Attachment J: Acoustic Assessment

List of Tables

List of Figures

1.0 INTRODUCTION

Wallula Gap, LLC (the Applicant), a subsidiary owned by OneEnergy Renewables, proposes development of the Wallula Gap Solar Energy Project (Facility) on up to approximately [illegible] acres in Benton County, Washington. The Facility will consist of a 60-megawatt solar photovoltaic energy generation system, optional battery energy storage system (BESS) with associated power conversion system (PCS) inverters capable of storing up to 60 megawatts of energy, and photovoltaic (PV) inverters with collocated transformers. In addition, the Facility will include supporting electrical infrastructure such as collection lines and substation with transformer, tracking motors, and internal access roads.

Tetra Tech, Inc. (Tetra Tech) prepared an acoustic assessment for the Facility to evaluate potential sound impacts relative to the applicable noise regulations prescribed in the Washington Administrative Code (WAC). The existing ambient acoustic environment was characterized based on land use, population density, and proximity to major roadways. An acoustic modeling analysis was conducted by simulating sound produced during both construction and operation. Operational sound sources consisted primarily of the inverters, step-up transformers, optional BESS, and transformer at the on-site substation. Modeled sound levels from Facility operation were evaluated against the WAC noise regulations. The overall objectives of this assessment were to: 1) identify Facility sound sources and estimate sound propagation characteristics; 2) computer-simulate sound levels using internationally accepted calculation standards; and 3) confirm that the Facility will operate in compliance with the applicable noise regulations.

1.1 Project Area Extent

The Facility will be located approximately 4 miles northwest of the unincorporated community of Plymouth on parcels located north of Washington Highway 14, approximately 5 miles west of its intersection with Interstate 82.

All Facility parcels are zoned Growth Management Act Agricultural District (GMAAD). Until December of 2021, “power generating facilities, major” were a conditionally permitted use in the GMAAD zoning district in Benton County; however, the commissioners voted to remove the conditional use permit option for “power generator facility, major” from the GMAAD district. The property is partially developed and has historically been used for agricultural purposes since at least the 1970s, including both crop production and livestock grazing. Development on the Facility parcels has highly disturbed and modified the natural landscape. The Project Area Extent is mostly flat but gently slopes southward, which is ideal for solar PV projects and overall constructability. A few small areas with grades above 10 percent may require grading, although none will occur in surface waters, wetlands, or frequently flooded areas.

Figure 1 provides an overview of the Project Area Extent and provides the location of the closest residence, which is referred to as a Noise Sensitive Receptor (NSR).

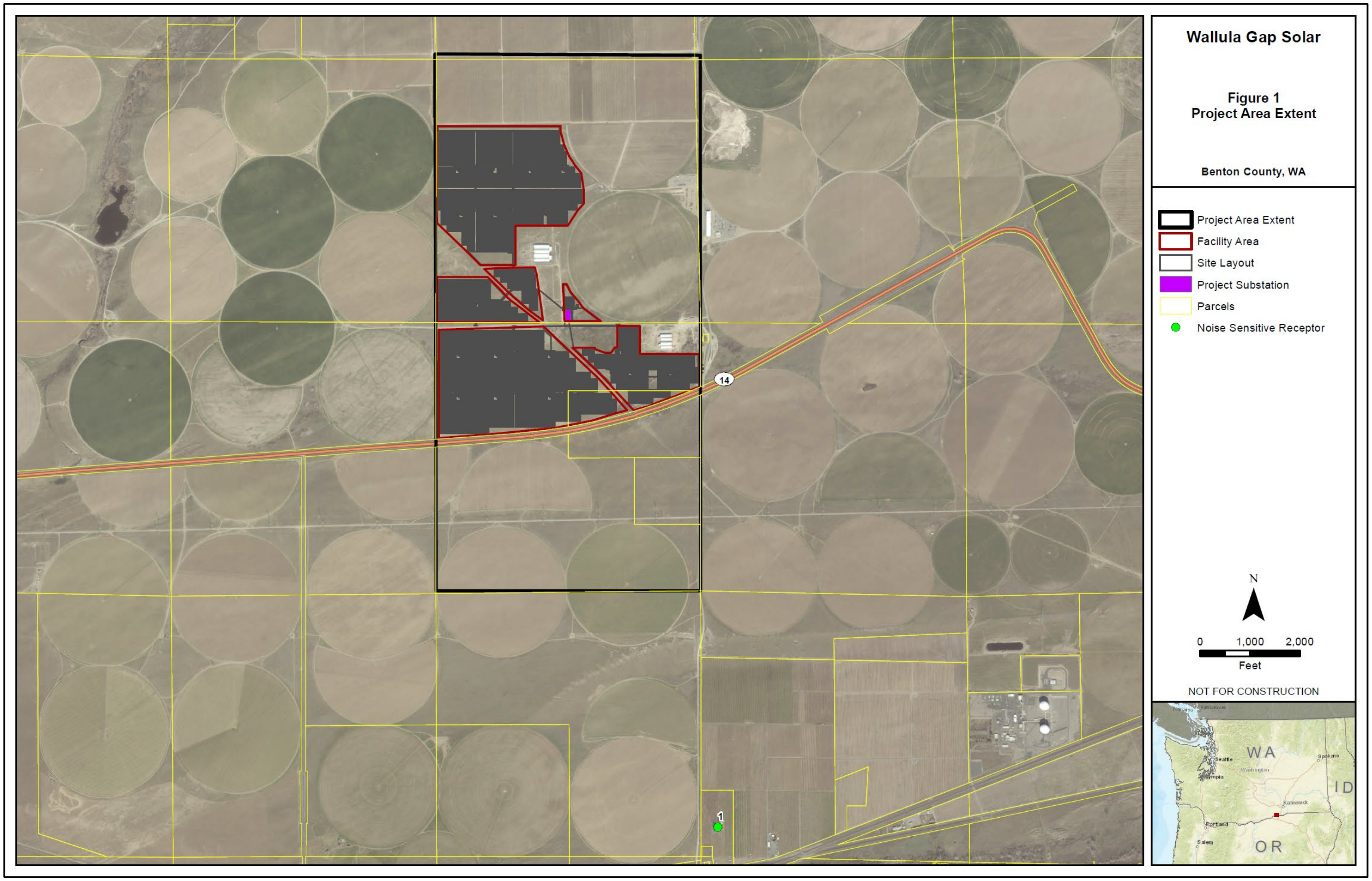

Figure 1. Project Area Extent

1.2 Acoustic Metrics and Terminology

All sounds originate from 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 (LW), which is independent of any external factors. 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 (LP) is a measure of the sound wave fluctuation at a given receiver location and can be obtained using 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 20.1. 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.

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), which measures 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 decibels (dBA).

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (Leq). The Leq 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 Washington. Estimates of noise sources and outdoor acoustic environments and the comparison of relative loudness are listed in Table 1. Table 2 presents additional reference information on terminology used in the report.

Table 1. Sound Pressure Levels 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	

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
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: Beranek (1988) and EPA (1971a)

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 (LP)	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 (LW)	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.
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 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 Noise Regulations and Guidelines

1.3.1 Federal Regulations

There are no federal noise regulations applicable to the Facility.

1.3.2 Washington Administrative Code State Regulations

Environmental noise limits have been established by the Washington Administrative Code (WAC 173-60). WAC 173-60 establishes noise limits based on the Environmental Designation for Noise Abatement (EDNA) of the sound source and the receiving properties.

- Class A EDNA—Lands where people reside and sleep. They typically include residential property; multiple family living accommodations; recreational facilities with overnight accommodations such as camps, parks, camping facilities, and resorts; and community service facilities including orphanages, homes for the aged, hospitals, and health and correctional facilities.

- Class B EDNA—Lands involving uses requiring protection against noise interference with speech. These typically will include commercial living accommodations; commercial dining establishments; motor vehicle services; retail services; banks and office buildings; recreation and entertainment property not used for human habitation such as theaters, stadiums, fairgrounds, and amusement parks; and community service facilities not used for human habitation (e.g., educational, religious, governmental, cultural, and recreational facilities).
- Class C EDNA—Lands involving economic activities of a nature that noise levels higher than those experienced in other areas are normally to be anticipated. Typical Class A EDNA uses generally are not permitted in such areas. Typically, Class C EDNA include storage, warehouse, and distribution facilities; industrial property used for the production and fabrication of durable and nondurable man-made goods; and agricultural and silvicultural property used for the production of crops, wood products, or livestock.

Land use that is considered agricultural is defined as Class C receiving properties. Conversely, agricultural properties principally used for residential purposes with no clearly visible farming or ranching activities are identified as Class A receiving properties. The WAC does maintain flexibility for interpretation in the classification of the appropriate EDNA on both the state and local level. In this assessment, receiving properties consist of Class C Lands and Class C Lands containing Class A residential structures. In fact, there is only one residential structure located nearby, which is approximately 0.9 miles south of the Project Area Extent. Between the hours of 10:00 p.m. and 7:00 a.m., the noise limitations are reduced by 10 dBA for receiving property within Class A EDNAs. WAC 173.60.050 exempts temporary construction noise from the state noise limits.

The noise level limits by EDNA classifications are presented in Table 3. The WAC allows these limits to be exceeded for certain periods of time: 5 dBA for no more than 15 minutes in any hour, 10 dBA for no more than 5 minutes of any hour, and 15 dBA for no more than 1.5 minutes of any hour; these are commonly presented as LN statistical sound levels as well as maximum sound levels (Lmax), as shown in Table 4.

Table 3. Washington State Environmental Noise Limits

EDNA of Source Property	EDNA of Receiving Property		
	Class A Land Day/Night	Class B Land	Class C Land
Class A Land	**55/45**	57	60
Class B Land	**57/47**	60	65
Class C Land	**60/50**	65	70

Source: WAC 173-60-040.

2.0 EXISTING SOUND ENVIRONMENT

The degree of audibility of a new or modified sound source is dependent in a large part upon the relative level of the ambient noise. A range of noise settings occurs within the Project Area Extent. Variations in acoustic environment are due in part to existing land uses, population density, and proximity to transportation corridors. Elevated existing ambient sound levels in the region occur near major transportation corridors such as interstate highways and in areas with higher population densities. Nearby rural airstrips and airports, including the Hermiston Municipal Airport, Tri-Cities Airport, and Richland Airport, also contribute to ambient noise levels in both surrounding urban and rural areas. Principal contributors to the existing acoustic environment likely include motor vehicle traffic, mobile farming equipment, all-terrain vehicles, local roadways, periodic aircraft flyovers, and natural sounds such as birds, insects, and leaf or vegetation rustle during elevated wind conditions. Diurnal effects result in sound levels that are typically quieter during the night than during the daytime, except during periods when evening and nighttime insect noise dominates in warmer seasons.

The analysis area is inclusive of all areas that could be potentially affected by construction or operational noise resulting from the Facility. The analysis area for noise around the Facility was defined as the area bounded by a perimeter extending approximately 1.2 miles (2 kilometers) from the Facility Area. In the absence of ambient measurement data, the existing sound level environment in the vicinity of Facility was estimated with a method published by the Federal Transit Administration in its Noise and Vibration Impact Assessment (FTA 2018). This document presents the general assessment of existing noise exposure based on the population density per square mile and proximity to area sound sources such as roadways and rail lines.

The proposed Facility is approximately 9 miles (14.5 kilometers) northwest of the city of Hermiston, which has a population density of 19,423 per square mile according to the U.S. Census Bureau (2022). Table 5 indicates the estimated baseline sound levels based on population density for daytime, evening, and nighttime L_{eq} as well as the day-night average sound level (L_{dn}). The L_{dn} is the average equivalent sound level over a 24-hour period; a penalty is added for noise occurring during the nighttime hours between 10:00 p.m. and 7:00 a.m. During the nighttime period, 10 dB is added to reflect the impact of the noise.

Table 5. Estimated Baseline Sound Levels in Proximity to the Facility

Mean Sound Level (dBA)	L_{eq} (Day)	L_{eq} (Evening)	L_{eq} (Night)	L_{dn}
	50	45	40	50

3.0 FACILITY CONSTRUCTION

Construction of the Facility is expected to be typical of other solar power generating facilities in terms of schedule, equipment, and activities. Construction is anticipated to occur over 12 to 18 months and would require a variety of equipment and vehicles.

3.1 Noise Calculation Methodology

Acoustic emission levels for activities associated with Facility construction were based on typical ranges of energy equivalent noise levels at construction sites, as documented by the U.S. Environmental Protection Agency (EPA; 1971b) and the EPA's "Construction Noise Control Technology Initiatives" (EPA 1980). The EPA methodology distinguishes between type of construction and construction stage. Using those energy equivalent noise levels as input to a basic propagation model, construction noise levels were calculated at a series of set reference distances.

The basic model assumed spherical wave divergence from a point source located at the closest point of the Facility site. 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

Construction work will not consist of a phased approach. Table 6 summarizes the expected equipment to be used during Facility construction. Table 6 also shows the maximum noise level at 50 feet.

Table 6. Facility Construction Equipment Noise Levels

Construction Equipment	Maximum (Lmax) Equipment Noise Level at 50 feet
Pickup Truck	55
Crane	85
Excavator	85
Dozer	85
Backhoe	80
Trencher	82
Compactor	80
Forklift	80
Telescopic Handler	85
Loader	80
Grader	85
Concrete Mixer	85
Semi-Truck	84
Generator	82
Hydraulic Driller	84

Table 7 shows the projected noise levels from Facility construction at the one nearby NSR. Periodically, sound levels may be higher or lower than those presented in Table 7; 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 the EPA data were developed.

The construction of the Facility 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 open. Noise levels resulting from the construction activities would vary significantly depending on several factors such as the type and age of equipment, specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers.

Facility construction would generally occur during the day, Monday through Friday. 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.

Table 7. Facility Construction Noise Levels

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zoning 11		Distance from NSR to nearest Construction Area		Received Noise Level, dBA
		Easting	Westing	Meters	Feet	
1	Unknown	311271	5088662	2,565	8,415	50

3.3 Construction Noise Mitigation

Since construction equipment operates intermittently, 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.

4.0 OPERATIONAL NOISE

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

4.1 Noise Prediction Model

The CadnaA (Computer-Aided Noise Abatement) computer noise model was used to calculate sound pressure levels from the operation of the Facility equipment in the vicinity of the Facility site. An industry standard CadnaA was developed by DataKustik GmbH (2020) 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 Facility, and in most cases, yields conservative results of operational noise levels in the surrounding community.

The outdoor noise propagation model is based on the ISO 9613, Part 2: "Attenuation of Sound during Propagation Outdoors" (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 or conditions that are typically considered worst-case. The calculation of sound propagation from source to receiver locations consists of full octave band sound frequency algorithms that 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 such as residential land uses;
- 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.

CadnaA 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 U.S. Geological Survey digital elevation data. A default ground attenuation factor of 0.5 was assumed for off-site sound propagation over acoustically "mixed" ground. A conservative ground attenuation factor of 0.0 for a reflective surface was assumed on site.

The output from CadnaA 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 Facility layout 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. The primary noise sources during operation are the PV inverters, their integrated step-up transformers, optional BESS units with associated PCS inverters, and substation transformers. Electronic noise from inverters can be audible but is often reduced by a combination of shielding, noise cancelation, filtering, and noise suppression. The Facility layout consists of 17 PV inverters with collocated transformers and 60 tracking motors operating for approximately 17.91 minutes per day for the PV portion of the site. The optional BESS portion of the Facility consists of up to 240 megawatt-hours of BESS units. Additional BESS equipment depends on the final site architecture (up to 17 PCS inverters for alternating current–coupled BESS or up to 120 direct current (DC)/DC converters for DC-coupled BESS).

Substations have switching, protection, and control equipment, as well as a main power transformer, which generate the sound generally described as a low humming. Three chief noise sources are associated with a transformer: core noise, load noise, and noise generated by the operation of the cooling equipment. The core is the principal noise source and does not vary significantly with electrical load. The load noise is primarily caused by the load current in the transformer's conducting coils (or windings); consequently, the main frequency of this sound is twice the supply frequency: 120 Hz for 60 Hz transformers. The cooling equipment (fans and pumps) may also be an important noise component, depending on fan design. During air forced cooling method, cooling fan noise is produced in addition to the core noise. The resulting audible sound is a combination of hum and the broadband fan noise. Breaker noise is a sound event of very short duration, expected to occur only a few times throughout the year. Just as horsepower ratings designate the power capacity of an electric motor, a transformer's megavolt amperes rating indicates its maximum power output capacity.

Reference sound power levels input to CadnaA 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 sound power level data for the major sources of equipment provided by the Applicant. Table 8 summarizes the equipment sound power level data used as inputs to the acoustic modeling analysis. It was assumed for this analysis that all equipment would operate consistently during both daytime and nighttime periods.

Table 8. Modeled Octave Band Sound Power Level for Major Pieces of Facility Equipment

Sound Source	Sound Power Level (L_W) by Octave Band Frequency dBL									Broadband Level
	31.5	63	125	250	500	1k	2k	4k	8k	dBA
BESS	102	87	94	88	81	75	68	61	56	84
Inverter	92	90	92	91	95	86	85	93	86	97
72 MVA Substation Transformer	57	77	89	91	97	94	90	85	76	100
1 MVA Auxiliary Transformer	28	48	60	62	68	65	61	56	47	71
Tracking Motor	36	36	40	44	48	48	44	40	36	53

4.3 Noise Prediction Model Results

Broadband (dBA) sound pressure levels were calculated for expected normal Facility operation assuming that all components identified previously are operating continuously and concurrently at the representative manufacturer-rated sound power level. It is expected that all sound-producing equipment would operate during both daytime and nighttime periods. After calculation, 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 2 for operations with the under clear and rainy conditions. The sound 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 Facility site. The contour lines shown are analogous to elevation contours on a topographic map (i.e., the sound contours are continuous lines of equal noise level around some source, or sources, of sound).

Table 9 shows the projected exterior sound levels resulting from full, normal operation of the Facility during both daytime and nighttime hours at all nearby NSRs. The Facility is located on Class C land while the adjacent properties consist of a mix of both Class C land with Class A residential structures, which has a daytime limit of 60 dBA and nighttime limit of 50 dBA, and Class C land, which has a daytime and nighttime limit of 70 dBA. The Facility will comply with the applicable noise regulations with the one NSR located within 1 to 2 miles of the Facility site.

Table 9. Acoustic Modeling Results Summary

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zone 11		Operational Sound Level (dBA)
		Easting	Northing	
1	Unknown	311271	5088662	18

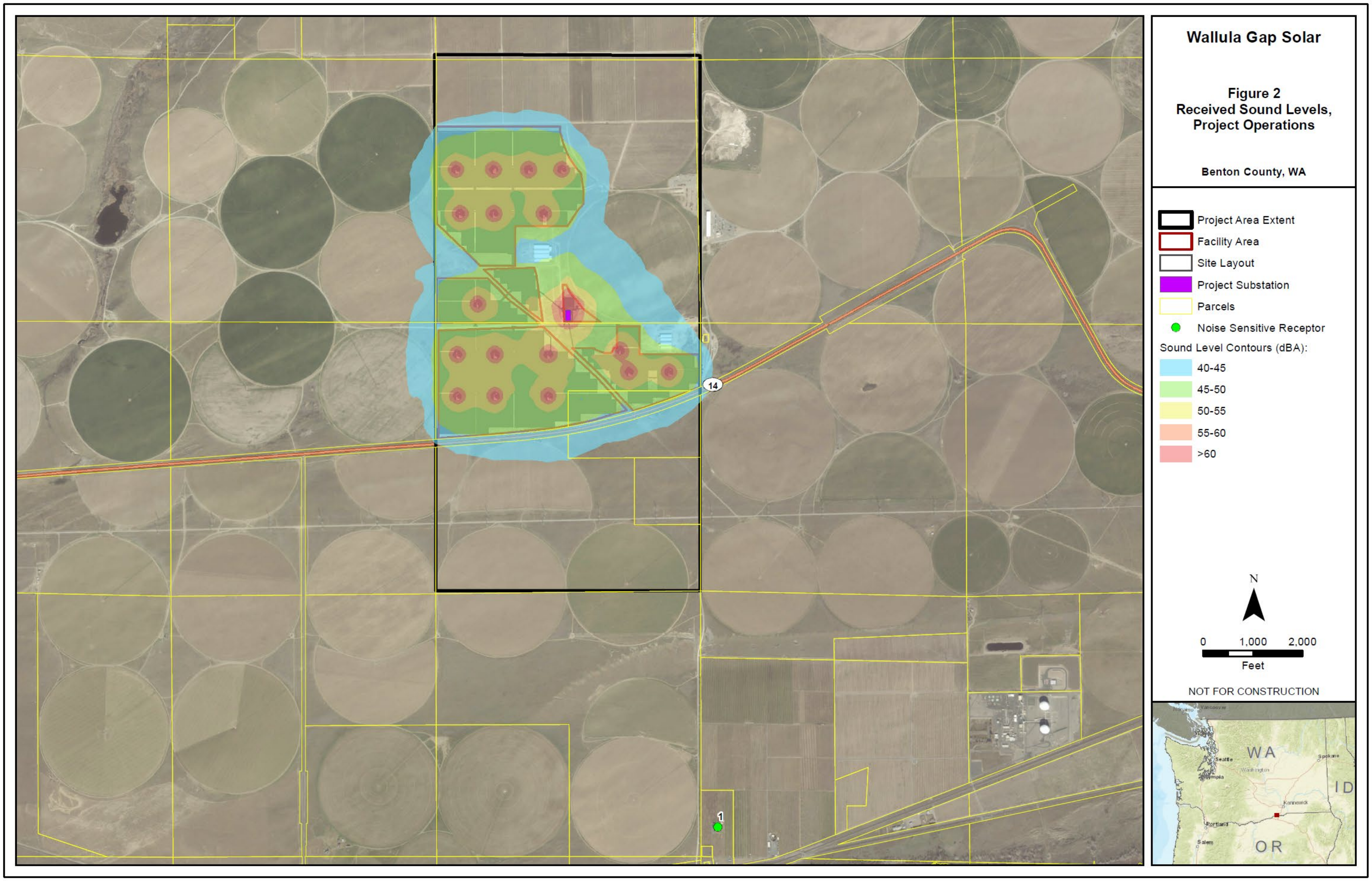

Figure 2. Operational Received Levels

5.0 CONCLUSION

Tetra Tech completed a detailed acoustic assessment of the proposed Wallula Gap Solar Project, to be constructed in Benton County, Washington. The assessment included an evaluation of potential Facility sound level impacts during construction and operation phases.

The construction noise assessment indicated that construction noise would be periodically audible at off-site locations; however, that noise would be temporary and minimized to the extent practicable through implementation of best management practices and noise mitigation measures as identified in Section 3.3. Traffic noise generated during construction on site and off site would also add to overall sound levels but would be intermittent and short-term.

Operational sound levels were modeled and evaluated at the one nearby NSR. Anticipated Facility sound sources consist of the collector substation main power transformers, PV inverter and collocated transformer units, optional BESS units with associated PCS inverters, and the tracking motors. Incorporating several conservative assumptions, acoustic modeling results indicate that the Facility is well below the WAC 173-160 the 60 dBA daytime limit and 50 dBA nighttime limit. In addition, the Facility is predicted to comply with all the applicable WAC regulatory limits at the Facility lease boundary.

Sound generated from existing sound sources in the Facility Area, such as the operation of agricultural equipment, would be expected to be relatively higher than Facility operations. Overall, sound emissions associated with the Facility are expected to remain at a low level, consistent with other solar energy facilities of similar size and design.

6.0 REFERENCES

Beranek, L. 1988. Noise and Vibration Control, Chapter 7 - Sound Propagation Outdoors. Institute of Noise Control Engineering, Washington, DC.

DataKustik GmbH. 2020. Computer-Aided Noise Abatement Model CadnaA, Version MR 1 Munich, Germany.

EPA (U.S. Environmental Protection Agency). 1971a. Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

EPA. 1971b. Technical Document NTID300.1, Noise from Construction Equipment and Operations, US Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, DC. December 1971.

EPA. 1980. Construction Noise Control Technology Initiatives. Technical Report No. 1789. Prepared by ORI, Inc. Prepared for USEPA, Office of Noise Abatement and Control. September 1980.

FTA (Federal Transit Administration). 2018. FTA Noise and Vibration Impact Assessment Manual, FTA Report No. 0123 .

ISO (International Organization for Standardization). 1996. Standard ISO 9613-2 Acoustics – Attenuation of Sound during Propagation Outdoors. Part 2 General Method of Calculation. Geneva, Switzerland.

U.S. Census Bureau. 2022. Decennial Census of Population and Housing Datasets.