4 AFFECTED ENVIRONMENT

Because this PEIS provides an assessment of environmental, social, and economic issues at a programmatic level and not at the site-specific level, the descriptions of the affected environment presented in this chapter do not provide detailed information about conditions that exist at specific project locations. Rather, these descriptions provide the level of detail needed to support the programmatic impact assessment presented in Chapter 5. Information needed to assess the range of potential impacts that may occur because of wind energy development on BLM-administered lands and to identify effective mitigation measures that may be applicable at individual sites is presented. In addition, the many site-specific factors that must be evaluated at the project level are identified.

4.1 GEOLOGIC RESOURCES AND SEISMIC SETTING

Any type of construction or industrial activity has the potential to impact soil, sand and gravel resources, and other sources of rock. These impacts can occur within the specific area of construction as a result of excavation, grading, and so forth, or regionally as a result of extraction and the use of building materials. In addition, construction activities can impact or be impacted by local seismic and geologic hazard conditions. The impacts would vary by location and depend on the local geology. Detailed studies of soil, sand, gravel, and other aggregate resources, as well as the seismic setting, would need to be conducted, as discussed in the following sections, to define the affected environment for an individual project.

4.1.1 Geologic Resources

The type and distribution of soils vary widely across the western states and also may vary considerably within a specific wind energy project site. Specific soil types and thicknesses at a given site will determine the degree of potential erosion and/or compaction problems and the associated engineering requirements for activities that could disturb soils (e.g., excavations, grading and clearing surfaces, road construction, structural foundations). Detailed soil surveys may be required wherever extensive soil disturbance is possible at a site.

Sand and gravel deposits and rocks suitable for use in construction occur throughout the western states. These resources may be present within a specific wind energy project site, in the immediate vicinity, or some distance away. Detailed reviews of the availability of these resources in sufficient quantities to meet the project-specific needs would need to be conducted. Specifically, the location, quality, and potential competing uses of these materials would need to be characterized.

4.1.2 Seismic Setting

Many parts of the western United States are seismically active, with varying degrees of potential for earthquakes. In addition, other geologic hazards exist, such as the potential for landslides and rock falls. The potential for volcanic activity exists as well, although this is less widespread. Detailed reviews of the local geology and seismic setting are required to identify which hazards are present at a specific wind energy project site and, therefore, to determine the need for engineering controls.

4.2 PALEONTOLOGICAL RESOURCES

Paleontological resources are the fossilized remains of plants and animals. Some fossil remains have major scientific value. Greater attention is often given to vertebrate fossils than to invertebrate fossils because of their rarity; however, some invertebrate fossils are also rare. The rarity of such specimens and the unique information that can be gleaned from these items emphasizes the need for their protection. No laws specifically address paleontological resources; some protection is offered, however, through the Antiquities Act of 1906 to specimens of significant scientific value. Two other federal acts, the Archaeological Resources Protection Act of 1979 and the Federal Cave Resources Protection Act of 1988, protect fossils found in primary context and from significant caves, respectively. Fossils on federal lands (e.g., BLM-administered lands) are further protected by laws penalizing the theft or degradation of property of the U.S. government (Theft of Government Property [62 Stat. 764, 18 USC 1361] and FLPMA [Public Law (P.L.) 94-579; 90 Stat. 2743; 43 USC 1701]).

The large number of productive fossil-bearing geological landforms found on federal land in the American West has encouraged the BLM to provide guidance on protecting this resource. Guidance on the treatment of paleontological resources is given in the 2000 Report by the Secretary of the Interior on Fossils on Federal Land (DOI 2000). Further guidance is provided in the BLM Manual titled *8270 — Paleontological Resource Management* (BLM 1998). Procedures for managing this resource are identified in an attachment to BLM Manual 8270, the Paleontological Resources Handbook 8270-1. The goal of the BLM program is to locate, evaluate, manage, and protect paleontological resources on public lands. (See Section 4.7.4 for a description of designated ACECs.)

To date, no comprehensive inventory of fossils and no systematic inventory of fossil-bearing areas on BLM-administered lands have been conducted. Most assessments and inventories of paleontological resources on public lands are conducted on a project-specific basis. BLM Field Offices maintain records of the paleontological finds made on the lands they manage. Often this information is held by the primary state repository for fossil finds in that area. Site-specific information regarding paleontological resources would need to be collected to define the affected environment for an individual project.

4.3 WATER RESOURCES

The availability and quality of water resources are major issues in many portions of the 11-state study area. Large portions of the region have very dry climates, and water availability can become a limiting factor on all kinds of development and, consequently, on population growth. Both surface water and groundwater resources are highly valued commodities; water rights are strictly enforced, and all water use is closely evaluated. Activities that use water resources or have the potential to impact the quality of water resources must be reviewed within the context of local and regional water concerns. Detailed studies of water resources need to be conducted to define the affected environment for an individual project. In this PEIS, Section 3.2 and Appendix E provide discussions of applicable regulations regarding water resources, such as the CWA and the SDWA.

4.3.1 Groundwater

Groundwater quality and availability vary widely across the western states. The availability of groundwater resources to support site construction activities would need to be assessed at the project level, along with other characteristics such as groundwater quality, depth to groundwater, and local groundwater uses. At some sites, the hydrologic regime may need to be characterized to assess the relationship at a specific site between groundwater and surface water resources, including wetlands, if any, and to determine whether groundwater resources are recharged locally.

4.3.2 Surface Water

While surface water resources also vary widely across the western states, they are fairly limited in many areas that are quite arid. The presence of both permanent and ephemeral surface water bodies would need to be assessed at the project level, along with other characteristics such as water quality, water use by both humans and wildlife, surface runoff patterns, and hydrologic connectivity to local groundwater resources, if any.

4.4 AIR QUALITY

Air quality changes over time as economic development occurs and regulatory programs affect the emissions from sources. At the time a site is proposed for wind energy development, the air quality at that site would need to be assessed. The following discussion provides a general picture of air quality in the 11-state study area and comments on the current major regulatory programs. The text box on the next page titled “Air Quality Terms” provides definitions for some of the terms used in this section.

The affected air environment can be characterized in terms of concentrations of the criteria pollutants carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). The EPA has established National Ambient Air Quality Standards (NAAQS) for these pollutants. There are two standards for particulate matter, one for particulates less than 10 µm in diameter (PM_{10}) and one for particulates less than 2.5 µm in diameter ($PM_{2.5}$). Table 4.4-1 lists the NAAQS. Some states have additional standards for these pollutants and standards for other pollutants. One of the goals of air quality regulatory programs is to ensure that concentrations of pollutants in the air do not exceed these standards.

Air Quality Terms

National Ambient Air Quality Standards (NAAQS) are established by the U.S. Environmental Protection Agency (EPA) for criteria pollutants. The primary NAAQS specify maximum ambient (outdoor air) concentrations of the criteria pollutants that would protect public health with an adequate margin of safety. Secondary NAAQS specify maximum concentrations that would protect public welfare. Some of the NAAQS for averaging times of 24 hours or less allow the standard values to be exceeded a limited number of times per year.

Ozone (O_3) is formed in the atmosphere by chemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds. The reactions are energized by sunlight. Emissions of NO_x and volatile organic compounds are controlled to reduce ozone levels.

Particulate Matter (PM) is dust, smoke, and other solid particles, and liquid droplets in the air. The size of particulates is important and is measured in micrometers (µm). A micrometer is 1 millionth of a meter (0.000039 in.).

Volatile Organic Compounds (VOCs) are organic vapors in the air that can react with other substances, principally NO_x, to form ozone. VOCs have many sources such as solvents, combustion, and evaporation of fuels.

Areas where air quality exceeds the NAAQS are called nonattainment areas, and states must develop plans for attaining and maintaining the NAAQS. These plans generally include emissions reduction measures, such as limitations on stationary source emissions, and work practice standards. There are no nonattainment areas for NO_2 (EPA 2004a). Tailpipe emissions from mobile sources (cars, trucks, construction equipment, etc.) are regulated by the federal government except in California, which has its own mobile source programs and regulations.

Figures 4.4-1 and 4.4-2 show counties in the 11-state study area containing nonattainment areas for PM_{10}, CO, and O_3 (1-hour standard).[1,2] These pollutants are associated mostly with emissions from construction activities for wind energy projects. In addition, parts of four Arizona counties are nonattainment for SO_2, and part of one county in Montana is nonattainment for Pb; however, neither SO_2 nor Pb is emitted in appreciable quantities by development or operation of wind energy projects. A highlighted county may contain more than one

1 Nonattainment areas for $PM_{2.5}$ have not been designated; this document concentrates on PM_{10}. The conclusions would be the same for $PM_{2.5}$.

2 On April 15, 2004, the EPA designated nonattainment areas for the 8-hour O_3 standard (EPA 2004b). Both O_3 standards will remain in effect for some time, and states have yet to prepare plans for meeting the 8-hour standard. Since O_3 nonattainment should have little, if any, impact on development and operation of wind energy projects, only the counties containing nonattainment areas under the older 1-hour standard are shown in the figure. A list of the 8-hour nonattainment areas and the associated counties can be found in EPA (2004b).

TABLE 4.4-1 National Ambient Air Quality Standards

Pollutant	Averaging Time	Ambient standard[a] (Value)[b]	Type[c]
SO_2	3 hours	1,300 (0.5)	S
	24 hours	365 (0.14)	P
	Annual	80 (0.03)	P
NO_2	Annual	100 (0.053)	P,S
CO	1 hour	40,000 (35)	P
	8 hours	10,000 (9)	P
O_3	1 hour	235 (0.12)	P,S
	8 hours	157 (0.08)	P,S
PM_{10}	24 hours[d]	150	P,S
	Annual[d]	50	P,S
$PM_{2.5}$	24 hours[d]	65	P,S
	Annual[d]	15	P,S
Pb	Calendar quarter	1.5	P,S

[a] Refer to 40 CFR Part 50 for detailed information on attainment determination and methods for monitoring.

[b] Values that are not in parentheses are in $\mu g/m^3$. Parenthetical values are part(s) per million (ppm) by volume.

[c] P = primary (health-based) standard; S = secondary (welfare-based) standard.

[d] Implementation of the standard has been delayed, and states have not developed attainment plans.

Source: 40 CFR Part 50.

nonattainment area, and a particular nonattainment area may be a small fraction of a highlighted county. Nonattainment areas also change as air quality changes over time. Site-specific air quality would need to be assessed at all sites, even those not located in or close to nonattainment areas.

The NAAQS establish maximum pollutant levels that should not be exceeded. The Prevention of Significant Deterioration (PSD) program limits the deterioration of existing air quality in areas with air cleaner than the NAAQS levels. This program establishes a baseline level of air quality and specifies increments that cap the increases in pollutant levels above that baseline. The program applies to sulfur oxides, PM_{10}, and NO_2 emitted by new or modified major sources. Smaller increments apply in special areas, such as National Parks and Wilderness Areas (Class I areas), than in other areas (Class II areas). An operating wind energy development project would not be a major source.

FIGURE 4.4-1 Counties Containing a PM_{10} Nonattainment Area (Source: EPA 2004a)

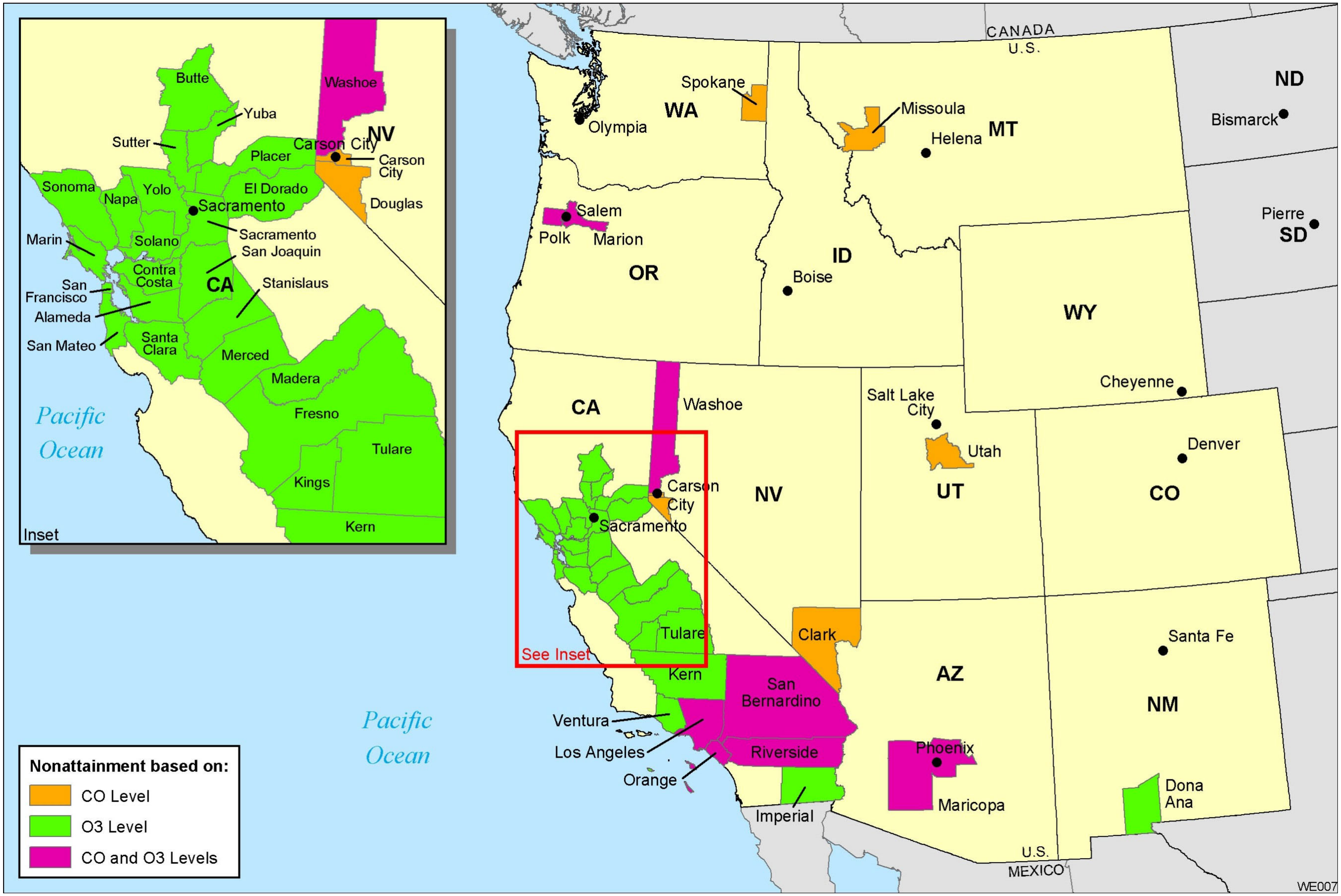

FIGURE 4.4-2 Counties Containing a 1-Hour Ozone or a Carbon Monoxide Nonattainment Area (Source: EPA 2004a)

The EPA and the states also control air toxics or hazardous air pollutants (HAPs), substances judged to have adverse impacts on human health when present in the ambient air. The EPA and some states have issued lists of substances regulated as air toxics. The specific substances listed and the types of regulations applied differ among jurisdictions. Again, given its small emissions, an operating wind energy project would probably not be regulated for emissions of air toxics.

4.5 NOISE

This section presents a brief discussion of environmental noise fundamentals, background noise levels, noise propagation, and noise standards and guidelines.

4.5.1 Fundamentals of Acoustics

Sound can be defined as any pressure variation that the human ear can detect. Noise is defined as "unwanted sound."

The unit used to describe the intensity of sound is the decibel (dB). Audible sounds range from 0 dB ("threshold of hearing") to about 140 dB ("threshold of pain"). The normal audible frequency range is approximately 20 Hz to 20 kHz. The A-weighted scale, denoted as dB(A), approximates the range of human hearing by filtering out lower frequency noises, which are not as damaging as the higher frequencies. It is used in most noise ordinances and standards. To provide a frame of reference, rustling leaves have a decibel level of 10 dB(A); conversational speech, 60 dB(A); and aircraft takeoff, 120 dB(A).

While A-weighted sound may adequately indicate the level of sound at a given instant in time, it does not account for the duration of the sound or that sound levels can vary with time. In wind turbine assessment, two descriptors (L_{eq} and L_{dn}) are generally used to describe this variation. The equivalent sound pressure level (L_{eq}) is a single number that, if continuous during a specific time period, would contain the same total energy as the actual time-varying sound. The day-night average sound level (L_{dn} or DNL) is the average A-weighted sound level over a 24-hour period, with a 10-dB penalty artificially added to nighttime (10:00 p.m. to 7:00 a.m.) sound levels to account for more noise-sensitive activities (e.g, TV viewing or sleep) during that period.

The effects of noise on people can be classified into three general categories: (1) subjective effects of annoyance, nuisance, and dissatisfaction; (2) interference with activities such as speech, sleep, and learning; and (3) physiological effects such as anxiety or hearing loss. The sound levels associated with environmental noise generally produce effects only in the first two categories.

Whether a noise is objectionable will vary depending on the type of noise (tonal, broadband, low frequency, or impulsive) and the circumstances and sensitivity of the individual who hears it. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by the hearer.

The human response to changes in decibel levels has the following characteristics (NWCC 1998):

- A 3-dB change in sound level is considered a barely noticeable difference;
- A 5-dB change in sound level will typically result in a noticeable community response; and
- A 10-dB change, which is generally considered to be a doubling of the sound level, almost certainly causes an adverse community response.

Noise containing discrete tones (tonal noise) is much more noticeable and more annoying at the same relative loudness level than other types of noise, because it stands out against background noise.

4.5.2 Characterization of Background Noise Levels

Wind energy projects in the United States are mostly located in undeveloped hilly terrain in rural or remote areas. While these areas have low human population densities, they may have high populations of some animal species. Ambient noise levels at these sites are quite low. Typically, primary noise sources around the project area would include noise caused by wind and vehicular traffic along the major roads. Other noise sources would be farm machinery (e.g., tractors) and animal noise (e.g., dog barking, bird chirping). In general, background noise levels (i.e., noise from all sources not associated with a wind farm) are higher during the day than at night. For a typical rural environment, background noise is expected to be approximately 40 dB(A) during the day and 30 dB(A) at night (Harris 1979), or about 35 dB(A) as DNL (Miller 2002).

4.5.3 Noise Propagation

To predict the noise level at receptor locations from a known power level, a number of sound propagation mechanisms should be considered. Major factors determining noise levels at the receptor (Beranek and Vér 1992) include the following:

- Source characteristics (e.g., sound power, directivity, source height);
- Geometric spreading as the result of the distances from the noise source to the receptor;
- Atmospheric air absorption, which depends strongly on frequency and relative humidity but less strongly on temperature and pressure;

- Ground effects resulting from vegetation (e.g., grass, shrubbery, trees);
- Intervening topography between the source and the receptor or man-made or natural barrier/structures; and
- Meteorological factors resulting from atmospheric inhomogeneities (i.e., refraction because of vertical wind and temperature gradients, and air turbulence).

Sound propagation involves the complicated interactions of many attenuation elements, especially among the factors listed above. In general, noise levels from a point source, such as a compressor or wind turbine, decrease about 6 dB per doubling of distance from the point source because of the way sound spreads. However, noise levels from along a line source, such as highways or transmission lines, decrease about 3 dB per doubling of distance.

The overall effect on noise propagation is a complex site-specific combination of the factors described above. In many screening applications, only the geometric spreading term is assumed to predict noise levels at receptor locations of interest. For a refined analysis, a sound propagation model that integrates most of the sound attenuation mechanisms described above would be required. The effects of two meteorological factors (wind direction and changes in temperature with height) are discussed below.

Sound propagation for horizontal distances less than about 330 ft (100 m) is essentially independent of atmospheric conditions. For locations at greater distances from a given source, wind direction can cause considerable differences in sound levels between upwind and downwind locations. The typical increase of wind speed with height will bend the path of sound to “focus” it in the downwind direction and make a “shadow” in the upwind direction. Upwind sound levels will be lower and downwind levels higher than if there were no wind.

In addition, changes in temperature with height play a major role in sound propagation. During the day, air temperature tends to decrease with height. In contrast, on a clear night, the temperature often increases with height (a condition known as a temperature inversion). Because the speed of sound varies with temperature, sound tends to bend (refract) upward during the day, leading to reduced sound levels on the ground; it bends downward during inversions, leading to higher sound levels on the ground. These temperature effects are uniform in all directions from the source, whereas the wind affects receptors primarily in the upwind and downwind directions.

4.5.4 Noise Standards and Guidelines

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978 [42 USC Parts 4901–4918]), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although no federal noise regulations exist, the EPA has promulgated noise guidelines (EPA 1974). Similarly, most states have no quantitative noise-limit regulations. Many local governments, however, have enacted noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. They are commonly enforced by the police, but also may be enforced by an agency that issues development permits.

In particular, some state or local governments have set permissible environmental noise limits for regulatory purposes. Nonetheless, complaints about noise from wind energy projects may still occur, even when fixed-level noise criteria or standards are met (NWCC 2002). This is because of the changes between the relative level of broadband turbine and background noises. If tonal components exist, higher levels of broadband background noise are needed to effectively mask the tone(s). In this respect, it is common for community noise standards to incorporate a penalty for pure tones, typically 5 dB(A). Also, the impact of noise depends on what people are doing: lower levels of noise will be objectionable during sleeping hours than during the day. Many European countries (Gipe 1995) and some states in the United States have lower noise standards during night hours.

The EPA guideline recommends an L_{dn} of 55 dB(A) to protect the public from the effect of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974). This level is not a regulatory goal but is “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety.” For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq} of 70 dB(A) or less over a 40-year period.

4.6 ECOLOGICAL RESOURCES

The following discussions of the ecological resources that may be affected by wind energy development on BLM-administered lands are presented from an ecoregion and ecological resource perspective.

4.6.1 Ecoregion Distribution and Associated Vegetation in the 11 Western States

Ecoregions delineate areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources present in the area (Omernik 1987). Ecoregions are based on unique combinations of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. A number of individuals and organizations have characterized North America on the basis of ecoregions (e.g., Omernik 1987; CEC 1997; Bailey 1995). The intent of such ecoregion classifications has been to provide a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. The ecoregion discussions presented in this PEIS follow the Level III ecoregion classification based on Omernik (1987) and refined through collaborations among EPA regional offices, state resource management agencies, and other federal agencies (EPA 2002).

Existing wind energy projects in the United States can be found in a variety of habitat types, including cultivated agriculture, native grasslands, shrub steppe, desert scrub, and forest (Erickson et al. 2002). The 11 western states in the study area encompass 34 ecoregions