2.10 Noise

Noise is defined as any unwanted sound (sound that is loud, unexpected, or undesirable) and sound is defined as any pressure variation that the human ear can detect. Because the human ear can detect such a wide range of sound pressures, sound pressure is converted to sound pressure level (SPL), which is measured in units called decibels (dB). The decibel is a relative measure of the sound pressure with respect to a standardized reference quantity. Because the dB scale is logarithmic, a relative increase of 10 dB represents a sound pressure that is 10 times higher. However, humans do not perceive a 10-dBA increase as 10 times louder. Instead, they perceive it as twice as loud. Table 2-28 lists some sound levels for typical daily activities.

Table 2-28 Sound Pressure Levels of Representative Sounds and Noises

Source	Decibels	Description
Jet takeoff (nearby)	150	
Pneumatic riveter	130	
Jet takeoff (60 meters)	120	Pain threshold
Construction noise (3 meters)	110	
Subway train	100	
Heavy truck (15 meters)	90	Constant exposure endangers hearing
Average factory	80	
Busy traffic	70	
Normal conversation (1 meter)	60	
Quiet office	50	
Quiet Library	40	
Soft whisper (5 meters)	30	Very quiet
Rustling leaves	20	
Normal breathing	10	Barely audible
Hearing threshold	0	

Source: Beranek 1988

There are several ways to measure noise, depending on the source of the noise, the receiver, and the reason for the noise measurement. Table 2-29 summarizes the specialized terms used to describe noise.

Noise levels are generally stated in terms of dBA to reflect the response of the human ear by filtering out some of the noise in the low- and high-frequency ranges that the ear does not detect well. The A-weighted scale is used in most noise ordinances and standards. The L_{eq} is defined as the average noise level, on an energy basis, for a stated period of time (such as hourly).

Table 2-29 Definitions of Acoustical Terms

Term	Definitions
Ambient noise level	The composite of noise from all sources near and far from a given location. The normal or existing level of environmental noise at a given location.
Decibel (dB)	A numerical expression of the relative loudness of a sound, equal to 20 times the logarithm to the base 10 of the ratio of the reference pressure to the sound pressure.
Frequency (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.
Decibel A-weighted sound level (dBA)	The sound pressure level in decibels as measured on a sound-level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted unless stated otherwise.
Equivalent noise level (L_{eq})	The energy average A-weighted noise level during the measurement period.
Percentile noise level (L_n)	The A-weighted noise level exceeded during n% of the measurement period, where n is a number between 0 and 100 (e.g., L_{90}).

Source: Beranek (1988).

Statistical methods are also used to capture the dynamics of a changing acoustical environment. These measurements are typically denoted by L_n, where $_n$ represents the percent of time a sound level is exceeded. The L_{25} represents the noise level that is exceeded during 25 percent of the measurement period (15 minutes of an hourly interval).

The effects of noise on people fall into three general categories:

- Subjective impacts of annoyance, nuisance, and dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological impacts such as startling and hearing loss

In most cases, environmental noise effects are limited to the first two categories. However, workers in industrial plants may experience noise impacts in the third category. No completely satisfactory way exists to measure the subjective impacts of noise or to measure the corresponding reactions of annoyance and dissatisfaction. This lack of a common standard is primarily a result of the wide variation in individual thresholds of annoyance and tolerance to noise.

It also is useful to understand the difference between a sound pressure level (or noise level) and a sound power level. A sound power level (commonly abbreviated as PWL or Lw) is analogous to the wattage of a light bulb; it is a measure of the acoustical energy emitted by the source and is, therefore,

independent of distance. A sound pressure level (commonly abbreviated as SPL or Lp) is analogous to the brightness or intensity of light experienced at a specific distance from a source and is measured directly with a sound-level meter. Sound pressure levels always should be specified with a location or distance from the noise source.

Sound power level data are used in acoustic models to predict sound pressure levels. This is because sound power levels take into account the size of the acoustical source and account for the total acoustical energy emitted by the source.

It is also important to note that decibels cannot be directly added, that is, 50 dBA + 50 dBA does not equal 100 dBA. When two sources of equal level are added together the result will always be 3 dB greater; that is 50 dBA + 50 dBA = 53 dBA and 70 dBA + 70 dBA=73 dBA. If the difference between the two sources is 10 dBA, the level will not increase; that is 40 dBA + 50 dBA=50 dBA and 60 dBA + 70 dBA=70 dBA.

The decrease in sound level due to distance from any single sound source normally follows the inverse square law, i.e., the SPL changes in inverse proportion to the square of the distance from the sound source. In a large open area with no obstructive or reflective surfaces, it is a general rule that at distances greater than 50 feet the SPL from a point source of sound drops off at a rate of 6 dB with each doubling of the distance from the source. Sound energy is absorbed in the air as a function of temperature, humidity, and the frequency of the sound. This attenuation can be up to 2 dB over 1,000 feet. The drop-off rate will also vary based on terrain conditions and the presence of obstructions in the sound's propagation path.

2.10.1 Affected Environment

All WRAs

The proposed Project is comprised of over 124,000 acres within Columbia and Garfield counties. The Project area is generally characterized as rolling rural landscape, dominated by agricultural areas and grasslands. Livestock production occurs within portions of the Project area and consists primarily of cattle and sheep. Scattered residences and farm buildings are present within the Project area. These residences are the primary noise sensitive uses within the Project area.

Sources of noise within the Project area are typical of similar rural areas, primarily related to agricultural activities and traffic on local roads and highways. The existing noise levels are expected to vary with distance from these sources as well as local wind speeds. When the local wind speed is low or calm, the noise levels are expected to be less than when the winds are elevated.

The total noise that can be perceived is a logarithmic sum of background and projected wind turbine noise. At residences in or near any project proposed for development, there is no single, consistent background noise level. Ambient noise levels are highly variable, and there is no means to accurately depict actual conditions at all times. This is because the factors that contribute to background noise may vary between project areas. Ambient noise is the result of a number of factors including weather, wind conditions and the presence of other noise sources (including, without limitation, agricultural equipment operations, irrigation pumps and equipment, livestock, road, rail and air traffic, wildlife (birds, insects) dogs and routine human activities). Ambient levels may vary between receptors and the level at a single site may vary from one day to the next. This is borne out by measurements made in similar rural areas, which documented a wide range in existing levels, from below 20 dBA to over 40 dBA in areas remote from transportation corridors. In areas closer to transportation corridors, noise levels extended into the mid-60's dBA (Kittitas Valley Wind Power Project, 2007 and Golden Hills Wind Project 200). The increased noise level resulting from the operation of any project, including those that emit a constant level will vary as a result of the varying ambient noise levels. For a wind project, the projects noise level also varies with wind speed at the turbines. For example, when the winds are calm the turbines emit very little noise compared to stronger wind conditions when the turbines generate their highest levels noise. A wind project's noise level at a particular receptor is primarily determined by the wind speed occurring at the turbine and the distance to the closest turbines. The Washington Department of Ecology has adopted maximum permissible noise levels that apply to differing types of noise generators and receivers (e.g., residential, commercial and industrial) which are described in Section 2.10.1.1.

2.10.1.1 Regulatory Standards and Guidance

Section 173-60 of the Washington Administrative Code (WAC) provides the applicable noise standards for the State of Washington, including Garfield and Columbia counties.

Neither county has promulgated independent state-approved noise standards pursuant to WAC 173-60-110. WAC 173-60 establishes maximum permissible environmental noise levels. These levels are based on the environmental designation for noise abatement (EDNA), which is defined as "an area or zone (environment) within which maximum permissible noise levels are established." There are three EDNA designations (WAC 173-60-030), which roughly correspond to residential, commercial/recreational, and industrial/agricultural uses:

- **Class A:** Lands where people reside and sleep (such as homes);
- **Class B:** Lands requiring protection against noise interference with speech (such as commercial/recreational); and
- **Class C:** Non-residential lands where economic activities are of such a nature that higher noise levels are anticipated (such as agricultural).

Pursuant to the state noise standards, it is possible to interpret all of the lands and receptors adjacent to the Project site as Class C agricultural receptors, rather than the more sensitive Class A residential receptors, if receptor class is determined based on zoning, rather than specific use on the site. However, for purposes of this noise impact analysis, and to provide a more conservative assessment of potential noise impacts, all existing non-participating residences near the Project site are evaluated as noise-sensitive areas, which are equivalent to Class A EDNA areas. Participating landowners and the Applicant may address noise impacts separately. Table 2-30 summarizes the maximum permissible levels applicable to noise originating from an industrial site (e.g., the proposed wind turbine generators [WTGs]) as received at homes (Class A EDNA) and at agricultural areas (Class C EDNA).

Table 2-30 State of Washington Noise Regulations (WAC 173-60-040)

	Maximum Permissible Noise Levels (dBA) from a Class C EDNA		
	Class A EDNA Receiver		Class C EDNA Receiver [1]
Statistical Descriptor	Daytime (7 a.m.–10 p.m.)	Nighttime (10 p.m.–7 a.m.)	Anytime
L_{eq} (hourly average)	60	50	70
L_{25} (15 minutes per hour)	65	55	75
$L_{16.7}$ (5 minutes per hour)	70	60	80
$L_{2.5}$ (1.5 minutes per hour)	75	65	85

Source: WAC 173-60

Note:
[1] Standard applies at the property line of the receiving property.

The following are exempted from the limits presented in Table 2-30 (per WAC 173-60-050):

- Construction noise (including blasting) between the hours of 7 a.m. and 10 p.m.;
- Motor vehicles operated on public highways;
- Motor vehicles operated off public highways, except when such noise affects residential receivers; and
- Noise from electrical substations is exempted from the nighttime limits (WAC 173-60-050[2][a]).

The applicant will be required to comply with all applicable noise standards.

2.10.2 Impacts and Mitigation

This section presents the potential noise impacts of construction and operation of the Project and lists mitigation measures that will be instituted as necessary to control noise levels.

2.10.2.1 Preferred Alternative

Construction Impacts

All WRAs

Noise from construction activities associated with the Project would generate short-term impacts at some residences during the construction period. Assessing and quantifying these impacts is difficult because construction activities will constantly be moving around the site, leading to highly variable impacts over time at any given point.

The major construction activities associated with the installation of a wind energy facility include the following:

- Access road construction and electrical line trenching,
- Site preparation and foundation installation,
- Wind turbine erection, and
- Substation/switchyard construction

Noise-generating construction activities, including blasting, conducted during the hours of 7 a.m. and 10 p.m. are exempt from the limits per WAC 173-60-050. Additionally, blasting activities are furthered governed by both federal regulations promulgated by the Department of Homeland Security and state regulations promulgated by Department of Labor and Industries. To the maximum extent feasible, blasting activities will be conducted between the hours of 7 a.m. and 10 p.m. Due to the remote, hilly nature of the Project area, construction noise effects will be largely attenuated and are not expected to be a significant impact. All applicable noise standards for non-exempt construction periods will be met.

Traffic Impacts

Traffic volume will increase on local roadways surrounding the Project during the construction phases due to commuting construction workers and the transportation of materials. As a result, noise levels along local roadways would increase temporarily.

Project Facility Impacts

All WRAs

The Applicant is considering a range of turbines varying in size from 1.8-megawatt (MW) to 2.3-MWs for the Project. The procedures for determining sound power levels from wind turbines are defined in International Electrotechnical Commission 61400 *Wind Turbine Generator Systems—Part 11: Acoustic Noise Measurement Techniques—Amendment 1* (IEC 2006). This measurement technique outlines procedures to determine corrections for background noise, apparent sound power level, and wind speed dependence. Turbine manufacturers typically provide noise emission data for turbine models

collected following this methodology. The anticipated range in maximum sound power levels for the individual turbines being considered for the Project is 104 to 108 dBA.

As is typical for projects of this nature, the final layout will not be available until detailed engineering studies (e.g., geotechnical analysis), turbine selection and micrositing are completed. These tasks are accomplished as part of the final design efforts. As discussed in the Section 2.10.1 Affected Environment, existing and Project noise levels and any potential increases thereto will vary. The methods used to determine Project noise levels are discussed below. The State of Washington regulates noise emissions as discussed above; see Table 2-30, *supra*. The Project will comply with the 70 dBA agricultural property line and 50 dBA residential noise emission limits at all receptors by adjusting turbine spacing, provided, however, that individual landowners may, by contract, agree to the Applicant's exceedence of these limits on their property.

The Applicant has reviewed information received from Garfield and Columbia counties on the location of homes in the vicinity of the Project. These locations, including topographical and other man-made features, will be assessed during mircositing, and leased parcel boundaries will be clarified and updated as part of the detailed design efforts to ensure the Project complies with the applicable noise limits. Figures 2-13 through 2-16 depict a projected noise contour of 50 dBA noise level under high wind speeds (maximum noise generating conditions) for a potential turbine layout within the proposed turbine corridors without taking into account the potential reductions afforded by topographic shielding or other noise attenuating factors (the model is discussed in more detail below). These figures identify those existing participating and nonparticipating residences within the vicinity of the 50 dBA noise contour under these assumptions.

At a residence, the Garfield County Zoning Ordinance requires a minimum setback of one-quarter mile (1,320 feet) or four times the height of the wind energy tower measured from the ground level to the highest point on a wind turbine (including the rotor blades), whichever is greater. Since the total height of the turbine tower and blades is expected to be 410 feet, the minimum setback would need to be 1,640 feet at a residence in Garfield County. As shown in Figures 2-13 through 2-16, it is anticipated that 50 dBA would be achieved within approximately 1,500 feet from a string of turbines. The noise level would be diminished even further at 1,640 feet. Thus, the Garfield County zoning setbacks are expected to mitigate noise impacts suffiecient to meet state standards. However, more detailed evaluation of noise impacts will be conducted during micrositing to ensure state standards can be met.

The Columbia County Zoning Ordinance requires a minimum setback of one-quarter mile (1,320 feet) from a turbine to the Project area boundary. When necessary in order to meet the WAC 173-60-040 noise limit of 50 dBA at a residence, turbines will be set back in excess of the Columbia County minimum

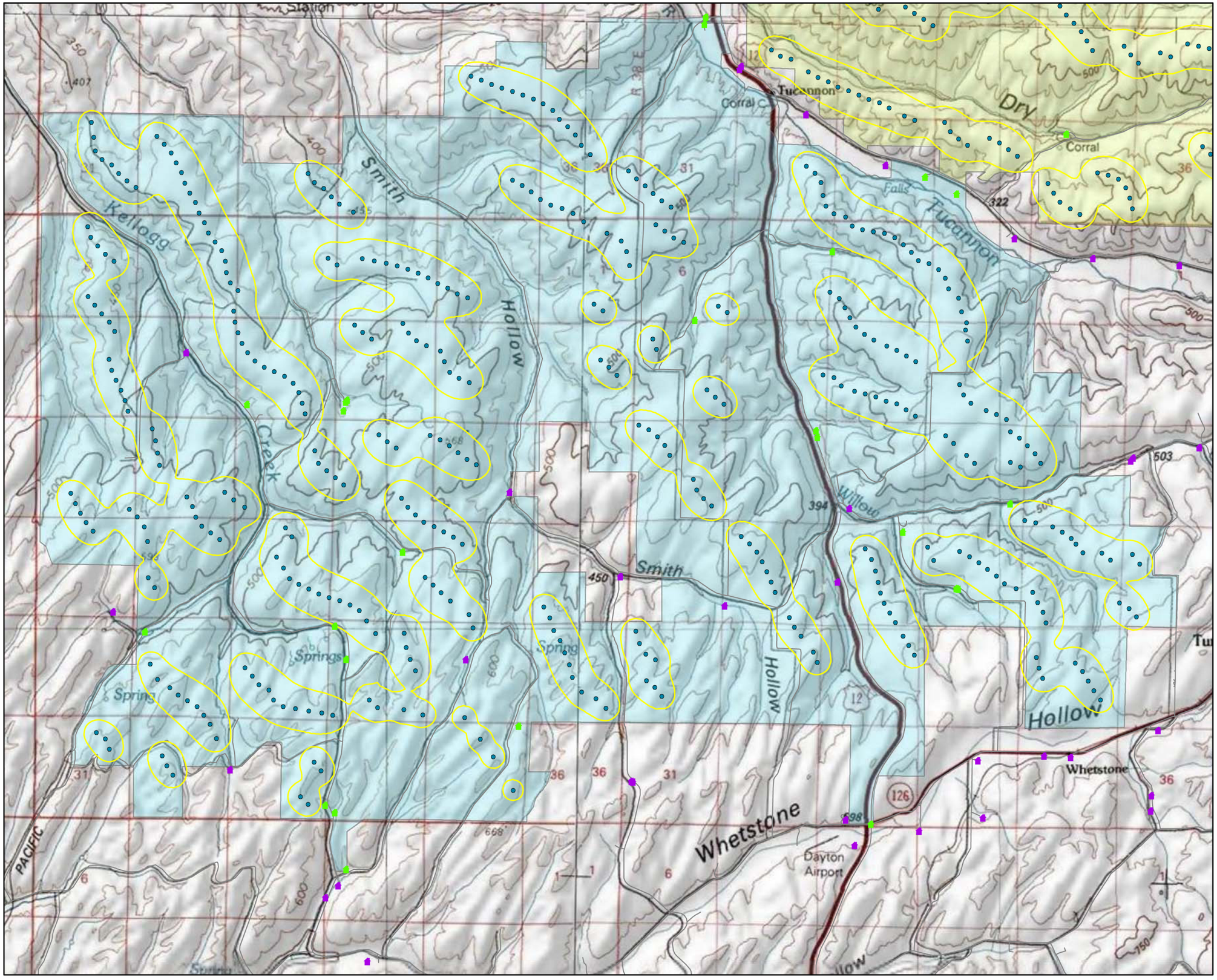
standard of 1,320 feet from the Project boundary. More detailed evaluation of noise impacts will be conducted during micrositing to ensure state standards can be met.

An acoustical model will be used to simulate the outdoor propagation of sound generated during operation of the Project based on the final Project layout, turbine model selected and location and size of ancillary facilities (substations). The model will be used to calculate the sound pressure level that would occur at receptors during the simultaneous operation of all the Project turbines and substations taking into account losses due to spreading of sound energy over distance, atmospheric absorption, and terrain effects. The modeling algorithms are based on the International Organization for Standardization 9613-2 *Acoustics — Attenuation of Sound during Propagation Outdoors* (ISO, 1996). To ensure compliance under the greatest noise generating conditions, the turbine's maximum sound power levels will be used as a basis for noise modeling.

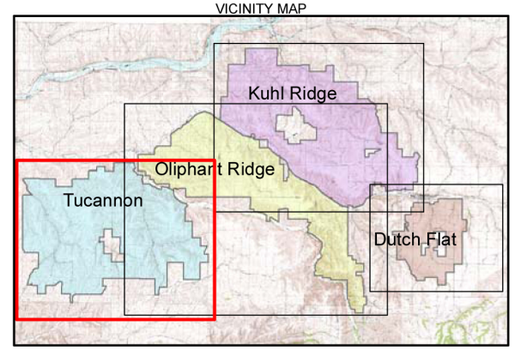
The noise level from each turbine at each receptor is determined and then acoustically summed to calculate the overall Project noise level at the receptor. The primary attenuating factor is distance. The reduction afforded by distance is determined by twenty times the logarthim of the distance (20*Log(d)). This results in a 6 dBA reduction per doubling of distance from a single turbine. When the contribution of multiple turbines is acoustically summed the resulting attenuation from distance is between 3 dBA and 6 dBA per doubling of distance. If the line of sight to a turbine is blocked by topography, additional reductions may be taken into account. The Applicant will ensure that the maximum noise level at the closest receptors would not exceed the applicable limits (50 dBA residential/70 dBA property lines).

Another source of operational noise is corona noise associated with the proposed 230 kV transmission line. Corona is the electrical ionization of the air that occurs near the surface of the energized conductor and suspension hardware due to very high electric field strength. Corona is typically a design concern at voltages above 345 kV. During wet or foul weather conditions, the conductor will produce the greatest amount of corona noise, generally characterized as crackling, hissing or humming sound. However, during heavy rain the noise generated by the falling rain drops hitting the ground will typically be greater than the noise generated by corona and thus will mask the audible noise from the transmission line. The maximum level of corona noise under foul weather conditions is anticipated to be 46 dBA directly underneath the line. This will decrease to less than 35 dBA at a distance of 500 feet. Under more typical fair weather conditions, the maximum level underneath the line is expected to be 21 dBA and drop to below 10 dBA at 500 feet.

Substation transformers and high-voltage switching equipment would be specified and constructed to comply with the allowable nighttime noise limits and daytime exemption specified in WAC 173-60-040 and 173-60-050 (see Table 2-30).



VICINITY MAP



LEGEND

- Participating Residence
- Non-participating Residence
- Proposed Turbine
- 50 dBA*
- Street
- Dutch Flat
- Kuhl Ridge
- Oliphant Ridge
- Tucannon

Notes:

1. Turbines and Residences are not to scale and are shown only for demonstrative purposes.
2. Size of turbines and houses overemphasized for clarity; put to scale, houses and turbines would be difficult to discern.
3. Does not depict potential reductions afforded by topographic shielding.
4. Preliminary layout; final turbine siting subject to revisions based on, but not limited to, further environmental analysis, micrositing and manufactures specifications.

* 50 dBA is the most restrictive noise limit at residential zones in accordance with WAC 173-60.

N

0 1,850 3,700 7,400

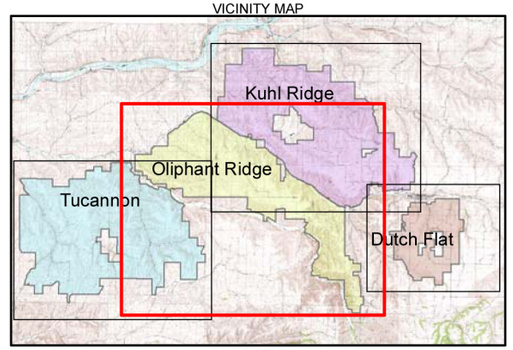
Feet

Figure 2-13

Preliminary Noise Contours for the Tucannon Wind Resource Area

Lower Snake River Wind Project

VICINITY MAP



LEGEND

- Participating Residence
- Non-participating Residence
- Proposed Turbine
- 50 dBA*
- Street
- Dutch Flat
- Kuhl Ridge
- Oliphant Ridge
- Tucannon

Notes:

1. Turbines and Residences are not to scale and are shown only for demonstrative purposes.
2. Size of turbines and houses overemphasized for clarity; put to scale, houses and turbines would be difficult to discern.
3. Does not depict potential reductions afforded by topographic shielding.
4. Preliminary layout; final turbine siting subject to revisions based on, but not limited to, further environmental analysis, micrositing and manufactures specifications.

* 50 dBA is the most restrictive noise limit at residential zones in accordance with WAC 173-60.

N

0 2,450 4,900 9,800

Feet

Figure 2-14

Preliminary Noise Contours for the Oliphant Ridge Wind Resource Area

Lower Snake River Wind Project