# Appendix J: Noise and Vibration Technical Resource Report

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


By

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For the

**Shorelands and Environmental Assistance Program**

Washington State Department of Ecology

Olympia, Washington

June 2025, Publication 25-06-002

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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 |

# Summary

This technical resource report describes the conditions of noise and vibration in the study area. It also describes the regulatory context, potential impacts, and measures to avoid, reduce, and mitigate impacts. This report focuses on 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 Technical Report* (Appendix G).

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

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** related to 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 are closer than 650 feet from a noise-sensitive receptor or closer than 2,000 feet from a noise-sensitive receptor in a quiet rural area
- A project 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 potentially significant and unavoidable adverse impacts** related to noise and vibration would occur.

# Crosswalk with Noise and Vibration Technical 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 technical 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<br>• Some differences in measures to avoid, reduce, and mitigate impacts | • Differences in the types of facility noise- and vibration-generating activities<br>• Larger distance at which potential impacts from facilities could occur<br>• Some differences in measures to avoid, reduce, and mitigate impacts |

# 1 Introduction

This technical resource report describes noise and vibration in the study area and assesses probable impacts associated with types of facilities (alternatives) and 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

The following resources could have impacts that overlap with impacts to noise and vibration. Impacts on these resources are reported in their respective technical resources reports:

- **Tribal rights, interests, and resources:** Impacts on Tribal communities are discussed in the *Tribal Rights, Interests, and Resources Technical Report* (Appendix B).
- **Environmental justice:** Analysis of noise impacts on environmental justice populations and overburdened community areas is included in the *Environmental Justice Technical Resource Report* (Appendix C).
- **Earth:** Vibrations from naturally occurring phenomena, such as earthquakes, are addressed in the *Earth Resources Technical Report* (Appendix D).
- **Biological resources:** 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 Technical Report* (Appendix G).
- **Recreation:** Analysis of noise impacts on recreationists is described in the *Recreation Resources Technical Report* (Appendix M).
- **Historic and cultural resources:** Vibration from construction activities could result in impacts to adjacent structures for structures that have been designated as historic, for which more stringent impact criteria apply. Potential vibration impacts on historic structures or Traditional Cultural Properties are considered in the *Historic and Cultural Resources Technical Report* (Appendix N).

### 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 3.2.2 provides more detail on noise-sensitive receptors.

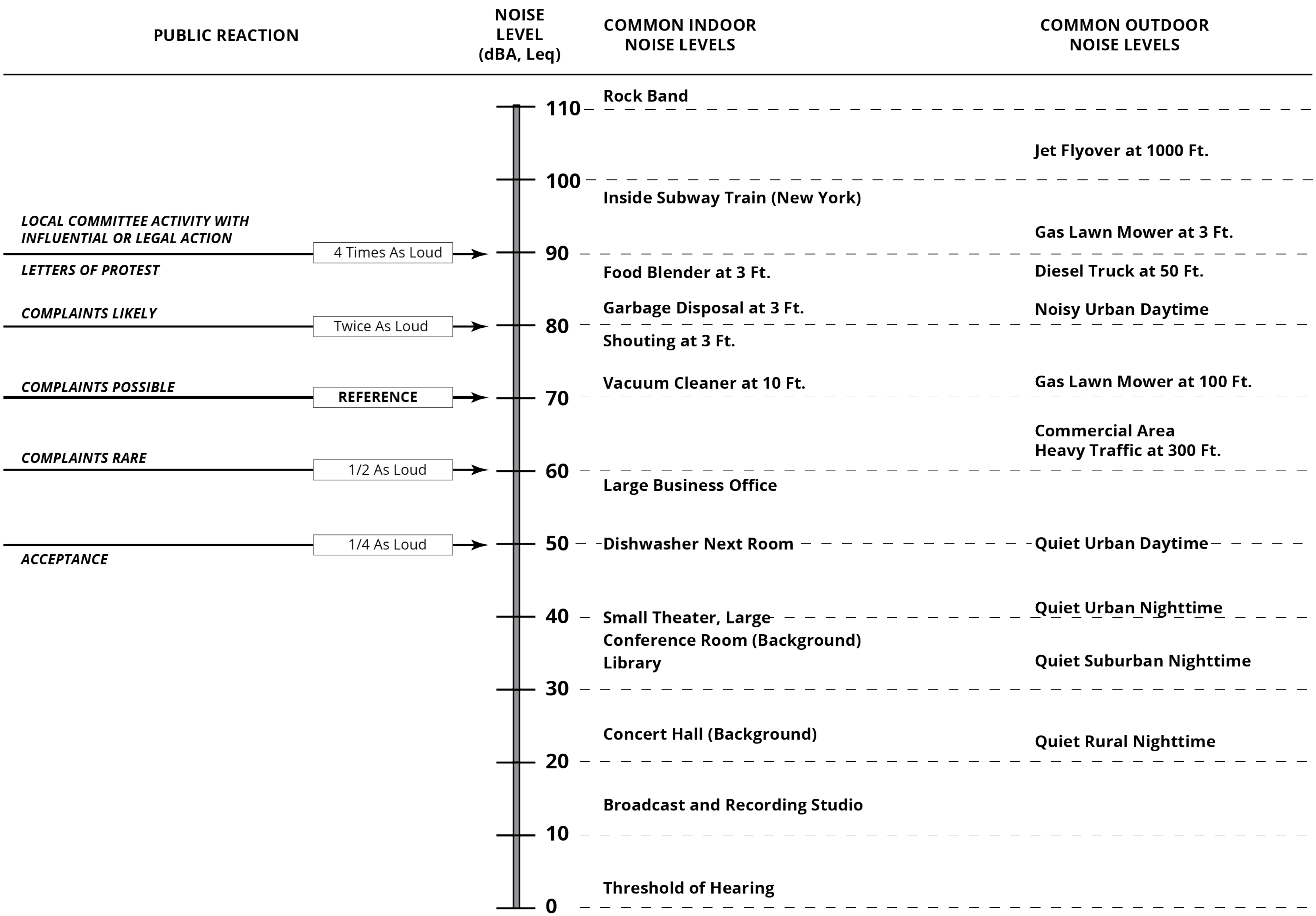


Figure 1. Common range of noise levels

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 Resources Technical Report*.

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 3.2.3 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.<br>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 | Many counties and cities in Washington defer to the Washington Administrative Code regulations. Some counties and cities may have additional standards for noise and vibration. |

# 2 Methodology

## 2.1 Study area

The study area for noise and vibration includes the overall solar geographic scope of study (Figure 2). The 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 project sites and along access roads associated with truck hauling of materials and supplies.

The PEIS geographic scope of study includes various federal, state, and locally managed lands; however, Tribal reservation lands; national parks, wilderness areas, and wildlife refuges; state parks; and areas within cities and urban growth areas were excluded.

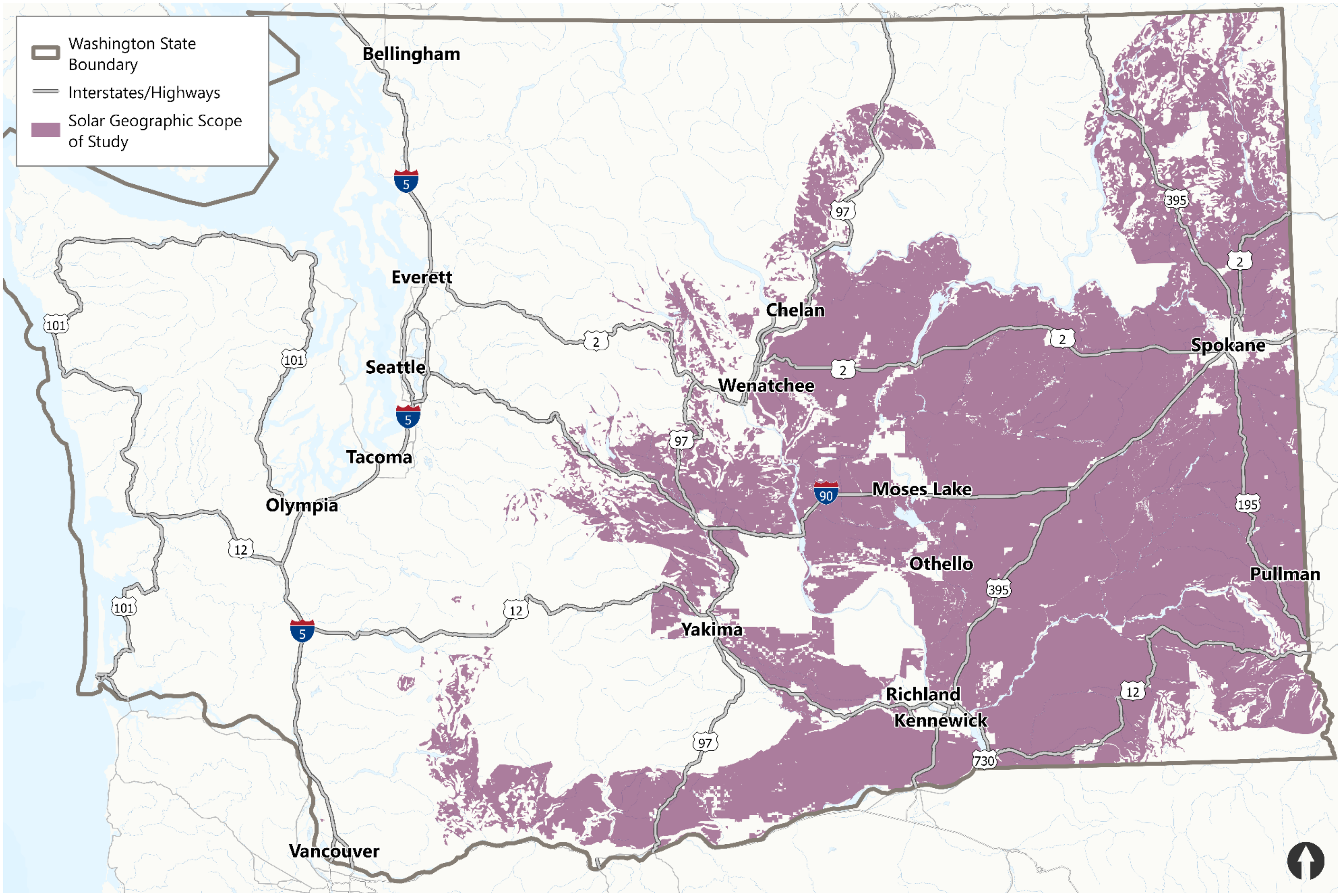


Figure 2. Solar Energy Facilities PEIS – geographic scope of study

## 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, 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, reference noise levels from sources associated with these projects 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 projects 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 project footprint.

## 2.3 Impact assessment approach

The PEIS analyzes a time frame of up to 20 years of potential project construction and up to 30 years of potential project operations (totaling up to 50 years into the future). 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 typically associated with construction-related activities. 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 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 project; and noise from control/administrative buildings.

For the purposes of this assessment, a potentially significant impact would occur if a project resulted in the following:

- Noise from site characterization, construction, and decommissioning:
    - Noise impacts that would conflict with local ordinances or potential exposure of noise-sensitive land uses in excess of the FTA criteria.
    - An increase of 10 dBA over ambient, which corresponds to a perceived doubling loudness, for temporary construction activities (FHWA 2017). This was included in recognition that existing noise levels are commonly quiet in rural areas where siting of energy facilities would likely occur. 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.
- Noise from operations:
    - Noise impacts that conflict with local ordinances or have the 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.
    - An increase of 5 dBA over ambient, which corresponds to a readily perceptible increase in noise for permanent operations (FHWA 2017). This was included in recognition that existing noise levels are commonly quiet in rural areas where siting of energy facilities would likely occur.
- Construction vibration impacts that 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 project and the relative quiet (low ambient noise levels) of a given location. This section also evaluates measures to 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 existing conditions at the time this study was prepared. Given the substantial geographic extent of the study area, the affected environment, in terms of existing ambient noise levels, would vary based on the specific project 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.

Projects 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 10:00 p.m. and 7:00 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 Resources Technical Report* for an analysis of noise impacts on recreationists.

Environmental justice populations and overburdened community areas may be at increased risk for adverse impacts from noise. Refer to the *Environmental Justice Technical Resource Report* for analysis of noise impacts on environmental justice populations and overburdened community areas.

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 Technical 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 of conventional (modern) construction versus older historic structures that are more sensitive to vibration. Sensitive receptors for vibration could occur within the study area or on adjacent lands.

## 3.3 Potentially required permits and approvals

There would be no specific permit requirements related to noise or vibration unless blasting or nighttime work is planned.

If blasting is needed for construction, then a blasting permit would be required:

- **Blasting permits (local fire department or building authority):** Required for blasting activities. 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. Compliance with local noise ordinances is also required and would be reviewed as part of the use permit process:

- **Land use permits (e.g., comprehensive plan amendments, conditional use permit/special use permit, or zoning amendments) (local agency):** Required if changes to a comprehensive plan or zoning designation and/or if a conditional use permit, special use permit, or variance is required for the project.

# 3.4 Utility-scale solar facilities

## 3.4.1 Impacts from construction and decommissioning

### *3.4.1.1 Construction and decommissioning noise*

Construction and decommissioning would generate noise from multiple sources, including the following:

- Off-road equipment used for site characterization, preparation, construction, and decommissioning
- 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 utility-scale solar energy facility (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 project 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 |
| 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 project 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 projects 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, even a small to medium solar project would require between 6,500 to 270,000 posts driven by pile driver, which could have a duration of impact of several weeks. Larger projects would require more pile-driven posts and a longer impact duration.

**Blasting noise**

Blasting is not expected to be needed for construction of most project components 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 construction site and exporting excavated materials from the site would potentially increase noise levels along roadways used to access a given solar project. 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 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 typical 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, construction, and decommissioning project phases. 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 the implementation of measures to avoid and reduce impacts, most construction 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 projects and with appropriate control measures and monitoring programs in place and as required by permits, temporary construction-related vibration effects for the construction of 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 projects 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 the implementation of measures to 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 range from a **less than significant impact** to a **potentially significant adverse impact** depending on the distance from sensitive receptors.

### 3.4.2 Impacts from operation

Operation activities would not be expected to generate vibration.

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

**Solar energy project noise**

The major noise sources 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. Larger projects would likely require a larger, and potentially louder, substation transformer.

Project-level noise assessments for proxy projects were used to estimate the noise generation potential of different sizes of projects. Project-level analysis for solar energy projects 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 small to medium projects was for a proposed 100-megawatt (MW) solar project (Bluebird Solar in Klickitat County, Washington). The proxy project analysis used for larger projects was for a proposed 750-MW solar project (McCoy Solar in Blythe, California).

Noise modeling developed for the small to medium 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 projects 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 for a small- to medium-sized project. 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.

For larger projects, based on modeling for the proxy project, the increase of 5 dBA over ambient noise that could potentially result when stationary equipment generates a noise level of 40 dBA at a receptor in quiet rural areas is estimated to have potential to occur within approximately 2,000 feet from the nearest substation location.

**Corona noise**
Utility-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 projects is assumed to be wider than this. The 34.5-kV lines would likely be inaudible outside the right-of-way assumed for solar projects. 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 the implementation of measures to avoid and reduce impacts, most operations activities would likely result in **less than significant impacts** related to noise and vibration.

Stationary equipment closer than 350 feet from a noise-sensitive receptor or closer than 1,100 feet from a noise-sensitive receptor in quiet rural areas would have a **potentially significant adverse impact**. Substations located closer than 650 feet from a noise-sensitive land use or closer than 2,000 feet from a noise-sensitive land use in a quiet rural area would have a **potentially significant adverse impact**.

### 3.4.3 Measures to avoid, reduce, and mitigate impacts

The PEIS identifies a variety of measures to avoid, reduce, and mitigate impacts. These measures are grouped into five categories:

- **General measures:** The general measures apply to all projects using the PEIS.
- **Recommended measures for siting and design:** These measures are recommended for siting and design in the pre-application phase of a project.
- **Required measures:** These measures must be implemented, as applicable, to use the PEIS. These include permits and approvals, plans, and other required measures.
- **Recommended measures for construction, operation, and decommissioning:** These measures are recommended for the construction, operation, and decommissioning phases of a project.
- **Mitigation measures for potential significant impacts:** These measures are provided only in sections for which potential significant impacts have been identified.

Noise and vibration impact distances identified in this programmatic analysis are based on proxy projects and unspecified existing conditions and locations of sensitive receptors. Developers would need to conduct project- and site-specific modeling for each project to determine the applicable distances necessary to avoid a significant noise or vibration impact.

#### *3.4.3.1 General measures*

- **Laws, regulations, and permits:** Obtain required approvals and permits and ensure that a project adheres to relevant federal, state, and local laws and regulations.

  ***Rationale*:** Laws, regulations, and permits provide standards and requirements for the protection of resources. The PEIS impact analysis and significance findings assume that developers would comply with all relevant laws and regulations and obtain required approvals.

- **Coordination with agencies, Tribes, and communities:** Coordinate with agencies, Tribes, and communities prior to submitting an application and throughout the life of the project to discuss project siting and design; construction, operations, and decommissioning impacts; and measures to avoid, reduce, and mitigate impacts. Developers should also seek feedback from agencies, Tribes, and communities when developing and implementing the resource protection plans and mitigation plans identified in the PEIS.

  ***Rationale*:** Early coordination provides the opportunity to discuss potential project impacts and measures to avoid, reduce, and mitigate impacts. Continued coordination provides opportunities for adaptive management throughout the life of the project.

- **Land use:** Consider the following when siting and designing a project:
    - Existing land uses
    - Land ownership/land leases (e.g., grazing, farmland, forestry)
    - Local comprehensive plans and zoning

- Designated flood zones, shorelines, natural resource lands, conservation lands, priority habitats, and other critical areas and lands prioritized for resource protection
- Military testing, training, and operation areas

***Rationale*:** Considering these factors early in the siting and design process avoids and minimizes the potential for land use conflicts. Project-specific analysis is needed to determine land use consistency.

- **Choose a project site and a project layout to avoid and minimize disturbance:** Select the project location and design the facility to avoid potential impacts to resources. Examples include the following:
  - Minimizing the need for extensive grading and excavation and reducing soil disturbance, potential erosion, compaction, and waterlogging by considering soil characteristics
  - Minimizing facility footprint and land disturbances, including limiting clearing and alterations to natural topography and landforms and maintaining existing vegetation
  - Minimizing the number of structures required and co-locating structures to share pads, fences, access roads, lighting, etc.

***Rationale*:** Project sites and layouts may differ substantially in their potential for environmental impacts. Thoughtful selection of a project site and careful design of a facility layout can avoid and reduce environmental impacts.

- **Use existing infrastructure and disturbed lands, and co-locate facilities:** During siting and design, avoid and minimize impacts by:
  - Using existing infrastructure and disturbed lands, including roads, parking areas, staging areas, aggregate resources, and electrical and utility infrastructure
  - Co-locating facilities within existing rights-of-way or easements
  - Considering limitations of existing infrastructure, such as water and energy resources

***Rationale*:** Using existing infrastructure and disturbed lands and co-locating facilities reduces impacts to resources that would otherwise result from new ground disturbance and placement of facilities in previously undisturbed areas.

- **Conduct studies and surveys early:** Conduct studies and surveys early in the process and at the appropriate time of year to gather data to inform siting and design. Examples include the following:
  - Geotechnical study
  - Habitat and vegetation study
  - Cultural resource survey
  - Wetland delineation

***Rationale*:** Conducting studies and surveys early in the process and at the appropriate time of year provides data to inform siting and design choices that avoid and reduce impacts. This can reduce the overall timeline as well by providing information to agencies as part of a complete application for environmental reviews and permits.

- **Restoration and decommissioning:** Implement a Site Restoration Plan for interim reclamation following temporary construction and operations disturbance. Implement a Decommissioning Plan for site reclamation at the end of a project. Coordinate with state and local authorities, such as the Washington Department of Fish and Wildlife, county extension services, weed boards, or land management agencies on soil and revegetation measures, including approved seed mixes. Such plans address:
    - Documentation of pre-construction conditions and as-built construction drawings
    - Measures to salvage topsoil and revegetate disturbed areas with native and pollinator-supporting plants
    - Management of hazardous and solid wastes
    - Timelines for restoration and decommissioning actions
    - Monitoring of restoration actions
    - Adaptive management measures

  ***Rationale*:** Restoration and decommissioning actions return disturbed areas to pre-construction conditions, promote soil health and revegetation of native plants, remove project infrastructure from the landscape, and ensure that project components are disposed of or recycled in compliance with all applicable laws and regulations.

- **Cumulative impact assessment:** Assess cumulative impacts on resources based on reasonably foreseeable past, present, and future projects. Identify actions to avoid, reduce, and mitigate cumulative impacts. Consider local studies and plans, such as comprehensive plans.

  ***Rationale*:** Cumulative impacts can result from incremental, but collectively significant, actions that occur over time. The purpose of the cumulative impacts analysis is to make sure that decision-makers consider the full range of consequences under anticipated future conditions.

#### *3.4.3.2 Recommended measures for siting and design*

- Site noise sources to reduce impacts and take advantage of existing topography and distances.
- Model project-level noise and vibration for construction and operations activities and equipment to determine project-specific setback distances for noise and vibration-sensitive land uses and receptors. Model noise and vibration using estimates that address variations in equipment type selected in final project design.
- Use noise and vibration modeling results during siting and design and establish setback distances for construction and operations. Provision of a setback distance from noise- or

vibration-sensitive receptors would reduce the need for additional mitigation measures. Examples of activities and equipment to consider when establishing setback distances include the following:
    - Sources of construction vibration
    - Construction vehicle routes
    - Immobile construction equipment (e.g., compressors and generators)
    - Permanent sound-generating facilities, including transformers, inverters, and substations
    - Blasting
- 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.

#### *3.4.3.3 Required measures*

This section lists permits and approvals, plans, and other required measures for use of the PEIS, as applicable. See Section 3.3 for more detailed information on potentially required permits and approvals.

- Blasting permits (local fire department or building authority)
- Land use permits (e.g., comprehensive plan amendments, conditional use permit/special use permit, or zoning amendments) (local agency)
- Implement a worker hearing protection program for work areas with noise in excess of 85 dBA per Occupational Safety and Health Administration Standard 1910.95(c)(1).

#### *3.4.3.4 Recommended measures for construction, operation, and decommissioning*

- Implement noise reduction measures during construction, including the following:
    - Notify potentially affected 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.
    - Schedule construction activity during normal working hours on weekdays.
    - Limit possible evening shift work to low-noise activities, such as welding, wire pulling, and similar activities.
    - Maintain tools and equipment in good operating order according to manufacturer specifications.
    - Ensure all heavy trucks and internal combustion engines are properly maintained and equipped with noise-control (e.g., muffler) devices, in accordance with manufacturer specifications.
    - Limit noise-producing signals, such as horns, whistles, or alarms, to safety warning purposes only. Prohibit nighttime (10:00 p.m. to 7:00 a.m.) blasting.

### 3.4.3.5 Mitigation measures for potential significant impacts

- If project-specific construction noise modeling indicates potential significant impacts to noise-sensitive receptors, implement a Construction Noise Management Plan to reduce noise impacts.

  ***Rationale*:** A Construction Noise Management Plan can reduce the potential for construction noise impacts to noise-sensitive receptors.

- If project-level noise analysis for receiving properties indicates EDNA threshold exceedances or an increase of 5 dBA over ambient noise levels in quiet rural areas, use acoustical enclosures or barriers to reduce operations noise levels. 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.

  ***Rationale*:** Use of acoustical enclosures or barriers can reduce operational noise impacts. A well-designed acoustical enclosure can reduce noise levels between 15 and 25 dBA.

- Establish a noise complaint resolution process and hotline.

  ***Rationale*:** A hotline can facilitate reporting of noise concerns and complaints. A noise complaint resolution process can be used to systematically address any noise complaints received.

- If project-specific construction vibration modeling indicates potential significant impacts to existing structures, implement a Construction Vibration Management Plan to reduce the potential for building damage. Measures and controls should be identified based on project-specific design and may include, but are not limited to, the following:
  - Installing cast-in-place concrete piles to minimize vibration.
  - Vibrating piles into place and installing shrouds around the pile-driving hammer.
  - Using 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.
  - Using active or passive vibration isolation systems for equipment that may produce high levels of vibration.
  - Implementing a vibration, crack, and line and grade monitoring program for identified historic buildings in coordination with a geotechnical engineer and qualified architectural historian.
  - During blasting, calculating and maintaining 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.

***Rationale*:** A Construction Vibration Management Plan can reduce the potential for building damage to occur during construction.

### 3.4.4 Unavoidable significant adverse impacts

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

## 3.5 Solar facilities with battery energy storage systems

### 3.5.1 Impacts from construction and decommissioning

Site characterization, construction, and decommissioning 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 in Section 3.4, with the minor addition of construction of the BESS, using similar construction equipment and methods. Therefore, construction and decommissioning noise and vibration impacts for solar energy facilities and co-located BESSs would be the same as those identified for utility-scale facilities and would range from **less than significant impacts** to **potentially significant adverse impacts** depending on the distance from sensitive receptors.

### 3.5.2 Impacts from operation

**Solar energy project noise**

Operation of the utility-scale solar energy facility with co-located BESS would add the BESS to the same equipment analyzed for utility-scale facilities. 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 2023).

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 project could change the operational noise impacts identified for utility-scale 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 project.

**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.

### 3.5.3 Measures to avoid, reduce, and mitigate impacts

Available measures to avoid, reduce, and mitigate impacts are the same as those identified in Section 3.4.3. 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 measures related to the BESS are outlined below.

#### *3.5.3.1 Mitigation measures for potential significant impacts*

- If project-level noise analysis identifies noise level exceedances, additional measures include the following:
    - Acoustical enclosures or barriers for BESS containers
    - Utilizing a dispersed or distributed layout of BESSs

***Rationale*:** Use of acoustical enclosures or barriers can reduce operational noise impacts. The layout of BESSs can affect noise impacts. Compared to a consolidated layout of BESSs, a dispersed or distributed layout of BESSs may result in reduced noise impacts.

### 3.5.4 Unavoidable significant adverse impacts

Through compliance with laws and permits and with the implementation of measures to avoid, reduce, and mitigate significant impacts, construction, operation, or decommissioning of facilities with co-located BESSs would have **no significant and unavoidable adverse impacts** related to noise and vibration.

## 3.6 Solar facilities that include agricultural uses

### 3.6.1 Impacts from construction and decommissioning

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 project is located. Site characterization, construction, and decommissioning of an agrivoltaic project would generate the same construction noise levels and vibration as those analyzed for utility-scale facilities without combined agriculture land use. Therefore, construction and decommissioning noise and vibration impacts for agrivoltaic facilities would be the same as those identified for utility-scale facilities and would range from **less than significant impacts** to **potentially significant adverse impacts** depending on the distance from sensitive receptors.

### 3.6.2 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 project construction, the noise contribution from these existing activities would reduce the increase over ambient that is assumed to occur 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 operational noise impacts identified for utility-scale 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 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 project.

### 3.6.3 Measures to avoid, reduce, and mitigate impacts

Measures to avoid, reduce, and mitigate impacts are the same as those identified in Section 3.4.3.

### 3.6.4 Unavoidable significant adverse impacts

Through compliance with laws and permits and with the implementation of measures to avoid, reduce, and mitigate significant impacts, construction, operation, or decommissioning of facilities with agricultural uses would have **no significant and unavoidable adverse impacts** related to noise and vibration.

## 3.7 No Action Alternative

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

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