ATTACHMENT O: ACOUSTIC ASSESSMENT REPORT

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Badger Mountain Solar Energy Project
Acoustic Assessment Report

Prepared for:

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Prepared by:

TETRA TECH

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Acronyms and Abbreviations

µPa	microPascal
Applicant	Aurora Solar, LLC
ASC	Application for Site Certification
BESS	battery storage system
County	Douglas County
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel
DCC	Douglas County Code
EDNA	Environmental Designation for Noise Abatement
EFSEC	Energy Project Site Evaluation Council
EPA	U.S. Environmental Protection Agency
Project	Badger Mountain Solar Energy Project
FHWA	Federal Highway Administration
Hz	hertz
ISO	International Organization for Standardization
L_{dn}	day-night average sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
L_P	sound pressure level
L_W	sound power level
kV	kilovolt
MW	megawatt
NSR	noise sensitive receptor
POI	point of interconnection
Tetra Tech	Tetra Tech, Inc.
WAC	Washington Administrative Code

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1.0 Introduction

Aurora Solar, LLC (Applicant), a wholly owned subsidiary of Avangrid Renewables, LLC, proposes to construct and operate the Badger Mountain Solar Energy Project (Project), a 200-megawatt (MW) solar photovoltaic generation facility with an optional 200-MW battery storage system (BESS) located in unincorporated Douglas County (County), Washington. The Project is generally located 3.5 miles northeast of the city limits of East Wenatchee and south of Badger Mountain Road. The Project will use solar modules configured in a solar array to convert energy from the sun into electric power. The solar array will consist of the solar modules, trackers, posts, cabling, inverters, transformers, and electrical collector lines. The Project includes the following supporting components: collector substation, overhead 230-kilovolt (kV) generation-tie transmission line (gen-tie line), two Point of Interconnect (POI) options, switchyard, operations and maintenance (O&M) building, associated access and Project service roads, perimeter fencing, and the optional BESS. The overhead 230-kV gen-tie line will transmit the generated electricity to the grid via one of two POI options. Option 1 will connect the Project collector substation to the existing Puget Sound Energy 230-kV transmission line. Option 2 will connect the Project collector substation to an existing Bonneville Power Administration transmission line. The Applicant has elected to permit the Project through submittal of a streamlined solar Application for Site Certification (ASC) to the State of Washington Energy Facility Site Evaluation Council (EFSEC).

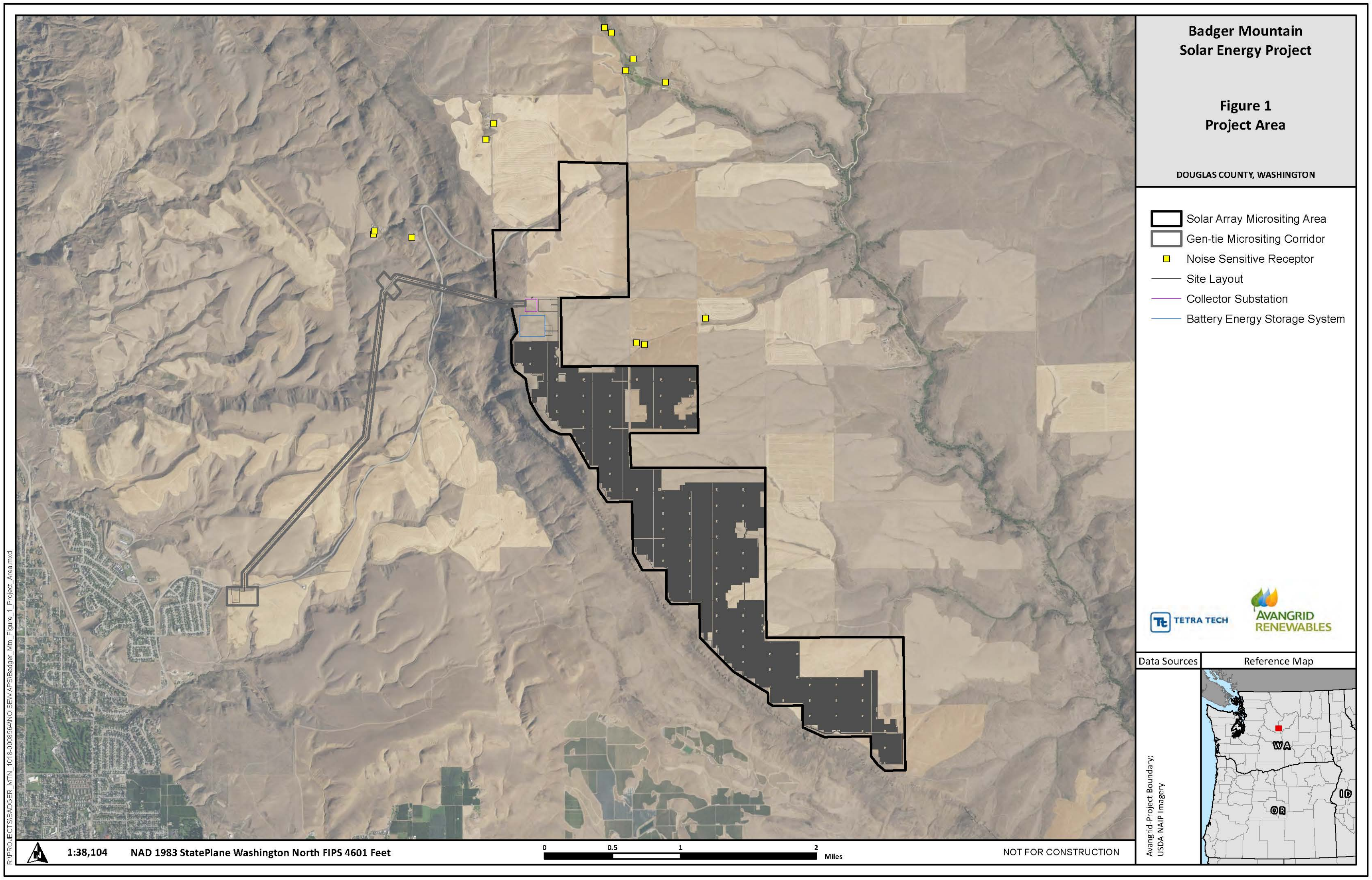
Tetra Tech, Inc. (Tetra Tech) has prepared this acoustic assessment for the Project, evaluating potential sound impacts relative to the applicable noise regulations prescribed in the Washington Administrative Code (WAC). The existing ambient acoustic environment was characterized based on land use, population density, and proximity to major roadways. An acoustic modeling analysis was conducted simulating sound produced during both construction and operation. Operational sound sources consisted primarily of the solar array inverters and step-up transformers, optional BESS, and two transformers at the Project collector substation. Modeled sound levels from Project operation were evaluated against the WAC noise regulations. The overall objectives of this assessment were to: 1) identify Project sound sources and estimate sound propagation characteristics; 2) computer-simulate sound levels using internationally accepted calculation standards; and 3) confirm that the Project will operate in compliance with the applicable noise regulations. Acoustic modeling results demonstrate that the Project will successfully comply with applicable WAC noise regulations at the closest property lines and nearby noise sensitive receptors (NSRs; i.e., residences).

1.1 Project Area

The Project Lease Boundary encompasses 21 privately owned assessor parcels and two state-owned assessor parcels for which the Applicant has executed or is pursuing an Option to Lease with the underlying property owner. The Project Lease Boundary contains the assessor parcels crossed by the Project. Construction and operation of the Project are limited to the approximately 2,390-

acre Project area that occurs within the Project Lease Boundary (ASC Attachment A, Figure A-1). The Project area includes an approximately 2,274-acre Solar Array Micrositing Area and approximately 116-acre Gen-tie Micrositing Corridor. The Solar Array Micrositing Area is the area where the solar array and supporting components will be sited during final engineering design. The Gen-tie Micrositing Corridor is a 3.7-mile-long and approximately 200-foot-wide corridor where the Project's overhead 230-kV gen-tie line, POI options, and switchyard will be located. Project components are identified on the Preliminary Site Plan (ASC Attachment A, Figure A-1) and further described in Part 2 of the ASC.

The Project area is within Douglas County's Dryland Agriculture (A-D) and Rural Resource (RR-20) zoning districts, and outside of the East Wenatchee urban growth area (UGA) boundary (ASC Attachment A Figure A-6). Current land uses in the Project area include dryland agriculture, rangeland, and undeveloped land, with local roads and existing electrical infrastructure. Adjacent assessor parcels are also primarily used and zoned for dryland agricultural and rural resource purposes. An area adjacent to the western end of the Gen-Tie Micrositing Corridor is in East Wenatchee's Low Residential (R-L) zoning district and includes residential development and undeveloped land. Land within the Solar Array Micrositing Area is dominated by active dryland agricultural use, whereas land uses within the Gen-tie Micrositing Corridor include a mixture of dryland agriculture, rangeland, and undeveloped land. Figure 1 provides an overview of the Project area and provides the locations of nearby residences, which are considered NSRs.


Badger Mountain
Solar Energy Project
Figure 1
Project Area
DOUGLAS COUNTY, WASHINGTON
Solar Array Micrositing Area
Gen-tie Micrositing Corridor
Noise Sensitive Receptor
Site Layout
Collector Substation
Battery Energy Storage System
TETRA TECH
AVANGRID RENEWABLES
Data Sources
Reference Map
Avangrid-Project Boundary; USDA-NAIP Imagery
WA
OR
ID
1:38,104
NAD 1983 StatePlane Washington North FIPS 4601 Feet
0
0.5
1
2
Miles
NOT FOR CONSTRUCTION

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 (L_W), 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 (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 20.1. 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), 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 decibels (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 Washington. 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 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 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.

Term	Definition
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 Project.

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 limits on sounds crossing property boundaries 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 where their principal use is 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. For example, in previous siting decisions EFSEC has identified and defined different land use types within single contiguous properties, dissecting properties into separate EDNAs. For instance, on a single contiguous property, residences, structures and immediate yards were classified as Class A receivers, whereas agricultural portions of the land surrounding the residences, structures and immediate yards were considered Class C receivers. 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 and are commonly presented as L_n statistical sound levels as well as maximum sound levels (L_{max}) 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.			

Table 4. L_n Environmental Noise Limits for Class C Sources

EDNA of Source Property	Statistical Sound Level Limits			
	LN_{25}	$LN_{8.3}$	$LN_{2.5}$	L_{MAX}
Class A Land	**60/50**	**65/55**	**70/60**	**75/65**
Class B Land	65	70	75	80
Class C Land	70	75	80	85
Source: WAC 173-60-040 (b) and (c).				

Table 4 shows a maximum noise limit of 60 dBA for a Class C sound source and a Class A receiving property, which is subject to a further reduction of 10 dBA during nighttime hours. The WAC regulatory limits are absolute and independent of the existing acoustic environment; therefore, a baseline noise survey is not requisite to determine conformance.

1.3.3 Douglas County Code

Chapter 8.04 of the Douglas County Code provides numerical decibel limits consistent with the maximum permissible noise levels established by WAC 173-60, described above.

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 wide range of noise settings occur within the Project area. 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. Several nearby rural airstrips and airports, including the Pangborn Memorial Airport, also contribute to ambient noise levels in both surrounding urban and rural areas. The Project area consists primarily of dryland agriculture, rangeland, and undeveloped land and is rural in nature. Based on its rural nature, the Project area will have comparatively lower ambient sound levels, possibly 30 dBA or less during nighttime, than more populated areas near East Wenatchee. Principal contributors to the existing acoustic environment likely include motor vehicle traffic, mobile farming equipment, farming activities such as plowing and irrigation, all-terrain vehicles, local roadways, rail movements, 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 Project area is inclusive of areas that could be potentially affected by construction or operational noise resulting from the Project. The analysis area for operational noise around the Project was defined as the area bounded by a perimeter extending approximately 2 kilometers from the Solar Array Micrositing Area. In the absence of ambient measurement data, the existing sound level environment in the vicinity of Project was estimated with a method published by the Federal Highway Administration (FHWA) in its Transit Noise and Vibration Impact Assessment (FHWA 2006). 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 Project is approximately 3.5 miles east of the city limits of East Wenatchee, which has a population density of 3,470 per square mile according to the U.S. Census Bureau (2020); however, based on review of aerial imagery and County records, the population density within 2 kilometers of Project's sound-generating sources is in the range of 1 to 100 per square mile. 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, with a penalty added for noise during the nighttime hours of 10:00 p.m. – 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 Badger Mountain Solar Energy Project

Population Density	Average Sound Level (dBA)			
	L_{eq} (Day)	L_{eq} (Evening)	L_{eq} (Night)	L_{dn}
East Wenatchee 3,470 people/sq. mi.	55	50	45	55
Rural Project Area 1-100 people/sq. mi.	35	30	25	35

3.0 Project Construction

Project construction is expected to be typical of other solar power generating facilities in terms of schedule, equipment, and activities. Construction is anticipated to occur over approximately 18 months and will require a variety of equipment and vehicles.

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 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 Project 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

Table 6 summarizes the expected equipment to be used during Project construction, organized into the following work stages: site preparation and grading, trenching and road construction, equipment installation, and commissioning. Table 6 also shows the maximum noise level at 50 ft and the usage factor percentage for the expected equipment phases.

Table 6. Project Construction Noise Levels by Phase

Phase No.	Construction Phase	Construction Equipment	Usage Factor %	Maximum (L_{max}) Equipment Noise Level at 50 ft
1	Site Preparation and Grading	(2) Graders (174 hp) (1) Rubber Tired Loaders (164 hp) (1) Scrapers (313 hp) (2) Water Trucks (189 hp) (2) Generator Sets	57 59 72 50 74	95
2	Trenching and Road Construction	(5) Excavators (168 hp) (2) Graders (174 hp) (2) Water Trucks (189 hp) (1) Trencher (63 hp) (2) Rubber Tired Loaders (164 hp) (2) Generator Sets	57 57 50 75 54 74	97
3	Equipment Installation	(1) Crane (399 hp) (5) Forklifts (145 hp) (8) Pile drivers (15) Pickup Trucks/ATVs (2) Water Trucks (189 hp) (2) Generator Sets	43 30 20 40 50 74	110
4	Commissioning	(5) Pickup Trucks/ATVs	40	62

Table 7 shows the projected noise levels from Project construction per phase at nearby NSRs. 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 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 open. Noise levels resulting from the construction activities will 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.

Project construction will generally occur during the day, Monday through Friday. Furthermore, reasonable efforts will 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. Project Construction Noise Levels by Phase, dBA L_{eq}

NSR ID	Distance (feet)	Phase 1	Phase 2	Phase 3	Phase 4
NSR-1	6,810	50	51	61	15
NSR-2	6,235	50	52	61	16
NSR-3	1,740	62	63	72	27
NSR-4	720	69	71	80	35
NSR-5	4,920	53	54	63	18
NSR-6	770	69	70	80	34
NSR-7	6,300	50	52	61	16
NSR-8	10,660	46	47	57	11
NSR-9	10,550	46	47	57	12
NSR-10	9,940	46	48	57	12
NSR-11	9,350	47	48	58	13
NSR-12	9,650	47	48	58	12
NSR-13	6,300	50	52	61	16

3.3 Construction Noise Mitigation

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

- Maintain 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, will 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 use 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; and
- Use 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 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-Aided Noise Abatement) 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 (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 Project and in most cases, yields conservative results of operational noise levels in the surrounding community.

The outdoor noise propagation model is based on the International Organization for Standardization (ISO) 9613, Part 2: "Attenuation of Sound during Propagation Outdoors" (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. A conservative ground attenuation factor of 0.25 for a reflective surface was assumed onsite.

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. The primary noise sources during operations are the solar array inverters and their integrated step-up transformers, optional BESS units, and collector substation transformers. Inverters serve the function of converting DC to AC in accordance with electrical regulatory requirements. The AC electricity from the inverters will be routed to transformers that will increase the output voltage from the inverter to the collection system voltage (34.5 kV). The transformers will be co-located with the inverters and will step up the voltage from the inverters. Sound emissions will be associated with the transformers and inverters. Electronic noise from inverters can be audible but is often reduced by a combination of shielding, noise cancellation, filtering, and noise suppression. An optional BESS is also being evaluated for inclusion in the Project. The principal sources of noise from the optional BESS are the cooling fans on the BESS units and associated BESS transformers.

Substations have switching, protection, and control equipment, as well as power transformers, which generate the sound generally described as a low humming. There are three chief noise sources 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) and 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 noise components, 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.

The Applicant is considering one of two POI options to connect the Project to existing transmission lines. Modern transmission lines are designed, constructed, and maintained so that the line will generate a minimum of corona-related noise during dry conditions. Corona can be a design concern with transmission lines of 345 kV and higher; however, the Project is considering connecting to an existing transmission line and will therefore not generate additional corona noise. The gen-tie line associated with the Project will be 230 kV and is therefore not expected to be a significant generator of corona noise. An associated switchyard will also be constructed along the interconnection route. An associated switchyard will also be constructed along the overhead 230 kV gen-tie line route at the determined POI option. However, since the switchyard will not have any transformers, it is not expected to generate significant noise levels. Therefore, the overhead 230 kV gen-tie line and associated switchyard were not included in this acoustic analysis.

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 8 summarizes the equipment sound power level data used as inputs to the acoustic modeling analysis. For the purpose of the analysis, it was assumed that all equipment would operate consistently during both daytime and nighttime periods.

Table 8. Modeled Octave Band Sound Power Level for Major Pieces of Project 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
Integrated Inverter/Transformer	78	86	93	94	93	90	85	78	71	99
BESS	--	67	66	74	81	86	83	76	69	89
Substation Transformer	96	100	96	96	96	90	86	79	72	105

4.3 Noise Prediction Model Results

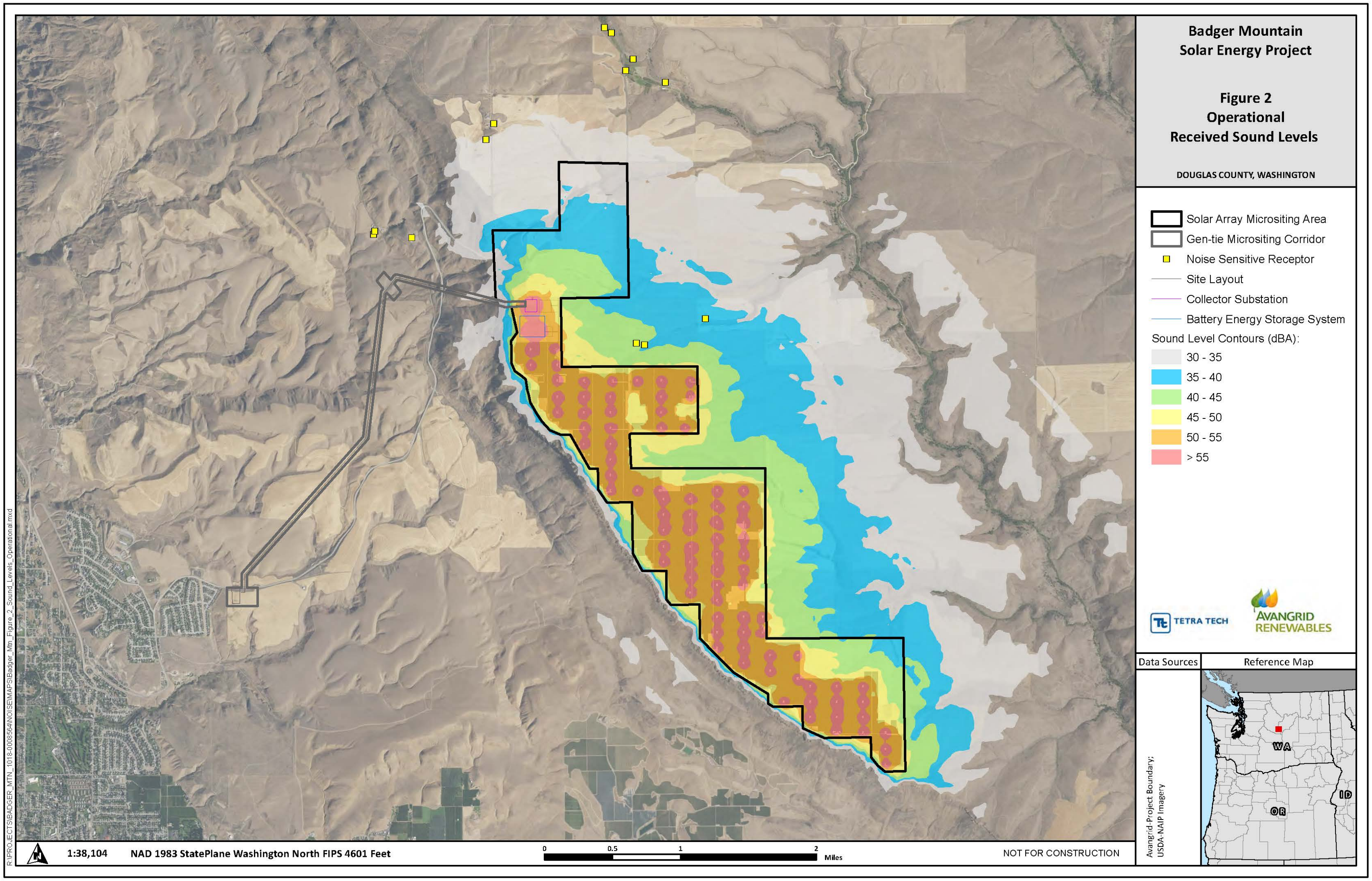
Broadband (dBA) sound pressure levels were calculated for expected normal Project operation assuming that all components identified previously are operating continuously and concurrently at the representative manufacturer-rated sound power level. It is expected that all sound-producing equipment would 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 potential 24-hour operation. 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 Project 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 Project during both daytime and nighttime hours, at nearby NSRs. The Project is located on Class C land while the adjacent properties consist of a mix of both Class A land, 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 Project successfully demonstrates compliance with the applicable 60 dBA daytime and 50 dBA nighttime limit at NSRs (i.e., residential structures). In addition, compliance was evaluated at the property lines closest to the Project area. As displayed in Figure 2, the Project is expected to successfully comply with the applicable WAC regulatory limits at the closest property lines.

Table 9. Acoustic Modeling Results Summary

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zone 10		Received Sound Level (dBA)
		Easting	Northing	
NSR-1	Non-participant	709532	5264123	30
NSR-2	Non-participant	708145	5262772	29
NSR-3	Non-participant	712101	5261882	37
NSR-4	Non-participant	711388	5261554	41
NSR-5	Non-participant	708599	5262744	30
NSR-6	Non-participant	711291	5261569	42
NSR-7	Non-participant	709445	5263929	31
NSR-8	Non-participant	710809	5265295	26
NSR-9	Non-participant	710894	5265235	27
NSR-10	Non-participant	711161	5264932	27
NSR-11	Non-participant	711078	5264792	27
NSR-12	Non-participant	711548	5264665	28
NSR-13	Non-participant	709532	5264123	30

Model results are based on the layout described in Part 2 of the Applicant's ASC and shown on Figure 1. The Applicant is requesting flexibility to microsite the Project and its supporting components anywhere within the Project area to accommodate the 200-MW layout. The exact locations of Project components may be revised or shifted during final Project design. The north side of the Solar Array Micrositing Area shown on Figure 1 is not part of the current Project layout, and was not included in this acoustic analysis. However, a preliminary analysis was conducted to estimate potential noise impacts from the area north of the Project collector substation to account for potential shifts in Project design. The analysis concluded that potential noise from solar arrays (including noise generating equipment assessed with the Project layout such as inverters and step-up transformers), if installed and operated in the northernmost areas of the Solar Array Micrositing Area, will not cause exceedances of the applicable 60 dBA daytime and 50 dBA nighttime limits at NSRs shown on Figure 1.


Badger Mountain
Solar Energy Project
Figure 2
Operational
Received Sound Levels
DOUGLAS COUNTY, WASHINGTON
Solar Array Micrositing Area
Gen-tie Micrositing Corridor
Noise Sensitive Receptor
Site Layout
Collector Substation
Battery Energy Storage System
Sound Level Contours (dBA):
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
> 55
TETRA TECH
AVANGRID RENEWABLES
Data Sources
Avangrid-Project Boundary;
USDA-NAIP Imagery
Reference Map
WA
OR
ID
1:38,104
NAD 1983 StatePlane Washington North FIPS 4601 Feet
0
0.5
1
2
Miles
NOT FOR CONSTRUCTION
R:\PROJECTS\BADGER_MTN_1018-0008564\NOISE\MAPS\Badger_Mtn_Figure_2_Sound_Levels_Operational.mxd

5.0 Conclusion

Tetra Tech completed a detailed acoustic assessment of the Badger Mountain Solar Energy Project, proposed in Douglas County, Washington. The assessment included an evaluation of potential Project sound level impacts during construction and operation phases.

The construction noise assessment indicated that construction noise will be periodically audible at off-site locations; however, that noise will 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 onsite and offsite will also add to overall sound levels but will be intermittent and short-term.

Operational sound levels were modeled and evaluated at nearby NSRs and property lines. Anticipated Project sound sources consist of the collector substation main power transformers, integrated solar array inverter/transformers, and optional BESS units. Incorporating a number of conservative assumptions, acoustic modeling results indicate that received sound levels resulting from Project operations using the optional BESS will comply with the applicable WAC 173-60-040 dBA daytime and nighttime limits at nearby NSRs and property lines. Received sound levels at NSRs identified on Figure 1 will be between 26 and 42 dBA, which are below the applicable 60 dBA daytime and 50 dBA nighttime limits, and similar to the sound level expected at a "quiet library" or "rural residential area with no activity" as described in Table 1. In addition, sound generated from existing sound sources in the Project area such as the operation of agricultural equipment will be expected to be relatively higher than Project operations. Overall, sound emissions associated with the Project are expected to remain at a low level, consistent with other solar photovoltaic generation facilities of similar size and design and the Project will comply with applicable standards under WAC 173-60-040 and WAC 173-60-050.

6.0 References

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