5 POTENTIAL IMPACTS OF WIND ENERGY DEVELOPMENT AND ANALYSIS OF MITIGATION MEASURES

This chapter describes the potential positive and negative environmental, social, and economic impacts that could occur as a result of wind energy development on BLM-administered lands under the MPDS described in Chapter 2. It also presents information about relevant mitigation measures that can be applied to reduce these impacts.[1] This information was derived from comprehensive reviews of wind energy development activities (as described in Chapter 3); published data regarding wind energy development impacts; existing, relevant mitigation guidance (see Section 3.6); and standard industry practices.

After all relevant mitigation measures were identified, they were further evaluated to identify appropriate BMPs for inclusion in the proposed Wind Energy Development Program (Section 2.2.3). The primary purpose of this evaluation was to limit the programmatic BMPs to those that would be applicable to all wind energy development projects on BLM-administered lands. Sections 5.1 through 5.14 present the potential impacts and possible mitigation measures for each resource that could be implemented as project-specific stipulations. Section 5.15 discusses the evaluation process used to identify the programmatic BMPs.

Because this is a programmatic evaluation, site-specific and species-specific issues associated with individual wind energy development projects are not assessed in detail. Rather, this PEIS identifies the range of possible impacts on resources present in the 11-state study area. This assessment considers both direct and indirect impacts. Direct impacts are those effects that result solely and directly from the proposed wind energy development, such as soil disturbance, habitat fragmentation, or noise generation. Indirect impacts are those effects that are related to the proposed development but that are the result of some intermediate step or process, such as changes in surface water quality because of soil erosion at the construction site.

Depending upon which resource is being evaluated, direct and indirect impacts may be (1) confined to a specific long-term footprint of development (e.g., the immediate footprint of a turbine foundation), (2) limited to the entire project area (e.g., habitat fragmentation resulting from the network of roads, turbines, and ancillary structures), or (3) extended over a much larger area beyond the project area (e.g., visual impacts that can be observed many miles away from the project). This assessment discusses potential impacts and mitigation measures across all of these areas as they are relevant to specific resources.

This impact assessment is based on descriptions of wind energy development projects and activities associated with each phase of development presented in Chapter 3. The potential magnitude of the impacts are defined, in part, by the MPDS and WinDS model estimates for

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[1] Mitigation measures that may be applicable to reduce impacts of wind energy development but that are not relevant to development on BLM-administered lands were not included in this chapter. These include measures that address issues that are not likely to be encountered on BLM-administered lands (e.g., development in close juxtaposition to residences and other public spaces) and measures that run counter to existing BLM policies and management decisions (e.g., requirements for fencing around the entire wind energy development site).

each of the 11 states, as discussed in Section 2.2.1 and Appendix B. The MPDS estimates the amount and location of BLM-administered lands that are potentially developable on the basis of wind resources and land status, and the WinDS model estimates the number of acres of land that are likely to be economically developable given various constraints. The WinDS model output, however, does not predict where the economically developable lands are located. As Table 5-1 shows, economically developable lands make up a small percentage of the potentially developable lands. For the purposes of this impact assessment, the MPDS estimates were used to define where wind energy development might occur (i.e., in which ecological regions, on what types of landscapes), and the WinDS model estimates were used to define the amount of BLM-administered lands that would be developed through ROW authorizations (i.e., the project areas). The amount of land impacted by a long-term footprint at a specific site would vary depending upon a number of factors, including site terrain and project design. As discussed in Section 3.1.2.1, on the basis of experience to date, the long-term, final footprint would likely be no more than 5 to 10% of the total acreage of the site. This is a conservative estimate, including lands underlying turbine towers, control buildings, transformer pads, electric substations, roads, and other ancillary structures. Table 5-1 shows the estimated number of acres of BLM-administered lands that could be impacted by a long-term footprint in each state.

TABLE 5-1 Estimated Number of Acres of BLM-Administered Lands Likely To Be Impacted by Wind Energy Development under the Proposed Action (acres)[a]

State	Total Potentially Developable Lands[b]	Total Economically Developable Lands[c]	Total Acreage with Long-Term Footprint[d]
Arizona	210,000	1,500	150
California	1,595,000	72,300	7,230
Colorado	208,000	4,200	420
Idaho	956,000	9,100	910
Montana	5,172,000	1,800	180
Nevada	1,157,000	34,700	3,470
New Mexico	1,542,000	9,800	980
Oregon	1,183,000	9,700	970
Utah	671,000	12,700	1,270
Washington	38,000	600	60
Wyoming	7,902,000	3,700	370
Total	20,634,000	160,100	16,010

[a] To convert to hectares, multiply by 0.4047.

[b] Acreage estimates generated by the MPDS model.

[c] Acreage estimates generated by the WinDS model.

[d] Acreage estimates equal to 10% of the economically developable lands.

5.1 GEOLOGIC RESOURCES

A wind energy development project can impact geologic resources and soils in several different ways, including the use of geologic resources (e.g., sand and gravel), activation of geological hazards, and increased soil erosion.

5.1.1 Site Monitoring and Testing

Generally, the impacts during site monitoring and testing are relatively limited and temporary. Typically, during this phase of development, excavation activities and road construction for access to the project area would be very limited. Some clearing or grading may be needed for installing monitoring towers and monitoring equipment enclosures. Heavy-duty all-wheel-drive pickup trucks would be used to bring monitoring towers to the site; this, however, would not likely require major road construction. As a result, very little, if any, geologic resources would likely be used, and it is unlikely that activities would activate geological hazards or increase soil erosion. Thus, impacts to geologic resources and soils are expected to be negligible to small, unless extensive excavation or road construction occurs. (Section 5.1.2 discusses the resulting impacts if major construction is needed during the site monitoring and testing phase.)

5.1.2 Site Construction

The types of activities during the construction phase that would impact geologic resources and soils include clearing, excavation, blasting, trenching, grading, and heavy vehicle traffic.

5.1.2.1 Use of Geologic Resources

Sand and gravel and/or quarry stone would be needed during the construction phase. These materials would most likely be mined as close to the potential wind energy development site as possible. If existing quarries were not used to provide these resources, excavation from a new source would disturb the land surface, thus creating the potential local soil erosion. The sand and gravel and/or quarry stone would be used for:

- *Access roads.* New access roads may need to be constructed or existing roads may need to be upgraded to accommodate heavy and/or oversized vehicles. Roads would need to be a minimum of 10 ft (3 m) wide but could be as much as 30 ft (9 m) wide. The amount of material that would be needed would depend on the number, length, and size of the access roads.

- *Concrete for buildings, substations, transformer pads, wind tower foundations, and other ancillary structures.* Each tower foundation would nominally extend to depths of 40 ft (12 m) or less, depending on local soil conditions. The diameter of a tower base is generally 15 to 20 ft (5 to 6 m), depending on the turbine model. The vertical reinforced-concrete-ring foundation has a nominal ring thickness of 1 ft (0.3 m).

- *On-site lay-down and crane staging areas.* The geologic material would be used to improve soil-bearing capacity.

5.1.2.2 Potential Geological Hazards

Geological hazards that could affect the construction and operation of a wind energy development site include landslides, rock falls, earthquakes, and volcanic activities. Earthquakes and volcanic activities happen in areas under specific geologic conditions and are determined by the local geology. Site construction activities can destabilize slopes if they are not conducted properly. Slope failures can occur naturally or be enhanced by slope modifications that change the local groundwater regimes and slope angles. In regions that have active earthquakes or volcanoes, heavy precipitation, or where geologic hazards are common, slope stability is sensitive to minor changes of landscape because of human intervention. Also, the water quality downslope of a failed slope can be adversely affected. During the construction phase, the activities that can potentially activate geological hazards include:

- Slope (or grade) increase resulting from site grading or construction of access roads;
- Toe-cutting at the bases of slopes for construction of on-site structures or access roads; and
- Alteration of natural drainage patterns (e.g., alterations of slope or implementation of on-site storm water controls) or increase of precipitation infiltration (e.g., from clearing vegetation, backfilling with permeable materials, roadbed fracturing due to heavy vehicles) that can increase pore pressure, which weakens the strength of soils on slopes or causes accelerated soil erosion, thereby creating slope instability.

5.1.2.3 Soil Erosion

Soil erosion can be aggravated locally through ground surface disturbance. The impact of soil erosion includes soil nutrient loss and degradation of water quality in nearby surface water bodies. The magnitude of the impact depends on the project size, erosion potential of the soil, local terrain, vegetation covers, and the distance from a site to nearby surface water bodies. The activities that could contribute to soil erosion include:

- *Ground surface disturbance on site, at borrow sites, and along access roads.* Ground surface disturbance would occur during the construction or installation of access roads, wind tower pads, staging areas, lay-down areas, substations, transformer pads, underground cables, and other on-site structures. The extraction of geologic materials from borrow areas or quarries would also result in ground surface disturbance.

- *Heavy equipment traffic*. Heavy vehicles can disturb or destroy originally stable soil conditions and enhance soil erosion by both wind and surface runoff.

- *Surface runoff pattern disturbance.* Construction activities (e.g., grading and excavation) and the implementation of on-site storm water controls (e.g., culverts and drainage ditches along roads) could alter surface runoff patterns by diverting natural drainage into new areas and locally increasing runoff volume.

5.1.3 Site Operation

After construction, the geologic and soil conditions may stabilize with time, particularly if appropriate mitigation measures are implemented during the construction phase (Section 5.1.5). The amount of time this would take would depend in part on the mitigation measures used on site during and following construction, as well as local environmental conditions. Once the system reaches equilibrium again, the environmental impact during the operation phase would largely be limited to soil erosion induced by vehicle traffic on unpaved roads.

5.1.4 Site Decommissioning

The impacts on geologic resources and soils during decommissioning would primarily involve potential soil erosion. The stabilized soil system would be disturbed again with the removal of all access roads, on-site roads, substations, buildings, and other structures. The potential impacts would be largely the same as those described for soil erosion during the construction phase.

5.1.5 Mitigation Measures

The potential for impacts to geologic resources and soils would occur primarily during construction and decommissioning. The following mitigation measures could reduce impacts:

- The size of disturbed land should be minimized as much as possible. Existing roads and borrow pits should be used as much as possible.

- Topsoil removed during construction should be salvaged and reapplied during reclamation. Disturbed soils should be reclaimed as quickly as possible or protective covers should be applied.

- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.

- On-site surface runoff control features should be designed to minimize the potential for increased localized soil erosion. Drainage ditches should be constructed where necessary but held to a minimum. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, drainage ditches, and culverts should be cleaned and maintained regularly.

- Operators should identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and dip angles of geologic strata). Operators also should avoid creating excessive slopes during excavation and blasting operations. Special construction techniques should be used where applicable in areas of steep slopes, erodible soil, and stream channel/wash crossings.

- Borrow material should be obtained only from authorized and permitted sites.

- Access roads should be located to follow natural contours of the topography and minimize side hill cuts.

- Foundations and trenches should be backfilled with originally excavated materials as much as possible. Excavation material should be disposed of only in approved areas to control soil erosion and to minimize leaching of hazardous constituents. If suitable, excess excavation materials may be stockpiled for use in reclamation activities.

5.2 PALEONTOLOGICAL RESOURCES

Significant paleontological remains could be encountered on BLM-administered lands in the 11 western states. Paleontological resources are generally identified on a project-specific basis. Because fossils only appear in sedimentary rock formations, this is an efficient initial screen as to the potential for the presence of fossils in a project area. Many states maintain a database or repository for information on past paleontological finds either through the SHPO or through a designated repository, such as a university. Additional information regarding the presence of paleontological resources may be provided by amateur fossil hunters. If there is a strong potential for fossil remains to be present in a project area, a survey would be required. The following subsections describe the potential impacts to paleontological resources should they be present in a project area and the relevant mitigation measures.

5.2.1 Site Monitoring and Testing

Impacts to paleontological resources could potentially occur during site monitoring and testing; however, the causes of possible impacts would be limited to minor ground-disturbing activities and the potential for unauthorized collection of fossils. Typically, excavation activities and road construction for access to the project area would be very limited. Some clearing or grading may be needed for installing monitoring towers and equipment enclosures. If more extensive excavation or road construction is needed during this phase, more extensive impacts are possible (see Section 5.2.2 for a discussion of the possible impacts during construction).

Vehicular traffic and ground clearing (such as the removal of vegetation cover) could affect certain more delicate fossils directly or indirectly through an increased potential for erosion if the project area has significant potential to contain such resources. Borings for geotechnical surveys and for the installation of guy wires could impact paleontological resources; however, because these activities would affect small localized areas, the likelihood of an impact (i.e., destroying the resource) is small in most cases. Finally, the collection of fossils by workers or fossil hunters using the access roads to get to areas previously inaccessible to the public would be another possible impact. Although the activities during the monitoring and testing phase are characterized as temporary actions, paleontological resources are nonrenewable and once impacted (i.e., removed or damaged) are not likely to be recovered or recreated in the appropriate context for scientific analysis.

5.2.2 Site Construction

The construction of the infrastructure necessary for wind energy development has the greatest potential to impact paleontological resources because of the increased ground disturbance during this phase. Impacts can occur both locally through construction activities on site and remotely at off-site locations where construction materials are excavated.

The access roads capable of supporting the large trucks necessary to transport the towers would require vegetation removal, grading, potential blasting, and the laying of aggregate materials collected either locally or remotely from an off-site source. Grading and blasting would directly impact fossils if they are present in the area. The construction of wind turbines may also require the widening of existing roads and reinforcement of bridges. However, these activities are unlikely to impact paleontological resources since they occur in previously disturbed areas. The creation of access roads could also modify drainage patterns and possibly result in impacts caused by erosion. Erosion has the potential to alter fossil beds, including the possible separation of a collection of fossils.

Construction of a turbine can disturb as much as 3 acres (1 ha), with tower foundations extending 35 to 40 ft (11 to 12 m) below the surface. Construction of the foundation may require blasting, and the immediate area around the tower would be compacted by the heavy vehicles. In addition to towers, the construction of support buildings, storage buildings, and pads for transformers would also require leveling and grading. The towers would also likely have lightning protection that could require drilling down to the closest aquifer; however, given the small size of this excavation, it is unlikely that this construction would impact fossils.

In addition to access roads and the actual footprint for the turbines, the construction of lay-down areas, staging areas for cranes, turnaround areas, and if concrete is used, a batching plant may be necessary and lines may be buried. All of these activities would require ground leveling and soil removal.

One of the greatest threats to paleontological resources is people removing fossils rather than reporting them. Development of a wind energy project would bring numerous workers into the area, which would require the creation of new roads; such roads would give the public access to areas that were previously inaccessible. These factors pose a great risk to the resource, which could be minimized by training and educating the workforce and the public, as well as by monitoring of the area by a paleontologist (Section 5.2.5).

5.2.3 Site Operation

Very few impacts to paleontological resources would be expected during operation. The incidence of unauthorized fossil collection (i.e., looting) would increase with increasing numbers of personnel present at the site. Most activities associated with operation of a wind energy development project would not result in earthmoving activities or increases in erosion. The access to the public provided by the new roads installed during the construction phase would present the greatest threat to the resource.

5.2.4 Site Decommissioning

Decommissioning of a wind energy development project has a limited potential for affecting paleontological resources because these resources are nonrenewable and would either have been removed professionally prior to construction (if mitigation measures are followed as described in Section 5.2.5), or would have been already disturbed or destroyed by prior activities. Foundation removal represents a slight opportunity for additional disturbance; this work, however, would likely stay within the area disturbed during construction; alternatively, foundations could be left in place. The vegetation would be allowed to reestablish on access roads and cleared areas; although it is possible that improved access to the area would remain after the removal of the development. This could allow for increased removal of fossils by amateurs since the area would no longer be periodically monitored.

5.2.5 Mitigation Measures

To mitigate or minimize potential paleontological resource impacts, the following mitigation measures could be adopted:

- Operators should determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area, a records search for past paleontological finds in the area, and/or a paleontological survey.

- A paleontological resources management plan should be developed for areas where there is a high potential for paleontological material to be present. Management options may include avoidance, removal of the fossils, or monitoring. If the fossils are to be removed, a mitigation plan should be drafted identifying the strategy for collection of the fossils in the project area. Often it is unrealistic to remove all of the fossils, in which case a sampling strategy can be developed. If an area exhibits a high potential but no fossils were observed during surveying, monitoring could be required. A qualified paleontologist should monitor all excavation and earthmoving in the sensitive area. Whether the strategy chosen is excavation or monitoring, a report detailing the results of the efforts should be produced.

- If an area has a strong potential for containing fossil remains and those remains are exposed on the surface for potential collection, steps should be taken to educate workers and the public on the consequences of unauthorized collection on public lands.

5.3 WATER RESOURCES

A wind energy project can impact surface water and groundwater in several different ways, including the use of water resources, changes in water quality, alteration of the natural flow system, and the alteration of interactions between the groundwater and surface water. For the most part, however, wind energy development does not require much water, except during the construction phase and, to a lesser extent, during decommissioning. These water uses are temporary, and during the operations phase, water use would be minimal. This section describes the types of impacts that might occur during each phase of development.

5.3.1 Site Monitoring and Testing

Generally, the impacts during site monitoring and testing would be relatively limited because new access roads might not be needed, on-site activities would be limited and temporary, and the size of the work crew would be small. As a result, very little, if any, water would likely be used during this phase of development. If water was needed, it would probably be trucked in from off site. Impacts to water resources, local water quality, water flows, and surface water/groundwater interactions are expected to be negligible to small, unless extensive excavation or road construction occurs.

5.3.2 Site Construction

Most of the impacts on water resources would occur during construction.

5.3.2.1 Use of Water Resources

A number of construction activities would use water. Because the construction phase may last more than 1 year, potentially large amounts of water would be needed. The water may be trucked in from off site or obtained from local groundwater wells or surface water bodies near the facility, depending upon the availability of those sources. Activities related to use of water resources would include:

- Water used for dust control during the construction of access roads, clearing of vegetation, grading, and road traffic;

- Water used for making concrete used in the foundations of wind towers, substations, central control buildings, and various personnel support facilities; and

- Water used by the construction crew.

5.3.2.2 Water Quality

Many construction activities associated with a wind energy development project could alter the quality of surface water and, to a lesser extent, groundwater. These include:

- Activities that aggravate soil erosion, such as activities that disturb the ground surface, heavy equipment traffic, activities that alter surface runoff patterns, and extraction of geologic materials from borrow areas or quarries (Section 5.1.2.3);

- Weathering of freshly exposed soil or spoils from foundation excavation, quarry or borrow pit operations, or access road construction, which would release various chemicals through oxidation and leaching processes;

- Discharges of wastewater or sanitary water; and

- Pesticide application, unless use is limited to nonpersistent, immobile pesticides and applied only in accordance with label and application permit directions and stipulations.

5.3.2.3 Alteration of Water Flow Systems

Natural surface water and groundwater flow systems could be potentially impacted by construction activities. Surface water flows may be diverted on site and off site by access road systems or storm water control systems. Excavation activities or geologic material extraction may alter surface overflow and groundwater flow. The withdrawal of surface water and groundwater for water uses and the discharge of wastewater and storm water would also affect the water flows of the surface water bodies and groundwater.

5.3.2.4 Alteration of Surface Water/Groundwater Interaction

Construction activities could alter the interaction between surface water bodies and local groundwater in systems where the two resources are hydrologically connected. In these circumstances, extracting water from one source eventually could affect the other source as well. Similarly, altering the water quality of one source could affect the water quality of other sources at downgradient locations. Impacts also could occur if construction activities (e.g., excavation, blasting, trenching) create a conduit between a surface water body and a groundwater aquifer, or between two aquifers, by breaching the hydrologic barrier. This could result in unwanted dewatering or recharge of any of these water resources, depending on local hydrogeologic conditions. In addition, storm water control systems and any other activity that alters the ground surface could affect groundwater infiltration as well as the response time of a nearby surface water body.

5.3.3 Site Operation

As various construction and related activities diminish, the environment will reestablish a new equilibrium. If appropriate mitigation measures are implemented during the construction phase (Section 5.3.5), potential impacts to water during site operation would be limited to the degradation of water quality as a result of improper pesticide use or vehicle traffic.

5.3.4 Site Decommissioning

The impacts on water resources during decommissioning would depend on the decommissioning activities involved. Such activities may involve removal of all access roads, on-site roads, transformer pads, and building foundations. Originally disturbed land areas would likely be restored to their original grade and revegetated. Water wells may be abandoned in place. The potential impacts would largely be the same as those described for the construction phase.

5.3.5 Mitigation Measures

Potential water resource impacts would mostly occur during the site construction and decommissioning phases. Mitigations measures that could reduce such impacts include:

- The size of cleared and disturbed lands should be minimized as much as possible. Existing roads and borrow pits should be used as much as possible.

- Topsoil removed during construction should be salvaged and reapplied during reclamation. Disturbed soils should be reclaimed as quickly as possible or protective covers should be applied.

- Operators should identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and dip angles of geologic strata). Operators also should avoid creating excessive slopes during excavation and blasting operations. Special construction techniques should be used where applicable in areas of steep slopes, erodible soil, and stream channel/wash crossings.

- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.

- Operators should gain a clear understanding of the local hydrogeology. Areas of groundwater discharge and recharge and their potential relationships with surface water bodies should be identified.

- Operators should avoid creating hydrologic conduits between two aquifers during foundation excavation and other activities.

- Proposed construction near aquifer recharge areas should be closely monitored to reduce the potential for contamination of said aquifer. This may require a study to determine localized aquifer recharge areas.

- Foundations and trenches should be backfilled with originally excavated material as much as possible. Excess excavated material should be disposed of only in approved areas.

- Existing drainage systems should not be altered, especially in sensitive areas such as erodible soils or steep slopes. When constructing stream or wash crossings, culverts or water conveyances for temporary and permanent roads should be designed to comply with county standards, or if there are no county standards, to accommodate the runoff of a 10-year storm. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts should be cleaned and maintained regularly.

- On-site surface runoff control features should be designed to minimize the potential for increased localized soil erosion. Drainage ditches should be constructed where necessary but held to a minimum. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, drainage ditches, and culverts should be cleaned and maintained regularly.

- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

5.4 AIR QUALITY

The activities involved in developing and constructing a wind energy development project would vary greatly among sites. Potential impacts would need to be assessed for each site on the basis of that site's air quality and the anticipated extent and duration of the site monitoring and testing, construction, operation, and decommissioning activities. Activities at all sites would need to be carried out in conformance with the applicable SIPs. The following discussion identifies the activities associated with each phase of development and identifies the associated pollutants. On the basis of the limited extent and duration of activities, minimal air quality impacts are expected during monitoring and testing and operation. Nonetheless, each site must be assessed based on its unique characteristics. Construction and decommissioning activities would have the greatest air quality impact and should be subjected to the most thorough analysis for a specific site.

Certain activities are common to most or all of the phases of wind energy development. Table 5.4-1 lists these common activities and identifies the pollutants they produce and the site-specific factors upon which they depend. There may be other factors involved; the table identifies those most commonly used to estimate emissions. The text box on this page discusses emissions associated with vehicles.

Vehicle Emissions

Vehicles include both light-duty vehicles, such as cars, vans, and pickups; heavy-duty vehicles, such as trucks; and construction equipment. Vehicles can be powered by either gasoline or diesel engines. There are two sources of emissions associated with vehicles: tailpipe emissions and emissions from dust that becomes airborne as the vehicle passes, so-called fugitive dust, or road dust. Tailpipe emissions include CO, NO_x, PM_{10}, SO_2, VOCs, and air toxics. SO_2 emissions are higher from diesel-powered vehicles. The reentrained dust is primarily PM_{10}. On dirt roads, the reentrained dust exceeds the particulates from the tailpipe.

5.4.1 Site Monitoring and Testing

As noted in Section 3.1.2, the site monitoring and testing phase could last up to 3 years. The operations involved in setting up the towers and gathering the data would include:

- Limited worker and equipment vehicle traffic on access and site roads to carry in the towers,

TABLE 5.4-1 Pollutants and Factors Influencing Emissions from Common Activities Associated with a Wind Energy Development Project

Activity	Pollutants	Factors
Vehicular traffic	CO, NO_x, VOCs, particulates, SO_2, air toxics	Vehicle-miles traveled (VMT)[a]
Vehicle fugitive dust from paved and unpaved roads	Particulates	VMT, road conditions (e.g., silt loading, silt content, moisture content, and vehicle weight)
Construction fugitive dust from earthmoving activities	Particulate	Acres disturbed
Construction equipment exhaust	CO, NO_x, VOCs, particulates, SO_2, air toxics	Volume of fuel used
Concrete batch plant[b]	Particulates	Volume of concrete produced
Emergency generators[b]	CO, NO_x, VOCs, particulates, SO_2, air toxics	Volume of fuel used or hours of operation

[a] VMT on a road is the product of the number of vehicles traveling the road and the miles traveled by each vehicle.

[b] May not be present at all sites.

- Worker vehicle traffic for performance of routine maintenance,
- Possible limited brush clearing at tower sites, and
- Erection of meteorological towers.

These operations would generate fugitive dust from road travel and brush clearing and tailpipe emissions from vehicular exhaust. However, these activities would all be limited in extent and duration, and, except in unusual circumstances where access road construction or disturbance of large areas is required, should have no appreciable impact on air quality.

5.4.2 Site Construction

Before beginning a construction project, a construction permit from the state or local air agency is generally required. Most jurisdictions do not require modeling of the air quality impacts since the major air impacts of construction projects are local and temporary. Instead, agencies condition the permit to require that certain mitigation practices be conducted, such as watering areas to be disturbed, to control emissions of fugitive dust. It is important to consult with the cognizant agency prior to beginning construction or any on-site activities, including monitoring and testing and decommissioning activities. Agencies may also have special regulations for the type of temporary, portable concrete batch plants that might be used during construction of a wind energy development project.

Section 3.1.2 describes four stages of construction: site access, clearing, and grade alterations; foundation excavations and installations; tower erection and nacelle and rotor installation; and miscellaneous ancillary construction. Each of these is discussed below.

5.4.2.1 Site Access, Clearing, and Grade Alterations

These actions upgrade access to the site and prepare it for actual construction. Activities required for both road construction and site preparation include:

- Worker and equipment vehicle traffic on access roads;
- Removal of vegetative cover;
- Road construction involving excavation, moving soils, and grading;
- Construction of lay-down areas, staging areas, and pads; and
- Possibly blasting.

Emissions generated during these operations would include tailpipe emissions from worker vehicles, material delivery trucks, and water trucks, and the emissions from diesel equipment, such as bulldozers, scrapers, dump trucks, loaders, and rollers. Fugitive dust from disturbed soils would be a major source of particulate emissions. Blasting, if required, would produce small amounts of CO, NO_X, and particulates.

5.4.2.2 Foundation Excavations and Installations

The activities associated with these actions would vary, depending on conditions at the site and may include:

- Worker traffic on access roads;
- Delivery vehicle traffic;
- Grading;
- Operation of construction equipment, such as loaders and trucks;
- Removal of vegetative cover;
- Possible boring, pile driving, or blasting of rock;

- Excavation of soils;
- Possible installation and operation of one or more concrete batch plants and preparation of the storage areas for the sand and aggregate needed as raw materials;
- Possible operation of on-site diesel generators for the batch plants;
- Pouring of concrete for tower foundations, pads, and on-site buildings:
  - Delivery of concrete in mixer trucks over access and site roads, or
  - Operation of the on-site batch plant and on-site delivery of concrete;
  - Operation of ancillary equipment, such as small mixers, vibrators, and concrete pumps; and
- Backfilling of tower bases.

Construction equipment operations would generate fugitive dust from vehicle travel and the movement and transportation of soil (grading, excavation, backfilling, and dumping). In addition, diesel engines would be the primary source of tailpipe emissions. Additional tailpipe emissions would be generated by worker and delivery vehicles and the operation of ancillary construction equipment. Use of on-site power from diesel generators for the batch plant and smaller generators for equipment, such as concrete vibrators and pumps, would also result in emissions of the same pollutants as vehicle tailpipes.

Concrete batching would produce fugitive particulates associated both with truck travel and mixing of concrete. Storage piles associated with the concrete batching would also be sources of fugitive dust.

Blasting, if required, would produce small amounts of CO, NO_X, and particulates. Drilling and pile driving would produce fugitive dust as well as tailpipe emissions from the associated power units.

5.4.2.3 Wind Turbine Erection

Unless a self-erecting tower is used, a large lifting crane would be needed to erect a turbine. Activities associated with the erection of the wind turbine towers and installation of the nacelles and rotors would include:

- Worker traffic on access and site roads;
- Traffic associated with transportation of the dismantled crane to and from the site;

- Delivery vehicle traffic associated with delivery of tower sections and turbine parts;

- Transportation and assembly of a large lifting crane and movement of the crane between tower sites, unless self-erecting towers are used; and

- Use of a crane to lift the tower sections, nacelles, and rotors into place.

Emissions from these operations would be fugitive and tailpipe emissions from worker vehicles, delivery vehicles, and movement and operation of the crane. Emissions similar to tailpipe emissions would also result from the diesel power unit used in a self-erecting tower.

5.4.2.4 Miscellaneous Ancillary Construction

Miscellaneous ancillary construction activities would include:

- Worker traffic on access roads;

- Delivery vehicle traffic;

- Construction of on-site control and storage buildings;

- Construction of electrical substations; and

- Installation of electrical interconnections among turbines, control buildings, and substations.

Emissions would include particulates and tailpipe emissions resulting from worker vehicles and delivery vehicles. Construction would produce fugitive particulates from earthmoving, backfilling, and grading as well as the tailpipe emissions from construction equipment. Trenching for buried electrical lines or erection of utility poles would produce fugitive particulate emissions.

5.4.3 Site Operation

The operation of a wind energy development project would not adversely impact air quality. Operational activities would include operation of the wind turbines and associated maintenance activities. Maintenance activities during operation would not include construction and would be limited to routine maintenance and major overhauls and repairs (Section 3.1.2). Major overhauls and repairs could involve bringing a crane and heavy truck on site to remove and transport the component needing attention. The operations involved would include:

- Operation of the wind turbines themselves,

- Scheduled changes of lubricating and cooling fluids and greases,

- Limited routine worker access traffic associated with maintenance,
- Infrequent heavy overhaul/repair traffic, and
- Possibly routine brush clearing.

Operating wind turbines do not produce direct emissions. There could be some minor VOC emissions during routine changes of lubricating and cooling fluids and greases. The other operations would generate fugitive dust from road travel, vehicular exhaust, and brush clearing in addition to the tailpipe emissions associated with vehicle travel. However, all these activities would be limited in extent and duration and should have no appreciable air quality impact.

5.4.4 Site Decommissioning

As noted in Section 3.1.2, decommissioning is the reverse of the construction process and involves many of the same operations. Turbines and towers would need to be removed. Disturbed land would need to be restored, but belowground structures would probably not be removed. Operations could include:

- Worker and equipment vehicular traffic on access and site roads;
- Use of a heavy crane and hauling trucks to dismantle and remove turbine and tower components;
- Removal of concrete pads and ancillary structures, such as electrical interconnections among turbines, control buildings, and substations; and
- Use of equipment to restore (grading, reseeding, and replanting) disturbed areas.

These operations would produce particulates from road dust, earthmoving, and vehicle tailpipes. In addition, there would be the other tailpipe emissions associated with operation of cranes, trucks, and earthmoving equipment. These emissions would be of limited duration and extent. Depending on the amount of land disturbed, an analysis of the particulate impacts may be needed.

5.4.5 Mitigation Measures

As discussed above, the potential for adverse air quality impacts during the site monitoring and testing and operation phases would be limited. The greatest potential impacts would occur during the construction and decommissioning phases. Generation of fugitive particulates from vehicle traffic and earthmoving activities would need to be controlled both through the permitting process and the application of mitigation measures. Typical measures

(ABC Wind Company, LLC undated; PBS&J 2002) that can be implemented to control particulates and other pollutants include these:

- *Mitigation measures for areas subject to vehicular travel*

  – Access roads and on-site roads should be surfaced with aggregate materials, wherever appropriate.

  – Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.

  – Speed limits should be posted (e.g., 25 mph [40 km/h]) and enforced to reduce airborne fugitive dust.

- *Mitigation measures for soil and material storage and handling*

  – Workers should be trained to handle construction material to reduce fugitive emissions.

  – Construction materials and stockpiled soils should be covered if they are a source of fugitive dust.

  – Storage piles at concrete batch plants should be covered if they are a source of fugitive dust.

- *Mitigation measures for clearing and disturbing land*

  – Disturbed areas should be minimized.

  – Dust abatement techniques should be used as earthmoving activities proceed and prior to clearing.

- *Mitigation measures for earthmoving*

  – Dust abatement techniques should be used before excavating, backfilling, compacting, or grading.

  – Disturbed areas should be revegetated as soon as possible after disturbance.

- *Mitigation measures for soil loading and transport*

  – Soil should be moist while being loaded into dump trucks.

  – Soil loads should be kept below the freeboard of the truck.

- Drop heights should be minimized when loaders dump soil into trucks.
- Gate seals should be tight on dump trucks.
- Dump trucks should be covered before traveling on public roads.

• *Mitigation measure for blasting*

- Dust abatement techniques should be used during blasting.

5.5 NOISE IMPACTS

This section describes the potential noise impacts from site monitoring and testing, construction, operation, maintenance, and decommissioning activities associated with wind energy development. Mitigation measures are also presented.

5.5.1 Site Monitoring and Testing

Most activities associated with site monitoring and testing would generate relatively low levels of noise. Potential short-term sources of noise at the beginning or end of this phase could include the use of a grader or bulldozer [about 85 dB(A)] if an access road was needed and there was traffic caused by heavy-duty or medium-duty trucks used to transport the towers to and from the site. A light-duty pickup truck would be used periodically for meteorological data collection and instrument maintenance during the course of the monitoring and testing phase. All these activities would occur during daytime hours when noise is tolerated more than at night, because of the masking effect of background noise. Accordingly, potential impacts of site monitoring and testing activities on ambient noise would be expected to be temporary and intermittent in nature.

5.5.2 Site Construction

The construction phase would include a wide array of activities, including access road construction, grading, drilling and blasting (for tower foundations), construction of ancillary structures, cleanup, and revegetation (see Section 3.1.2 for more details). The noise levels generated by construction equipment would vary significantly, depending on such factors as type, model, size, and condition of the equipment; operation schedule; and condition of the area being worked. In addition to daily variations in activities, major construction projects are accomplished in several different stages. Each stage has a specific equipment mix, depending on the work to be accomplished. Most construction activities would occur during the day, when noise is tolerated better because of the masking effect of background noise. Nighttime noise levels probably would drop to the background levels of the project area. In general, construction activities would last for a short period (1 or 2 years at most) compared with operation of the wind turbines, and, accordingly, their potential impacts would be temporary and intermittent in nature.

5.5.2.1 Heavy Equipment

Average noise levels for typical construction equipment range from 74 dB(A) for a roller, to 85 dB(A) for a bulldozer, to 101 dB(A) at a pile driver (impact) (HMMH 1995). In general, the dominant noise source from most construction equipment is the diesel engine, which is continuously operating around a fixed location or with limited movement. This is particularly true if the diesel engine is poorly muffled. In a few cases, noise generated by pile driving or pavement breaking would dominate. Other sources of continuous noise would include field compressors, bulldozers, and backhoes.

Noise levels for typical construction equipment that would likely be used at a wind turbine project site are about in the 80 to 90 dB(A) range at a distance of 50 ft (15 m), as shown in Table 5.5.2-1. For a general assessment of construction impacts, it can be assumed that only two of the noisiest pieces of equipment would operate simultaneously. Assuming geometric spreading only (i.e., a decrease of about 6 dB per doubling of distance from a point source) and an 8-hour work day, on the basis of the noise levels presented in Table 5.5.2-1, it is estimated that with the two noisiest pieces of equipment operating simultaneously at peak load, noise levels would exceed the EPA guideline for residential L_{dn} noise [55 dB(A)] for a distance of about 1,640 ft (500 m) (EPA 1974). This distance would decrease if reasonable factors for noise attenuation (e.g., air absorption and ground effects due to terrain and vegetation) and operating loads were considered.

TABLE 5.5.2-1 Noise Levels at Various Distances from Typical Construction Equipment

	Noise Level $L_{eq(1\text{-}h)}$[a] at Distances [dB(A)]					
Construction Equipment	50 ft[b]	250 ft	500 ft	1,000 ft	2,500 ft	5,000 ft
Bulldozer	85	71	65	59	51	45
Concrete mixer	85	71	65	59	51	45
Concrete pump	82	68	62	56	48	42
Crane, derrick	88	74	68	62	54	48
Crane, mobile	83	69	63	57	49	43
Front-end loader	85	71	65	59	51	45
Generator	81	67	61	55	47	41
Grader	85	71	65	59	51	45
Shovel	82	72	62	56	48	42
Truck	88	74	68	62	54	48

[a] $L_{eq(1\text{-}h)}$ is the equivalent steady-state sound level that contains the same varying sound level during a 1-hour period.

[b] To convert feet to meters, multiply by 0.3048.

Source: HMMH (1995).

5.5.2.2 On-Road Vehicular Traffic

On-road vehicular traffic includes hauling of materials in and out of the construction site, movement of heavy equipment, and commuter and visitor traffic. The associated noise levels would increase and decrease rapidly. The number of truck trips associated with construction would vary, depending on the construction stage but, overall, the total traffic volume along local roads could be increased throughout the construction phase. Potential noise impacts would be greatest at the highest number of peak-hour trips and total heavy-duty truck trips. Commuter and visitor vehicular traffic, which would consist of mostly light-duty vehicles with lower-level noise sources (roughly 10 passenger cars equal 1 heavy truck on an L_{eq} basis), would be primarily limited to morning and afternoon rush hours. Other vehicular traffic, such as transport of heavy equipment, delivery of general construction materials, and a water truck for fugitive dust control, is anticipated; the noise contribution from these sources, however, would likely be short-lived.

To determine potential noise impacts from on-road vehicles associated with construction of a wind energy development project, noise levels at various distances from the road by hourly vehicle traffic were estimated. The peak pass-by noise level of a heavy truck operating at 50 mph (80 km/h) was estimated to be about 83 dB(A) (Menge et al. 1998), assuming an 8-hour daytime activity. Table 5.5.2-2 gives the noise levels at various distances and by hourly vehicle traffic. Except at receptor locations in close proximity to the road and/or heavy traffic volume, noise levels are below the EPA guideline of 55 dB(A) as L_{dn} for residential zones (EPA 1974).

5.5.2.3 Blasting

Depending on local geological conditions, explosive blasting for wind turbine foundations might be needed. Blasting would create a compressional wave in the air (air blast overpressure), the audible portion of which would be manifested as noise. In general, blasting activities between the hours of 7 a.m. and 10 p.m. are specifically exempt from noise regulation in some states (e.g., Washington). Depending on site conditions, it is anticipated that most wind turbine foundations would require one to two blasts. Potential impacts to the closest residential structure could be determined; however, residential structures probably would be located a considerable distance away from the site given the remote nature of most potential wind development locations on BLM-administered lands.

5.5.3 Site Operation

During operation, major noise sources would be mechanical and aerodynamic noise; transformer and switchgear noise from substations; corona noise from transmission lines; vehicular traffic noise, including commuter and visitor and material delivery; and noise from the operation and maintenance (O&M) facility. These noise sources are described below. Noise from infrequent diesel generator operations (e.g., 2 hours per month for mandatory testing) at the O&M facility and from traffic, ranging from light- to medium-duty vehicles, is expected to be negligible. Overall, the noise levels of continuous site operation would be lower than the noise levels associated with short-term construction activities.

TABLE 5.5.2-2 Noise Levels at Various Distances from Heavy Trucks[a]

	Noise Level $L_{eq(1\text{-}h)}$[b] at Distances [dB(A)]					
Hourly Vehicle Traffic	50 ft[c]	250 ft	500 ft	1,000 ft	2,500 ft	5,000 ft
1	50.7	43.8	40.7	37.7	33.8	30.7
10	60.7	53.8	50.7	47.7	43.8	40.7
50	67.7	60.7	57.7	54.7	50.7	47.7
100	70.7	63.8	60.7	57.7	53.8	50.7
	Noise Level L_{dn}[d] at Distances [dB(A)]					
Hourly Vehicle Traffic	50 ft	250 ft	500 ft	1,000 ft	2,500 ft	5,000 ft
1	46.0	39.0	36.0	33.0	29.0	26.0
10	56.0	49.0	46.0	43.0	39.0	36.0
50	63.0	56.0	53.0	50.0	46.0	43.0
100	66.0	59.0	56.0	53.0	49.0	46.0

[a] The EPA recommends an L_{dn} of 55 dB(A) for residential areas (EPA 1974).

[b] $L_{eq(1\text{-}h)}$ was estimated on the basis of an A-weighted peak pass-by noise level generated by a heavy truck operating at 50 mph (80 km/h) and traffic flow and distance adjustments.

[c] To convert feet to meters, multiply by 0.3048.

[d] L_{dn} was estimated by assuming an 8-hour daytime shift.

Source: Menge et al. (1998).

5.5.3.1 Wind Turbine Noise

Wind turbines produce two categories of noise: mechanical and aerodynamic. These categories are associated with four types of noise (tonal, broadband, impulsive, and low-frequency) (NWCC 1998). Recent improvements in the mechanical design of large wind turbines have resulted in significantly reduced mechanical noise. As a result, aerodynamic noise is the dominant source from modern wind turbines (Fégeant 1999). A brief discussion of each of these noise characteristics follows; a more detailed review is included in Wagner et al. (1996).

Mechanical noise, associated with the rotation of mechanical and electrical components, tends to be tonal, although a broadband component exists. It is primarily generated by the gearbox and other parts, such as generators, yaw drives, and cooling fans. However, the hub, rotor, and turbine may act as loudspeakers and transmit the mechanical noise over greater distances. Recent technological improvements have reduced mechanical noise. It can be further reduced through sound-proofing and noise insulation materials. Accordingly, mechanical noise must, to some extent, be viewed as an indication of poor design.

Aerodynamic noise from wind turbines originates mainly from the flow of air over and past the blades; therefore, the noise generally increases with tip speed. It is directly linked to the production of power and therefore inevitable, even though it could be reduced to some extent by altering the design of the blades (Wagner et al. 1996). The aerodynamic noise has a broadband character, often described as a “swishing” or “whooshing” sound, and is typically the dominant part of wind turbine noise today. The noise caused by this process is unavoidable. Inflow turbulent noise caused by the interaction of blades with atmospheric turbulence is a major contributor to broadband noise, but it has not yet been fully quantified (Wagner et al. 1996).

Although aerodynamic noise mostly has a broadband character, airfoil-related noise can also create a tonal component and there can be both impulsive and low-frequency components. Impulsive noise and low-frequency noise are primarily associated with older-model downwind turbines, the blades of which are on the downwind side of the tower; these types of noise are caused by the interaction of the blades with disturbed air flow around the tower. Impulsive noise is characterized by short acoustic impulses or thumping sounds that vary in amplitude (level) as a function of time. Low-frequency noise is a more steady sound in the range of 20 to 100 Hz. These types of noise can be avoided, however, with good engineering design.

There are many wind turbine designs. In general, upwind turbines are less noisy than downwind turbines and their lower rotational speed and pitch control results in lower noise generation. A variable speed wind turbine generates relatively lower noise emissions than a fixed speed turbine. A large variable speed wind turbine operates at slower speeds in low winds, resulting in much quieter operation in low winds than a comparable fixed speed wind turbine. As wind speed increases, the wind itself masks the increasing turbine noise.

To determine the potential noise impacts at nearby residences from wind turbine operations, sound level data would be needed. These data can be provided by the wind turbine manufacturer or vendor, obtained from field measurements, or from a literature survey. The sound power level from a single wind turbine is approximately 100 to 104 dB(A) for the rated power ranging from 1 to 1.4 MW (Rogers and Manwell 2002). Considering geometric spreading only, this results in a sound pressure level of 58 to 62 dB(A) at a distance of 50 m (164 ft) from the turbine, which is about the same level as conversational speech at a 1-m (3-ft) distance. At a receptor approximately 2,000 ft (600 m) away, the equivalent sound pressure level would be 36 to 40 dB(A) when the wind is blowing from the turbine toward the receptor. This level is typical of background levels of a rural environment (Section 4.5.2). To estimate combined noise levels from multiple turnbines, the sound pressure level from each turbine should be estimated and summed. Different arrangements of multiple wind turbines (e.g., in a line along a ridge versus in clusters) would result in different noise levels; however, the resultant noise levels would not vary by more than 10 dB.

On a clear night, temperature usually increases with height due to radiant cooling of the surface. Under this condition (called a temperature inversion), sound refracts or bends downward, which is a favorable condition for propagation (i.e., sound will travel farther). However, this condition would occur only at low wind speeds, approximately less than 9 ft/s (3 m/s), because stronger winds interfere with this effect. Modern-day wind turbines have a cut-in speed of about 8.2 to 13 ft/s (2.5 to 4 m/s) (see Appendix C, Table C-2); thus, increased noise propagation associated with temperature inversion would be minimal in most operations. The exception would be in sheltered valleys with relatively low ambient noise levels. In general, the effects of wind speed on noise propagation would generally dominate over those of temperature gradient.

Whether the turbine noise is intrusive or not depends not only on its distribution of amplitude and frequency but also on the background noise, which varies with the level of human and animal activities and meteorological conditions (primarily wind speed). In general, wind-generated background noise (i.e., noise caused by the interaction between wind and vegetation or structures) tends to increase more rapidly with wind speed than aerodynamic noise from wind turbines. Wind-generated noise would increase by about 2.5 dB(A) per each 3-ft/s (1-m/s) wind speed increase (Hau 2000); the noise level of a wind turbine, however, would increase only by about 1 dB(A) per 3-ft/s (1-m/s) increase. In general, if the background noise level exceeds the calculated noise level of a wind turbine by about 6 dB(A), the latter no longer contributes to a perceptible increase of noise. At a wind speed of about 33 ft/s (10 m/s), wind-generated noise is higher than aerodynamic noise. In addition, it is difficult to measure sound from modern wind turbines above a wind speed of 26 ft/s (8 m/s) because the background wind-generated noise masks the wind turbine noise at that speed (DWIA 2003). As a result, noise issues are more commonly a concern at lower wind speeds (Fégeant 1999).

5.5.3.2 Substation Noise

There are basically two sources of noise associated with substations: transformer noise and switchgear noise. Each has a characteristic noise spectrum and pattern of occurrence. A transformer produces a constant low-frequency humming noise primarily because of the vibration of its core. The core’s tonal noise should be uniform in all directions and continuous. The average A-weighted core sound level at a distance of 492 ft (150 m) from a transformer would be about 43 and 46 dB(A) for 100 and 200 million volt-amperes (MVA) (corresponding to about 80 and 160 MW), respectively (Wood 1992). These noise levels at a distance of 1,640 ft (500 m) would be 33 and 36 dB(A), which are typical of background levels in a rural environment (Section 4.5.2). Current transformer design trends have shown decreases in noise levels. The cooling fans and oil pumps at large transformers produce broadband noise only when additional cooling is required; in general, this noise is less noticeable than the tonal noise.

Switchgear noise is generated by the operation of circuit breakers used to break high-voltage connections at 132 kV and above. An arc formed between the separating contacts has to be "blown out" using a blast of high-pressure gas. The resultant noise is impulsive in character (i.e., loud and of very short duration). The industry is moving toward the use of more modern circuit breakers that use a dielectric gas to extinguish the arc and generate significantly less noise. Frequency of switchgear activities, such as regular testing, maintenance, and rerouting, is an operational issue unique to a specific utility company. During an electrical fault due to line overloads, the switch would open to isolate the fault and thereby protect the equipment. However, these operations would occur infrequently, and, accordingly, potential impacts of switchgear noise would be temporary and minor in nature.

5.5.3.3 Transmission Line Noise

Potential transmission line noise can result from corona discharge, which is the electrical breakdown of air into charged particles. Corona noise is composed of broadband noise, characterized as a crackling or hissing noise, and pure tones, characterized as a humming noise of about 120 Hz. Corona noise is primarily affected by weather and, to a lesser degree, by altitude and temperature. It is created during all types of weather when air ionizes near isolated irregularities (e.g., nicks, scrapes, and insects) on the conductor surface of operating transmission lines. Modern transmission lines are designed, constructed, and maintained so that during dry conditions the line will generate a minimum of corona-related noise. During dry weather conditions, noise from transmission lines is generally indistinguishable from background noise at locations beyond the edge of the transmission line ROW (50 ft [15 m] from the center of the tower) (BPA 1996). In wet conditions, however, water drops collecting on the lines provide favorable conditions for corona discharges. Occasional corona humming noise at 120 Hz and higher is easily identified and, therefore, may become the target of complaints from neighboring residents. During rainfall events, the noise level at the edge of the ROW of 230-kV transmission line towers would be less than 39 dB(A) (BPA 1996), which is typical of the noise level at a library. The noise level at a distance of 300 ft (91 m) would be about 31 dB(A), which is lost in the background noise typical of a rural environment at night (Section 4.5.2).

A preliminary study by Pearsons et al. (1979) indicated that because of its high-frequency components, corona noise may be judged to be as annoying as other environmental noises even when it is actually 10 dB(A) lower than those other noises However, corona noise tends to decrease faster with distance than other environmental noise because of its higher frequency components. In general, because of the arid climate in the study region and the remote location of most potential wind development sites on BLM-administered land, the impact of corona noise during the operations phase is not expected to be significant. Sites located at higher elevations or in more humid areas would generate some corona noise. Although corona noise could be an issue where transmission lines cross more populated areas, it would not likely cause a problem unless the residence is located next to the transmission line, say within 500 ft (152 m).

5.5.3.4 Noise Related to Maintenance Activities

Regular maintenance activities would include periodic site visits to wind turbines, communication cables, transmission lines, substations, and auxiliary structures. These activities would involve light- or medium-duty vehicle traffic with relatively low noise levels. Infrequent but noisy activities would be anticipated, such as road maintenance work with heavy equipment, or repair or replacement of old or inoperative wind turbines or auxiliary equipment. However, the anticipated level of noise impacts from maintenance activities would be far lower than that from construction activities.

5.5.4 Site Decommissioning

In general, noise impacts from decommissioning activities would be similar to but less than those associated with construction activities because the activity type and level would be similar but shorter in duration. As in the construction period, most of the decommissioning activities would occur during the day, when noise is tolerated better than at night because of the masking effect of background noise. Nighttime noise levels would drop to the background levels of a rural environment because decommissioning activities would cease at night. Like construction activities, decommissioning activities would last for a short period compared with wind turbine operation, and, accordingly, the potential impacts would be temporary and intermittent in nature.

5.5.5 Mitigation Measures

The following mitigation measures are recommended as ways to reduce potential noise impacts:

- Proponents of a wind energy development project should take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project (Section 4.5.2).

- Noisy construction activities (including blasting) should be limited to the least noise-sensitive times of day (daytime only between 7 a.m. and 10 p.m.) and weekdays.

- Whenever feasible, different noisy activities (e.g., blasting and earthmoving) should be scheduled to occur at the same time since additional sources of noise generally do not add a significant amount of noise. That is, less-frequent noisy activities would be less annoying than frequent less-noisy activities.

- All equipment should have sound-control devices no less effective than those provided on the original equipment. All construction equipment used should be adequately muffled and maintained.

- All stationary construction equipment (i.e., compressors and generators) should be located as far as practicable from nearby residences.

- If blasting or other noisy activities are required during the construction period, nearby residents should be notified in advance.

5.6 TRANSPORTATION IMPACTS

Transportation requirements for construction, operation, and decommissioning of a typical wind energy development project are discussed in Section 3.5. In general, the heavy equipment and materials needed for site access, site preparation, and foundation construction are typical of road construction projects and do not pose unique transportation considerations. However, depending on the design, some of the turbine components could be extremely long (e.g., blades) or heavy (e.g., the nacelle containing all drivetrain components except the rotor) and, therefore, require permitting as oversized loads. In addition, it is likely that the main cranes required for tower and turbine assembly would require a certain number of oversized and/or overweight shipments. Similar equipment and material would require transportation during site decommissioning.

5.6.1 Site Monitoring and Testing

During site monitoring and testing, transportation activities would be largely limited to very low volumes of heavy-duty all-wheel-drive pickup trucks, medium-duty trucks, or personal vehicles. It is likely that existing access roads would suffice, thus no special requirements or significant impacts are anticipated.

5.6.2 Site Construction

The movement of equipment and materials to the site during construction would cause a relatively short-term increase in the level of service of local roadways during the construction period. Most equipment (e.g., heavy earthmoving equipment and cranes) would remain at the site for the duration of construction activities. Shipments of materials, such as gravel, concrete, and water, would not be expected to significantly affect local primary and secondary road networks.

Shipments of overweight and/or oversized loads can be expected to cause temporary disruptions on the secondary and primary roads used to access a construction site. As noted in Section 3.1.2.1, it is possible that local roads might require fortification of bridges and removal of obstructions to accommodate overweight or oversized shipments. The need for such actions must be determined on a site-specific basis. Moreover, the wind energy development project access road must be constructed to accommodate such shipments. Because of the anticipated weight of the turbine components and electrical transformers that would be brought to the site, maximum grade becomes a critical road design parameter. While straight-line access roads would obviously minimize distance and cost, the combination of turning clearance requirements and maximum grade can be expected to result in access roads climbing a hill along a serpentine path. Visual impacts associated with road construction also would need to be considered (Section 5.11).

5.6.3 Site Operation

During operations, larger sites may be attended during business hours by a small maintenance crew of six individuals or fewer. Consequently, transportation activities would be limited to a small number of daily trips by pickup trucks, medium-duty vehicles, or personal vehicles. It is possible that large components may be required for equipment replacement in the event of a major mechanical breakdown. However, such shipments would be expected to be infrequent. Transportation activities during operations would not be expected to cause noticeable impacts to local road networks.

5.6.4 Site Decommissioning

With some exceptions, transportation activities during site decommissioning would be similar to those during site development and construction. Heavy equipment and cranes would be required for turbine and tower dismantlement, breaking up tower foundations, and regrading and recontouring the site to the original grade. With the possible exception of a main crane, oversized and/or overweight shipments are not expected during decommissioning activities because the major turbine components could be disassembled, segmented, or size-reduced prior to shipment. Thus, potential disruptions to local traffic during decommissioning would likely be fewer than those during original construction activities.

5.6.5 Mitigation Measures

Potential impacts from transportation activities related to site monitoring and testing, construction, operation, and decommissioning of typical wind energy development projects are expected to be low, provided appropriate planning and implementation actions are taken. The following measures to mitigate transportation impacts address the expected major activities associated with future wind energy development projects and general safety standards.

- Existing BLM standards regarding road design, construction, and maintenance are described in the BLM Manual 9113 (BLM 1985) and the Gold Book (RMRCC 1989). An access road siting and management plan should be prepared incorporating these standards, as appropriate. Generally, roads should be required to follow natural contours; be constructed in accordance with standards as described in BLM Manual 9113; and be reclaimed to BLM standards. As described in BLM Manual 9113, BLM roads should be designed to an appropriate standard no higher than necessary to accommodate their intended functions.

- Existing roads should be used to the maximum extent possible, but only if in safe and environmentally sound locations. If new access roads are necessary, they should be designed and constructed to the appropriate standard no higher than necessary to accommodate their intended functions (e.g., traffic volume and weight of vehicles). Abandoned roads and roads that are no longer needed should be recontoured and revegetated.

- A transportation plan should be developed, particularly for the transport of turbine components, main assembly cranes, and other large pieces of equipment. The plan should consider specific object sizes, weights, origin, destination, and unique handling requirements and should evaluate alternative transportation approaches (e.g., barge or rail). In addition, the process to be used to comply with unique state requirements and to obtain all necessary permits should be clearly identified.

- A traffic management plan should be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan should incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration. Signs should be placed along roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimize impacts on local commuters, consideration should be given to limiting construction vehicles traveling on public roadways during the morning and late afternoon commute time.

- Project personnel and contractors should be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow.

- During construction and operation, traffic should be restricted to the roads developed for the project. Use of other unimproved roads should be restricted to emergency situations.

5.7 HAZARDOUS MATERIALS AND WASTE MANAGEMENT IMPACTS

The use, storage, and disposal of hazardous materials and waste associated with a typical wind energy project are discussed in Section 3.4. Potential adverse health and environmental impacts associated with improper management of these materials could be significant. In general, most potential impacts are associated with the release of these materials to the environment, which could occur if the materials are improperly used, stored, or disposed of. Direct impacts of such releases could include contamination of vegetation, soil, and water, which could result in indirect impacts to human and wildlife populations.

If appropriate management practices are implemented, the impacts associated with hazardous materials and wastes are expected to be minimal to nonexistent. Measures to mitigate or prevent environmental impacts associated with these materials are presented below. They were developed on the basis of the expected major activities associated with wind energy projects and standard industry practices.

The following mitigation measures are recommended for implementation during all activities associated with a wind energy project:

- The BLM should be provided with a comprehensive listing of the hazardous materials that would be used, stored, transported, or disposed of during activities associated with site monitoring and testing, construction, operation, and decommissioning of a wind energy project.

- Operators should develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan should identify all hazardous materials that would be used, stored, or transported at the site. It should establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials. The plan should also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.

- Operators should develop a waste management plan identifying the waste streams that are expected to be generated at the site and addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan should address all solid and liquid waste that may be generated at the site.

- Operators should develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.

- Operators should develop a storm water management plan for the site to ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion.

- If pesticides are to be used on the site, an integrated pest management plan should be developed to ensure that applications will be conducted within the framework of BLM and DOI policies and entail the use of only EPA-registered pesticides. Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- Secondary containment should be provided for all on-site hazardous materials and waste storage, including fuel. In particular, fuel storage (for construction vehicles and equipment) should be a temporary activity occurring only for as long as is needed to support construction and decommissioning activities. Fuel storage facilities should be removed from the site after these activities are completed.

- Wastes should be properly containerized and removed periodically for disposal at appropriate off-site permitted disposal facilities.

- In the event of an accidental release to the environment, the operator should document the event, including a root cause analysis, appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event should be provided to the BLM authorized officer and other federal and state agencies, as required.

- Any wastewater generated in association with temporary, portable sanitary facilities should be periodically removed by a licensed hauler and introduced into an existing municipal sewage treatment facility. Temporary, portable sanitary facilities provided for construction crews should be adequate to support expected on-site personnel and should be removed at the completion of construction activities.

5.8 HEALTH AND SAFETY IMPACTS

Occupational and public health and safety considerations related to typical wind energy projects are discussed in Section 3.3. Potential impacts to the health and safety of workers and the public are discussed in the following sections. Potential mitigation measures are identified on the basis of the expected major activities, general safety standards, and research specific to wind power generation.

5.8.1 Occupational Safety

Potential occupational health and safety risks are very limited during the site monitoring and testing phase because of the limited extent of activities. Occupational hazards are greater during construction, operation, and decommissioning of a wind energy development project; they can be minimized, however, when workers adhere to safety standards and use appropriate protective equipment. Nevertheless, with the unique occupational hazards associated with wind energy, as well as hazards similar to those in heavy construction and the electric power industry, fatalities and injuries from on-the-job accidents can still occur. The following mitigation measures are recommended for implementation during all phases associated with a wind energy project:

- All construction, operation, and decommissioning activities should be conducted in compliance with applicable federal and state occupational safety and health standards (e.g., OSHA's Occupational Health and Safety Standards, 29 CFR Parts 1910 and 1926, respectively (DOL 2001, 2003).

- A safety assessment should be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.

- A health and safety program should be developed to protect workers during construction, operation, and decommissioning of a wind energy project. The program should identify all applicable federal and state occupational safety standards, establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; OSHA standard practices for safe use of explosives and blasting agents; and measures for reducing occupational EMF exposures), establish fire safety evacuation procedures, and define safety performance standards (e.g., electrical system standards and lighting protection standards). The program should include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies should be established.

- Electrical systems should be designed to meet all applicable safety standards (e.g., National Electrical Code [NEC] and IEC).

- For the mitigation of explosive hazards, workers should be required to comply with the OSHA standard (1910.109) for the safe use of explosives and blasting agents (DOL 1998).

- Measures should be considered to reduce occupational EMF exposures, such as backing the generator with iron to block EMF, shutting down the generator when working in the vicinity, and/or limiting exposure time while the generator is running (Robichaud 2004).

5.8.2 Public Safety

Potential public safety hazards during the site monitoring and testing phase are minimal. During construction, operation, and decommissioning of a wind energy development project, the hazards are greater but they can be effectively mitigated. These hazards include risks associated with major construction sites, rare tower failures, human-caused fire, EMF exposure, aviation safety interference, EMI, low-frequency sound, and shadow flicker. The following mitigation measures are recommended for implementation during all phases associated with a wind energy project:

- The project health and safety program should also address protection of public health and safety during construction, operation, and decommissioning of a wind energy project. The program should establish a safety zone or setback for wind turbine generators from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from various hazards during the operation of wind turbine generators. It should identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or decommissioning activities. It should also identify measures to be taken during the operations phase to limit public access to facilities (e.g., permanent fencing should be installed around electrical substations, and turbine tower access doors should be locked to limit public access).

- Operators should consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) should be identified and addressed in the traffic management plan.

- If operation of the wind turbines is expected to cause significant adverse impacts to nearby residences and occupied buildings from shadow flicker, low-frequency sound, or EMF, site-specific recommendations for addressing these concerns should be incorporated into the project design (e.g., establishing a sufficient setback from turbines).

- The project should be planned to minimize EMI (e.g., impacts to radar, microwave, television, and radio transmissions) and comply with FCC regulations. Signal strength studies should be conducted when proposed locations have the potential to impact transmissions. Potential interference with public safety communication systems (e.g., radio traffic related to emergency activities) should be avoided.

- In the event an installed wind energy development project results in EMI, the operator should work with the owner of the impacted communications system to resolve the problem. Potential mitigation may include realigning the existing antenna or installing relays to transmit the signal around the wind energy project. Additional warning information may also need to be conveyed to aircraft with onboard radar systems so that echoes from wind turbines can be quickly recognized.

- The project should be planned to comply with FAA regulations, including lighting requirements, and to avoid potential safety issues associated with proximity to airports, military bases or training areas, or landing strips.

- Operators should develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.

5.9 ECOLOGICAL RESOURCES

This section describes the potential impacts to ecological resources on BLM-administered lands that could occur during each phase of development of a wind energy project; it also identifies potential mitigation measures for avoiding or mitigating these potential impacts. The descriptions focus primarily on potential impacts during the construction and operation of a wind energy project (Sections 5.9.2 and 5.9.3, respectively), because impacts resulting from these phases are considered to be greater. Impacts associated with site monitoring and testing activities and decommissioning are also discussed (Sections 5.9.1 and 5.9.4, respectively). Mitigation measures are recommended for all phases of development (Section 5.9.5).

The types of ecological resources that could be affected by wind energy development on BLM-administered lands depend on the specific location of the proposed project and its environmental setting. Ecological resources that could be affected include vegetation, fish, and wildlife, as well as their habitats. These biota include species that have been designated as threatened, endangered, or species of special concern by federal or state natural resource agencies (e.g., USFWS, BLM, and Wyoming Game and Fish Department [WGFD]) within the 11 western states where wind energy development projects may be implemented on BLM-administered lands.

Figure 5.9-1 shows the distribution of BLM-administered lands with a medium to high potential for wind energy development, relative to ecoregions that occur in the 11 western states. The types of plant communities and wildlife species that could be affected by wind energy development depend on the ecoregion in which the project is located and the type of plant community that is present at the project location within the ecoregion. The ecoregions with the greatest extent of areas with medium to high potential for wind energy development are the Wyoming Basin ecoregion in Wyoming; the Northwest Glaciated Plains and Northwest Great Plains ecoregions in Montana; the Northern Basin and Range ecoregion in California, Idaho, Nevada, Oregon, and Utah; and the Chihuahuan ecoregion in New Mexico (Figure 5.9-1). The vegetation communities in these ecoregions are largely arid and semiarid grass and shrub lands (Appendix F). Appendix F presents state-level maps showing the distribution of areas on BLM-administered lands with a medium to high potential for wind energy development across ecoregions of the 11 western states.

For the purposes of this assessment, impacts from wind energy development on biological resources were considered important if they would result in, or contribute to, any of the following:

- Reduction of the quality and/or quantity of habitat for fish, wildlife, or plants;
- A decrease in a plant or wildlife population to below self-sustaining levels;
- Establishment or increases of noxious weed populations;
- Elimination of a plant or animal community;

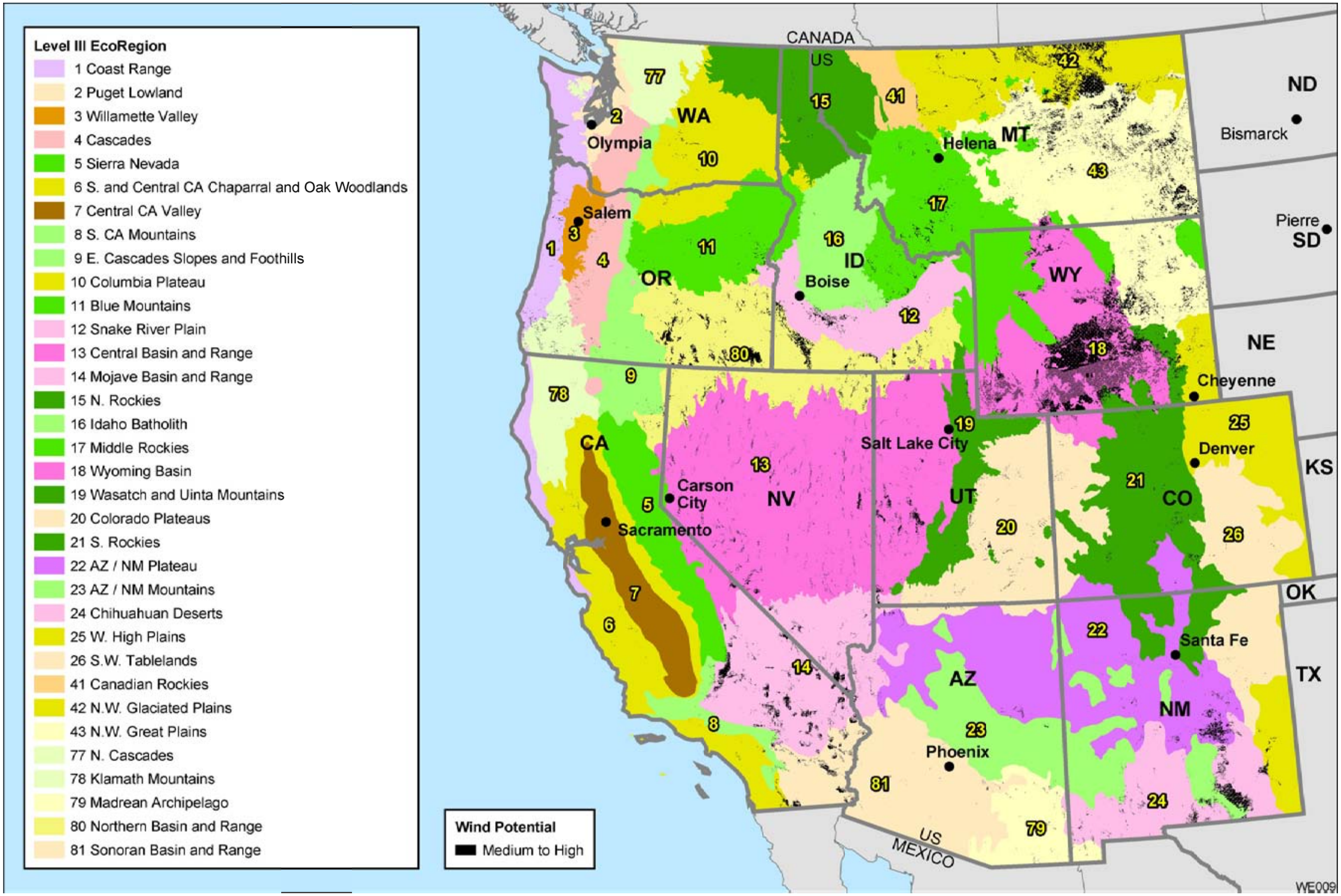

FIGURE 5.9-1 Distribution of BLM-Administered Lands with a Medium to High Potential for Wind Energy Development across Ecoregions of the 11 Western States

- Violations of the ESA, the BEPA, MBTA, or applicable state laws;

- A decline in bat, raptor, or migratory bird populations;

- Interference with the movement of any resident or migratory fish or wildlife species; or

- Conflicts with management strategies for BLM Special Management Areas.

The importance of these impacts can only be fully evaluated on a site-specific level, on the basis of a variety of factors, such as the status of native and invasive plant and animal populations; the types of habitats that would be disturbed and the nature of the disturbance; management activities and goals for plants, fish, and wildlife; results from monitoring area biota; and local, state, and federal criteria for area plants, fish, and wildlife. Furthermore, the changes in any of these conditions must be clearly linked to a wind energy project and not the result of some other, non-wind-energy-related activity.

The following sections discuss potential effects to ecological resources that may be incurred during the monitoring and testing of sites to determine their suitability for development, during the construction and operation of a wind energy development project, and during facility decommissioning. To evaluate the potential effects of wind energy development on ecological resources, it was assumed that all wind turbines might present a hazard to some vertebrate wildlife from an individual and/or population perspective and that some wind energy development sites would present less of a hazard than other sites.

5.9.1 Site Monitoring and Testing

During site monitoring and testing, impacts to vegetation, wildlife habitat, and aquatic habitats generally would be minimal. Monitoring and testing activities could lead to the introduction and spread of invasive vegetation. However, road construction and excavation would typically be very limited; some clearing or grading might be needed to install monitoring equipment or access a site. If more extensive road construction or excavation were needed, more extensive impacts could result (see Section 5.9.2 for impacts during construction).

5.9.2 Site Construction

During construction, adverse ecological effects could occur from (1) erosion and runoff; (2) fugitive dust; (3) noise; (4) the introduction and spread of invasive vegetation; (4) modification, fragmentation, and reduction of habitat; (5) mortality of biota; (6) exposure to contaminants; and (7) interference with behavioral activities. Site clearing and grading, along with construction of access roads, towers, support buildings, utility and transmission corridors, and other ancillary facilities, could reduce, fragment, or dramatically alter existing habitat in the disturbed portions of the project area. During construction, it is expected that ecological resources would be most affected by the disturbance of habitat in areas where turbines, support facilities, access roads, utility corridors, and transmission lines were being placed. Wildlife in surrounding habitats might also be affected if the construction activity (and associated noise) disturbs normal behaviors, such as feeding and reproduction.

The types of impacts from construction are expected to be similar to those that have occurred at other construction projects. The construction impacts of most concern with regard to ecological resources are those associated with the reduction, modification, and fragmentation of habitat.

5.9.2.1 Construction Effects on Vegetation

A number of construction-associated activities may adversely impact vegetation at a wind energy development site. These activities include the clearing and grading of vegetated areas in preparation of tower and infrastructure construction; clearing and grading of utility corridors and access roads; assembly of the turbines and towers; construction of transmission line towers that would connect the wind facility to existing electricity corridors; and refueling of construction equipment. Impacts associated with these activities may be of long- or short-term duration and would largely be localized to the immediate project area. The introduction of invasive vegetation into disturbed areas of the wind energy project site, and possibly into surrounding areas, could result in long-term impacts to the native plant community at the site, access routes, and transmission corridors, and in surrounding areas.

Regardless of the location of a wind energy development project, the nature of the construction impacts to vegetation (e.g., direct destruction from grading and clearing, loss of permanent habitat at turbines and support structures) would be similar in all ecoregions, while the extent of the impacts would depend on the size of the project. During construction of a wind energy project and its ancillary facilities (utility and transmission corridors, and access roads), vegetation may be adversely affected by (1) injury or mortality of vegetation, (2) fugitive dust, (3) exposure to contaminants, and (4) the introduction of invasive vegetation (Table 5.9.2-1). Generally, the significance of vegetation loss associated with a wind energy project depends on the amount of area disturbed, the types of plant communities (and the habitats they make up) that would be affected, the nature of the effect, the capacity for the disturbed habitat to recover (some habitat types may take a much longer time to recover than others), and whether listed or sensitive plants would be affected. These factors would determine whether the construction impacts to vegetation would be short or long term.

5.9.2.1.1 Direct Injury or Loss during Clearing, Grading, and Facility Construction. The various clearing, grading, and construction activities would result in direct injury to and/or loss of vegetation, thereby altering or eliminating the plant communities in the permanently disturbed portions of the project site (i.e., turbine and support facility footprints). These areas would represent no more than 5 to 10% of the entire project area. Direct impacts from trampling, crushing, or removal of vegetation could result in permanent habitat loss at the turbines, support buildings, substation, parking area, and access road locations. Impacts to

TABLE 5.9.2-1 Potential Wind Energy Construction Effects on Vegetation

Ecological Stressor	Associated Project Activity or Feature	Potential Effect	Effect Extent and Duration
Direct injury or mortality of vegetation	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Destruction and injury of vegetation, habitat reduction or degradation.	Long-term within construction footprints for turbines, support facilities, and access roads; short-term in areas adjacent to the construction area and other project locations if mowing was employed to remove surface vegetation.
Fugitive dust generation	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Damage to plant cuticle and thereby increased water loss; decreased carbon dioxide uptake, decreased photo-synthesis.	Short-term and localized.
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or hazardous materials.	Exposure may affect plant survival, reproduction, development, or growth.	Short-term and localized to spill area.
Invasive vegetation	Site clearing and grading.	Establishment of invasive vegetation, decrease in native vegetation; decrease in wildlife habitat quality.	Long-term if established in areas where turbines, support facilities, and access roads would be situated, both on and off site.

vegetation along transmission lines and staging areas would be temporary, with vegetation expected to regenerate following completion of construction activities. Most vegetation in the direct construction footprint of the turbines, support facilities, and access roads would be permanently removed. Additional impacts on vegetation communities could occur from soil compaction, loss of topsoil, and removal of or reductions in the seed bank. Clearing of trees adjacent to a proposed wind energy project or within the transmission line ROW may also be required. The extent of clearing at the wind energy project would depend on the topography and wind characteristics at the site and on the relative height and placement of the turbines (NWCC 2002).

The temporary disturbance of vegetation in some project areas during facility construction may not be considered ecologically significant. Nevertheless, it could take several years for temporarily affected areas to recover (Erickson et al. 2003a), and some types of habitat may never fully recover from disturbance.

5.9.2.1.2 Fugitive Dust. Fugitive dust generated during clearing, grading, and construction activities may impact vegetation immediately surrounding the project area. Dust cover on leaves has been shown to increase leaf temperature, which is one of the major parameters controlling photosynthesis (Eller 1977; Hirano et al. 1995); increase water loss (Ricks and Williams 1974; Eveling and Bataille 1984); and decrease carbon dioxide (CO_2) uptake (Thompson et al. 1984; Hirano et al. 1995). Dust coating on leaves may also reduce photosynthesis through shading (Hirano et al. 1995; Thompson et al. 1984) and physically remove cuticular wax, which may lead to increased water loss and wilting (Eveling and Bataille 1984).

Fugitive dust generation may be relatively high at wind energy development sites located in the more arid ecoregions. However, the generation of fugitive dust during the construction phase of a wind energy project can be expected to be short term and localized to the immediate area of the wind project.

5.9.2.1.3 Exposure to Contaminants. During construction of a wind energy development project, construction equipment would need to be refueled and some hazardous materials or wastes (such as waste paints and degreasing agents) may be generated. Accidental fuel spills or releases of hazardous materials could result in the exposure of vegetation at the project site, and reestablishment of the vegetation may be impacted or delayed because of residual soil contamination. However, after expected hazardous materials handling and refueling requirements were met, only small spills or releases would be anticipated. (See Section 5.7 for a discussion of hazardous materials and waste management impacts and pertinent mitigation measures.)

5.9.2.1.4 Introduction of Invasive Vegetation. Plant seeds can be dispersed by a variety of mechanisms, including water or wind transportation, consumption and excretion by wildlife, and transport on the bodies of wildlife (Barbour et al. 1980). For example, Canada thistle is readily dispersed by wind or water, while seeds from the spotted knapweed (an exotic species) may be spread outward and downwind from the perimeter of existing stands by wind or over longer distances by wildlife and livestock (USDA 2003). Seeds may also become stuck in tire treads or in soil or mud on vehicles or other equipment and be transported to new, potentially suitable habitats (ISDA 2002). For example, seed transport on logging trucks, OHVs, and trail bikes has been reported to contribute greatly to the spread of spotted knapweed into new areas in British Columbia (USDA 2003).

The dispersal of invasive plant seeds by vehicles may affect native plant communities. In such cases, plant communities dominated by native vegetation may be replaced with ones dominated by invasive species. Other adverse impacts from the spread of invasive species may include:

- A decrease in biological diversity of ecosystems;
- A reduction in water quality and availability for wildlife species;

- A decrease in the quality of habitats for wildlife;
- Alterations in habitats needed by threatened and endangered species; and
- Health hazards, because some species are poisonous to humans, wildlife, and livestock.

Land that has been cleared at a wind energy project site may create an opportunity for invasive species. The magnitude and extent of invasive plant establishment at a wind energy site would be a function of the aggressiveness of the introduced plants, the number and frequency of seed introductions to a particular area, and the availability of suitable conditions (e.g., disturbed habitat) for colonization by the introduced seeds. The establishment of invasive vegetation may be limited by early detection and subsequent eradication of the plants. Seeds can be easily introduced into these areas via construction vehicles that have been in other areas where invasive species are present. Construction activities could introduce invasive species not only into the disturbed areas of the project site itself, but also into the surrounding vegetation communities. Invasive vegetation could also be introduced in the soils used to backfill and grade portions of a construction site. Depending on the source of the fill, it may contain seeds or other propagules of invasive plant species and thus provide an opportunity for introduction of invasive species.

5.9.2.2 Construction Effects on Wildlife

As with vegetation, wildlife may be affected during construction of a proposed wind energy development project and its ancillary facilities (i.e., access roads, utility corridors, and transmission corridors). The wildlife that could be affected would depend on the ecoregion in which the wind facility is planned (Figure 5.9-1) and the nature and extent of the habitats at the project area and surrounding vicinity. Construction activities may adversely affect wildlife through (1) habitat reduction, alteration, or fragmentation; (2) introduction of invasive vegetation; (3) injury or mortality of wildlife; (4) decrease in water quality from erosion and runoff; (5) fugitive dust; (6) noise; (7) exposure to contaminants; and (8) interference with behavioral activities. The location and timing of construction activities may also affect the migratory and other behavioral activities of some species. The overall impact of construction activities on wildlife populations at a wind energy site would depend on the type and amount of wildlife habitat that would be disturbed, the nature of the disturbance (e.g., complete, permanent reduction because of tower placement, or temporary disturbance in construction support areas), and the wildlife that occupy the project site and surrounding areas (Table 5.9.2-2).

5.9.2.2.1 Habitat Disturbance. The construction of a wind energy development project and its ancillary facilities may impact wildlife through the reduction, alteration, or fragmentation of habitat, which represents the greatest construction-related impact to on-site wildlife. All existing habitat within the construction footprints of turbines and support facilities, along new access road corridors, and within new utility ROWs would be disturbed. The amount of habitat that would be disturbed would be a function of the size of the proposed wind energy project

TABLE 5.9.2-2 Potential Wind Energy Construction Effects on Wildlife

Ecological Stressor	Associated Project Activity or Feature	Potential Effect	Effect Extent and Duration
Habitat disturbance	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Reduction or alteration of on-site habitat; all wildlife.	Long-term habitat reduction within tower, building, and access road footprints; long-term reduction in habitat quality in other site areas (utility and transmission corridors).
Invasive vegetation	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Reduced habitat quality; all wildlife.	Long-term if established in areas where turbines, support facilities, and access roads are situated.
Direct injury or mortality	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Destruction and injury of wildlife with limited mobility; amphibians, reptiles, birds, and mammals.	Permanent within construction footprints of turbines, support facilities, and access roads; short-term in areas adjacent to construction area.
Erosion and runoff	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Reduced reproductive success of amphibians using on-site surface waters; drinking water supplies may be affected.	Short-term; may extend beyond site boundaries.
Fugitive dust generation	Site clearing and grading; turbine and tower construction; access road and utility corridor construction.	Respiratory impairment; all wildlife.	Short-term.
Noise	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Disturbance of foraging and reproductive behaviors; habitat avoidance; birds and mammals.	Short-term.
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or hazardous materials.	Exposure may affect survival, reproduction, development, or growth; all wildlife.	Short-term and localized to spill area.
Interference with behavioral activities	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Disturbance of migratory movements; avoidance of construction areas by migrating birds and mammals.	Short-term.
	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Disturbance of foraging and reproductive behaviors; birds and mammals.	Short-term for some species, long-term for other species that may completely abandon the disturbed habitats and adjacent areas.

(i.e., number of turbines), amount of associated infrastructure (such as access roads and utility corridors), and current degree of disturbance already present in the project site area. The construction of a wind energy project would not only result in the direct reduction or alteration of wildlife habitat within the project footprint but could also affect the diversity and abundance of area wildlife through the fragmentation of existing habitats (EFSEC 2003). The amount of habitat that would be physically disturbed by construction would be limited to the footprint of the turbines, support facilities, access roads, and utility corridors. These areas typically represent a small fraction (5 to 10%) of the entire wind energy development site.

Any effects of habitat reduction, disturbance, or fragmentation on wildlife would be related to the type and abundance of the habitats affected and to the wildlife that occur in those habitats. For example, on large sites (e.g., 1,000 acres [405 ha] or more), habitat effects could represent a significant impact to local wildlife, especially to species whose affected habitats are uncommon and not well represented in the surrounding landscape. In contrast, fewer impacts would be expected, in general, for wind projects located on previously disturbed lands that have not been adequately restored or reclaimed (e.g., open pit mining sites).

5.9.2.2.2 Introduction of Invasive Vegetation. Wildlife habitat could also be impacted if invasive vegetation becomes established in the construction-disturbed areas and adjacent off-site habitats. The establishment of invasive vegetation could reduce habitat quality for wildlife and locally affect wildlife occurrence and abundance.

5.9.2.2.3 Injury or Mortality. Clearing and grading activities would result in the direct injury or death of wildlife that are not mobile enough to avoid construction operations (e.g., reptiles, small mammals, and young), that utilize burrows (e.g., ground squirrels and burrowing owls), or that are defending nest sites (such as ground-nesting birds). Although more mobile species of wildlife, such as deer and adult birds, may avoid the initial clearing activity by moving into habitats in adjacent areas, it is conservatively assumed that adjacent habitats are at carrying capacity for the species that live there and could not support additional biota from the construction areas. The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations.

The overall affect of construction-related injury or death on local wildlife populations would depend on a number of factors. The number and types of species present at the site that could be affected would be a function of the habitat that could be disturbed. The abundance of the affected species on the site and in surrounding areas would have a direct influence on population level effects. Impacts to common and abundant species may be expected to have less population-level effects than would the loss of individuals from a species that is uncommon. The greater the size of the project site, the greater the potential for more individual wildlife to be injured or killed. Finally, the timing of construction activities could directly affect the number of individual wildlife injured. For example, construction during the reproductive period of ground-nesting birds, such as sage-grouse, would have a greater potential to kill or injure birds than would construction at a different time.

5.9.2.2.4 Erosion and Runoff. Construction activities may result in increased erosion and runoff from freshly cleared and graded sites. This erosion and runoff could reduce water quality in on-site and surrounding water bodies that are used by amphibians, thereby affecting reproduction, growth, and survival. The potential for water quality impacts during construction would be short term, for the duration of construction activities and postconstruction soil stabilization (e.g., reestablishment of natural or man-made ground cover). Any impacts to amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending completion of construction activities and stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts to local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae).

5.9.2.2.5 Fugitive Dust. Little information is available regarding the effects of fugitive dust on wildlife; however, if exposure is of sufficient magnitude and duration, the effects may be similar to the respiratory effects identified for humans. Those effects may include breathing and respiratory symptoms, damage to lung tissue, carcinogenesis, and premature death. Among humans, the major subgroups of the population that appear to be most sensitive to the effects of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease or influenza, asthmatics, the elderly, and the young (EPA 2004c).

Fugitive dust generation during construction activities is expected to be short term and localized to the immediate area of the wind energy project and is not expected to result in any long-term individual or population-level effects.

5.9.2.2.6 Noise. Principal sources of noise during construction activities would include truck traffic, operation of heavy machinery, and foundation blasting (if necessary). The most adverse impacts associated with construction noise could occur if critical life-cycle activities were disrupted (e.g., mating and nesting) (NWCC 2002). If birds were disturbed sufficiently during the nesting season to cause displacement, then nest or brood abandonment might occur, and the eggs and young of displaced birds would be more susceptible to cold or predators.

On the basis of the types of construction equipment that would likely be employed (such as bulldozers and graders), the noise levels associated with the equipment would range from about 81 to 85 dB(A) within 50 ft (15 m) of the construction area and be at the mid-40-dB level approximately 5,000 ft (1,524 m) from the site (see Table 5.5.2-1). Construction noise levels associated with heavy-truck traffic (assuming that a heavy truck operates at 50 mph [80 kph]) would be in the range that the EPA recommends for residential areas: 55 dB(A) (see Table 5.5.2-2). These noise levels would be temporary.

Much of the research on wildlife-related noise effects to date has focused on birds. This research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996). Several studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electric transmission lines, and gas compressors. Several studies (Reijnen and Foppen 1994, 1995; Foppen and Reijnen 1994; Reijnen et al. 1995, 1996, 1997) have shown reduced densities of some species in forest (26 of 43 species) and grassland (7 of 12 species) habitats adjacent to roads, with effects detectable from 66 to 11,581 ft (20 to 3,530 m) from the roads. On the basis of these studies, Reijnen et al. (1996) identified a threshold effect sound level of 47 dB(A) for all species combined and 42 dB(A) for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels. This threshold sound level of 42 to 47 dB(A) (which is somewhat below the EPA-recommended limit for residential areas) is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 ft (76 m) or more from the construction area or access roads, or the levels generated by typical construction equipment at distances of 2,500 ft (762 m) or more from the construction site.

Blast noise (e.g., from military activities or construction blasting) has been found to illicit a variety of effects on wildlife (Manci et al. 1988; Larkin 1996). Brattstrom and Bondello (1983) reported that peak sound pressure levels reaching 95 dB resulted in a temporary shift in hearing sensitivity in kangaroo rats that required at least 3 weeks for the hearing thresholds to recover. The authors postulated that such hearing shifts could affect the ability of the kangaroo rat to avoid approaching predators. A variety of adverse effects of noise on raptors have been demonstrated, but in many cases, the effects were temporary, and the raptors became habituated to the noise (Andersen et al. 1989; Brown et al. 1999; Delaney et al. 1999).

5.9.2.2.7 Exposure to Contaminants. Accidental fuel spills or releases of hazardous materials could result in the exposure of wildlife at the project site. Potential impacts to wildlife would vary according to the material spilled, the volume of the spill, the location of the spill, and the species that could be exposed. Spills could contaminate soils and surface water and could affect wildlife associated with these media. A spill would be expected to have a population-level adverse impact only if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event is very unlikely. Because the amounts of fuels and hazardous materials are expected to be small, an uncontained spill would affect only a limited area (much less than 1.0 acre [0.4 ha]). In addition, wildlife use of the area during construction would be very minor or nonexistent, thus greatly reducing the potential for exposure.

5.9.2.2.8 Interference with Behavioral Activities. The construction of towers, support facilities, access roads, and transmission lines may affect local wildlife by disturbing normal behavioral activities such as foraging, mating, and nesting. Wildlife may avoid foraging, mating, or nesting or vacate active nest sites in areas where construction is occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In addition, active construction may also affect movements of some birds and mammals; for example, they may avoid a localized migratory route because of ongoing construction.

5.9.2.3 Construction Effects on Wetland and Aquatic Biota

Wind energy development typically occurs on ridges and other elevated land where wetlands and surface bodies are not likely to occur; however, access roads and transmission lines may cross lands where these features may be more common. As a result, wetland and aquatic biota could be affected during construction of the wind energy project and its associated facilities. The types of aquatic biota and wetlands that could be affected would be a function of the ecoregion in which the facility is located (Figure 5.9-1) and of site-specific environmental conditions present at the facility location. Construction activities may adversely affect wetlands and aquatic biota through (1) habitat disturbance, (2) mortality or injury of biota, (3) erosion and runoff, (4) exposure to contaminants, and (5) interference with migratory movements. Except for the construction of stream crossings for access routes or the unavoidable location of a transmission line support tower in a wetland, construction within wetlands or other aquatic habitats would be largely prohibited. Thus, most potential impacts to wetlands and aquatic biota would be indirect.

The overall impact of construction activities on wetlands and aquatic resources would depend on the type and amount of aquatic habitat that would be disturbed, the nature of the disturbance (e.g., grading and filling, or erosion in construction support areas), and the aquatic biota that occupy the project site and surrounding areas (Table 5.9.2-3). The construction of stream crossings could directly impact aquatic habitat and biota within the crossing footprint. This impact would be long term, but of relatively small extent and magnitude.

5.9.2.3.1 Habitat Disturbance. Clearing, grading, and construction activities may result in direct disturbance or reduction of aquatic habitats that may be present within construction footprints and along any new access roads, utility corridors, and transmission corridors. Site clearing and grading (which could result in filling of aquatic habitats) would result in the reduction of aquatic habitats that could be present along access roads and transmission line corridors, and these activities could lead to the establishment of invasive wetland vegetation (such as tamarisk). Wetlands and other aquatic habitats could be injured if erosion from construction areas results in runoff and siltation into the aquatic habitat, thus decreasing water quality and silting-over of biota.

Compliance with the CWA and BLM restrictions regarding activities in wetlands on BLM-administered lands would limit the likelihood of construction occurring in wetland habitats.

5.9.2.3.2 Injury or Mortality. Wetland vegetation and aquatic biota could be impacted if construction of an access road or transmission line resulted in long-term disturbance of aquatic habitat. Temporary habitat disturbance (e.g., from construction equipment crossing streams, soil runoff) could injure or kill aquatic biota in the temporarily disturbed habitats; the nature and extent of the injury would depend on the biota present in the habitats and the nature of the disturbance.

TABLE 5.9.2-3 Potential Wind Energy Construction Effects on Aquatic Biota and Habitat

Ecological Stressor	Associated Project Activity or Feature	Potential Effect	Effect Extent and Duration
Habitat disturbance	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Reduction or alteration of on-site habitat, affecting all aquatic biota; establishment of invasive vegetation.	Long-term habitat reduction within tower, building, and access road footprints, possibly in other site areas (utility and transmission corridors).
Direct injury or mortality	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Destruction and injury of aquatic biota.	Long-term within construction footprints; short-term in areas adjacent to construction area.
Erosion and runoff	Site clearing and grading; turbine and tower construction; access road and utility corridor construction.	Decreased water quality, including increased turbidity and siltation, decreased light penetration, and decreased dissolved oxygen levels; siltation of eggs, larvae, and/or adults of aquatic invertebrates and vertebrates; decreased primary productivity; decreased wetland function.	Short-term and localized.
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or hazardous materials.	Exposure may affect survival, reproduction, development, or growth of aquatic biota.	Acute effects short-term, chronic effects long-term; effects largely localized but may extend off site.
Facility construction activities	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Interference with migratory behavior, avoidance or blockage of stream migration paths.	Short-term if interference is related to erosion and runoff; short- or long-term if related to contaminant exposure; long-term if related to habitat disturbance or reduction.

5.9.2.3.3 Erosion and Runoff. Water quality and aquatic habitat can be affected if wind energy project development increases runoff or erosion. Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most aquatic organisms tolerate short-term changes in these parameters. Generally, adverse impacts only occur if sediment loads are unusually high, last for extended periods of time, or occur at unusual times of the year. Increased sediment can decrease the feeding efficiency of aquatic biota; reduce plant, invertebrate, and fish abundance; and decrease fish spawning success by adversely affecting the survival of eggs and fry. Erosion and runoff could also affect wetland hydrology, function, and water quality (FPL Energy North Dakota Wind, LLC 2003). While any impacts to aquatic biota would be localized to the surface waters receiving site runoff, significant impacts to local populations could result if the magnitude and duration of the runoff were sufficiently high.

However, the amount of erosion and runoff into aquatic habitats at, and in the vicinity of, the site is expected to be very small; and impacts from erosion and runoff are expected to be localized and temporary. The potential for water quality impacts during construction would be short term (the duration of construction activities), and postconstruction soil stabilization activities (e.g., reestablishment of natural or man-made ground cover) would greatly reduce or eliminate further erosion and runoff from the site. As previously discussed, wind energy projects would be subject to the CWA, and if a project was expected to disturb 5 or more acres (20 or more ha) of wetland, a Storm Water Pollution Prevention Plan and NPDES compliance permit would be needed.

5.9.2.3.4 Exposure to Contaminants. Accidental fuel spills or releases of hazardous materials could result in the exposure of aquatic biota at or near the project site. By following hazardous material handling and refueling procedure requirements, accidental spills or releases would be small. However, any contaminant that did enter a stream could be transported off site. For a comparable spill volume, a water-based spill would be expected to have a more extensive potential impact than a land-based spill, because of the spatial extent of contamination within and the higher degree of difficulty to clean up a water spill. The effects of a spill on aquatic biota would primarily depend on the location of the spill relative to the aquatic habitat, the type of material spilled, the concentration of the contaminant, the life stage of the exposed biota (e.g., eggs, larvae, and juveniles are most sensitive), and duration of exposure.

Depending on the quantity of material spilled, a contaminant such as diesel fuel can affect aquatic organisms in several ways. Physically coating an aquatic organism and especially its respiratory surfaces (i.e., gills) can cause immobilization or suffocation. Acute exposure to high concentrations could result in the direct mortality of the exposed biota. Chronic exposures to lower concentrations may have sublethal effects, such as reduced growth, reduced reproduction, or altered behavior. The presence of a contaminant may also cause some fish to avoid areas traditionally used for reproduction, feeding, or migration.

5.9.2.4 Construction Effects on Threatened and Endangered Species

Construction activities could affect threatened, endangered, and sensitive species in the same manner that vegetation, wildlife, and aquatic resources could be affected (see previous sections). Threatened and endangered species (including federal and state listed species and BLM-designated sensitive species) could be affected as a result of (1) habitat disturbance, (2) the introduction of invasive vegetation, (3) injury or mortality, (4) erosion and runoff, (5) fugitive dust, (6) noise, (7) exposure to contaminants, and (8) interference with behavioral activities. Which species may be at risk to construction-related effects would depend on the ecoregion in which the wind energy project is located (Figure 5.9-1), and the specific habitat present at, and in the vicinity of, the project site.

Direct impacts on threatened, endangered, and sensitive wildlife species could include injury or mortality, while indirect effects could involve reduction or fragmentation of habitat, reduction or displacement of habitat features such as cover and forage, exposure to contaminants (e.g., diesel fuel) from a spill, and destruction of individual biota (e.g., from clearing and grubbing activities or from vehicle collisions).

Because of the regulatory requirements of the ESA and various state regulations, and the requirements specified in BLM Manual 6840 — Special Status Species Management (BLM 2001) and other resource-specific regulations and guidelines, appropriate survey, avoidance, and mitigation measures would be identified and implemented prior to any construction activities to avoid impacting any sensitive species or the habitats on which they rely.

5.9.3 Site Operation

During operation, adverse ecological effects could occur from (1) disturbance of wildlife by turbine noise and human activity; (2) site maintenance (e.g., mowing); (3) exposure of biota to contaminants; (4) mortality of biota from colliding with the turbines and meteorological towers, and (5) mortality of biota from electrocution or collision with transmission lines.

During operation of the wind facility, ecological resources may still be affected by the reduction in habitat quality associated with habitat fragmentation due to the presence of turbines, support facilities, access roads, and utility and transmission corridors. In addition, the presence of a wind energy development project and its associated access roads and transmission line ROWs may increase human use of surrounding areas, which in turn could impact ecological resources in the surrounding areas through the (1) introduction and spread of invasive vegetation, (2) disturbance of biota, and (3) increased potential for fire. The presence of a wind energy project (and its associated infrastructure) could also interfere with migratory and other behaviors of some wildlife.

Impacts of normal operations are expected to be similar in nature to those that have been observed at existing wind energy projects. The operational impacts of most concern to ecological resources are those associated with bird and bat strikes with turbines and associated infrastructure (e.g., transmission lines and meteorological towers) and, to a lesser extent, electrocution of birds. Potential impacts to gallinaceous birds from the operation of wind energy projects have also been identified as an issue of concern, with potential impacts related to habitat fragmentation, noise, presence of tall structures, and disturbance from human and vehicle activity. These same factors may affect other wildlife as well.

5.9.3.1 Operational Effects on Vegetation

A variety of operational activities could impact vegetation at, and in the vicinity of, a wind energy project. These activities include (1) site maintenance activities involving mowing and herbicide use and (2) the accidental releases of pesticides, fuels, or hazardous materials (Table 5.9.3-1). Increased use of surrounding BLM-administered lands, resulting from additional access corridors (via new access roads and utility and transmission corridors) could also affect vegetation through (1) direct injury to vegetation, (2) the legal and illegal take of plants, (3) the introduction of invasive vegetation, and (4) an increased potential for fire (Table 5.9.3-1).

5.9.3.1.1 Site Maintenance. During facility operation, routine site maintenance activities could include mowing around site buildings and turbine structures, along utility and transmission corridors, and possibly along access roads. Mowing in these areas would maintain plant communities in early successional stages of community development and may prevent reestablishment of desirable shrub species. Plant community succession would remain restricted over the lifetime of the facility. While mowing would not be expected to directly result in the establishment and spread of invasive vegetation, continued mowing could encourage the establishment of some invasive species.

Site maintenance activities may also include the licensed application of herbicides (i.e., pesticides) to control vegetation along access roads, utility and transmission corridors, and around support buildings and turbine towers. Herbicide use may be in addition to, or in lieu of, mowing. The accidental spill of herbicides may result in environmental concentrations exceeding licensed levels, and these herbicides could migrate off site and affect native vegetation in surrounding areas. Potential effects of such exposure are discussed in the following section.

5.9.3.1.2 Exposure to Contaminants. Operation of the wind energy project may require limited on-site storage and use of fuel (e.g., gasoline, diesel), pesticides, and hazardous materials. Very small quantities of hazardous wastes also may be generated (see Section 5.7 on hazardous materials and waste management). On-site storage of these materials is likely to be minimal (Table 3.4.1-1). The amount stored would depend on the size of the wind energy project and the nature of the vegetation maintenance program developed for the site (e.g., mowing only, mowing and herbicide use, herbicide use only).

TABLE 5.9.3-1 Potential Wind Energy Operation and Non-Facility-Related Human Activity Effects on Vegetation

Ecological Stressor	Activity	Potential Effect	Effect Extent and Duration
Wind Energy Operations			
Mowing	Mowing at support buildings and turbine locations, utility corridors, and transmission corridors.	Maintenance of plant communities in early successional stages; invasive plant invasion.	Short-term (duration of facility operation) for vegetation injury; long-term for invasive vegetation establishment.
Exposure to contaminants	Accidental spill or release of pesticides, fuel, or hazardous materials.	Exposure may affect plant survival, reproduction, development, or growth.	Short- or long-term, localized to spill locations.
Non-Facility-Related Human Activities			
Increased foot and vehicle traffic	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Trampling of vegetation by foot and vehicle traffic.	Short- or long-term, in areas adjacent to the wind energy project, access roads, utility corridors, and transmission corridors.
Legal and illegal take of vegetation	Access to surrounding areas.	Reduced abundance and/or distribution of some species.	Short- and long-term, depending on species affected and magnitude of take.
Invasive vegetation	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Establishment of invasive vegetation; exclusion of native vegetation; decrease in wildlife habitat quality.	Long-term, both on and off site.
Fire	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Loss of native vegetation; introduction and establishment of invasive vegetation; decrease in wildlife habitat quality.	Long-term.

Because of the relatively small amount of fuel and pesticides expected to be stored and used at a wind energy development project, an accidental release of these materials would be expected to impact only a small area of the site, and the vegetation at the spill locations would likely be vegetation regularly affected by mowing. Thus, impacts to vegetation from exposure to accidental fuel or pesticide releases are expected to be very localized and minor. Similarly, only relatively small amounts of hazardous wastes could be expected to be generated at a wind energy project, and any accidental releases would be small and affect vegetation primarily at the release location.

Exposure of vegetation in areas adjacent to the wind energy project would be minimal because of the limited amounts of fuels and hazardous materials that could be expected at the site, the relatively small amounts that might be accidentally released, and the implementation of spill response procedures designed to contain and clean up any such releases.

5.9.3.1.3 Direct Injury to Vegetation. The presence of a wind energy project on BLM-administered land may increase access to adjacent lands that previously had limited access, with a subsequent increase in the use of areas adjacent to the wind energy site. Impacts on vegetation at and adjacent to a wind energy project and its ancillary facilities could occur from increased use, unauthorized OHV use, illegal dumping, and illegal collection of plants from these areas (PBS&J 2002). Human activities, especially OHV use, could mechanically disturb cryptobiotic organisms (soil-dwelling microorganisms found in surface soils of the arid and semiarid west and critical to soil stability, nutrient cycling, nitrogen fixation, and plant growth) and decrease cryptobiotic cover, change species diversity and community composition, and alter soil nutrient dynamics (Belnap et al. 2001), which in turn could adversely affect plant productivity. Visitors and OHVs may crush or trample vegetation or destroy roots and other belowground plant structures (Payne et al. 1983; Cole 1995; Douglass et al. 1999).

5.9.3.1.4 Legal and Illegal Take of Plants. Increased access to adjacent BLM-administered lands could lead to an increase in the illegal take of some plant species, especially cacti. Depending on the species involved and the extent and magnitude of the illegal take, local populations of some species may be impacted. Most plant collecting has minimal impacts (e.g., seed collection for viability studies), but sometimes significant damage can occur, especially to species that are very sensitive to physical disturbance and population changes. Commercial collectors can impact plant populations through both the legal and illegal gathering of plants and plant products, such as endangered cacti or wild *Echinacea* species and other medicinal herbs. Collecting plants for herbarium specimens and collecting wildflower seeds for personal gardens generally have little impact on populations if conducted responsibly and in accordance with the terms of the collecting permit, if required.

5.9.3.1.5 Introduction of Invasive Vegetation. The increased access of OHVs and hiking onto previously less accessible areas may act to disperse seeds of invasive vegetation. Uncontrolled and largely unmanaged trail systems have been identified as ready corridors for weed dispersal (Douglass et al. 1999). Visitors may carry seeds on their clothing and equipment, and motorized vehicles can carry seeds on tires and in vehicle mud (Douglass et al. 1999; ISDA 2002; USDA 2003).

5.9.3.1.6 Fire. Increased human activity also increases the potential for fires. Wildland fires could be initiated by (1) poorly maintained and extinguished campfires associated with recreational activities, (2) contact with hot engine parts during OHV use, and (3) careless cigarette use. The potential for wildland fires would be greatest in the arid and semiarid ecoregions and would be expected to occur most often in summer and autumn, when native and invasive grasses have died back and fuel loads are at their greatest.

While fires have historically been a part of the Western landscape, and especially in shrub-steppe habitats (Knick 1999), an increase in fire frequency since the turn of the century throughout the arid West has enhanced the establishment of invasive vegetation such as cheatgrass (Young and Allen 1997; DOI 1996; USDA 2002a). Invasive grasses may especially benefit from fire, and once established, may promote recurrent fire to such an extent that native species decline and native plant communities are converted to invasive annual grasslands (Brooks and Pyke 2001).

Sagebrush is especially vulnerable to fires and may incur both short- and long-term effects (Quinney 2000). Big sagebrush plants are readily killed by fire, while native grasses and forbs are generally unharmed by fires (USDA 2002a). Frequently repeated fires reduce or prevent reestablishment of sagebrush seedlings from nearby unburned plants. Fires may kill some seeds of native grasses in upper soil layers, significantly reducing seedling emergence in burned areas (USDA 2002a). In contrast, fire may enhance the productivity of some native grasses (USDA 2002a).

5.9.3.2 Operational Effects on Wildlife

Wildlife may be affected by wind energy project operations through (1) electrocution from transmission lines; (2) noise; (3) the presence of, or collision with, turbines, meteorological towers, and transmission lines; (4) site maintenance activities; (5) exposure to contaminants; (6) disturbance associated with activities of the wind energy project workforce; (7) interference with migratory behavior; and (8) increased potential for fire (Table 5.9.3-2). Among these, the presence of, or collisions with, facility structures probably represent the greatest potential hazard to wildlife. In some instances, turbines, transmission lines, and other facility structures may interfere with behavioral activities, including migratory movements, and may provide additional perch sites for raptors, thereby increasing predatory levels on other wildlife (such as small mammals and birds).

Wildlife may be affected by human activities that are not directly associated with the wind energy project or its workforce but that are instead associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, and (2) an increase in the incidence of fires (Table 5.9.3-2).

5.9.3.2.1 Electrocution. The electrocution of birds along electric transmission and distribution lines has been well documented (e.g., see Bevanger 1994). Thus, lines associated with the wind energy project may pose a risk to some birds. Birds reported to incur electrocution (and collisions with transmission lines) belong to 15 orders, 41 families, 129 genera, and 245 species; species belonging to the Ciconiformes (vultures), Falconiformes (falcons), Strigiformes (owls), Gruiformes (quail and grouse) and Passeriformes (passerines) are among the

TABLE 5.9.3-2 Potential Wind Energy Operation and Non-Facility-Related Human Activity Effects on Wildlife

Ecological Stressor	Activity	Potential Effect and Likely Wildlife Affected	Effect Extent and Duration
Wind Energy Operations			
Electrocutions	Electric transmission lines and electrical utility lines.	Mortality of birds.	On-site, low magnitude, but long-term.
Noise	Turbine operation, support machinery, motorized vehicles, and mowing equipment.	Disturbance of foraging and reproductive behaviors of birds and mammals; habitat avoidance.	Short- and long-term; greatest effect in highest noise areas.
Collision with turbines, towers, and transmission lines	Presence and operation of turbines; presence of transmission and meteorological towers and transmission lines.	Injury or mortality of birds and bats.	On-site, low magnitude but long-term for many species; population effects possible for other species.
Predation	Transmission and meteorological towers.	Increase in avian predators due to more perch sites for foraging; may decrease local prey populations.	Long-term; may be of high magnitude for some prey species.
Mowing	Mowing at support building and turbine locations.	Injury and/or mortality of less mobile wildlife; reptiles, small mammals, ground-nesting birds.	Short-term.
Exposure to contaminants	Accidental spill or release of pesticides, fuel, or hazardous materials.	Exposure may affect survival, reproduction, development, or growth; all wildlife.	Short- or long-term, localized to spill locations.
Workforce presence	Daily human and vehicle activities.	Disturbance of nearby wildlife and bird and mammal behavior; habitat avoidance.	Short- or long-term, localized and of low magnitude.
Decreased aquatic habitat quality	Erosion and runoff from poorly stabilized surface soils.	Reduced reproductive success of amphibians; wildlife drinking water supplies may be affected.	Short-or long-term, localized.
Interference with behavioral activities	Presence of wind facility and support structures.	Migratory mammals may avoid previously used migration routes, potentially affecting condition and survival.	Long-term, localized to populations directly affected by the presence of the facility.

TABLE 5.9.3-2 (Cont.)

Ecological Stressor	Activity	Potential Effect and Likely Wildlife Affected	Effect Extent and Duration
		Species may avoid areas surrounding the wind energy facility, including foraging and nesting habitats	Long-term for species that completely abandon adjacent areas; population-level effects possible for some species.
Non-Facility-Related Human Activity			
Disturbance of nearby biota	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Impacts to wildlife habitats by foot and vehicle traffic; disturbance of foraging and reproductive behaviors; all wildlife.	Short- or long-term, in areas adjacent to the wind facility, access roads, utility corridors, and transmission corridors.
Legal and illegal take of wildlife	Access to surrounding areas.	Reduced abundance and/or distribution of some wildlife.	Short- or long-term, depending on species affected and magnitude of take.
Invasive vegetation	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Establishment of invasive vegetation resulting in reduced wildlife habitat quality; all wildlife.	Long-term, off site.
Fire	Access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Some mortality of wildlife; reduction in habitat quality due to loss of native vegetation and introduction and establishment of invasive vegetation.	Long-term.

most frequently reported (Bevanger 1994). Large birds are occasionally electrocuted on distribution or transmission lines when they touch two electrical conductors or touch one conductor and a grounded wire (NWCC 2002).

The number of electrocutions that could occur depends on the types of birds present at the site, the location of the site with regard to migratory routes, and local weather conditions. For example, electrocutions have been a source of avian mortality at the Altamont Pass wind energy project; seasonal fog and rain coupled with wind have been suggested as contributing to higher electrocution risks (Stemer 2002).

Although electrocutions of birds from electric transmission lines have been widely reported, some species of birds regularly nest on electrical transmission line towers. Nesting success of raptors and common ravens using transmission towers has been reported to be similar to or higher than that of pairs nesting elsewhere, and modifications of tower design have been suggested to further attract birds and improve nesting success (Steenhof et al. 1993). The accidental electrocution of birds from contact with distribution or transmission lines is not expected to adversely affect bird populations in the vicinity of a wind energy development project.

While bird electrocutions have been widely reported, the electrocution of other wildlife from contact with electrical transmission lines is much less common. Reported nonavian wildlife include snakes, mice, squirrels, raccoons, bobcat, and black bear (Edison Electric Institute 1980; Williams 1990). Among the mammals, squirrels are among the most commonly reported species to be electrocuted because of their penchant for chewing on electrical wires. Because of the relatively rare nature of their electrocution, impacts on nonavian wildlife from electrocution is not expected to adversely impact populations of these wildlife in the vicinity of a wind energy development project.

5.9.3.2.2 Noise. The principal noise-generating activities associated with normal wind energy project operations include turbine noise, transmission line noise (corona), and truck and maintenance equipment noise. The magnitude and duration of noise associated with trucks and maintenance equipment (such as lawn-mowing equipment) is expected to result in only minor annoyance of wildlife at the site and not result in any long-term adverse effects. The primary noise concern for wildlife is the noise generated by operating turbines and the noise generated by wind passing over the turbine blades.

A study of the effect of wind turbines on grassland birds was conducted in southwestern Minnesota (Leddy et al. 1999). In that study, higher bird population densities were reported from control areas and areas that were 591 ft (180 m) away from turbines than in areas that were within 262 ft (80 m) of the turbines. While the authors could not determine the cause of the observed effect, they suggested that noise, the presence of an access road, and the physical movement of the turbines could have produced the effect. Bird population densities along transmission line ROWs in Oregon that exhibited noise levels of approximately 50 dB(A) were reported to be reduced up to 25% (Lee and Griffith 1978).

A study of the effects of gas well compressor noise on breeding bird populations in New Mexico found their response to noise to vary among species (LaGory et al. 2001). Lower numbers of some species were associated with noise levels greater than 40 dB(A). The greatest reductions were found in areas where the species were exposed to sound pressure levels of 50 dB(A) or greater (areas within 150 ft [46 m] of a compressor).

The results of these various studies suggest that the densities of bird populations in the vicinity of wind energy projects may be reduced near turbines, transmission lines, and other facility equipment if continuous noise levels are in the range of 40 dB(A) or higher.

However, birds may not be able to distinguish blade noise from ambient wind noise when the blade and wind noise levels are within 1.5 dB of each other. Overall noise levels measured during a moderate wind day at the Altamont Pass wind energy project were about 70 dB(A) (Dooling 2002), which is above the noise threshold reported by many researchers for disturbance effects on birds. The blade noise measured at the Altamont Pass wind energy project on a moderate wind day was spread relatively evenly across the spectrum of bird hearing (typically 1 to 5 kHz). Under reported wind conditions, blade noise from a normally operating turbine would simply add to the background noise fairly evenly across the sound spectrum and be inaudible to the bird at a distance of 82 ft (25 m) from the base of the turbine (Dooling 2002).

Wildlife in areas adjacent to a wind energy project may also be disturbed by increased noise levels associated with human activities. The greatest noise levels would be associated with vehicle use, while noise during activities such as hiking would be primarily associated with speech. In all cases, the noise levels would be temporary and would be present only during the time visitors were present.

5.9.3.2.3 Collisions with Turbines, Meteorological Towers, and Transmission Lines. Collisions with turbines, meteorological towers (and associated guy wires), and overhead distribution lines represent a potential collision hazard to birds and bats. Bird and bat deaths from collisions with wind energy project structures have received the major emphasis regarding adverse impacts to ecological resources associated with wind energy developments.

Avian Collisions. The number of turbines associated with a wind energy project has been identified as the major variable associated with potential avian mortality (EFSEC 2003). Erickson et al. (2001) provided a projected estimate of 33,000 bird fatalities per year from the estimated 15,000 operating wind turbines (by the end of 2001) in the United States.

Bird fatalities associated with wind turbines are composed of a variety of different groups, including raptors, passerines, waterfowl, and shorebirds (Erickson et al. 2001). The relative abundance of a bird species does not predict the relative frequency of fatalities per species (Thelander and Rugge 2000). Some species may become more susceptible to turbine collisions because postconstruction conditions at the wind energy project have increased prey abundance within the vicinity of turbines or ancillary facilities. Disturbed ground surface can be more suitable for burrowing animals, many of which are attractive prey for raptors (NWCC 2002). Where wind energy projects are located in grazing allotments, cattle often cluster around wind turbines (e.g., for shade). Cattle waste can attract insects that are prey items for some raptors (NWCC Wildlife Workgroup 2003).

Avian mortality estimates based on data collected from the various wind energy projects in the United States indicate an average of 2.19 avian fatalities per turbine per year for all species combined, and an average of 0.033 fatalities for raptors per turbine per year (Erickson et al. 2001). These estimates are based on survey methods that may or may not be equivalent between wind energy facilities, and may not accurately estimate actual mortality estimates. Excluding California, these averages are 1.83 total avian fatalities per turbine per year, and only 0.006 raptor fatalities per turbine per year. The number of bird fatalities per turbine per year from individual studies has ranged from 0 birds per turbine per year (at Searsburg, Vermont, and Algona, Iowa) to 4.45 birds per turbine per year (at Buffalo Ridge Phase III, Minnesota). Recent estimates of raptor mortality for the Altamont Pass Wind Resource Area (WRA) (Smallwood and Thelander 2004) ranged from 0.16 fatalities per turbine per year to 0.24 fatalities per turbine per year. The range of fatality rates reported for these facilities probably reflects differences in the habitats and bird communities among the sites, as well as differences in the designs of the mortality monitoring studies that generated the reported data. The monitoring study survey methods are not equivalent between facilities, and because of differences in searcher efficiency and study survey design may not accurately estimate mortality rates.

Table 5.9.3-3 summarizes avian fatality rates that have been reported at a number of wind energy projects. At the Foote Creek Rim wind energy project, each meteorological tower killed an estimated 8.1 birds per year compared with turbine estimates of 1.5 bird fatalities per year (Young et al. 2003a). Table 5.9.3-4 lists the number of bird species that have been observed as fatalities at wind energy projects; these data indicate that vulnerability to collisions with turbines is species- and habitat-specific (Erickson et al. 2001).

A comparison of the numbers of species, by order, observed as fatalities in six western states (Tables 5.9.3-4) with the number of species, by order, reported to occur in those same states (Table 4.6.2-2) further indicates that relatively few species actually die as a result of collisions with wind energy facilities. For example, only one species of waterfowl (the Anseriformes: duck, swans, and geese) has been observed as incurring fatalities at wind energy developments in Oregon, Washington, and Wyoming. In comparison, between 37 and 44 waterfowl species have been reported to occur in these states. This difference in numbers probably reflects site-specific differences in the distribution of waterfowl at wind facility locations and their distribution in their habitats in those states. In contrast, seven or more species of raptors (the Falconinformes: kites, eagles, hawks, and osprey) have been observed as fatalities at wind energy developments in California. This number of species represents almost one-third of the raptor species reported to occur in California, with the majority of the fatalities occurring at the Altamont facility. These results further emphasize the importance of species-specific, habitat-specific, and facility-location-specific considerations of bird vulnerability to collisions with turbines. Because they tend to fly at relatively high altitudes, birds conducting long-range migrations may not be likely to be impacted by turbines except during weather conditions that induce them to fly low (Hanowski and Hawrot 2000). Resident birds may have a higher probability of colliding with turbines than migrants, given that residents tend to fly lower and spend more time in the area (Janss 2000).

Some additional information is available for bird casualties at a few other wind energy projects in the United States. The following information is a general summary of bird fatalities recorded for each site:

- Madison, New York — seven turbines located on farmland, four bird fatalities recorded over a period of 1 year;

- St. Mary’s, Kansas — two turbines located in grassland prairie, no bird fatalities recorded in three migration seasons; and

TABLE 5.9.3-3 Avian Fatality Rates Observed at Some Wind Energy Projects[a]

Wind Resource Area	State	No. of Turbines	No. of Bird Fatalities per Turbine per Year[b]	No of Bird Fatalities per 100,000 m^2 of RSA per year[b]	No. of Raptor Fatalities per Turbine per Year[b]	No. of Raptor Fatalities per 100,000 m^2 of RSA per year[b]
Altamont Pass	California	5,400 (in 2001), 7,340 (in early 1990s)	0.33 to 0.87, 0.05 to 0.1, 0.19	NA	0.16 to 0.24, 0.007 to 0.1, 0.048, 0.1	9.0 to 22.0, 1.0 to 2.0[c]
Buffalo Ridge (all phases)	Minnesota	354	2.8	161.0	NA	NA
Buffalo Ridge Phase 1	Minnesota	73	0.33 to 0.66, 0.98	NA	0.01	NA
Buffalo Ridge Phase 2	Minnesota	143	2.27	NA	0.0	NA
Buffalo Ridge Phase 3	Minnesota	138	4.45	NA	0.0	NA
Foote Creek Rim	Wyoming	69	1.5, 1.75	108.0	0.03, 0.036	3.0, 0.3[c]
Green Mountain (Searsburg)	Vermont	11	0.0	0.0	0.0	0.0
IDWGP (Algona)	Iowa	3	0.0	0.0	0.0	0.0
Klondike	Oregon	16	1.42	NA	0.0	NA
Montezuma Hills	California	600	NA	NA	0.48	NA
Mountaineer Wind Energy Center	West Virginia	44	4.04	NA	0.33	NA
Nine Canyon Wind Energy Project	Washington	37	3.59	119.8	0.08	2.6
Princeton	Massachusetts	8	0.0	0.0	0.0	0.0
San Gorgonio	California	2,900	2.31	NA	0.01	NA
Somerset County	Pennsylvania	8	0.0	0.0	0.0	0.0
Stateline	Oregon/ Washington	454	1.7	96.6	0.05	NA
Vansycle	Oregon	38	0.63	38.0	0.0	0.0
Wisconsin	Wisconsin	31	2.83	73.3	0.02	NA

[a] Abbreviations: IDWGP = Iowa Distributed Wind Generation Project; NA = not applicable (not calculated or appropriate); RSA = rotor-swept area.

[b] Multiple values are included if there were results from more than one study.

[c] Golden eagles only.

Sources: Curry and Kerlinger (2004a,b); Erickson et al. (2001, 2002, 2003a,b); Johnson et al. (2002, 2003a); Kerns and Kerlinger (2004); Osborn et al. (2000); Smallwood and Thelander 2004; Strickland et al. (2001a,b); Thelander and Rugge (2001); Young et al. 2003a.

TABLE 5.9.3-4 Number of Bird Species, by Order, Observed as Fatalities at Wind Energy Developments in Various Western States

	State				
Order	CA	CO	OR	WA[a]	WY
Gaviformes – Loons	–[b]	–	–	–	–
Podicipediformes – Grebes	1	–	–	–	1
Procellariiformes – Albatrosses, Fulmars, Shearwaters, Petrels, and Storm-Pertrels	–	–	–	–	–
Pelicaniformes – Tropic Birds, Boobies, Gannets, Pelicans, Cormorants, Anhingas, and Frigate Birds	1	–	–	–	–
Ciconiiformes – Bitterns, Herons, Egrets, Ibises, Spoonbills, and Storks	1+[c]	–	1	1	–
Ciconiiformes – Vultures	–	–	1	–	–
Anseriformes – Swans, Geese, and Ducks	1+	1+	1	1	1
Falconiformes – Kites, Eagles, Hawks, and Osprey	7+	–	2	2	1
Falconiformes – Caracaras and Falcons	2	–	1	1	1
Galliformes – Chachalacas, Pheasants, Grouse, Ptarmigan, Turkeys, and Quail	3	–	3+	3	–
Gruiformes – Rails, Gallinules, Coots, Limpkins, and Cranes	2	–	–	1	–
Charadriiformes – Plovers, Oystercatchers, Stilts, Avocets, Jacanas, Sandpipers, and Phalaropes	–	–	–	–	–
Charadriiformes – Jaegers, Gulls, Skuas, Terns, and Skimmers	1+	1	–	–	–
Charadriiformes – Auks and Murres	–	–	–	–	–
Columbiformes – Pigeons and Doves	2	–	–	–	1
Psittaciformes – Parrots	–	–	–	–	–
Cuculiformes – Cuckoos, Roadrunners, and Anis	1	–	–	–	–
Strigiformes – Owls	5+	–	–	–	1
Caprimulgiformes – Nighthawks and Nightjars	–	–	–	–	2
Apodiformes – Swifts	1	2	1	–	–
Apodiformes – Hummingbirds	–	–	–	–	–
Trogoniformes – Trogans	–	–	–	–	–
Coraciiformes – Kingfishers	–	–	–	–	–
Piciformes – Woodpeckers	1	1	2	–	–
Passeriformes – Flycatchers, Kingbirds, and Phoebes	–	1	–	–	–
Passeriformes – Shrikes	1	–	–	–	–
Passeriformes – Vireos	–	–	–	–	1
Passeriformes – Jays and Crows	2	–	1	1	–
Passeriformes – Larks	1	1	1	1	1
Passeriformes – Swallows	2	2	–	–	2+
Passeriformes – Chickadees and Titmice	–	–	–	–	–
Passeriformes – Verdin, Bushtits, and Wrentits	–	–	–	–	–
Passeriformes – Nuthatches and Creepers	–	–	–	1	1
Passeriformes – Wrens	1	–	2	2	2
Passeriformes – Dippers	–	–	–	–	–
Passeriformes – Kinglets, Old World Warblers, and Gnatcatchers	–	1	2	3	1

TABLE 5.9.3-4 (Cont.)

Order	CA	CO	OR	WA[a]	WY
	State				
Passeriformes – Thrushes and Bluebirds	4	–	1	1	3+
Passeriformes – Mockingbirds and Thrashers	–	–	–	4	1
Passeriformes – Starlings and Accentors	1	1	1	1	–
Passeriformes – Wagtails and Pipits	1	–	–	–	1
Passeriformes – Waxwings	–	–	–	–	–
Passeriformes – Silky Flycatchers	–	–	–	–	–
Passeriformes – Wood Warblers	1	–	2	2	5+
Passeriformes – Tanagers	1	–	–	–	1
Passeriformes – Towhees, Sparrows, and Longspurs	3+	4	6+	7	9
Passeriformes – Cardinals, Grosbeaks, Bunting, and Dickcissel	–	–	–	–	–
Passeriformes – Blackbirds and Orioles	4+	1	2	3	1+
Passeriformes – Finches	1	1	1	1	–
Passeriformes – House Sparrow	–	–	–	–	–

[a] Partially duplicative of Oregon, as data include the Stateline Wind Project that is located at the Oregon/Washington border.

[b] A dash indicates not observed.

[c] + = includes unidentified specimens that may or may not be additional species.

Sources: Erickson et al. (2001, 2003a,b); Strickland et al. (2001a,b); Thelander and Rugge (2001); Thelander et al. (2003); Young et al. (2003a).

- Door County, Wisconsin — 31 turbines located on farmland, 21 bird fatalities (mostly passerines) recorded from 1999 to 2000 (Curry and Kerlinger 2004a,b).

Many of the reported bird fatalities involved common, yearlong resident species such as horned lark, house sparrows, starlings, gulls, and rock doves (Erickson et al. 2001, 2003a). The composition of species that could collide with wind energy facility structures will be a function of the habitat type and quality that is present at and in the vicinity of the facility.

Factors Potentially Contributing to Avian Collisions. As is the case with other tall structures, reduced visibility because of fog, clouds, rain, and darkness may be a contributing factor in collisions of birds with wind turbines. As many as 51 of the 55 collision fatalities (93%) at the Buffalo Ridge Wind Resource Area (WRA) may have occurred in association with inclement weather such as thunderstorms, fog, and gusty winds (Johnson et al. 2002). Aviation marker lights installed on turbines (and meteorological towers) more than 200 ft (60 m) tall may also be a factor in bird fatalities (NWCC 2002). Observed fatality rates of passerines for lit turbines at the Nine Canyon Wind Power Project were higher than for unlit turbines, although differences were not statistically significant (Erickson et al. 2003b). Birds seem most sensitive to red light and appear to be attracted to that color. Blinking red marker lights in poor visibility conditions appear to disorient birds and simulate stars as navigation cues. Quickly flashing white strobes appear to be less attractive to birds (Ugoretz 2001). The presence of lighting on some turbines might attract birds to the area and increase the potential for collision mortality at both the lit and unlit turbines (Johnson et al. 2002). Substations and ancillary facilities that are lit for security purposes may also contribute to this problem, particularly if they are located in close proximity to turbines (Kerlinger and Kerns 2003; NWCC Wildlife Workgroup 2003). The FAA would evaluate proposed wind energy development projects and make recommendations regarding possible airway marking, lighting, and other safety requirements that would become part of the project. Under current (June 2003) FAA regulations, navigation lights would need to be mounted on the first and last turbine of each string and every 1,000 to 1,400 ft (30 to 427 m) in between (EFSEC 2003).

In comparison with early-generation turbines, the new-generation turbines have a larger rotor diameter and, therefore, a larger rotor-swept area (RSA). For example, it would take three to eight average Altamont Pass turbines (150 kW) to make up the same RSA of a single new-generation wind turbine (600 kW to 1.5 MW; Erickson et al. 2002). Bird collision metrics are often provided as fatalities per 100,000 m^2 (1,076,391 ft^2) of RSA in addition to fatalities per turbine. Yearly raptor fatalities at Foote Creek Rim are 0.04 per turbine, which is at the upper range of raptor fatality rates for new-generation wind energy projects. This fatality rate equates to three raptor fatalities per 100,000 m^2 (1,076,391 ft^2) RSA, which is about three to seven times lower than at the Altamont Pass WRA (9 to 22 raptor fatalities per 100,000 m^2 [1,076,391 ft^2] of RSA) (Erickson et al. 2002).

Other factors that may contribute to the variation in bird strikes at different wind energy projects include the spatial arrangement of turbines (including turbine spacing), tower types (e.g., lattice versus tubular), and tower height (e.g., blades rotate closer to the ground on shorter turbines). Also, birds may not be able to see the blade tips of rapidly rotating wind turbine rotors because motion smear makes them seem transparent (Stemer 2002; Hodos 2003). Birds may also not hear the turbine well, especially in noisy (windy) conditions. A human with normal hearing can probably hear a turbine blade twice as far away as the average bird (Dooling 2002).

Raptors. Fatalities of raptors are of special concern because of their generally low numbers and protected status. Except at the Altamont Pass WRA, the number of raptors killed at any facility is small (see Table 5.9.3-3; NWCC 2002). At Foote Creek Rim Construction Unit I, 92% of avian fatalities were passerines, with a little over half of these being nocturnal migrants. Raptor casualties (0.03 bird per turbine per year) were considered low on the basis of high raptor use for the site. The yearly casualty rate for all birds was estimated at 1.5 birds per turbine per year (Young et al. 2003a). Depending on the species involved and its population size, the number of fatalities may or may not result in population-level effects to the affected raptors. To date, no studies have shown population-level effects in raptor populations associated with wind energy projects. The text box beginning on the next page provides additional information about the compatibility of wind energy development and raptors, including information about possible measures to mitigate raptor fatalities.

Passerines. Passerines (both resident and migratory species) are the most common group of birds killed at new wind energy projects, making up more than 80% of reported fatalities (Erickson et al. 2001). About half of the passerine mortalities involve nocturnal migrants, although no large episodic mortality (as has been documented for bird strikes with communication towers) has been known to occur. The largest single incident reported was 14 migrants found at two turbines (Erickson et al. 2002). At Foote Creek Rim WRA, guyed meteorological towers had an estimated per-structure passerine fatality rate four to five times higher than the rate for wind turbines (Young et al. 2003a).

On the basis of mortality estimates at existing wind energy projects, the mid-range expected for passerine mortality would be approximately 1.2 to 1.8 birds per turbine per year. This level of mortality may not have any population-level consequences for individual species, because of the expected low fatality rates for most species and the high population sizes of the common species, such as European starling, American robin, horned lark, and western meadowlark (Young and Erickson 2003). However, population effects may be possible for some species, although no studies to date have documented such effects. Researchers estimated that 6,800 birds are killed annually at the San Gorgonio Pass WRA, while 69 million birds pass through the Coachella Valley annually; therefore, the calculated mortality (approximately 1 in 10,000) from the wind energy project was concluded not to be biologically significant (Erickson et al. 2002). Impacts of the Stateline WRA on grassland nesting passerines may have been largely due to the direct reduction of habitat from turbine pads and roads and the temporary disturbance of habitat between turbines and road shoulders, rather than to collisions with turbines (Erickson et al. 2003a).

Waterfowl. Waterfowl mortality at wind energy projects is relatively minor. Wind energy projects with significant sources of open water near turbines (San Gorgonio, California, and Buffalo Ridge, Minnesota) have the highest documented waterfowl mortality, with 10 to 20% of all fatalities consisting of waterfowl and shorebirds. Some sites with agricultural landscapes are occasionally observed to have large flocks of Canada geese during winter. However, only one Canada goose fatality has been documented (Erickson et al. 2002).

Bat Collisions. There are 45 bat species in the United States, 32 of which have been reported from the 11 western states (see Section 4.6.2.3). To date, only 9 species (6 species in the western states) have been recorded as fatalities at wind farms (Erickson et al. 2002; Johnson and Strickland 2004). Table 5.9.3-5 lists bat species that have been observed as fatalities at wind energy projects. Hoary bats (*Lasiurus cinereus*) and eastern red bats (*L. borealis*) made up most of the bat fatalities in the Midwest and eastern United States, while hoary bats and silver-haired bats (*Lasionycteris noctivagans*) were most commonly observed in the 11 western states. Table 5.9.3-6 summarizes bat fatality rates that have been estimated for several wind energy projects. The estimates are based on survey methods that may or may not be equivalent between individual WRAs, and may not accurately estimate actual mortality levels.

Compatibility of a Wind Energy Development Project and Raptors

Continuing concerns about the effects of wind energy development projects on ecological resources have focused on collisions of birds with turbines. Primary attention has focused on raptor species because of early observations of golden eagle, red-tailed hawk, and American kestrel fatalities at the Altamont Pass and Tehachapi wind energy projects (Erickson et al. 2001). Avian studies have focused on raptors because:

- There is a relatively high proportion of raptors killed at some wind energy projects;
- Raptors have a high public profile;
- Some raptor species have relatively small populations or slow breeding rates; and
- Raptors often fly at heights within the blade sweep area (Kingsley and Whittam 2003).

Other raptor fatalities at wind energy development projects include ferruginous hawk, northern harrier, prairie falcon, Swainson's hawk, white-tailed kite, turkey vulture, barn owl, burrowing owl, flamulated owl, short-eared owl, long-eared owl, and great horned owl (Erickson et al. 2001; Thelander et al. 2003).

Thelander et al. (2003) evaluated bird fatalities from 1998 through 2000 and provided a yearly mortality estimate of 24 golden eagles, 244 red-tailed hawks, 56 American kestrels, and 93 burrowing owls at the Altamont Pass WRA. Smallwood and Thelander (2003) estimated that there were 400 to 800 golden eagle, 2,980 to 5,960 red-tailed hawk, and 2,700 to 5,400 burrowing owl fatalities at the Altamont Pass WRA from 1983 to 2003. Altamont Pass is unusual in its intensive use by raptors, relative to most wind farms, and all fatalities at wind farms are not due to collisions with turbines. During a 7-year study of radio-tagged golden eagles at the Altamont Pass WRA, Hunt (2002) recorded deaths from turbine collisions, electrocutions, wire strikes, vehicle strikes, poisoning, and other causes.

The golden eagle hunts mainly small mammals while soaring or from perches, and may hunt cooperatively (NatureServe 2004). The majority of the golden eagle turbine-strike mortalities at the Altamont Pass WRA occur to subadults and floaters. A reserve of floaters exists (Hunt et al. 1998; Hunt 2002); therefore, collisions of golden eagles with wind farm structures have not resulted in detectable population level effects to this species within the region of the Altamont Pass WRA (Hunt 2002).

The American kestrel is one of the more commonly observed raptor species at most wind projects and is among the most commonly observed raptors killed at Altamont Pass (California), Tehachapi Pass (California), San Gorgonio (California), and Foote Rim Creek (Wyoming). No bald eagle mortalities have been reported at any WRA in the United States. Red-tailed hawk fatalities are also commonly observed at the Altamont WRA. This hawk's relatively motionless flight within an updraft may increase its risk of turbine-related collisions. Scavenger species (e.g., common raven and turkey vulture) are common at many wind farms but are not apparently susceptible to collision (Erickson et al. 2001, 2002; Hoover 2002).

The factors that contribute to a high number of raptor fatalities in California include unusually high raptor densities, topography, and, possibly, older turbine technology (Kingsley and Whittam 2003). Generally, raptors are able to avoid wind turbines (Young et al. 2003b). There is little or no information related to how owl species react to turbines, but they generally fly within turbine height or lower, which puts them at risk of collision. The numbers of owls killed at a wind energy project varies, representing a proportion ranging from 0.0% up to 10 to 15% of the total number of birds killed (Kingsley and Whittam 2004).

When turbines are placed in areas where raptors spend a great deal of time, the incidence of collision increases up (Hoover 2002). However, the relative abundance of a raptor species does not predict the relative frequency of fatalities per species (Thelander and Rugge 2000). Some species may become more susceptible to turbine collisions because postconstruction conditions at the wind farm have increased prey abundance within the vicinity of turbines or ancillary facilities. For example, rock piles produced during construction are used by desert cottontails, which are prey for the eagles, and thus, the eagles are more likely to encounter the turbines while foraging around these rock piles. Thelander et al. (2003) reported a similar relationship between pocket gopher abundance around turbines and red-tailed hawk mortality. The pocket gophers were more abundant on steeper

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Compatibility of a Wind Energy Development Project and Raptors (Cont.)

slopes into which lay-down areas and access roads were cut. Where wind farms are located in grazing allotments, cattle often cluster around wind turbines and their waste can attract insects that are prey items for raptors such as American kestrels and burrowing owls (NWCC Wildlife Workgroup 2003).

Few raptor species targeted during nest surveys have been observed as fatalities at newer wind plants. Correlations are very low between fatalities and overall raptor nest density (Johnson et al. 2003b).

Among the 841 avian fatalities reported from California studies, 42% were diurnal raptors and 11% were owls. Of the 192 avian fatalities reported from outside of California, 2.7% were diurnal raptors and 0.5% were owls. U.S. average raptor fatalities were estimated at 0.033 per turbine per year, which would equate to 495 raptor fatalities for the projected 15,000 operational turbines by the end of 2001. Excluding California, raptor fatalities were estimated at 0.006 per turbine per year, which would equate to 21 raptor fatalities for the 3,500 operational turbines in the United States (excluding California) by the end of 2001 (Erickson et al. 2001).

The reported differences in raptor (and all avian) mortality may be based on differences in turbine characteristics, tower design, and turbine placement (Erickson et al. 2002; Smallwood and Thelander 2004). For example, a 5-year study evaluating bird mortality at the Altamont Pass WRA (Smallwood and Thelander 2004) recovered 1,189 bird carcasses (including 481 raptor carcasses) during the study period. Most of the recovered birds (approximately 70%) were associated with 2 of the 10 turbine/tower combinations present at the facility; more than 45% of all recovered carcasses were associated with lattice-towered turbines. Most of the recovered birds were also found in summer and winter, and at two elevation levels, 115 to 225 m (377 to 738 ft) and 280 to 350 m (918 to 1,148 ft) above sea level. These data also suggest that other environmental factors may contribute to the reported differences in avian mortality at wind facilities.

At the Mountaineer Wind Energy Center, West Virginia, 1 red-tailed hawk and 2 turkey vultures were among the 24 bird carcasses (24 species) found between April 4 and November 11, 2003. The estimated raptor mortality rate is 0.33 per turbine (0.11 per turbine for the red-tailed hawk and 0.22 per turbine for the turkey vulture). This estimate is based on bird fatalities that exclude the fatalities from the May 23, 2003, event where 33 dead birds (no raptors) were observed near three turbines and the substation (Kerns and Kerlinger 2004).

Mitigation measures that could minimize raptor fatalities at wind energy development projects include:

- Raptor use of the project area should be evaluated, and the project should be designed to minimize or mitigate the potential for raptor strikes. Scientifically rigorous raptor surveys should be conducted; the amount and extent of baseline data required should be determined on a project-specific basis.
- Areas with a high incidence of fog, mist, low cloud ceilings, and low visibility should be avoided.
- Turbine locations should be configured in order to avoid landscape features (including prairie dog colonies and other high-prey potential sites) known to attract raptors.
- Turbine arrays should be configured to minimize avian mortality (e.g., orient rows of turbines parallel to known bird movements).
- Underground or raptor-safe transmission lines should be used to reduce collision and electrocution potential.
- A habitat restoration plan should be developed that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species (e.g., avoid the establishment of habitat that attracts high densities of prey animals used by raptors).
- Road cuts, which are favored by pocket gophers and ground squirrels, should be minimized.
- Either no vegetation or native plant species that do not attract small mammals should be maintained around the turbines.

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Compatibility of a Wind Energy Development Project and Raptors (Cont.)

- Tubular supports rather than lattice supports should be used, with no external ladders and platforms.
- The minimum amount of pilot warning and obstruction avoidance lighting specified by the FAA should be used, and the FAA should be consulted.
- Operators should determine if active raptor nests (i.e., raptor nests used during the breeding season) are present. Buffers should be provided to avoid disturbance of nesting raptors.
- Areas with high bird use should be avoided through micrositing alternatives (e.g., at the Foote Creek Rim project, turbines were located slightly away from the rim edge of a flat top mesa [Strickland et al. 2001a]).

With proper design and siting of wind projects (e.g., turbine arrangement and design and land management), raptor mortality can generally be reduced (Defenders of Wildlife 2004; Ling and Linehan 2003). Mitigation measures should be evaluated objectively on a site-specific basis before they are implemented at new wind energy development projects (Strickland et al. 2001a).

Reported bat mortality rates ranged from 0.74 bat per turbine at the Vansycle Ridge Wind Project in Oregon to 3.21 bats per turbine at the Nine Canyon Wind Energy Project in Washington (Erickson et al. 2003b). Using an approximate range of estimates from existing wind energy projects in the West and Midwest, it appears that approximately 1 to 2 bat fatalities occur per turbine per year. Actual levels of mortality could vary, depending on regional migratory patterns, patterns of local movements through the area, and the response of bats to turbines, individually and collectively (Young and Erickson 2003).

Comparative estimates of bat mortalities between wind energy projects and other structures are lacking. However, there are reports of bat strikes with other structures (e.g., television and communication towers, lighthouses, buildings, and powerlines; see Erickson et al. 2002). There are also reports of bats being impaled on barbed-wire fences (DeBlase and Cope 1967).

Preliminary data from the Buffalo Ridge WRA suggest that while a number of bats may be susceptible to turbine collisions, the observed mortality is not sufficient to cause population declines in the vicinity of the facility. This is based on relatively stable fatality rates over time. The effect on migrant bat populations from sustained collision mortality over an extended period of years, however, is not known (Erickson et al. 2002). If the species that were killed were uncommon, impacts could result in population-level effects, while impacts from killing small numbers of common bat species would not be expected to result in population-level effects. The text box beginning on the next page provides additional information about bats and wind energy development projects, including information about possible measures to mitigate bat fatalities.

5.9.3.2.4 Site Maintenance. During the operational period, grass mowing and brush cutting may be required once every few years. These activities would result in minor impacts to

TABLE 5.9.3-5 Bat Species Observed as Fatalities at WRAs in the United States

Species	Western States					Eastern and Midwestern States				
	CA	CO	OR	WA[a]	WY	MN	PA	TN	WI	WV
Big brown bat (*Eptesicus fuscus*)	–[b]	–	X	X	X	X	–	X	X	X
Hoary bat (*Lasiurus cinereus*)	X	X	X	X	X	X	–	X	X	X
Long-eared myotis (*Myotis evotis*)	–	–	–	–	–	–	–	–	–	X
Silver-haired bat (*Lasionycteris noctivagans*)	–	–	X	X	X	X	–	X	X	X
Eastern red bat (*Lasiurus borealis*)	–	–	–	–	–	X	–	X	X	X
Western red bat (*Lasiurus blossevillii*)	X	–	–	–	–	–	–	–	–	–
Little brown bat (*Myotis lucifugus*)	–	–	X	X	X	X	X		–	X
Eastern pipistrelle (*Pipistrellus subflavus*)	–	–	–	–	–	X	–	X	–	X
Myotis sp.	–	–	–	–	–	–	–	–	–	X
Unidentified	X	X	X	X	X	X	–	–	–	X

[a] Duplicative of Oregon, as data are for the Stateline Wind Project that is located at the Oregon/Washington border.

[b] A dash indicates not observed; X indicates observed.

Sources: Erickson et al. (2002, 2003a,b); Johnson and Strickland (2004); Johnson et al. (2003b); Kern and Kerlinger (2004); Strickland et al. (2001a,b); Young et al. (2003a,b).

TABLE 5.9.3-6 Bat Fatality Rates Observed at Wind Energy Projects

Wind Resource Area	State	No. of Turbines	Estimated No. of Bat Fatalities per Turbine per Year[a]	Estimated No. of Bat Fatalities per 100,000 m^2 of RSA per year[b]
Buffalo Mountain	Tennessee	3	10.0	NA[c]
Buffalo Ridge	Minnesota	354	2.3	164.0
Buffalo Ridge Phase 1	Minnesota	73	0.07, 0.26, 2.02	NA
Buffalo Ridge Phase 2	Minnesota	143	1.78, 2.02	NA
Buffalo Ridge Phase 3	Minnesota	138	2.04, 2.32	NA
Foote Creek Rim	Wyoming	69	1.04, 1.34	97.0
Klondike	Oregon	16		33.3
Nine Canyon	Washington	37	3.21	106.6
Stateline	Oregon/ Washington	454	0.95	53.3
Vansycle	Oregon	38	0.74	45.0
Wisconsin	Wisconsin	31	1.1	246.4

[a] Multiple values were included if there were results from more than one study.

[b] RSA = rotor-swept area.

[c] NA = not applicable (not calculated or appropriate).

Sources: Erickson et al. (2002, 2003a,b); Johnson et al. (2003a); Strickland et al. (2001a,b); Young et al. (2003a,b).

wildlife. Mobile animals would be displaced to adjacent undisturbed habitats. Less mobile wildlife could be killed or injured during mowing and cutting; however, the overall significance of such impacts on local wildlife populations would likely be minor, because of the likely limited quality and carrying capacity of the maintained habitats.

The licensed use of pesticides and herbicides at a wind energy project would not be expected to adversely affect local wildlife. Applications of these materials would be conducted by following label directions and in accordance with applicable permits and licenses. However, accidental spills or releases of these materials could impact exposed wildlife. Potential effects of such exposures are discussed below.

5.9.3.2.5 Exposure to Contaminants. During operation of a wind energy project, wildlife may be exposed to accidental spills or releases of pesticides, fuel, or hazardous materials. Exposures to these materials could affect reproduction, growth, development, or survival of exposed individuals. If the magnitude and extent of the spill and subsequent exposure are sufficient, population level effects may be incurred. However, such exposures are not expected under normal facility operations. Only small amounts of these materials would be expected to be present at any facility, and spill response plans would be in place to address any accidental spills or releases. Furthermore, given the small area potentially affected by a spill (much less than 1.0 acre [0.4 ha]), a land-based spill would affect relatively few individual animals and a relatively limited portion of the habitat or food resources for large-ranging mammal species (e.g., deer or elk).

5.9.3.2.6 Disturbance of Wildlife. During wind energy project operations, wildlife both on and off site could be disturbed by vehicles, workers, and project machinery. The response of wildlife to such disturbance is highly variable and depends on species; distance; and type, intensity, and duration of disturbance. Some species may become readily habituated to daily site activities; others may temporarily move from the area; still others may permanently move from the area; and, finally, some species (e.g., raccoons and coyote) may be drawn to the wind energy project areas, particularly if garbage is allowed to accumulate or is improperly managed. Wildlife permanently moving from the area may incur high mortality levels if the surrounding habitats are at or near carrying capacity, or have little similar habitat capable of supporting the displaced individuals.

The presence of new (or improved) access roads and utility and transmission line corridors to the wind energy development site could result in increased access. Increased foot traffic from hikers fording streams, OHVs crossing streams or driving along stream beds, and increased fishing activities could result in impacts to shoreline and shallow water vegetation, increased erosion from shoreline areas disturbed by foot and vehicle traffic, disruption of stream bottoms that support invertebrate and fish populations, and increased fishing pressure. The magnitude and extent of such impacts would be a function of the types of aquatic resources present in the wind energy project area, the proximity of those habitats to access roads and utility and transmission line corridors, and the current level and type of activities that occur on BLM-administered lands in the project area.

While no information was found regarding the injury or mortality of wildlife from human activities, wildlife may incur injury or death through collision with vehicles, particularly OHVs. While occasional wildlife may be injured or killed by a vehicle, most can be expected to respond to the noise of an oncoming vehicle by temporarily fleeing the area or by seeking shelter in a burrow or under rocks. Wildlife may also be impacted if increased access leads to an increase in the legal and illegal take of biota, which could impact local populations of some species.

Increased use of surrounding areas may increase the potential for the introduction and establishment of invasive vegetation and fish (introduced as released bait fish). Establishment of such species could reduce habitat quality and wetland function and alter the biotic community.

The text box beginning on the next page provides information about gallinaceous birds (e.g., sage-grouse) and wind energy development, including information about possible measures to mitigate impacts.

Compatibility of a Wind Energy Development Project and Bats

Much of the research concerning the impacts of wind energy development projects on wildlife has concentrated on avian mortality. However, bat mortality can also be expected at wind farms (Erickson et al. 2002). This concern has gained increased attention ever since the observations of a comparatively large number of bat fatalities at the Mountaineer Wind Energy Center in West Virginia (Johnson and Strickland 2004; Kerns and Kerlinger 2004). However, relatively low numbers of bat fatalities are generally observed at most wind energy development projects, especially in the West.

Only 5 of the 32 bat species reported from the 11 western states have been observed as fatalities at wind farms (Table 5.9.3-5); hoary bat (*Lasiurus cinereus*) and silver-haired bat (*Lasionycteris noctivagans*) fatalities were most commonly observed. The big brown bat (*Eptesicus fuscus*), western red bat (*Lasiurus blossevillii*), and little brown bat (*Myotis lucifugus*) have also been documented as fatalities at some wind energy developments in the western states.

The hoary bat is the most widespread North American bat (CDFG 2004b). It occurs throughout the United States, including all 11 western states. The hoary bat has a dispersed population and is basically solitary except for the mother-young association and during migration when groups of up to hundreds of individuals may form. In summer, adult males are distributed mainly in the western half of North America while the females predominantly occur in eastern North America (NatureServe 2004). The hoary bat occurs in forests and woodlands, usually roosting in tree foliage 3 to 5 m (10 to 16 ft) above ground with dense foliage above and open flying room below (NatureServe 2004). It feeds chiefly on large moths over clearings and may forage around lights in nonurban situations. The hoary bat may forage more than 1.6 km (1.0 mi) from its diurnal roost site, often along streams or lake edges (NatureServe 2004). It may migrate long distances between summer and winter ranges. During spring and fall migrations, large groups are sometimes encountered. Hoary bats that winter in colder climates hibernate (CDFG 2004b). On the basis of the ecology and life history of the hoary bat, fatalities at wind energy development projects would be minimal during summer and minimal to nonexistent during winter.

The silver-haired bat occurs throughout much of the United States, including all 11 western states. Maternity colonies are small. The silver-haired bat usually roosts singly, but occasionally it roosts in groups of up to six individuals. It generally migrates south for the winter and is usually found only during spring and fall migration over most of its range (NatureServe 2004). It prefers forested areas adjacent to lakes, ponds, and streams. The silver-haired bat will sometimes occur in xeric areas during migration. Summer roosts and nursery sites include tree foliage, cavities, or under loose bark; sometimes in buildings (NatureServe 2004). It forages less than 6 m (20 ft) over forest streams, ponds, and open brushy areas (CDFG 2004b). On the basis of the ecology and life history of the silver-haired bat, fatalities at wind energy development projects would be minimal during summer and winter.

Among the 11 western states, the eastern red bat (*Lasiurus borealis)* only occurs within Montana and Colorado, which are at the western limits of its distribution. The western red bat occurs within western Washington, western Oregon, California, western and southern Nevada, Utah, and scattered locations in Arizona and New Mexico (NatureServe 2004). The eastern red bat winters mainly in the southeastern United States. In some nonurban situations, it often forages around lights (NatureServe 2004). The western red bat has a similar life history to that of the eastern red bat (NatureServe 2004). Overall, both the eastern red bat and the western red bat would have a minimal susceptibility to wind turbine fatalities during summer and winter.

The little brown bat occurs throughout the 11 western states except for Arizona (NatureServe 2004). It uses human-made structures, caves, and hollow trees for nesting and maternity sites. It generally forages in woodlands near water and feeds low over water margins of lakes, streams, and ponds as well as along forest edges. On the basis of the ecology and life history of the little brown bat, fatalities at wind energy development projects would be minimal during summer and essentially nonexistent in winter.

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Compatibility of a Wind Energy Development Project and Bats (Cont.)

The big brown bat occurs throughout the United States, including all 11 western states. The big brown bat occurs in wooded and semiopen habitats, including cities, and forages over land or water, clearings and lake edges, and around lights in rural areas. On the basis of the ecology and life history of the big brown bat, fatalities at wind energy development projects would be minimal during summer and essentially nonexistent in winter (Nature Serve 2004; CDFG 2004b).

Between April 4 and November 11, 2003, a total of 475 bat carcasses representing seven species were detected at the Mountaineer Wind Energy Center in West Virginia. It was estimated that 2,092 bat fatalities actually occurred during this period, representing a fatality rate of 47.53 bats per turbine. Most carcasses were found between August 18 and September 30 (92.5%) (Kerns and Kerlinger 2004). Bat fatalities at a three-turbine wind farm on Buffalo Mountain in Tennessee have been studied over a period of 3 years. During this period, 119 dead bats have been documented (Johnson and Strickland 2004). The estimated bat mortality rate for this site was 28.5 bats per turbine per year (Kerns and Kerlinger 2004). Data from the Mountaineer wind energy project support previous conclusions that migrating bats are at most risk of turbine collision and that resident, breeding, or foraging bats have a low risk of collision mortality (Erickson et al. 2002; Johnson and Strickland 2004).

Generally, bat fatality rates are much lower than those observed at the Mountaineer and Buffalo Mountain sites. On the basis of the 184 bat fatalities documented from 1996 to 1999 at the 354-turbine Buffalo Ridge wind energy project in Minnesota, the estimated bat mortality rate was 1.53 bats per turbine per year (Johnson et al. 2003b). No significant difference was noted between bat mortalities at lit and unlit turbines (Johnson et al. 2003b). This lack of difference has also been noted at the Klondike Phase I Wind Project in Oregon, the Buffalo Ridge site in Minnesota, and at the Nine Canyon Wind Power Project in Washington (Erickson et al. 2002, 2003b; Johnson et al. 2003b).

Other reported bat mortality rates range from 0.74 bats per turbine per year at the Vansycle Ridge Wind Project in Oregon, to 3.21 bats per turbine per year at the Nine Canyon Wind Energy Project in Washington (Erickson et al. 2003b). Using an approximate range of estimates from existing wind farms in the West and Midwest, it appears that approximately 1 to 2 bat fatalities occur per turbine per year. Actual levels of mortality could vary depending on regional migratory patterns; patterns of local movements through the area; and the response of bats to turbines, individually and collectively (Young and Erickson 2003).

At the 16-turbine Klondike Phase I Wind Project in Sherman County, Oregon, the estimated total bat mortality over the 1-year study period was 19 or 1.16 bats per turbine per year. Six bats were actually found during the study — during months when this species is generally migrating.

Johnson and Strickland (2004) summarized bat fatality studies that have been conducted at several other eastern U.S. wind facilities. No bat fatalities were found at four facilities: two in farmland habitats and two in forested areas. One little brown bat fatality was found at a facility in a forested area. The number of turbines at these facilities ranged from 2 to 11.

Major trends in bat mortality at wind farms are (1) the majority of bat mortalities tend to be tree-dwelling vesper bats, and (2) most mortality involves migrant or dispersing bats rather than resident breeding bats (Johnson and Strickland 2004; Johnson et al. 2003b; Keeley 2001).

Mitigation measures that could minimize bat fatalities at wind energy development projects include:

- Turbines should not be located near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.
- Bat use of the project area should be evaluated, and the project should be designed to minimize or mitigate the potential for bat strikes. Both macro- and micro-siting options can be considered to minimize impacts to bats.

With proper design and siting of wind projects (e.g., turbine arrangement and design and land management), bat mortality can be greatly reduced and population-level effects avoided (Defenders of Wildlife 2004; Ling and Linehan 2003).

5.9.3.2.7 Interference with Migratory Behavior. Wildlife may also be affected if a wind energy project and/or its ancillary facilities interfere with migratory movements, while migrating birds and bats are expected to simply fly around individual structures or around or over the facility site and continue their migratory movement. (Impacts to migratory birds and bats from collisions with facility structures are addressed in Section 5.9.3.2.3.) The presence of a wind energy project could disrupt movements of terrestrial wildlife, particularly during migration. Herd animals, such as elk, deer, and pronghorn antelope, could potentially be affected if rows of turbines are placed along migration paths between winter and summer ranges or in calving areas (NWCC 2002). However, studies conducted at Foote Creek Rim in Wyoming have not demonstrated any displacement effects on pronghorn antelope, and antelope use of the area has not declined since construction of the wind energy project (Johnson et al. 2000). The wind energy development project and associated transmission lines and access roads would be maintained as areas of low vegetation that may hinder or prevent movements of some wildlife species.

5.9.3.2.8 Fire. Increased human activity also increases the potential for fires (see Section 5.9.3.1.6). Fire may affect wildlife through (1) direct mortality, (2) reduction of habitat, or (3) a reduction in habitat quality. In general, short-term and long-term fire effects on wildlife are related to fire impacts on vegetation, which in turn affect habitat quality and quantity, including the availability of forage shelter (Groves and Steenhof 1988; Sharpe and Van Horne 1998; Lyon et al. 2000b; USDA 2002a,b; Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1996; Watts and Knick 1996; Schooley et al. 1996; USDA 2002b,c).

Wildlife may survive fires by either seeking underground or aboveground refuge within the fire or by moving away from it (Ford et al. 1999; Lyon et al. 2000a). While individuals caught in a fire could incur increased mortality, depending on how quickly the fire spreads, most wildlife would be expected to escape by either outrunning the fire or seeking safety in burrows. Some mortality of burrowing mammals from asphyxiation in their burrows during fire has been reported (Erwin and Stasiak 1979). Burrowing kangaroo rats were reported as the only rodents to survive a chaparral fire, probably because the burrows protected them from the fire (Lyon et al. 2000b).

In the absence of long-term vegetation changes, rodents in grasslands usually show a decrease in density after a fire, but they often recover to achieve densities similar to or greater than preburn levels (Beck and Vogel 1972; Lyon et al. 2000b; USDA 2002d). Long-term changes in vegetation from a fire (such as loss of sagebrush or the invasion or increase of nonnative annual grasses) may affect food availability and quality and habitat availability for wildlife; the changes could also increase the risk from predation for some species (Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1997; Watts and Knick 1996; Schooley et al. 1996; Lyon et al. 2000b; USDA 2002b,c).

Compatibility of a Wind Energy Development Project and Gallinaceous Birds

Most concerns about the effects of wind energy development projects on ecological resources have focused on collisions of birds and bats with turbines. However, increasing attention is being paid to the potential impacts associated with reduction, fragmentation, and modification of grassland and shrubland habitats by wind energy projects and their associated infrastructure (Manes et al. 2002). The lesser prairie-chicken, sharp-tailed grouse, and sage-grouse (both Gunnison and greater sage-grouse) are of particular concern relative to reduction and fragmentation of sagebrush habitat within the 11 western states.

Depending on the population of sage-grouse, which varies from nonmigratory to migratory, a population may occupy an area that exceeds 1,040 mi^2 (2,700 km^2) on an annual basis. The distance between leks and nesting sites can exceed 12.4 mi (20 km) (Connelly et al. 2000). However, sage-grouse have a high fidelity to a seasonal range (Connelly et al. 2000).

Among the gallinaceous bird species, the sage-grouse is especially of concern to the BLM because about half of the remaining sage-grouse habitat occurs in areas that are under BLM jurisdiction. Therefore, the BLM has an important role in the conservation of sage-grouse and other sagebrush-dependent wildlife species. Sage-grouse need contiguous, undisturbed areas of high-quality habitat during their four distinct seasonal periods: (1) breeding, (2) summer-late brooding and rearing, (3) fall, and (4) winter (Connelly et al. 2000).

The breeding and nesting characteristics of the lesser prairie-chicken and sharp-tailed grouse are similar to those of the sage-grouse. However, their habitats and general food types vary somewhat from those of the sage-grouse; both species are less dependent upon sagebrush as habitat and, especially, as a winter food source (NAGP 2004; NatureServe 2004).

Loud, unusual sounds and noise from construction and human activities disturb gallinaceous birds, cause birds to avoid traditional use areas, and reduce sage-grouse use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2004). Thus, site construction, turbine operation, and site-maintenance activities could be a source of auditory and visual disturbance to sage-grouse.

Transmission lines, turbines, and access roads may adversely affect habitats important to gallinaceous birds by causing fragmentation, reducing habitat value, or reducing the amount of habitat available (Braun 1998). Transmission lines, turbines, and other structures can also provide perches and nesting areas for raptors and ravens that may prey upon gallinaceous birds.

Measures that have been suggested for management of sage-grouse and their habitats (e.g., Paige and Ritter 1999; Connelly et al. 2000; Montana Sage-Grouse Work Group 2003) that have pertinence to wind energy development projects include:

- Identify and avoid both local (daily) and seasonal migration routes.
- Consider sage-grouse and sage habitat when designing, constructing, and utilizing project access roads and trails.
- Avoid, when possible, siting energy developments in breeding habitats.
- Adjust the timing of activities to minimize disturbance to sage-grouse during critical periods.
- When possible, locate energy-related facilities away from active leks or near sage-grouse habitat.
- When possible, restrict noise levels to 10 dB above background noise levels at the lek sites.
- Minimize nearby human activities when birds are near or on leks.
- As practicable, do not conduct surface-use activities within crucial sage-grouse wintering areas from December 1 through March 15.
- Maintain sagebrush communities on a landscape scale.

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Compatibility of a Wind Energy Development Project and Gallinaceous Birds (Cont.)

- Provide compensatory habitat restoration for impacted sagebrush habitat.
- Avoid the use of pesticides at grouse breeding habitat during the brood-rearing season.
- Develop and implement appropriate measures to prevent the introduction or dispersal of noxious weeds.
- Avoid creating attractions for raptors and mammalian predators in sage-grouse habitat.
- Consider measures to mitigate impacts at off-site locations to offset unavoidable sage-grouse habitat alteration and reduction at the project site.

The BLM manages more sage-grouse habitat than any other entity; therefore it has developed a National Sage-Grouse Habitat Conservation Strategy for BLM-administered public lands to manage public lands in a manner that will maintain, enhance, and restore sage-grouse habitat while providing for multiple uses of BLM-administered public lands (BLM 2004g). The strategy was issued in November 2004 and is consistent with the individual state sage-grouse conservation planning efforts. The purpose of this strategy is to set goals and objectives, assemble guidance and resource materials, and provide more uniform management directions for the BLM's contributions to the multistate sage-grouse conservation effort being led by state wildlife agencies (BLM 2004g). The BLM (2004g) strategy includes guidance for (1) addressing sagebrush habitat conservation in BLM land use plans, and (2) managing of sagebrush plant communities for sage-grouse conservation. This guidance is designed to support and promote the rangewide conservation of sagebrush habitats for sage-grouse and other sagebrush-obligate wildlife species on public lands administered by the BLM, and presents a number of suggested management practices (SMPs). These SMPs include management or restoration activities, restrictions, or treatments that are designed to enhance or restore sagebrush habitats. The SMPs are divided into two categories: (1) those that will help maintain sagebrush habitats (e.g., practices or treatments to minimize unwanted disturbances while maintaining the integrity of the sagebrush communities), and (2) those that will enhance sagebrush habitat components that have been reduced or altered (BLM 2004g).

SMPs that are or may be pertinent to wind energy development projects include:

- Development of monitoring programs and adaptive management strategies,
- Control of invasive species,
- Prohibition or restriction of OHV activity,
- Consideration of sage-grouse habitat needs when developing restoration plans,
- Avoidance of placing facilities in or next to sensitive habitats such as leks and wintering habitat,
- Location or construction of facilities so that facility noise does not disturb grouse activities or leks,
- Consolidation of facilities as much as possible (use existing ROWs),
- Initiation of restoration practices as quickly as possible following land disturbance,
- Installation of antiperching devices on existing or new power lines in occupied sage-grouse habitat, and
- Design of wind energy facilities to reduce habitat fragmentations and mortality to sage grouse.

Raptor populations generally are unaffected by, or respond favorably to, burned habitat (Lyon et al. 2000b). Fires may benefit raptors by reducing cover and exposing prey; raptors may also benefit if prey species increase in response to post-fire increases in forage (Lyon et al. 2000b; USDA 2002d). Direct mortality of raptors from fire is rare (Lehmen and Allendorf 1989), although fire-related mortality of burrowing owls has been documented (USDA 2002d). Most adult birds can be expected to escape fire, while fire during nesting (prior to fledging) may kill young birds, especially of ground-nesting species (USDA 2002d).

5.9.3.3 Operational Effects on Wetlands and Aquatic Resources

Potential operational impacts to wetlands and aquatic resources may be expected to be of lesser magnitude than impacts that could be incurred during construction of the wind energy project (see Section 5.9.2.3). Wetlands and aquatic resources could be affected by (1) site maintenance activities that involve mowing or cutting of wetland and riparian vegetation, (2) exposure to contaminants, and (3) decreased water quality due to surface runoff from the site (Table 5.9.3-7). Wetlands and aquatic resources could also be affected by human activities not related to wind energy project operations but rather associated with increased access to BLM-administered lands in the immediate vicinity of the wind energy project site. Potential impacts from increased access may include (1) disturbance of biota in wetland and aquatic habitats, (2) the introduction of invasive fish and vegetation, and (3) the illegal take of fish or other aquatic biota (Table 5.9.3-7).

5.9.3.4 Operational Effects on Threatened and Endangered Species

If present, threatened and endangered species (including federal and state listed species and BLM-designated sensitive species) could be affected by the same operational stressors and in the same manner as identified for vegetation, wildlife, and aquatic resources. Primary operational concerns would be associated with disturbance of species-specific behaviors (reproductive and foraging); electrocution from contact with transmission lines; collision with turbines, meteorological towers, and transmission lines; exposures to accidental releases of hazardous materials; decreased water quality; and interference with migratory movements.

The potential for operational impacts may be considered low for a variety of reasons. First, consistent with the requirements of the ESA and other applicable laws, regulations, policies, program guidance, and management plans (e.g., FLPMA), it is unlikely that a wind energy development project would be sited in a location known to have one or more federal listed species. Second, the siting and design of a wind energy project would be conducted in a manner to avoid or minimize, to the maximum extent possible, impacting threatened or endangered species. Third, the siting, construction, and subsequent operation of a wind energy project on BLM-administered lands would be conducted in compliance with BLM Manual 6840 — Special Status Species Management (BLM 2001), which provides policy and guidance, consistent with appropriate laws, for the conservation of special status species of

TABLE 5.9.3-7 Potential Wind Energy Operation Effects on Aquatic Biota and Habitat

Ecological Stressor	Associated Project Activity or Feature	Potential Effect	Effect Extent and Duration
Wind Energy Facility Operations			
Injury from mowing	Mowing at support buildings and turbine locations, utility corridors, and transmission corridors.	Maintenance of plant communities in early successional stages; invasive plants; decrease in habitat quality.	Short-term (duration of facility operation) for vegetation injury; long-term for invasive vegetation establishment; short- or long-term habitat quality impacts; localized to mowed areas.
Exposure to contaminants	Accidental spill or release of pesticides, fuel, or hazardous materials.	Exposure may affect survival, reproduction, development, or growth of aquatic biota.	Short- or long-term; largely localized to spill locations.
Decreased water quality	No specific operations-related activity; increased erosion and runoff from bare ground areas, such as access roads and parking areas, and from site locations disturbed during construction and poorly stabilized.	Decreased survival or habitat avoidance of invertebrates and fish due to decreased levels of dissolved oxygen; reduced photosynthesis and productivity of algae and aquatic macrophytes due to increased turbidity and decreased light penetration; decreased egg and larvae survival due to siltation.	Long-and short-term, depending on type of aquatic habitat and associated biota; short-term impacts episodic, associated with precipitation events.
Non-Facility-Related Human Activities			
Disturbance of nearby biota	Increased access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Impacts to shoreline habitats from foot and vehicle traffic; disruption of stream bottoms from foot and vehicle traffic fording streams and from vehicle travel along stream beds; increased fishing pressure.	Short- or long-term in areas adjacent to the wind facility, access roads, utility corridors, and transmission corridors; long-term at areas that become commonly used.
Introduction and establishment of invasive species	Increased access to surrounding areas by visitors, including unauthorized vehicles, along facility access roads and utility and transmission corridors.	Introduction of invasive bait fish, resulting in community-level changes on resident fishes. Establishment of invasive vegetation, resulting in reduced wetland habitat quality and functions and a reduced number of fish, waterfowl, and/or riparian wildlife.	Long-term, off-site.
Legal and illegal take of aquatic biota	Increased access to surrounding areas.	Increased fishing pressure; reduced abundance and/or distribution of some biota.	Short- or long-term, depending on species affected and magnitude of take.

plant and animals and the ecosystems on which they depend. Finally, the use of mitigation measures would further act to avoid or minimize the potential for affecting threatened or endangered species.

Potential impacts to threatened or endangered species (if present) from non-facility-related human activity would also be similar to those identified for vegetation, wildlife, and aquatic resources. These potential impacts would be unrelated to facility operations and out of the control of the facility and its operators.

Impacts may include the dispersal of invasive plant species into quality native plant habitats, which in turn could affect the availability of forage and habitat for wildlife and thus impact wildlife population levels.

5.9.4 Site Decommissioning

Impacts to biological resources from decommissioning activities would be similar in nature to the impacts that occur during construction, but of a reduced magnitude. There would be a temporary increase in noise and visual disturbance associated with the removal of wind energy project facilities and site restoration. Negligible to no reduction in wildlife habitat would be expected, and injury and mortality rates of vegetation and wildlife would be much lower than they would be during construction. Removal of turbines, meteorological towers, and overhead transmission components would eliminate the impacts associated with wildlife interactions with wind facility structures. Following site restoration, the biological resources at the project site could return to preproject conditions.

5.9.5 Mitigation Measures

The previous evaluations identified a number of potential impacts that could be incurred during the construction, operation, and decommissioning of a wind energy facility. A variety of mitigation measures may be implemented at wind energy projects to reduce potential ecological impacts, and these are described in the following sections. In addition, monitoring during the various phases of wind energy development can be utilized to identify potential concerns and direct actions to address those concerns. Monitoring data can be used to track the condition of ecological resources, to identify the onset of impacts, and to direct appropriate site management responses to address those impacts.

The following sections identify measures that may be appropriate for mitigating impacts that could be associated with new wind energy projects. In addition to these measures, a variety of federal and state agencies and environmental organizations have identified measures for mitigating the ecological impacts of other human activities. BLM guidance documents also identify measures for mitigating ecological impacts associated with other approved activities on BLM-administered lands, and these mitigation measures may be applicable to wind energy projects (see Section 3.6.2).

5.9.5.1 Mitigation during Site Monitoring and Testing

Site monitoring and testing would generally result in only minimal impacts to ecological resources. The following mitigation measures may ensure that ecological impacts during this stage of the project would be minimal:

- Existing roads should be used to the maximum extent feasible to access a proposed project area.
- If new access roads are necessary, they should be designed and constructed to the appropriate standard.
- Existing or new roads should be maintained to the condition needed for facility use.
- The area disturbed during the installation of meteorological towers (i.e., the tower footprint and its associated lay-down area) should be kept to a minimum.
- Individual meteorological towers should not be located in or near sensitive habitats or in areas where ecological resources known to be sensitive to human activities are present.
- Installation of meteorological towers should be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors (e.g., during periods of sage-grouse nesting).

5.9.5.2 Mitigation during Plan of Development Preparation and Project Design

Mitigation measures may be considered during preparation of the POD and project design to ensure that the siting of the overall wind energy development project and of individual facility structures, as well as various aspects of the design of individual facility structures, do not result in unacceptable impacts to ecological resources. The following measures should be incorporated into the development of the POD and siting of the wind development project:

- Operators should identify important, sensitive, or unique habitat and biota in the project vicinity and site, and design the project to avoid (if possible), minimize, or mitigate potential impacts to these resources. The design and siting of the facility should follow appropriate guidance and requirements from the BLM and other resource agencies, as available and applicable.
- The BLM and operators should contact appropriate agencies early in the planning process to identify potentially sensitive ecological resources that may be present in the area of the wind energy development.

- The operators should conduct surveys for federal- and state-protected species and other species of concern within the project area.

- Operators should evaluate avian and bat use (including the locations of active nest sites, colonies, roosts, and migration corridors) of the project area by using scientifically rigorous survey methods (e.g., see NWCC 1999).

- The project should be planned to avoid (if possible), minimize, or mitigate impacts to wildlife and habitat.

- Discussion should be held with the appropriate BLM Field Office staff regarding the occurrence of sensitive species or other valued ecological resources in the proposed project area.

- Existing information on species and habitats in the project area should be reviewed.

The amount and extent of necessary preproject data would be determined on a project-by-project basis, based in part on the environmental setting of the proposed project location. Methods for collecting such data may be found in NWCC (1999).

5.9.5.2.1 Mitigating Habitat Impacts. The following measures may be incorporated into the POD and considered during project siting to minimize potential habitat disturbance:

- If survey results indicate the presence of important, sensitive, or unique habitats (such as wetlands and sagebrush habitat) in the project vicinity, facility design should locate turbines, roads, and support facilities in areas least likely to impact those habitats.

- Habitat disturbance should be minimized by locating facilities (such as utility corridors and access roads) in previously disturbed areas (i.e., locate transmission lines within or adjacent to existing power line corridors).

- Existing roads and utility corridors should be utilized to the maximum extent feasible.

- New access roads and utility corridors should be configured to avoid high quality habitats and minimize habitat fragmentation.

- Site access roads and utility corridors should minimize stream crossings.

- A habitat restoration management plan should be developed that identifies vegetation, soil stabilization, and erosion reduction measures and requires that restoration activities be implemented as soon as possible following facility construction activities.

- Individual project facilities should be located to maintain existing stands of quality habitat and continuity between stands.

- The creation of, or increase in, the amount of edge habitat between natural habitats and disturbed lands should be minimized.

- To minimize impacts to aquatic habitats from increased erosion, the use of fill ramps rather than stream bank cutting should be designated for all stream crossings by access roads.

- Stream crossings should be designed to provide in-stream conditions that allow for and maintain uninterrupted movement and safe passage of fish.

5.9.5.2.2 Mitigating Site/Wildlife Interactions. To reduce the potential use of site facilities by perching birds, to reduce the potential for collisions with project facilities, and to reduce the potential for electrocution, the following measures should be considered during the development of the POD and design of individual facility structures:

- Locations that are heavily utilized by migratory birds and bats should be avoided.

- Permanent meteorological towers, transmission towers, and other facility structures should be designed to discourage their use by birds for perching or nesting.

- The use of guy wires on permanent meteorological towers should be avoided or minimized.

- Electrical supply lines should be buried in a manner that minimizes additional surface disturbance. Overhead lines should be used in cases where the burial of lines would result in further habitat disturbance.

- Power lines should be configured to minimize the potential for electrocution of birds, by following established guidelines (e.g., APLIC [1996], APLIC and USFWS [2005]).

- Operators should consider incorporating measures to reduce raptor use of the project site into the design of the facility layout (e.g., minimize road cuts and maintain nonattractive vegetation around turbines).

- Turbines and other project facilities should not be located in areas with known high bird usage; in known bird and/or bat migration corridors or known flight paths; near raptor nest sites; and in areas used by bats as colonial hibernation, breeding, and maternity/nursery colonies, if site studies show that they would pose a high risk to species of concern.

- Wind energy projects should not be located in areas with a high incidence of fog and mist.

- To reduce attraction of migratory birds to turbines and towers, the need for or use of sodium vapor lights at site facilities should be minimized or avoided.

- Turbines should be configured to avoid landscape features known to attract raptors, if site studies show that placing turbines there would pose a significant risk to raptors.

5.9.5.3 Mitigation during Construction

Construction of a wind energy project may impact ecological resources. A variety of measures may be implemented to minimize the potential for these impacts. In addition to general engineering practices, existing BLM program-specific guidance documents (see Section 3.6.2) identify other mitigation measures for activities on program-specific BLM-administered lands that may be applicable to wind energy development projects.

5.9.5.3.1 Mitigating Habitat Disturbance. To mitigate habitat reduction or alternation during construction, the following measures may be implemented:

- The size of all disturbed areas should be minimized.

- Where applicable, the extent of habitat disturbance should be reduced by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.

- Habitat restoration activities should be initiated as soon as possible after construction activities are completed.

5.9.5.3.2 Mitigating Disturbance and Injury of Vegetation and Wildlife. These measures may be applicable to mitigate the disturbance or injury of biota during construction:

- In consultation with staff from the BLM and other appropriate natural resource agencies, construction activities should be scheduled to avoid important periods of wildlife courtship, breeding, nesting, lambing, or calving.

- All construction employees should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship, nesting) seasons. In addition, any pets should not be permitted on site during construction.

- Buffer zones should be established around raptor nests, bat roosts, and biota and habitats of concern, if site studies show that proposed facilities would pose a significant risk to avian or bat species of concern.

- Noise-reduction devices (e.g., mufflers) should be maintained in good working order on vehicles and construction equipment.

- Explosives should be used only within specified times and at specified distances from sensitive wildlife or surface waters as established by the BLM or other federal and state agencies.

- The use of guy wires on permanent meteorological towers should be avoided.

5.9.5.3.3 Mitigating Erosion and Fugitive Dust Generation. Measures to minimize disturbance of ecological resources from erosion and fugitive dust may include:

- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.

- All areas of disturbed soil should be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities should be undertaken as early as possible on disturbed areas.

- Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.

- Construction materials and stockpiled soil should be covered if they are a source of fugitive dust.

- Erosion and fugitive dust control measures should be inspected and maintained regularly.

5.9.5.3.4 Mitigating Fuel Spills. To minimize potential impacts to ecological resources from accidental fuel spills, the following mitigation measures may be implemented:

- All refueling should occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.

- Drip pans should be used during refueling to contain accidental releases.

- Drip pans should be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.

- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and soil removal initiated if needed.

5.9.5.3.5 Mitigating Establishment of Invasive Vegetation. The following measures may be implemented to minimize the potential establishment of invasive vegetation at the site and its associated facilities:

- Operators should develop a plan for control of noxious weeds and invasive plants, which could occur as a result of new surface disturbance activities at the site. The plan should address monitoring, weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching should be required.

- If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area should be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.

- Access roads and newly established utility and transmission line corridors should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.

- Fill materials that originate from areas with known invasive vegetation problems should not be used.

- Certified weed-free mulch should be used when stabilizing areas of disturbed soil.

- Habitat restoration activities and invasive vegetation monitoring and control activities should be initiated as soon as possible after construction activities are completed.

- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.

- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

5.9.5.4 Mitigation during Operation

5.9.5.4.1 Mitigating Fuel Spills and Exposure to Site-Related Chemicals. The following measures may be implemented to minimize the potential for exposure of biota to accidental spills:

- Drip pans should be used during refueling to contain accidental releases.

- Pesticide use should be limited to nonpersistent, immobile pesticides and herbicides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and removal initiated, if needed.

5.9.5.4.2 Mitigating Establishment of Invasive Vegetation. The following measure may be implemented to minimize the potential establishment of invasive vegetation at the site and its associated facilities:

- Access roads, utility and transmission line corridors, and tower site areas should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.

5.9.5.4.3 Mitigating Site/Wildlife Interactions. Measures to mitigate these interactions were previously addressed by the measures identified for inclusion in development of the POD and facility siting and design. The following measures may further reduce the potential for bird collisions, primarily through reducing the attractiveness of the facility to birds:

- Higher-height vegetation (i.e., shrub species) should be encouraged along transmission corridors to minimize foraging in these areas by raptors to the extent local conditions will support this vegetation.

- Areas around turbines, meteorological towers, and other facility structures should be maintained in an unvegetated state (e.g., crushed gravel), or only vegetation that does not support wildlife use should be planted.

- All unnecessary lighting should be turned off at night to limit attracting migratory birds.

- Employees, contractors, and site visitors should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets should be controlled to avoid harassment and disturbance of wildlife.

- Observations of potential wildlife problems, including wildlife mortality, should be reported to the BLM authorized officer immediately.

5.9.5.5 Mitigation during Decommissioning

The measures identified to mitigate construction impacts are applicable to decommissioning activities and may include:

- All turbines and ancillary structures should be removed from the site.

- Topsoil from all decommissioning activities should be salvaged and reapplied during final reclamation.

- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.

- The vegetation cover, composition, and diversity should be restored to values commensurate with the ecological setting.

Following removal of the project facilities, implementation of appropriate habitat restoration activities could restore disturbed areas to preproject conditions.

5.9.5.6 Mitigation for Threatened, Endangered, and Sensitive Species

If federal listed species are present in the project vicinity, the BLM will consult with the USFWS as required by Section 7 of the ESA. A Biological Assessment could be required, in addition to the assessment of impacts in the site-specific NEPA document for the project. Subsequently, formal consultation may be required that would result in a Biological Opinion issued by the USFWS. The Biological Opinion would specify reasonable and prudent measures and conservation recommendations to minimize impacts on the federal listed species at the site.

A variety of site-specific and species-specific measures may be required to mitigate potential impacts to special status species if present in the project area. Such measures may include:

- Field surveys should be conducted to verify the absence or presence of the species in the project area and especially within individual project footprints.

- Project facilities or lay-down areas should not be placed in areas documented to contain or provide important habitat for those species.

5.10 LAND USE

The construction and operation of a wind energy development project would have an impact on land use if there were:

- Conflict with existing land use plans and community goals;
- Conflict with existing recreational, educational, religious, scientific, or other uses of the area; or
- A conversion of the existing commercial land use of the area (e.g., mineral extraction) (PBS&J 2002).

5.10.1 Potential Impacts to BLM-Administered Lands

Generally, all public lands unless otherwise classified, segregated, or withdrawn are available at the BLM's discretion for ROW authorization for wind energy development under the FLMPA. As stated in Section 2.2.1, all lands that compose the BLM's NLCS would be excluded from consideration for authorization for wind energy development, with the exception of the California Desert Conservation Area (CDCA). The CDCA was authorized by Section 601 of the FLPMA. The Secretary of the Interior was directed by Section 601(d) to prepare and implement a comprehensive long-range plan for the management, use, development, and protection of the public lands within the CDCA. The *California Desert Conservation Area Plan*, *as Amended* (BLM 1999), identifies wind energy development as an authorization of the public lands, consistent with the Plan and NEPA. Consequently, public lands located in the CDCA are not off-limits for wind energy development.

Similarly, ACECs would also be excluded from consideration (Section 2.2.1). ACECs are considered land use authorization avoidance areas because they are known to contain resource values that could result in denial of applications for land uses that cannot be designed to be compatible with the management objectives and prescriptions for the ACEC (BLM 2003l). Adverse impacts to natural, cultural, and visual resources would be largely minimized by excluding the NLCS lands and ACECs from wind resource development authorization.

Site monitoring and testing would generally result in temporary, localized impacts to existing land uses associated with the meteorological towers and minimum-specification access roads (if required). Meteorological data would be collected for 1 to 3 years (Section 3.1.1) and would require the installation of meteorological towers to characterize the wind regime at a potential WRA. Since a meteorological tower would occupy only a few square feet, only a negligible impact to most existing land uses would be expected. However, the presence of the towers and possible access roads may impact more remote recreational experiences.

Construction activities would generally result in temporary impacts to existing land uses. For example, if the area was used for grazing, livestock might need to be removed from the areas where blasting or heavy equipment operations were taking place (EFSEC 2003). Permanent land use impacts are based on the amount of land that would be displaced by a proposed project and by the compatibility of the proposed use with existing, adjacent uses (PBS&J 2002). A significant permanent land use impact would occur from an uncompensated loss of the current productive use of the site or foreclosure of future land uses (FPL Energy North Dakota Wind, LLC 2003). However, permanently converted acreage would usually compose only a small portion of that available within a project area. For example, at the proposed Kittitas Valley Wind Power Project in Washington, a maximum of only 118 out of 7,000 acres (48 out of 2,833 ha) of rangeland within the project area, or only 118 out of 445,000 acres (48 out of 180,085 ha) of pasture or unimproved grazing lands within Kittitas County, would be permanently converted to energy production (EFSEC 2003). Given the overall footprints of wind turbine towers and ancillary structures, the amount of acreage required for most wind energy development projects should be a small fraction of the leased area.

Generally, wind turbines need to be separated by a distance equivalent to at least several tower heights in order to allow wind strength to reform and for the turbulence created by one rotor not to harm another turbine downwind. Therefore, only a small percentage of land area is taken out of use by the turbines, access roads, and other associated infrastructure. Depending on the location, size, and design of a wind energy development project, wind development is compatible with a wide variety of land uses and generally would not preclude recreational, wildlife habitat conservation, military, livestock grazing, oil and gas leasing, or other activities that currently occur within the proposed project area. The opportunity may also exist for wind development on reclaimed mine lands. A review of existing land use plans, zoning designations, and policies would need to be conducted in order to provide appropriate, up-front guidance to developers on where and how to locate wind energy projects so that they would be as consistent as reasonably possible with existing land uses and the environment (NWCC 2002).

Overall, the establishment of a wind energy development project and its ancillary structures (e.g., transmission lines and access road) would modify the existing land cover), particularly if the wind energy development project was located within existing forests and shrublands.

Indirect land use impacts would not be expected, because it is anticipated that a wind energy development project would not substantially induce or reduce regional growth to the extent that it would change off-site land uses or use of off-site resource-based recreation areas (EFSEC 2003).

Upon decommissioning, land use impacts from facility construction and operation would be mostly reversible. No permanent land use impacts would occur from decommissioning (EFSEC 2003). The BLM could decide to continue the use of, and maintain, access roads.

5.10.2 Potential Impacts to Aviation

The FAA requires a notice of proposed construction for a project so that it can determine whether it would adversely affect commercial, military, or personal air navigation safety (FAA 2000). One of the triggering criteria is whether the project would be located within

20,000 ft (6,096 m) or less of an existing public or military airport (depending upon the type of airport or heliport, see Sections 4.7.2 and 4.7.3). If the potential site for a wind energy development project is known, an Internet database can be searched online to obtain this information (AirNav.com 2004). Inputting the geographic coordinates allows identification of public, private, and military airports; balloon ports; glider ports; heliports; seaplane bases; short takeoff and landing airports (STOLports); and ultralight flight parks within a minimum radius of 6 mi (10 km) to a maximum of 200 mi (322 km). Another FAA criterion triggering the notice of proposed construction is any construction or alteration of more than 200 ft (61 m) in height above ground level. This criterion applies regardless of the distance from the proposed project to an airport (FAA 2000). Because a wind energy development project would have to meet appropriate FAA criteria, no adverse impacts to aviation would be expected.

5.10.3 Potential Impacts to Military Operations

A proposed WRA could be in conflict with existing or proposed military testing and training operations. Military testing and training exercises involve the use of aircraft, ground troops, and weapons (including guided missiles). Much of this testing and training requires extensive areas of highly secured air space such as the 20,000 mi^2 (51,800 km^2) of restricted air space in south-central California that is used by Edwards Air Force Base, China Lake Naval Weapons Center, and Fort Irwin Military Reservation. Restricted air space allows for real-world maneuvering room for high-speed military aircraft, while providing large buffer zones surrounding the test ground to ensure public safety (Feiste 2003). However, military test ranges are being challenged by encroachments such as population growth, urban expansion, growing air space congestion, and, even as a result of the unintended consequences of environmental laws that reduce the flexibility of military training (Feiste 2003). The presence of turbines, permanent meteorological towers, and aboveground transmission lines associated with wind energy projects could add additional constraints to military testing and training operations that may occur at low altitudes (e.g., helicopter low-altitude tactical navigation areas, military operations areas, and military training routes). These structures may also be a source of ground-based and, more importantly, aircraft radar interference. The aforementioned constraints to military testing and training operations could be the basis for denial of a ROW authorization should there be no available mitigation alternatives. Therefore, developers should conduct preapplication consultations with the BLM and appropriate military representatives.

5.10.4 Potential Impacts to Recreational Areas

Impacts on recreational resources would be considered significant if they occurred in a high-density, concentrated, developed recreation site or facility, or included (1) noise impacts; (2) dust or air quality impacts; or (3) visual impacts, particularly if such impacts occurred in remote settings and landscapes (PBS&J 2002). During construction, noise, dust, traffic, and the presence of a construction force would temporarily affect the rural to primitive character of the area. People engaged in hiking, camping, birding, and hunting would be affected the most by construction activities. Some parks and campsites may experience increased use by transient workers who seek temporary accommodations during project construction. This could displace recreational users, particularly on weekdays. No significant adverse impacts on recreational users would be expected from operations as the operating workforce would be limited.

In the long-term, improved accessibility to the area could increase recreational opportunities; although at the same time, this could alter the experience for people wanting a backcountry setting. However, development of a wind energy project could modify the ROS class (Section 4.7.5) within which the proposed project would be located. For example, the area could be modified from either a semiprimitive nonmotorized or motorized class to a roaded natural or rural class. Most long-term effects would relate to visual disturbances and are discussed in Section 5.11.

In summary, development of a wind energy project would have both positive and negative effects on the opportunities for dispersed recreational activities in the project area. It is possible that at least some portions of the access road or transmission line ROW could be integrated with local trail and road systems and used for hiking, OHVs, and additional access to hunting and fishing areas. Therefore, the wind energy project could enhance public access to some previously difficult or inaccessible areas. Alternately, hunting and fishing pressures could increase in some areas, and some private landowners might experience an increased level of intrusion on their property. In addition, persons who may otherwise use the area for a remote and undisturbed recreational experience may decide to go elsewhere.

5.10.5 Mitigation Measures

The previous evaluations identified potential land use impacts that could be incurred during the construction, operation, and decommissioning of a wind energy facility. The nature, extent, and magnitude of these potential impacts would vary on a site-specific basis and on the specific phase of the project (e.g., construction or operation). The greatest potential for land use impacts would occur as a result of decisions made during the design and siting of the wind energy project. A variety of mitigation measures may be incorporated, as stipulations, into the design and development of the POD and the design of a wind energy project to reduce potential land use impacts. These measures include:

- Wind energy projects should be planned to mitigate or minimize impacts to other land uses;

- Federal and state agencies, property owners, and other stakeholders should be contacted as early as possible in the planning process to identify potentially sensitive land uses and issues, rules that govern wind energy development locally, and land use concepts specific to the region;

- The DoD should be consulted regarding the potential impact of a proposed wind energy project on military operations in order to identify and address any DoD concerns;

- The FAA-required notice of proposed construction should be made as early as possible to identify any air safety measures that would be required;

- When feasible, a wind energy project should be sited on already altered landscapes;

- To plan for efficient land use, necessary infrastructure requirements should be consolidated whenever possible, and current transmission and market access should be evaluated; and

- Restoration plans should be developed to ensure that all temporary use areas are restored.

5.11 VISUAL RESOURCES

In the simplest terms, adverse visual impacts can be defined as unwelcome visual intrusions — or the creation of visual contrasts — that affect the quality of a landscape. The perception of adverse visual impacts reflects the belief that the use and development of lands and waters should not significantly detract from recognized scenic resources and scenic views and the conviction that conditions should be imposed on development to control unreasonable or unnecessary adverse effects on scenic resources (Smardon and Karp 1993).

It is widely acknowledged that aesthetic impacts are among the most important impacts associated with wind energy development and operations. However, it is difficult to determine the relative significance of aesthetic impacts (Hau 2000; Bisbee 2003). Visual impacts are intangible, highly subjective, and dynamic, and because they cannot be completely avoided, they are one of the greatest sources of objection to wind energy development projects (Bisbee 2003). Because of the subjective and experiential nature of visual resources, the human response to those changes and the significance of the impacts cannot be quantified, even though the visual impact of a proposed development can be described specifically (Hankinson 1999). This raises the challenge of making widely accepted, collective decisions about the relative worth and disposition of individual visual resource “experiences” relative to competing resource demands. Fortunately, there is also some commonality in individuals’ experiences of visual resources. While it may not be possible to objectively assess subjective experience and values, it is possible to systematically examine and characterize visual values and to reach consensus about visual impacts and their trade-offs. VRM procedures provide the means to evaluate, mediate, and mitigate the subjective nature of relative impacts on visual resources, and they are a critical part of decision making to evaluate any modification of the BLM landscapes for wind energy development.

Adverse visual impacts have in the past been referred to as “visual pollution.” In a review of EISs considering visual quality, Smardon and Karp (1993) found three major types of adverse visual impacts: unnatural intrusions of man-made appearance or disfigurement; partial degradation, reduction, or impairment of the existing level of visual quality; and complete loss of the visual resource. The BLM’s VRM system defines visual impact as the contrast perceived by observers between existing landscapes and proposed projects and activities (Section 4.8.1). The degree to which an activity intrudes on, degrades, or reduces the visual quality of a landscape depends on the amount of visual contrast it introduces. Visual changes or modifications that do not harmonize with landscapes often look out of place, and the resulting contrast may be unpleasant and undesirable. Environmental design concepts and techniques can be applied to minimize visual contrast, and thus visual impacts (see Section 5.11.6 regarding mitigation measures).

Visual contrasts are produced through a range of direct and indirect actions or activities. The BLM administers lands — and landscapes — that have valuable aesthetic or scenic qualities; these lands are also used for multiple activities that have the potential to disturb the surface of the landscape and impact scenic values. These activities, such as recreation, mining, timber harvest, livestock grazing, road development, wind power, and others, may also interact or synergize in complex ways. These interactions among impacting activities may be contemporaneous or they may represent more incremental and cumulative changes occurring over longer, possibly historic periods of time (see Section 6.4.1.11 regarding cumulative impacts). The following presents potential impacts on visual resources during each phase of a wind energy development project. Several sources were consulted during development of this list of impacts (AusWEA 2002; EECA 1995; EFSEC 2003; Gipe 1998, 2002; NWCC 2002; PBS&J 2002; and WDFW 2003a).

5.11.1 Site Monitoring and Testing

Possible sources of impacts to visual resources during site monitoring and testing include occasional, short-duration road traffic and parking, and associated dust; the erection and presence of meteorological towers; the presence of solar panels, if used, and the possibility of associated reflections producing sun glint; and the presence of idle or dismantled equipment, if allowed to remain on the site.

5.11.2 Site Construction

During construction, there are several possible sources of visual impacts. Road development (new roads or expansion of existing roads) may introduce strong visual contrasts in the landscape, depending on the route relative to surface contours, and the width, length, and surface treatment of the roads. Conspicuous and frequent small-vehicle traffic for worker access and frequent large-equipment (trucks, graders, excavators, and cranes) traffic for road construction, site preparation, and turbine installation are expected. Both would produce visible activity and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds and road surface materials. Temporary parking for worker's vehicles would be needed within staging areas or on adjacent surfaces. Unplanned and unmonitored parking could likely expand these areas, producing visual contrast by suspended dust and loss of vegetation in portions of the site. Site development may be progressive, persisting over a significant period of time. It may also be intermittent, staged, or phased, giving the appearance that work starts and stops. Repeated visual experiences may provoke perceptions of lost benefit and productivity, like that alleged for idle equipment. Timing and duration concerns may result. There would be a temporary presence of large cranes or a self-erection apparatus to assemble and mount towers, nacelles, and rotors. Duration may be short, depending on the number of turbines. All such equipment would produce emissions while operational and may thus create visible exhaust plumes. There may also be a temporary presence of support facilities and fencing associated with the construction work site.

Ground disturbance would result in visual impacts that produce contrasts of color, form, texture, and line. Excavating for turbine foundations and ancillary structures; trenching to bury electrical distribution systems; grading and surfacing roads; clearing and leveling staging areas; and stockpiling soil and spoils (if not removed) would (1) damage or remove vegetation, (2) expose bare soil, and (3) suspend dust. Destruction and removal of vegetation due to clearing, compaction, and dust are expected. Soil scars and exposed slope faces would result from excavation, leveling, and equipment movement. Invasive species may colonize disturbed and stockpiled soils and compacted areas. These species may be introduced naturally or in seeds, plants, or soils introduced for intermediate restoration, or by vehicles. The land area or footprint of installed equipment would be typically small, as little as 5 to 10% of the site, but could be susceptible to broader disturbance and alteration over longer periods of time. Site restoration activities would reduce many of these impacts.

5.11.3 Site Operation

Wind energy development projects on BLM-administered lands would be highly visible because of the introduction of turbines into typically rural or natural landscapes, many of which have few other comparable structures. Figures 5.11-1 through 5.11-3 show views of existing wind energy projects in Wyoming from different vantage points, distances, and perspectives. They illustrate the visual resource contrast elements from wind energy operations on the landscape. The artificial appearance of wind turbines may have visually incongruous “industrial” associations for some, particularly in a predominantly natural landscape. Visual evidence of wind turbines cannot be avoided, reduced, or concealed, owing to their size and exposed location; therefore, effective mitigation could be limited.

Daily and seasonal low sunlight conditions striking ridgelines and towers would tend to make them more visible and more prominent. Given the typical pale color of turbines, their color contrast with surroundings would likely be the least in the winter season, with less greening and more snowcover. In regions with variable terrain, wind developments along ridgelines would be most visible, particularly when viewed from other similar or lower elevations, owing partly to silhouetting against the sky. Much higher viewing points would reduce silhouetting. Valley alignment with wind energy projects may allow greater visibility (Burton 1997; EFSEC 2003; Owens 2003; and WDFW 2003a). Interposition of turbines between observers and the sun, particularly in the early and late hours of the day and during the winter season when sun angles are low, could produce a strobe-like effect from flickering shadows cast by the moving rotors onto the ground and objects. At its most severe, shadow flicker would be temporary and limited to daylight hours; it may be significant, however, because of its motion and frequency. A related

FIGURE 5.11-1 View of the Wyoming Wind Project near Arlington, Wyoming (Source: NREL 2004d. Photo #06584. Photo credit: Tom Hall.)

FIGURE 5.11-2 View of a Wind Energy Development Project near Evanston, Wyoming

FIGURE 5.11-3 Another View of a Wind Energy Development Project near Evanston, Wyoming

but less severe effect would be a sun-dial-like effect, also increased at low sun angles, as the shadows of very tall turbines sweep great distances over the landscape. Interposition of turbines between observers and the sun may also produce a strobe-like effect caused by the regular reflection of the sun off rotating turbine blades. Unlike shadow flicker, perception of blade glint would depend on the orientation of the nacelle, angle of the rotor, and the location of the observer relative to the position of the sun. Blade glint would also be influenced by the color, reflectivity, and age of the blades. This effect may be noticeable at distances of about 6.2 to 9.3 mi (10 to 15 km) and may be especially pronounced when aligned with roadways or other viewing corridors.

All aboveground ancillary structures (including fences around substations) would potentially produce visual contrasts by virtue of their design attributes (form, color, line, and texture) and by virtue of the reflectivity of their surfaces and resulting glare. If security and safety lighting are used, even if they are downwardly focused, visibility of the site would increase, particularly in dark nighttime sky conditions typical of rural areas. It would also contribute to sky glow resulting from ambient artificial lighting. Any degree of lighting would produce off-site “light trespass”; it would be most abbreviated, however, if the lighting was limited to just the substation and controlled by motion sensors.

FAA rules would require lights mounted on nacelles that flash white during the day and twilight (20,000 candela) and red at night (2,000 candela). White lights would be less obtrusive in daylight, but red lights would likely be conspicuous at great distances against dark skies

(Gipe 2002). Typically, the FAA requires warning lights on the first and last turbines in a string and every 1,000 to 1,400 ft (305 to 427 m) in between. Although these beacons would concentrate light in the horizontal plane, they would increase visibility of the turbines, particularly in dark nighttime sky conditions typical of rural areas. Beacons would likely not contribute (because of intermittent operation) to sky glow resulting from artificial lighting. The emission of light to off-site areas could be considerable.

Towers, nacelles, and rotors may need to be upgraded or replaced, thereby repeating initial visual impacts of construction and assembly. Opportunity and pressures to break uniformity between turbines and among components (different sizes, styles, and mixes) may be greater than during initial construction, thus potentially increasing visual contrast and visual "clutter." Additional construction and installation of monitoring equipment may be required to optimize measurements (change locations) or to replace or upgrade equipment. Repeated visual evidence of disturbance would result. Infrequent outages, disassembly, and repair of equipment may occur. These may produce the appearance of idle or missing rotors, "headless" towers (when nacelles are removed), and lowered towers. Negative visual perceptions of "lost benefits" (e.g., loss of wind power) and "bone yards" (for storage) may result.

Similar to other phases of development, occasional small-vehicle traffic for testing, commissioning, monitoring, maintenance, and repair, and infrequent large-equipment traffic for turbine replacements and upgrades can be expected. Both would produce apparent activity and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds and road surface materials.

5.11.4 Site Decommissioning

During decommissioning, impacts on visual resources would be similar to those encountered during construction. These impacts are related to road redevelopment, temporary fencing of the work site, intermittent or phased activity persisting over extended periods of time, removal of buried structures and equipment, and the presence of idle or dismantled equipment, if allowed to remain on site. Visual deconstruction impacts of heavy equipment, support facilities, and lighting would be substantially the same as those in the construction phase. Restoring a decommissioned site to preproject conditions would entail recontouring, grading, scarifying, seeding and planting, and perhaps stabilizing disturbed surfaces. Newly disturbed soils would create a visual contrast that would persist at least several seasons before revegetation would begin to disguise past activity. Restoration to preproject conditions may take much longer. Invasive species may colonize newly and recently reclaimed areas. These species may be introduced naturally or in seeds, plants, or soils introduced for intermediate restoration, or by vehicles. Nonnative plants that are not locally adapted would likely produce contrasts of color, form, texture, and line.

5.11.5 Synergistic Effects

The subjective quality of aesthetic impacts, including visual and auditory impacts, introduces the opportunity for multisensory responses to wind energy development and for the interaction of impacts in the perception of those exposed. Because soundscape and landscape are terms that may describe two simultaneous and overlapping qualities of the same environment, visual and aural signals may also interact in complex ways within the subjective experience of those who are viewing and listening.

Research finds that visual perception (in landscapes) is not neutral but is influenced by auditory impressions (Viollon 2003). More specifically, research specific to combined sensory reactions to wind turbines documents that noise annoyance is correlated to visual factors, such as a respondent's opinion of wind turbines' (visual) impact on the landscape (Pedersen and Waye 2003). Shadows, or "light shade," of turbines and their vanes in rotation are beginning to be investigated in relation to visual judgment of landscapes to better understand interactions between noise annoyance and visual disturbance (Pedersen and Waye 2003; Maffei and Lembo 2003). That visual and audible factors may be related, and that their impacts can interact, are accepted. An example may be seen in the finding that auditory "expectations" may be induced by visual "information" (Viollon 2003). Much research is now beginning to focus on how such synergisms work.

5.11.6 Mitigation Measures

Mitigation measures are a means of reducing visual impacts on public aesthetic resources. The BLM and USFS have established mitigation measures pertaining to visual impacts of energy production on federal lands of the western United States (BLM 1984, 1986a,b, 2004a-d; RMRCC 1989).

Additional mitigation measures have been derived from experiences with wind energy on several continents, particularly North America, Europe, and Australia. Useful lessons drawn from less-than-best practices in early California wind energy developments have enriched mitigation practices on other continents. North American experience in Texas and mountainous areas of the Appalachian region play a lesser role, although limited experience in Vermont, with its strong landscape protection tradition, offers informed perspective on visual impacts and mitigation. Europe offers the longest and most pervasive experience with contemporary (and ancient) wind energy development, especially with recent development in highly populated areas and with intensive social and aesthetic impacts. Australia might offer the best analog to development in the rural/remote, arid, range, and mountain lands of the western United States, but its literature does not yet provide sufficient information. Many sources were consulted in developing the following list of recommended mitigation measures for addressing visual impacts on BLM-administered lands (NWCC 2002; AusWEA 2002; Gipe 1998, 2002; NYSDEC 2000).

- Existing mitigation measures developed by the BLM regarding VRM should be followed.

- The public should be involved and informed about the visual site design elements of the proposed wind energy projects. Possible approaches include conducting public forums for disseminating information regarding wind energy development, such as design, operations, and productivity; offering organized tours of operating wind energy development projects (Gipe 2002); using computer simulation and visualization techniques in public presentations; and conducting surveys regarding public perceptions and attitudes about wind energy development.

- Turbine arrays and the turbine design should be integrated with the surrounding landscape. To accomplish this integration, several elements of design need to be incorporated.

  - The operator should provide visual order and unity among clusters of turbines (visual units) to avoid visual disruptions and perceived “disorder, disarray, or clutter” (Gipe 2002).

  - To the extent possible given the terrain of a site, the operator should create clusters or groupings of wind turbines when placed in large numbers; avoid a cluttering effect by separating otherwise overly long lines of turbines, or large arrays; and insert breaks or open zones to create distinct visual units or groups of turbines.

  - The operator should create visual uniformity in the shape, color, and size of rotor blades, nacelles, and towers (Gipe 1998).

  - The use of tubular towers is recommended. Truss or lattice-style wind turbine towers with lacework, pyramidal, or prism shapes should be avoided. Tubular towers present a simpler profile and less complex surface characteristics and reflective/shading properties.

  - Components should be in proper proportion to one another. Nacelles and towers should be planned to form an aesthetic unit and should be combined with particular sizes and shapes in mind to achieve an aesthetic balance between the rotor, nacelle, and tower (Gipe 1998).

  - Color selections for turbines should be made to reduce visual impact (Gipe 2002) and should be applied uniformly to tower, nacelle, and rotor, unless gradient or other patterned color schemes are used.

  - The operator should use nonreflective paints and coatings to reduce reflection and glare. Turbines, visible ancillary structures, and other equipment should be painted before or immediately after installation. Uncoated galvanized metallic surfaces should be avoided because they would create a stronger visual contrast, particularly as they oxidize and darken.

  - Commercial messages on turbines and towers should be prohibited (Gipe 2002).

- The site design should be integrated with the surrounding landscape.

  - To the extent practicable, the operator should avoid placing substations or large operations buildings on high land features and along "skylines" that are visible from nearby sensitive view points. The presence of these structures should be concealed or made less conspicuous. Conspicuous structures should be designed and constructed to harmonize with desirable or acceptable characteristics of the surrounding environment (Gipe 2002).

  - The operator should bury power collection cables or lines on the site in a manner that minimizes additional surface disturbance.

  - Commercial symbols (such as logos), trademarks, and messages should not appear on sites or ancillary structures of wind energy projects. Similarly, billboards and advertising messages should also be prohibited (Gipe 1998, 2002).

  - Site design should be accomplished to make security lights nonessential. Such lights increase the contrast between a wind energy project and the night sky, especially in rural/remote environments, where turbines would typically be installed. Where they are necessary, security lights should be extinguished except when activated by motion detectors (e.g., only around the substation) (Gipe 1998).

- Operators should minimize disturbance and control erosion by avoiding steep slopes (Gipe 1998) and by minimizing the amount of construction and ground clearing needed for roads, staging areas, and crane pads. Dust suppression techniques should be employed in arid environments to minimize impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils. Disturbed surfaces should be restored as closely as possible to their original contour and revegetated immediately after, or contemporaneously with construction. Action should be prompt to limit erosion and to accelerate restoring the preconstruction color and texture of the landscape.

- The wind development site should be maintained during operation. Inoperative or incomplete turbines cause the misperception in viewers that "wind power does not work" or that it is unreliable. Inoperative turbines should be completely repaired, replaced, or removed. Nacelle covers and rotor nose cones should always be in place and undamaged (Gipe 1998). Wind energy projects should evidence environmental care, which would also reinforce the expectation and impression of good management for benign or clean power. Nacelles and towers should also be cleaned regularly (yearly, at minimum) to remove spilled or leaking fluids and the dirt and dust that would accumulate, especially in seeping lubricants. Facilities and off-site surrounding areas should be kept clean of debris, “fugitive” trash or waste, and graffiti. Scrap heaps and materials dumps should be prohibited and prevented. Materials storage yards, even if thought to be orderly, should be kept to an absolute minimum. Surplus, broken, disused materials and equipment of any size should not be allowed to accumulate (Gipe 2002).

- Aesthetic offsets should be considered as a mitigative option in situations where visual impacts are unavoidable, or where alternative mitigation options are only partially effective or uneconomical (NYSDEC 2000, BLM 2005a). An aesthetic offset is a correction or remediation of an existing condition located in the same viewshed of the proposed development that has been determined to have a negative visual or aesthetic impact. For example, aesthetic offsets could include reclamation of unnecessary roads in the area, removal of abandoned buildings, cleanup of illegal dumps or trash, or the rehabilitation of existing erosion or disturbed areas (BLM 2005a).

- A decommissioning plan should be developed, and it should include the removal of all turbines and ancillary structures and restoration/reclamation of the site.

5.12 CULTURAL RESOURCES

While impacts to cultural resources are determined on a site-specific basis, certain activities associated with wind energy development have a greater potential for adversely affecting cultural resources than others, assuming such resources are present in the project area. Earthmoving activities (e.g., grading and digging) have the highest potential for disturbing or destroying significant cultural resources; however, pedestrian and vehicular traffic and indirect impacts of earthmoving activities, such as soil erosion, may also have an effect. Visual impacts on significant cultural resources, such as sacred landscapes, historic trails, and viewsheds from other types of historic properties (e.g., homes and bridges) may also occur. In this section, the activities that could potentially affect cultural resources are described for each stage of wind energy development, and relevant mitigation measures are presented.

5.12.1 Site Monitoring and Testing

The potential exists for impacts on cultural resources to occur during site monitoring and testing; however, the causes of possible impacts would be limited to minor ground-disturbing activities and activities that result in the potential for unauthorized collection of artifacts and acts of vandalism. Typically, excavation activities and road construction to provide access to the project area would be very limited. Some clearing or grading might be needed in order to install monitoring towers and equipment enclosures. If more extensive excavation or road construction was needed during this phase, more extensive impacts would be possible (see Section 5.12.2 for a discussion of impacts during construction).

Vehicular traffic and ground clearing (such as the removal of vegetative cover) might directly affect cultural resources if they are present in the project area by compacting soils, potentially crushing artifacts, disturbing historic features (e.g., trails), and displacing cultural material from its original context. These activities might also impact areas of interest to Native Americans, such as sacred areas or areas used for harvesting traditional resources, such as medicinal plants. Indirect effects on cultural resources might occur through an increased potential for soil erosion as a result of these activities. The collection of artifacts by workers or amateur collectors accessing areas that may have been previously inaccessible to the public would be another possible impact. Increased access might also increase the potential for vandalism. Although the activities that occur during the monitoring and testing phase are characterized as temporary actions, cultural resources are mostly nonrenewable and, once impacted (i.e., removed or damaged), are not likely to be recovered or returned to their proper context.

5.12.2 Site Construction

The construction of the infrastructure necessary for wind energy development has the greatest potential to impact cultural resources because of the increased ground disturbance during this phase. The amount of area disturbed could be considerable and would destroy cultural resources if they were present in that area. An indirect effect of this ground disturbance would be soil erosion, which could also impact cultural resources outside the construction footprint.

The development of a wind energy project and its associated access roads would provide access to areas that might have been previously inaccessible. Any increase in the presence of humans in an uncontrolled and unmonitored environment containing significant cultural resources increases the potential for adverse impacts caused by looting (unauthorized collection of artifacts), vandalism, and inadvertent destruction to unrecognized resources.

In addition, visual impacts on cultural resources could occur during the construction phase (see also Section 5.11). Large areas of exposed ground surface, increases in dust, and the presence of large-scale machinery, equipment, and vehicles could contribute to an adverse impact on cultural resources (e.g., those with a landscape component that contributes to their significance, such as a historic trail or sacred landscape).

5.12.3 Site Operation

Fewer impacts on cultural resources are likely from the operation of a wind development project than from its construction. Impacts associated with operation are possible, however, because of the improved access to the area and the presence of workers and the public. As stated above, human presence potentially increases the likelihood of unauthorized collection of artifacts and vandalism, as well as inadvertent destruction of unrecognized resources. In addition, there may be visual impacts on the resource (Section 5.11), since the visible wind turbines may be perceived as an intrusion on a sacred or historical landscape. If the development site would need to be expanded during operation, the impacts would be similar to those associated with construction.

5.12.4 Site Decommissioning

Very few impacts on cultural resources would be expected from decommissioning. Ground disturbance during decommissioning would be confined primarily to areas that were originally disturbed during construction. Most cultural resources are nonrenewable and would either have been removed professionally prior to construction or would have been already disturbed or destroyed by prior activities. However, visual impacts on cultural resources would be mostly removed after decommissioning, as long as the site was restored to its preconstruction state. Despite the physical removal of equipment and the institution of site restoration practices, the impact of a scarred environment in an area sacred to Native Americans would likely remain. If access roads were left in place, the potential for looting and vandalism would also remain and might even increase, since the area would no longer be periodically monitored by the operator. If additional work areas were needed beyond those disturbed during construction, there would be the potential for new impacts similar to those that would occur during construction.

5.12.5 Mitigation Measures

- The BLM should consult with Native American governments early in the planning process to identify issues and areas of concern regarding the proposed wind energy development. Aside from the fact that consultation is required under the NHPA, consultation is necessary to establish whether the project is likely to disturb traditional cultural properties, affect access rights to particular locations, disrupt traditional cultural practices, and/or visually impact areas important to the Tribe(s). Under the conditions of the nationwide BLM PA, the state BLM offices should already have established a relationship with local Tribal governments. A list of the federally recognized Tribes for the 11-state region is available in Chapter 7.

- The presence of archaeological sites and historic properties in the area of potential effect should be determined on the basis of a records search of recorded sites and properties in the area and/or an archaeological survey. The SHPO is the primary repository for cultural resource information, and most BLM Field Offices also maintain this information for lands under their jurisdiction.

- Archaeological sites and historic properties present in the area of potential effect should be reviewed to determine whether they meet the criteria of eligibility for listing on the NRHP. Cultural resources listed on or eligible for listing on the NRHP are considered “significant” resources.

- When any ROW application includes remnants of a National Historic Trail, is located within the viewshed of a National Historic Trail's designed centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP, the operator should evaluate the potential visual impacts to the trail associated with the proposed project and identify appropriate mitigation measures for inclusion as stipulations in the POD.

- If cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a CRMP should be developed. This plan should address mitigation activities to be implemented for cultural resources found at the site. Avoidance of the area is always the preferred mitigation option. Other mitigation options include archaeological survey and excavation (as warranted) and monitoring. If an area exhibits a high potential, but no artifacts are observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report should be prepared documenting these activities. The CRMP also should (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of artifacts and destruction of property on public land.

- Periodic monitoring of significant cultural resources in the vicinity of development projects may help curtail potential looting/vandalism and erosion impacts. If impacts are recognized early, additional actions can be taken before the resource is destroyed.

- Unexpected discovery of cultural resources during construction should be brought to the attention of the responsible BLM authorized officer immediately. Work should be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

5.13 ECONOMICS

The economic impact of wind energy development projects on BLM-administered lands was assessed at the state level for each of the 11 western states. Impacts were measured in terms of employment, income, GSP and tax revenues (sales and state income), and ROW rental receipts to the federal government. The impact of wind energy development projects on property values was also assessed.

To calculate impacts, representative data from a range of recent wind energy development projects in the western United States were used (PBS&J 2002; Cox 2004; ECONorthwest 2002; Northwest Economic Associates 2003; Goldberg et al. 2004). These data include material and labor costs and employment for project construction and operation, and fiscal data used to estimate sales and income tax revenues. These data were used to calculate the direct economic and fiscal impacts of a representative wind energy development project. IMPLAN economic data were then used to calculate the indirect impacts associated with wind energy development project wage and salary spending, material procurement spending, and expenditures of tax revenues (Minnesota IMPLAN Group 2004).

Impact estimates were based on projections of potential wind development on BLM-administered land taken from the WinDS model calculations generated by NREL (see Table 5.13-1 and Appendix B). The WinDS model takes into account project location, power generation capital costs, fossil fuel prices, and transmission system issues in determining maximum market potential for wind power for each state. As discussed in Appendix B and reflected in Table 5.13-1, the WinDS model was used to calculate total potential wind energy supply over the next 20 years in each state of the study area; additional analyses were conducted to estimate which portion of that state total would be located on BLM-administered lands. The WinDS model relies heavily on the assumptions and results from the reference case in DOE (2004a), as developed by the DOE Energy Information Administration, for input data on electricity demand, fossil fuel prices, generator costs, and other driving factors. While this reference case is a reasonable projection of the future U.S. energy situation, it is always possible that unforeseen factors might change those projected economic circumstances. For example, a major recession in the United States could dampen future electricity demand; or natural gas resources might prove to be more plentiful, which would decrease gas prices and increase the demand for gas-fired generation. Wind supply projections from the WinDS model that form the basis of the economic impact analysis for this PEIS include the PTC but exclude renewable energy portfolio standards.

5.13.1 Summary of Economic Impacts

Except in California and Nevada, the WinDS model predicts only relatively small amounts of wind energy development during the period 2005 to 2015. By 2025, all states would have wind energy development, but the majority would be concentrated in California, Nevada, and Utah (Figure 5.13.1-1).

The economic impacts of construction and operation activities associated with wind energy development projects on BLM-administered lands as projected by the WinDS model are shown in Tables 5.13.1-1 through 5.13.1-3 for the three years 2005, 2015, and 2025. Impacts include both the direct and indirect effects of project construction and operation. Direct impacts would include the creation of new jobs for workers at wind energy development projects and the associated income and taxes paid. Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the expanded workforce or that provide project materials, and associated income and taxes. Impacts of construction presented in the three tables represent the total impacts of all wind energy projects on BLM-administered land for each year, rather than the impacts of new energy projects completed in each year. Impacts of operation correspond to the annual impact of operating wind developments in each year.

TABLE 5.13-1 Projected Wind Power Development by State, Landholding, and Year (MW)[a,b]

State	Landholding	2005	2015	2025
Arizona	Non-BLM	19	37	192
	BLM	1	2	31
	Total	20	40	223
California	Non-BLM	2,830	5,395	7,651
	BLM	784	1,323	1,462
	Total	3,614	6,718	9,113
Colorado	Non-BLM	225	622	1,848
	BLM	33	67	85
	Total	258	688	1,933
Idaho	Non-BLM	75	156	916
	BLM	52	105	185
	Total	127	261	1,101
Montana	Non-BLM	121	397	1,287
	BLM	10	27	37
	Total	131	424	1,325
Nevada	Non-BLM	417	545	604
	BLM	388	574	701
	Total	805	1,119	1,305
New Mexico	Non-BLM	476	952	1,344
	BLM	54	108	199
	Total	530	1,060	1,543
Oregon	Non-BLM	452	743	1,562
	BLM	92	144	196
	Total	543	887	1,758
Utah	Non-BLM	162	467	485
	BLM	89	248	256
	Total	251	716	741
Washington	Non-BLM	246	630	1,314
	BLM	3	6	12
	Total	249	636	1,326
Wyoming	Non-BLM	105	211	357
	BLM	12	24	75
	Total	117	234	433
Total	Non-BLM	5,128	10,154	17,561
	BLM	1,517	2,628	3,240
	Total	6,645	12,782	20,801

[a] Totals may be off due to rounding. Projections include additional new capacity on private and BLM-administered lands; existing capacity is excluded.

[b] According to the AWEA (2004), 1 MW of wind-generated power creates enough electricity to supply about 240 to 300 households per year.

Source: WinDS Model (Appendix B).

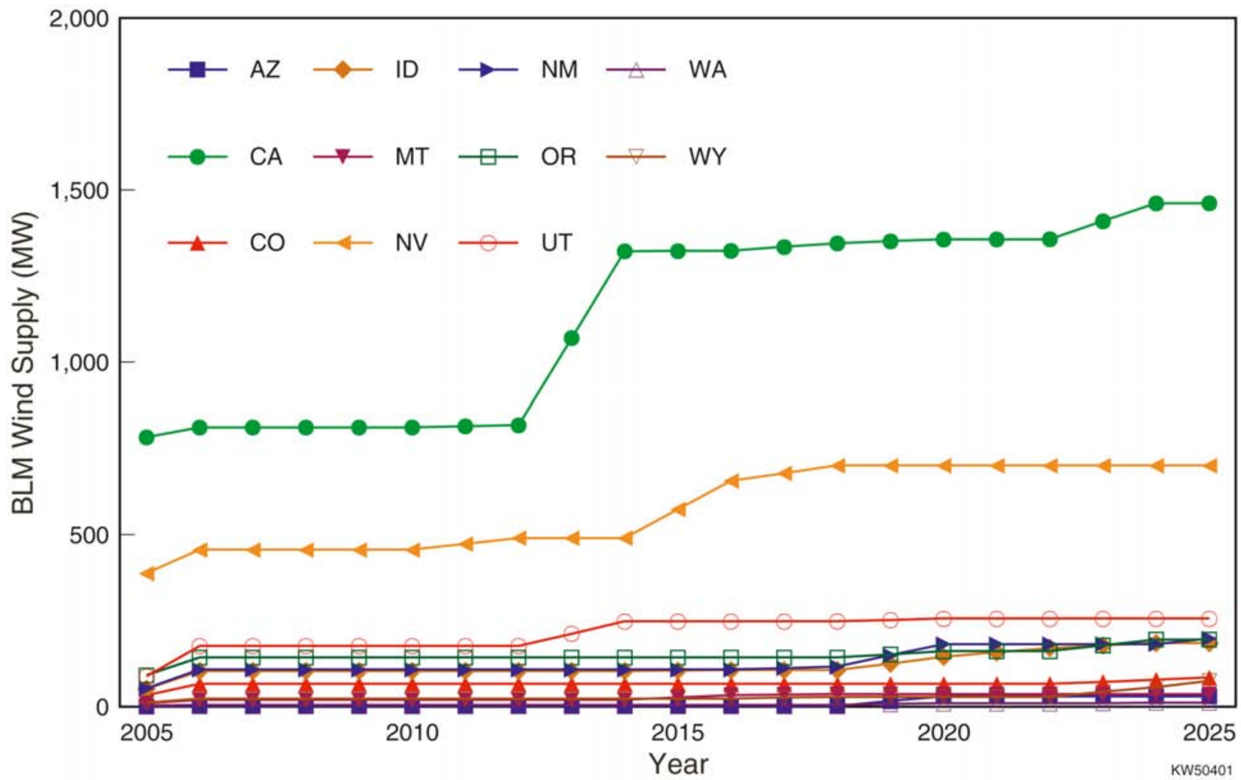

FIGURE 5.13.1-1 Projected Wind Power Development on BLM-Administered Lands by State and Year

The WinDS model predicts that all states in the study area would have wind energy development on BLM-administered lands by 2005. In Arizona and Washington, the level of development on BLM-administered lands would be very low (i.e., less than 5 MW), and most of the development would be in California (784 MW) and Nevada (388 MW). Construction activities associated with these projects would generate 560 direct and 1,590 overall jobs in California, $71 million in income, and $252 million in GSP (Table 5.13.1-1). The state would collect $17 million in sales taxes, and $4.5 million in income taxes would be generated. Impacts in Nevada in 2005 would be slightly smaller than those in California, with 280 direct and 700 total jobs created, $29 million in income, and $112 million in GSP generated. The State of Nevada would collect $7.9 million in sales taxes.

Operational activities on BLM-administered lands by 2005 would generate 210 direct and 270 total jobs in California, $11 million in income, $25 million in GSP, $2.6 million in sales taxes, and $4.6 million in income taxes (Table 5.13.1-1). Under the rental rates defined in the BLM Interim Wind Energy Policy (BLM 2002a) (Appendix A), wind energy operations in California would also produce $1.9 million in ROW rental receipts to the federal government. In Nevada, wind energy project operation would create 110 direct and 120 total jobs, $4.5 million in income, and $11 million in GSP. Sales taxes generated would amount to $1.2 million. ROW rental receipts in Nevada would amount to $0.9 million.

TABLE 5.13.1-1 Economic Impacts of Projected Wind Power Development on BLM-Administered Lands in 2005 ($ millions 2003, except employment)[a]

Economic Indicator	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Utah	Washington	Wyoming
Construction											
Employment											
Direct	0	560	20	40	10	280	40	70	60	0	10
Total	0	1,590	70	110	20	700	130	90	210	10	20
Income											
Direct	0	18.2	0.8	1.2	0.2	9.0	1.3	2.1	2.1	0.1	0.3
Total	0.1	71.4	3.0	4.0	0.7	29.3	4.4	7.3	7.4	0.2	0.8
Gross state product	0.3	252.0	10.7	15.5	2.9	111.8	17.0	27.7	28.0	0.9	3.5
Taxes											
Sales	0	17.3	0.7	1.1	0.2	7.9	1.2	1.9	1.9	0.1	0.2
Income	0	4.5	0.2	0.3	0	0.0	0.3	0.5	0.5	0	0.0
Operations											
Employment											
Direct	0	210	10	10	0	110	20	30	20	0	0
Total	0	270	10	20	0	120	20	40	40	0	10
Income											
Direct	0	6.0	0.3	0.4	0.1	3.0	0.4	0.7	0.7	0	0.1
Total	0	10.7	0.4	0.6	0.1	4.5	0.6	1.2	1.1	0	0.1
Gross state product	0	25.1	1.0	1.5	0.3	10.8	1.6	2.8	2.8	0.1	0.3
Taxes											
Sales	0	2.6	0.1	0.2	0	1.2	0.2	0.3	0.3	0	0
Income	0	4.6	0.2	0.3	0	0.0	0.3	0.5	0.5	0	0.0
ROW rental receipts[b]	0	1.9	0.1	0.1	0	0.9	0.1	0.2	0.2	0	0

[a] Employment = number of jobs. Impacts are the result of projected, new capacity on private and BLM-administered lands; impacts from existing capacity are excluded.

[b] ROW rental receipts to the federal government include annual minimum rent only, as based on installed capacity (in MW). The BLM may also charge additional production rents, depending on electricity production. These additional rents are not included since the projected electricity output from wind development is uncertain.

TABLE 5.13.1-2 Economic Impacts of Projected Wind Power Development on BLM-Administered Lands in 2015 ($ millions 2003, except employment)[a]

Economic Indicator	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Utah	Washington	Wyoming
Construction											
Employment											
Direct	0	940	50	80	20	410	80	100	180	0	20
Total	10	2,690	140	230	60	1,040	260	300	590	10	50
Income											
Direct	0.1	30.8	1.5	2.4	0.6	13.3	2.5	3.3	5.8	0.1	0.6
Total	0.2	120.6	6.0	8.0	1.9	43.4	8.8	11.5	20.9	0.5	1.7
Gross state product	0.7	425.5	21.4	31.3	7.9	165.4	34.0	43.4	78.7	1.8	6.9
Taxes											
Sales	0	29.2	1.5	2.2	0.6	11.7	2.3	3.0	5.4	0.1	0.5
Income	0	7.6	0.4	0.5	0.1	0.0	0.6	0.7	1.3	0	0.0
Operations											
Employment											
Direct	0	360	20	30	10	160	30	40	70	0	10
Total	0	450	20	50	10	170	40	60	110	0	10
Income											
Direct	0	10.1	0.5	0.8	0.2	4.4	0.8	1.1	1.9	0	0.2
Total	0	18.1	0.9	1.2	0.3	6.7	1.3	1.9	3.2	0.1	0.3
Gross state product	0.1	42.5	2.1	3.1	0.8	16.0	3.2	4.4	7.8	0.2	0.6
Taxes											
Sales	0	4.3	0.2	0.3	0.1	1.8	0.3	0.5	0.8	0	0.1
Income	0	7.8	0.4	0.6	0.2	0.0	0.6	0.8	1.4	0	0.0
ROW rental receipts[b]	0	3.1	0.2	0.2	0.1	1.4	0.3	0.3	0.6	0	0.1

[a] Employment = number of jobs. Impacts are the result of projected, new capacity on private and BLM-administered lands; impacts from existing capacity are excluded.

[b] ROW rental receipts to the federal government include annual minimum rent only, as based on installed capacity (in MW). The BLM may also charge additional production rents, depending on electricity production. These additional rents are not included since the projected electricity output from wind development is uncertain.

TABLE 5.13.1-3 Economic Impacts of Projected Wind Power Development on BLM-Administered Lands in 2025 ($ millions 2003, except employment)[a]

Economic Indicator	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Utah	Washington	Wyoming
Construction											
Employment											
Direct	20	1,040	60	130	30	500	140	140	180	10	50
Total	60	2,980	180	400	80	1,270	480	410	610	20	160
Income											
Direct	0.7	34.0	2.0	4.3	0.9	16.3	4.6	4.6	6.0	0.3	1.8
Total	2.6	133.3	7.6	14.1	2.7	53.0	16.2	15.7	21.5	0.9	5.3
Gross state product	9.6	470.2	27.4	55.1	10.9	202.1	62.6	59.3	81.2	3.6	22.1
Taxes											
Sales	0.6	32.3	1.9	3.9	0.8	14.3	4.3	4.1	5.6	0.3	1.6
Income	0.2	8.4	0.5	0.9	0.2	0.0	1.0	1.0	1.4	0.0	0.0
Operations											
Employment											
Direct	10	400	20	50	10	190	50	50	70	0	20
Total	10	500	30	80	20	210	80	80	110	0	30
Income											
Direct	0.2	11.2	0.7	1.4	0.3	5.4	1.5	1.5	2.0	0.1	0.6
Total	0.4	20.0	1.1	2.2	0.4	8.1	2.4	2.5	3.3	0.2	0.8
Gross state product	0.9	46.9	2.6	5.4	1.0	19.5	5.8	6.0	8.1	0.4	2.0
Taxes											
Sales	0.1	4.8	0.3	0.6	0.1	2.2	0.6	0.6	0.8	0.0	0.2
Income	0.2	8.6	0.5	1.1	0.2	0.0	1.1	1.1	1.5	0.0	0.0
ROW rental receipts[b]	0.1	3.5	0.2	0.4	0.1	1.7	0.5	0.5	0.6	0.1	0.2

[a] Employment = number of jobs. Impacts are the result of projected, new capacity on private and BLM-administered lands; impacts from existing capacity are excluded.

[b] ROW rental receipts to the federal government include annual minimum rent only, as based on installed capacity (in MW). The BLM may also charge additional production rents, depending on electricity production. These additional rents are not included since the projected electricity output from wind development is uncertain.

By 2015, wind energy development on BLM-administered lands would have increased in all states, although production in Arizona and Washington would still be quite low (2 MW and 6 MW, respectively), and continuing development in California (1,323 MW) and Nevada (574 MW) would still be greatest. In California, construction activities would produce 2,690 jobs, $121 million in income, and $426 million in GSP. Sales taxes and income taxes generated would amount to $29 million and $7.6 million, respectively (Table 5.13.1-2). Smaller impacts would occur in Nevada, with 1,040 jobs created, $43 million in income, and $165 million in GSP. The state would collect $12 million in sales taxes. Jobs would also be created in Utah (590), Oregon (300), New Mexico (260), Idaho (230), and Colorado (140).

By 2015, wind energy operations on BLM-administered lands in California would produce 450 jobs, $18 million in income, and $43 million in GSP (Table 5.13.1-2). Sales taxes and income taxes generated would amount to $4.3 million and $7.8 million, respectively. Wind power operations in California would also produce $3.1 million in ROW rental receipts to the federal government. Smaller impacts would occur in Nevada, with 170 jobs created, $6.7 million in income, and $16 million in GSP. Sales taxes generated would amount to $1.8 million. Wind energy operations in Nevada would also generate $1.4 million in ROW rental receipts to the federal government. Jobs would also be created in Utah (110), Oregon (60), Idaho (50), and New Mexico (40).

By 2025, wind energy development on BLM-administered land would have increased in all states, although production in Washington would remain around 12 MW. While continuing development would still be greatest in California (1,462 MW) and Nevada (701 MW), development in Utah (256 MW), Oregon (196 MW), New Mexico (199 MW), and Idaho (185 MW) would reach appreciable levels. In California, construction activities would produce 2,980 jobs, $133 million in income, and $470 million in GSP (Table 5.13.1-3). Sales taxes and income taxes generated would amount to $32 million and $8.4 million, respectively. Smaller impacts would occur in Nevada, with 1,270 jobs created, $53 million in income, and $202 million in GSP; $14 million in sales taxes would also be generated. Jobs would also be created in Utah (610), New Mexico (480), Oregon (410), Idaho (400), and the other five states.

By 2025, wind energy operations on BLM-administered lands in California would generate 500 jobs, $20 million in income, and $47 million in GSP (Table 5.13.1-3); $4.8 million in sales taxes and $8.6 million in income taxes would also be generated. Wind power operations in California would also produce $3.5 million in ROW rental receipts to the federal government. Smaller impacts would occur in Nevada, with 210 jobs created, $8.1 million in income, and $19.5 million in GSP; $2.2 million in sales taxes would also be generated. Wind power operations in Nevada would also produce $1.7 million in ROW rental receipts to the federal government. Smaller impacts would occur in Utah (110 jobs created), Idaho (80 jobs), New Mexico (80 jobs), Oregon (80 jobs), and the other five states.

5.13.2 Property Value Impacts

The potential impact of wind energy development projects on residential property values has often been a concern in the vicinity of locations selected for wind power. Although this PEIS does not directly assess the potential impacts of wind power on property values, a review of two studies that examined potential property value impacts of wind power facilities suggests that there would not be any measurable negative impacts.

ECONorthwest (2002) interviewed county tax assessors in 13 locations that had recently experienced multiple-turbine wind energy developments. While not all the locations chosen had wind turbines that were visible from residential areas, and some development projects had been constructed too recently for their full impact to be properly assessed, the study found no evidence that wind turbines decreased property values. Indeed, in one area examined, it was found that designation of land parcels for wind development actually increased property values.

Sterzinger et al. (2003) analyzed the effects of 10 wind energy development projects built during the period 1998 to 2001 on housing sale prices. The study used a hedonic statistical framework that attempted to account for all influences on changes in property value; its data came from sales of 25,000 properties, both within view of recent wind energy developments and in a comparable region with no wind energy projects, before and after project construction. The results of the study indicate that there were no negative impacts on property values. For the majority of the wind energy projects considered, property values actually increased within the viewshed of each project. Property values also tended to increase faster in areas with a view of the wind turbines than in areas with no wind projects.

5.14 ENVIRONMENTAL JUSTICE

The analysis of environmental justice issues associated with the development of wind energy projects on BLM-administered lands considered impacts at the state level in 11 western states. Site monitoring and testing, construction, operation, and decommissioning of wind energy development projects on BLM-administered lands in the 11 western states could impact environmental justice if any adverse health and environmental impacts resulting from any phase of wind development were significantly high, and if these impacts would disproportionately affect minority and low-income populations. If the analysis determined that health and environmental impacts would not be significant, there would not be any disproportionate impacts to minority and low-income populations. In the event that impacts were significant, disproportionality would be determined by comparing the proximity of high and adverse impacts to the location of low-income and minority populations.

Section 4.11 describes the distribution of low-income and minority populations in the 11-state study area. Data presented at the state level only provide a general indication of the potential for environmental justice concerns on BLM-administered lands in each state. The analysis undertaken for specific wind energy development projects would need to consider the potential impact on environmental justice at a more local level, where the relative concentration of minority and low-income populations could be significantly different from that at the state level.

5.14.1 Site Monitoring and Testing

Activities associated with site monitoring and testing activities would be relatively limited and typically would result in little change to the landscape. Unless extensive access road construction is involved, it is unlikely that there would be any significantly high adverse impacts associated with this phase of wind energy development on BLM-administered lands. Therefore, it is unlikely that there would be an environmental justice issue associated with these activities.

5.14.2 Site Construction

Noise and dust impacts during construction of wind towers and related transmission and other facilities would likely be minimal given the small amount of land typically disturbed and the relative remoteness of sites usually chosen for wind energy development projects. Mitigation can be applied to keep dust impacts to a minimum. A more significant issue may be impacts from access roads required during construction for the delivery of equipment and materials to wind energy development project sites. Associated visual impacts also could be a concern. Depending on the terrain across which these roads would be constructed, access road length, the length of time they would be used for construction traffic, the volume of traffic, and the proximity to minority and low-income populations, there could be environmental justice issues associated with wind energy project construction on BLM-administered lands.

5.14.3 Site Operation

A major potential environmental justice impact of wind energy development project operation on BLM-administered lands could be the visual impact of wind towers and associated transmission infrastructure. Although the MPDS and the BLM’s policies exclude development on BLM-administered lands that are designated as being of scenic quality or interest, wind energy development projects could potentially alter the scenic quality in areas of traditional or cultural significance to minority and low-income populations.

Impacts from project operation could also create an environmental justice issue if noise impacts from wind turbine operation are significant. The extent to which noise is an issue would depend on the number of towers in any specific wind energy development project, and the proximity to minority and low-income populations. Additional potential areas of environmental justice concern during operations would be electromagnetic exposure and shadow flicker. Although a range of mitigation measures could be implemented to ensure that the risk to the human population would be minimal (Section 5.8), there may be some health and safety risks with respect to these hazards. The extent to which these hazards create an environmental justice concern would depend on the precise location of low-income and minority populations in relation to specific wind energy development projects. Full analysis of the potential impacts of specific projects on low-income and minority populations would be undertaken as part of site-specific NEPA reviews of each proposed wind energy development site.

5.14.4 Site Decommissioning

Activities occurring during decommissioning would be largely the same as those that occur during construction, only in reverse. As a result, the potential for significantly high adverse impacts to disproportionately affect minority and low-income populations should be about the same during both phases, assuming population demographics remain stable over the life of the wind energy development project.

5.15 EVALUATION AND IDENTIFICATION OF PROGRAMMATIC BMPs

The PEIS analysis of the potential impacts of wind energy development and relevant mitigation measures presented in Sections 5.1 through 5.14 was used to identify the programmatic BMPs to be included in the proposed Wind Energy Development Program (Section 2.2.3.2). The process for evaluating and identifying the programmatic BMPs is discussed below. An assessment of the effectiveness of the programmatic BMPs at mitigating potential impacts, along with an assessment of other aspects of the proposed Wind Energy Development Program, is presented in Chapter 6. The management alternatives to the proposed action also are assessed in Chapter 6.

One objective of the proposed program is to establish programmatic BMPs that would be applicable to all wind energy development projects on BLM-administered lands. As a result, the mitigation measures discussed in this chapter were reviewed to determine whether they are applicable to all wind energy development projects. Certain mitigation measures address issues that are likely to occur in a limited number of locations (e.g., efforts needed to minimize impacts to the movement and safe passage of fish) or only for specific species (e.g., mitigations for impacts to sage-grouse or golden eagles). These mitigation measures would be relevant to wind energy development on BLM-administered lands at specific locations and, in accordance with a policy included in the proposed Wind Energy Development Program, they would be incorporated into the project-specific POD and the ROW authorization stipulations, as needed, to address site-specific and species-specific issues. However, because these types of mitigation measures are not applicable to all projects, they are not included in the proposed programmatic BMPs.

Additional mitigation measures presented in Sections 5.1 through 5.14 are not included in the programmatic BMPs because they provide relatively detailed guidance regarding issues that are common to a variety of activities other than wind energy development on BLM-administered lands (e.g., road construction and maintenance, wildlife management, hazardous materials and waste management, cultural resource management, pesticide use, and integrated pest management). The proposed Wind Energy Development Program includes a policy stating that the requirements of other, existing and relevant BLM mitigation guidance will be incorporated into project PODs, as appropriate.