3.10 Noise

This section describes the existing conditions and potential impacts pertaining to noise that would result from the proposed project. Where feasible, mitigation measures are recommended for those impacts that were determined to be significant.

3.10.1 Existing Conditions

Terminology

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Noise can be defined as unwanted sound. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level is the most common descriptor used to characterize the loudness of an ambient sound level. The decibel (dB) scale is used to quantify sound intensity. Because sound pressure can vary enormously within the range of human hearing, a logarithmic loudness scale is used to keep sound intensity numbers at a convenient and manageable level. The human ear is not equally sensitive to all frequencies in the entire spectrum, so noise measurements are weighted more heavily for frequencies to which humans are sensitive in a process called *A-weighting*, written *dBA*. In general, human sound perception is such that a change in sound level of 3 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving sound level.

Different types of measurements are used to characterize the time-varying nature of sound. Below are brief definitions of these measurements and other terminology used in this analysis.

- **Sound.** A vibratory disturbance created by a vibrating object that, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Maximum Sound Level (L_{max}).** The maximum sound level measured during the measurement period.
- **Minimum Sound Level (L_{min}).** The minimum sound level measured during the measurement period.
- **Equivalent Sound Level (L_{eq}).** The equivalent steady state sound level that, in a stated period of time, would contain the same acoustical energy.

- **Percentile-Exceeded Sound Level (L_{xx}).** The sound level exceeded *x* percent of a specific time period. L_{10} is the sound level exceeded 10% of the time.

- **Day-Night Level (L_{dn}).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.

- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 5 dB added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.

L_{dn} and CNEL values rarely differ by more than 1 dB. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment.

To analyze outdoor sound propagation, some additional concepts are important. From an ideal point source, sound pressure level decreases with distance as a result of the spreading out of sound waves originating from the source. This geometrical or spherical spreading results in a reduction of sound pressure level of 6 dB per doubling of distance from the source. The strength of the source is often characterized as *sound power level*. Sound power level is independent of the distance a receiver is from the source and is a property of the source alone. Knowing the sound power level of an idealized source and its distance from a receiver, sound pressure level at the receiver point can be calculated on the basis of geometrical spreading.

The sound pressure level, because of spherical spreading, can be further modified by a number of additional factors. The first is the presence of a reflecting plane such as the ground. In areas of hard ground, a reflecting plane typically increases A-weighted sound pressure levels by 3 dB. If some of the reflected sound is absorbed by the surface, the increase will be less than 3 dB. Other factors affecting the predicted sound pressure level are often lumped together into a term called *excess attenuation*. Excess attenuation is the amount of additional attenuation that occurs beyond simple spherical spreading. Outdoor sound propagation is almost always subject to excess attenuation, producing lower levels than what would be predicted by spherical spreading. Some examples include attenuation by sound absorption in air; attenuation by barriers; attenuation by rain, sleet, snow, or fog; attenuation by grass, shrubbery, and trees; and attenuation from shadow zones created by wind and temperature gradients. For sound propagating over soft ground at near-grazing angles of incidence, excess attenuations of 20 to 30 dB can be measured from the interference effect of the direct and reflected sound. Under certain meteorological conditions, some of these excess attenuation mechanisms are reduced or eliminated, leaving spherical spreading as the primary determinant of sound pressure level at a receiver location.

When more than one point source contributes to the sound pressure level at a receiver point (such as sound from multiple wind turbines), the overall sound level is determined by combining the contributions of the sources. Adding the individual sound pressures together accomplishes this. Because of the logarithmic nature of sound level, two sources that are independent and equal result in a combined level 3 dB greater than the level of each taken alone. In assessing environmental noise, a 3 dB increase in level is typically considered as just perceivable, while an increase of 1 dB is difficult to detect (Solano County Department of Resource Management 2006).

While the A-weighting sound filter can describe noise at a particular instant in time, it does not provide an estimate of fluctuating noises. Humans often become desensitized to constant sounds and "tune out" background noise; changes in noise are often more noticeable and can therefore cause more of an impact on the surrounding environment than steady-state noise. To account for fluctuating noise, time variation can be calculated in terms of the CNEL. The CNEL is calculated by taking the average of the A-weighted levels recorded over the course of 24 continuous hours and adjusting the figure to allow for greater sensitivity during nighttime hours.

Environmental Setting

Ambient Noise Environment

The proposed project area is rural, with few scattered residences located in the vicinity (see *Noise-Sensitive Land Uses* below). The existing noise environment in the project area can be characterized by the area's population density, as population density and ambient noise levels tend to be closely correlated. Areas that are not urbanized are relatively quiet, while areas that are more urbanized are subjected to higher noise levels associated with roadway traffic, industrial activities, and other human activities. Table 3.10-1 summarizes typical ambient noise levels based on land use. Ambient noise at the project site is expected to fall in the 40–50 dBA, L_{dn} range typical of rural settings.

Table 3.10-1. Land Use and Associated Ambient Noise Levels

Description	dBA, L_{dn}
Rural	40–50
Suburban	
Quiet suburban residential or small town	45–50
Normal suburban residential	50–55
Urban	
Normal urban residential	60
Noisy urban residential	65
Very noisy urban residential	70
Downtown, major metropolis	75–80
Under flight path at major airport, 0.5–1 mile from runway	78–85
Adjoining freeway or near a major airport	80–90

Sources: Cowan 1984; Hoover and Keith 2000.

Noise-Sensitive Land Uses

Noise-sensitive land uses are typically defined as land uses such as residences, schools, libraries, hospitals, and other similar uses where noise can adversely affect the land use. The Shasta County General Plan Noise Element establishes residential areas, parks, schools, churches, hospitals, and long-term care facilities as "noise-sensitive areas and uses" (Shasta County 2004). Noise-sensitive land uses in the proposed project vicinity comprise residences on Haines Road west of Burney (approximately 1.5–2 miles east of the southern end of the project area) and residences and campsites in the Moose Camp area (approximately 3.5 miles southwest of the project area).

Regulatory Setting

This section discusses the state and local policies and regulations that are relevant to the analysis of noise issues in the proposed project vicinity. There are no noise-related federal policies or regulations applicable to the proposed project.

State Policies and Regulations

California General Plan Guidelines

California Government Code Section 65302(f) requires that cities and counties include a noise element in their general plans. The purpose of the noise element is to provide a guide for establishing a pattern of land uses that minimizes the exposure of community residents to excessive noise. The Office of Planning and Research has published general plan guidelines that include guidelines for noise land use compatibility (Table 3.10-2).

Local Policies and Regulations

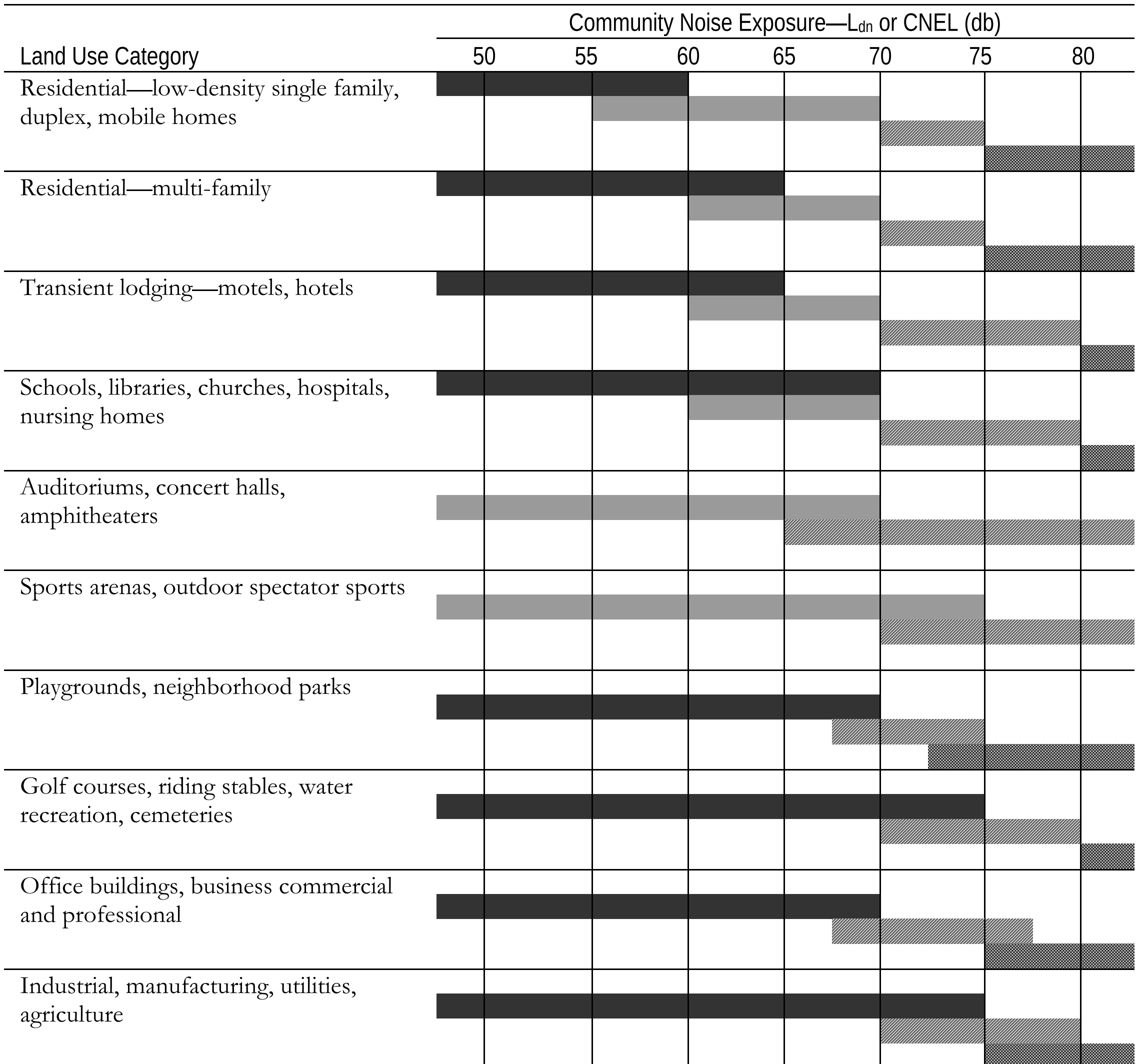
The proposed project area is in a rural area of Shasta County. The County has established policies and regulations concerning the generation and control of noise that could adversely affect its citizens and noise-sensitive land uses. The General Plan is a comprehensive, long-term document that establishes policies and identifies implementation of those policies to guide development and protection of the county's natural and cultural resources. The noise element of the General Plan contains planning guidelines relating to noise and identifies goals and policies to support achievement of those goals. Noise element guidelines relate primarily to land use compatibility with noise sources that are regulated at the local level, such as traffic, aircraft, and trains.

The following is a brief discussion of the General Plan policies and noise ordinance regulations implemented by Shasta County and to protect its citizens from the adverse impacts of noise.

County of Shasta General Plan Noise Element

The Noise Element establishes policies and regulations concerning the generation and control of noise that could adversely affect the county's citizens and noise-sensitive land uses. The County has established guidelines to assist in determining compatibility with surrounding land uses. The County's performance standards for new projects affected by or including non-transportation noise sources are summarized in Table 3.10-3.

Table 3.10-2. State Land Use Compatibility Standards for Community Noise Environment



Normally Acceptable
Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Conditionally Acceptable
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features are included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

Normally Unacceptable
New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Clearly Unacceptable
New construction or development generally should not be undertaken.

Source: California Governor's Office of Planning and Research 2003.

Table 3.10-3. Shasta County Noise Element Noise Level Performance Standards for New Projects Affected by or Including Non-Transportation Sources

Noise Level Descriptor	Daytime (7:00 a.m.–10:00 p.m.)	Nighttime (10:00 p.m.–7:00 a.m.)
Hourly L_{eq}, Db	55	50

The noise levels specified above will be lowered by 5 dB for simple tone noises, noises consisting primarily of speech or music, or recurring impulsive noises. These noise level standards do not apply to residential units established in conjunction with industrial or commercial uses (e.g., caretaker dwellings).

The County can impose noise level standards that are more restrictive than those specified above on the basis of the determination of existing low ambient noise levels.

In rural areas where large lots exist, the exterior noise level standard will be applied at a point 1,000 feet from the residence.

Industrial, light industrial, commercial, and public service facilities that have the potential for producing objectionable noise levels at nearby noise-sensitive uses are dispersed throughout the county. Fixed noise sources that are typically of concern include but are not limited to those listed below.

HVAC systems	Cooling towers/evaporative condensers
Pump stations	Lift stations
Emergency generators	Boilers
Steam valves	Steam turbines
Generators	Fans
Air compressors	Heavy equipment
Conveyor systems	Transformers
Pile drivers	Grinders
Drill rigs	Gas or diesel motors
Welders	Cutting equipment
Outdoor speakers	Blowers

The types of uses that may typically entail noise sources described above include, but are not limited to, facilities such as lumber mills, trucking operations, tire shops, auto maintenance shops, metal fabricating shops, shopping centers, drive-up windows, car washes, loading docks, public works projects, batch plants, bottling and canning plants, recycling centers, electric generating stations, race tracks, landfills, sand and gravel operations, and athletic fields.

Note: For the purposes of the Noise Element, transportation noise sources are defined as traffic on public roadways, railroad line operations, and aircraft in flight. Control of noise from these sources is preempted by federal and state regulations. Other noise sources are presumed to be subject to local regulations, such as a noise control ordinance. Non-transportation noise sources may include industrial operations, outdoor recreation facilities, HVAC units, loading docks, etc.

Source: Shasta County 2004.

County of Shasta Noise Ordinance

Shasta County does not have a noise ordinance. However, the County uses the standards set forth in the General Plan Noise Element (Table 3.10-3) to assess noise impacts, and imposes conditions on projects using those standards as thresholds (Kelley pers. comm.).

3.10.2 Impact Analysis

This section describes the analysis of impacts relating to both short-term construction-related noise and long-term operational noise associated with the proposed project. It describes the methods used to determine the project's impacts and the thresholds of significance of those impacts. Measures to mitigate (avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany each impact discussion.

Methodology

Project Construction

Evaluation of construction noise impacts associated with the proposed project is based on methodology developed by the Federal Transit Administration (Federal Transit Administration 2006). This evaluation considers the types of construction equipment operating and associated noise emission levels, distance from receiver to construction equipment, effects of topography and ground on noise propagation, and period of equipment operation.

Construction activities associated with the proposed project are described in detail in Chapter 2, *Project Description*. A detailed inventory of the construction equipment expected to be used for the project is provided in Table 3.3-4; accordingly, this noise analysis is based on construction equipment that is expected to be used. Table 3.10-4 presents a list of noise generation levels for the anticipated equipment inventory for various activities associated with construction of the proposed project. The table shows predictive calculations developed by the City of Boston to regulate construction noise during that city's "Big Dig" construction project (these calculations were used in this analysis to estimate construction noise). A reasonable worst-case assumption is that the three loudest pieces of equipment for each phase would operate simultaneously and continuously over at least a 1-hour period for a combined source noise level.

Project Operation

To assess noise generated by wind turbine operation that would be added to existing noise conditions, a study prepared by Illingworth & Rodkin Inc. evaluated the noise performance of three turbine options ranging from 1.8 MW to 2.3 MW (the turbine option most likely to be selected by the applicant). The study assessed the proposed Montezuma Hills Wind Project in Solano County, California, and utilized information collected on operating wind turbines in the Solano Wind Resource Area. Information from this study was utilized to assess potential noise impacts of the proposed project. All the turbine models considered use an upwind configuration, avoiding some of the low-frequency concerns associated with the older, downwind turbine design.

For all three wind turbines under consideration, the overall A-weighted sound power level is provided by the manufacturer at the primary speed of 8 m/sec (18 mph) in accordance with the International Electrotechnical Commission (IEC) IEC 61400-11 procedure. This speed is used as a point of reference for turbine noise impacts when compared to background noise.

The A-weighted sound power levels for each turbine considered ranged from 102 to 107 dBA. A *steady* noise level analysis determines the highest possible steady noise levels based on operating wind turbines at wind speeds producing the maximum sound power output. As sound spreads out from a noise source, the underlying physics of sound propagation shows that sound is reduced by 6 dB for each doubling of distance from the source. Sound is also reduced with distance where factors such as atmospheric absorption and shielding from topographic features cause attenuation of noise. However, because the project location atop the ridgeline of Hatchet Mountain would preclude topographic shielding, it was assumed for the purposes of this analysis that there would be no excess attenuation.

To account for some reflection from the ground, it was assumed that 70% of the sound striking the ground would be reflected. This is a very conservative assumption for forest land. Under these assumptions, the resultant estimates define the highest potential noise levels, which are greater than noise levels likely to be generated during the preponderance of operations. The assumption that turbines radiate sound uniformly in all directions is implied in analysis of wind turbine generator noise, in accordance with the IEC Standard for sound determination.

Using this assumption along with the 70% ground reflection, the steady sound pressure level 1,000 feet (304.8 meter) from a single wind turbine generator operating at the reference wind speed of 8 m/sec is calculated at 44–47 dBA. It is typically considered that an increase of about 3 dB in noises that sound similar is barely detectable. In the absence of tones, the sounds of wind turbine noise and wind-induced background noise are expected to be quite similar. Consequently, the wind turbine noise and wind-induced background noise will sound similar, particularly when several wind turbines are heard in combination. Under such circumstances, the potential for the background noise to mask wind turbine generator noise is optimal. Accordingly, if the wind turbine noise is equal to or less than the background noise level, the combined increase in noise level would be 3 dB or less and is expected to be, at most, barely detectable.

For wind speeds of 8 m/s and more, predicted turbine noise levels are well below the background noise regression line, suggesting that noise from the wind turbines would be fully masked by background noise.

It should be noted that actual wind-induced background noise, as well as other environmental parameters, may vary from location to location; these variables contribute some uncertainty to the results of this analysis. However, the analysis generally indicates that the wind turbine noise would be below the background noise level under most operating conditions for any of the three project options. Accordingly, it is unlikely that the turbines would be audible at any sensitive receptors at higher wind speeds under any of the three turbine options (Illingworth & Rodkin 2006). Additional attenuation from ground absorption due to softscape ground conditions was not assumed because each turbine/tower combination would have a maximum height ranging from 103 to 127.5 meters (338 to 418 feet), negating any attenuation of operational turbine noise by ground absorption.

Thresholds of Significance

Criteria for determining the significance of impacts related to noise are based on criteria set forth in Appendix G of the State CEQA Guidelines (14 CCR 15000 et seq.). The proposed project would have a significant noise impact if it would result in any of the conditions listed below.

- Construction or operational noise would exceed the following limits.
  - 50 dBA at the property line of noise-sensitive uses between the nighttime hours of 10:00 p.m. and 7:00 a.m.
  - 55 dBA at the property line of noise-sensitive uses between the evening hours of 7:00 p.m. and 10:00 p.m.

Table 3.10-4. Big Dig Project Construction Equipment Noise Emission Criteria Limits

Equipment Description	L_{max} Noise Limit at 50 feet, dBA (slow)	Is Equipment an Impact Device?	Acoustic Usage Factor
All other equipment > 5 HP	85	No	50%
Auger drill rig	85	No	20%
Backhoe	80	No	40%
Compactor (ground)	80	No	20%
Compressor (air)	80	No	40%
Concrete mixer truck	85	No	40%
Concrete pump	82	No	20%
Crane (mobile or stationary)	85	No	20%
Dozer	85	No	40%
Dump truck	84	No	40%
Excavator	85	No	40%
Flatbed truck	84	No	40%
Front end loader	80	No	40%
Generator (25 KVA or less)	70	No	50%
Generator (more than 25 KVA)	82	No	50%
Grader	85	No	40%
Paver	85	No	50%
Pickup truck	55	No	40%
Pneumatic tools	85	No	50%
Scraper	85	No	40%
Tractor	84	No	40%
Vibratory concrete mixer	80	No	20%

Source: Massachusetts Turnpike Authority 2000.

Notes: Impact equipment is assumed to produce separate discernable sound pressure maxima. *Acoustic Usage Factor* represents the percent of time that equipment is assumed to be running at full power while working on site.

Impacts and Mitigation Measures

Impact NOI-1: Potential for construction-related noise from the project to exceed thresholds (less than significant)

Noise from construction activities includes noise from grading, excavation, and other earthmoving activities. Construction noise also results from machinery and equipment used in the construction process. Table 3.10-4 presents a list of noise generation levels for various types of equipment anticipated to operate at the project site during project construction. Based on the noise levels presented in Table 3.10-4, Table 3.10-5 calculates estimated sound levels from construction activities as a function of distance assuming simultaneous operation of a crane, dozer, and excavator for a combined source level of 90 dBA, L_{eq} at 50 feet. The magnitude of construction noise impacts was assumed to depend on the type of construction activity, the noise level generated by various pieces of construction equipment, and the distance between the activity and noise sensitive receivers. The calculations in Table 3.10-5 are based on an attenuation rate of 6 dB per doubling of distance. Any shielding effects that might result from local barriers (including topography) are not included, thus making the analysis conservative.

Noise attenuation from ground absorption is included in the analysis for ground-level construction-related noise due to the "softscape" character of the project area.

Table 3.10-5. Estimated Construction Noise in the Vicinity of an Active Construction Site

Entered Data:			
Construction condition: Site leveling			
Source 1: Crane – sound level (dBA) at 50 feet =		85	
Source 2: Bulldozer – sound level (dBA) at 50 feet =		85	
Source 3: Excavator – sound level (dBA) at 50 feet =		85	
Average height of sources – Hs (feet) =		10	
Average height of receiver – Hr (feet) =		5	
Ground type (soft or hard) =		soft	
Calculated Data:			
All Sources Combined – Sound level (dBA) at 50 feet =		90	
Effective Height (Hs+Hr)/2 =		7.5	
Ground factor (G) =		0.62	
Distance Between Source and Receiver (feet)	**Geometric Attenuation (dB)**	**Ground Effect Attenuation (dB)**	**Calculated Sound Level (dBA)**
50	0	0	90
100	-6	-2	82
200	-12	-4	74
300	-16	-5	69
400	-18	-6	66
500	-20	-6	64
600	-22	-7	62
700	-23	-7	60
800	-24	-7	58
900	-25	-8	57
1,000	-26	-8	56
1,500	-30	-9	51
2,000	-32	-10	48
2,500	-34	-10	45
3,000	-36	-11	43
5,280	-40	-12	NA[1]
7,920	-44	-14	NA[1]
10,560	-46	-14	NA[1]

Note: Calculations based on Federal Transit Administration 2006. Calculations do not include the effects, if any, of local shielding, which may further reduce sound levels.

[a] Calculated sound level anticipated to be below ambient noise level.

Noise-sensitive land uses in the vicinity of the proposed project area comprise residences on Haines Road west of Burney (approximately 1.5–2 miles east of the southern end of the project area) and residences and campsites in the Moose Camp area (approximately 3.5 miles southwest of the project area). Table 3.10-5 indicates that construction noise at the nearest sensitive receptors (1.5 miles) is anticipated to be below the ambient noise level. The impact is less than significant.

Impact NOI-2: Potential for exposure of existing residences to operational noise (less than significant)

As previously indicated, noise associated with operation of the wind turbines was estimated assuming a base noise level of 44–47 dBA, L_{eq} at a distance of 1,000 feet for the operation of one wind turbine. A worst-case scenario—i.e., three turbines operating within 50 feet of one another simultaneously and continuously over at least a 1-hour period (i.e., standard noise modeling procedure)—would equate to a combined source noise level of 78 dBA, L_{eq} at a distance of 50 feet from the wind turbines and 52 dBA, L_{eq} at a distance of 1,000 feet. However, because the turbine foundations would generally be spaced 600–800 feet (183–244 meters) apart along an alignment near the crest of Hatchet Mountain, it is anticipated that actual noise levels would be lower than the noise levels calculated in this assessment. Table 3.10-6 shows estimated sound levels from the operation of three wind turbines as a function of distance. Because of the logarithmic nature of sound (similar sound at similar level is not additive) as described above, the cumulative impact of all 42, 44, or 68 turbines (depending on the final turbine option selected) along the 6.5-mile ridgeline experienced by a hypothetical receptor at 1,000 feet is expected to be 52 dBA, Leq.

Table 3.10-6. Estimated Wind Turbine Noise as a Function of Distance

Entered Data:			
Construction Condition: Site leveling			
Source 1: Wind turbine – Sound level (dBA) at 50 feet =		73	
Source 2: Wind turbine – Sound level (dBA) at 50 feet =		73	
Source 3: Wind turbine – Sound level (dBA) at 50 feet =		73	
Average height of sources – Hs (feet) =		418	
Average height of receiver – Hr (feet) =		5	
Ground type (soft or hard) =		soft	
Calculated Data:			
All Sources Combined – Sound level (dBA) at 50 feet =		78	
Effective Height (Hs+Hr)/2 =		211.5	
Ground factor (G) =		0.62	
Distance Between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated Sound Level (dBA)
3	24	0	102
50	0	0	78
200	-12	0	66
300	-16	0	62
400	-18	0	60
500	-20	0	58
600	-22	0	56
700	-23	0	55
800	-24	0	54
900	-25	0	53
1,000	-26	0	52

1,500	-30	0	48
2,000	-32	0	46
2,500	-34	0	44
3,000	-36	0	42
5,280	-40	0	NA[a]
7,920	-44	0	NA[a]
10,560	-46	0	NA[a]

Note: Calculations based on Federal Transit Administration 2006. Calculations do not include the effects, if any, of local shielding, which may further reduce sound levels.

[a] Calculated sound level anticipated to be below ambient noise level.

As shown in Table 3.10-6, noise levels associated with operation of the proposed project noise at the nearest sensitive receptors (1.5 miles) is anticipated to be below the ambient noise level and would generally be undetectable at these locations. The impact would be less than significant.

Impact NOI-3: Potential for construction-related and operational noise to affect wildlife (less than significant)

Both construction-related activities and turbine operations generate noise that has the potential to disturb wildlife species in the area. This issue is addressed in Section 3-4, *Biological Resources*. Construction noise is a short-term occurrence. Existing wildlife may be temporarily displaced by construction activities; however, because the project area consists primarily of locally and regionally common habitats that are actively managed and recently disturbed, this impact is considered less than significant.

Noise from wind turbine operation may also displace terrestrial species near turbine sites, but for the reason discussed above and in Impact BIO-14, and because of the extensive availability of similar habitat in the surrounding area, this impact is considered less than significant.