Appendix H: Noise and Vibration Resource Report

For Programmatic Environmental Impact Statement on Utility-Scale Solar Energy Facilities in Washington State

By

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For the

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DEPARTMENT OF ECOLOGY
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Acronyms and Abbreviations List

BESS	battery energy storage system
dB	decibel
dBA	A-weighted decibel
EDNA	Environmental Designation for Noise Abatement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
gen-tie line	generation-tie transmission line
Hz	hertz
in/sec	inches per second
kV	kilovolt
lb	pound
L_{dn}	average A-weighted noise level during a 24-hour day
L_{eq}	equivalent-continuous sound level
L_{max}	maximum, instantaneous noise level
MRI	magnetic resonance imaging
MW	megawatt
PEIS	Programmatic Environmental Impact Statement
PPV	peak particle velocity
PV	photovoltaic
RCNM	Roadway Construction Noise Model
RMS	root mean square
VdB	decibel notation
WAC	Washington Administrative Code

Executive Summary

This resource report describes the noise and vibration conditions in the study area. It also describes the regulatory context, outlines methods for assessing potential noise and vibration impacts from types of solar energy facilities, presents current noise levels in the study area, identifies sensitive receptors for noise and vibration. It also assesses the potential impacts and actions that could avoid or reduce impacts. This technical memorandum focuses on the noise and vibration impacts on people and the vibration impacts on structures. Potential impacts of noise and vibration on terrestrial and aquatic species and habitats are described in the *Biological Resources Report* (Anchor QEA 2024a).

Findings for noise and vibration impacts described in this resource report are summarized below.

Through compliance with laws and permits and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** on noise and vibration.

Potentially significant adverse impacts related to noise would occur if:

- Construction, operations, or decommissioning activities occur within 1,000 feet of noise-sensitive receptors in a quiet rural area
- During operations, stationary equipment is closer than 350 feet from a noise-sensitive receptor or closer than 1,100 feet from a noise-sensitive receptor in a quiet rural area
- During operations, substations for small to medium facilities are closer than 110 feet from a noise-sensitive receptor or closer than 350 feet from a noise-sensitive receptor in a quiet rural area, or substations for large facilities are closer than 650 feet from a noise-sensitive receptor or 2,000 feet from a noise-sensitive receptor in a quiet rural area
- A facility with a battery energy storage system of certain design and consolidated configuration is closer than 1.5 miles from noise-sensitive receptors

Potentially significant adverse impacts related to vibration would occur if:

- Pile driving during construction and decommissioning activities occur closer than 350 feet from residential land uses or in close proximity to modern or historic structures
- Blasting is conducted within 2,000 feet of historic structures

No significant and unavoidable adverse impacts related to noise and vibration would occur.

Crosswalk with Noise and Vibration Resource Report for Utility-Scale Onshore Wind Energy

Two Programmatic Environmental Impact Statements (PEISs) are being released at the same time, one for utility-scale solar energy facilities and one for utility-scale onshore wind energy facilities. This crosswalk identifies the areas with substantial differences between the noise and vibration resource reports for each PEIS.

Utility-Scale Solar Energy PEIS (this document)	Utility-Scale Onshore Wind Energy PEIS
• Differences in the types of facility noise- and vibration-generating activities • Some differences in actions to avoid and reduce impacts	• Differences in the types of facility noise- and vibration-generating activities • Larger distance at which potential impacts from facilities could occur • Some differences in actions to avoid and reduce impacts

1 Introduction

This resource report describes noise and vibration within the study area and assesses probable impacts associated with types of facilities (alternatives), including a No Action Alternative. Chapter 2 of the State Environmental Policy Act Programmatic Environmental Impact Statement (PEIS) provides a description of the types of facilities evaluated (alternatives).

1.1 Resource description

1.1.1 Fundamentals of noise

Noise is generally defined as unwanted sound. Sound, traveling in the form of waves from a source, exerts a sound pressure level that is measured in decibels (dB), which is the standard unit of sound amplitude measurement. The dB scale is a logarithmic scale that describes the physical intensity of the pressure vibrations that make up any sound, with 0 dB corresponding roughly to the threshold of human hearing and 120 to 140 dB corresponding to the threshold of pain.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude spanning 20 to 20,000 Hz.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to extremely low and extremely high frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). Some representative noise sources and their corresponding A-weighted noise levels are shown on Figure 1. All noise levels presented in this technical memorandum are A-weighted unless otherwise stated.

Some land uses are considered more sensitive to noise than others due to the amount of noise exposure and the types of activities typically involved. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums generally are more sensitive to noise than are commercial and industrial land uses. Section 3.2 provides more detail on noise-sensitive receptors.

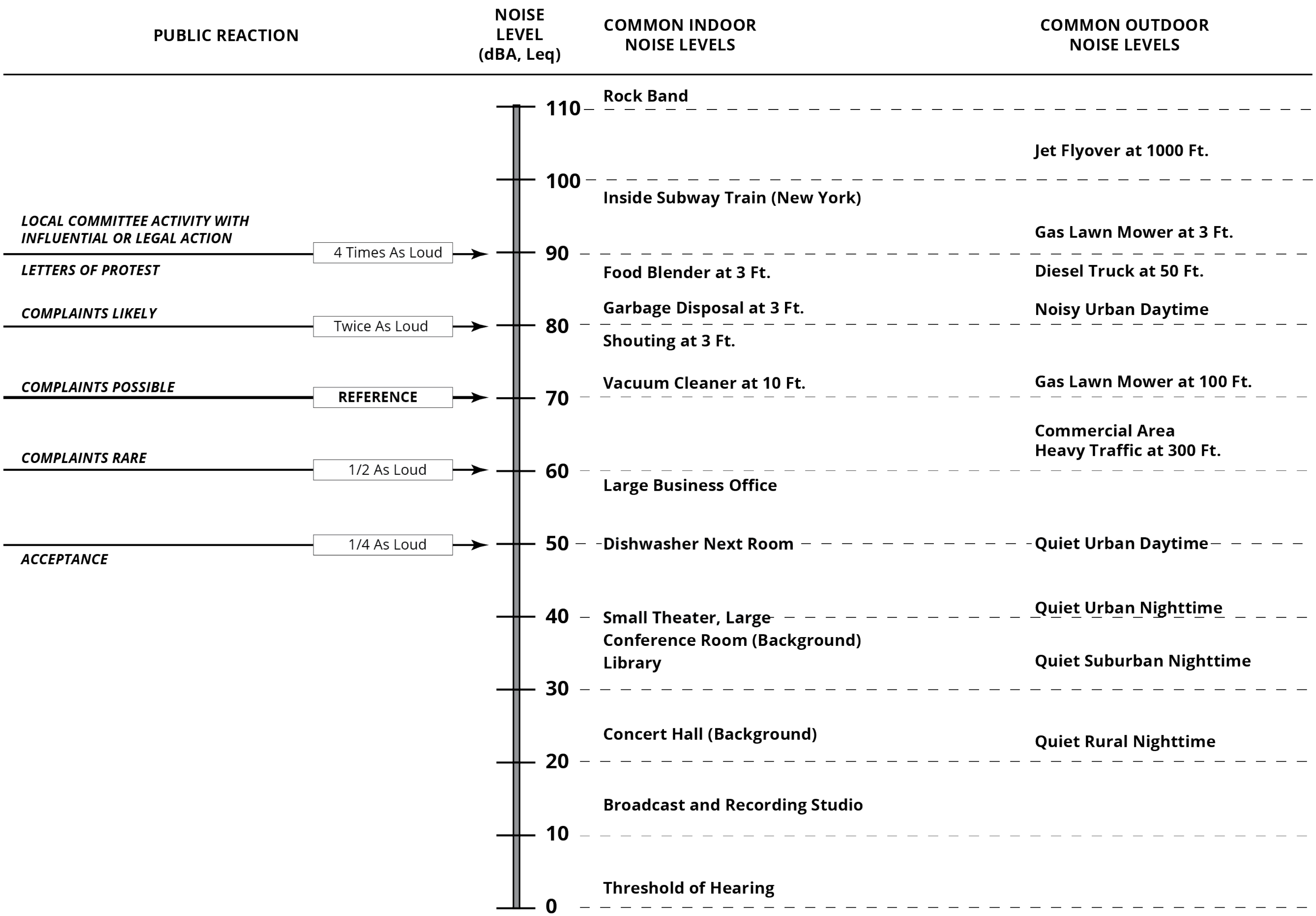

Figure 1. Common range of noise levels

Data source: Caltrans 2013; and modification by ESA

1.1.2 Fundamentals of vibration

The generally accepted source document for assessment of vibration impacts is the Federal Transit Administration's (FTA's) Transit Noise and Vibration Impact Assessment (FTA 2018). It is unusual for vibration from sources such as trucks to be perceptible, even in locations close to major roads. Some common sources of human-induced groundborne vibration are trains; loaded haul trucks on rough roads; and construction activities, such as blasting, pile driving, and operation of heavy earth-moving equipment. Vibrations from naturally occurring phenomena, such as earthquakes, are addressed in the *Earth Resource Report* (Anchor QEA 2024b).

Several different methods are used to quantify vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous peak of the vibration signal. The PPV is most frequently used to describe vibration impacts on buildings. The root mean square (RMS) amplitude is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (VdB) is commonly used to measure RMS. Typically, groundborne vibration generated by man-made activities attenuates rapidly with distance from the source of the vibration.

The effects of groundborne vibration include movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, vibration can damage buildings. Building damage is not a factor for most projects, with the occasional exception of blasting and pile driving during construction. The FTA measure of the threshold of architectural damage for historic structures[1] is 0.12 inch/second (in/sec) PPV (FTA 2018).

In residential areas, the background vibration velocity level is usually around 50 VdB (approximately 0.0013 in/sec PPV). This level is well below the vibration velocity level threshold of perception for humans, which is approximately 65 VdB. A vibration velocity level of 75 VdB is considered to be the approximate dividing line between barely perceptible and distinctly perceptible levels for many people (FTA 2018). Annoyance from vibration often occurs when the vibration levels exceed the threshold of perception by only a small margin. A vibration level that causes annoyance would be well below the damage threshold for modern buildings.

Sensitive receptors for vibration include historic structures that may be damaged by vibration, residential uses during nighttime hours, and vibration-sensitive equipment, such as magnetic resonance imaging (MRI) machines. Section 3.2 provides more detail on vibration-sensitive receptors.

[1] FTA applies this criterion for buildings extremely susceptible to vibration damage.

1.2 Regulatory context

Potentially applicable federal, state, and local laws and regulations are listed in Table 1, which will contribute to the evaluation of potential noise and vibration impacts.

Table 1. Applicable laws, plans, and policies

Regulation, statute, guideline	Description
Federal	
Noise Control Act of 1972 (42 *United States Code* 4910)	Protects the health and welfare of U.S. citizens from the growing risk of noise pollution, primarily from transportation vehicles, machinery, and other commerce products. Increases coordination between federal researchers and noise-control activities; establishes noise emissions standards; and presents noise emissions and reduction information to the public.
Federal Transit Administration Construction Noise Impact Criteria for General Assessment; Transit Noise and Vibration Impact Assessment Manual (FTA 2018)	This document provides procedures and guidance for analyzing the level of noise and vibration, assessing the resulting impacts, and determining possible mitigation for most federally funded transit projects.
State	
Washington State Noise Control Act of 1974 (Chapter 70.107 Revised Code of Washington)	This act establishes maximum environmental noise levels. The regulations (Chapter 173-60 Washington Administrative Code) apply to a variety of land uses, activities, and facilities, including general construction activities and maintenance facilities. Exemptions include electrical substations, mobile noise sources, vehicles traveling in public right-of-way, and safety warning devices, such as bells. Many cities and counties in Washington have adopted the state provisions.
Local	
County and City Municipal Codes	Based on the scale of the study area, it is infeasible to review the county and municipal code of each local government within the scale of the Programmatic Environmental Impact Statement. However, it is noted that many counties and cities in Washington defer to the Washington Administrative Code regulations.

2 Methodology

2.1 Study area

The study area for noise and vibration includes the overall solar geographic study area (Figure 2). The programmatic study area for assessment of noise and vibration impacts associated with site characterization, construction, operation, and decommissioning of the potential utility-scale solar energy facilities includes consideration of potential sensitive human receptor locations surrounding solar facility sites and along access roads associated with truck hauling of materials and supplies.

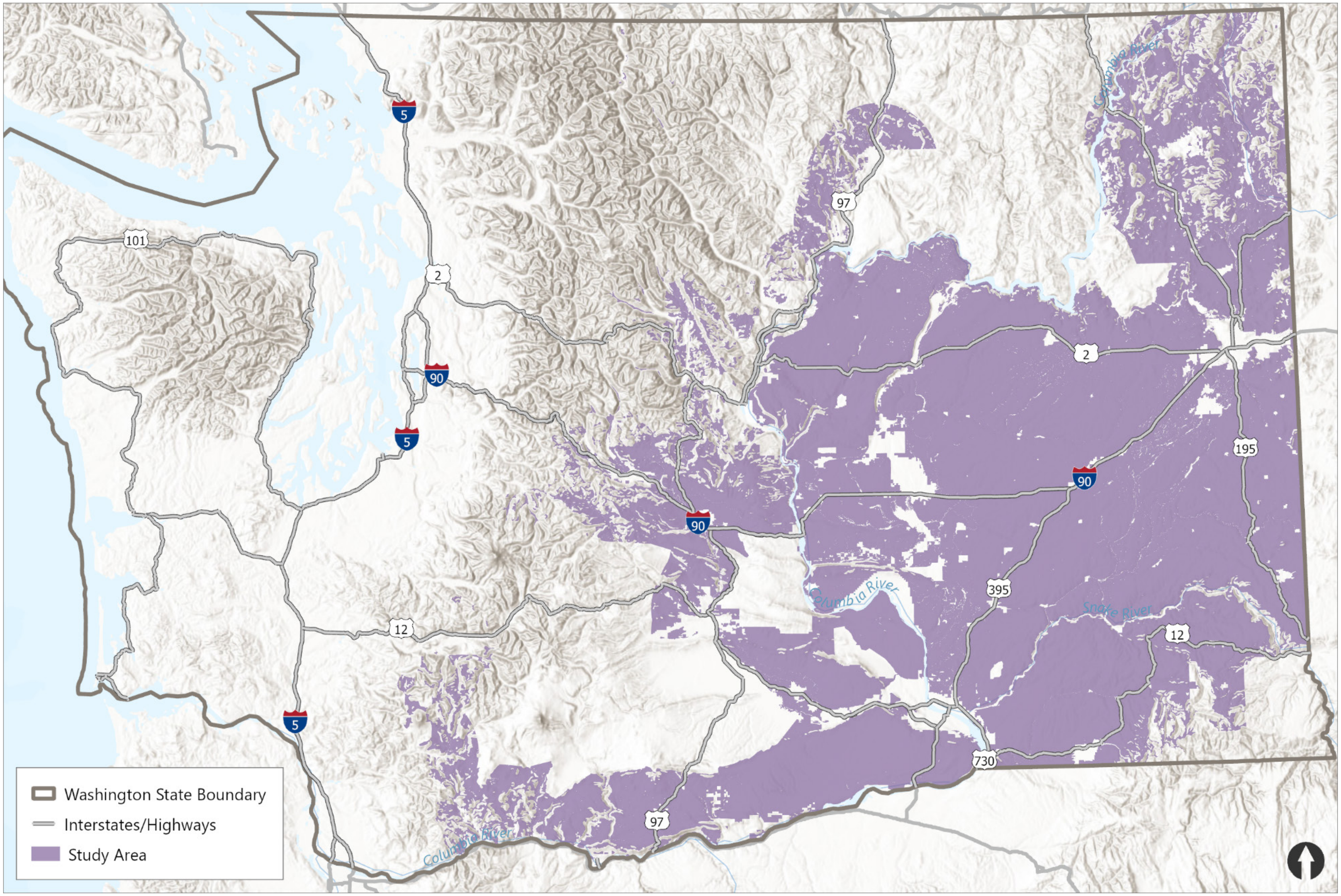

Figure 2. Solar Energy Facilities PEIS – geographic scope of study

2.2 Technical approach

The approach for assessing construction-related noise impacts utilizes the General Assessment methodology of the FTA's Noise and Vibration Impact Assessment Manual (FTA 2018). Based on an equipment list commonly used for construction of solar facilities, a tabular range of construction noise was generated with respect to distance from the outermost equipment for a typical construction site. The Federal Highway Administration's (FHWA's) Roadway Construction Noise Model (RCNM) was used to calculate noise levels at certain distances for comparison to FTA's published construction noise criteria (FHWA 2006). A separate analysis was provided for conditions where blasting or pile driving would be a necessary method of construction. This analysis can also be applied to linear construction work for generation-tie transmission lines (gen-tie lines).

Similarly, the approach for construction-related vibration impact assessment used a tabular estimate of vibration generation with distance from specific construction equipment known to generate vibration. Reference vibration levels published by FTA were used to develop impact distances to modern structures of standard construction, as well as to historic structures.

For operational impacts from utility-scale solar energy facilities, reference noise levels from sources associated with these facilities were researched from existing project-level analysis (proxy projects) that included three-dimensional noise modeling of noise generation. Using the existing analysis from proxy projects that fall within the scale of the facilities considered for the PEIS, a conservative estimate of noise generation with distance was developed for distances at which potential impacts of operational noise may occur from the extent of a solar energy facility footprint.

2.3 Impact assessment

The impact analysis for noise and vibration considered the following:

- Site characterization activities of utility-scale solar energy development would result in noise and vibration associated with construction of meteorological towers and soil coring.
- Construction and decommissioning would result in noise and vibration associated with construction-related activities typically employed for such facilities. These would include operation of off-road equipment, pile driving for solar collector foundations, the potential on-site operation of a concrete batch plant, and operation of haul trucks to bring in equipment and materials and remove soil or demolition debris. Blasting, if required, would also generate noise and vibration impacts.
- Construction for gen-tie lines for facilities could include noise and vibration from off-road equipment along alignments for power poles and line stringing, cut and cover trenching, and potentially sheet pile installation for jack-and-bore pits, where necessary.
- Operational noise sources may include intermittent noise from substation operations, battery storage liquid cooling units, battery storage inverters, potential corona noise

from overhead connector and gen-tie lines during wet weather conditions, and intermittent noise from operations and maintenance activities of employees during daytime hours. Electrical-related noise sources include pad-mounted inverters. The audible noise level of an inverter is attributable to the cooling fan. Many inverters would be located among the modules of a photovoltaic (PV) facility. The transformers at PV facilities are typically located near a site boundary.

- Noise-generating activities common for PV facilities during operations and maintenance also include those from site inspection; solar tracking devices; maintenance and repair at the solar field (e.g., panel washing, replacement of broken panels); vehicles for employee commuting, support activities, and deliveries within and around the solar energy facility; and noise from control/administrative buildings.

Site characterization, construction, and decommissioning related noise impacts were evaluated for likely conflicts with local ordinances or potential exposure of noise-sensitive land uses in excess of the FTA criteria. Additionally, in recognition that existing noise levels are commonly quiet in rural areas where siting of energy facilities would likely occur, an increase of 10 dBA over ambient was applied to the assessment, which corresponds to a perceived doubling loudness for temporary construction activities (FHWA 2017). Chapter 173-60 Washington Administrative Code (WAC) exempts sounds originating from blasting and from temporary construction sites as a result of construction activity between the hours of 7:00 a.m. and 10:00 p.m.

Operational noise impacts were evaluated for likely conflicts with local ordinances or potential to exceed the maximum permissible environmental noise levels specific to land use as codified in Chapter 173-60 WAC. For residential uses, an Environmental Designation for Noise Abatement (EDNA) of 50 dBA would apply during nighttime hours. Additionally, in recognition that existing noise levels are commonly quiet in rural areas where siting of energy facilities would likely occur, an increase of 5 dBA over ambient is applied, which corresponds to a readily perceptible increase in noise for permanent operations (FHWA 2017).

Construction vibration impacts were evaluated for the potential to expose nearby land uses and structures to PPV levels that would meet or exceed FTA criteria of 0.5 in/sec for modern structures or 0.12 in/sec for historic structures.

3 Technical Analysis and Results

3.1 Overview

This section describes the potentially significant adverse noise and vibration impacts that might occur for a utility-scale solar energy facility analyzed in the PEIS. The extent of the impact area would depend on the size and design of the specific facility and the relative quiet (low ambient noise levels) of a given location. This section also evaluates actions that could avoid, minimize, or reduce the identified impacts, and potential unavoidable significant adverse impacts.

3.2 Affected environment

3.2.1 Ambient noise levels

The affected environment represents the conditions before any construction begins. Given the substantial geographic extent of the solar facility study area, the affected environment, in terms of existing ambient noise levels, would vary based on the specific facility siting conditions. Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors (highways and railways), airports, industrial facilities, and construction activities. To characterize noise levels associated with general community activities over the study area, countywide background L_{dn}[2] (i.e., average A-weighted noise level during a 24-hour day) levels may be estimated based on population density. More densely populated counties, such as King County and Pierce County, have generalized background L_{dn} values of between 45 and 55 dBA, while more remote, sparsely populated counties, such as Columbia County, have a background L_{dn} values of less than 35 dBA (BLM 2024). These are geographically averaged estimates, and localized values, particularly in urban areas, can be as high as 70 L_{dn} adjacent to freeways.

Utility-scale solar energy facilities would often likely be located in rural areas with low population density. These areas are expected to have low ambient sound levels, given the lack of industrial and commercial sound sources. Noise may be sporadically elevated in localized areas due to roadway noise or periods of human activity. The existing acoustic environment in these areas could include existing wind turbines; motor vehicle traffic; mobile farming equipment; farming activities, such as plowing and irrigation; all-terrain vehicles; local roadways; periodic aircraft flyovers; and natural sounds. Rural areas can be exposed to natural wind noise that can generate noise levels of up to 85 dBA at high windspeeds. Sound levels in non-industrial and rural areas are typically quieter during the night than during the daytime.

[2] The L_{dn} metric is the energy average of the A-weighted sound levels occurring during a 24-hour period, with a 10 dB penalty added to sound levels between 10 p.m. and 7 a.m. It is commonly used for land use compatibility assessment.

Sound propagating through the air is affected by air temperature, humidity, wind and temperature gradients, vicinity and type of ground surface, obstacles, and terrain features. Natural terrain features, such as hills, and constructed features, such as buildings and walls, can significantly alter noise levels. Rural areas can commonly possess a range of topographical features that can serve to reduce the propagation of noise.

It is uncommon for trees and vegetation to result in a noticeable reduction in noise. A vegetative strip must be very dense and wide for there to be any meaningful shielding effect. However, a heavily vegetated ground surface may increase ground absorption, which can increase attenuation over distance.

3.2.2 Noise-sensitive receptors

Some land uses are considered more sensitive to noise than others due to the amount of noise exposure (in terms of both exposure duration and insulation from noise) and the types of activities typically involved. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums generally are more sensitive to noise than are commercial and industrial land uses. Recreational uses are also sensitive to noises; refer to the *Recreation Resource Report* (Anchor QEA 2024c) for an analysis of noise impacts on recreationists.

Sensitive wildlife and habitats, including the habitat of rare, threatened, or endangered species, can also be impacted by noise. For noise impacts on wildlife, including airborne noise effects on terrestrial wildlife and waterborne noise effects on fish and marine mammals, please refer to the *Biological Resources Report*.

3.2.3 Vibration-sensitive land uses and structures

Sensitive receptors for vibration include structures (especially older masonry structures), people (particularly residential uses during nighttime hours), and vibration-sensitive equipment (such as recording studios or MRI). There are separate criteria for evaluating the potential for structural damage depending on whether the structure is considered to be of modern construction versus older historic structures that are more sensitive to vibration.

3.3 Potentially required permits

With the exception of unique circumstances, there would be no specific permit requirements related to noise or vibration. If blasting is needed for construction, then a blasting permit would be required. Permits are typically administered by the city or county in which the work is conducted. Blasting with explosives requires a Washington State explosives license to abate potential hazards, including noise and vibration.

Additionally, local jurisdictions may require a permit or variance to conduct nighttime construction work.

3.4 Small to medium utility-scale facilities of 20 MW to 600 MW (Alternative 1)

3.4.1 Impacts from construction

3.4.1.1 Construction noise

Construction of a small to medium utility-scale facility (Alternative 1) would generate noise from multiple sources, including the following:

- Off-road equipment used for site characterization, preparation, and construction
- Blasting
- On-road truck trips to bring materials to work sites, including sand, fly ash, and cement to a concrete batch plant
- Noise generated by rock processing at a concrete batch plant

Off-road equipment noise for site preparation and construction

An example inventory of equipment needed to construct a small to medium-sized utility-scale solar energy development (Tetra Tech 2023) is provided in Table 2. The table summarizes equipment that may be used and identifies associated noise levels at a reference distance of 50 feet, as well as at 100, 1,000, and 2,500 feet from each piece of equipment, as well as from the combined contribution of all equipment. The combined noise levels in Table 2 include construction blasting, which is further addressed in the next section.

Table 2. Maximum and modeled equivalent noise levels from construction equipment associated with solar facility construction

Equipment	L_{max} equipment sound level at 50 feet (dBA)[1]	Usage factor (%)[2]	Equipment sound level (L_{eq}) at 50 feet (dBA)	Equipment sound level (L_{eq}) at 100 feet (dBA)	Equipment sound level (L_{eq}) at 1,000 feet (dBA)	Equipment sound level (L_{eq}) at 2,500 feet (dBA)
Crane	85	16	77	71	51	43
Generator	81	50	78	72	52	44
Forklift	83	40	79	73	53	45
Backhoe	78	40	74	68	48	40
Grader	85	40	81	75	55	38
Dozer	82	40	78	72	52	44
Loader	79	40	75	69	49	41
Truck	77	40	73	67	47	39
Welder	74	40	70	64	44	36
Compressor	78	40	74	68	48	40
Concrete Batch Plant	83	15	75	69	49	41
Pile Driver[3]	84	20	77	71	51	43

Equipment	L_{max} equipment sound level at 50 feet (dBA)[1]	Usage factor (%)[2]	Equipment sound level (L_{eq}) at 50 feet (dBA)	Equipment sound level (L_{eq}) at 100 feet (dBA)	Equipment sound level (L_{eq}) at 1,000 feet (dBA)	Equipment sound level (L_{eq}) at 2,500 feet (dBA)
Blasting	94	1	74	68	48	40
Combined	NA	NA	87	81	61	53

Source: FHWA (2006) and NextEra (2013)
Notes:

1. These are maximum field-measured values at 50 feet as reported from multiple samples. Where sufficient data are unavailable, the reference noise level is a manufacturer-specified level.
2. The usage factor is the percentage of time during operation that a piece of construction equipment is operating at full power
3. Small pile drivers are used for the installation of posts that support PV panels. These drivers have lower reference noise levels than a pile driver commonly used in building construction. Source noise levels are from data provided for the Blythe Solar Power Project (NextEra 2013).

As shown in Table 2, FTA's daytime criterion of 90 dBA would be exceeded only if blasting activities were conducted within 50 feet of noise-sensitive receptors. For a solar facility located in a rural environment, this would be an unlikely scenario.

However, in recognition that existing noise levels are commonly low in rural areas where siting of energy facilities would likely occur, potentially 35 to 40 dBA or lower, a prolonged noise contribution of 45 to 50 dBA could also result in a noise impact at noise-sensitive receptors located closer than 2,500 feet, particularly during nighttime hours. The extent of a construction noise impact would depend on the existing ambient noise level at any given receptor.

As shown in Table 2, at a distance of 2,500 feet, all construction activities except forklift operations would be below 45 to 50 dBA. Forklift operations would be 45 dBA at a distance of 2,500 feet. Forklift operations would be centered around materials loading and unloading areas. Pile driving or drilling may be needed to install solar panel foundations. Small pile drivers are used for the installation of posts that support PV panels, and these drivers have lower reference noise levels than those commonly used in building construction. The duration of construction noise at panel installation areas typically lasts for 5 minutes or less and, hence, may not constitute a prolonged noise increase at a distance of 2,500 or even 1,000 feet. However, a small to medium solar facility would require between 6,500 to 270,000 posts driven by pile driver, which could have a duration of impact of several weeks.

Blasting noise

Blasting is not expected to be needed for construction of most facilities but may occur depending on subsurface conditions. Noise from blasting activities was estimated using reference noise levels from RCNM and assuming one blast per hour; the associated noise levels are presented in Table 2. Blasting mats are usually used to control noise. Blasting would typically be a part of site preparation and, therefore, not occur simultaneously with pile driving or other construction building activities. As shown in Table 2, noise generated by blasting is similar in magnitude to that of other construction activities, based on the reference noise levels for RCNM and the low usage factor. The combined noise levels in Table 2 include construction blasting. Vibration impacts from blasting are addressed in Section 3.4.1.2.

Noise from on-road trucks
Noise from trucks bringing materials from off-site locations to a facility construction site and exporting excavated materials from the facility site would potentially increase noise levels along roadways used to access a given solar facility. Generally, these truck trips would be distributed throughout the day, and, except in cases where substantial volumes of material would be hauled, the increase in noise levels would not be sufficient to result in a noticeable increase in traffic noise.

Concrete batch plant noise
Noise from a concrete batch plant during facility construction was estimated using reference noise levels from RCNM and the associated noise levels are presented in Table 2. Concrete batch plants may be used to provide material for construction of foundations and would occur simultaneously with pile driving or other construction activities. As shown in Table 2, noise generated by batch plant operations is similar in magnitude to that of other construction activities, based on the reference noise levels for RCNM. The combined noise levels in Table 2 include operation of a batch plant.

Construction noise impact summary
Heavy equipment use would vary during the site preparation and construction phases for facilities. Site characterization activities would include noise generation during soil coring and the construction of meteorological towers. Typically, noise levels are highest during site preparation when land clearing, grading, and road construction would occur.

Most local jurisdictions and the noise standards in Chapter 173-60 WAC exempt temporary construction site noise between the hours of 7:00 a.m. and 10:00 p.m. Outside of these times, construction activities would be required to meet noise limits. In addition, construction activities would be temporary and of short duration.

Potential construction noise impacts would depend on the activities, terrain, vegetation, and local weather conditions, as well as distance to the nearest sensitive receptors.

Through compliance with laws and permits and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** from noise. If construction activities occur within 1,000 feet of noise-sensitive receptors in quiet rural areas, this would result in a **potentially significant adverse impact**.

3.4.1.2 Construction vibration

Construction may involve blasting and the use of equipment, such as impact pile drivers and vibratory rollers, that can generate substantial vibration.

Vibration impacts and human annoyance

Vibration impact criteria related to human disturbance published by FTA are established in terms of the VdB metric. Vibration levels from various construction activities were estimated in Table 3 using reference vibration levels published by FTA (2018) and attenuating that vibration at a range of distances encompassing impact criteria. Cells with bold font in Table 3 indicate the distances at which vibration levels would exceed the applicable FTA criterion. As seen from the table, vibration from pile driving would exceed the applicable FTA criterion at distances closer than 350 feet, while vibration from vibratory rollers would exceed FTA criterion at distances closer than 50 feet. All other construction equipment could be 25 feet or closer without exceeding FTA criteria. Therefore, vibration from specific construction activities occurring at distances closer than 350 feet from residential land uses could be a potential impact with respect to human annoyance.

Table 3. Predicted vibration levels (VdB) from construction activities at distance

Equipment/ activity	Predicted VdB					
	At 25 feet (Reference)	At 50 feet	At 100 feet	At 200 feet	At 350 feet	FTA Criteria for Residential Uses (Human response)
Jack Hammer	79	70	61	52	45	80
Loaded Trucks	**86**	77	68	59	52	80
Large Bulldozer	**87**	78	69	60	53	80
Caisson Drilling	**87**	78	69	60	53	80
Vibratory Roller	**94**	**85**	76	66	60	80
Impact Pile Driver	**104**	**65**	**86**	**77**	70	72[a]

Source: FTA 2018

Notes:

Cells with bold font indicate exceedance of the applicable FTA criterion.

a. Residential standard for frequent events applies to pile driving.

Vibration impacts and structural damage

Construction-related vibration also has the potential to result in architectural damage to nearby structures. For historic structures, including buildings that are structurally weakened, a continuous vibration limit of 0.12 in/sec PPV is the standard applied to minimize the potential for structural or cosmetic damage (e.g., minor cracking in plastered walls). A continuous vibration limit of 0.50 in/sec PPV is applied to minimize the potential for cosmetic damage at buildings of modern construction.

Table 4 presents the analysis of vibration from typical construction activities with distances to structures. In Table 4, distances at which vibration levels would exceed the criterion for conventional structures are indicated with a superscript "a." Distances at which the criterion would be exceeded for historic structures or structurally weakened buildings are marked with a superscript "b." As shown in Table 4, cosmetic damage could result from pile driving closer than

30 feet to a conventionally constructed building, or closer than 80 feet to a historic building. Therefore, vibration from specific construction activities occurring in close proximity to conventional or historic structures could result in building damage. However, given the distances at which most off-site structures and sensitive receptors are assumed to be located from potential utility-scale facilities and with appropriate control measures and monitoring programs in place and as required by permits, temporary construction-related vibration effects for the construction of small to medium utility-scale solar energy facilities would be less than significant.

Table 4. Vibration levels (PPV) for construction activity

Equipment	Estimated PPV (inches per second)			
	At 25 feet	At 30 feet	At 40 feet	At 80 feet
Jackhammer	0.035	0.027	0.01710	0.00610
Loaded Trucks	0.076	0.058	0.038	0.013
Caisson Drilling	0.089	0.068	0.044	0.016
Large Bulldozer	0.089	0.068	0.044	0.016
Vibratory Roller	0.20[b]	0.160[b]	0.104	0.037
Impact Pile Driver	0.65[a]	0.494[b]	0.321[b]	0.113

Source: FTA 2018
Notes:

a. Indicates distances where vibration levels would exceed the criterion for conventional structures.
b. Indicates the distances at which the criterion for historic structure or buildings that are documented to be structurally weakened would be exceeded.

Vibration generated by blasting

Blasting is not expected to be needed for construction of most facilities but may occur as part of site preparation activities, depending on subsurface conditions. When blasting occurs at greater distances from sensitive structures, the primary concern is the potential for cosmetic damage. Cosmetic damage can occur as a result of groundborne vibration or acoustic overpressures. Vibration levels that may be generated by blasting events were calculated using methods established by the former U.S. Bureau of Mines (USDI 2000) and are presented in Table 5. Calculated ground vibration levels are summarized in Table 5 for a variety of charge weights and distances. Receptors located farther from blasting activities would experience lower vibration levels.

Table 5. Ground vibration levels generated by blasting

Distance (feet)	Blasting level (in/sec PPV) for various explosive charge weights per delay[1] (lbs)		
	175 lbs	350 lbs	700 lbs
2,000	0.098	0.170	0.296
3,000	0.051	0.089	0.155
4,000	0.032	0.056	0.098

Note:

1. The maximum quantity of explosive charge detonated on one interval (delay) within a blast.

As shown in Table 5, blasting using a charge weight of 700 pounds per delay[3] within 2,000 feet of sensitive structures, could generate groundborne vibration levels as high as 0.296 in/sec PPV, which would be below the 0.5 in/sec PPV threshold for modern structures, but would exceed the 0.12 in/sec PPV threshold for historic structures. Consequently, use of charge weights in excess of approximately 250 pounds per delay could result in vibration impacts if historic structures are located within 2,000 feet**.**

Construction vibration impact summary

Potential construction vibration impacts would depend on the equipment, methods, and distance to sensitive receptors or structures. Through compliance with laws and permits and with implementation of actions that could avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** related to vibration.

Vibration from specific construction activities occurring at distances closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures, would be a **potentially significant adverse impact** with respect to human annoyance or building damage. If some types of blasting are conducted within 2,000 feet of historic structures, it would result in a **potentially significant adverse impact.**

3.4.2 Impacts from operation

Operation activities would not be expected to generate vibration.

Solar energy facility noise

The major noise sources for small to medium facilities are inverters, inverter distribution transformers, and substation transformers. It is expected that all equipment would operate during the day, and only the substation transformers would operate during the more noise-sensitive nighttime hours.

[3] The maximum quantity of explosive charge detonated on one interval (delay) within a blast.

For the small to medium facilities, a project-level noise assessment for a proxy project was used to estimate the noise generation potential. Project-level analysis for solar energy facilities generally requires modeling with a three-dimensional noise propagation program, such as CadnaA, that develops noise contours around facilities to determine the spatial extent of noise levels from inverters and transformers. The proxy project analysis used for the small to medium facilities was for a proposed 100-megawatt (MW) solar facility (Bluebird Solar in Klickitat County, Washington).

Noise modeling developed for the proxy project shows that a noise level of 43 dBA, equivalent sound level (L_{eq}) extends approximately 800 feet from the inverter and transformer locations (Tetra Tech 2023).

In Washington state, maximum permissible environmental noise levels specific to land use are codified in Chapter 173-60 WAC. For residential uses, an EDNA of 50 dBA would apply during nighttime hours. Therefore, siting of stationary equipment closer than 350 feet from a given noise-sensitive land use would have the potential to exceed the WAC standards.

Additionally, in recognition that existing ambient noise levels are commonly quiet in rural areas where siting of energy facilities would likely occur, an increase of 5 dBA over ambient could also result in a noise impact at noise-sensitive receptors located in such an area. An increase of 5 dBA corresponds to a readily perceptible increase in noise for permanent operations (FHWA 2017). As discussed in Section 3.2.1, remote, sparsely populated counties, such as Columbia County, can have a background L_{dn} value of 35 dBA or lower (BLM 2024). In such rural areas, an increase of 5 dBA over ambient noise could potentially result when stationary equipment generates a noise level of 40 dBA at such a receptor. Based on two-dimensional geometric spreading equations, this increase is estimated to have potential to occur within approximately 1,100 feet of stationary equipment.

Substation noise

An approximately 5-acre collector substation would be within the solar array area. A typical substation transformer is estimated to generate a noise level of 72 dBA at a distance of 6 feet during full load with fans and pumps running (I&R 2019). With two transformers running simultaneously, the noise level would be 3 dBA higher. Equipment-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA or more noise reduction at distant receptors. At a distance of 110 feet, noise would be attenuated to below the 50 dBA EDNA that would apply during nighttime hours. It is further noted that WAC 173-60-050(2)(a) specifically exempts noise from electrical substations from its EDNA standards.

Similarly, at a distance of 350 feet, noise would be attenuated to below 40 dBA, which is the working assumption for a 5 dBA increase over ambient conditions in a rural area.

Corona noise

Small- to medium-scale solar facilities would require overhead gen-tie lines of 69 kilovolts (kV) to 345 kV to match the voltage of existing lines. Collector lines would range from 34.5 kV to

230 kV. Higher-voltage overhead lines of 100 kV or more may be used if the distance to the electrical substation is long. The localized electric field near an energized conductor can be sufficiently concentrated to produce a small electric discharge, which can ionize air close to the conductors. This effect is called corona, and it is associated with all energized electric power lines. Corona can produce small amounts of sound. Corona noise is typically characterized as a hissing or crackling sound, which 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, making corona discharge and the associated audible noise more likely. Therefore, audible noise levels from gen-tie lines are generally higher during wet weather.

Computer modeling software developed by the Bonneville Power Administration (BPA 1977) indicates that, during wet weather conditions, audible noise levels of up to 46 dBA can occur within the gen-tie right-of-way corridor for a 230-kV line. The study assumed an 80-foot-wide right-of-way, and the gen-tie right-of-way for solar facilities is assumed to be wider than this. The 34.5-kV lines would likely be inaudible outside the right-of-way assumed for solar facilities. Noise from lower voltage lines and/or during dry conditions would be lower. Such a noise level would be below the 50 dBA EDNA applicable to residential uses within the State of Washington.

Operational noise impact summary

Through compliance with laws and permits and with implementation of actions that could avoid and reduce impacts, most operations activities would likely result in **less than significant impacts** related to noise and vibration.

Substations and stationary equipment for small to medium facilities located closer than 350 feet from a noise-sensitive land use or closer than 1,100 feet from a noise-sensitive land use in a quiet rural area would have a **potentially significant adverse impact**.

3.4.3 Impacts from decommissioning

For the purposes of this analysis, it is assumed that facility decommissioning would result in similar noise levels and vibration as construction, with the exception of pile driving and blasting activities, which would not occur for decommissioning. Therefore, noise and vibration impacts from decommissioning activities would be similar or less than those described for construction and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.4.4 Actions to avoid and reduce impacts

Because this a programmatic environmental review of utility-scale solar facilities, site-specific mitigation actions would be developed during project-specific reviews and permitting for each facility proposed in the future. Potential actions that could avoid or reduce impacts from construction, operation, or decommissioning of facilities are outlined below.

Recommended siting distances identified in this programmatic analysis are based on proxy projects and unspecified existing noise conditions and locations of sensitive receptors. Each individual facility would need to conduct facility- and site-specific modeling to determine the applicable distances necessary to avoid a significant noise or vibration impact.

3.4.4.1 Siting and design considerations

Careful site selection and layout for a utility-scale solar facility represents the best tool available to reduce the potential for noise and vibration impacts. For the potentially significant adverse noise and vibration impacts identified previously, the following site selection considerations could be used to reduce these potential impacts to a less than significant level.

Construction and decommissioning noise

As discussed above, FTA's daytime criterion for construction would likely not be exceeded if the construction footprint was located more than 50 feet from noise-sensitive receptors. For facility construction in quiet rural areas, a distance of at least 1,000 feet to noise-sensitive receptors should be provided. Provision of a buffer distance from noise-sensitive receptors would reduce the need for additional mitigation measures.

Operational noise

As discussed above, siting of solar facilities closer than 350 feet from a noise-sensitive land use would have the potential for a significant adverse impact with respect to the State of Washington nighttime EDNA of 50 dBA for residential uses, and facility-specific modeling would be required to substantiate the need for mitigation. Consequently, siting of transformers and inverters 350 feet or farther from the closest noise-sensitive land use could preclude a significant adverse operational impact.

For facilities in quiet rural areas, a distance of at least 1,100 feet to noise-sensitive receptors should be provided for siting of stationary noise sources associated with utility-scale solar equipment, which could avoid a significant adverse operational noise impact.

Construction vibration

Siting utility-scale solar facilities such that the construction zone would be at least 80 feet from the closest structure would avoid a significant adverse construction-related vibration impact.

3.4.4.2 Permits, plans, and best management practices

The only permit, plan, or best management practice related to noise or vibration associated with construction of a utility-scale solar facility would be a blasting permit, if blasting were needed for site preparation. Blasting with explosives requires a Washington State explosives license to abate potential hazards, including noise and vibration.

3.4.4.3 Additional mitigation measures

Construction noise

If the construction area of a proposed utility-scale solar facility is closer than 1,000 feet from a noise-sensitive receptor, then a Construction Noise Management Plan should be developed and implemented to minimize localized noise increases from prolonged construction activity. Elements of the Construction Noise Management Plan may include the following:

- Install cast-in-place concrete piles, as feasible.

- Vibrate piles into place and install shrouds around the pile-driving hammer where feasible.
- Site immobile construction equipment (e.g., compressors and generators) and permanent sound-generating facilities away from nearby residences and other sensitive receptors.
- Incorporate low-noise systems (e.g., for pumps, generators, compressors, and fans) and select equipment with low noise emissions and/or without prominent discrete tones, as indicated by the manufacturer.
- Use noise-reduction measures, such as siting noise sources to take advantage of existing topography and distances and constructing engineered sound barriers and/or berms to reduce potential noise impacts at the locations of nearby sensitive receptors.
- Establish a noise complaint resolution process and hotline to address any noise complaints received.
- Enclose noisy equipment when located near sensitive receptors.
- Notify nearby residents in advance of noisy activities, such as blasting or pile driving, before and during the construction period.
- Post warning signs at high-noise areas and implement a hearing protection program for work areas with noise in excess of 85 dBA.
- Maintain tools and equipment in good operating order according to manufacturers' specifications.
- Schedule construction activity during normal working hours on weekdays to reduce noise impacts.
- Limit possible evening shift work to low-noise activities, such as welding, wire pulling, and other similar activities.
- Equip internal combustion engines 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 noise-producing signals, such as horns, whistles, or alarms, to safety warning purposes only.
- Locate construction vehicle routes at the most distant point feasible from noise-sensitive receptors.
- Ensure all heavy trucks are properly maintained and equipped with noise-control (e.g., muffler) devices, in accordance with manufacturers' specifications, at each work site during facility construction, decommissioning, and site reclamation to minimize heavy truck traffic noise effects on sensitive receptors.
- Limit construction operations located within 1,000 feet of residences to daytime hours.
- Prohibit nighttime (10 p.m. to 7 a.m.) blasting.

Operational noise

- Use of acoustical enclosures or barriers could be a feasible mitigation strategy for reducing potential operational noise impacts. Many manufacturers provide optional customized enclosures for mechanical equipment. Alternatively, acoustical barriers may be designed for a particular source or group of sources using acoustically rated materials. A well-designed acoustical enclosure can conservatively reduce noise levels between 15 and 25 dBA.

Construction vibration

- Blast vibrations are a function of several variables besides distance, primarily the weight of explosives per delay. The blasting contractor can control this variable to ensure that blasting activities do not result in either structural damage or human annoyance. The Oregon Department of Transportation estimates that if a structure is 1,320 feet away (1/4 of a mile) and the PPV at that receptor is limited to 0.5 in/sec to avoid structural damage, then the maximum weight of explosives that can be detonated is approximately 2,300 pounds per delay period (ODOT 2000). Therefore, blasting contractors should calculate and maintain the weight of explosives necessary to ensure that vibrations from blasting do not exceed a performance standard of 0.5 PPV in/sec for conventional construction and 0.12 PPV in/sec for historic structures.
- If the construction area of a proposed utility-scale solar facility is closer than 80 feet from an existing structure, then a Construction Vibration Management Plan should be developed and implemented to reduce the potential for building damage. Measures and controls should be identified based on facility-specific design and may include, but are not limited to, the following:
    - Use nonvibratory excavator-mounted compaction wheels and small, smooth drum rollers for final compaction of asphalt base and asphalt concrete. If needed to meet compaction requirements, use smaller vibratory rollers to minimize vibration levels during repaving activities where needed to meet vibration standards.
    - Implement buffers and use specific types of equipment to minimize vibration impacts during construction at nearby receptors.
    - Implement a vibration, crack, and line and grade monitoring program for identified historic buildings located within 80 feet of construction activities, in coordination with a geotechnical engineer and qualified architectural historian.

3.4.5 Unavoidable significant adverse impacts

Through compliance with laws and permits and with implementation of actions to avoid and mitigate significant impacts, small to medium utility-scale solar facilities would have **no significant and unavoidable adverse impacts** from noise from construction, operation, or decommissioning.

3.5 Large utility-scale facilities of 601 MW to 1,200 MW (Alternative 2)

3.5.1 Impacts from construction

Site characterization and construction of a large utility-scale solar energy facility would include the same equipment and activities generating construction noise and vibration as those analyzed for small to medium utility-scale facilities, but likely across a larger facility footprint and over a greater construction period. Noise and vibration from multiple sources, including off-road equipment, pile driving, blasting, vendor and haul truck trips, and a concrete batch plant, could all increase noise levels at receptors in the vicinity of the construction area footprint. Construction equipment and methods for large facilities would be the same as those for small to medium facilities. Therefore, construction noise and vibration impacts would be the same as those identified for small to medium facilities and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.5.2 Impacts from operation

Solar energy facility noise

Larger facilities would likely require a larger, and potentially louder, substation transformer. For the large-scale facilities, a project-level noise assessment for a proxy project was used to estimate the noise generation potential. The proxy project analysis used for the large facility was for a proposed 750-MW solar facility (McCoy Solar in Blythe, California).

Noise modeling for the proxy project was generated for operation of the inverters, as well as for the contributions from substations and solar arrays. The contours show that the substations are the predominant noise source and that the 40 dBA, L_{eq} noise contour extends approximately 2,000 feet at the noisiest location (BLM and Tetra Tech 2011). Based on two-dimensional geometric spreading equations, it is estimated that the 50 dBA contour would occur at 650 feet.

For residential uses, an EDNA of 50 dBA would apply during nighttime hours. Therefore, siting stationary equipment associated with solar facilities closer than 650 feet from a noise-sensitive land use could result in an exceedance of the EDNA WAC standard.

In recognition that existing ambient noise levels are commonly quiet in rural areas where energy facilities would likely be sited, an increase of 5 dBA over ambient would correspond to a readily perceptible increase in noise for permanent operations (FHWA 2017). In quiet rural areas, an increase of 5 dBA over ambient noise could potentially result when equipment generates a noise level of 40 dBA at a receptor. Based on the modeling conducted for the proxy project for a large-scale solar facility, this increase is estimated to have potential to occur within approximately 2,000 feet from the nearest substation location. Consequently, siting of substations closer than 650 feet from a noise-sensitive land use or 2,000 feet from a noise-sensitive land use in a quiet rural area would have a **potentially significant adverse impact**.

Corona noise
Analysis of corona noise for overhead lines of 34.5 kV is included in Section 3.4.2 and would be the same for large-scale facilities. Noise estimates would be negligible (EFSEC 2022) and would result in a **less than significant impact**.

3.5.3 Impacts from decommissioning

Decommissioning noise and vibration impacts for large facilities would be the same as those identified in Section 3.4.3 and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.5.4 Actions to avoid and reduce impacts

Available means of reducing noise and vibration-related impacts for large facilities are the same as those identified in Section 3.4.4.

3.5.5 Unavoidable significant adverse impacts

Through compliance with laws and permits and with implementation of actions to avoid and mitigate significant impacts, large utility-scale solar facilities would have **no significant and unavoidable adverse impacts** from noise from construction, operation, or decommissioning.

3.6 Solar facility and co-located battery energy storage system (Alternative 3)

3.6.1 Impacts from construction

Site characterization and construction of a utility-scale solar energy facility and a co-located battery energy storage system (BESS) would generate the same construction noise levels and vibrations as those analyzed for small to medium facilities and large facilities, with the minor addition of construction of the BESS, using similar construction equipment and methods. Therefore, construction noise and vibration impacts for solar energy facilities and co-located BESSs would be the same as those identified for small to medium and large facilities and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.6.2 Impacts from operation

Solar energy facility noise
Operation of the utility-scale solar energy facility with co-located BESS would add the BESS to the same equipment analyzed for small to medium facilities and large facilities (Alternatives 1 and 2). Noise from a BESS would be generated by battery storage liquid cooling units, as well as inverters specific to the BESS. BESS would not be expected to generate operational vibration. In general, these sources would likely operate 24-hours a day and, hence, would generate noise during the more noise-sensitive nighttime hours.

For utility-scale solar facilities with co-located BESSs, project-level noise assessments for proxy projects were used to estimate the noise generation potential. The proxy projects reviewed that were inclusive of BESS noise included the following: 1) the 200-MW Luna Valley Solar Project in Fresno County, California; 2) the 470-MW Wautoma Solar Energy Project in Benton County, Washington; and 3) the 250-MW Medway Grid Energy Storage Project in Medway, Massachusetts. These proxy projects include both distributed and consolidated BESS arrangements.

For distributed BESS arrangements where the BESSs are allocated to groups of one or more solar collectors, noise modeling for the Luna Valley proxy project indicated that the cooling units do not meaningfully contribute to the noise generated by the substation transformers where they are typically located (Clearway 2020). For the distributed layout for the larger Wautoma Solar Energy Project, the analysis indicates that the 65-dBA noise contour extends approximately 1,000 feet from each collector (Tetra Tech 2022).

However, for the consolidated BESS arrangement for the Wautoma Solar Energy Project, large-scale consolidated direct current-coupled BESSs were indicated to generate higher noise levels when concentrated in a single area. Such systems can result in a noise level of approximately 65 dBA at a distance of 0.5 mile (2,600 feet) as compared to approximately 700 feet from each of a single distributed unit. Analysis for the Medway Grid Energy Storage Project indicates that the 50-dBA noise contour extends approximately 700 feet from the consolidated collectors (Epsilon Associates 2022).

These proxy project analyses indicate that there is a wide range of variability in predicted noise levels based on BESS design and configuration, particularly when comparing distributed and consolidated BESSs. The potential exists for some consolidated BESS operations to exceed the Chapter 173-60 WAC EDNA of 50 dBA at distances ranging up to 1.5 miles from consolidated BESS equipment, depending on the design layout of the BESS.

The addition of BESSs to a solar facility could change the operational noise impacts identified for small to medium facilities and large facilities, and the operational noise impact would range from **less than significant impact** to a **potentially significant adverse impact** depending on the design and layout of the BESS and distance of sensitive receptors from the facility.

Corona noise

Analysis of corona noise for overhead lines of 34.5 kV is included in Section 3.4.2 and would be the same for facilities with co-located BESS. Noise estimates would be negligible (EFSEC 2022) and result in a **less than significant impact**.

Vibration

The BESS would not be expected to generate operational vibration.

3.6.3 Impacts from decommissioning

Decommissioning noise and vibration impacts for solar facilities with co-located BESSs would be the same as those identified for small to medium facilities and large facilities and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.6.4 Actions to avoid and reduce impacts

Available means of reducing noise and vibration-related impacts for solar energy facilities with co-located BESSs are the same as those identified in Section 3.4.4, including additional mitigation measures. Additionally, noise generated by BESSs may need to be controlled to maintain operational noise exposure to within the noise standards of Chapter 173-60 WAC. Additional potential actions that could avoid or reduce impacts are outlined below.

3.6.4.1 Siting and design considerations

- Include acoustical enclosures or barriers for BESS containers to reduce potential operational noise impacts.
- Utilize a dispersed or distributed layout of BESSs.

3.6.5 Unavoidable significant adverse impacts

Through compliance with laws and permits and with implementation of actions to avoid and mitigate significant impacts, utility-scale solar facilities with co-located BESSs would have **no significant and unavoidable adverse impacts** from noise from construction, operation, or decommissioning.

3.7 Solar facilities that include agricultural land uses (agrivoltaic) (Alternative 4)

3.7.1 Impacts from construction

A utility-scale solar facility that includes agricultural land uses may be located on land that already had existing agricultural uses or the facility could add a new agricultural use where the facility is located. Site characterization and construction of an agrivoltaic facility would generate the same construction noise levels and vibration as those analyzed for small to medium facilities and large facilities without combined agriculture land use. Therefore, construction noise and vibration impacts for agrivoltaic facilities would be the same as those identified for small to medium and large facilities and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.7.2 Impacts from operation

For a facility that includes agricultural land uses, any existing agricultural lands would be maintained, or new agricultural use could be co-located with the utility-scale solar facility, including rangeland or farmland. Activities at agrivoltaic facilities may include maintenance of existing or addition of new infrastructure, roads, fences, gates, and operation of farming machinery. If the agricultural uses exist prior to facility construction, any noise contribution from these existing activities would reduce the increase over ambient that is assumed to occur (as analyzed in Sections 3.4.2 and 3.5.2). New agricultural uses could generate seasonal noise from discing, harvesting, or other activities involving agricultural equipment. The operational noise impacts for agrivoltaic facilities would be similar to those operational noise impacts identified for small to medium facilities and large facilities without agricultural use, depending on siting proximity to noise-sensitive receptors. While mobile equipment operations of agricultural equipment could represent a new additional noise source, the seasonality of such operations and temporary the duration of any additional noise generation would be a **less than significant** noise contribution. Overall operational noise impact would range from **less than significant impact** to a **potentially significant adverse impact** depending on the distance of the receptor from the facility.

3.7.3 Impacts from decommissioning

Decommissioning noise and vibration impacts for a facility that includes agricultural land uses would be the same as those identified for small to medium and large facilities and would range from **less than significant impact** to **potentially significant adverse impact** depending on the distance from sensitive receptors.

3.7.4 Actions to avoid and reduce impacts

Available means of reducing noise and vibration-related impacts for a facility that includes agricultural land uses are the same as those identified in Section 3.4.4.

3.7.5 Unavoidable significant adverse impacts

Through compliance with laws and permits and with implementation of actions to avoid and mitigate significant impacts, utility-scale solar facilities with agricultural uses would have **no significant and unavoidable adverse impacts** from noise from construction, operation, or decommissioning.

3.8 No Action Alternative

Under the No Action Alternative, the city, county, and state agencies would continue to conduct environmental review and permitting for utility-scale solar energy development under existing state and local laws on a project-by-project basis. The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described previously for construction, operations, and decommissioning, depending on facility size and design, and would range from **less than significant impacts** to **potentially significant adverse impacts**.

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