3 OVERVIEW OF WIND ENERGY PROJECTS

3.1 DESCRIPTION OF WIND ENERGY PROJECTS

The following sections describe the activities likely to occur during each of the major phases associated with the development of a wind energy project: site testing and monitoring, construction, operation, and decommissioning. An overview of wind energy technology, including discussions of terminology, turbine design, existing commercial wind projects, and research and development, is presented in Appendix D. The descriptions in this section are based upon the information presented in Appendix D, literature reviews, and interviews with wind energy developers.

3.1.1 Site Monitoring and Testing Activities

Site monitoring and testing involve the collection of sufficient amounts of meteorological data to accurately characterize the wind regime. These data are used to support decisions on whether the wind resources at the site are suitable for development and, if so, the appropriate number, type, and location of wind turbines.

The collection of meteorological data requires the erection of meteorological towers equipped with weather instruments. These towers can be as high as 165 ft (50 m); meteorological data, however, are collected at appropriate heights as determined by the site-specific wind resources and terrain. In general, most sites can be adequately characterized with 10 or fewer towers, although the required number of towers depends on the size of the project area and the complexity of the terrain. The towers are interconnected with data collection and integration equipment. This equipment is usually in a weatherproof enclosure centrally located between the towers. Data may be communicated by radio transmitter to a remote location for processing or aggregated electronically on the site and collected periodically by maintenance personnel.

Meteorological towers are typically metal (galvanized or painted), lattice-type structures, and many are equipped with self-erecting capabilities. However, composite materials are also being used.[1] Heavy-duty all-wheel-drive pickup trucks or medium-duty trucks are usually sufficient to transport the towers to the site; many towers are permanently mounted to their own trailers. It is estimated that it takes less than 1 day to erect each tower. Towers and instruments are relatively lightweight and often do not require belowground foundations, especially if they are to be in service for limited periods of time; however, guy wires may be necessary for the larger towers in very windy areas. Some smaller towers are designed to be erected directly from their transport trailers, with the trailer effectively serving as the foundation. The towers typically do not require signal lights, but as developers seek to install taller towers so that the elevation of meteorological instruments approximates the hub heights of anticipated turbines, meteorological towers may become subject to FAA signal lighting requirements. Such taller towers may also

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1 Although the classical design for meteorological towers has been the open lattice type, some manufacturers are now offering smooth-skinned towers (e.g., IsoTruss Structures, Inc. 2004; see also Compositesworld 2003).

require subsurface foundations, especially if they are expected to remain in service beyond the site testing period and throughout the operational phase of the wind energy project. Signal cables used during the site monitoring and testing phase are not likely to be buried. As noted above, at least some of the monitoring towers would remain operational throughout the life of the site and would ultimately require a more permanent installation. For these towers, subsurface foundations may be required.

Very little in the way of site modification is necessary during this phase. Only the most remote sites require construction of a minimum-specification access road, which may be upgraded later to become the site's main access road. Only a small crew is required to erect the meteorological towers, and typically no personnel support facilities are required.

Meteorological data, such as data on wind speed and direction, wind shear, temperature, and humidity, are typically collected over a period of at least 1 year. However, some developers may choose to collect data for as long as 3 years to account for anticipated annual weather variations. This is permitted under the terms of the BLM's Interim Wind Energy Development Policy (BLM 2002a) (Appendix A), which allows ROW authorizations for site monitoring and testing for up to 3 years. During this phase, the site is unattended, with periodic visits by maintenance personnel. At the end of the site monitoring and testing phase, temporary towers are removed.

3.1.2 Site Construction Activities

The specific requirements of construction are very site dependent. The following discussion is intended to represent typical expected construction activities. However, some qualifiers to these construction activities are also introduced because of unique site conditions. Construction of a wind energy development project is likely to involve the following major actions: establishing site access; performing site grading; constructing lay-down areas and an on-site road system; removing vegetation from construction and lay-down areas (primarily for fire safety); excavating for tower foundations; installing tower foundations; erecting towers; installing nacelles and rotors; installing permanent meteorological towers (as necessary); constructing the central control building and a weatherproof equipment and parts storage area (which may be separate or combined with the control building); constructing electrical substations; interconnecting towers, the control building, meteorological towers, and substations with power-conducting cables and signal cables; and performing shake-down tests. Additional activities may also be necessary at very remote locations or for very large wind energy projects; they can include constructing temporary offices, sanitary facilities, or a concrete batching plant.

Site development strategies and construction schedules are also very site dependent. While many wind energy development projects can be constructed in 1 year or less, very large projects consisting of hundreds of turbines may be developed in phases. The schedules for each phase are dictated by electric power market conditions and can stretch over several years. Market forces and phased development notwithstanding, developers can be expected to develop sites in accordance with economies of scale whenever possible. To take full advantage of such economies, similar activities are likely to be completed throughout the entire site over a continuous period during site development. (For example, specialty crews would be brought to the site to complete all of their functions throughout the site, such as grading, excavating for tower foundations, installing tower foundations, erecting the towers, and installing the nacelles and rotors.) Each of the major aspects of site development is discussed in detail in one of the following subsections.

3.1.2.1 Site Access, Clearing, and Grade Alterations

Specifications for the main access road would be dictated by the expected weights of the vehicles transporting turbine components and the construction and lifting equipment that would be used during construction.[2] Because some of the turbine components are extremely long (e.g., blades) or heavy (e.g., nacelles containing all drivetrain components except the rotor), ROW clearances and minimum turning radii also become critical parameters for road design. Typically, access roads would be a minimum of 10 ft (3 m) wide, but they may need to be as much as 30 ft (9 m) wide to accommodate wide or excessively long loads (PBS&J 2002). A ROW approximately twice the final width of the road would typically be required. All ground disturbances would likely be confined to the ROW. Finally, 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.[3] 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 to follow a serpentine path. Other site-specific factors, such as streams and immovable obstacles, would also dictate the path. At a minimum, construction of the access road would require removing vegetative cover. Because candidate sites can be in forested areas, clearing the road path may also involve some tree removal. Depending on subsurface stratigraphy, surface soils may need to be excavated, and gravel and/or sand may need to be imported to establish a sufficiently stable road base. The road is expected to have all-weather capability but is not likely to be paved. Compacted gravel is the most likely finishing material. Although the ideal path would be chosen to avoid grade changes as much as possible, some grade alterations can nevertheless be anticipated. Engineered storm water control may be necessary, and natural drainage patterns are likely to be altered, at least on a local scale. In sites with near-surface aquifers, provisions for subsurface drainage may be required to maintain road stability. The road base itself may also act as an artificial path for subsequent groundwater movements. Although wetlands would be avoided, roadways in the vicinity of wetlands may still need to be evaluated for their impacts on the wetlands.

Transportation logistics have become a major consideration for wind energy development projects because of the trend toward larger rotors and taller towers. Depending on contractual arrangements, either the site developer or the turbine manufacturer (or a transportation subcontractor) is responsible for securing all necessary permits (Steinhower 2004). Depending

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2 It is conceivable that some sites would require multiple access paths; however, it is expected that only one main path would be established over which the heavy and/or large construction equipment and turbine components would be brought to the site.

3 See Table D-2, Appendix D, for anticipated ranges of turbine component sizes and weights.

on the location of the manufacturer's fabrication plant, transportation may involve ship, barge, rail, and/or road transport. While the majority of environmental impacts would occur while creating access to the site from existing public highways, previously disturbed public or private roadways may also need to be altered to accommodate heavy and/or oversized transport vehicles. It is reasonable to expect that special road transportation permits would be required for some vehicles, and modifications to existing roads may also be necessary. Excessive weight may require fortification of existing bridges. Large loads may require the temporary removal of height or turning radius obstacles.

On-site roads can also be expected to be built to the minimum specifications necessary to support vehicles for transporting turbine components and construction and lifting equipment. Constructing both the access road and the on-site roads may also involve fording streams or creeks. However, if fording a river with a permanent structure is unavoidable, it is likely that the development costs would increase to the point that either an alternative access route would be selected, or the site would no longer be considered a viable candidate for development. However, as mentioned previously, fortifications of existing bridges on public or private roads would still be within the realm of possibility.

On the basis of experience to date, the final footprint of the wind energy development project (turbine towers, control buildings, transformer pads, electric substations, roads, and other ancillary structures) is likely to be no more than 5 to 10% of the total acreage of the site. Additional areas would incur temporary impacts resulting from the construction of equipment lay-down areas and crane staging areas, as they are needed; such areas then would be reclaimed. There is some flexibility as to where lay-down areas would be located, and developers are likely to adapt to site conditions to keep creation of these areas as simple as possible. At a minimum, the construction of equipment lay-down areas and crane staging areas could involve removing vegetation for purposes of safety, access, and visibility during lifting operations. Additional controls may be necessary regarding the final disposition of this biomass. Although surface soils may not need to be removed from the construction zone, some regrading might occur to create relatively level areas, and rock and/or gravel are expected to be laid down to give these areas all-weather accessibility and to support the weights of vehicles and staged equipment. It is estimated that as much as 1 to 3 acres (0.4 to 1.2 ha) of land area may need to be cleared for each turbine, and numerous lay-down and crane staging areas can be anticipated over the period of site development. However, depending on the turbine array, the same areas would likely support erection of more than one turbine. Regardless of whether regrading occurs, the soils in these lay-down areas can be expected to be compacted as a result of construction and transportation vehicle traffic and the temporary storage of equipment and construction materials. In addition to the clearing of lay-down and crane staging areas, intervening areas may also need to be cleared of trees to provide overhead clearance for suspended turbine components being brought into position. Some areas cleared for construction purposes would be revegetated with indigenous vegetation once construction is completed. However, smaller areas around towers, control buildings, and electrical substations would have to be maintained free of vegetation throughout the operating life of the wind energy project for safety and access purposes. These areas are likely to be covered in rock or gravel to ensure all-weather accessibility.

3.1.2.2 Foundation Excavations and Installations

The tall towers anticipated in future wind energy development projects would require substantial foundations, nominally extending to depths of 35 to 40 ft (11 to 12 m), depending on subsurface conditions. On the basis of what is already known about subsurface stratigraphy, geotechnical studies may need to be performed to establish foundation specifications. Geotechnical surveys, if necessary, would involve numerous borings with hollow core augers to nominal depths of 40 ft (12 m) or less to recover subsurface soil cores for analysis and compressive strength testing (performed at an off-site location).

Installation of tower foundations would involve excavations to the required depths (probably 40 ft [12 m] below grade or less), with the diameters of excavations roughly the same as the diameter of the tower base (nominally 15 to 20 ft [5 to 6 m], depending on the turbine model selected). The latest foundation construction methods involve installing a vertical reinforced concrete ring of a nominal 1-ft (0.3-m) thickness rather than installing a monolithic concrete pillar approximately equivalent to the entire diameter of the tower. Developers of the proposed Table Mountain Wind Generating Facility in Nevada intend to use approximately 80 yd^3 (61 m^3) of 4,000-pounds-per-square-inch (psi) test concrete and an additional 80 yd^3 (61 m^3) of 1,000-psi test concrete for each foundation for the 140 to 280 towers for each turbine (NEG Micon Model 900 or NEG Micon Model 1500) (PBS&J 2002). An average of 6,000 gal (22,712 L) of water would be used to produce this much concrete. Once the concrete has cured (nominally 28 days), the remaining spaces inside and outside the ring within the excavation would be backfilled with the excavated materials. While this would accommodate much of the volume of the material initially excavated, some excavated material would remain and would need to be redistributed on the site. In certain areas, subsurface materials may have the potential of imparting acidic character to precipitation runoff; thus care may need to be taken in stockpiling excavation materials or redistributing excess. Throughout the period of foundation installation, precipitation or groundwater that accumulates within the open excavations would need to be removed. Depending on prevailing subsurface conditions, foundation excavations may also require drilling or blasting.

Although the latest construction methods minimize the amount of concrete necessary for the foundation, it may still be necessary to construct a temporary concrete batching plant on the site, especially if haul distances from existing or specially constructed off-site concrete plants are excessive.[4] Depending on available materials on site, constituents of the concrete (aggregate and sand) may also need to be hauled to the on-site batching plant. Electrical power for the batching plant would be provided by a portable diesel engine/generator set (nominally, 125-kW capacity). The land area required for a typical batching plant and aggregate material storage areas can be expected to be on the order of 10 acres (4 ha) or less. Like the equipment lay-down areas, surface vegetation would need to be removed, some regrading of surface soils might be required, and soils are expected to be heavily compacted as a result of batching plant activities, including

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4 The working time for concrete is dependent on a number of factors, including ambient temperature and humidity, as well as the strength of the concrete mix. It is assumed that for the strength required in a tower foundation, the concrete would have a “working time” of 1 hour or less.

associated truck traffic. The batching plant and any excess concrete constituents are expected to be removed at the end of the concrete-pouring phase. In the Table Mountain example, the 160 yd^3 (122 m^3) of concrete to be used in each tower foundation would require 18 to 20 typical concrete-hauling trucks to deliver concrete to the site from an off-site location. Also, at the same time as tower foundations are poured, foundations for the control building and any other on-site material storage buildings, as well as pads for each electrical transformer, would be poured. It is expected that all on-site buildings would be of modest proportion and require only slab-on-grade foundations, at the most, augmented by frost-resistant perimeter footings. The use of innovative self-erecting towers made of lightweight composite materials may reduce requirements for tower foundations.

No major maintenance is expected to be performed on site on construction and lifting equipment; however, fluid levels would be maintained. Because most of this equipment cannot be transported on public roads, it is most likely that fuel would be staged on site in portable tanks. These tanks are expected to be staged at or near the lay-down areas and resupplied throughout the construction period by commercial vendors. Even at the largest construction sites, the total volume of fuel (primarily diesel fuel) present on site is not expected to exceed 1,000 gal (3,785 L).

3.1.2.3 Tower Erection and Nacelle and Rotor Installation

The same lifting equipment would be used for tower erection and for nacelle and rotor installations. Staging areas for the erecting cranes would need to be established. Like material and equipment lay-down areas, these crane staging areas would have their surface vegetation removed and be regraded to relatively level surfaces, then indigenous soils remaining in these areas would be heavily compacted. Depending on indigenous soils, gravel and rock may need to be placed on the staging area to support the weight of the crane and to provide all-weather access. Crane staging areas may be as large as 1 to 2 acres (0.4 to 0.8 ha). Depending on the geometry of the turbine array, the same crane staging area may be used for erecting multiple turbines. Taller towers are expected to arrive on site in segments (typically, segments would be no longer than 66 ft [20 m] in length) and be welded/bolted together as the tower is erected. The nacelles are expected to contain an already assembled drivetrain. The rotor and blades would be installed individually after the nacelle was installed on top of the tower. Figures 3.1.2-1, 3.1.2-2, and 3.1.2-3 show typical installations of a tower, nacelle, and rotor, respectively. Because of the modular nature of major turbine components and the preassembly of major subsystems, installation of these elements would proceed quickly; each tower erection and turbine and rotor installation would be completed in 3 days or less. (Longer periods would be required for towers whose lower segments were constructed of concrete, to allow for adequate curing of the concrete before it was allowed to bear the weight of the remainder of the tower, nacelle, and rotor.) It is anticipated that very small amounts of paints, lubricants, and grease would be used during installation.

FIGURE 3.1.2-1 Arial View of Preparations to Erect a Wind Turbine Tower at the Public Service of Colorado Ponnequin Wind Farm, Weld County, Colorado (Source: NREL 2004a, Photo #08607. Photo credit: Warren Getz.)

3.1.2.4 Miscellaneous Ancillary Construction

Additional construction activities would include the installation of electric transformers and substations and power-conducting cables and signal wires. For some wind energy projects, electric transformers might be installed at the base of each turbine to perform initial conditioning of the power generated by that turbine before that power was delivered to an on-site central electric substation.[5] In other installations, power cables from each turbine would connect directly to a central substation. For very large wind energy projects, more than one substation may be constructed. The footprints of substations are expected to be 5 acres (2 ha) or less in size and, notwithstanding control and storage buildings and on-site roads, would represent the footprint of greatest contiguous area on the site. Conventional construction methods are expected to be sufficient for these facilities. The ground vegetation would be cleared, and rock or gravel would be placed over the entire area to ensure drainage.

5 However, some turbine manufacturers install a dedicated transformer in the nacelle. See, for example, the large-capacity turbine models offered in Gamesa Eolica (2004). Other designs call for a transformer for each turbine positioned on the ground near the tower base.

FIGURE 3.1.2-2 Wind Turbine Nacelle Installation at Golden Prairie Wind Farm, Lamar, Colorado (Source: NREL 2004b. Photo # 13060. Photo credit: David Jager.)

For electrical safety, one or more grounding rods may be installed. Alternatively, a metal grounding grid or metal net may be installed over the entire footprint of the substation. These grounding features would also provide for lightning grounding. On rocky sites with little to no soil mantle, adequate electrical grounding may be problematic and may require the installation of a grounding well reaching to the uppermost saturated zone below the ground surface. Each turbine tower would have similar lightning grounding needs. Either ground rods, grounding grids, or, if necessary, grounding wells would need to be installed for each tower. Concrete pads would be installed for each transformer. With the exception of only the largest models used, the

FIGURE 3.1.2-3 Installation of a Rotor on a General Electric 1.5-MW Wind Turbine at the Klondike, Oregon, Wind Farm (Source: NREL 2004c, Photo #11919. Photo credit: Paul Woodin.)

transformers would be sealed. For the largest models, installation may involve adding dielectric fluids after they are positioned on their foundations. Transformer bushings, switches, capacitors, and other dielectric fluid-containing electrical devices are likely to use mineral-oil-based dielectric oils with no polychlorinated biphenyls (PCBs).

Construction of the control building would involve either conventional construction techniques or the placement of a prefabricated building on a concrete foundation. An additional storage building for parts and equipment might also be constructed, or these functions could be incorporated into the control building. Some limited amount of maintenance or repair on turbine components might also be provided for, in conjunction with parts and equipment storage. Ambient conditions within the control building would need to be maintained to meet equipment operating requirements and/or to support the presence of maintenance personnel.[6] Conventional propane space heating would likely be installed. At remote sites subject to severe weather, emergency sleeping quarters would also likely be incorporated into the control building. Although electric power demands of the control building and the operating equipment could be

6 At some larger wind energy projects, a small number of maintenance personnel may be present daily during business hours.

supplied by the on-site substation, emergency electricity power generation would also likely be provided by a commercially available diesel engine/generator set.

Power-conducting cables and signal cables would interconnect the turbine towers with the control building and the electrical substation.[7] Where the soil mantle permits, it is expected that these cables would be buried to a nominal depth of 4 ft (1.2 m); they might be bedded in sand for additional protection against frost heave.[8] Standard trenching techniques are expected to be sufficient. However, on rocky sites where trenching is not possible or difficult, it may be necessary for the cables to be suspended from conventional power poles.

During the construction phase, potable water and sanitary facilities would need to be established to support the construction crews. Potable water would be provided from off-site sources. Sanitary facilities would most likely be satisfied by portable latrines.

Throughout the construction phase, fugitive dust may have a significant but localized impact on certain soil conditions. Fugitive dust may result from the disturbance of ground surfaces, removal of vegetative cover, vehicle traffic, and material handling (e.g., materials handled in an on-site concrete batching plant). The issue of fugitive dust may be further exacerbated by the fact that the candidate site is located within a windy area. Such impacts are typically mitigated by keeping disturbed surface areas to an absolute minimum and by the regular application of water to access roads and on-site roads and other disturbed areas throughout the construction phase. For example, developers of the proposed Table Mountain Wind Generating Facility anticipate using an average of 120,000 gal (454,249 L) of water per day during construction to effect adequate dust control across the entire 4,500-acre (1,821-ha) site (PBS&J 2002). In the Table Mountain example, the water will be purchased from a nearby municipality and trucked daily to the site (an average of 30 trips per day for a typically sized water truck of 4,000-gal [15,142-L] capacity). Where no such sources are readily available, it is possible that water may be obtained from nearby surface water features. Precisely coordinated construction schedules, as well as limitations on certain activities during windy periods, could also be employed to mitigate fugitive dust from surface-disturbed areas. Water recovered from on-site wells or surface water features would not need to be treated to drinking water standards before being used for fugitive dust control.

Finally, because the BLM’s multiple-use management objectives are inconsistent with fencing the entire project area, site security requirements would be limited to fencing the electrical substation and locking the turbine tower access doors. Temporary fences or barricades may need to be erected during some portions of the construction phase in accordance with applicable OSHA regulations (Title 29, Part 1910.2C, of the *Code of Federal Regulations* [29 CFR 1910.26]) or as a result of the application of “safe work” practices in order to prevent

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7 Typically, only one central substation would be necessary for each wind energy project. However, when projects span large distances, it is conceivable that each separated cluster of wind turbines may be served by its own substation.

8 Burying the cables can greatly reduce maintenance demands, reduce vandalism problems, eliminate obstructions for bird strikes, improve site safety, and virtually eliminate weather-related downtime. Burying cables may also be necessary to preserve the wind energy projects for other simultaneous land uses.

unauthorized entry of individuals or animals into hazardous active construction zones and to provide for the safety of the construction workforce during periods when open excavations are present. Temporary equipment storage areas may also be temporarily fenced.

3.1.3 Site Operation

Even though the operation of a wind energy development project can be monitored and controlled from a remote location, larger sites may be attended during business hours by a small maintenance crew of six or fewer individuals (Steinhower 2004). For smaller sites, maintenance personnel may be on call but not necessarily at the site.

Regardless of whether the site is attended during normal business hours, all major components of the wind turbines are expected to undergo routine maintenance. This would involve the use of small amounts of greases, lubricants, paints, and/or coatings for corrosion control. Depending on the scale of operations, the wind energy project may include a maintenance shop facility. Wastes resulting from component maintenance typically include small amounts of gear oil and lubricating oils from yaw motors or of transmission and glycol-based coolants from transmissions equipped with forced-flow radiator cooling loops. Most turbine designers construct their turbines in modular fashion. Thus, it is likely that most major overhauls or repairs of turbine components would involve removing the component from the site to a designated off-site repair facility. Because most towers are equipped with lifting devices of sufficient capacity to lower or raise individual drivetrain components, a crane should not be needed for such component replacements.

Operators are likely to take advantage of the latest advances in wind turbine technologies over the lifetimes of their sites in order to remain competitive in the energy market. This may result in “repowering” all or part of the site by replacing existing turbines with ones incorporating state-of-the-art technologies or with larger and more cost-efficient turbines. Repowering may also involve replacing some electrical power management and conditioning equipment. All proposals to repower or otherwise modify a site over its operating life would be reviewed and approved by the BLM and could result in modifications to the terms of the original ROW authorization.

3.1.4 Site Decommissioning

With some exceptions, site decommissioning would involve the reverse of site development. Typical decommissioning procedures are described below.

All turbines and their towers would be dismantled and either recycled at other wind energy projects, sold for scrap, or disposed of off site as solid waste after fluid removal. Turbine towers constructed partially of concrete would be broken up. Broken concrete could be used by highway departments for road base or bank stabilization. Electronic equipment would be recycled or disposed of (in some cases as hazardous waste because of the heavy metals present). Transformers and electrical control devices would either be reused in other applications or sold as scrap after fluid removal. Turbine foundations and belowground cable runs are expected to be left in place.[9]

The access road, on-site roads, rock or gravel in the electrical substations, transformer pads, and building foundations would be removed and recycled if no longer needed. Disturbed land areas covered in rock or gravel or building/tower footprints would be restored to original grade (which would include adjusting soil compaction that might have resulted from previous uses) and reseeded or replanted with indigenous vegetation.

Dismantlement of electrical substations and storage buildings would be accompanied by inspection for the presence of industrial contamination from minor spills or leaks and decontamination as necessary.

3.2 REGULATORY REQUIREMENTS FOR WIND ENERGY PROJECTS

This section identifies the major laws, regulations, E.O.s, compliance instruments, and policies that may impose environmental protection and compliance requirements on the site monitoring and testing, construction, operation, and decommissioning phases of a wind energy project on BLM-administered land. The laws and regulations discussed in this section may not apply to every wind project; each project must be assessed on the basis of its activities, location, and other circumstances.

The BLM conducts its operations in accordance with the FLPMA (43 USC 1701 et seq.) and in an environmentally safe manner in compliance with all applicable statutes, regulations, and standards. In addition, E.O. 12088, "Federal Compliance with Pollution Control Standards" (U.S. President 1978), requires federal agencies (including the BLM) to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA) of 1976, Clean Air Act (CAA), Noise Control Act of 1972 (NCA), Clean Water Act (CWA), and Safe Drinking Water Act (SDWA). Other compliance requirements may include the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), hazardous material transportation law, ecological resources requirements (e.g., ESA), and cultural and paleontological resources requirements.

The BLM has established an Interim Wind Energy Development Policy (BLM 2002a) (Appendix A). This policy provides guidance on processing ROW applications for wind energy site testing and monitoring facilities as well as applications for wind energy development projects on BLM-administered land. Under this policy, all wind energy applications would be processed in accordance with the requirements of Title V of FLPMA and 43 CFR Part 2800, "Rights-of-Way, Principles and Procedures." Details regarding the applications and authorizations for wind energy projects are set forth in the policy. In addition, the policy requires

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9 However, to accommodate revegetation over turbine footprints, the foundations may need to be removed to a depth of at least 3 ft (1 m) below the initial grade, with sufficient indigenous soils added to cover the foundations and establish a root zone of sufficient depth.

that all wind energy project ROW applications, whether for site testing and monitoring or for commercial development, be subjected to environmental review in accordance with the requirements of NEPA and that such development be in compliance with the requirements of the ESA, Migratory Bird Treaty Act of 1918 (MBTA), NHPA, and other appropriate laws.

The potentially applicable laws and regulations have been divided into general categories, described below. A listing of the laws and regulations by category is provided in Appendix E.

- *Wind energy project siting*. The construction and operation of a wind energy project, including generation and substations, may require siting approval or certification from state energy authorities. Approval may also be needed to connect to the local electric grid system. In addition, certain states, including California, Montana, and Washington, have equivalent environmental policy acts tied to the issuance of state-level environmental permits.

- *Land use.* Depending on the location of a proposed wind energy project, special land use determinations may need to be made, particularly if the project is to be sited in or would impact environmentally sensitive or protected areas.

- *Floodplains and wetlands.* If project facilities are located in wetland areas or adjacent to other water bodies, their placement will be subject to all applicable statutory requirements and associated regulations, such as Section 404 of the CWA.

- *Water bodies and wastewater.* The discharge of wastewater (e.g., sanitary wastewater treatment systems or rinse/test waters) from the construction or operation of a wind energy project into waters of the United States or waters of a state may require a National Pollutant Discharge Elimination System (NPDES) permit or the state equivalent. According to administrative and judicial interpretation, the navigable waters of the United States encompass any body of water whose use, degradation, or destruction would or could affect interstate or foreign commerce. These bodies of water include, but are not limited to, interstate and intrastate lakes, rivers, streams, wetlands, playa lakes, prairie potholes, mudflats, intermittent streams, and wet meadows. In addition, the CWA requires an NPDES permit, or state equivalent, for storm water discharges from industrial activities or from construction activities disturbing more than 5 acres (2 ha) of land. Also, under the Storm Water Phase II Final Rule, small construction activities disturbing between 1 and 5 acres (0.4 and 2 ha) of land are subject to NPDES permitting requirements.

- *Groundwater, drinking water, and water rights.* The provision of drinking water from wells or surface water to a transient noncommunity water system at wind energy facilities would require compliance with the SDWA. In addition, the withdrawal of groundwater for industrial or drinking water purposes may require approvals or permits.

- *Source water protection.* Under the SDWA, Protection of Underground Sources of Drinking Water (42 USC 300h-7), each state is to establish a wellhead protection program to delineate wellhead protection areas, identify potential sources of contamination, and establish control measures to prevent contamination of drinking water sources. If hazardous chemicals or materials are used during the construction or operation of a wind energy project that is located within a wellhead protection area, reporting or control measures may apply.

- *Cultural resources.* If paleontological or historical sites are found to be located on the site where a wind energy project is proposed, certain consultations and mitigation actions may be required. In addition, the BLM has entered into agreements with the affected SHPOs providing for cooperation concerning cultural resources disturbed on BLM-administered lands located in that state (e.g., the Cultural Resources Programmatic Agreement [PA] among the BLM, Advisory Council on Historic Preservation, and National Conference of State Historic Preservation Officers signed March 26, 1997).

- *Wildlife.* The construction and operation of a wind energy project may impact wildlife or their habitats. The BLM manages public lands to protect and improve habitat for all federal status, BLM-designated sensitive (i.e., the list published by the BLM state office of species occurring on public lands whose populations or habitats are rare or in significant decline), and state listed species. The BLM evaluates all projects and activities occurring on public lands to ensure that they will not contribute to the need to list species as threatened or endangered.

- *Air quality.* Air emissions from wind energy project construction and operation are subject to the CAA (42 USC 7401 et seq.), as amended. Although air emissions from the operation of the actual wind energy equipment are expected to be minimal, other air emissions that occur during construction and operation may be subject to regulation. The CAA provides that each state must develop and submit for approval to the EPA a State Implementation Plan (SIP) for controlling air pollution and air quality in that state, and that each state must develop its own regulations to monitor, permit, and control air emissions within its boundaries. The CAA also requires that federal actions conform to the appropriate SIPs (42 USC 7506). Under Section 112(r) of the CAA, owners and operators of facilities that produce, process, handle, or store specific hazardous substances above threshold quantities must meet certain requirements for planning and reporting and risk management planning requirements (40 CFR Part 68).

- *Noise.* Noise impacts may result from the construction and operation of a wind energy project. The EPA has not published regulations on noise levels from construction operations. The agency has, however, issued guidelines for outdoor noise levels that are consistent with the protection of human health and welfare against hearing loss, annoyance, and activity interference (EPA 1974). Such guidelines state that undue interference with activity and annoyance will not occur if outdoor levels of noise are maintained at an energy equivalent of 55 decibels (dB). However, these levels are not to be construed as legally enforceable standards.

- *Hazardous materials.* Hazardous materials may be used in the construction and operation of a wind energy project. In addition, fuels, petroleum, oils, and lubricants may be stored and used at wind energy project facilities during construction, operation, and decommissioning phases; however, quantities present during operations would be minimal.

- *Pesticides and noxious weeds.* Pesticides may have to be applied during the construction and operation of a wind energy project to control pests and weeds. Such applications must comply with the Federal Insecticide, Fungicide, and Rodenticide Act and state equivalent requirements. In addition, wind energy sites are subject to federal provisions to control noxious weeds and invasive species and may be subject to regulations governing state-established control areas.

- *Solid waste.* Solid wastes would be generated during the construction, operation, and decommissioning of wind energy projects and must be managed in accordance with the Solid Waste Disposal Act and all state and local requirements for solid waste accumulation, collection, transportation, and disposal.

- *Hazardous waste and PCBs.* Hazardous wastes generated during the construction, operation, and decommissioning of wind energy projects (e.g., used solvents and paints) must be accumulated, collected, transported, and disposed of in accordance with RCRA. PCBs are not likely to be used during the construction and operation of new wind energy projects; however, if they are, they must be managed in accordance with the TSCA.

In addition to these categories, the construction and operation of a wind energy project on BLM-administered land that has valid mining claims must not materially interfere with the claimant's right to mine, remove, or sell the minerals from the claim (30 USC Ch. 2). Also, depending on the activities, location, and other circumstances, the construction of a wind energy project may be required to consider impacts on local populations, including E.O. 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (U.S. President 1994), and E.O. 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (U.S. President 1997). Certain states may have specific requirements with regard to nuisances, including Arizona (Environmental Nuisances [*Arizona Revised Statutes* (ARS) 49-141 et seq.] and Light Pollution [ARS 49-1101 et seq.]) and New Mexico (Night Sky Protection Act [74-12-1 *New Mexico Statutes Annotated* (NMSA) 1978 et seq.]).

3.3 HEALTH AND SAFETY ASPECTS OF WIND ENERGY PROJECTS

Potential human health and safety issues related to construction and operation of typical wind energy projects are described in this section. On the basis of expected major activities associated with future wind energy projects described in Section 3.1, the following sections identify physical hazards to workers and potential safety and health issues for the general public.

3.3.1 Occupational Hazards

The types of activities that typically occur during construction, operation, and maintenance of a wind energy development project include a variety of major actions, such as establishing site access; excavating and installing the tower foundations; erecting towers; constructing the central control building, electrical substations, meteorological towers, and access roads; and routine maintenance of the turbines and ancillary facilities. Construction and operations workers at any facility are subject to risks of injuries and fatalities from physical hazards. While such occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment, fatalities and injuries from on-the-job accidents can still occur. Occupational health and safety are protected through the federal Occupational Safety and Health Act (29 USC 651 et seq.), and states may have additional laws and regulations that build on that law.

Some of the occupational hazards associated with wind energy projects are similar to those of the heavy construction and electric power industries, while others are unique to wind energy projects (i.e., heights, high winds, energized systems, and rotating/spinning equipment). In particular, the hazards of installing and repairing turbines are similar to those of building and maintaining bridges and other tall structures (Sørensen 1995). Gipe (1995) reports 14 fatalities worldwide and several serious injuries in the United States between the 1970s and mid-1990s attributable to wind energy projects; most were from construction-related accidents, although 5 fatalities occurred during operation or maintenance of the turbines. In contrast, Sørensen (1995) reports 20 fatalities and hundreds of injuries during wind turbine construction. It is likely that these results are not statistically representative because several of the fatalities occurred in the early years of wind technology development (Gipe 1995). However, they highlight the types of serious hazards to workers that can occur at a wind energy project (e.g., falls, neglecting to use a safety belt, and electric burns).

Accident rates have been tabulated for most types of work, and risks can be calculated on the basis of historical industrywide statistics for use in a site-specific impact assessment. The U.S. Bureau of Labor Statistics (BLS) and the National Safety Council (NSC) maintain statistics on the annual number of injuries and fatalities by industry type (NSC 2002). The expected annual number of worker fatalities and injuries for specific industry types can be calculated on the basis of BLS and NSC rate data and the number of annual full-time equivalent workers required for construction and operations activities at a wind energy project. While the BLS does not break out wind energy projects as an industry type, it can be assumed that, in general, the types of activities required of these employees would be similar to those required of workers in the construction, transportation, public utilities, and electric services industries (NSC 2002).

As noted above, in addition to hazards that are typical of other industries, there are some occupational hazards specific to wind farms. The International Electrotechnical Commission (IEC), a worldwide organization for standardization in the electrical and electronic fields, has published minimum safety requirements for wind turbine generator systems (WTGSs) (IEC 1999). The IEC requires that the WTGS manufacturer provide an operator's instruction manual with supplemental information on special local conditions. The manual should include system safe operating limits and descriptions, start-up and shutdown procedures, alarm response actions, and an emergency procedures plan (IEC 1999). The emergency procedures plan should identify probable emergency situations and the actions required of operating personnel. The emergency procedures plan should address overspeeding, icing conditions, lightning storms, earthquakes, broken or loose guy wires, brake failure, rotor imbalance, loose fasteners, lubrication defects, sandstorms, fires, floods, and other component failures.

Chemical exposures during construction and operation of a typical wind energy project are expected to be routine and minimal and mitigated by using personal protective equipment and/or engineering controls to comply with OSHA permissible exposure limits (PELs) (DOL 1997) that are applicable for construction activities. The potential for ozone exposure in a wind turbine is nonexistent because synchronous or asynchronous generators that are brushless and make alternating current (ac) would be used; thus, they would not create sparks like a brushing generator would in making direct current (dc) (Robichaud 2004).

3.3.2 Public Safety

One of the primary safety hazards of wind turbines occurs if a rotor blade breaks and parts are thrown off. This could occur as a result of rotor overspeed, although such an occurrence has been extremely rare and happens mostly with older and smaller turbines (Hau 2000). Material fatigue can also cause a blade to break (Hau 2000). The difficulty of predicting the trajectory of a broken rotor blade makes the quantitative determination of safety risk very uncertain (Hau 2000). However, it is known that these types of events are very rare and the probability of a fragment hitting a person is even lower (Manwell et al. 2002; Hau 2000). A blade or turbine part has rarely traveled farther than 1,640 ft (500 m) from the tower; usually most pieces land within 328 to 656 ft (100 to 200 m) (Manwell et al. 2002). Today, with proper engineering design and quality control, blade throw should rarely occur. A related issue, ice throw, can occur if ice builds up on the turbine blades. A sufficient safety zone or setback from residences, roads, and other public access areas is often required by permitting agencies (Manwell et al. 2002). In addition to blade and ice throws, these setbacks may also mitigate potential noise and visual impacts (Gipe 1995). Ultimately, any calculation of the risk for such incidents also needs to consider simultaneous land uses for the wind energy project that may cause individuals in addition to wind project workers to be in the vicinity of rotating blades.

Another potential public safety issue is unauthorized or illegal access to the site facilities and the potential for members of the public to attempt to climb towers, open electrical panels, or encounter other hazards.

Dry vegetation and high winds may combine to cause a potential fire hazard around wind facilities. Under these conditions, fires have started for a variety of reasons, such as electrical shorts, insufficient equipment maintenance, contact with power lines, and lightning. The IEC requires that the design of a WTGS electrical system comply with relevant IEC standards (IEC 1999).

3.3.3 Electric and Magnetic Fields

Exposures to extremely low-frequency (ELF) EMF from natural and anthropogenic sources are so ubiquitous that there has been concern about potential adverse health effects from residential and occupational exposures (Ahlborn et al. 2001). Because they are generated by electric transmission and distribution lines, EMF would be present in the vicinity of overhead power lines and the electric substation. A number of reviews of epidemiological and biological research studies have generally concluded that there is no scientific basis to support a finding of adverse human health effects from EMF (e.g., Jahn 2000), although others have found that there may be an association between EMF and certain diseases (Ahlborn et al. 2001). However, the difficulty of accounting for confounding factors in assessing EMF exposure supports the need for additional research.

The National Institute of Environmental Health Sciences (NIEHS) conducted a 6-year research project specifically addressing health effects of exposure to ELF range fields from power lines (NIEHS 1999). The NIEHS concluded that "the scientific evidence suggesting that ELF-EMF exposure pose any health risk is weak" (p. ii, NIEHS 1999). The report also states, however, that ELF-EMF exposure cannot be considered entirely safe because of the relatively consistent results of epidemiological studies that show a small increased risk of chronic lymphocytic and childhood leukemia with increasing EMF exposure. On the other hand, the report states that laboratory research studies have not been able to consistently support the epidemiological findings, which weakens but does not discount them. Brain et al. (2003) suggest that the failure to observe effects from EMF in bioassay systems may be due to the selection of EMF exposure metrics.

Regarding the occupational environment, while there is the potential for any generator to produce EMF, the 60-Hz ac frequencies are thought to be too low to damage human tissue (Robichaud 2004). Definitive data are not available, however.

3.3.4 Aviation Operations and Electromagnetic Interference

The two main aviation safety considerations in the development of a wind energy project are (1) the physical obstruction of the tower itself and (2) the effects on communications, navigation, and surveillance systems, such as radar (DTI 2002). The potential vertical obstruction of the wind turbine, like any tall structure, could pose a hazard to aircraft arriving or departing at a nearby airfield as well as to military training and other low-flying aircraft (DTI 2002).

With respect to radar, moving wind turbine blades interfere with radar by essentially creating radar echoes (AWEA 2004). According to the British Wind Energy Association (BWEA 2004), radar installations can be modified to eliminate this problem: “This study concludes that radars can be modified to ensure that air safety is maintained in the presence of wind turbine farms. Individual circumstances will dictate the degree and cost of modification required, some installations may require no change at all whilst others may require significant modification.”

Wind turbines have the potential to interfere with electromagnetic signals that make up much of modern communication networks (Burton et al. 2001). In addition to radar, interference with other electromagnetic transmissions can occur when a large wind turbine is placed between a radio, television, or microwave transmitter and receiver (Manwell et al. 2002). Disruptions of public safety communication systems (e.g., radio traffic related to emergency response activities) may be a potential public safety issue. EMI from wind turbines is affected by blade construction and rotational speed (Manwell et al. 2002). Modern blades made of glass-reinforced epoxy (a material similar to fiberglass) should not create any electrical disturbance (CRS 2004). However, lightning protection on blade surfaces can increase EMI (Manwell et al. 2002).

3.3.5 Low-Frequency Sound

In addition to more audible noise (Section 5.5.3.1), wind turbines are capable of generating low-frequency sound waves (Hau 2000). Low-frequency sound is considered to be in the range of 20 to 80 Hz, and infrasound is in the range of 1 to < 20 Hz (ACGIH 2001). Low-frequency sound is generally the result of wind turbulence that causes the aerodynamic lift forces at the rotor blades to rapidly change (Hau 2000). Moller and Lydolf (2002) conducted a survey of 198 people in Denmark about complaints regarding infrasound and low-frequency noise and found that almost all participants experienced a sensory perception of sound. They perceived the sound not only with their ears but also as a vibration in their bodies or external objects (Moller and Lydolf 2002). This study supports earlier research results indicating that low-frequency sound is disturbing, irritating, and even tormenting to some people. Insomnia, headaches, and heart palpitations were also reported as secondary effects.

Infrasound and low-frequency noise are ubiquitous, since they are generated from natural sources (e.g., earthquakes, wind) and anthropogenic sources (e.g., automobiles, industrial machinery, household appliances) and are common in urban environments (Leventhall 2003). Because low-frequency noise and infrasound have numerous sources, propagate efficiently, and are inefficiently attenuated in buildings, their effects (including those on human health) have been the subject of considerable research. Leventhall (2003) reviewed much of the published literature on the effects of low-frequency noise on humans and concluded that the primary effect of infrasound appears to be annoyance. He also found that there is not much agreement in the many studies of the biological effects of infrasound on humans. However, while infrasound does not appear to result in “dramatic health effects,” exposure at a perceptible level can “produce symptoms including weariness, annoyance, and unease”; these symptoms may present safety concerns in certain occupational settings (p. 55, Leventhall 2003). Infrasound also has been found to have negative effects on mental performance; however, the ACGIH (2001) considers these to be the result of the relaxation effects of infrasound and not an adverse health impact.

It is clear that certain individuals exposed to infrasound and low-frequency sound experience stressful ear, central nervous system, and other resonance-related symptoms. However, there does not appear to be serious health consequences from exposure (Leventhall 2003). The ACGIH (2001) recommends threshold limit values (TLVs) of 1 to 80 Hz of sound to protect against auditory pain and the sensation of throat-tickling and choking. However, the TLV also includes a note stating that infrasound and low-frequency sound exposures that cause unwanted vibrations and pressure sensations should be avoided. Low-frequency sound emissions in rotors can be reduced by careful turbine design that reduces flow velocity and optimizes rotor clearance to the tower (Hau 2000), and by the establishment of a sufficient safety zone or setback from residences, roads, and other public access areas. In addition, while wind turbines with a downwind rotor generate considerably higher infrasound levels, modern turbines with the rotor located upwind of the tower produce very low levels of infrasound (Jakobsen 2004).

3.3.6 Shadow Flicker

Shadow flicker refers to the phenomenon that occurs when the moving blades of wind turbines cast moving shadows that cause a flickering effect (Manwell et al. 2002). When the sun is behind the blades and the shadow falls across occupied buildings, the light passing through windows can disturb the occupants (Gipe 1995). Shadow flicker is recognized as an important issue in Europe but is generally not considered as significant in the United States (Gipe 1995). The American Wind Energy Association (AWEA 2004) states that shadow flicker is not a problem during the majority of the year at U.S. latitudes (except in Alaska where the sun’s angle is very low in the sky for a large portion of the year). In addition, it is possible to calculate if a flickering shadow will fall on a given location near a wind farm and for how many hours in a year (AWEA 2004). While the flickering effect may be considered an annoyance, there is also concern that the variations in light frequencies may trigger epileptic seizures in the susceptible population (Burton et al. 2001). However, the rate at which modern three-bladed wind turbines rotate generates blade-passing frequencies of less than 1.75 Hz, below the threshold frequency of 2.5 Hz, indicating that seizures should not be an issue (Burton et al. 2001).

3.4 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

3.4.1 Hazardous Materials

Proponents of activities on BLM-administered lands, including wind energy projects, are required by BLM policy to provide a comprehensive list of the hazardous and/or extremely hazardous materials that will be produced, used, stored, transported, or disposed of during the proposed action. Proponents must also comply with all applicable federal and state regulations regarding notices to federal and local emergency response authorities and development of applicable emergency response plans. For the purposes of this discussion, hazardous materials are defined as those chemicals listed in the EPA Consolidated List of Chemicals Subject to Reporting under Title III of the Superfund Amendments and Reauthorization Act of 1986. Extremely hazardous materials are defined by federal regulation in 40 CFR Part 355.

Construction, operation, and decommissioning activities at a wind energy project would require the use of some hazardous materials, although the variety and amounts of hazardous materials present during operation would be minimal. Types of hazardous materials that may be used include fuels (e.g., gasoline, diesel fuel), lubricants, cleaning solvents, paints, pesticides, and explosives. (Table 3.4.1-1 provides a complete list of hazardous materials associated with a typical wind energy project.)

Compliance with all applicable federal and state regulations regarding notices to federal and local emergency response authorities and development of applicable emergency response plans are required for hazardous materials when quantities on hand exceed amounts specified in regulations.

3.4.2 Solid and Hazardous Wastes

Limited quantities of both solid and hazardous wastes would be generated during the construction, operation, and decommissioning of a wind energy project. Wastes meeting the definition of hazardous waste under RCRA must be managed in accordance with all applicable federal and state regulations. Possible sources of these wastes are described in this section; operators are required to determine which of these wastes are hazardous.

Solid wastes produced during construction of a wind energy development project would include containers, dunnage and packaging materials for turbine components, and miscellaneous wastes associated with assembly activities. Solid wastes resulting from the presence of the construction work crews would include food scraps and other putrescible wastes. Solid wastes produced during the operational phase would be very limited and consist primarily of office-related wastes generated at the control facility and food wastes from the maintenance crews who might be present on the site during business hours. All such wastes are expected to be nonhazardous, and typically they are containerized on site and periodically removed by commercial haulers to existing off-site, appropriately permitted disposal facilities. Generally, food service and housing are not provided on site.

Industrial wastes that would be generated during the construction phase would include minor amounts of paints and coatings and spent solvents associated with the assembly of turbines and towers. Minor amounts of wastes associated with the on-site maintenance of off-road construction equipment would also be generated. However, it is anticipated that such on-site maintenance activity would be limited to that which is immediately necessary to keep the equipment in running condition. Routine, periodic maintenance, such as oil, coolant, and filter changes, is expected to be performed off site.

TABLE 3.4.1-1 Hazardous Materials Associated with a Typical Wind Energy Project

Hazardous Material	Uses	Typical Quantities Present
Fuel: diesel fuel[a]	Powers most construction and transportation equipment during construction and decommissioning phases.	Less than 1,000 gal (3,785 L); stored in aboveground tanks during construction and decommissioning phases.[b]
	Powers emergency generator during operational phase.	Less than 100 gal (379 L); stored in aboveground tanks to support emergency power generator throughout the operation phase.
Fuel: gasoline[c]	May be used to power some construction or transportation equipment.	Because of the expected limited number of construction and transportation vehicles utilizing gasoline, no on-site storage is likely to occur throughout any phase of the life cycle of the wind energy project.
Fuel: propane[d]	Most probable fuel for ambient heating of the control building.	Typically 500 to 1,000 gal (1,893 to 3,785 L); stored in aboveground propane storage vessel.
Lubricating oils/grease/ hydraulic fluids/gear oils	Lubricating oil is present in some wind turbine components and in the diesel engine of the emergency power generator.	Limited quantities stored in portable containers (capacity of 55 gal [208 L] or less); maintained on site during construction and decommissioning phases.
	Maintenance of fluid levels in construction and transportation equipment is needed.	Limited quantities stored in portable containers (capacity of 55 gal [208 L] or less); stored on site during operational phase.
	Hydraulic fluid is used in the rotor driveshaft braking system and other controls.	
	Gear oil and/or grease are used in the drivetrain transmission and yaw motor gears.	
Glycol-based antifreeze	Present in some wind turbine components for cooling (e.g., 5 to 10 gal [19 to 38 L] present in recirculating cooling system for the transmission).	Limited quantities (10 to 20 gal [38 to 76 L] of concentrate) stored on site during construction and decommissioning phases.
	Present in the cooling system of the diesel engine for the emergency power generator.	Limited quantities (1 to 10 gal [4 to 38 L] of concentrate) stored on site during operational phase.

TABLE 3.4.1-1 (Cont.)

Hazardous Material	Uses	Typical Quantities Present
Lead-acid storage batteries and electrolyte solution	Present in construction and transportation equipment. Backup power source for control equipment, tower lighting, and signal transmitters.	Limited quantities of electrolyte solution (< 20 gal [76 L]) for maintenance of construction and transportation equipment during construction and decommissioning phases. Limited quantities of electrolyte solution (< 10 gal [38 L]) for maintenance of control equipment during operational phase.
Other batteries (e.g., nickel-cadmium [NI-CAD] batteries)	Present in some control equipment and signal-transmitting equipment.	No maintenance of such batteries is expected to take place on site.
Cleaning solvents	Organic solvents (most probably petroleum-based but not RCRA-listed) used for equipment cleaning and maintenance. Where feasible, water-based cleaning and degreasing solvents may be used.	Limited quantities (< 55 gal [208 L]) on site during construction and decommissioning to maintain construction and transportation equipment. Limited quantities (< 10 gal [38 L]) on site during operational phase to maintain equipment.
Paints and coatings[e]	Used for corrosion control on all exterior surfaces of turbines and towers.	Limited quantities (< 50 gal [189 L]) for touch-up painting during construction phase. Limited quantities (< 20 gal [76 L]) for maintenance during operational phase.
Dielectric fluids[f]	Present in electrical transformers, bushings, and other electric power management devices as an electrical insulator.	Some transformers may contain more than 500 gal (1,893 L) of dielectric fluid.
Explosives	May be necessary for excavation of tower foundations in bedrock. May be necessary for construction of access and/or on-site roads or for grade alterations on site.	Limited quantities equal only the amount necessary to complete the task. On-site storage expected to occur only for limited periods of time as needed by specific excavation and construction activities.
Pesticides	May be used to control vegetation around facilities for fire safety.	Pesticides would likely be brought to the site and applied by a licensed applicator as necessary.

Footnotes appear on next page.

TABLE 3.4.1-1 (Cont.)

[a] It is assumed that commercial vendors would replenish diesel fuel stored on site as necessary.

[b] This value represents the total on-site storage capacity, not the total amounts of fuel consumed. See footnote a. On-site fuel storage during construction and decommissioning phases would likely be in aboveground storage tanks with a capacity of 500 to 1,000 gal (approximately 2,000 to 4,000 L). Tanks may be of double-wall construction or may be placed within temporary, lined earthen berms for spill containment and control. At the end of construction and decommissioning phases, any excess fuel as well as the storage tanks would be removed from the site, and any surface contamination resulting from fuel handling operations would be remediated. Alternatively, rather than store diesel fuel on site, the off-road diesel-powered construction equipment could be fueled directly from a fuel transport truck.

[c] Gasoline fuel is expected to be used exclusively by on-road vehicles (primarily automobiles and pickup trucks). These vehicles are expected to be refueled at existing off-site refueling facilities.

[d] Delivered and replenished as necessary by a commercial vendor.

[e] It is presumed that all wind turbine components, nacelles, and support towers would be painted at their respective points of manufacture. Consequently, no wholesale painting would occur on site. Only limited amounts would be used for touch-up purposes during construction and maintenance phases. It is further assumed that the coatings applied by the manufacturers during fabrication would be sufficiently durable to last throughout the operational period of the equipment and that no wholesale repainting would occur.

[f] It is assumed that transformers, bushings, and other electrical devices that rely on dielectric fluids would have those fluids added during fabrication. However, very large transformers may be shipped empty and have their dielectric fluids added (by the manufacturer's representative) after installation. It is further assumed that servicing of electrical devices that involves wholesale removal and replacement of dielectric fluids would not likely occur on site and that equipment requiring such servicing would be removed from the site and replaced. New transformers, bushings, or electrical devices are expected to contain mineral-oil-based, or synthetic dielectric fluids that are free of PCBs; some equipment may instead contain gaseous dielectric agents (e.g., sulfur hexafluoride [SF_6]) rather than liquid dielectric fluids.

Industrial wastes would also be generated during the operational phase. These wastes would include used oils and lubricants and spent coolants removed from turbine drivetrain components as a result of routine preventative maintenance or unexpected repair activities. Maintenance intervals are likely to be based on actual hours of operation for each turbine rather than being isochronal (i.e., based on elapsed calendar time). The introduction of filters, either as original equipment or as retrofits, can extend lubricating fluid change-out intervals even further. External filter systems are commercially available for high-viscosity fluids typically used in wind turbine transmissions (C.C. Jensen Group 2004). Used transmission oil wastes are, of course, completely eliminated with turbines that utilize direct drive designs. More sophisticated wind turbines may be equipped with sensors that monitor the condition of the lubricating fluid, thus allowing maintenance intervals to be extended. Typically, a transmission is expected to contain 10 gal (37 L) or less of lubricating fluid that will likely be changed out an average of every 2 to 3 years (of turbine operation, not calendar time). Coolant systems for transmissions typically contain 20 to 30 gal (76 to 114 L) of a 50% aqueous solution of ethylene glycol that can be expected to be changed every 3 to 4 years. Yaw control gears can be expected to contain less than 10 gal (37 L) of gear oil that may be changed no more than once every 5 years. Climate extremes at a given wind energy project may alter these maintenance schedules slightly. Although federal regulations do not categorically identify spent lubricating oils, hydraulic fluids, or coolants as hazardous wastes, some state regulations may. Nonetheless, it is standard practice that all such wastes be containerized, characterized in accordance with applicable federal or state regulations, stored on site for brief periods of time, and subsequently transported by a licensed hauler to appropriately permitted off-site disposal facilities.

Industrial wastes associated with equipment maintenance also would include solvents and cleaning agents. Judicious choice of solvents should prevent such wastes from meeting the federal or applicable state regulatory definitions of hazardous wastes. In the event of the wholesale failure of a turbine drivetrain component, that component is expected to be removed and transported from the site for repair or disposal. No major rebuilding of components is expected to occur on site.

Industrial wastes may also result during construction and decommissioning phases as well as during the operational phase as a result of leaks or accidental spills. Existing regulations and standard work practices require that spill debris (recovered spilled material as well as contaminated environmental media) be removed, containerized, characterized, stored briefly, and subsequently hauled off site by a licensed hauler to appropriate treatment, storage, or disposal facilities. Leaks from turbine drivetrain equipment can be expected to be initially contained within the nacelle or the support tower and may not, therefore, constitute a release to the environment. In the event of a spill of battery electrolyte, spill response may also involve elementary neutralization of the free acid to stabilize this corrosive waste for transportation to off-site treatment, storage, or disposal facilities.

To mitigate impacts from leaks of hazardous materials or industrial wastes during on-site storage, materials storage and dispensing areas (e.g., fueling stations for off-road construction equipment), as well as waste storage areas, are typically equipped with secondary containment features. Likewise, fluid-containing transformers may also be installed within secondary containment features or be designed in such a way that their outer cases serve as containment devices. To further mitigate adverse impacts and ensure timely response to accidental leaks or spills, appropriate spill containment and recovery equipment could be maintained at the wind energy project.

Finally, during decommissioning, substantial quantities of solid wastes and industrial wastes could result from dismantlement of a wind energy project. Fluids drained from turbine drivetrain components (e.g., lubricating oils, hydraulic fluids, coolants) are likely to be similar in chemical composition to spent fluids removed during routine maintenance and would be managed in the same manner as analogous maintenance-related wastes. Tower segments are expected to be stored on site for a brief period and eventually sold as scrap. Likewise, turbine components (emptied of their fluids) may have some salvage value. Electrical transformers are expected to be removed from the site and available for other applications elsewhere (in most cases, without the need for removing dielectric fields). Substantial amounts of broken concrete from tower and building foundations as well as rock or gravel from on-site roads or electrical substations would also result from decommissioning. All such materials are expected to be salvageable for use in road-building or bank stabilization projects. Miscellaneous materials without salvage value are expected to be nonhazardous and should be removed from the site by a licensed hauler and delivered to appropriately permitted disposal facilities.

3.4.3 Wastewater

Especially during the construction and decommissioning phases, and, to a lesser extent, during the operational phase, sanitary wastewater is generated by the work crews or maintenance personnel present on site. During the construction and decommissioning phases, work crews of 50 to 100 individuals may be present. During the operational phase, a maintenance crew of 6 individuals or fewer is likely to be present on the site daily during business hours. Wastewater would be collected in portable facilities and periodically removed by a licensed hauler and introduced into existing municipal sewage treatment facilities.

3.4.4 Storm Water and Excavation Water

Except in those instances of spills or accidental releases, storm water runoff from the site and excavation waters are not expected to have industrial contamination but may contain sediment from disturbed land surfaces.

3.4.5 Existing Contamination

It is possible that wind energy projects would be proposed for areas at which other industrial activities had previously taken place (or are ongoing). In those situations, industrial contamination may be encountered during site development, especially during foundation and cable trench excavations. Once identified, all such contamination would need to be characterized, and a separate plan to remove contamination or stabilize it in place would need to be developed. Additional agreements may be needed to negotiate specific responsibilities for characterizing and remediating contamination.

3.5 TRANSPORTATION CONSIDERATIONS

A variety of transportation operations are necessary to support wind energy development. Table 3.5-1 summarizes representative transportation requirements for each phase of development. The majority of transportation operations would involve material and equipment moved to the site during the construction phase. The types and amounts of material and equipment required for construction of the wind energy development project would depend on site characteristics as well as the design selected. The following discussion provides a general overview of the expected transportation requirements during development, focusing on the unique considerations posed by the wind turbines, towers, and rigging equipment necessary to erect them.

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. The types of heavy equipment required would include bulldozers, graders, excavators, front-end loaders, compactors, and dump trucks. Typically, the equipment would be moved to the site by flatbed combination truck and would remain on site through the duration of construction activities. Typical construction materials hauled to the site would include gravel, sand, and water, which are generally available locally. Ready-mix concrete might also be transported to the site, if available. The movement of equipment and materials to the site during construction would cause a relatively short-term increase in the traffic levels on local roadways during the construction period.

As discussed in Section 3.1.2.1, transportation logistics have become a major consideration for wind energy development projects; the trend is toward larger rotors and taller towers and the associated equipment needed to erect them. Depending on the design, some of the turbine components would be extremely long (e.g., blades) or heavy (e.g., the nacelle containing all drivetrain components except the rotor). (Table D-2, Appendix D, has anticipated ranges of turbine component sizes and weights.) The size and weight of these components would dictate the specifications for site access roads for required ROWs, turning radii, and fortified bridges. It is estimated that each wind turbine generator would require between 5 and 15 truck shipments of components, some of which could be oversized or overweight.

Erecting the towers and assembly of the wind turbine generators would require a main crane with a capacity likely to be between 300 and 750 tons (272 and 680 t), depending on the design. A 300-ton (272-t) main crane would require 15 to 20 truckloads, including several overweight and/or oversized shipments (Wood 2004). A 750-ton (680-t) crane would require up to 50 truckloads, including overweight/oversized shipments (Wood 2004). In addition, main crane assembly would require a smaller assist crane, and several assist cranes would likely be required for rotor/hub assembly. Cranes would remain on site for the duration of construction activities.

In the United States, the transportation regulation system has unique rules, regulations, and oversized permit requirements for each state. This system requires transporters to evaluate the type of shipment being planned, its origin, and destination (Smith 2002). Demonstrating to permit officials that all possible means have been assessed or used to either minimize travel distances or select appropriate bypass routes is critical in obtaining permits (Smith 2002). Typically, the transport company develops detailed transportation plans based on specific object sizes, weights, origin, destination, and unique handling requirements. The final transportation plan is developed after alternative approaches have been evaluated, costs refined, and adjustments have been made to comply with unique state requirements.

Overweight permits usually are issued with specific dates during which transport is prohibited. These dates are state specific but tend to eliminate periods during the spring when frozen ground is thawing. Over-dimension permits are likely to have travel time limits in congested areas, limiting movement to non-rush-hour periods.

Depending on the origin and destination sites, shipments of components and main cranes within the United States could be made by truck, rail, or barge. If rail or barge were utilized, the cargo would require unloading at the nearest transfer point followed by overland transportation to the site by truck.

TABLE 3.5-1 Representative Transportation Requirements

Project Phase/Activity	Equipment/Material	Transportation Requirements	Access Road Requirements	Special Requirements
Monitoring and Testing				
	Meteorological towers	Heavy duty all-wheel-drive pickup trucks or medium-duty trucks. 1 to 2 trucks per tower.	Minimum-specification access road.	None.
Construction				
Site and road grading and preparation	Heavy earthmoving equipment: bulldozers, graders, excavators, front-end loaders, compactors, dump trucks	Heavy equipment typically transported to the site using combination trucks with flatbed or goose-neck trailers. Equipment requirements are site dependent. Typical construction may require 10 to 20 pieces of heavy equipment.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).
Road, pad, and lay-down areas	Sand and gravel	Delivered from on- or off-site sources in dump trucks. Quantity required is site dependent.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).
Tower foundations	Premixed concrete, or aggregate, sand, cement, and water for an on-site batch plant	Premixed concrete could be delivered in approximately 10-yd^3 (8-m^3) trucks from off-site sources. Alternatively, raw material for an on-site concrete batch plant could be delivered by dump truck. Approximately 15 to 20 truck shipments per foundation.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).

TABLE 3.5-1 (Cont.)

Project Phase/Activity	Equipment/Material	Transportation Requirements	Access Road Requirements	Special Requirements
General	Water (potable, dust suppression, concrete batch plant)	Tens of thousand of gallons likely required per day. Water could be obtained from on-site wells or trucked from off-sites sources. Off-site shipments typically in 4,000- to 5,000-gal (15,142- to 18,927-L) tank trucks. Approximately 10 to 30 shipments per day.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).
WTGS components	Rotors, nacelle, transformer, control units, tower sections	WTGS design dependent. Depending on source, components may be transported by ship, barge, rail, or truck to the vicinity of the site. Components shipped to the site using combination trucks with flatbed or goose-neck trailers. Some shipments (e.g., rotors, nacelle) likely overweight and/or oversized. Typically 5 to 15 truckloads per WTGS.	Improved access road. Limited turning radius and grades due to size and weight. Bridges may need to be fortified and overhead obstructions (e.g., transmission lines) rerouted.	Overweight and/or oversized loads require specialized equipment and state-specific permits. Traffic management requires consideration (e.g., flaggers, escort vehicles, and travel time restrictions).
WTGS assembly and installation	Cranes: 300- to 750-ton (272- to 680-t) capacity main crane, 70-ton (64-t) capacity assist crane, driveable assembly cranes	Required crane capacity dependent on WTGS design. A 300-ton (272-t) main crane would require 15 to 20 truckloads, including several overweight/oversized shipments. A 750-ton (680-t) crane would require up to 50 truckloads, including overweight/oversized shipments. Several smaller, driveable cranes required for main crane assembly and rotor assembly.	Same as WTGS components.	Same as WTGS components.

TABLE 3.5-1 (Cont.)

Project Phase/Activity	Equipment/Material	Transportation Requirements	Access Road Requirements	Special Requirements
WTGS interconnections and transmission lines	Trenching or augering equipments, line trucks	WTGS design dependent.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).
Operation				
	Operation and maintenance personnel	Pickup or medium-duty trucks.	Minimum-specification access road.	None.
Decommissioning				
Foundation removal, site regrading, recontouring	Heavy earthmoving equipment: bulldozers, graders, excavators, front-end loaders, dump trucks	Heavy equipment typically transported to the site using combination trucks with flatbed or goose-neck trailers.	Improved access road.	None. Loads expected to be legal-weight, under 80,000 lb (36,287 kg).
WTGS and tower disassembly	Cranes: 300- to 750-ton (272- to 680-t) capacity main crane, 70-ton (64-t) capacity assist crane	Similar to assembly requirements. Required crane capacity may be less than that required for initial assembly, depending upon the method used during decommissioning.	Similar to WTGS components.	Similar to WTGS components.
Equipment, debris removal	Medium- and heavy-duty trucks	Debris, dismantled equipment would be shipped for recycling, reuse, or disposal. Level of activity would be site and design dependent.	Improved access road.	None.

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.

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 dismantling turbines and towers, 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 can be disassembled, segmented, or size-reduced prior to shipment.

3.6 EXISTING MITIGATION GUIDANCE

The establishment of BMPs, guidelines, or stipulations is a standard method for ensuring that the impacts of specific activities on the surrounding environment are kept to a minimum. Toward that end, a number of organizations have developed guidance to mitigate the impacts of wind power projects. In developing policies and BMPs for inclusion in the BLM's proposed Wind Energy Development Program, existing guidance has been reviewed, and relevant and appropriate elements have been incorporated into the BLM's proposed program (Section 2.2.3).

While some of the potential impacts associated with wind energy development projects described in Chapter 5 are unique to this type of activity, a large portion of the potential impacts (e.g., road construction and habitat fragmentation) are common to other types of development activities on public lands. For this reason, existing BLM guidance and planning documents established for other types of development activities (i.e., nonwind energy activities) also have been reviewed and considered for inclusion in the BLM's proposed Wind Energy Development Program.

3.6.1 Existing Guidance on Wind Energy Development in the United States and Abroad

A number of organizations have developed or are in the process of developing guidance regarding the development of wind energy projects and mitigation measures. While many of the existing guidelines have been incorporated into the BLM's proposed program (Section 2.2.3), the specific requirements of the proposed policies and BMPs have been defined on the basis of reviews and analyses conducted in the course of this PEIS and, therefore, may vary from those put forth by other organizations.

The following text briefly identifies the key organizations that have issued or are developing comprehensive wind energy guidelines and describes the elements of their recommendations. Readers are advised to obtain the complete guidance documents from each organization if they wish to obtain more information.

- *American Wind Energy Association (AWEA).* The AWEA Siting Committee currently is developing a document that identifies and discusses issues and potential solutions related to siting wind energy projects (Jodziewicz 2004).

- *Australian Wind Energy Association (AusWEA).* The AusWEA published a document entitled *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* to facilitate the development of "high quality" wind energy projects in Australia (AusWEA 2002). These guidelines were modeled after guidelines previously published by the BWEA and the European Wind Energy Association (EWEA) described below. These guidelines provide an overview of the technical, commercial, environmental, consultative, and contractual considerations related to the different phases of wind power project development. With respect to environmental and socioeconomic considerations that should be addressed during the site selection, feasibility study, and detailed assessment phases, the guidelines identify visual resources, ecological resources, archaeological and historical heritage, conservation and recreational uses, proximity to dwellings, noise levels, EMI, aircraft safety, construction traffic safety, economic impacts, and decommissioning requirements. Impact mitigation methods for design, construction, and operation stages are provided.

- *British Wind Energy Association (BWEA).* The BWEA issued its *Best Practice Guidelines for Wind Energy Development* to facilitate the development of appropriately sited and sensitively developed wind power projects (BWEA 1994). Similar to the AusWEA guidelines, these guidelines address the technical, commercial, environmental, and consultative considerations associated with the different phases of wind power development.

- *European Wind Energy Association (EWEA).* The EWEA issued its *European Best Practice Guidelines for Wind Energy Development* to facilitate the development of appropriately sited and sensitively developed wind power projects (EWEA 1999). The document provides guidelines for activities to be undertaken during each phase of project development, including initial site selection, detailed assessment, monitoring, and final site clearance. It addresses technical, commercial, environmental, and consultative considerations. Environmental aspects discussed in the document include visual resources, noise, ecological resources, archaeological and historical resources, hydrology, telecommunications interference, aircraft safety, other safety concerns, traffic management, road construction, electrical connections, economic impacts, global environmental effects, and tourism and recreation.

- *National Wind Coordinating Committee (NWCC).* In 2002, the NWCC published a revised handbook entitled *Permitting of Wind Energy Facilities* that was prepared by its own Siting Subcommittee (NWCC 2002). The handbook is intended to serve as a guide for those involved in evaluating wind projects and “to assist stakeholders to be informed participants in the wind energy development decision-making process” (p. 1, Executive Summary). It provides an overview of wind development and permitting activities, guidelines for structuring a permitting process (including planning and monitoring phases), and a discussion of specific permitting and siting considerations and mitigation strategies. Siting considerations addressed in this handbook include land use, noise, birds and other biological resources, visual resources, soil erosion and water quality, public health and safety, cultural and paleontological resources, solid and hazardous wastes, and air quality and climate.

- In 1999, the NWCC published a document entitled *Studying Wind Energy/Bird Interactions: A Guidance Document* prepared by its Avian Subcommittee (NWCC 1999). This document provides an overview of wind energy/bird interactions for regulators and stakeholders as well as more technical information regarding the concepts and tools for studying such interactions. It is intended to serve as a reference document for assessing the suitability of proposed sites and the potential effects of a proposed project on birds of concern. It also recommends methods, metrics, and definitions for use in studies of wind energy/bird interactions.

- *U.S. Fish and Wildlife Service (USFWS).* The USFWS issued *Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines* in 2003 (USFWS 2003). These voluntary guidelines, prepared by the USFWS Wind Turbine Siting Working Group, address the evaluation of potential wind energy development sites, location and design of turbines and associated structures, and pre- and post-construction research and monitoring needs. Specifically, the guidelines provide a site evaluation process with checklists, a series of site development and turbine design and operation recommendations, and a literature review of impacts of wind turbines on wildlife. The USFWS plans to evaluate these guidelines and modify them as necessary on the basis of their performance in the field and the latest scientific and technical discoveries. The USFWS also has issued interim guidelines for protecting birds from the siting, construction, operation, and decommissioning of communication towers (Clark 2000), some of which could be applicable to both turbines and meteorological towers at a wind energy development project. In addition, the USFWS worked jointly with the Avian Power Line Interaction Committee to develop guidelines for protecting birds from electrocution and collisions with power lines (APLIC and USFWS 2005), some of which are applicable to wind energy development.

- *Washington Department of Fish and Wildlife (WDFW).* The WDFW issued *Wind Power Guidelines*, which addresses baseline and monitoring studies for wind energy projects and habitat mitigation concerns (WDFW 2003b). These guidelines define the purpose and scope of preproject habitat and wildlife assessment studies, recommend methods for avoiding or minimizing impacts to wildlife, and establish requirements for operational monitoring activities. They also establish a framework for ensuring habitat mitigation through both restoration and acquisition of replacement habitat.

3.6.2 Existing BLM Mitigation Guidance Relevant to Wind Energy Development

The BLM has developed many program-specific guidance documents that establish mitigation requirements for a variety of activities. This guidance comes in many forms: plans, manuals, handbooks, instruction memoranda, environmental memoranda, technical references, BMPs, standards, directives, and other such documents. While none of the existing guidance, other than the Interim Wind Energy Development Policy (BLM 2002a) (Appendix A), directly addresses wind energy development, guidance is provided on topics relevant to wind energy development.

A number of the key sources for relevant mitigation guidance are discussed in this section. The proposed Wind Energy Development Program includes policies and BMPs requiring that relevant BLM mitigation guidance be incorporated into individual wind energy development project PODs, as appropriate, to address site-specific issues.

3.6.2.1 BLM Land Use Plans

The BLM's land use plans are planning and management documents that (1) define how resources will be managed within a specific planning area or subdivision of a planning area, and (2) establish restrictions on activities to be undertaken in that planning area or subdivision. The land use planning process is the key tool that the BLM uses to protect resources and designate uses on federal lands that it manages. These plans help ensure that the public lands are managed in accordance with applicable laws and regulations under the principles of multiple use and sustained yield; recognizing the nation's need for domestic sources of minerals, food, timber, and fiber while protecting the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water, and archaeological values. The BLM develops land use plans in accordance with federal requirements and BLM regulations and planning policies. Depending on when a land use plan was written or last revised, it may exist as a Management Framework Plan (MFP), the original format, or as a newer Resource Management Plan (RMP).

Land use plans typically are organized according to the resources present in the planning area. For each identified resource (e.g., wildlife, minerals, recreation areas), the plan will identify management objectives and management actions. Often the management actions establish restrictions or stipulations regarding the use or development of the given resource. The scope of a given land use plan is dictated by the resources that are present in the corresponding planning area. For example, if oil and gas resources do not exist in a planning area, the corresponding land use plan will not contain management objectives or actions related to this resource. However, many resources are common to virtually all BLM planning areas, and the corresponding land use plans establish management actions to ensure appropriate resource management. Many of these are resources that might be impacted by wind energy development projects: wildlife (including federal- and state-protected species), wildlife habitat, soils, water resources, cultural and historic resources, visual resources, recreation areas, and forestry resources. In addition, many land use plans establish restrictions or stipulations specific to relevant management issues, such as hazardous materials management, fire management, and wild horse management.

3.6.2.2 Guidance for Oil and Gas Development

Many organizations, including the BLM, have developed mitigation guidance specific to oil and gas exploration and development and related ROW activities. These guidance documents are too numerous to identify and describe comprehensively in this PEIS. A review of many of them, however, indicated that they generally address the same issues identified in BLM guidance, described below, although to varying degrees of specificity and control (Western Governors' Association 2004; WGFD 2004a; ALL Consulting and Montana Board of Oil and Gas Conservation 2002; NPS 2002).

The BLM's "Gold Book" (RMRCC 1989) provides guidelines for operators conducting oil and gas and related ROW activities on BLM-administered lands. To supplement the guidance provided in the Gold Book, the BLM Washington Office, Fluid Minerals Group, has identified BMPs specific to fluid minerals development activities, including oil and gas operations and related ROW activities (BLM 2004a-e). The stated goal of these BMPs is to promote environmental resource protection and sustainable development of energy resources on public lands. The guidance provided by the BMPs recognizes that site variability defines the most appropriate management practices, and that there is no single solution applicable to all areas.

In addition, in February 2005, the BLM issued Instruction Memorandum No. 2005-069, *Interim Offsite Compensatory Mitigation for Oil, Gas, Geothermal and Energy Rights-of-Way Authorizations*, which outlines interim policy for the use of off-site mitigation for BLM authorizations for oil, gas, geothermal, and energy ROW programs, including wind energy development (BLM 2005a). Compensatory mitigation is defined in the memorandum as mitigation actions that are undertaken off site to compensate for an impact by replacing or providing substitute resources or environments. This off-site mitigation can be immediately adjacent to the area impacted but can also be located anywhere in the same general geographic area. According to the memorandum, off-site compensatory mitigation measures must be voluntary on the part of the applicant.

3.6.2.3 Other BLM Program-Specific Mitigation Guidance

The BLM has issued many program-specific documents addressing environmental issues relevant to wind energy projects. The topics covered by these documents that reasonably can be identified as relevant include land use planning; NEPA; visual resource management; road construction and maintenance; wildlife management (including special status species, ESA species, threatened and endangered species, and sage-grouse management); ACECs; hazardous materials and waste management; cultural resource management; Native American consultations; pesticide use and integrated pest management; and occupational health and safety. Additional program-specific guidance may be relevant, depending on project-specific factors.

A comprehensive review of these BLM program-specific mitigation documents is beyond the scope of this PEIS, although discussion of many of these documents is included in sections of Chapters 4 and 5. Readers are advised to obtain the complete guidance documents if they wish to obtain more information. Electronic copies of some of the BLM directives, manuals, and handbooks are available at http://www.blm.gov/nhp/efoia/.