant.
B. Be prepared by a qualified person experienced in the fields of environmental noise assessment and architectural acoustics.
C. Include representative noise level measurements with sufficient sampling periods and locations to adequately describe local conditions and the predominant noise sources.
D. Estimate existing and projected cumulative (20 years) noise levels in terms of Ldn or CNEL and/or the standards of Table N-1, and compare those levels to the adopted policies of the Noise Element.
E. Recommend appropriate mitigation to achieve compliance with the adopted policies and standards of the Noise Element, giving preference to proper site planning and design over mitigation measures which require the construction of noise barriers or structural modifications to buildings which contain noise-sensitive land uses.
F. Estimate noise exposure after the prescribed mitigation measures have been implemented.
G. Describe a post-project assessment program that could be used to evaluate the effectiveness of the proposed mitigation measures.

Source: Colusa County General Plan 2012

1.5.3 Colusa County Code

Chapter 13 of the Colusa County Code establishes the noise limits in Table 6 that shall not be exceeded when measured at the property boundary of the affected property.

Table 6. Colusa County Code Noise Criteria

Land Use*	Maximum Noise Level (dBA)	
	Day	Night
Residential	55	50
Commercial	60	55
High Noise Traffic Corridor	65	65
* Determination of which land use and time period applies to a noise source shall be based upon the affected (complainant's) property's land use. Decibel levels shall be measured at the affected (complainant's) property plane at the point closest to the noise source. The high noise traffic corridors include the following: Highway 20 and Interstate 5. The land uses as shown in the above table are defined using the county general plan.		

Source: Colusa County Code 2021

The Colusa County Code also establishes the following exemptions from the Table 6 limits:

> (b) Construction and Landscape Maintenance Equipment. Notwithstanding any other provision of this chapter, between the hours of seven a.m. and seven p.m. on Mondays through Fridays, and between the hours of eight a.m. and eight p.m. on Saturdays and Sundays, construction, alteration, repair, or maintenance activities which are authorized by valid county permit or business license, carried out by employees or contractors of the county, or private activities not requiring a permit shall be allowed if they meet at least one of the following noise limitations:

(1) No individual piece of equipment produces a noise level exceeding eighty-three dBA at a distance of twenty-five feet. If the device is housed within a structure on the property, the measurement shall be made outside the structure at a distance as close to twenty feet from the equipment as possible.

(2) The noise level at any point outside of the property plane of the project does not exceed eighty-six dBA.

(A) The provisions of subsections (b)(1) and (2) of this section shall not be applicable to impact tools and equipment; provided, that such impact tools and equipment shall have intake and exhaust mufflers recommended by manufacturers thereof and approved by the director of public works as best accomplishing maximum noise attenuation, and that pavement breakers and jackhammers shall also be equipped with acoustically attenuating shields or shrouds recommended by the manufacturers thereof and approved by the director of public works as best accomplishing maximum noise attenuation. In the absence of manufacturer's recommendations, the director of public works may prescribe such means of accomplishing maximum noise attenuation as he/she may determine to be in the public interest. Construction projects located more than two hundred feet from existing homes may request a special use permit to begin work at six a.m. on weekdays from June 15th until September 1st. No percussion type tools (such as ramsets or jackhammers) can be used before seven a.m. The permit shall be revoked if any noise complaint is received by the sheriff's department.

(B) No individual powered blower shall produce a noise level exceeding seventy dBA measured at a distance of fifty feet.

(C) No powered blower shall be operated within a one-hundred-foot radius of another powered blower simultaneously.

(D) On single-family residential property, the seventy dBA at fifty feet restriction shall not apply if operated for less than ten minutes per occurrence.

(c) Air Conditioners and Similar Equipment. Air conditioners, pool pumps and similar equipment are exempt from this chapter, provided they are in good working order.

(d) Work Required for the Public Health and Safety. Work performed by the county, county franchises, persons under contract with the county for repairs or maintenance of roads, water wells, water service lines, trees, and landscape, as well as street sweeping, garbage removal, and similar activities, are exempt from this chapter.

(e) Safety Devices. Aural warning devices which are required by law to protect the health, safety, and welfare of the community shall be exempt from the provisions of this chapter.

(f) Emergencies. Emergencies are exempt from this chapter. (Ord. No. 730, § 13.20.030.)

1.5.4 Federal Transit Authority Construction Noise Guidelines

There is no standardized state or federal regulatory standards developed for assessing construction noise impacts. However, the FTA has developed and published a guideline criterion that is considered to be reasonable to assess noise impacts from construction operations. The FTA criteria is summarized in Table 7 below.

Table 7. Federal Transit Authority Construction Noise Criteria

Land Use	8-hour (dBA L_{eq})		30-Day Average L_{dn} (dB) or L_{eq} (dBA)
	Day	Night	
Residential	80	70	75[a]
Commercial	85	85	80[b]
Industrial	90	90	85[b]

[a] In urban areas with very high ambient noise levels (Ldn > 65 dB), Ldn from construction operations should not exceed existing ambient + 10 dB.
[b] Twenty-four-hour Leq, not Ldn.

2.0 EXISTING SOUND ENVIRONENMENT

Tetra Tech conducted a series of ambient sound level measurements to characterize the existing acoustic environment near the Project during both daytime and nighttime periods. This section summarizes the methodology used by Tetra Tech to conduct the sound survey and describes the measurement locations.

2.1 FIELD METHODOLOGY

To document the existing conditions, baseline sound level measurements were performed on March 17, 2020. The measurement locations were selected to be representative of the surroundings of potential receptors nearest to the proposed Project site. The ambient sound survey included short-term measurements in the presence of an acoustics expert for a minimum duration of 30 minutes. The short-term measurements were made during both daytime (10:00 a.m. to 4:00 p.m.) and nighttime (10:00 p.m. to 2:00 a.m.) periods at noise-sensitive areas.

All the measurements were conducted using a Larson Davis Model 831 precision integrating sound-level meter that meets the requirements of the American National Standards Institute standards for Type 1 precision instrumentation. This sound analyzer has an operating range of 5 dB to 140 dB, and an overall frequency range of 8 to 20,000 Hz. During the measurement program, microphones were fitted with a windscreen, set upon a tripod at a height of approximately 1.5 meters (5 feet) above the ground and located out of the influence of any vertical reflecting surfaces. The sound analyzer was calibrated at the beginning and end of the measurement period using a Larson Davis Model CAL200 acoustic calibrator following procedures that are traceable to the National Institute of Standards and Technology. Table 8 lists the measurement equipment employed during the survey. The sound level meters were programmed to sample and store A-weighted and octave band sound level data, including L_{eq} and the percentile sound levels.

Table 8. Measurement Equipment

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	831
Preamplifier	Larson Davis	PRM902
Microphone	PCB	377B02
Windscreen	ACO Pacific	7-inch
Calibrator	Larson Davis	CAL200

During the survey, weather conditions were conducive to accurate data collection. Weather conditions were mainly sunny with few clouds and no precipitation occurring during the measurement period. Temperatures ranged from 50 to 57 degrees Fahrenheit during the day, and 50 degrees Fahrenheit during the night.

2.2 FIELD MEASUREMENTS

Two short-term, attended sound measurements were performed at public locations near residential properties proximate to the Project site. The monitoring locations, ML-1 and ML-2 were selected to represent ambient conditions at land uses in the vicinity of the Project site. The short-term monitoring locations are described in Table 9 and mapped on Figure 1.

Table 9. Sound Level Monitoring Locations

Monitoring Location	Coordinates (Universal Transverse Mercator Zone 10S)		Distance and Direction from Project Site Boundary
	Easting (m)	Northing (m)	
ML-1	562114	4326636	50 feet southwest
ML-2	562120	4328054	250 feet north

2.2.1 Location ML-1

This monitoring location is located on Spring Valley Road approximately 2.3 miles south of Walnut Dr, and 50 feet from the southwestern Project boundary line. This location represents the closest residence to the south.

During the daytime measurement period, the most prominent noise was generated from distant farm equipment and songbirds. During the nighttime measurement period, the most prominent noise came from distant coyotes howling and the occasional buzz from a transmission line.

2.2.2 Location ML-2

This monitoring location is on Spring Valley Road approximately 1.3 miles south of Walnut Drive, and 250 feet from the northern Project boundary line. This location represents the closest residence to the north.

During the daytime measurement period, the most prominent noise was generated by distant farm equipment, cattle, and occasional vehicles along Spring Valley Road. During the nighttime measurement period, the most prominent noise came from distant coyotes howling.

2.3 MEASUREMENT RESULTS

Table 10 provides a summary of the measured ambient sound levels observed at each of the monitoring locations for both the daytime and nighttime L_{eq}.

Table 10. Sound Measurement Results – L_{eq} Sound Levels

Monitoring Location	Time Period	L_{eq} (dBA)
ML-1	Day	32
	Night	24
ML-2	Day	34
	Night	28

Ambient sound levels exhibited typical diurnal patterns. Daytime L_{eq} sound levels at the measurement locations ranged from a low of 32 dBA at ML-1 to a high of 34 dBA at ML-2. Nighttime sound levels ranged from a low of 24 dBA at ML-1 to a high of 28 dBA at ML-2.

3.0 PROJECT CONSTRUCTION

3.1 NOISE CALCULATION METHODOLOGY

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

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

3.2 PROJECTED NOISE LEVELS DURING CONSTRUCTION

The construction processes are anticipated to occur during a period of approximately 11 months and begin in late 2022. Project construction would consist of five major stages. The first stage would include mobilization, site preparation, fencing, and laydown. The second stage would involve excavation, trenching and trench backfill.The third stage includes installation of cables and utilities. The fourth stage includes construction of the inverters, PV modules, and battery energy storage system units, and also includes commissioning and testing.

Table 11 summarizes the projected noise levels at the NSAs due to Project construction.

Table 11. Projected Construction Noise Levels by Stage (dBA L_{eq})

Construction Stage	Equipment				Construction Noise Level, dBA					
	Equipment Type	Quantity	Usage Factor (%)	USEPA Construction Noise Level (50 feet), dBA	Project Boundary (50 feet)	NSA-1 (1,430 feet)[1]	NSA-2 (100 feet)[1]	NSA-3 (1080 feet)[1]	NSA-4 (300 feet)[1]	NSA-5 (250 feet)[1]
Preparation	Backhoes	4	40	80	93	64	87	66	76	79
	Plate Compactors	2	20	80						
	Crawler Tractors	2	40	84						
	Dump Trucks	5	40	84						
	Forklifts	2	20	85						
	Generator Sets	4	50	82						

Construction Stage	Equipment				Construction Noise Level, dBA					
	Equipment Type	Quantity	Usage Factor (%)	USEPA Construction Noise Level (50 feet), dBA	Project Boundary (50 feet)	NSA-1 (1,430 feet)[1]	NSA-2 (100 feet)[1]	NSA-3 (1080 feet)[1]	NSA-4 (300 feet)[1]	NSA-5 (250 feet)[1]
	Graders	2	40	85						
	Scrapers	2	40	85						
	Skid Steer Loaders	4	40	80						
Excavation	Backhoes	4	40	80	93	64	87	66	77	79
	Plate Compactors	2	20	80						
	Crawler Tractors	2	40	84						
	Dump Trucks	5	40	84						
	Forklifts	2	20	85						
	Generator Sets	4	50	82						
	Graders	2	40	85						
	Scrapers	2	40	85						
	Skid Steer Loaders	2	40	80						
Utilities/ Sub-grade	Backhoes	4	40	80	93	64	87	66	76	79
	Plate Compactors	2	20	80						
	Crawler Tractors	2	40	84						
	Dump Trucks	5	40	84						
	Forklifts	2	20	85						
	Generator Sets	4	50	82						
	Graders	2	40	85						
	Scrapers	2	40	85						
	Skid Steer Loaders	2	40	80						
Construction	Backhoes	7	40	84	98	69	92	71	82	84
	Bore/Drill Rigs	10	20	85						
	Cement Mixers	10	40	85						
	Forklifts	5	20	85						
	Concrete Saws	3	20	90						
	Plate Compactors	1	20	80						
	Cranes	1	16	85						

Construction Stage	Equipment				Construction Noise Level, dBA					
	Equipment Type	Quantity	Usage Factor (%)	USEPA Construction Noise Level (50 feet), dBA	Project Boundary (50 feet)	NSA-1 (1,430 feet)[1]	NSA-2 (100 feet)[1]	NSA-3 (1080 feet)[1]	NSA-4 (300 feet)[1]	NSA-5 (250 feet)[1]
	Dump Truck	5	40	84						
	Excavators	2	40	85						
	Generator Sets	4	50	82						
	Pavers	1	50	85						
	Paving Equipment	1	40	85						
	Skid Steer Loaders	2	40	80						
	Trenchers	10	50	82						
	Rollers	1	20	85						
Paving	Rollers	1	20	85	78	50	72	51	62	64

[1]Distance to residential structure.

The construction of the Project may cause short-term, but unavoidable noise impacts that could be loud enough at times to temporarily interfere with speech communication outdoors and indoors with windows closed at NSA-2 and NSA-4, and with windows open at NSA-3 and NSA-5. The noise levels resulting from the construction activities would vary significantly depending on several factors such as the type and age of equipment, specific equipment manufacture and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers.

Project construction would occur between 7:00 a.m. and 7:00 p.m., Monday through Friday, and between 8:00 a.m. and 8:00 p.m., Saturday and Sunday in compliance with the Colusa County's Code. Furthermore, all reasonable efforts would be made to minimize the impact of noise resulting from construction activities including implementation of standard noise reduction measures. Due to the infrequent nature of loud construction activities at the site, the limited hours of construction and the implementation of noise mitigation measures, the temporary increase in noise due to construction is considered to be a less than significant impact.

3.3 CONSTRUCTION NOISE MITIGATION

Since construction machines operate intermittently, and the types of machines in use at the Project site change with the stage of construction, noise emitted during construction would be mobile and highly variable, making it challenging to control. The construction management protocols would include the following noise mitigation measures to minimize noise impacts:

- Maintain all construction tools and equipment in good operating order according to manufacturers' specifications.
- Limit use of major excavating and earth-moving machinery to daytime hours.
- To the extent practicable, schedule construction activity during normal working hours on weekdays when higher sound levels are typically present and are found acceptable. Some limited activities, such as concrete pours, would be required to occur continuously until completion.
- Equip any internal combustion engine used for any purpose on the job or related to the job with a properly operating muffler that is free from rust, holes, and leaks.

- For construction devices that utilize internal combustion engines, ensure the engine's housing doors are kept closed, and install noise-insulating material mounted on the engine housing consistent with manufacturers' guidelines, if possible.
- Limit possible evening shift work to low noise activities such as welding, wire pulling, and other similar activities, together with appropriate material handling equipment.
- Utilize a Complaint Resolution Procedure to address any noise complaints received from residents.

3.4 VIBRATION CALCULATION METHODOLOGY

Vibration levels for activities associated with Project construction were based on the average of source levels in PPV published with the FTA (2006) Noise and Vibration Manual, which documents several types of construction equipment measured under a wide variety of construction activities. Using the documented vibration levels as input into a basic propagation model, construction vibration levels were calculated at the nearest Project site boundary and then at the NSA structure.

3.5 PROJECTED VIBRATION LEVELS DURING CONSTRUCTION

As discussed in Section 3.2, Project construction would be completed in five work stages. This vibration analysis evaluated the worst-case vibration source, which would be the roller. Based on vibration propagation calculations, construction vibration levels are predicted to range from 0.0007 PPV inches per second (in/sec; 45 VdB) to 0.0263 PPV in/sec (76 VdB) dBA at the NSAs. These levels are based on the worst-case vibration producing equipment and it is expected that other vibration generating equipment proposed for the Project construction would result in lower vibration levels. Table 12 summarizes the predicted vibration levels at each of the NSAs based on the highest vibration generating equipment. As shown in Table 12, vibration levels may be perceptible at the nearest sensitive receptors but will be below the maximum vibration level of 80 VdB. This level is considered acceptable for impacts to sensitive receptors.

Table 12. Projected Construction Vibration Levels

Construction Operation	Vibration Level Metric	Project Boundary (50 feet)	NSA-1 (1,430 feet)[1]	NSA-2 (100 feet)[1]	NSA-3 (1,080 feet)[1]	NSA-4 (300 feet)[1]	NSA-5 (250 feet)[1]
Roller	PPV in/sec	0.0743	0.0005	0.0263	0.0007	0.0051	0.0067
	VdB	85	41	76	45	62	64

[1]Distance to residential structure.

4.0 OPERATIONAL NOISE

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

4.1 NOISE PREDICTION MODEL

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

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

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

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

Off-site topography was obtained using the publicly available United States Geological Survey digital elevation data. A default ground attenuation factor of 0.5 was assumed for off-site sound propagation over acoustically “mixed” ground.

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

4.2 INPUT TO THE NOISE PREDICTION MODEL

The Project’s general arrangement was reviewed and directly imported into the acoustic model so that on-site equipment could be easily identified; buildings and structures could be added; and sound emission data could be assigned to sources as appropriate. Figure 2 shows the Project equipment layout based on the version 4 layout which RWE provided to Tetra Tech on June 28, 2021.

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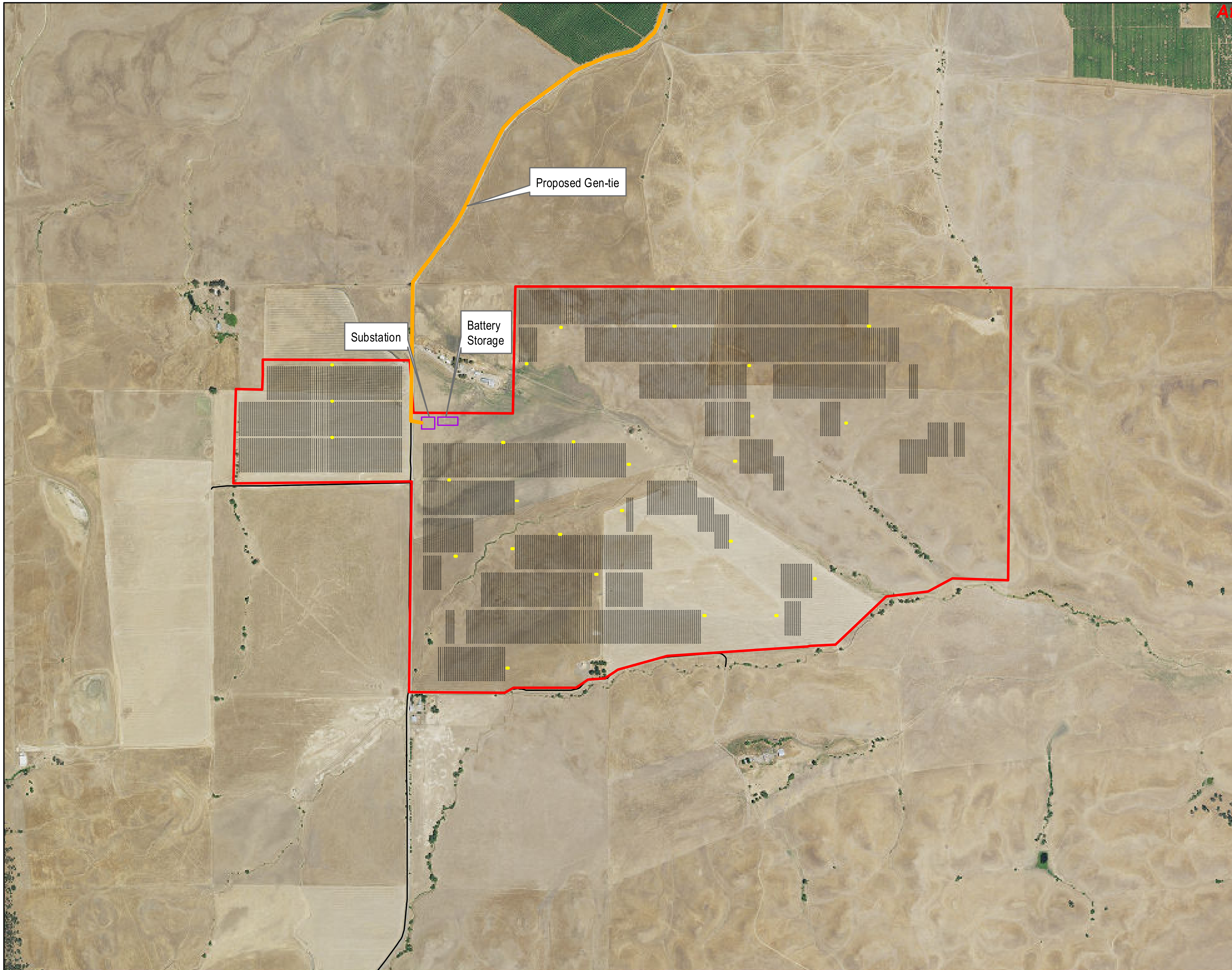
Figure 2: Facility Equipment Layout



Project Area
Solar Array
Substation and Battery Storage
Inverter
Proposed Gen-tie

0 0.25 0.5 Miles

Scale is 1:15,000 when printed at 11"x17"

NOT FOR CONSTRUCTION

The primary noise sources during operations are the inverters, transformers, battery storage heating, ventilation, and air conditioning (HVAC) units, and battery storage inverters. It is expected that all equipment would operate during the daytime period. During the nighttime period the battery storage would discharge electricity resulting in the operation only of the battery storage HVAC units, battery storage inverters, and substation transformer. It is assumed that the solar panel inverters and the solar panel inverter distribution transformers would not operate during the nighttime period. Reference sound power levels input to Cadna-A were provided by equipment manufacturers, based on information contained in reference documents or developed using empirical methods. The source levels used in the predictive modeling are based on estimated sound power levels that are generally deemed to be conservative. The projected operational noise levels are based on applicant-supplied sound power level data for the major sources of equipment. Table 13 summarizes the equipment sound power level data used as inputs to the initial modeling analysis.

Table 13. Modeled Sound Power Level (L_w) for Major Pieces of Project Equipment

Sound Source	Sound Power Level (L_P) by Octave Band Frequency dBL									Broadband Level
	31.5	63	125	250	500	1k	2k	4k	8k	dBA
Inverter Distribution Transformer	56	66	71	72	71	68	63	65	68	78
Substation Transformer	57	63	64	60	60	53	49	44	37	60
Battery Storage Inverter	67	71	74	74	74	68	65	66	61	75
Battery Storage HVAC	-	78	77	74	69	68	62	57	51	72

4.3 NOISE PREDICITION MODEL RESULTS

Broadband (dBA) sound pressure levels were calculated for expected normal Project operation assuming that all components identified previously are operating continuously and concurrently at the representative manufacturer-rated sound. It is expected that all equipment would operate during the daytime period, while only the battery storage HVAC units, battery storage inverters, and substation transformer would operate during the nighttime period. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of reception. Sound contour plots displaying broadband (dBA) sound levels presented as color-coded isopleths are provided in Figure 3 for daytime levels, and Figure 4 for the nighttime levels. The noise contours are graphical representations of the cumulative noise associated with full operation of the equipment and show how operational noise would be distributed over the surrounding area of the Project site. The contour lines shown are analogous to elevation contours on a topographic map, i.e., the noise contours are continuous lines of equal noise level around some source, or sources, of noise. Figure 3 and Figure 4 also show the ambient sound monitoring locations, representative of proximate noise sensitive land uses, that were used to assess potential noise impacts on a cumulative basis.

Table 14 and Table 15 show the projected exterior sound levels at the property boundary of each receptor, while Table 16 and Table 17 show the projected exterior sound levels near the residential structure of each receptor. The tables also provide the total predicted net increase in sound energy at each of the receptors.

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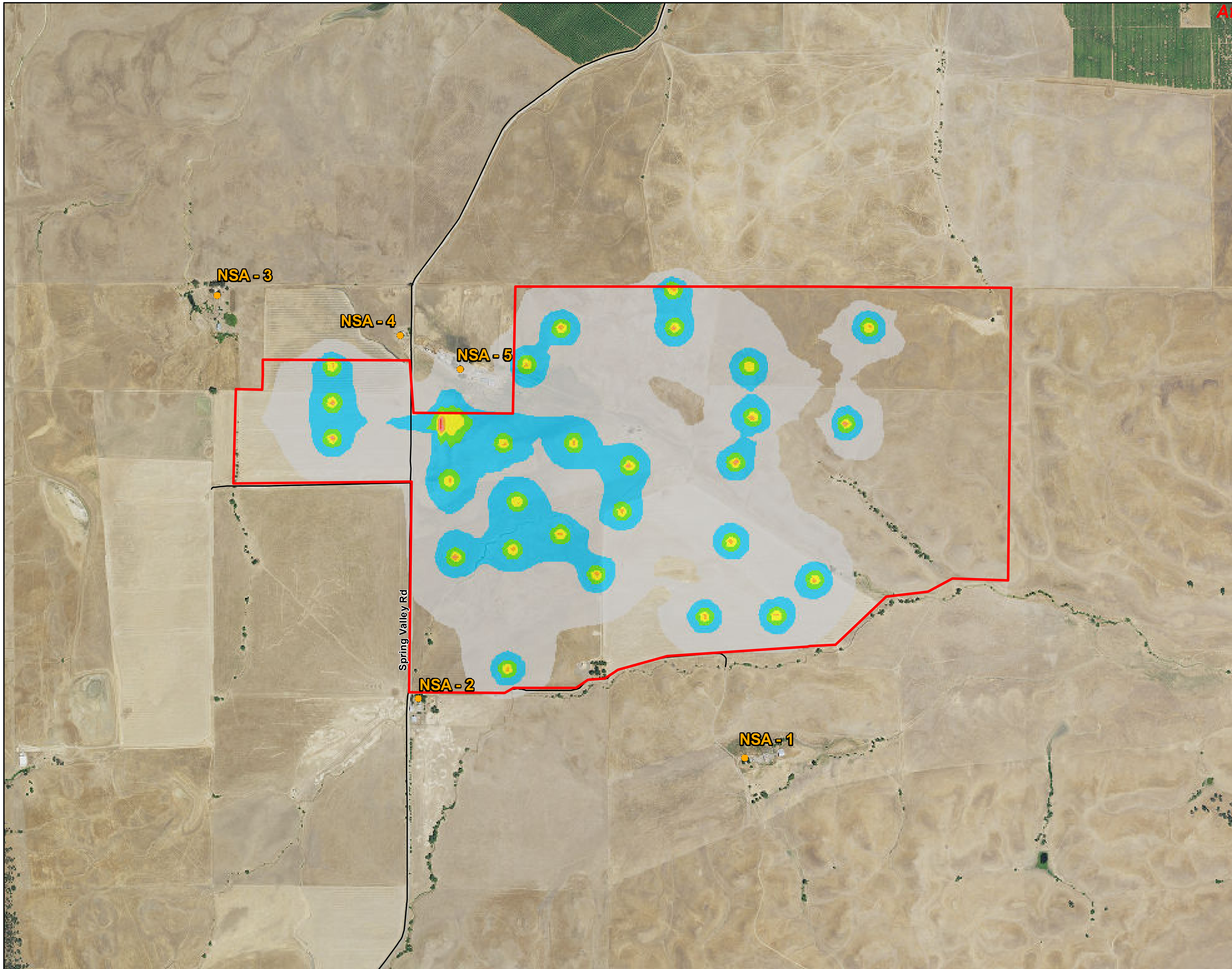
Figure 3: Daytime Received Sound Levels



Project Area

Noise Sensitive Receptor

Recieved Sound Levels (dBA)

30-35

35-40

40-45

45-50

50-55

55-60

60-65

0 0.25 0.5 Miles

Scale is 1:15,000 when printed at 11"x17"

NOT FOR CONSTRUCTION

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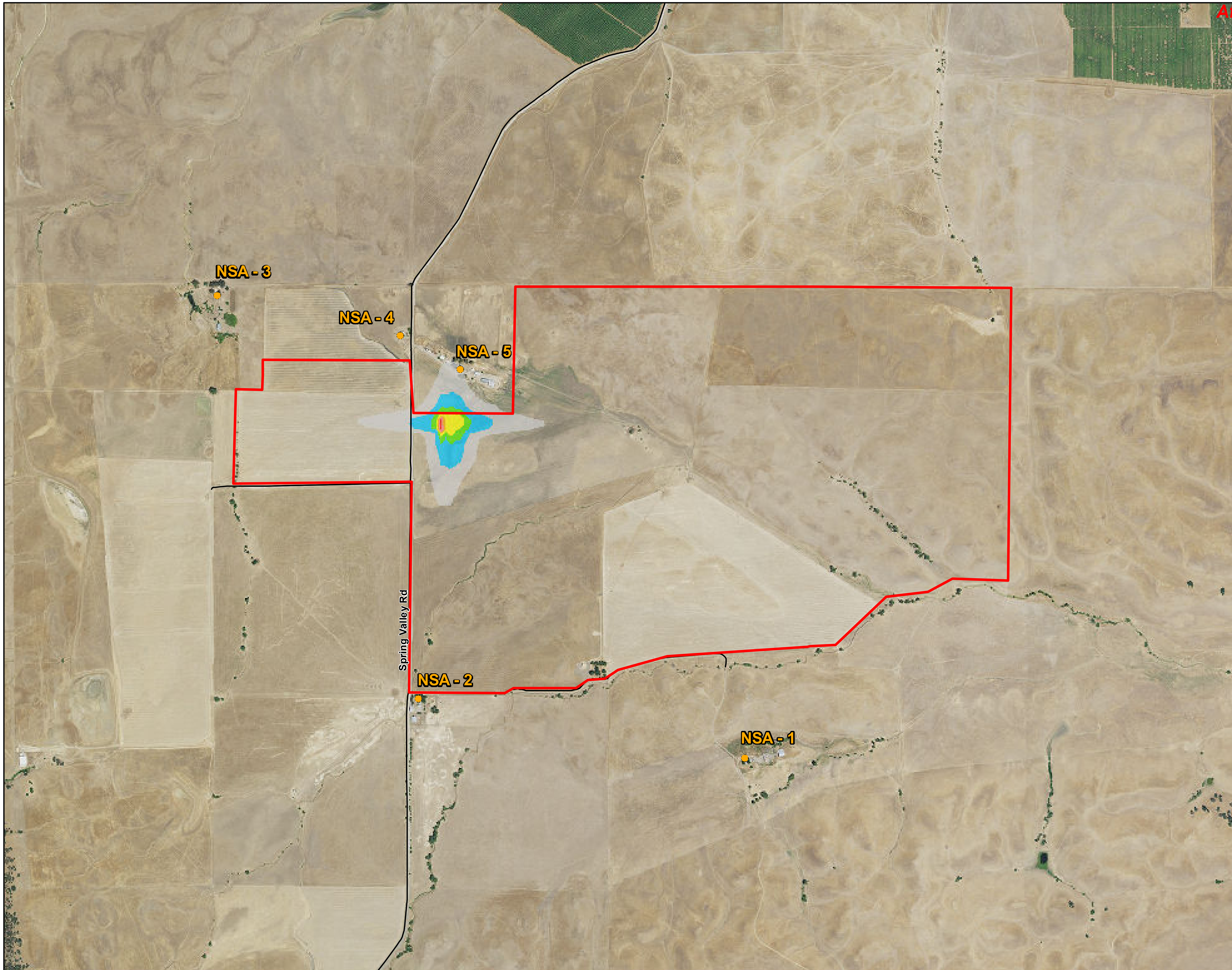
Figure 4: Nighttime Received Sound Levels



Project Area

Noise Sensitive Receptor

Recieved Sound Levels (dBA)

30-35

35-40

40-45

45-50

50-55

55-60

60-65

0 0.25 0.5 Miles

Scale is 1:15,000 when printed at 11"x17"

NOT FOR CONSTRUCTION

Table 14. Daytime Acoustic Modeling Results Summary – County Limits

NSA Property Line	Participation Status	UTM Coordinates (meters)		Daytime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA
		Easting	Northing			
NSA-1	Non-participant	563475	4326765	32	27	33
NSA-2	Non-participant	562516	4326624	32	32	35
NSA-3	Non-participant	561506	4327674	34	27	35
NSA-4	Non-participant	562084	4328070	34	27	35
NSA-5	Participant	532273	4327769	34	46	46
Noise Element Exterior Daytime Noise Level Limit						55 dB
Colusa County Code Daytime Noise Level Limit						55 dB

Table 15. Nighttime Acoustic Modeling Results Summary – County Limits

NSA Property Line	Participation Status	UTM Coordinates (meters)		Nighttime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA
		Easting	Northing			
NSA-1	Non-participant	563475	4326765	24	3	24
NSA-2	Non-participant	562516	4326624	24	14	24
NSA-3	Non-participant	561506	4327674	28	16	28
NSA-4	Non-participant	562084	4328070	28	22	29
NSA-5	Participant	532273	4327769	28	45	45
Noise Element Exterior Nighttime Noise Level Limit						45 dB
Colusa County Code Nighttime Noise Level Limit						50 dB

Table 16. Daytime Acoustic Modeling Results Summary – CEQA Thresholds

NSA Structure	Participation Status	UTM Coordinates (meters)		Daytime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA	Net Increase in Sound Level, dBA
		Easting	Northing				
NSA-1	Non-participant	563489	4326375	32	17	32	0
NSA-2	Non-participant	562162	4326600	32	24	33	1
NSA-3	Non-participant	561324	4328230	34	21	34	0
NSA-4	Non-participant	562072	4328230	34	27	35	1
NSA-5	Participant	562316	4327942	34	32	36	3
Noise Element CEQA Threshold							3 dB

Table 17. Nighttime Acoustic Modeling Results Summary – CEQA Thresholds

NSA Structure	Participation Status	UTM Coordinates (meters)		Nighttime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA	Net Increase in Sound Level, dBA
		Easting	Northing				
NSA-1	Non-participant	563489	4326375	24	0	24	0
NSA-2	Non-participant	562162	4326600	24	14	24	0

NSA Structure	Participation Status	UTM Coordinates (meters)		Nighttime Ambient L_{eq}, dBA	Project Sound Level, dBA	Total Sound Level (Ambient + Project), dBA	Net Increase in Sound Level, dBA
		Easting	Northing				
NSA-3	Non-participant	561324	4328230	28	10	28	0
NSA-4	Non-participant	562072	4328230	28	21	29	1
NSA-5	Participant	562316	4327942	28	31	33	5
Noise Element CEQA Threshold							3 dB

Table 14 and Table 15 show the highest total sound levels, inclusive of ambient and project operational levels, are associated with participating receptor NSA-5, which would comply with the Colusa County Noise Element daytime threshold limit of 50 dBA, as well as the nighttime threshold of 45 dBA. Table 16 and Table 17 shows compliance with the CEQA limits at all non-participating receptors, and 1 exceedance during the nighttime at participating receptor NSA-5.

4.4 TRANSMISSION LINE NOISE ANALYSIS

A 3-mile-long overhead, 60 kilovolt (kV) transmission line would be located partially on the Colusa County's right-of-way on Walnut Drive and Spring Valley Road and partially on private land from the Project Site to the point of interconnection at the Cortina Substation.

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

The Electric Power Research Institute has conducted several studies of corona effects (EPRI 1978, 1987). The typical noise levels for transmission lines with wet conductors are shown in Table 18.

Table 18. Transmission and Subtransmission Line Voltage and Audible Noise Levels

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

As shown in Table 18, the audible noise associated with transmission and subtransmission lines decreases as the line voltage decreases; the audible noise associated with the 66-kV line is lower than 34 dBA. This noise level would comply with the County's noise threshold.

5.0 CONCLUSIONS

The construction of the Project has been organized into five major work stages. Based on sound propagation calculations, construction sound levels are predicted to range from 50 to 92 dBA at the NSAs. Periodically, sound levels may be higher or lower than those presented in Table 11; however, the overall sound levels should generally be lower due to excess attenuation and the trend toward quieter construction equipment in the intervening decades since these data were developed. As shown in Table 11, the highest projected sound level from construction-related activity is expected to occur at NSA-2 during Stage 4 construction. Furthermore, reasonable efforts would be made to minimize the impact of noise resulting from construction activities at proximate noise sensitive areas through the use of noise mitigation. Because of the temporary nature of the construction noise, no adverse or long-term effects are expected.

During Project construction, the worst-case vibration source would be rollers. Based on vibration propagation calculations, construction vibration levels are predicted to range from 0.0007 PPV in/sec (45 VdB) to 0.0263 PPV in/sec (76 VdB) dBA at the NSAs. These levels are based on the worst-case vibration producing equipment and it is expected that other vibration generating equipment proposed for the Project construction would result in lower vibration levels. As shown in Table 12, vibration levels may be perceptible at the nearest sensitive receptors but will be below the maximum vibration level of 80 VdB. This level is considered acceptable for impacts to sensitive receptors.

Normal Project operations would occur during the daytime period, while only the battery storage HVAC units, battery storage inverters, and substation transformer would operate during the nighttime period. The highest total sound levels, inclusive of ambient and project operational levels, are associated with participating receptor NSA-5, which would be 46 dBA during the day and 45 dBA during the night at the property line, and 36 dBA during the day and 33 dBA during the night at the residential structure. The highest levels for a non-participating receptor are associated with NSA-4, which would be 35 dBA during the day and 29 dBA during the night at the property line and at the residential structure. As NSA-5 is a participating landowner, these levels show compliance with the Colusa County Noise Element daytime threshold limit of 50 dBA, the nighttime threshold of 45 dBA, and the CEQA threshold of 3 dB above ambient.

The Project substation would connect to a transmission line that would be constructed to connect the Project's output to the existing Cortina Substation. The audible noise associated with the 66-kV line is lower than 34 dBA. This noise level would comply with the County's nighttime threshold of 45 dBA.

6.0 REFERENCES

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