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Upper Great Plains Wind Energy Programmatic Environmental Impact Statement

Draft

U.S. Department of Energy
Western Area Power Administration

and

U.S. Department of the Interior
U.S. Fish and Wildlife Service

Western
AREA POWER ADMINISTRATION

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

COVER SHEET

Lead Agencies: U.S. Department of Energy, Western Area Power Administration, and U.S. Department of the Interior, U.S. Fish and Wildlife Service

Cooperating Agencies: U.S. Department of the Interior, Bureau of Reclamation; U.S. Department of the Interior, Bureau of Indian Affairs; and U.S. Department of Agriculture, Rural Utility Services

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Location: States of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota

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Abstract: Western Area Power Administration (Western) and the U.S. Fish and Wildlife Service (Service) have jointly prepared this draft programmatic environmental impact statement (PEIS) to identify environmental impacts associated with various environmental review processes that could be implemented to evaluate requests for interconnection of wind energy projects to Western's transmission system or requests for placement of wind energy project components in areas managed by the Service as wetland or grassland conservation easements in Western's Upper Great Plains Customer Service Region, which encompasses all or parts of the States of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. The draft PEIS assesses environmental impacts associated with wind energy development and identifies management practices to address impacts. Decisions regarding implementation of a programmatic process for environmental evaluations of requests for interconnection of wind energy projects to Western's transmission facilities or for placement of wind energy elements on easements managed by the Service will be issued following the final PEIS as Records of Decision for each agency. Comments on the draft PEIS may be submitted electronically using the online comment form available on the project Web site (http://plainswindeis.anl.gov) or by mailing them to WESTERN/FWS Draft Wind Energy PEIS Comments, c/o John Hayse, Argonne National Laboratory, 9700 S. Cass Avenue – EVS/240, Argonne, IL 60439. Comments must be postmarked no later than May 21, 2013.

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NOTATION

The following is a list of acronyms and abbreviations, chemical names, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

AC	alternating current
ACEC	Area of Critical Environmental Concern
ACGIH	American Conference of Governmental Hygienists
ACHP	Advisory Council on Historic Preservation
ACP	advanced conservation practice
AGL	above ground level
AHPA	Archaeological & Historical Preservation Act
AIRFA	American Indian Religious Freedom Act
AOPA	Aircraft Owners and Pilots Association
AQRV	air-quality related value
Argonne	Argonne National Laboratory
ARM	Administrative Rules of Montana
ARPA	Archeological Resources Protection Act of 1979
ARRA	American Recovery and Reinvestment Act of 2009
ARS	Agricultural Research Service (USDA)
ASM	American Society of Mammalogists
ATC	Air Traffic Control
ATCBI	ATC Beacon Interrogator Radar
AWEA	American Wind Energy Association
BA	Biological Assessment
BACT	best available control technology
BCR	Bird Conservation Region
BEPC	Basin Electric Power Cooperative
BERR	Department for Business Enterprise and Regulatory Reform
BGEPA	Bald and Golden Eagle Protection Act of 1940
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BLS	U.S. Bureau of Labor Statistics
BMP	Best Management Practice
BO	Biological Opinion
BO/BA	Biological Opinion/Biological Assessment
BPA	Bonneville Power Administration
BWEA	British Wind Energy Association
CanWEA	Canadian Wind Energy Association
CDCA	California Desert Conservation Area
CDFG	California Department of Fish and Game
CDW	Colorado Division of Wildlife

CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CI	critically imperiled
CNEL	Community Noise Equivalent Level
CRP	Conservation Reserve Program
CWA	Clean Water Act
CX	Categorical Exclusion
DHS	Department of Homeland Security
DISDI	Defense Installation Spatial Data Infrastructure Program
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DSIRE	Database on State Incentives for Renewables and Efficiency
DTI	Department of Trade and Industry
EA	Environmental Assessment
ECP	Eagle Conservation Plan
EERE	Office of Energy Efficiency and Renewable Energy
EF	Enhanced Fujita Scale
EIA	Energy Information Administration
EIS	Environmental Impact Statement
ELF	extremely low-frequency
EMF	electric and magnetic fields
EMI	electromagnetic interference
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
ERCOT	Electric Reliability Council of Texas
ERO	Electric Reliability Organization
ESA	Endangered Species Act of 1973
ESRI	Environmental Systems Research Institute, Inc.
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act of 1976
FONSI	Finding of No Significant Impacts
FR	*Federal Register*
FY	fiscal year
GAP	Gap Analysis Program
GE	General Electric
GHG	greenhouse gas
GIS	geographic information system

GPWE HCP	Great Plains Wind Energy Habitat Conservation Plan
GWP	Global Warming Potential
HAP	hazardous air pollutant
HB	House Bill
HMA	Herd Management Area
IAC	Iowa Administrative Code
IBA	Important Bird Area(s)
ICUN	International Union for Conservation of Nature
IDNR	Iowa Department of Natural Resources
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFG	Idaho Fish and Game
IM	Instruction Memorandum
IPCC	Intergovernment Panel on Climate Change
IRAC	Interdepartment Radio Advisory Committee
IUB	Iowa Utility Board
JEDI	NREL’s Jobs and Economic Development Impact model
KOP	key observation points
L_{dn}	day-night average sound level
L_{eq}	equivalent sound pressure level
LFN	low frequency noise
LGI	Large Generator Interconnection
MAR	Minnesota Administrative Rules
MBTA	Migratory Bird Treaty Act of 1918
MCA	Montana Code Annotated
MDEQ	Montana Department of Environmental Quality
MDNR	Montana Department of Natural Resources
MEPA	Montana Environmental Policy Act
MGGRA	Midwest Greenhouse Gas Reduction Accord
Midwest ISO	Midwest Independent System Operator
MRO	Midwest Reliability Council
MSDS	Material Safety Data Sheets
MTFWP	Montana Fish, Wildlife & Parks
MTR	military training route
NAC	Noise Area Classification
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NAGPRA	Native American Graves Preservation Act
NAICS	North American Industry Classification System
NBII	USGS National Biological Information Infrastructure
NCDC	National Climatic Data Center

NCLS	National Landscape Conservation System
NDAC	North Dakota Administrative Code
NDCC	North Dakota Century Code
NDEQ	Nebraska Department of Environmental Quality
NDGFD	North Dakota Game and Fish Department
NDPRD	North Dakota Parks and Recreation Department
NDPSC	North Dakota Public Service Commission
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act of 1969
NERC	North American Electric Reliability Council
NEXRAD	next generation radar
NGPC	Nebraska Game and Parks Commission
NHPA	National Historic Preservation Act
NHS	National Historical Site
NIEHS	National Institute of Environmental Health Sciences
NIETC	National Interest Electric Transmission Corridors
NLCD	USGS National Land Cover Database
NLCS	National Landscape Conservation System
NM	National Monument
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NP	National Park
NPCC	Northern Power Coordinating Council
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NRCS	National Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRI	National Resource Inventory
NRHP	National Register of Historic Places
NR/UR	not ranked or under review
NSBP	National Scenic Byways Program
NTIA	National Telecommunications and Information Administration
NWCC	National Wind Coordinating Committee
NWI	National Wetlands Inventory
NWRS	National Wildlife Refuge System
NWS	National Weather Service
O&M	operation and maintenance
OHV	off-highway vehicle
OSHA	Occupational Safety and Health Administration
PAD-US	Protected Areas Database of the United States
PCB	polychlorinated biphenyl
PE	Presumed Extinct
PEIS	programmatic environmental impact statement
P.L.	Public Law
PM	particulate matter

$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 μm or less
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 μm or less
POD	plan of development
PPE	personal protective equipment
PPR	Prairie Pothole Region
PSC	Public Service Commission
PSC/MSU	Public Service Commission/Michigan State University
PSD	Prevention of Significant Deterioration
PSR	personal surveillance radar
PTC	Production Tax Credit
PUC	Public Utilities Commission
PWS	public water system
RAM	radar absorbing materials
RCRA	Resource Conservation and Recovery Act of 1976
RCS	radar cross section
RD&D	Research, Development, and Demonstration
Reclamation	U.S. Bureau of Reclamation
RETI	Renewable Energy Transmission Initiative
RFC	Reliability First Corporation
RLOS	radar line of sight
ROC	Radar Operations Center
ROD	Record of Decision
ROW	right-of-way
RPS	Renewable Energy Portfolio Standard
RRC	Regional Reliability Councils
SAAQS	State Ambient Air Quality Standards
SB	Senate Bill
SDCL	South Dakota Codified Laws
SDDENR	South Dakota Department of Environment and Natural Resources
SDDGFP	South Dakota Game, Fish & Parks
SDWA	Safe Drinking Water Act of 1974
Se	selenium
SERC	SERC Reliability Coordinating Council
Service	U.S. Fish and Wildlife Service
SGI	Small Generator Interconnection
SHPO	State Historic Preservation Office(r)
SIAP	Smithsonian Institution Affiliations Program
SIP	State Implementation Plan
SPCC	Spill Prevention Control and Countermeasures (SPCC) Plan
SPLs	sound pressure levels
SPP	Southwest Power Pool, Inc.
SSA	sole source aquifer
SSR	secondary surveillance radar
SUA	Special Use Airspace
SWPPP	Storm Water Pollution Prevention Plan

THPO	Tribal Historic Preservation Offices
TSA	Transportation Security Administration
TSCA	Toxic Substances Control Act of 1976
TSDF	Treatment, storage and disposal facilities
UGP	Upper Great Plains
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
USCB	United States Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VAD	vibroacoustic disease
VdB	vibration impact level
VOC	volatile organic compound
WECC	Western Electricity Coordinating Council
Western	Western Area Power Administration
WEWAG	Wind Energy Whooping Crane Action Group
WGA	Western Governors' Association
WHO	World Health Organization
WindPACT	Wind Partnerships for Advanced Component Technologies
WinDS	Wind Deployment System
WRA	wind resource area
WRP	Wetlands Reserve Program
WSR	weather surveillance radar
WTGS	wind turbine generator system

CHEMICALS

CO	carbon monoxide	NO_x	nitrogen oxides
CO_2	carbon dioxide	O_3	ozone
CO_{2e}	carbon dioxide equivalent	Pb	lead
CO_4	methane	SO_2	sulfur dioxide
NO_2	nitrogen dioxide		

UNITS OF MEASURE

ac	acre	°F	degree(s) Fahrenheit
ac-ft	acre-foot (feet)	ft	foot (feet)
ac-ft/yr	acre-foot (feet)/ year	ft^2	square foot (feet)
°C	degree(s) Celsius	gal	gallon(s)
cm	centimeter(s)	GW	gigawatt(s)
		GHz	gigahertz
dB	decibel(s)		
dBA	A-weighted decibel(s)	h	hour(s)

ha	hectare(s)
Hz	hertz
in.	inch(es)
kg	kilogram(s)
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
kWh	kilowatt hours
kV	kilovolt(s)
kV/m	kilovolts/meter
kW	kilowatt(s)
kWh	kilowatt-hour(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m/sec	meters per second
m^2	square meter(s)
m^3	cubic meter(s)
mi	mile(s)
mi^2	square mile(s)
mph	mile(s) per hour
MW	megawatt(s)
ppm	part(s) per million
psi	pound(s) per square inch
rpm	revolution(s) per minute
s	second(s)
t	metric ton(s)
W	watt(s)
yd^3	cubic yard(s)
yr	year
μm	micrometer(s)
VdB	vibration impact level

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

The following table lists the appropriate equivalents for English and metric units.

Multiply	By	To Obtain
English/Metric Equivalents		
acres	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
degrees Fahrenheit (ºF) –32	0.5555	degrees Celsius (ºC)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m^3)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft^2)	0.09290	square meters (m^2)
square yards (yd^2)	0.8361	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
yards (yd)	0.9144	meters (m)
Metric/English Equivalents		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
cubic meters (m^3)	264.2	gallons (gal)
degrees Celsius (ºC) +17.78	1.8	degrees Fahrenheit (ºF)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km^2)	0.3861	square miles (mi^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)

EXECUTIVE SUMMARY

ES.1 BACKGROUND

Executive Order 13212 ("Actions to Expedite Energy-Related Projects") directed Federal agencies to expedite their review of permits or to take other actions that will increase the production, transmission, or conservation of energy while maintaining safety, public health, and environmental protections. Additional requirements for departments and agencies to consider and to facilitate the development of renewable energy and electric power transmission projects have been promulgated in the Energy Policy Act of 2005 (EPAct) and the American Recovery and Reinvestment Act of 2009, along with other policies and initiatives. On March 11, 2009, the Secretary of the Interior issued a secretarial order establishing renewable energy production as a top priority for the U.S. Department of the Interior (DOI). Wind energy development is likely to be a major component in meeting these mandates.

To better address environmental concerns associated with increased development of wind energy production, Western Area Power Administration (Western) and the U.S. Fish and Wildlife Service (Service) are considering the implementation of environmental evaluation procedures and mitigation strategies for wind energy development projects in Western's Upper Great Plains Customer Service Region (UGP Region), which encompasses all or parts of the States of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. The environmental procedures and mitigation strategies would be applied to interconnection requests made to Western by project developers and to requests for consideration of easement exchanges to accommodate wind energy project development on grassland and wetland easements managed by the Service within the UGP Region. The Upper Great Plains area of the United States has been identified as having a high potential for wind energy development because of the availability of an excellent wind resource regime. In the six-State region being considered in this programmatic environmental impact statement (PEIS), installed commercial wind energy generation capacity has grown from approximately 0.5 gigawatts (GW) to more than 8 GW in the past 10 years. Much of this growth has occurred in the past 5 years, and it is anticipated that the industry's installed generating capacity within the UGP Region will continue to increase at a rapid pace.

Western and the Service have interests in streamlining their procedures for conducting environmental reviews of wind energy applications by implementing evaluation procedures and identifying measures to address potential environmental impacts associated with wind energy projects in the Upper Great Plains area. As joint lead agencies, Western and the Service have prepared this PEIS to (1) assess the potential environmental impacts associated with wind energy projects within the UGP Region that may connect to Western's transmission system or that may propose placement of project elements on grassland or wetland easements managed by the Service; and (2) evaluate how environmental impacts would differ under alternative sets of environmental evaluation procedures, best management practices (BMPs), and mitigation measures that the agencies would request project developers to implement (as appropriate for specific wind energy projects).

ES.2 SCOPING PROCESS

Public involvement is an important requirement of the National Environmental Policy Act of 1969 (NEPA), especially for determining the appropriate scope of the analyses to be conducted. The scope includes the range of alternatives that will be considered and potentially significant impacts that should be evaluated. This public involvement process (which also included consultations with other State and Federal agencies and Native American tribes) is referred to as scoping. As part of the public involvement process, a Notice of Intent (NOI) to prepare the PEIS was published in the *Federal Register* on September 11, 2008 (73 FR 52855–52858). The NOI invited interested members of the public to provide comments on the scope and objectives of the PEIS, including identification of issues and alternatives that should be considered in the PEIS analyses. Western and the Service conducted scoping for the PEIS from September 11, 2008, through November 10, 2008.

The public was provided with three methods to submit scoping comments for the PEIS: (1) via an online comment form on the project Web site, (2) by mail, and (3) in person at public scoping meetings. Comments received during the scoping period primarily pertained to (1) policies of the agencies relative to wind energy, (2) alternatives that should be considered in the PEIS, (3) interagency cooperation and government-to-government consultation, (4) siting and technology concerns, (5) environmental and socioeconomic concerns, (6) cumulative impacts, and (7) mitigation of impacts.

In addition to the public scoping, Western and the Service coordinated with tribes within the UGP Region by making presentations to individual tribes regarding the development of the PEIS and soliciting scoping input. Letters to State and Federal agencies were also sent out to alert those agencies that the PEIS was being prepared and to solicit input from agencies regarding the availability of information that could be used to evaluate environmental impacts and information about specific concerns or issues that should be considered.

ES.3 PUBLIC REVIEW OF THE DRAFT PEIS

Public and agency comments on the draft PEIS will be sought during a 60-day period following release of the public draft of the PEIS.

ES.4 PROPOSED ACTION

The proposed action is for Western and the Service to streamline the environmental reviews for wind energy projects that will interconnect to Western’s transmission facilities or that would require consideration of an easement exchange to accommodate placement of project facilities on easements managed by the Service. Under the proposed action, the agencies would identify standardized environmental evaluation procedures, BMPs, and mitigation measures that would be applied to wind energy projects requesting interconnections or easement exchanges.

ES.5 DESCRIPTION OF ALTERNATIVES

Four alternatives, including the No Action Alternative, are evaluated in the PEIS. The No Action Alternative would entail no change to the procedures currently used by Western and the Service to evaluate and address the environmental impacts associated with wind energy projects. The other three alternatives would require changes in the current environmental evaluation procedures used by the agencies and represent different ways in which the agencies could accomplish the proposed action. The alternatives are described in the following sections and are summarized in table ES.5-1.

ES.5.1 No Action Alternative

Under the No Action Alternative, requests for interconnection of wind energy projects to Western's transmission systems would be processed, reviewed, and evaluated in the current manner, including environmental reviews performed for specific projects. Similarly, proposals to place wind energy facilities on wetland and grassland easements managed by the Service would continue to be considered as they have in the past. This means the Service will work with the developer to avoid impacting easement interests if possible, and then minimize the unavoidable impacts to the extent practicable. The resulting wind energy facilities that do not impact critically needed habitat or species of special concern, and that do not significantly impair any easement's ability to achieve its conservation purpose, will be accommodated by executing an exchange of easement interests.

NEPA analyses would be prepared by each agency, as appropriate, on a project-by-project basis and BMPs, mitigation measures, and monitoring requirements would be developed on a case-by-case basis only. Government-to-government consultation with Native American tribes would continue to be conducted separately for each project as appropriate. Endangered Species Act (ESA) Section 7 consultation with the Service regarding potential effects of project development on federally listed species and consultation with appropriate agencies and federally recognized Native American tribes under Section 106 of the National Historic Preservation Act of 1966 (NHPA) (36 CFR 800) regarding potential effects on cultural and historic resources would also be conducted separately for each project.

ES.5.2 Alternative 1: Programmatic Regional Wind Energy Development Evaluation Process for Western and the Service

Alternative 1 is identified by Western and the Service as the preferred alternative. Under Alternative 1, both agencies would implement a standardized process for evaluating the environmental effects of wind energy projects. Western would establish standardized procedures for the environmental review when considering interconnection requests and would identify BMPs and mitigation measures to be applied by developers where specific resource conditions occur. The Service would continue to process requests for easement exchanges to accommodate wind energy structures on Service easements using current procedures, but would adopt a standardized approach for reviewing potential environmental impacts of easement exchanges. Standardized BMPs, mitigation measures, and monitoring requirements

TABLE ES.5-1 Description of the Programmatic Alternatives Evaluated in the PEIS

Alternative	Western Area Power Administration	U.S. Fish and Wildlife Service
No Action Alternative	• Process and evaluate environmental reviews of interconnection requests on a case-by-case basis. • Separate project-specific NEPA evaluations and analyses required for each interconnection request. • Separate project-specific ESA Section 7 consultation initiated for each interconnection request. • BMPs and mitigation measures identified on a project-by-project basis.	• Process and evaluate requests for easement exchanges separately on a case-by-case basis. • Separate project-specific NEPA evaluations and analyses would be required for projects affecting easement lands. • Separate project-specific ESA Section 7 consultation would be required for projects affecting easement lands. • BMPs, mitigation measures, and monitoring requirements identified on a project-by-project basis for projects affecting easement lands.
Alternative 1 (Preferred Alternative)	• Adopt a standardized structured process for collecting information and evaluating and reviewing environmental impacts of wind energy interconnection requests. • Apply programmatic BMPs and mitigation measures developed in the PEIS to minimize impacts of interconnection requests. • Project-specific NEPA analyses tier off the analyses in the PEIS as long as the appropriate identified BMPs and mitigation measures are implemented as part of proposed projects. • Project-specific ESA Section 7 consultations tier off programmatic consultation as long as the BMPs, minimization measures, mitigation measures, and monitoring requirements established as part of the programmatic ESA Section 7 consultation are implemented, as appropriate.	• Process and evaluate requests for easement exchanges separately on a case-by-case basis. • Adopt a standardized structured process for collecting information and evaluating and reviewing potential environmental impacts of easement exchanges if wind energy facilities cannot avoid Service easements. • Require implementation of programmatic BMPs, mitigation measures, and monitoring to ensure the integrity and conservation objectives of Service easements are maintained. • Project-specific NEPA analyses tier off the analyses in the PEIS as long as the identified BMPs, mitigation measures, and monitoring requirements are implemented as part of projects. • Future project-specific ESA Section 7 consultations tier off programmatic consultation as long as the BMPs, minimization measures, mitigation measures, and monitoring requirements established as part of the programmatic ESA Section 7 consultation are implemented, as appropriate.
Alternative 2	• Same as Alternative 1.	• No easement exchanges to accommodate wind energy facilities would be allowed.

TABLE ES.5-1 (Cont.)

Alternative	Western Area Power Administration	U.S. Fish and Wildlife Service
Alternative 3	• Separate project-specific NEPA evaluations required for each interconnection request. • No additional BMPs or mitigation measures would be requested by Western beyond those mandated under applicable Federal, State, and local regulations.	• Process and evaluate requests for easement exchanges separately on a case-by case basis. • No additional mitigation measures, BMPs, or monitoring would be required by the Service for easement exchanges beyond those mandated under applicable Federal, State, and local regulations. • Easement exchanges would occur for wind energy projects as presented by developers, without consideration of additional measures to reduce impacts.

that developers would need to apply to address potential environmental effects to affected easements would be identified. Both agencies would continue to require site-specific NEPA evaluations for projects (including analysis of cumulative impacts), but those NEPA evaluations would tier off the analyses in this PEIS as long as the project developers are willing to implement the applicable evaluation process, BMPs, and mitigation measures identified for this alternative. If a developer does not wish to implement the evaluation process, BMPs, or mitigation measures identified for this alternative, a separate NEPA evaluation that does not tier off the analyses in the PEIS would be required. Government-to-government consultation with Native American tribes and consultation with appropriate agencies under Section 106 of the NHPA regarding potential effects on cultural and historic resources would continue to be conducted separately for each project as appropriate. Project-specific ESA Section 7 consultations would tier off programmatic consultation conducted for this PEIS, as long as developers agree to implement the appropriate avoidance measures, mitigation measures, and monitoring requirements identified during the programmatic consultation.

Both this PEIS and the associated programmatic ESA Section 7 consultation endeavor to capture BMPs and mitigation measures that have been found to be effective in avoiding or reducing impacts on specific environmental resources. Because of the desire to include all practicable measures in this PEIS, some measures may not be appropriate or effective in all situations, so Western and the Service would coordinate with project developers during project planning activities to identify the project-specific measures that would be applicable to each project.

Programmatic elements for each agency under this alternative include the following:

- Adoption of a standardized approach for evaluating environmental effects of proposed wind energy projects;

- Adoption of programmatic BMPs and mitigation measures that would be applied or recommended for specific projects and various resource conditions; and

- Identification of environmental review requirements for situations where programmatic BMPs and mitigation measures are adopted by project developers and for situations where they are not adopted.

The agencies believe that the benefits of implementing Alternative 1 include the following:

- *Tiering of project-specific environmental analyses.* Future, project-specific environmental analyses for wind energy development would tier off of the analyses conducted in this PEIS and the decisions in the Record of Decision (ROD), thereby allowing the project-specific analyses to focus on site-specific issues that are not already addressed in sufficient detail.

- *Development of comprehensive procedures and mitigation measures.* Implementing the programmatic elements identified for Alternative 1 would provide developers with a set of standardized environmental review procedures, BMPs, and mitigation measures that would provide guidance on environmental reviews and requirements for wind energy projects requesting connection to Western's transmission system and/or proposing modification of the Service's wetland or grassland easements through easement exchanges.

- *Consistency of the application and authorization process*. Implementation of the proposed standardized environmental review procedures, BMPs, and mitigation measures would result in greater consistency and efficiency in the environmental reviews of applications for wind energy interconnections and for the environmental evaluation of requests for easement exchanges to accommodate wind energy development on easements lands.

- *Support development of wind energy projects and infrastructure within the UGP Region.* A programmatic process for evaluating environmental effects of wind energy interconnection and development requests would facilitate understanding by potential developers of the requirements for approval and would result in a reduction of environmental impacts from wind energy development. The ability to tier site-specific NEPA reviews off this PEIS would reduce the amount of time needed to evaluate, plan, and construct wind energy projects.

ES.5.2.1 Programmatic Environmental Evaluation Process

Western Area Power Administration. All wind energy interconnection requests will follow the procedures established by Western's Open Access Transmission Service Tariff. Within those procedures, Western proposes to adopt the following approach for environmental review and consultation requirements for wind energy interconnection requests under Alternative 1:

- Project developers seeking to develop a wind energy project that would connect to Western's transmission facilities shall consult with appropriate Federal, State, and local agencies regarding specific projects as early in the planning process as appropriate to ensure that all potential pre-project surveys, monitoring, construction, operation, maintenance, and decommissioning issues and concerns are identified and addressed.

- As early in the planning process as appropriate, Western will initiate government-to-government consultation with Native American tribal governments whose interests might be directly and substantially affected by the planned interconnection activities so that construction, operation, maintenance, and decommissioning issues are identified and addressed.

- Western will consult with the Service as required by Section 7 of the ESA for all interconnections. A programmatic consultation will be developed as part of this PEIS to address listed species, although specific consultation requirements will be determined on a project-by-project basis. Under the proposed programmatic evaluation process, additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing appropriate and applicable programmatic avoidance, minimization, and mitigation measures that would result in a determination that listed species and critical habitat are not likely to be adversely affected. Conversely, project-specific ESA Section 7 consultation would be initiated for (1) any listed species or critical habitat not considered in the programmatic consultation and (2) any listed species or critical habitat for which project developers are unwilling or unable to implement the programmatic avoidance, minimization, or mitigation measures applicable to a project. ESA Section 7 consultation for individual projects that are addressed under the programmatic consultation will be documented with a letter to the appropriate Service office; this letter will provide details about the project location and design, identify the applicable listed species, and identify the appropriate and applicable programmatic avoidance, minimization, and mitigation measures that the project developer has agreed to incorporate into the project plan.

- Western will consult with the appropriate State Historic Preservation Office (SHPO) as required by Section 106 of the NHPA. The specific consultation requirements will be determined on a project-by-project basis. Western will encourage project developers to coordinate their wind projects with the SHPO. In some States, consultation with the SHPO on private projects is already required as a provision of the State's utility siting permit process. Cultural resource surveys would be required for all ground-disturbing activities, except in cases involving modifications to existing substations or other areas where surveys have already been completed.

- The level of environmental analysis to be required under NEPA for individual wind power projects and related facilities will be determined by Western for projects requesting interconnection but no exchanges of Service easements; for projects that also require decisions regarding exchanges of Service easements, the required level of environmental analyses would be determined jointly by Western and the Service. It is Western's intent that future wind energy project environmental analysis will tier off of the analyses and decisions embedded in this PEIS and additional project-specific NEPA analyses will refer back to this PEIS for relevant information, allowing subsequent NEPA documents to focus on site-specific issues and concerns. The site-specific NEPA analyses will include analyses of project site configuration and micrositing considerations, unique or unusual aspects or issues not anticipated by the PEIS, and the application of appropriate mitigation measures. In particular, the BMPs and mitigation measures identified in the PEIS (summarized below) would be implemented when appropriate for addressing site-specific environmental conditions; additional measures not identified in the PEIS may be requested to address some site-specific situations. Public involvement will be incorporated into all wind energy development projects so that concerns and issues are identified and adequately addressed. In general, the scope of the NEPA analyses will focus on the proposed Federal action related to interconnection to Western's transmission facilities. However, the environmental effects of a developer's proposed project will also be analyzed so that the anticipated impacts and mitigation needs of the proposed project can be disclosed to the public and considered by Federal decision makers. The NEPA analysis may also need to assess the environmental effects from proposed transmission required to reach the point of interconnection. Western's analyses of impacts within ROWs will tier off of this PEIS to the extent that the proposed project falls within the scope of the PEIS analyses. Site-specific environmental analyses will tier from the PEIS and identify and assess any cumulative impacts that are beyond the scope of the cumulative impacts addressed in the PEIS.

Service Easements. The Service proposes to adopt the following approach for reviewing requests for wind energy development on Service easements under Alternative 1:

- Project developers seeking to place wind energy facilities on easements managed by the Service shall consult with appropriate Federal, State, and local agencies regarding specific projects as early in the planning process as appropriate to ensure that all potential planning and preconstruction surveys and information needs, construction, operation, and decommissioning issues and concerns are identified and addressed.

- Easements or portions of easements may be excluded from wind energy development on the basis of findings of unacceptable resource impacts that conflict with existing and planned conservation needs and/or cannot be suitably avoided or mitigated.

- The level of environmental analysis to be required under NEPA for individual wind power projects requesting exchanges of Service easements and not requesting interconnection to Western's transmission system will be determined by the appropriate Service Field Offices. For projects also requesting interconnection with Western's transmission system, the required level of environmental analyses would be determined jointly by Western and the Service. It is the Service's intent that future wind energy project environmental analysis will tier off of the decisions embedded in this PEIS and limit the scope of additional project-specific NEPA analyses. The site-specific NEPA analyses will consider project siting, site configuration and micrositing, monitoring requirements, and the application of appropriate mitigation measures. In particular, the BMPs and mitigation measures identified in the PEIS (and summarized below) would be used when appropriate and applicable for addressing site-specific environmental conditions; additional measures not identified in the PEIS may be requested to address some site-specific situations. Public involvement will be incorporated into all wind energy development projects to ensure that concerns and issues are identified and adequately addressed. In general, the scope of the NEPA analyses will focus on the Federal action on Service easements, but must also include the full project (for example, indirect effects and impacts from connected and similar actions, if any). If access to proposed development on adjacent non-Service-administered lands is entirely dependent on obtaining access to Service-administered easements and there are no alternatives to that access, the NEPA analysis may need to assess the environmental effects from that proposed development so that the anticipated impacts can be disclosed to the public and considered by Federal decision makers.

- Site-specific environmental analyses will tier from this PEIS, but will identify and assess any cumulative impacts that are beyond the scope of the cumulative impacts addressed in the PEIS.

- The Service will consult as required by Section 7 of the ESA for all exchanges of easement lands to accommodate wind energy facilities. A programmatic consultation will be developed as part of this PEIS to address listed species and critical habitat, although specific consultation requirements will be determined on a project-by-project basis. Under the proposed programmatic evaluation process, the Service would conclude that additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing the appropriate and applicable programmatic avoidance measures, minimization measures, construction BMPs, and mitigation measures that would result in a determination that listed species and critical habitat are not likely to be adversely affected. Conversely, the Service would initiate project-specific ESA Section 7 consultation for (1) any listed species or critical habitat not considered in the programmatic consultation and (2) for any listed species or critical habitat for which project developers are unwilling or unable to implement the programmatic minimization measures, BMPs, or mitigation measures applicable to a project. ESA Section 7 consultation for individual projects that are addressed under the programmatic consultation will be documented with a letter to the appropriate Service office; this letter will provide details about the project location and design, identify the applicable listed species, and identify the appropriate and applicable programmatic avoidance, minimization, and mitigation measures that the developer has agreed to incorporate into the project plan.

- The Service will consult with the SHPO as required by Section 106 of the NHPA. The specific consultation requirements will be determined on a project-by-project basis. In general, cultural resource surveys would be required for all ground-disturbing activities, except in cases involving areas where surveys have already been completed.

- Project developers seeking easement exchanges in order to accommodate wind energy facilities on Service easements shall develop a project-specific plan of development (POD) that incorporates applicable programmatic BMPs and mitigation measures and, as appropriate, the requirements of other existing and relevant mitigation guidance. Additional mitigation measures will be incorporated into the POD and into the authorization as project stipulations, as needed, to address site-specific and species-specific issues. The POD will include a site plan showing the locations of turbines, roads, power lines, other infrastructure, and other areas of short- and long-term disturbance.

- The Service will incorporate management goals and objectives specific to habitat conservation for species of concern, as appropriate, into the POD for proposed wind energy projects.

- The effectiveness of the programmatic review procedures and the programmatic BMPs and mitigation measures will be periodically reviewed and will be updated and revised as new data regarding the impacts of wind power projects become available. At the project level, operators may be required to develop monitoring programs, as appropriate, to evaluate the environmental conditions at affected easements through all phases of development, to establish metrics against which monitoring observations can be measured, to identify potential mitigation measures, and to establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and project-specific stipulations.

ES.5.2.2 Programmatic BMPs and Mitigation Measures

Under Alternative 1, Western and the Service would apply programmatic BMPs and mitigation measures to all wind energy development projects within the UGP Region that would interconnect to Western and/or require an exchange of Service easements. The BMPs and mitigation measures in the PEIS would be adopted, where appropriate and applicable, as elements of project-specific development plans. Measures related to site monitoring and testing and to preparation of development plans are also included and identify the elements of development plans that would be needed to address potential impacts associated with subsequent phases of development. Some of the proposed BMPs and mitigation measures address issues that are not unique to wind energy development, such as road construction and maintenance, wildlife management, hazardous materials and waste management, cultural resource management, and pesticide use and integrated pest management.

The identification and selection of applicable project-specific BMPs and mitigation measures would be based on whether the measure would (1) ensure compliance with relevant statutory or administrative requirements, (2) minimize local impacts associated with siting and design decisions, (3) promote post-construction stabilization of impacts, (4) maximize post-construction restoration of habitat conditions, (5) minimize cumulative impacts, and (6) promote economically feasible development of wind energy. Western and the Service acknowledge that certain BMPs and mitigation measures may not be reasonable or applicable at a particular project site; only those BMPs and mitigation measures found applicable to the situation at the specific project site would be implemented. The programmatic BMPs and mitigation measures are summarized below:

Site Monitoring and Testing.

- The area disturbed by installation of meteorological towers (i.e., footprint) shall be kept to a minimum.

- Existing roads shall be used to the maximum extent feasible. Meteorological towers shall be installed and other characterization activities (e.g., geotechnical testing) shall be conducted as close as practicable to existing access roads. If new roads are necessary, they shall be designed and constructed to the appropriate standard.

- Meteorological towers shall not be located in sensitive habitats or in areas where resources known to be sensitive to human activities (e.g., wetlands, cultural resources, and listed species) are present. Installation of towers shall be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors, and the disturbed area will be minimized.

- The use of guy wires on meteorological towers shall be avoided or minimized. Any needed guy wires shall have guys appropriately marked with bird flight diverters.

General Planning and Land Use.

- Project developers shall contact appropriate agencies, property owners, tribes, and other stakeholders early in the planning process to identify potentially sensitive land uses and issues, identify preproject surveys or data collection needs, and identify rules that govern wind energy development locally, as well as land use concerns specific to the region. Project developers should coordinate closely with the Service and the U.S. Department of Agriculture (USDA) during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.

- Consult with the Department of Defense (DOD) during initial project planning to evaluate impacts of a proposed project on military operations in order to identify and address any DOD concerns.

- The Federal Aviation Administration (FAA) required notice of proposed construction shall be made as early as possible to identify any air safety measures that would be required.

- Avoid locating wind energy developments in areas of unique or important recreation, wildlife, or visual resources. When feasible, a wind energy development should be sited on already altered landscapes.

- Available information describing the environmental and sociocultural conditions in the vicinity of the proposed project shall be collected and reviewed as needed to predict potential impacts of the project.

- To plan for efficient use of the land, necessary infrastructure requirements shall be consolidated wherever possible, and current transmission and market access shall be evaluated carefully.

- Projects shall be designed to utilize existing roads and utility corridors to the maximum extent feasible, and to minimize the number and length/size of new roads, lay-down areas, and borrow areas.

- Prior to start of construction, a monitoring plan shall be developed by the project developers so that environmental conditions are monitored during the construction, operation, and decommissioning phases. The monitoring plan shall be submitted to the Service and shall identify the monitoring requirements for important environmental conditions present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring results and additional mitigation measures into standard operating procedures and BMPs for the project.

- "Good housekeeping" procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash, or waste; to prohibit scrap heaps and dumps; and to minimize storage yards.

- An access road siting and management plan shall be prepared incorporating applicable standards regarding road design, construction, and maintenance. Access roads will be designed to minimize total length, avoid wetlands, and avoid or minimize stream and drainage crossings.

Ecological Resources.

Implementation of a Risk-Based Evaluation Approach. Many concerns relative to the potential types and levels of impacts of wind energy development on wildlife and other ecological resources depend upon site-specific and project-specific factors. Under Alternative 1, project developers shall employ a risk-based evaluation approach to identify project-specific concerns related to wildlife and other ecological resources, and the results of the evaluation will be incorporated into project-specific NEPA documentation. The risk evaluation approach used by developers should be consistent with the tiered approach identified in the *Land-Based Wind Energy Guidelines* finalized by the Service in 2012. These guidelines describe a decision framework for collecting information to evaluate environmental risks to wildlife and other ecological resources during project planning and, in some cases, after project development has been completed.

Using an evaluation process that is consistent with that identified in the *Land-Based Wind Energy Guidelines* during wind farm planning and development would provide project developers with a stepwise method for evaluating environmental concerns in their decision-making process. The evaluation process would help identify ecological resources that have a reasonable likelihood to be significantly affected by planned project designs and activities, as well as those ecological resources that are unlikely to be significantly affected. Proper identification of resources that could be significantly affected would allow the focus to be on modifying the design of the proposed project or identifying BMPs and mitigation measures to avoid, reduce, or otherwise compensate for potentially significant impacts and would reduce the potential for unexpected impacts on natural resources and subsequent delays in project development. In addition, requesting developers to implement a method for evaluating the potential for ecological resources to be affected by wind energy projects that is consistent with the *Land-Based Wind Energy Guidelines* would facilitate the ability of Western and the Service to (1) identify and address project-specific concerns related to species protected under the ESA; (2) identify and address project-specific concerns related to protection of eagles under the Bald and Golden Eagle Protection Act (BGEPA); and (3) meet responsibilities of Federal agencies to protect migratory birds as directed by Executive Order 13186 and to accomplish terms and objectives identified in a 2006 Memorandum of Understanding between the DOE and the Service regarding implementation of the Executive Order.

Timely communication with Western and/or the Service regarding results of the initial steps of the risk evaluation is encouraged. This would allow the opportunity for the agencies to provide, and developers to consider, technical advice about ways to modify the project design or to identify BMPs and mitigation measures that could be considered to avoid, reduce, or otherwise compensate for potentially significant impacts.

Protection of Federally Listed Species and Designated Critical Habitat. A programmatic consultation is being conducted as part of the PEIS to address federally listed species. However, the consultation requirements that apply would be determined on a project-by-project basis and would be based on the federally listed species and designated critical habitat that could be affected by the proposed project. Under the proposed environmental review process, Western and the Service would conclude that additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing appropriate and applicable programmatic avoidance, minimization, and mitigation measures that would result in a determination that listed species are not likely to be adversely affected. Conversely, project-specific ESA Section 7 consultation would be required for (1) any listed species not considered in the programmatic consultation and (2) any listed species for which project developers are unwilling or unable to implement the programmatic avoidance measures, minimization measures, or mitigation measures applicable to a project.

Western and the Service have been engaged in discussions relative to programmatic measures that could be implemented to limit the potential for adverse effects from wind energy projects on federally listed species (i.e., species listed as threatened or endangered and species that are candidates for listing under the ESA) and designated critical habitat for those species. Based upon these discussions, a draft set of avoidance, minimization, and mitigation measures that would result in determinations that listed species and designated critical habitat would not be affected or are not likely to be adversely affected by wind energy development activities have been identified for the federally listed species, candidates for listing, and designated critical habitats that occur within the UGP Region. These draft measures are summarized in table ES.5-2. Programmatic consultation with the Service would be completed before issuance of the final PEIS and could result in modifications to some of the identified measures.

A primary goal for development of the draft programmatic measures for protection of federally listed species and designated critical habitats was to identify a set of measures that would limit the potential for adverse effects to species and critical habitats while still accommodating the majority of wind energy projects likely to occur within the UGP Region. This met one of the agencies' objectives of establishing programmatic processes that would

TABLE ES.5-2 Summary of Draft Programmatic Species-Specific Survey Requirements, Avoidance Measures, and Conservation Measures for Federally Listed Species and Designated Critical Habitat in the UGP Region[a]

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants					
Platanthera leucophaea	Eastern prairie fringed orchid	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In counties where E. prairie fringed orchid is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Surveys should include proper identification and survey techniques as presented in the listing documents. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing E. prairie fringed orchid. Clearly delineate buffer zones around locations of plants within the project area and restrict activities within 100 ft (30.5 m) of those locations. Avoid mowing along access roads or transmission line ROWs in area containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing E. prairie fringed orchid, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure • Employ BMPs during and after construction to control erosions and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in suitable habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat	May affect, not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Asclepias meadii	Mead's milkweed	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In Counties where Mead's milkweed is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing Mead's milkweed. Avoid mowing along access roads or transmission line ROWs in areas containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing Mead's milkweed, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to avoid sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. Herbicide use is prohibited within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Lespedeza leptostachya	Prairie bush clover	Plants may be disturbed/destroyed, or future colonization precluded by site clearing for wind energy project construction activities.	Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing prairie bush clover. Avoid mowing along access roads or transmission line ROWs in areas containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing prairie bush clover, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Spiranthes diluvialis	Ute ladies'-tresses	Culvert and bridge construction for access roads may lead to bank erosion, sediment loading, or impacts on downstream flows that could result in alteration or loss of habitat.	Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing Ute ladies'-tresses.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing Ute ladies'-tresses, Developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species.	May affect, not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Platanthera praeclara	Western prairie fringed orchid	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In counties where w. prairie fringed orchid is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of occupied habitat.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing w. prairie fringed orchid, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect
Pinus albicaulis	Whitebark Pine	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities.	May occur in 29 counties in Montana. However, occurs on high-elevation sites at alpine timberline. In counties where whitebark pine is known to occur, preconstruction evaluations and surveys are required to identify occupied sites. Do not site turbines, access roads, transmission line towers, or other project facilities within 300 ft (91 m) of occupied locations.	None needed.	Not likely to jeopardize the continued existence

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates					
Nicrophorus americanus	American burying beetle	Habitat loss or degradation may occur due to movement of construction equipment along access roads, clearing/grading for turbine pads and substations, construction of transmission lines from turbines to the electrical grid, construction of access roads, and storage of equipment. Direct mortality may also occur from turbine strikes, increased presence of attractants (e.g., avian collision mortality at turbines), vehicular traffic, or construction disturbance of soil during the breeding season or overwintering period.	In counties where the species is known to occur, preconstruction evaluations and surveys are required to determine (1) the presence of suitable habitat and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in suitable habitat	None.	May affect, not likely to adversely affect
Hesperia dacotae	Dakota skipper	Direct impacts include mortality due to ground/vegetation disturbance, application of pesticides, or collisions with vehicles. Indirect impacts include a loss of native plants used by Dakota skippers due to construction of access roads, turbines, substations, or transmission lines.	Do not site turbines, access roads, transmission line towers, or other project facilities in occupied habitat.	For projects that encompass suitable habitat or that occur near occupied habitat: • Obtain a grassland easement of native prairie, equal to the amount disturbed that contains obligate plant species to minimize additional loss to suitable habitat or improve existing nearby grassland easements to incorporate obligate plants to provide additional suitable habitat. • Avoid using herbicides or pesticides in the vicinity suitable habitat.	Not likely to jeopardize the continued existence
Lampsilis higginsii	Higgins eye	Negative impacts are unlikely because wind energy development would not occur in areas adjacent to potential Higgins eye habitat.	Do not site turbines, access roads, transmission line towers, or other project facilities in aquatic habitat where Higgins eye mussels may be present.		No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates (Cont.)					
Oarisma poweshiek	Poweshiek skipperling	Direct impacts include mortality due to ground/vegetation disturbance, application of pesticides, or collisions with vehicles. Indirect impacts include a loss of native plants used by skipperlings due to construction of access roads, turbines, substations, or transmission lines.	Do not site turbines, access roads, transmission line towers, or other project facilities in suitable habitat.	For projects that encompass suitable habitat or that occur near occupied habitat: • Obtain a grassland easement of native prairie, equal to the amount disturbed that contains obligate plant species to minimize additional loss to suitable habitat or improve existing nearby grassland easements to incorporate obligate plants to provide additional suitable habitat. • Avoid using herbicides or pesticides in the vicinity suitable habitat.	Not likely to jeopardize the continued existence
Cicindela nevadica lincolniana	Salt Creek tiger beetle	Mortality could occur if wind energy facility construction causes flooding and sediment transport that inundates burrows along creek habitats in Nebraska.	Do not site turbines, access roads, transmission line towers, or other project facilities in the watersheds of critical habitat locations habitat.	Should wind farms be developed near saline wetlands measures should be taken to: Avoid changing existing surface water flows that would alter existing habitat in the Salt Creek and Rock Creek watersheds. Avoid using herbicides or pesticides in the vicinity suitable habitat.	May affect, but is not likely to adversely affect
	Designated critical habitat for Salt Creek tiger beetle	Critical habitat has been designated for four areas of Salt Creek, totaling approximately 1,933 ac (782 ha) in Lancaster and Saunders Counties, Nebraska. Saline wetland and stream complexes found along Little Salt Creek and Rock Creek comprise the critical habitat designation.	Do not site turbines, access roads, transmission line towers, or other project facilities in critical habitat.		No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates (Cont.)					
Leptodea leptodon	Scaleshell mussel	Negative impacts are unlikely because wind energy development would not occur in areas where scaleshell mussels are present.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to aquatic habitat where scaleshell mussels may be present.		No effect
Fish					
Thymallus arcticus	Arctic grayling	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to streams where Arctic grayling occur.	None needed.	Not likely to jeopardize the continued existence
Salvelinus confluentus	Bull trout	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Do not site turbines, access roads, transmission line towers, culverts, or other project facilities in or adjacent to designated core areas, spawning or rearing habitat, and migratory corridors.	For projects that encompass areas within drainages occupied by bull trout: • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Avoid actions that would alter surface water flow in occupied habitat.	No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Fish (Cont.)					
	Designated critical habitat for bull trout	Designated critical habitat within the UGP Region includes approximately 37 mi (59 km) of streams and 4,107 ac (1,662 ha) of lakes within the Saint Mary-Belly River Basins in Glacier County, Montana.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to designated critical habitat.		No effect
Scaphirhynchus albus	Pallid sturgeon	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to aquatic habitat where pallid sturgeon occurs.	For projects that encompass areas within drainages occupied by pallid sturgeon: • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Ensure that upstream and downstream fish passage is maintained in any areas where stream habitat disturbance occurs. • Avoid actions that would alter surface water flow in occupied habitat.	No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Fish (Cont.)					
Notropis topeka (=tristis)	Topeka shiner	Stream flow may be altered by installation of crossing structures or sediments, fish passage through crossing structures may be precluded with improper sizing/design/installation, and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning. Water withdrawals for construction may reduce available flows and entrain/impinge fish.	Conduct preconstruction evaluations in areas of potential occurrence to identify known or suitable habitat within known occupied Topeka shiner watersheds within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to known Topeka shiner habitat or habitat occupied by Topeka shiner. Avoid actions that would alter surface water flow in known or occupied habitat (i.e., do not withdraw water from suitable habitat)..	For projects that encompass areas within drainages with suitable aquatic habitat for the Topeka shiner: Conduct preconstruction surveys to confirm occupied streams within project boundaries. This requires a permit from the Service. • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Ensure that upstream and downstream fish passage is maintained in any areas where stream habitat disturbance occurs. • Avoid actions that would alter surface water flow in occupied habitat.	May affect, but is not likely to adversely affect
	Designated critical habitat for Topeka shiner	Stream flow may be altered by installation of crossing structures or by sediments; fish passage through crossing structures may be precluded with improper sizing/design/installation; and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning. Water withdrawals for construction may reduce available flows.	Do not site turbines, transmission line supports, access roads, or other project facilities in or adjacent to designated critical habitat. Avoid actions that would alter surface water flow in occupied habitat (i.e., do not withdraw water from Topeka shiner critical habitat).		No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Reptiles					
Sistrurus catenatus catenatus	Eastern massasauga	Direct mortality may occur from ground-breaking activities associated with construction or from vehicle collisions along access roads.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in occupied habitat.	For projects that encompass occupied habitat or that occur near occupied habitat: • Minimize disturbance (e.g., mowing, burning, excessive foot traffic) in suitable mesic grassland and prairie habitats, especially during the spring months. • Maintain ecological connectivity between parcels of suitable habitat within project boundaries. • Identify and implement strategies to reduce potential for road mortality on access roads (e.g., close roads or limit traffic during migration times, create road diversion structures to detour snakes, or post signs).	Not likely to jeopardize the continued existence

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds					
Centrocercus urophasianus	Greater sage-grouse	Loss and fragmentation of shrub-dominated habitat may occur from construction of access roads, turbine pads, transmission lines, and substations. Sage grouse tend to avoid suitable habitat due to the fragmentation and presence of tall structures such as turbines, construction work crews and equipment, and vehicular traffic. Survival and reproduction can be negatively affected; changes in habitat quality, predator communities, or disease dynamics can negatively impact sage grouse.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat, known core population areas, and lek locations, within project boundaries. Do not site turbines, access roads, transmission lines, or other project facilities within greater sage grouse core population areas. .	For projects that encompass potential (e.g., migration) sage-grouse habitat within the range of the species: • Do not use guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices. • Do not place new meteorological towers within 4 mi (6.4 km) of active sage-grouse leks, unless they are out of the direct line of sight of the active lek. • Restrict surface use activities in suitable sage-grouse nesting habitat located within 4 mi (6.4 km) of a known lek. • Disturbed areas in shrub/ grassland habitat should be maintained with >10% shrub cover and grasses greater than 6–7 in. (15–18 cm) tall. • Decrease habitat fragmentation by limiting the number of access roads through sagebrush habitat. • Bury all project-related collector and distribution lines. • Do not place overhead power lines in suitable sage-grouse nesting habitat located within 2 mi (3.2 km) of a known lek. • Install bird flight diverters on new overhead power lines that are located within occupied sage-grouse habitat. • Do not build new fences in occupied habitat and remove or mark existing fences with bird flight diverters. • Report incidences of mortality or injury of sage-grouse individuals within the project area to the appropriate Service Ecological Services Field Office.	Not likely to jeopardize the continued existence

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Sterna antillarum	Interior least tern	Direct mortality may occur from collision with turbine blades. Loss of habitat may also occur due to erosion along access roads and tern avoidance of suitable habitat near construction.	Do not site turbines, access roads, transmission lines, or other project facilities within 0.50 mi (0.8 km) of suitable sandbar habitat, reservoir shorelines, or other known shoreline nesting, resting, and foraging areas.	Conduct construction activities during the non-breeding season in areas near known occupied habitat. Mark new overhead power lines within 1 mi (1.6 km) of known least tern habitat with bird flight diverters. If least terns nest in the project area during construction, avoid construction activities within 0.5 mi (0.8 km) of nesting areas during late April to August.	May affect, but is not likely to adversely affect
Charadrius melodus	Piping plover	Direct mortality may occur from collision with turbine blades. Habitat loss may occur due to construction of wind energy facilities, access roads, and transmission lines. Erosion due to construction of access roads may affect nesting and foraging habitat.	Do not site turbines, access roads, transmission lines, or other project facilities within 2 mi (3.2 km) of suitable sandbar habitat, reservoir shorelines, alkali wetlands, or other known shoreline nesting, resting, and foraging areas.	Mark new overhead power lines within 1 mi (1.6 km) of known piping plover habitat with bird flight diverters. If piping plovers nest in the project area during construction, avoid construction activities within 0.5 mi (0.8 km) of nesting areas during late April to August.	May affect, but is not likely to adversely affect
	Designated critical habitat for piping plover	Habitat loss may occur due to construction of wind energy facilities, access roads, and transmission lines. Erosion due to construction of access roads may affect nesting and foraging habitat.	Do not site turbines, transmission lines, access roads, or other project facilities in or within 2 mi (3.2 km) of designated critical habitat.		No effect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Anthus spragueii	Sprague's pipit	Fragmentation of habitat from roads, substations, and turbine placement in grassland communities is likely the greatest impact on Sprague's pipits. Direct mortality may occur from collision with turbine blades or overhead transmission lines during aerial breeding displays or during periods of low visibility. Sprague's pipits may also avoid suitable habitat due to vehicular traffic and the presence of tall structures such as turbines. Nesting birds may be affected by construction.	Avoid placement of turbines, access roads, and transmission lines on or within 1,000 ft (304.8 m) of suitable native prairie tracts larger than 70 ac (0.28 km^2).	Design layouts to minimize further fragmentation of native prairie habitats that are suitable for Sprague's pipit. Conserve or restore native prairie habitats to offset impacts on native prairie caused by fragmentation, as determined in tiered site-specific consultation.	Not likely to jeopardize the continued existence

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Grus Americana	Whooping crane	Mortality may occur from collision with turbine blades or overhead power lines. Suitable wetland habitat may be avoided as a result of construction activities or may be degraded by erosion and runoff from access roads.	For projects that that occur within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings: • Conduct preconstruction evaluations and/or surveys to identify wetlands that provide potentially suitable stopover habitat.[c] • Do not site turbines, transmission lines, access roads, or other project facilities within or adjacent to wetlands that provide suitable stopover habitat or within 5 mi (8 km) of the Platte or Niobrara Rivers.	For projects that that occur within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings: • Place state-of-the-art bird flight diverters on any new or upgraded overhead collector, distribution, and transmission lines located within 1 mi (1.6 km) of suitable stopover habitat. • Establish a procedure for preventing whooping crane collisions with turbines during operations by establishing and implementing formal plans for monitoring the project site and surrounding area for whooping cranes during spring and fall migration periods throughout the operational life of the project and shutting down turbines and/or construction activities within 2 mi (3.2 km) of whooping crane sightings. Specific requirements of the monitoring and shutdown plan will be determined during site-specific ESA consultations, but will include adequate coverage (appropriate dates, times, numbers, and qualifications of observers) based on size of the wind farm. • Instruct workers to avoid disturbance of cranes present near project areas. • Within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings, the acreage of wetlands that are suitable migratory stopover habitat located within a 1 mi (1.6 km) radius of turbines may be mitigated based upon site-specific evaluations.	May affect, but is not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
	Designated critical habitat for whooping crane	Degradation of designated critical habitat may occur, impacting roosting and feeding behavior and avoidance of that habitat.	Do not site turbines, transmission lines, access roads, or other project facilities within 5 mi (8 km) of designated critical habitat.		No effect
Mammals					
Gulo gulo luscus	North American wolverine	Negative impacts are unlikely, due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development. Negative impacts other than global warming would include disturbance, infrastructure development and roads.	May occur in 29 counties in Montana. However, North American wolverines inhabit habitats with near-arctic conditions wherever they occur. They are dependent on deep persistent snow cover for successful denning. Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in occupied areas.	None needed.	Not likely to jeopardize the continued existence
Mustela nigripes	Black-footed ferret	Potential impacts include loss of habitat and prey, predation by larger carnivores, disease transport, and direct mortality from vehicle collisions.	Coordinate with the Service on any sitings of turbines, transmission lines, access roads, or other project facilities on black-footed ferret reintroduction sites. Conduct preconstruction surveys within 100 miles of reintroduction sites and in areas of suitable habitat, (as per the 1989 survey protocols) within project boundaries.		May affect, but is not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Mammals (Cont.)					
Lynx canadensis	Canada lynx	Negative impacts are unlikely, due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in boreal forested habitats occupied by Canada lynx. Do not site turbines, transmission lines, access roads, or other project facilities in boreal forested habitats that may provide linkage between occupied habitats.		No effect
	Designated critical habitat for Canada lynx		Do not site turbines, transmission lines, access roads, or other project facilities within designated critical habitat.		No effect
Canis lupus	Gray wolf	Wolves may be displaced or migratory corridors may be altered due to fragmentation of previously undeveloped habitats. Mortality may occur from vehicle collisions or shootings due to human access into previously undisturbed areas.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in habitats occupied by gray wolf.		May affect, but is not likely to adversely affect

TABLE ES.5-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Mammals (Cont.)					
Ursus arctos horribilis	Grizzly Bear	Negative impacts are unlikely due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in habitats occupied by grizzly bear.		No effect
Myotis sodalis	Indiana bat	Mortality may occur from turbine collision or barotrauma.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable foraging and roosting habitat within project boundaries and to identify the distance from project boundaries to hibernacula used by Indiana bats. Increase turbine cut-in speeds at developments within the counties where the Indiana bat is listed. Do not site turbines in areas within 20 mi (32 km) of hibernacula used by Indiana bats or within 1000 ft (300 m) of suitable foraging and roosting habitat.[d]	Immediately report observations of Indian bat mortality to the appropriate Service office.	May affect, but is not likely to adversely affect

[a] All of the applicable surveys, avoidance measures, and conservation measures are required for a project in order for ESA Section 7 consultation to be completed using the programmatic consultation approach. Otherwise, project-specific consultation would need to be initiated. The effect determination was developed to account for the potential impact after required avoidance and minimization measures were assessed.

[b] The overarching requirement for every species in this table is that any surveys will be coordinated with the Service's Ecological Services Field Office, survey results will be shared, and any adverse impacts effectively avoided for the life of the project.(i.e., efficacy of mitigation measures to avoid impacts are periodically evaluated and updated). Corrective mitigation measures also will be coordinated with the Service.

[c] Potentially suitable migratory stopover habitat for whooping cranes is considered to consist of wetlands with areas of shallow water without visual obstructions (i.e., high or dense vegetation) and submerged sandbars in wide, unobstructed river channels that are isolated from human disturbance (Service 2010b).

[d] Based on guidance developed by the Service. Available at http://www.fws.gov/midwest/endangered/mammals/inba/WindEnergyGuidance.html.

facilitate environmental evaluations for most of the requests for interconnection to Western's transmission system and for most of the requests to accommodate wind energy development on areas under Service easements. The agencies believe that the numbers of wind energy development projects that will be unable to implement the programmatic avoidance measures, minimization measures, or mitigation measures would be small and environmental evaluations could be conducted for such projects using project-specific NEPA evaluations and ESA Section 7 consultations that do not tier from the proposed programmatic environmental evaluation process.

The draft measures were developed by first identifying avoidance areas (e.g., types of habitats or locations) within the UGP Region where specific wind energy development and operational activities would be precluded or restricted in order to protect federally listed species and designated critical habitat within the UGP Region without affecting the ability for most wind energy projects to proceed. Species-specific avoidance measures are intended to limit the potential for most of the direct impacts of wind energy development and operations on designated critical habitats, on habitat areas considered vital to maintaining existing populations of federally listed species, and on individual organisms in areas known to be occupied by federally listed species. If there was information about species-specific threats to survival, habitat use, or behavior that indicated that the avoidance measures alone would not be sufficient to reasonably limit the potential for adverse effects, species-specific minimization measures were identified that would further reduce the potential for adverse effects through implementation of BMPs. For some species (e.g., whooping crane), species-specific mitigation measures were identified to compensate for potentially adverse losses of habitat or habitat use that could result from wind energy development and operation even if avoidance and minimization measures were applied.

The overarching requirement for listed species and critical habitat is that any surveys will be coordinated with the Service's Ecological Services Field Office. Survey results will be shared and any adverse impacts (plus the efficacy of mitigation measures to preclude impacts) on species will be reported, and corrective mitigation measures also will be coordinated with those offices through the ESA Section 7 consultation. Similar information needs regarding migratory birds will also be coordinated with Service's Ecological Services Field Office.

Compliance with the Bald and Golden Eagle Protection Act. Wind energy projects within some areas of the UGP Region have a potential to adversely affect bald and golden eagles. On July 9, 2007, the final rule (72 FR 37346) removing the bald eagle in the lower 48 States from the list of endangered and threatened wildlife was published; it became effective on August 8, 2007. Bald and golden eagles continue to be protected by the BGEPA (16 U.S.C. 668–668c) and the Migratory Bird Treaty Act (MBTA) (16 USC 703 *et seq.*). Both acts prohibit killing, selling or otherwise harming eagles, their nests, or their eggs. On June 5, 2007, the Service announced a final definition of "disturb," (72 FR 31132), a notice of availability for the final National Bald Eagle Management Guidelines (72 FR 31156), and a proposed regulation that would establish a permit process to allow a limited amount of "take" consistent with the preservation of bald and golden eagles (72 FR 31141). A final rule was published on May 20, 2008 (73 FR 29075) providing a process for permits for disturbance and take. The Service's existing authority to authorize "take" in 50 CFR 22 (e.g., scientific, educational, or religious purposes) is included in this final rule. In September 2009, the Service published a final rule establishing new permit regulations under the BGEPA for nonpurposeful take of eagles

(74 FR 46836). These regulations are related to permits to take eagles where the take is associated with, but not the purpose of, otherwise lawful activities. The regulations provide for both standard permits and programmatic permits.

Documented occurrence of eagles can be acquired from the local U.S. Fish and Wildlife Ecological Services office, State wildlife agencies, or State natural heritage databases. In accordance with the Service's *Land-Based Wind Energy Guidelines*, surveys during early project development should identify all important eagle use areas (nesting, foraging, and winter roost areas) within the project's footprint. If eagle use areas occur within a 10-mi (16-km) radius of a project footprint, the project developer would need to develop an Eagle Conservation Plan (ECP) in order to be able to tier off of this PEIS.

The *Draft Eagle Conservation Plan Guidance* that has been prepared by the Service provides recommendations for the development of ECPs to support issuance of eagle programmatic take permits for wind facilities. Programmatic take permits would authorize limited, incidental mortality and disturbance of eagles at wind facilities, provided effective offsetting conservation measures that meet regulatory requirements are carried out. To comply with the permit regulations, conservation measures must avoid and minimize take of eagles to the maximum degree possible and, for programmatic permits necessary to authorize ongoing take of eagles, advanced conservation practices (ACPs) must be implemented such that any remaining take is unavoidable. Further, for eagle management populations that cannot sustain additional mortality, any remaining take must be offset through compensatory mitigation such that the net effect on the eagle population is, at a minimum, no change. The *Draft Eagle Conservation Plan Guidance* interprets and clarifies the permit requirements in the regulations in 50 CFR 22.26 and 22.27.

It is recommended that ECPs be developed in five stages. Each stage builds on the prior stage, such that together the process is a progressive, increasingly intensive look at likely effects of the development and operation of a particular site and configuration on eagles. The *Draft Eagle Conservation Plan Guidance* recommends that project developers employ fairly specific procedures in their site assessments so the data can be combined with that from other facilities in a formal adaptive management process. This adaptive management process is designed to reduce uncertainty about the effects of wind facilities on eagles. Project developers are not required to use the recommended procedures; however, if different approaches are used, the developer should coordinate with the Service in advance to ensure that proposed approaches would provide comparable data.

The *Draft Eagle Conservation Plan Guidance* recommends that at the end of each of the first four stages, project developers determine which of the following categories the project, as planned, falls into: (1) high risk to eagles, little opportunity to minimize effects; (2) high to moderate risk to eagles, but with an opportunity to minimize effects; (3) minimal risk to eagles; or (4) uncertain. Projects in category 1 should be moved, significantly redesigned, or abandoned because the project would likely not meet the regulatory requirements for permit issuance. Projects in categories 2, 3, and possibly 4 would be candidates for ECPs. It is recommended that project developers use a standardized approach to categorize the likelihood that a site or operational alternative will meet standards in 50 CFR 22.26 for issuance of a programmatic eagle take permit. Biologists from the Service are available to work with project developers in the development of their ECP.

During project-specific NEPA evaluations, project developers would apply to the Service for a programmatic take permit for bald or golden eagles under 50 CFR 22.26. If granted, a programmatic permit would authorize limited, incidental mortality and disturbance of eagles at wind facilities, provided effective offsetting conservation measures are implemented that meet regulatory requirements. Regardless of when and whether a permit is authorized, the project developer should demonstrate due diligence in avoiding and minimizing take of eagles. Due diligence would be documented through the completion of an ECP and implementing ACPs. This may also entail development of an Avian and Bat Protection Plan.

Visual Resources. BMPs and mitigation measures for addressing potential impacts on visual resources are summarized below. Refer to section 5.7.1.3 for a more extensive listing of BMPs and mitigation measures.

- The public shall be involved with and informed about the visual site design elements of the proposed wind energy facilities. Possible approaches include conducting public forums for disseminating information and using computer simulation and visualization techniques in public presentations.

- Turbine arrays and turbine design shall be integrated with the surrounding landscape. Design elements to be addressed include visual uniformity, use of tubular towers, proportion and color of turbines, nonreflective paints, and prohibition of commercial messages on turbines.

- Other site design elements shall be integrated with the surrounding landscape to the extent practicable. Elements to address include micrositing to take advantage of local topography, minimizing the profile of the ancillary structures, burial of power collection systems, prohibition of commercial symbols, and lighting. Regarding lighting, efforts shall be made to minimize the need for and amount of lighting on ancillary structures.

Soil Resources. BMPs and mitigation measures for addressing potential impacts on soil resources are summarized below. Refer to section 5.2.3.1 for a more extensive listing of BMPs and mitigation measures.

- As feasible, construction and maintenance activities shall be conducted when the ground is frozen or when soils are dry and native vegetation is dormant.

- Disturbed areas that are not actively under construction shall be stabilized using methods such as erosion matting or soil aggregation, as the site conditions warrant.

- Excavation areas (and soil piles) shall be isolated from surface water bodies using silt fencing, bales, or other accepted and appropriate methods to prevent sediment transport by surface runoff.

- Topsoil shall be salvaged from all excavation and construction activities to reapply to disturbed areas once construction is completed.

Water Resources. BMPs and mitigation measures for addressing potential impacts on water resources are summarized below. Refer to section 5.3.2 for a more extensive listing of BMPs and mitigation measures.

- Turbines or transmission support structures shall not be placed in waterways or wetlands.

- New roads shall be sited to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.

- Standard erosion control BMPs shall be applied to all construction activities and disturbed areas (e.g., sediment traps, water barriers, erosion control matting), as applicable, to minimize erosion and protect water quality.

- Drainage ditches shall be constructed only where necessary and shall use appropriate structures at culvert outlets to prevent erosion.

- Alteration of existing drainage patterns shall be avoided, especially in sensitive areas such as erodible soils or steep slopes.

Air Quality. BMPs and mitigation measures for addressing potential impacts on air quality are summarized below. Refer to section 5.4.2 for a more extensive listing of BMPs and mitigation measures.

- All pieces of heavy equipment used during construction shall meet emission standards specified in the appropriate State regulations, and routine preventive maintenance shall be conducted, including tune-ups to manufacturer specifications to ensure efficient combustion and minimum emissions.

- Stockpiles of soils shall be sprayed with water, covered with tarpaulins, and/or treated with appropriate dust suppressants, especially when high wind or storm conditions are likely. Vegetative plantings may also be used to limit dust generation for stockpiles that will be inactive for relatively long periods.

Ground Transportation. BMPs and mitigation measures for addressing potential impacts on transportation are summarized below.

- A transportation plan shall be developed, particularly for the transport of turbine components, main assembly cranes, and other large pieces of equipment. The plan shall consider specific object sizes, weights, origin, destination, and unique handling requirements and shall evaluate alternative transportation approaches. In addition, the process to be used to comply with unique State requirements and U.S. Department of Transportation (DOT) requirements, and to obtain all necessary permits, shall be clearly identified.

- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any temporary changes in lane configuration as necessary.

Noise. BMPs and mitigation measures for addressing potential impacts on noise are summarized below. Refer to section 5.5.2 for a more extensive listing of BMPs and mitigation measures.

- Developers of a wind energy development project shall take measurements to assess existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.

- A process shall be established for documenting, investigating, evaluating, and resolving project-related noise complaints.

- All equipment shall be maintained in good working order in accordance with manufacturer specifications. Suitable mufflers and/or air-inlet silencers should be installed on all internal combustion engines and certain compressor components.

Noxious Weeds and Pesticides. BMPs and mitigation measures for controlling noxious weeds and for use of pesticides are summarized below. Refer to sections 5.6.2 and 5.12.1.4 for a more extensive listing of BMPs and mitigation measures.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could take advantage of opportunities provided by new surface disturbance activities. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation issues, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.

- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be conducted in an appropriate manner and would entail only the use of pesticides registered with the U.S. Environmental Protection Agency (EPA). Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied by a properly licensed applicator in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

Paleontological, Cultural, and Historic Resources. BMPs and mitigation measures for addressing potential impacts on paleontological, cultural, and historic resources are summarized below. Refer to sections 5.8.1.6 and 5.9.1.6 for a more extensive listing of BMPs and mitigation measures.

- As appropriate, the Service and Western shall consult with Native American tribal governments early in the planning process to identify issues regarding the proposed wind energy development, including issues related to the presence of cultural properties, access rights, disruption to traditional cultural practices, and impacts on visual resources important to the tribe(s).

- If cultural resources are known to be present at the site, or if areas with a high potential to contain cultural material have been identified, consultation with the SHPO shall be undertaken by the appropriate Federal agency (e.g., Western, the Service, USFS, BLM). In instances where Federal oversight is not appropriate, developers can interact directly with the SHPO.

- Cultural resource surveys shall be conducted in any area where ground-disturbing activities are planned, unless the area has been previously surveyed within the past 10 years.

- Cultural resources discovered during construction shall immediately be brought to the attention of the lead Federal agency or agencies. Work shall be halted in the vicinity of the find to avoid further disturbance of the resources while they are being evaluated and appropriate mitigation plans are being developed.

- Developers shall determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area; a records search of Federal, State, and local inventories for past paleontological finds in the area; review of past paleontological surveys; and/or a paleontological survey. A paleontological resources management plan shall be developed for areas where there is a high potential for paleontological material to be present.

ES.5.3 Alternative 2: Programmatic Regional Wind Energy Development Evaluation Process for Western and No Wind Energy Development Allowed on Easements

Under Alternative 2, Western would analyze typical impacts of wind energy development and would develop and identify standardized BMPs, mitigation measures, and monitoring needs for interconnection requests as identified for Alternative 1. Project-specific NEPA evaluations would be required by Western for interconnection requests, but those NEPA evaluations would tier off of the analyses in this PEIS as long as the project developer is willing to implement the evaluation process, BMPs, and mitigation measures identified for Alternative 1. If a developer does not wish to implement the evaluation process, mitigation measures, BMPs, and monitoring requirements, a separate NEPA evaluation of the interconnection request that does not tier off the analyses in the PEIS would be required. Under Alternative 2, the Service would not allow easement exchanges for wind energy development. Consequently, no wind energy development could occur on the particular tract(s) of land that are covered by Service-administered easements.

ES.5.4 Alternative 3: Regional Wind Energy Development Evaluation Process for Western and the Service with No Programmatic Requirements

Under Alternative 3, as with the other alternatives considered in this PEIS, wind energy projects would be required to meet established Federal, State, and local regulatory requirements. However, no additional BMPs, mitigation measures, or monitoring would be requested of project developers by Western or the Service. Project-specific NEPA evaluations would be required to evaluate potential environmental impacts. If an easement exchange was necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers, without requiring additional modifications to reduce the environmental impacts.

ES.6 SCOPE OF THE ANALYSIS

The PEIS analyzes information about known impacts and effective mitigation measures for wind energy facility development. The scope of the analysis includes an assessment of the positive and negative environmental, social, and economic impacts; discussion of BMPs and mitigation measures to address these impacts; and identification of appropriate programmatic procedures to be included in the proposed wind energy development programs implemented for environmental reviews. The geographical scope of the analysis includes Western's UGP Region and the grassland and wetland easements administered by Regions 3 and 6 of the Service that are located within the boundaries of the UGP Region. Thus, the areas considered include all or part of six States: Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. The analysis is based, in part, upon the potential levels of wind energy development activities within the UGP Region through 2030. The analysis presented in this PEIS used current, available, and credible scientific data regarding potential impacts. Expected direct and indirect impacts of wind energy development on the environment, social systems, and the economy have been evaluated at the programmatic level. Cumulative impacts associated with the proposed action have also been evaluated.

In many cases, even though there is a potential for impacts on environmental resources to be significant, the implementation of specific engineering controls and management practices may be used so that the anticipated impacts would be unlikely to occur or the magnitude of the impacts would be limited to acceptable levels. This PEIS identifies the range of potential environmental impacts for wind energy projects and identifies BMPs and mitigation measures that could be applied to satisfactorily eliminate, minimize, or reduce the environmental impacts for many wind energy projects. Under the proposed action, a programmatic process to be followed for environmental evaluations would be adopted by Western and the Service, along with identification of BMPs and mitigation measures that developers would be requested to implement in order to address environmental impacts. Western and the Service would request wind energy project developers and operators to follow the identified environmental review procedure and to incorporate the appropriate programmatic mitigation measures and BMPs into project-specific development and operations plans for projects requesting interconnection to Western's transmission facilities or easement exchanges from the Service for placement of wind energy facilities. For projects that follow the programmatic environmental evaluation process, and where agreements are reached to apply the appropriate standardized BMPs and mitigation measures during project planning, construction, and operation phases of development, the analyses presented in the PEIS would serve as the principal means of identifying the nature and magnitude of impacts. This would simplify the preparation of project-specific NEPA documentation and would reduce the time needed to complete environmental evaluations.

The proposed environmental evaluation processes, BMPs, and mitigation measures would not fully address some site-specific issues and concerns. Thus, there will be some site-specific issues that will require more detailed environmental evaluation during environmental reviews of individual project applications. Project-specific environmental reviews will be used to identify which BMPs and mitigation measures are applicable for specific projects and the degree to which individual project analyses, reviews, and approvals may tier off of the PEIS by using applicable content to streamline and expedite NEPA compliance. It is intended that the PEIS will address the majority of the environmental impacts that occur when wind energy projects are constructed, operated, maintained, and decommissioned, based on practical experience with existing projects. Thus, the PEIS will support, but will not supplant, individual project NEPA reviews. As a programmatic evaluation, this PEIS does not evaluate site-specific issues associated with individual wind energy development projects. A variety of location-specific factors (e.g., soil type, watershed characteristics, habitat, vegetation, viewshed, public sentiment, threatened and endangered species, and cultural resources) may vary considerably from site to site, especially over a six-State region. In addition, variations in project size and design will greatly influence the magnitude of the environmental impacts from given projects. The combined effects of location-specific and project-specific factors cannot be fully anticipated or addressed in a programmatic analysis; such effects must be evaluated at the project level for specific projects after they have been proposed.

ES.7 SUMMARY OF IMPACTS

ES.7.1 No Action Alternative

Western and the Service would not establish programmatic environmental evaluation procedures for wind energy development projects under the No Action Alternative. Instead, the agencies would evaluate the environmental effects of wind energy projects requesting interconnections (Western) and requests for easement exchanges (the Service) on a project-by-project basis, following existing procedures. Programmatic BMPs and mitigation measures would not be established under the No Action Alternative. However, under existing environmental evaluation procedures, Western and the Service would continue to identify and request BMPs and mitigation measures to address environmental concerns on a project-by-project basis. Thus, future wind energy projects would continue to be evaluated solely on an individual, case-by-case basis, and there would be no programmatic process for environmental reviews.

Compared to the various alternatives for accomplishing the proposed action, the absence of a standardized environmental process for wind energy projects would likely result in a slower rate of interconnection of wind energy developments to Western's transmission system and evaluations and approvals for easement exchanges to accommodate wind energy facilities on Service easements. The anticipated benefits of implementing programmatic wind energy environmental evaluation procedures, including the use of tiered NEPA analyses and identification and implementation of programmatic BMPs and mitigation measures, would not be realized under the No Action Alternative. Without these elements, the length of time needed to review, process, and approve requests for interconnection of wind energy projects and to make decisions regarding accommodation of wind energy facilities on easement lands would be expected to be greater.

Extended timelines for application and approval processes usually translate into increased costs for developers, and the cost per unit of wind energy developed would likely be greater under the No Action Alternative than under the various alternatives for implementing the proposed action. This could result in delays in establishing necessary project financing and power market contracts.

The potential adverse impacts on natural and cultural resources associated with the No Action Alternative could be greater than under Alternatives 1 and 2 if effective BMPs and mitigation measures are not applied to individual projects. In all likelihood, however, effective measures would be developed for individual wind energy projects by virtue of the environmental analyses required by Western and the Service. In that event, potential adverse impacts on natural and cultural resources under the No Action Alternative would be similar to those for Alternatives 1 and 2. The absence of a standardized programmatic process for environmental reviews of wind energy projects, however, could result in inconsistencies in the types of BMPs and mitigation measures required for individual projects.

Because it is difficult to estimate the degree to which the absence of the proposed programmatic environmental review process for wind energy development would affect the pace and amount of development, it is difficult to estimate the extent to which economic impacts under the No Action Alternative would vary from those estimated for the proposed action alternatives. While the economic impact of specific projects would likely be similar regardless of whether a programmatic review process is in place or not, uncertainties surrounding the time required for approvals and the consequent impact on project cost could delay the development of any given project. The consequent postponement of the various economic (employment, income, and output) and fiscal (taxes and ROW rental receipts) benefits of specific projects could affect economic development of the region.

ES.7.2 Alternative 1

Under Alternative 1, Western would adopt a standardized, structured process for collecting information and evaluating and reviewing the environmental impacts, and would establish programmatic BMPs and mitigation measures to minimize the environmental impacts from projects requesting interconnection with Western’s transmission facilities in the UGP Region. Under this alternative, the Service would adopt a similar process for evaluating and addressing the impacts associated with projects requesting easement exchanges in order to accommodate placement of wind energy facilities on Service easements. The overall extent of wind energy development expected within the UGP Region is expected to be the same as under the No Action Alternative.

Western and the Service reviewed the impact analysis and mitigation measures to identify appropriate programmatic environmental evaluation procedures, BMPs, and mitigation measures to be applied to wind energy development projects requesting interconnections to Western's transmission systems or easement exchanges to accommodate placement of facilities on easements managed by the Service within the UGP Region. The identified programmatic BMPs and mitigation measures would be applied to all projects, as appropriate, to address site-specific conditions and environmental resource concerns. The programmatic evaluation review process for Alternative 1 (see ES.5.2) would be used to identify the project-specific environmental issues that would need to be addressed and to identify which of the programmatic BMPs and mitigation measures would be required. In addition, the evaluation would be used to identify significant environmental impacts that would not be adequately addressed by the programmatic BMPs and mitigation measures and would guide identification of additional measures that may be needed. Thus, site-specific and species-specific issues would be addressed at the project level to ensure that potential impacts of a wind developer's project would be minimized. Project-specific BMPs and mitigation measures would be incorporated into plans of development and would be identified in site-specific NEPA documents that tier from the PEIS.

Implementation of the proposed wind energy development process, including the establishment of programmatic procedures, BMPs, and mitigation measures, would be expected to reduce delays and costs for wind energy projects by reducing the amount of time needed to complete environmental reviews. Some other factors that can affect the pace and cost of wind energy development within the region are largely beyond the influence or control of Western or the Service and would not be affected by implementation of the programmatic approach identified for Alternative 1; these include (1) the presence, absence, or structure of national production tax credits and national and State renewable portfolio standards; (2) access to and the cost of electricity transmission; (3) the cost of other fuels for electricity supply, including natural gas and coal; and (4) public support or opposition to wind power development. Implementation of Alternative 1 would promote efficiency and consistency in the environmental evaluation of wind project interconnection requests by Western and in the way environmental evaluations of easement exchanges for accommodation of wind energy facilities on easements managed by the Service are reviewed and resolved.

The programmatic evaluations alone would not eliminate the need for detailed analyses at the project level; they would, however, bring focus to the efforts. Decisions regarding what actions must be undertaken at the project level to address concerns for some resources cannot be resolved until specific information regarding the location and design of a proposed project is known. Identification of the appropriate BMPs and mitigation measures would be guided by the programmatic risk-based evaluation process identified for Alternative 1; those measures would then be incorporated into project-specific development plans. To the extent practicable, the environmental issues that must be evaluated in detail at the project level would be reduced to site-specific and species-specific issues and concerns that cannot be effectively dealt with in a standardized manner. The PEIS provides a general guide for developers regarding the impacts proposed projects might have on environmental resources and the BMPs and mitigation measures expected to be implemented to avoid and minimize those impacts. This would be helpful to developers in their planning and designing of projects to avoid or minimize environmental impacts up front, thus greatly reducing the need for mitigation.

Under Alternative 1, the time necessary to obtain approval of interconnection requests and easement exchanges could be reduced compared to the No Action Alternative, along with the associated costs to both the agencies and industry, without compromising the level of protection to natural and cultural resources. To the extent that decisions about future wind energy projects could be tiered off of the analyses in this PEIS or decisions in the resultant record of decision, there could be additional time and cost savings. Compared to the No Action Alternative, Alternative 1 would facilitate wind energy development in the UGP Region and reduce the agencies' workloads for processing requests from developers and completing NEPA evaluations, while ensuring that the adverse environmental, sociocultural, and economic impacts would be minimized.

The proposed BMPs and mitigation measures would establish environmentally sound and economically feasible mechanisms for avoiding and protecting natural and cultural resources. Environmental review processes are identified for establishing the issues and concerns that must be addressed by project-specific plans during each phase of development. Specifically, the proposed BMPs and mitigation measures would address issues associated with land use, project location, sensitive or critical habitats, habitat fragmentation, threatened and endangered and other protected species, avian and bat impacts, habitat restoration, visual resources, road construction and maintenance, transportation planning and traffic management, air emissions, noise, noxious weeds, pesticide use, cultural and paleontological resources, hazardous materials and waste management, erosion control, and human health and safety.

The Service considers the easement program to be a crucial tool in conserving native grassland habitat in the UGP Region, where conversion of grasslands to agriculture and other uses continues at a rapid rate. Although existing easement properties could be protected from impacts by not allowing wind energy development to occur on easements, there is a possibility that achievement of habitat conservation goals could be hampered by outright exclusion of wind energy development on easements if such a policy diminishes the ability to continue to secure easements from landowners in the future. Under Alternative 1, the Service would keep the potential for limited wind energy development on Service easements the same as under the No Action Alternative, while implementing requirements to steer wind energy development away from sensitive habitats; would require implementation of BMPs and mitigation measures to reduce impacts on remaining areas to negligible or minor levels; and would secure compensatory easement areas to offset habitat losses from facility placement. The amount of easement land that would require exchange to accommodate facilities under Alternative 1 would probably be small. If it is assumed that the level of accommodation of wind energy facilities on Service easements would be similar to the average level that occurred from 2002 to 2012, it is estimated that between 2012 and 2030 accommodation would be made for eight wind energy projects, which would occur on parts of 31 different easement tracts, and the total area of direct impacts from placement of facilities that would require easement exchanges would be approximately 83 ac (33.6 ha). Overall, it is anticipated that implementing the proposed action in the manner described for Alternative 1 would provide a minor benefit to overall conservation efforts by helping to encourage landowners to enter into easement agreements while still allowing for wind energy development.

Implementation of the proposed programmatic environmental review procedures, BMPs, and mitigation measures would help ensure that potential adverse impacts on most of the natural and cultural resources present at wind energy development sites would be negligible to minor (potential exceptions include some species of wildlife and visual resources). This would include potential impacts on soils and geologic resources, paleontological resources, water resources, air quality, noise, land use, and cultural resources not having a visual component. The proposed environmental review procedures, BMPs, and mitigation measures would encourage designing and locating projects to avoid environmental impacts to the extent practicable, and would require incorporation of BMPs and mitigation measures for resources that would be affected into project plans. This would include the incorporation of programmatic BMPs and mitigation measures together with additional measures developed to address site-specific or species-specific concerns. Western and the Service would periodically review and revise the programmatic procedures, BMPs, and mitigation measures on the basis of new information and experiences regarding the environmental impacts of wind energy projects.

Implementation of the proposed programmatic environmental evaluation process and the programmatic BMPs and mitigation measures would reduce potential impacts on wildlife by requiring that wildlife issues be addressed comprehensively, using a risk-based evaluation approach. For example, under Alternative 1, operators would be required to collect and review information regarding federally listed threatened and endangered species and designated critical habitats with a potential to occur in the vicinity of the project site and to design the project to avoid, minimize, and mitigate impacts on these resources. The specific measures needed to address many site-specific and species-specific issues, however, would be addressed at the project level. While it is possible that adverse impacts on wildlife could occur at some of the future wind energy development sites, the magnitude of potential impacts and the degree to which they could be successfully avoided or mitigated would vary from site to site.

The processes, BMPs, and mitigation measures that would be applied under Alternative 1 would also reduce potential impacts on visual resources, although the degree to which this could be achieved would be site-specific. This would include impacts on cultural resources that have a visual component (e.g., sacred landscapes). The proposed program would require that the public be involved in and informed about potential visual impacts of a specific project during the project review process. Minimum requirements regarding project design (e.g., measures such as setback distances from residences and roads, and color and lighting of turbines) would be incorporated into individual project plans. Ultimately, determinations regarding the magnitude of potential visual impacts would consider input from local stakeholders.

Implementation of the proposed action, as described for Alternative 1, would generally be expected to benefit local and regional economies. Projected development under the potential development scenarios would result in new jobs and increased income, sales tax, and income tax in each of the UGP Region States during both construction and operation. These economic benefits would be realized and increase to varying degrees in each State by the year 2030. Because the potential for wind energy development would be similar for all alternatives in terms of the overall level of development and the areas in which wind energy development is likely to occur, the impacts on the economy of the UGP Region States under all the alternatives would be similar to those under the No Action Alternative. However, reducing uncertainties surrounding the amount of time required for approving interconnection requests and exchanges for placement of wind energy facilities on easement lands could affect the relative timing and magnitude of economic benefits among alternatives.

ES.7.3 Alternative 2

Under Alternative 2, Western would analyze typical impacts of wind energy development and would develop and identify standardized BMPs and mitigation measures for projects seeking interconnection to Western's transmission system in the same manner as described for Alternative 1. However, the Service would not allow easement exchanges to accommodate placement of wind energy facilities on Service easements under Alternative 2.

Implementation of Alternative 2 would be expected to facilitate wind energy development in the UGP Region at a pace similar to that described for Alternative 1. Although cessation of the consideration of easement exchanges for accommodating wind energy facilities on Service easements could inconvenience some developers, it is anticipated that placement of wind energy facilities would shift to non-easement private lands in the same general vicinity. Because the Service would not need to consider requests for placement of wind energy facilities on easement properties, there would be reduced demand for the Service's time to evaluate such requests. Given the relatively small number of turbines and other wind energy facilities that have been placed on easement properties in the past, the impacts of such a decision on the overall pace of wind energy development within the UGP Region would be negligible.

Because Western would implement the same environmental review processes, BMPs, and mitigation measures for wind energy projects requesting interconnection as for Alternative 1, the overall environmental impacts of projects that interconnect to Western's transmission systems would be expected to be similar to those described for Alternative 1. Although existing easement properties would be protected from direct impacts of wind energy projects under Alternative 2 by not allowing wind energy development to occur on easements, it is possible that achievement of habitat conservation goals could be hampered if such a policy diminishes the ability to continue to secure easements from landowners in the future. Overall, however, it is anticipated that implementing such a policy under Alternative 2 would have a minor effect on conservation efforts by the Service in the UGP Region.

The potential economic impacts of Alternative 2 would be similar to those described for Alternative 1. Compared to the No Action Alternative and Alternative 1, some landowners who have entered into easement agreements with the Service could be affected by potential loss of income from an inability to alternately lease portions of those easement lands for wind energy development. However, at a regional or State scale, the number of affected leases would be small and it is anticipated that the necessary wind energy development leases would be negotiated for other nearby non-easement lands. Consequently, the regional or State-level economic impacts of such foregone revenue would probably be negligible.

ES.7.4 Alternative 3

Under Alternative 3, Western would evaluate environmental effects of wind energy projects requesting interconnections and the Service would evaluate requests for easement exchanges in order to accommodate placement of wind energy facilities on Service easements on a project-by-project basis following existing procedures. However, unlike the No Action Alternative, no additional BMPs or mitigation measures would be requested by Western or the Service beyond those mandated under applicable Federal, State, and local regulations. In addition, easement exchanges by the Service would occur for wind energy projects as presented by developers, without consideration of additional measures to reduce impacts.

The proposed approach under Alternative 3 would promote efficiency and consistency in the environmental evaluation of wind project interconnection requests by Western and in the way requests for easement exchanges to accommodate placement of wind energy facilities on easements managed by Service would be reviewed and resolved. While not changing the need for detailed NEPA environmental analyses at the project level, decisions and debate regarding which BMPs and mitigation measures would need to be undertaken at the project level might be resolved more quickly, because BMPs and mitigation measures to be addressed in project-specific plans of development would be determined solely on the basis of existing Federal, State, and local requirements and would not require consideration of additional measures by Western or the Service. As a result, the time necessary to obtain approval of interconnection requests and requests for easement exchanges under Alternative 3 could be reduced compared to other alternatives, along with the associated costs to both the Agencies and industry.

Under Alternative 3, implementation of environmental review procedures, BMPs, and mitigation measures for wind energy projects beyond those required to meet existing Federal, State, and local regulations would not be requested by Western or the Service. Easement exchanges to accommodate wind energy facilities on Service easements would continue to be considered and, if allowed, would not require consideration of additional measures to reduce potential environmental impacts. The types of potential impacts on various environmental attributes under Alternative 3 would be similar in nature to those identified for the No Action Alternative. However, the magnitude of impacts on some of those resources from wind energy projects considered for interconnection requests by Western or for accommodation of project facilities on easements by the Service could be greater under Alternative 3 than under the other alternatives. This is because some BMPs and mitigation measures are not mandated under existing regulations and would no longer be requested of developers. Although the Service's ability to acquire additional conservation easements would probably not change under Alternative 3, its ability to protect conservation values on those easements could be reduced if fewer BMPs and mitigation measures are implemented by developers. Overall, it is anticipated that Alternative 3 would result in less environmental protection than the other alternatives considered in the PEIS.

Because the overall regional level of development and the areas where development would be likely to occur are not expected to differ noticeably among the alternatives, the impacts on the economy of the UGP Region States under Alternative 3 would be similar to those under the No Action Alternative. However, improved resolution of uncertainties surrounding the amount of time required for approving interconnection requests and permits for placement of wind energy facilities on easement lands and the consequent impact on project cost and development time could result in positive economic benefits for developers. Therefore, it is anticipated that the economic benefits of Alternative 3 would be somewhat greater compared to the No Action Alternative.

1 INTRODUCTION

"*The increased production and transmission of energy in a safe and environmentally sound manner is essential to the well-being of the American people. In general, it is the policy of this Administration that executive departments and agencies (agencies) shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.*" (President Obama, Executive Order 13212 "Actions to Expedite Energy-Related Projects")

Executive Order 13212 ("Actions to Expedite Energy-Related Projects"), directed Federal agencies to expedite their review of permits or to take other actions that will increase the production, transmission, or conservation of energy while maintaining safety, public health, and environmental protections. Additional requirements for departments and agencies to consider and to facilitate the development of renewable energy and electric power transmission projects have been promulgated in the Energy Policy Act of 2005 (EPAct) and the American Recovery and Reinvestment Act of 2009, along with other policies and initiatives. On March 11, 2009, the Secretary of the Interior issued a secretarial order establishing renewable energy production as a top priority for the U.S. Department of the Interior (DOI). Wind energy development is likely to be a major component of renewable energy development.

To better address environmental concerns associated with increased development of wind energy production, the U.S. Department of Energy's (DOE's) Western Area Power Administration (Western) and DOI's U.S. Fish and Wildlife Service (Service) are considering changes in their environmental evaluation procedures and mitigation strategies for wind energy interconnection requests within Western's Upper Great Plains Customer Service Region (UGP Region) and on lands associated with the Service's grassland and wetland easements on private lands within the same area. The UGP Region encompasses all or parts of the States of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota.

Western and the Service are seeking to streamline their procedures for environmental review of wind energy applications and to identify appropriate mitigation to address potential impacts associated with wind energy projects. Along with other environmental aspects, Western and the Service are considering environmental evaluation procedures and mitigation strategies to help meet their responsibilities as Federal agencies to protect migratory birds, as directed by Executive Order 13186 (issued in January of 2001) and the 2006 Memorandum of Understanding between the DOE and the Service regarding implementation of the Executive Order.

The Upper Great Plains Region of the Western Area Power Administration has a high potential for wind energy development because of the availability of an excellent wind resource regime. In the six-State region addressed in this programmatic environmental impact statement (PEIS), installed commercial wind energy generation capacity has grown from 0.5 gigawatts (GW) to more than 8 GW in the past 10 years (figure 1-1). Much of this growth has occurred in the past 5 years, and it is anticipated that the industry's installed generating capacity within the UGP Region will continue to increase at a rapid pace.

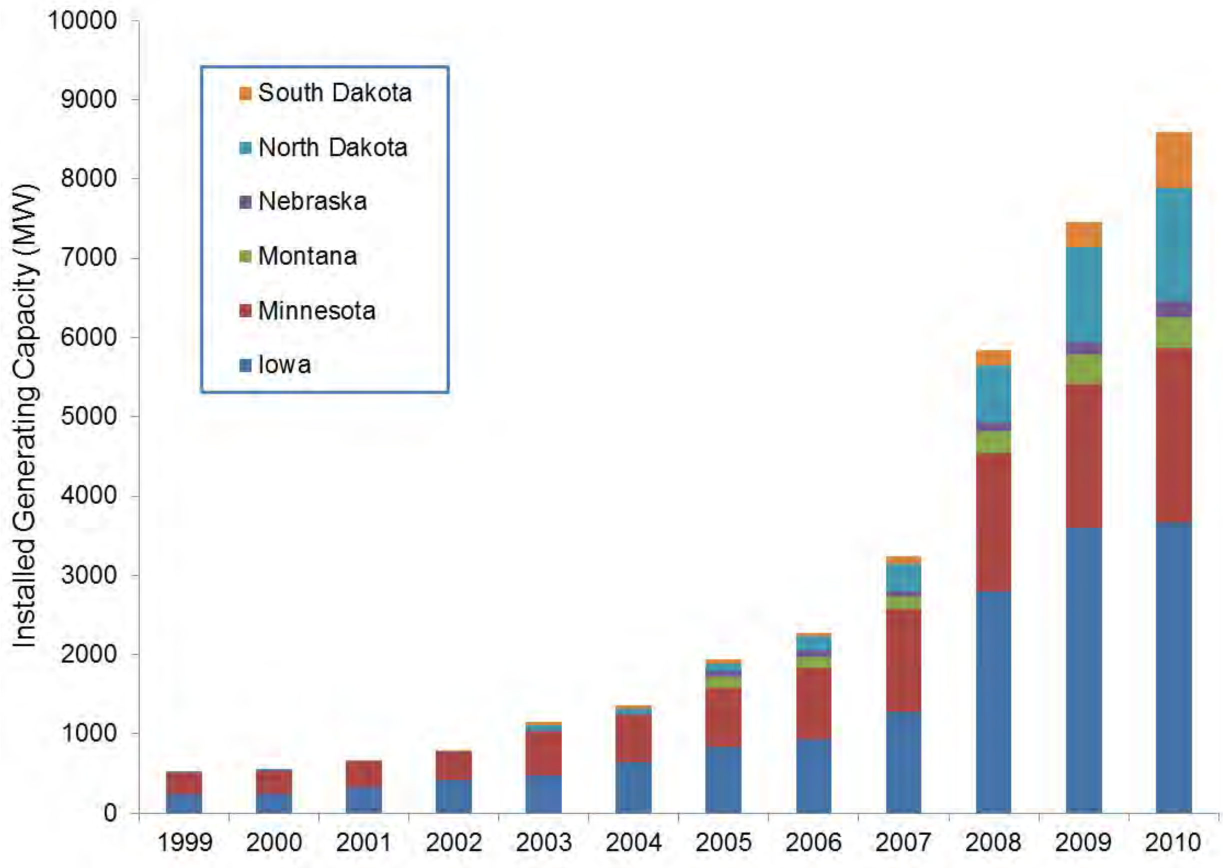

FIGURE 1-1 Installed Wind Energy Generating Capacity, 1999–2010 (Source: DOE 2011)

As joint lead agencies, Western and the Service have cooperatively prepared this PEIS to (1) assess potential environmental impacts associated with wind energy projects within the UGP Region that may connect to Western's transmission system or that may propose the placement of project elements on grassland or wetland easements managed by the Service; and (2) evaluate how environmental impacts would differ under alternative sets of environmental evaluation procedures, best management practices (BMPs), and mitigation measures that the agencies would request project developers to implement (as appropriate for specific wind energy projects).

1.1 BACKGROUND

1.1.1 Western Area Power Administration

Western's UGP Region sells more than 12 billion kilowatt-hours (kWh) of firm power (i.e., electricity that is guaranteed to be available under contracted provisions) each year, generated from eight dams and associated hydroelectric power plants of the Pick-Sloan Missouri Basin Program–Eastern Division. This power is enough to serve more than 3 million households. The UGP Region delivers this hydropower through approximately 100 substations and across nearly 7,800 mi (12,553 km) of Federal transmission lines in Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota.

> **Open Access Service Tariff**
>
> Western has a reciprocity tariff on file with the FERC. The Tariff ensures that Western may not be denied transmission access by any public utility under the jurisdiction of the Commission and requires Western to provide nondiscriminatory access to its transmission system comparable to its own use of its system.

Western offers transmission capacity in excess of the amount it requires for the delivery of long-term firm capacity and energy to current contractual electrical service customers of the Federal Government in accordance with its Open Access Service Tariff (Tariff). The Tariff was developed in response to Federal Energy Regulatory Commission (FERC) orders implementing key provisions of EPAct. In addition, Section 211 of the Federal Power Act requires that transmission service be provided upon request if transmission capacity is available.

Western applies the terms and conditions of its Tariff to each interconnection request from a wind energy developer, including its Large Generator Interconnection (LGI) and Small Generator Interconnection (SGI) procedures for providing nondiscriminatory transmission access, and responds to the project developer's request for interconnection to the Federal power system by approving or denying the request. If Western determines that existing transmission capacity is available for a proposed wind energy project, Western must ensure that existing transmission system reliability and service to existing customers is not degraded. The LGI and SGI procedures provide for transmission and system studies to ensure that capacity is available and that system reliability and service to existing customers are not adversely affected. These studies also identify system upgrades or additions that would be necessary to accommodate a proposed wind energy project and ensure that they are included in the proposed project's scope.

All of the States in the UGP Region, except for Nebraska, have developed renewable portfolio standards (RPSs) that require electricity providers to obtain a minimum percentage of their power from renewable energy resources by a certain date or have identified nonbinding goals for adoption of renewable energy (table 1.1-1). Western's process for addressing wind energy interconnection requests takes place on an individual basis and in an order of preference defined by interconnection procedures in its Tariff.

1.1.2 U.S. Fish and Wildlife Service

The Service is the principal Federal agency responsible for ensuring healthy populations of the Nation's fish, wildlife, and plants. In the northern Great Plains of the United States, wetlands and grasslands are critically important to many wildlife species. These same habitats also are under considerable pressure to produce products or services that meet societal demands, especially those related to agriculture and energy production. As a consequence, the amount of habitat that supports wildlife is shrinking. To sustain or improve the status of wildlife populations, especially migratory birds, the Service administers a program of grassland and wetland conservation easements in the Prairie Pothole Region of the United States. Wetland easements restrict the rights to drain, burn, fill, or level protected wetland basins, while

TABLE 1.1-1 Renewable Energy Portfolio Standards (RPSs) for States in the UGP Region

State	Electricity from Renewable Energy[a]	Year[b]	Organization Administering RPS
Iowa	105 MW		Iowa Utilities Board
Minnesota	25%	2025	Minnesota Department of Commerce
Montana	15%	2015	Montana Public Service Commission
Nebraska[c]	–	–	–
North Dakota[d]	10%	2015	North Dakota Public Service Commission
South Dakota[d]	10%	2015	South Dakota Public Utility Commission

[a] Percentages refer to a portion of electricity sales relative to total capacity.

[b] Standards phase in over years; date refers to when the full requirement takes effect.

[c] Nebraska has not established a RPS.

[d] North Dakota and South Dakota have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.

Source: DOE (2009).

grassland easements restrict the rights to convert grasslands to cropland or otherwise destroy the vegetation on protected areas. Lands protected by Service easements remain in private ownership and are intended to preserve critically needed migratory bird habitats, while allowing certain agricultural activities to continue at the same time. The Service, even with its Federal, State, and nongovernmental organization partners, is unable to purchase through fee title the amount of land necessary to maintain migratory bird populations at desired levels, nor is such an acquisition strategy fiscally possible or socially acceptable. Therefore, a robust easement program is the only feasible means of conserving migratory bird habitats on a landscape scale. Cooperation with the agricultural community is a critical factor that has contributed to the overwhelming success of this program, with more than 3 million acres (1.2 million ha) of grassland and wetlands protected through the easement program to date.

Currently, the Service evaluates the potential environmental impacts of each proposed wind energy project that would affect easement lands on a case-by-case basis. If it is determined that there is no reasonable means of avoiding the easement lands and that placement of facilities on the easement lands would not adversely affect conservation goals, the Service considers an agreement to exchange the affected easement lands for easement rights elsewhere, together with reversion of the original easement lands back to management by the Service once the wind energy facilities are decommissioned.

1.2 PURPOSE AND NEED FOR AGENCY ACTION

1.2.1 Purpose and Need for Action by Western Area Power Administration

Western needs to streamline the environmental review process for wind energy project interconnection requests to help expedite wind energy resource development in the UGP Region while maintaining environmental protections.

1.2.2 Purpose and Need for Action by the U.S. Fish and Wildlife Service

The Service has identified a need to standardize and streamline the environmental review process for wind energy projects in order to expedite environmental evaluation of requests to accommodate placement of wind energy facilities on wetland and grassland easements it manages in the UGP Region. A large proportion of the areas within the UGP Region that provide excellent wind energy regimes fall within the Prairie Pothole Region, which has high densities of wetlands and some of the Nation's largest intact tracts of native prairie grasslands. Because of the availability, location, and extent of these wetland and prairie habitat features, the Prairie Pothole Region is one of the most productive areas for migratory birds and waterfowl in North America. Due to the many threats to the continued ecological integrity of the grassland and wetland features in the UGP Region, the Service has determined that there is a need for additional grassland and wetland conservation in order to maintain desired wildlife populations. As a consequence, the Service desires to determine how wind energy development and the easement program might best coexist to meet the needs of both wildlife and the public. The goal is to develop policies and procedures that will allow renewable energy development and regional economic growth to continue in an environmentally responsible manner that is acceptable to landowners, the public, and other stakeholders.

The Service is considering implementation of a standardized environmental review process for evaluating proposals to place wind energy facilities on easement lands because of the anticipated increase in demand for wind energy development within the UGP Region and a desire to streamline the environmental evaluation process. The Service also seeks to identify measures to offset the adverse environmental impacts of wind energy projects. The PEIS addresses potential biological impacts (including cumulative impacts) and the impacts on habitat protection and enhancement goals. For example, where wind energy projects involve land exchanges on conservation easements, programmatic elements may include requirements to use specific BMPs and mitigation measures to avoid or minimize environmental impacts.

1.3 SCOPE OF THE ANALYSIS

This PEIS analyzes information about potential impacts and effective mitigation measures for wind energy facility development. It assesses the positive and negative environmental, social, and economic impacts; discusses BMPs and mitigation measures to address adverse effects; and identifies programmatic procedures that could be adopted by the agencies.

The geographical scope of the analysis includes Western's UGP Region and the grassland and wetland easements administered by Regions 3 and 6 of the Service that are located within the boundaries of the UGP Region. Thus, the areas considered include all or part of six States: Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. The analyses are based on potential levels of wind energy development activities within the UGP Region through 2030.

The analysis presented in this PEIS is based on currently available scientific information. Programmatic procedures, BMPs, and mitigation measures adopted by the agencies would be based on an interpretation of these scientific data and decisions on relevant mitigation requirements. Expected direct and indirect impacts of wind energy development on the environment, social systems, and the economy are evaluated at the programmatic level. Cumulative impacts associated with the action alternatives also are evaluated.

In many cases, even though there is a potential for a specific proposed project to have significant impacts on environmental resources, the project design and engineering, resource avoidance, and implementation of BMPs and mitigation measures may all be used so that the impacts would be unlikely to occur or the magnitude would be limited to acceptable levels. This PEIS identifies the range of potential environmental impacts expected for wind energy projects and identifies BMPs and mitigation measures that could be applied to satisfactorily eliminate, minimize, or reduce the environmental impacts for many wind energy projects.

The PEIS is intended to address the majority of the environmental impacts that occur when wind energy projects are constructed, operated, maintained, and decommissioned, based on practical experience with existing projects. Thus, the PEIS will support tiered NEPA environmental reviews for individual project proposals that fall within the program, but it does not supplant those reviews. Programmatic alternatives in this PEIS do not evaluate site-specific issues associated with individual wind energy development projects. A variety of location-specific factors (e.g., soil type, watershed characteristics, wildlife habitat, vegetation, viewshed, public sentiment, threatened and endangered species, and cultural resources) may vary considerably from site to site, especially over a six-State region. In addition, differences in project location, size, and design will greatly influence the magnitude of the environmental impacts from given projects. The combined effects of location-specific and project-specific factors cannot be fully anticipated or addressed in a programmatic analysis; such effects must be evaluated at the project level for specific projects after they have been proposed.

1.4 PUBLIC PARTICIPATION AND CONSULTATION

Public involvement is an important requirement of NEPA, especially for determining the appropriate scope of the analyses to be conducted. The scope includes the range of alternatives that will be considered and potentially significant impacts that should be evaluated. This public involvement process (which also includes consultations with other State and Federal agencies and Native American tribes) is referred to as scoping. As part of the public involvement process, a Notice of Intent (NOI) to prepare the PEIS was published in the *Federal Register* on September 11, 2008 (73 FR 52855–52858). The NOI invited interested members of the public to provide comments on the scope and objectives of the PEIS, including identification of issues and alternatives that should be considered in the PEIS analyses. Western and the Service conducted scoping for the PEIS from September 11, 2008, through November 10, 2008.

A project Web site provides background information and documents related to the PEIS, including information about the NEPA process (accessible at http://plainswindeis.anl.gov).

The public was provided with three methods to submit scoping comments for the PEIS: (1) via an online comment form on the project Web site, (2) by mail, and (3) in person at public scoping meetings. Public scoping meetings were held at three locations in September and October 2008. Comments received during the scoping period primarily pertained to (1) policies of the agencies relative to wind energy, (2) alternatives that should be considered in the PEIS, (3) interagency cooperation and government-to-government consultation, (4) siting and technology concerns, (5) environmental and socioeconomic concerns, (6) cumulative impacts, and (7) mitigation of impacts. Western and the Service considered the individual scoping comments as part of a process to refine the elements of the proposed action, identify action alternatives, and determine the scope of analyses in the PEIS. Additional information pertaining to public scoping for the PEIS is provided in section 8.1 of the PEIS and on the project Web site.

In addition to the public scoping meetings described above, Western and the Service coordinated with tribes within the UGP Region by making presentations to individual tribes regarding the development of the PEIS and by soliciting scoping input. Letters to State and Federal agencies were also sent to alert those agencies that the PEIS was being prepared and to solicit input from those agencies regarding the availability of information that could be used to evaluate environmental impacts and information about specific concerns or issues that should be considered. Additional details regarding consultations are provided in sections 8.2 and 8.3 of the PEIS.

1.5 ORGANIZATION OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This PEIS consists of chapters 1 through 10, and several appendices. A brief summary of each of these components follows.

Chapter 1 provides a discussion of the purpose and need for the proposed action and the scope of analysis.

Chapter 2 provides descriptions of the proposed action and of alternative ways for accomplishing the proposed action. The alternatives represent different options for managing environmental effects of wind energy development projects in the UGP Region that would interconnect to Western's transmission systems or that are proposed to occur, in part or in whole, on grassland and wetland conservation easements being managed by the Service. Chapter 2 also presents the potential wind energy development scenarios used to evaluate regional impacts of the alternatives and includes discussions of the elements of the proposed wind energy development procedures that would be adopted by the agencies agency under each alternative.

Chapter 3 presents information describing wind energy projects, including overviews of typical activities conducted during each phase of development, regulatory requirements, health and safety aspects, hazardous materials and waste management, transportation considerations, and relevant existing guidelines on mitigation.

Chapter 4 describes the affected environment within the portions of the six-State UGP Region under the purview of the proposed action, with general descriptions of the existing natural, cultural, and socioeconomic conditions. These descriptions provide the level of detail needed to support a programmatic evaluation and to identify site-specific factors that would need to be examined more closely at the individual project level.

Chapter 5 describes the potential environmental impacts of the alternatives for accomplishing the proposed action. The analyses evaluate the effectiveness of the management approaches for addressing potential environmental impacts and facilitating wind energy development within the UGP Region. Chapter 5 also identifies BMPs and mitigation measures for protecting environmental resources or to compensate for impacts to such resources from wind energy development activities.

Chapter 6 presents the cumulative environmental impacts of the proposed action together with other past, present, and reasonably foreseeable activities within the UGP Region.

Chapter 7 provides an analysis of the impacts of the alternatives on overall management concerns, including impacts on the pace of wind energy development, overall environmental considerations, and overall economic considerations within the UGP Region.

Chapter 8 describes the consultation and coordination activities conducted in the course of preparing this PEIS, including public scoping, public comment on the draft PEIS, government-to-government consultation, and interagency consultation and coordination.

Chapters 9 and 10 provide the list of preparers and a glossary, respectively.

Appendix A contains a summary of the comments received during the public scoping period. Individual comment letters and transcripts from the public comment meetings for the Draft PEIS are available via the project Web site at http://plainswindeis.anl.gov/involve/pubschedule/index.cfm.

Appendix B describes the projected wind energy development scenarios used, in part, as a basis for analyses of environmental impacts in the PEIS.

Appendix C contains supporting information pertaining to ecoregions of the UGP Region.

Appendix D provides a placeholder for the programmatic Biological Assessment that is being prepared to support ESA Section 7 consultation with the Service.

Appendix E presents the methodology used to identify the suitability of different areas in the UGP Region for development of wind energy projects.

Appendix F presents information about species of special concern that have been designated for protection in the UGP Region under State statutes.

1.6 REFERENCES

DOE (U.S. Department of Energy), 2009, *EERE State Activities and Partnerships: States with Renewable Portfolio Standards*, Office of Energy Efficiency and Renewable Energy, Washington, D.C. Available at http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm. Accessed Aug. 24, 2009.

DOE, 2011, *Wind Powering America: Installed U.S. Wind Capacity and Wind Project Locations*, Office of Energy Efficiency and Renewable Energy, Washington, D.C. Available at http://www.windpoweringamerica.gov/wind_installed_capacity.asp#current. Accessed Aug. 1, 2011.

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2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the No Action Alternative, and three action alternatives that could accomplish Western's and the Service's purposes to streamline environmental review and maintain environment quality.

The No Action Alternative of this PEIS represents no change from the current agency procedures. Currently, proposals to interconnect wind energy projects to Western's transmission systems and proposals to place wind energy facilities on wetland and grassland easements managed by the Service are administered through processes developed by each agency. Project-specific NEPA analyses are conducted for each individual project. The requirements and policies applicable to the decisions of each agency, as well as procedures for each agency's approval of wind energy development proposals, are described in the following subsection. Western and the Service identify two action alternatives (Alternatives 1 and 2) that would streamline agency environmental reviews and require changes in current procedures. These alternatives are programmatic in nature; they provide for a standard review process and standard mitigation measures that would be applied. A subsequent tiered NEPA document would be prepared for each site-specific, individual project that falls within the larger program. The subsequent document would summarize and reference this programmatic EIS and would address only the site-specific issues that are not covered within this analysis.

A third action alternative (Alternative 3) would require each proposal for wind energy interconnection or easement exchange to be independently evaluated under NEPA. The evaluations would be conducted by Western and the Service and would be based on the merits of the mitigation proposed by the proponent to achieve regulatory compliance. Western and the Service would not request mitigation above and beyond that required by regulation.

This chapter also discusses alternatives that were considered by Western and the Service but eliminated from detailed analysis.

2.1 EXISTING REQUIREMENTS AND PROCEDURES FOR WIND ENERGY DEVELOPMENT DECISIONS

2.1.1 Western Area Power Administration

Western considers and acts upon requests for interconnection to Western's transmission facilities, but does not directly authorize or permit developer projects, including wind energy development projects. Requests for interconnection are evaluated on a case-by-case basis and are subject to analyses to ensure that the transmission system can accommodate the additional power if a generation interconnection request is allowed, that power deliveries to existing power customers would not be affected, and that the reliability of the power system would not be negatively affected. As part of its evaluation, Western uses the NEPA process to evaluate and disclose the potential environmental effects of granting interconnection requests. The requesting entity may be an electric utility, a firm-power customer, a private power developer, or an independent power generator.

Western is responsible for operating and maintaining its power transmission facilities. Direct interconnection to Western's facilities does not involve or guarantee transmission capacity on Western's system; transmission service must be requested separately in accordance with Western's Tariff. The transmission service request review is a separate process from interconnection request review and, although some steps are shared for efficiency, this PEIS does not address transmission requests. Additional parallel processes include environmental review and land acquisition. There are eleven general steps in the interconnection process. Within legal and technical parameters, the steps in this process may be modified by Western on a case-by-case basis depending upon the specific circumstances of the requested interconnection. The steps in the interconnection process are as follows:

Step 1: Contact Western;

Step 2: Submit the interconnection application;

Step 3: Prepare an interconnection feasibility study;

Step 4: Complete a system impact study to assess the capability of the transmission system to support the requested interconnection;

Step 5: Conduct a facilities study to determine what upgrades or modifications are needed at the point of interconnection;

Step 6: Initiate an environmental review of the project to evaluate and disclose potential environmental impacts;

Step 7: Negotiate and complete acquisition of land required for implementing the interconnection;

Step 8: Develop Construction and Interconnection Agreements;

Step 9: Design and construct the interconnection facilities;

Step 10: Review and test the interconnection and energize the connection;

Step 11: Prepare an interconnection project close-out report.

As discussed in chapter 1, the Tariff allows for interconnections to Western's transmission system if capacity is available and existing transmission system reliability and service to existing customers are not degraded.

As a Federal agency, Western is required to assess the potential environmental impacts of its Federal proposed actions associated with any interconnection request in accordance with NEPA and other environmental regulations. Western assesses the environmental impacts of its proposed Federal action, but also considers the environmental impacts of private developer projects built on non-Federal lands, where the principle permitting agency is a State or county government. Depending upon the proposed action and the amount of environmental information provided by others, the environmental review process can range from a categorical exclusion to a comprehensive environmental impact statement (EIS), including public review for an EIS. The environmental review process is conducted simultaneously with other studies and, in general, the environmental review for interconnection of new generation projects to transmission facilities operated by Western will include an evaluation of the potential environmental impacts associated with the project developer's entire proposed project, in addition to Western's requirement to address the interconnection itself. Project developers requesting interconnections are advised to consult with Western as early as possible in the planning process to obtain guidance with respect to the appropriate level and scope of any studies or environmental information that Western requires. DOE's NEPA Implementing Procedures (10 CFR 1021) require that Western begin environmental review as soon as practicable. For interconnection projects, this is typically when a project developer files an interconnection request with Western, including a complete proposed project description, and provides funding for system impact studies and NEPA review work.

If the interconnection request does not involve integration of a new source of generation into Western's transmission facilities, change the operation limits of existing generation, provide service to new discrete loads, or cause major system changes (building new transmission lines greater than 10 mi [16 km] in length or reconstructing existing transmission lines greater than 20 mi [32 km] in length) and there are no significant impacts identified, Western may be able to prepare a categorical exclusion for the interconnection. However, if the interconnection does involve any of the actions mentioned above, the environmental review process may take up to 18 months or more, depending on the scope of the interconnection. If Western determines that an environmental assessment (EA) or an EIS is required, Western will prepare the EA or EIS, using a contractor selected by Western if necessary.

Western may also participate in the environmental process of another Federal or State agency involved with a project to cooperatively ensure that the resulting document completely satisfies Western's NEPA requirements. The environmental process may be influenced by system impact or facilities studies. If the results of studies demonstrate a need for system additions to support the interconnection, the environmental studies must address the additions along with the interconnection. The applicable NEPA documents will be completed before Western renders a final decision on the request for interconnection. Western does not issue a permit or license or otherwise authorize a requesting entity's proposed project; the agency does not hold jurisdictional or regulatory authority to take such actions. The NEPA document and associated environmental processes inform the public of the environmental impacts and discuss mitigation of the developer's proposed project and Western's Federal action (often modifications inside a substation, or a new interconnection facility).

2.1.2 U.S. Fish and Wildlife Service

Over the past 50 years, the Service has successfully protected nearly 3 million ac (1.2 million ha) of important migratory bird habitat with perpetual easements on wetlands and grasslands in the Prairie Pothole Region of the United States. The Service has defined a Conservation Strategy that calls for protection of approximately 1 million additional acres (400,000 ha) of wetlands and 10 million additional acres (4 million ha) of grasslands in order to sustain current levels of breeding waterfowl. The successful continuation and expansion of the Service's easement program is considered a crucial element for protecting wetland and grassland habitats on a landscape basis.

When wetland and grassland easements are purchased, the Service acquires certain rights in the described property. With few exceptions, easements are perpetual and transfer with the title to the land. Consideration is given to future uses of the property that may conflict with the easement purposes, and measures are taken during the acquisition phase to eliminate as many conflicts as possible. These measures notwithstanding, circumstances arise from time to time that result in requests and proposals for activities on easement lands that are restricted by the easement provisions. In such cases, the Service will work with the affected party (e.g., landowner, public service entity, municipality, or other stakeholder) to accommodate legitimate needs to modify a Service easement. It is not the intent, however, to allow for the exchange or amendment of easements for matters of convenience or just because landowners dislike the easement on their property. This section outlines the procedures that are followed when considering proposals to place wind energy facilities on lands protected by Service easements.

The anticipated expansion of wind energy development in the UGP Region is expected to occur in areas where there is a relatively high density of Service easements, especially in North and South Dakota. Therefore, it is expected that the number of requests for wind energy facilities to be placed on easements will continue to increase. To ensure consistency among stations in evaluating these requests, the Service has formulated internal guidance to help Service managers decide if and when wind energy development can be accommodated on lands protected by easement agreements. That guidance (1) outlines the necessary steps a manager must take when considering the possibility of wind turbine construction (including associated facilities) on lands protected by Service easements, (2) details the process for accommodating a wind energy project on Service lands once all regulatory and permitting requirements have been met, and (3) addresses the acquisition of new easements on lands encumbered by wind energy leases or options.

Prior to allowing wind energy development to move forward on a Service easement, Service managers first work with the developer and affected landowners to explore options to move development to areas not protected by easements. Where reasonable alternatives to development on easements exist, they are pursued. If reasonable alternatives do not exist off-easement, then managers will work with the developer and landowner to minimize the impacts to the easement-protected interests to the extent practicable. Examples of this include moving turbine pad sites nearer to existing roads or trails and limiting the amount of grassland that is disturbed. Once the potentially impacted area is known, it is then surveyed to ensure no critical habitat or species of special concern will be affected. Once this evaluation has been completed and it has been determined that no reasonable alternatives exist, no unacceptable impacts to critical habitat or species of special concern will occur, and the easement tract will still meet its intended conservation purpose, an exchange of easement interests for the impacted area can be executed. It should be noted that wetland easements only restrict the draining, filling, burning, and leveling of protected wetland basins on the easement tract. Development can occur in the uplands around the protected wetlands and the Service has no jurisdiction over those activities that do not drain, burn, fill, or level a protected basin.

The coordination steps to be followed in the wind energy review process are summarized below:

1. *Gather Project Information From Wind Developer Or Consultants.* The easement manager will request information from the developer including the

size and location of the project; the number, sizes, and locations of turbines; the proposed route and details regarding construction of project-related transmission lines; whether power agreements have been secured; whether turbine components have been acquired; the proposed construction schedule; whether the project will be connecting to transmission systems owned, operated, or financed by Western, the Midwest Independent Transmission System Operator, or the Rural Utilities Service; and whether financing for the project has been secured.

2. *Communication and Coordination with the Ecological Services Office*. Easement managers and developers will coordinate activities with the appropriate Regional Ecological Services Office to ensure compliance with requirements under NEPA, the Migratory Bird Treaty Act (16 USC 703 *et seq.*; MBTA), the Bald and Golden Eagle Protection Act (16 USC 668–668c; BGEPA), and the ESA for both on- and off-easement lands that may be affected by the proposed project.

3. *Review Project Area and Determine Impacts to Service Easements*. The easement manager will coordinate with the project developer to identify easements that may be in the proposed project area, prepare maps for wetland easements, negotiate changes to avoid and/or minimize impacts on easements, check acquisition dates of wetland easements versus landowner wind leases and agreements, review construction plans, develop and/or review restoration plans, and develop a memorandum of understanding, if necessary.

4. *Contact Regional Archaeologist*. The easement manager will coordinate activities with the regional archaeologist in order to ensure compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended.

5. *Contact Realty Office*. The Service's existing policy could allow wind energy development to occur on easement lands if that easement is exchanged for another easement property, with a reversionary clause to reinstate the original easement after development activities cease (Service 2010a). The easement manager and the developer will coordinate with the Service Realty Office, as appropriate, to prepare a Partial Term Relinquishment Document, negotiate replacement of easement lands that will be permanently impacted by the project, conduct official surveys of impacted areas, and ensure that letters of credit and decommissioning plans are in place.

6. *Communicate with Division Of Law Enforcement*. The easement manager and the developer will work with the Division of Law Enforcement regarding proper procedures to be followed for handling any direct mortality of migratory birds that may result from project operations.

As a Federal agency, the Service is required to assess the potential environmental impacts of any accommodated activity with a potential to affect Service easements in accordance with the NEPA and other environmental regulations. The required NEPA compliance documentation can range from a categorical exclusion to a comprehensive EIS. The environmental review process is conducted simultaneously with other studies. The environmental review to accommodate placement of wind energy facilities on Service easements may include an evaluation of the potential environmental impacts associated with the entire project, not just the portions of the project placed upon exchanged easement lands. As identified in step 2, above, project developers considering requesting wind energy development on easement lands are advised to consult with the Service as early as possible in the planning process to obtain guidance with respect to the appropriate level and scope of any studies or environmental information that will be needed. The nature of the request and the scope of the wind energy project will dictate the level of NEPA compliance required.

The Service has developed a process for determining the appropriate steps in NEPA compliance for wind energy projects that may affect easement lands. For wind energy projects that would affect Service-administered easements, Western or the Rural Utilities Service would be the lead Federal action agency for NEPA if there was an interconnection or Federal funding request, respectively, and the Service would provide input to the NEPA process as a cooperating agency. If there is no Federal involvement with regards to a transmission system interconnection or Federal funding request, the Service will be the Federal action agency for NEPA activities that address Service easements. Even in situations where there is no Federal nexus to a wind energy project through interconnection agreement, funding, licensing, or permitting actions, the developer may still be required to work with the Service to ensure compliance with the MBTA and the ESA.

2.2 DESCRIPTION OF THE PROPOSED ACTION

The proposed action considers each agency's purpose and need, as outlined in chapter 1, and attempts to establish a consistent programmatic approach to explicitly meet the purpose and needs of Western and the Service. By streamlining the environmental reviews for wind energy projects that will interconnect to Western's transmission facilities or that would require consideration of an easement exchange to accommodate placement of project facilities on easements managed by the Service, Western and the Service can ensure environmentally sound, fully compliant, expedited NEPA reviews. Under this proposed action, the agencies would identify standardized environmental evaluation procedures, BMPs, and mitigation measures that would be applied to wind energy projects. The agencies have identified three alternative ways this proposed action may be accomplished. These alternatives are described here together with the No Action Alternative.

2.3 DESCRIPTION OF ALTERNATIVES

2.3.1 No Action Alternative

Under the No Action Alternative, each request for interconnection of wind energy projects to Western's transmission systems would be processed, reviewed, and evaluated in the current manner, as described in section 2.1.1, including environmental reviews performed for specific projects. Similarly, each proposal to place wind energy facilities on wetland and grassland easements managed by the Service would continue to be considered as they have in

1 **TABLE 2.3-1 Description of the Programmatic Alternatives Evaluated in the PEIS**

Alternative	Western Area Power Administration	U.S. Fish and Wildlife Service
No Action Alternative	• Process and evaluate environmental reviews of interconnection requests on a case-by-case basis. • Separate project-specific NEPA evaluations and analyses required for each interconnection request. • Separate project-specific ESA Section 7 consultation initiated for each interconnection request. • BMPs and mitigation measures identified on a project-by-project basis.	• Process and evaluate requests for easement exchanges separately on a case-by-case basis. • Separate project-specific NEPA evaluations and analyses would be required for projects affecting easement lands. • Separate project-specific ESA Section 7 consultation would be required for projects affecting easement lands. • BMPs, mitigation measures, and monitoring requirements identified on a project-by-project basis for projects affecting easement lands.
Alternative 1 (Preferred Alternative)	• Adopt a standardized structured process for collecting information and evaluating and reviewing environmental impacts of wind energy interconnection requests. • Apply programmatic BMPs and mitigation measures developed in the PEIS to minimize impacts of interconnection requests. • Project-specific NEPA analyses tier off the analyses in the PEIS as long as the appropriate identified BMPs and mitigation measures are implemented as part of proposed projects. • Project-specific ESA Section 7 consultations tier off programmatic consultation as long as the BMPs, minimization measures, mitigation measures, and monitoring requirements established as part of the programmatic ESA Section 7 consultation are implemented, as appropriate.	• Process and evaluate requests for easement exchanges separately on a case-by-case basis. • Adopt a standardized structured process for collecting information and evaluating and reviewing potential environmental impacts of easement exchanges if wind energy facilities cannot avoid Service easements. • Require implementation of programmatic BMPs, mitigation measures, and monitoring to ensure the integrity and conservation objectives of Service easements are maintained. • Project-specific NEPA analyses tier off the analyses in the PEIS as long as the identified BMPs, mitigation measures, and monitoring requirements are implemented as part of projects. • Future project-specific ESA Section 7 consultations tier off programmatic consultation as long as the BMPs, minimization measures, mitigation measures, and monitoring requirements established as part of the programmatic ESA Section 7 consultation are implemented, as appropriate.
Alternative 2	• Same as Alternative 1.	• No easement exchanges to accommodate wind energy facilities would be allowed.

TABLE 2.3-1 (Cont.)

Alternative	Western Area Power Administration	U.S. Fish and Wildlife Service
Alternative 3	• Separate project-specific NEPA evaluations required for each interconnection request. • No additional BMPs or mitigation measures would be requested by Western beyond those mandated under applicable Federal, State, and local regulations.	• Process and evaluate requests for easement exchanges separately on a case-by case basis. • No additional mitigation measures, BMPs, or monitoring would be required by the Service for easement exchanges beyond those mandated under applicable Federal, State, and local regulations. • Easement exchanges would occur for wind energy projects as presented by developers, without consideration of additional measures to reduce impacts.

the past (section 2.1.2). This means the Service will work with the developer to avoid impacting easement interests if possible, then develop the elements needed for each project to minimize the unavoidable impacts to the extent practicable. The resulting wind energy facilities that do not impact critically needed habitat or species of special concern, and that do not completely impair any easement's ability to achieve its purpose, will be accommodated by executing an exchange of easement interests.

NEPA analyses would be prepared by each agency, as appropriate, on a project-by-project basis and BMPs, mitigation measures, and monitoring requirements would be developed on a case-by-case basis only. Government-to-government consultation with Native American tribes would continue to be conducted separately for each project as appropriate. ESA Section 7 consultation with the Service regarding potential effects of project development on federally listed species and consultation with appropriate agencies and federally recognized Native American tribes under Section 106 of the NHPA (36 CFR 800) regarding potential effects on cultural and historic resources would also be conducted separately for each project.

2.3.2 Alternative 1: Programmatic Regional Wind Energy Development Evaluation Process for Western and the Service

Alternative 1 is identified by Western and the Service as the preferred alternative. Under Alternative 1, each agency would implement a standardized process for evaluating the environmental effects of wind energy projects. Western would establish standardized procedures for the environmental review when considering interconnection requests and would identify BMPs and mitigation measures to be applied by developers where specific resource conditions occur (see sections 2.3.2.1 and 2.3.2.2). The Service would continue to process requests for easement exchanges to accommodate wind energy structures on Service easements using current procedures, but would adopt a standardized approach for reviewing potential environmental impacts of easement exchanges. Standardized BMPs, mitigation measures, and monitoring requirements that developers would need to apply to address potential environmental effects would be identified. Both agencies would continue to require site-specific NEPA evaluations for projects (including analysis of cumulative impacts), but those NEPA evaluations would tier off the analyses in this PEIS as long as the project developers are willing to implement the applicable evaluation process, BMPs, and mitigation measures identified for this alternative. If a developer does not wish to implement the evaluation process, BMPs, or mitigation measures identified for this alternative, a separate NEPA evaluation that does not tier off the analyses in the PEIS would be required. Government-to-government consultation with Native American tribes and consultation with appropriate agencies under Section 106 of the NHPA regarding potential effects on cultural and historic resources would continue to be conducted separately for each project as appropriate. Project-specific ESA Section 7 consultations would tier off programmatic consultation conducted for this PEIS, as long as developers agree to implement the appropriate avoidance measures, mitigation measures, and monitoring requirements identified during the programmatic consultation.

Both this PEIS and the associated programmatic ESA Section 7 consultation endeavor to capture BMPs and mitigation measures that have been found to be effective in avoiding or reducing impacts on specific environmental resources. Because of the desire to include all practicable measures in this PEIS, some measures may not be appropriate or effective in all situations, so Western and the Service would coordinate with project developers during project planning activities to identify the project-specific measures that would be applicable to each project.

Programmatic elements for each agency under this alternative would include the following:

- Adoption of a standardized approach for evaluating environmental effects of proposed wind energy projects;

- Adoption of programmatic BMPs and mitigation measures that would be applied or recommended for specific projects and various resource conditions; and

- Identification of environmental review requirements for situations where programmatic BMPs and mitigation measures are adopted by project developers and for situations where they are not adopted.

The agencies believe that implementing Alternative 1 would provide the following benefits:

- *Tiering of project-specific environmental analyses.* Future, project-specific environmental analyses for wind energy development would tier off of the analyses conducted in this PEIS and the decisions in the Records of Decision (ROD), thereby allowing the project-specific analyses to focus on site-specific issues that are not already addressed in sufficient detail to resolve the issues(s).

- *Development of comprehensive procedures and mitigation measures.* Western and the Service propose that implementing the programmatic elements identified for Alternative 1 would provide developers with a set of comprehensive procedures and mitigation measures that would provide guidance on environmental reviews and requirements for wind energy projects requesting connection to Western's transmission system and/or proposing modification of the Services wetland or grassland easements through easement exchanges.

- *Consistency of the application and authorization process*. Western and the Service propose that implementation of the proposed programmatic elements would result in greater consistency in the environmental reviews of applications for wind energy interconnections and for the environmental evaluation of requests for easement exchanges to accommodate wind energy development on easements lands.

- *Support development of wind energy projects and infrastructure within the UGP Region.* Western and the Service propose that standardizing their processes for evaluating environmental effects of wind energy interconnection and development requests would facilitate understanding of the requirements for approval by potential developers, would result in a reduction of environmental impacts from wind energy development, and would reduce the amount of time needed to plan and construct wind energy projects.

2.3.2.1 Programmatic Environmental Evaluation Process

Western Area Power Administration. All wind energy interconnection requests will follow the procedures established by the Tariff. Within those procedures, Western proposes to adopt the following approach for environmental review and consultation requirements for wind energy interconnection requests under Alternative 1:

- Project developers seeking to develop a wind energy project that would connect to Western's transmission facilities shall consult with appropriate Federal, State, and local agencies regarding specific projects as early in the planning process as appropriate to ensure that all potential pre-project surveys, monitoring, construction, operation, maintenance, and decommissioning issues and concerns are identified and adequately addressed.

- As early in the planning process as appropriate, Western will initiate government-to-government consultation with Native American tribal governments whose interests might be directly and substantially affected by the planned interconnection activities so that construction, operation, maintenance, and decommissioning issues and concerns are identified and adequately addressed.

- Western will consult with the Service as required by Section 7 of the ESA for all interconnections. A programmatic consultation will be developed as part of this PEIS to address listed species, although specific consultation requirements will be determined on a project-by-project basis. Under the proposed programmatic evaluation process, Western and the Service would conclude that additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing appropriate and applicable programmatic avoidance measures, minimization measures, BMPs, and mitigation measures that would result in a determination that listed species and critical habitats are not likely to be adversely affected. Conversely, project-specific ESA Section 7 consultation would be initiated for (1) any listed species or critical habitat not considered in the programmatic consultation and (2) for any listed species or critical habitat for which project developers are unwilling or unable to implement the programmatic avoidance measures, minimization measures, BMPs, or mitigation measures applicable to a project. ESA Section 7 consultation for individual projects that are addressed under the programmatic consultation will be documented with a letter to the appropriate Service office; this letter will provide details about the project location and design, identify the applicable listed species, and identify the appropriate and applicable programmatic minimization measures, BMPs, and mitigation measures that the project developer has agreed to incorporate into the project plan.

- Western will consult with the appropriate State Historic Preservation Office (SHPO) on its Federal undertaking as required by Section 106 of the NHPA.

The specific consultation requirements will be determined on a project-by-project basis. If programmatic Section 106 consultations have been conducted and are adequate to address a proposed project, additional consultation may not be needed. Western will encourage project developers to coordinate their wind projects with the SHPO. In some States, consultation with the SHPO on private projects is already required as a provision of the State's utility siting permit process. Cultural resource surveys would be required for all ground-disturbing activities, except in cases involving modifications to existing substations or other areas where surveys have already been completed.

- The level of environmental analysis to be required under NEPA for individual wind power projects and related facilities will be determined by Western. It is Western's intent that future wind energy project environmental analysis will tier off of the analyses and decisions embedded in this PEIS and additional project-specific NEPA analyses will refer back to this PEIS for relevant information, allowing subsequent NEPA documents to focus on site-specific issues and concerns. The site-specific NEPA analyses will include analyses of project site configuration and micrositing considerations, unique or unusual aspects or issues not anticipated by the PEIS, and the application of appropriate mitigation measures. In particular, the BMPs and mitigation measures identified in chapter 5 (and summarized below in section 2.3.2.2) would be implemented when appropriate for addressing site-specific environmental conditions; additional measures not identified in the PEIS may be requested to address some site-specific situations. Public involvement will be incorporated into all wind energy development projects so that concerns and issues are identified and adequately addressed. In general, the scope of the NEPA analyses will be focused on the proposed Federal action related to interconnection to Western's transmission facilities. The environmental effects of a project developer's proposed project will also be analyzed so that the anticipated impacts and mitigation needs of the proposed project can be disclosed to the public and considered by Federal decision-makers. The NEPA analysis may also need to assess the environmental effects from proposed transmission required to reach the point of interconnection. Western's analyses of impacts within ROWs will tier off of this PEIS to the extent that the proposed project falls within the scope of the PEIS analyses. Site-specific environmental analyses will tier from the PEIS and identify and assess any cumulative impacts that are beyond the scope of the cumulative impacts addressed in the PEIS.

Service Easements. The Service proposes to adopt the following approach for reviewing requests for wind energy development on Service easements under Alternative 1:

- Project developers seeking to place wind energy facilities on easements managed by the Service shall consult with appropriate Federal, State, and local agencies regarding specific projects as early in the planning process as appropriate to ensure that all potential planning and preconstruction surveys and information needs, as well as construction, operation, and decommissioning issues and concerns, are identified and adequately addressed.

- Easements or portions of easements may be excluded from wind energy development on the basis of findings of unacceptable resource impacts that conflict with existing and planned conservation needs and/or cannot be suitably avoided or mitigated.

- The level of environmental analysis to be required under NEPA for individual wind power projects will be determined by the Service's Field Offices. It is the Service's intent that future wind energy project environmental analysis will tier off of the decisions embedded in this PEIS and limit the scope of additional project-specific NEPA analyses. The site-specific NEPA analyses will consider project siting, site configuration, and micrositing; monitoring requirements; and the application of appropriate mitigation measures. In particular, the BMPs and mitigation measures presented in chapter 5 (and summarized below in section 2.3.2.2) would be used when appropriate and applicable for addressing site-specific environmental conditions; additional measures not identified in the PEIS may be requested to address some site-specific situations. Public involvement will be incorporated into all wind energy development projects to ensure that concerns and issues are identified and adequately addressed. In general, the scope of the NEPA analyses will focus on the Federal action on Service easements, but they must also include the full project (for example, indirect effects and impacts from connected and similar actions, if any). If access to proposed development on adjacent non-Service-administered lands is entirely dependent on obtaining access to Service-administered easements and there are no alternatives to that access, the NEPA analysis may need to assess the environmental effects from that proposed development so that the anticipated impacts can be disclosed to the public and considered by Federal decision-makers.

- Site-specific environmental analyses will tier from this PEIS, but will identify and assess any cumulative impacts that are beyond the scope of the cumulative impacts addressed in the PEIS.

- The Service will consult as required by Section 7 of the ESA for all exchanges of easement lands to accommodate wind energy facilities. A programmatic consultation will be developed as part of this PEIS to address listed species and critical habitat, although specific consultation requirements will be determined on a project-by-project basis. Under the proposed programmatic evaluation process, the Service would conclude that additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing the appropriate and applicable programmatic avoidance measures, minimization measures, construction BMPs, and mitigation measures that would result in a determination that listed species and critical habitat are not likely to be adversely affected. Conversely, the Service would initiate project-specific ESA Section 7 consultation for (1) any listed species or critical habitat not considered in the programmatic consultation and (2) for any listed species or critical habitat for which project developers are unwilling or unable to implement the programmatic minimization measures, BMPs, or mitigation measures applicable to a project. ESA Section 7 consultation for individual projects that are addressed under the programmatic consultation will be documented with a letter to the appropriate Service office; this letter will provide details about the project location and design, identify the applicable listed species, and that identify the appropriate and applicable programmatic minimization measures, BMPs, and mitigation measures that the developer has agreed to incorporate into the project plan.

- The Service will consult with the SHPO as required by Section 106 of the NHPA. The specific consultation requirements will be determined on a project-by-project basis. If programmatic Section 106 consultations have been conducted and are adequate to cover a proposed project, additional consultation may not be needed. In general, cultural resource surveys would be required for all ground-disturbing activities, except in cases involving areas where surveys have already been completed.

- Project developers seeking to place wind energy facilities on Service easements shall develop a project-specific plan of development (POD) that incorporates applicable programmatic BMPs and mitigation measures and, as appropriate, the requirements of other existing and relevant mitigation guidance. Additional mitigation measures will be incorporated into the POD and into the authorization as project stipulations, as needed, to address site-specific and species-specific issues. The POD will include a site plan showing the locations of turbines, roads, power lines, other infrastructure, and other areas of short- and long-term disturbance.

- The Service will incorporate management goals and objectives specific to habitat conservation for species of concern, as appropriate, into the POD for proposed wind energy projects.

- The effectiveness of the programmatic review procedures and the programmatic BMPs and mitigation measures will be periodically reviewed and will be updated and revised as new data regarding the impacts of wind power projects become available. At the project level, operators may be required to develop monitoring programs, as appropriate, to evaluate the environmental conditions at the site through all phases of development, to establish metrics against which monitoring observations can be measured, to identify potential mitigation measures, and to establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and project-specific stipulations.

2.3.2.2 Programmatic BMPs and Mitigation Measures

Under Alternative 1, Western and the Service would apply appropriate and applicable programmatic BMPs and mitigation measures to all wind energy development projects within the UGP Region that would interconnect to Western and/or require an exchange of Service easements. This section summarizes the principal BMPs and mitigation measures that are presented in chapter 5; the reader is referred to the appropriate resource-specific sections of chapter 5 for more extensive lists of BMPs and mitigation measures that may be appropriate and applicable for specific projects. This section also details evaluation procedures that would be followed to identify site-specific concerns for ecological resources. The BMPs and mitigation measures presented here and in chapter 5 would be adopted, where appropriate and applicable, as elements of project-specific development plans. Measures related to site monitoring and testing and to preparation of development plans are also included in this section and identify those elements of development plans that would be needed to address potential impacts associated with subsequent phases of development. Some of the proposed BMPs and mitigation measures address issues that are not unique to wind energy development, such as road construction and maintenance, wildlife management, hazardous materials and waste management, cultural resource management, and pesticide use and integrated pest management.

The identification and selection of applicable project-specific BMPs and mitigation measures would be based on whether the measure would (1) ensure compliance with relevant statutory or administrative requirements, (2) minimize local impacts associated with siting and design decisions, (3) promote post-construction stabilization of impacts, (4) maximize post-construction restoration of habitat conditions, (5) minimize cumulative impacts, and (6) promote economically feasible development of wind energy. Western and the Service acknowledge that certain BMPs and mitigation measures may not be reasonable or applicable at a particular project site; only those BMPs and mitigation measures found applicable to the situation at the specific project site would be implemented.

Site Monitoring and Testing.

- The area disturbed by installation of meteorological towers (i.e., footprint) shall be kept to a minimum.

- Existing roads shall be used to the maximum extent feasible. Meteorological towers shall be installed and other characterization activities (e.g., geotechnical testing) shall be conducted as close as practicable to existing access roads. If new roads are necessary, they shall be designed and constructed to the appropriate standard.

- Meteorological towers shall not be located in sensitive habitats or in areas where resources known to be sensitive to human activities (e.g., wetlands, cultural resources, and listed species) are present. Installation of towers shall be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors, and the disturbed area will be minimized.

- The use of guy wires on meteorological towers shall be avoided or minimized. Any needed guy wires shall have guys appropriately marked with bird flight diverters.

General Planning and Land Use.

- Project developers shall contact appropriate agencies, property owners, tribes, and other stakeholders early in the planning process to identify potentially sensitive land uses and issues, identify preproject surveys or data collection needs, and identify rules that govern wind energy development locally, and land use concerns specific to the region. They should coordinate closely with the Service and the U.S. Department of Agriculture (USDA) during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.

- Consult with the U.S. Department of Defense (DOD) during initial project planning to evaluate impacts of a proposed project on military operations in order to identify and address any DOD concerns.

- The Federal Aviation Administration (FAA) required notice of proposed construction shall be made as early as possible to identify any air safety measures that would be required.

- Avoid locating wind energy developments in areas of unique or important recreation, wildlife, or visual resources. When feasible, a wind energy development should be sited on already altered landscapes.

- Available information describing the environmental and sociocultural conditions in the vicinity of the proposed project shall be collected and reviewed as needed to predict potential impacts of the project.

- To plan for efficient use of the land, necessary infrastructure requirements shall be consolidated wherever possible, and current transmission and market access shall be evaluated carefully.

- Projects shall be designed to utilize existing roads and utility corridors to the maximum extent feasible, and to minimize the number and length/size of new roads, lay-down areas, and borrow areas.

- Prior to start of construction, a monitoring plan shall be developed by the project developers so that environmental conditions are monitored during the construction, operation, and decommissioning phases. The monitoring plan shall be submitted to the Service and shall identify the monitoring requirements for important environmental conditions present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring results and additional mitigation measures into standard operating procedures and BMPs for the project.

- “Good housekeeping” procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash, or waste; to prohibit scrap heaps and dumps; and to minimize storage yards.

- An access road siting and management plan shall be prepared incorporating applicable standards regarding road design, construction, and maintenance. Access roads will be designed to minimize total length, avoid wetlands, and avoid or minimize stream and drainage crossings.

Ecological Resources.

Implementation of a Risk-Based Evaluation Approach. Many concerns relative to the potential types and levels of impacts of wind energy development on wildlife and other ecological resources depend upon site-specific and project-specific aspects. Under Alternative 1, project developers shall employ a risk-based evaluation approach to identify project-specific concerns related to wildlife and other ecological resources, and the results of the evaluation will be incorporated into project-specific NEPA documentation. The risk evaluation approach used by developers should be consistent with the tiered approach identified in the *Land-Based Wind Energy Guidelines* (Service 2012) developed by the Service. These documents describe a decision framework for collecting information to evaluate environmental risks to wildlife and other ecological resources during project planning and, in some cases, after project development has been completed.

Using an evaluation process that is consistent with that identified in the *Land-Based Wind Energy Guidelines* (Service 2012) during wind farm development would provide project developers with a stepwise method for evaluating environmental concerns in their decision-making process. The evaluation process would help identify ecological resources that have a reasonable likelihood to be significantly affected by planned project designs and activities, as well as those ecological resources that are unlikely to be significantly affected. Proper identification of resources that could be significantly affected would allow the focus to be on modifying the design of the proposed project or identifying BMPs and mitigation measures to avoid, reduce, or otherwise compensate for potentially significant impacts and would reduce the potential for unexpected impacts on natural resources and subsequent delays in project development. In addition, requesting developers to implement a method for evaluating the potential for ecological resources to be affected by wind energy projects that is consistent with the *Land-Based Wind Energy Guidelines* would facilitate the ability of Western and the Service to (1) identify and address project-specific concerns related to species protected under the ESA; (2) identify address project-specific concerns related to protection of eagles under the BGEPA, and (3) meet responsibilities of Federal agencies to protect migratory birds as directed by Executive Order 13186 and to accomplish terms and objectives identified in a 2006 Memorandum of Understanding between the DOE and the Service regarding implementation of the Executive Order.

Project developers should review the *Land-Based Wind Energy Guidelines* (Service 2012) for specific details and useful information prior to project development. In general, the risk evaluation approach in the guidelines involves five iterative tiers of evaluation:

Tier 1 – Preliminary evaluation or screening of potential sites.
Tier 2 – Site characterization.
Tier 3 – Field studies to document site wildlife conditions and predict project impacts.
Tier 4 – Post-construction studies to estimate impacts.

Tier 5 – Other post-construction studies.

The first three tiers would be conducted during the pre-construction evaluation phase of wind energy projects. For each of these three tiers, the guidelines developed by the Service (2012) provide sets of questions to assist developers with the evaluation, along with recommended methods and metrics to use in answering the questions. Some questions are repeated at each tier, with successive tiers requiring a greater investment in data collection to answer certain questions. For example, while Tier 2 investigations may identify existing information on federally or State-listed species that suggests the one or more species of concern have a potential to be present at the proposed development site, it may be necessary to collect empirical data in Tier 3 studies to determine whether federally or State-listed species are actually present or likely to be present at the site. Timely communication with Western and/or the Service regarding results of the initial steps of the risk evaluation is encouraged; this would allow the opportunity for the agencies to provide, and developers to consider, technical advice about ways to modify the project design or to identify BMPs and mitigation measures that could be considered to avoid, reduce, or otherwise compensate for potentially significant impacts. BMPs and mitigation measures identified in section 5.6.2 shall be applied, as appropriate, to address concerns regarding site-specific ecological impacts identified as a result of the risk-based evaluation approach. In some cases, additional BMPs and mitigation measures may need to be developed to address specific concerns.

Protection of Federally Listed Species and Designated Critical Habitat. A programmatic consultation would be conducted to address federally listed species, although specific consultation requirements would be determined on a project-by-project basis. Under the proposed environmental review process, Western and the Service would conclude that additional ESA Section 7 consultation beyond the programmatic consultation would not be required for projects for which the project developers commit to implementing the appropriate and applicable programmatic avoidance measures, minimization measures, and mitigation measures that would result in a determination that listed species are not likely to be adversely affected. Conversely, project-specific ESA Section 7 consultation would be required for (1) any listed species not considered in the programmatic consultation and (2) any listed species for which project developers are unwilling or unable to implement the programmatic avoidance measures, minimization measures, or mitigation measures applicable to a project.

As part of the development of the PEIS, Western and the Service have been engaged in discussions relative to programmatic measures that could be implemented to limit the potential for adverse effects on federally listed species (i.e., species listed as threatened or endangered and species that are candidates for listing under the ESA) and designated critical habitat for those species. Based upon these discussions, a draft set of measures that would result in determinations that listed species and designated critical habitat would not be affected or are not likely to be adversely affected by wind energy development activities have been identified for each of the federally listed species, candidates for listing, and designated critical habitats that occur within the UGP Region. These draft measures are summarized in table 2.3-2. Programmatic consultation with the Service would be completed before issuance of the final PEIS and could result in modifications to some of the identified measures.

A primary goal for development of the draft programmatic measures for protection of federally listed species and designated critical habitats was to identify a set of measures that would limit the potential for adverse effects to species and critical habitats while still

TABLE 2.3-2 Summary of Draft Programmatic Species-Specific Survey Requirements, Avoidance Measures, and Conservation Measures for Federally Listed Species and Designated Critical Habitat in the UGP Region[a]

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants					
Platanthera leucophaea	Eastern prairie fringed orchid	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In counties where E. prairie fringed orchid is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Surveys should include proper identification and survey techniques as presented in the listing documents. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing E. prairie fringed orchid. Clearly delineate buffer zones around locations of plants within the project area and restrict activities within 100 ft (30.5 m) of those locations. Avoid mowing along access roads or transmission line ROWs in area containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing E. prairie fringed orchid, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure • Employ BMPs during and after construction to control erosions and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in suitable habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat	May affect, not likely to adversely affect

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TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Asclepias meadii	Mead's milkweed	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In Counties where Mead's milkweed is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing Mead's milkweed. Avoid mowing along access roads or transmission line ROWs in areas containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing Mead's milkweed, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to avoid sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. Herbicide use is prohibited within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Lespedeza leptostachya	Prairie bush clover	Plants may be disturbed/destroyed, or future colonization precluded by site clearing for wind energy project construction activities.	Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing prairie bush clover. Avoid mowing along access roads or transmission line ROWs in areas containing suitable habitats.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing prairie bush clover, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Spiranthes diluvialis	Ute ladies'-tresses	Culvert and bridge construction for access roads may lead to bank erosion, sediment loading, or impacts on downstream flows that could result in alteration or loss of habitat.	Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of suitable habitat containing Ute ladies'-tresses.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing Ute ladies'-tresses, Developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species.	May affect, not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Plants (Cont.)					
Platanthera praeclara	Western prairie fringed orchid	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities; and/or pollinator abundance may be negatively affected by construction, operations, or maintenance.	In counties where w. prairie fringed orchid is known to occur, preconstruction evaluations and surveys are required to identify (1) habitat containing suitable growing conditions and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities within 100 ft (30.5 m) of occupied habitat.	For project boundaries that encompass or intersect occupied habitat and/or a hydrologic catchment containing w. prairie fringed orchid, developers will: • Employ BMPs to control invasive plants associated with construction of access roads, turbine pads, substations, collection/distribution lines, and other infrastructure. • Employ BMPs during and after construction to control erosion and runoff along access roads to minimize sediment deposition in occupied suitable habitat. • Design layout configurations and construction activities to avoid alterations in surface water flow, infiltration, and groundwater levels in occupied habitat. • Restrict all herbicide use within 100 ft (30.5 m) of suitable habitat containing the species. • Restrict all vehicular traffic to access roads, turbine pads, and established roadways within suitable habitat.	May affect, not likely to adversely affect
Pinus albicaulis	Whitebark Pine	Plants may be disturbed/destroyed; future colonization may be precluded by site clearing for wind energy project construction activities.	May occur in 29 counties in Montana. However, occurs on high-elevation sites at alpine timberline. In counties where whitebark pine is known to occur, preconstruction evaluations and surveys are required to identify occupied sites. Do not site turbines, access roads, transmission line towers, or other project facilities within 300 ft (91 m) of occupied locations.	None needed.	Not likely to jeopardize the continued existence

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates					
Nicrophorus americanus	American burying beetle	Habitat loss or degradation may occur due to movement of construction equipment along access roads, clearing/grading for turbine pads and substations, construction of transmission lines from turbines to the electrical grid, construction of access roads, and storage of equipment. Direct mortality may also occur from turbine strikes, increased presence of attractants (e.g., avian collision mortality at turbines), vehicular traffic, or construction disturbance of soil during the breeding season or overwintering period.	In counties where the species is known to occur, preconstruction evaluations and surveys are required to determine (1) the presence of suitable habitat and (2) species occurrence within and adjacent to project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in suitable habitat	None.	May affect, not likely to adversely affect
Hesperia dacotae	Dakota skipper	Direct impacts include mortality due to ground/vegetation disturbance, application of pesticides, or collisions with vehicles. Indirect impacts include a loss of native plants used by Dakota skippers due to construction of access roads, turbines, substations, or transmission lines.	Do not site turbines, access roads, transmission line towers, or other project facilities in occupied habitat.	For projects that encompass suitable habitat or that occur near occupied habitat: • Obtain a grassland easement of native prairie, equal to the amount disturbed that contains obligate plant species to minimize additional loss to suitable habitat or improve existing nearby grassland easements to incorporate obligate plants to provide additional suitable habitat. • Avoid using herbicides or pesticides in the vicinity suitable habitat.	Not likely to jeopardize the continued existence
Lampsilis higginsii	Higgins eye	Negative impacts are unlikely because wind energy development would not occur in areas adjacent to potential Higgins eye habitat.	Do not site turbines, access roads, transmission line towers, or other project facilities in aquatic habitat where Higgins eye mussels may be present.		No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates (Cont.)					
Oarisma poweshiek	Poweshiek skipperling	Direct impacts include mortality due to ground/vegetation disturbance, application of pesticides, or collisions with vehicles. Indirect impacts include a loss of native plants used by skipperlings due to construction of access roads, turbines, substations, or transmission lines.	Do not site turbines, access roads, transmission line towers, or other project facilities in suitable habitat.	For projects that encompass suitable habitat or that occur near occupied habitat: • Obtain a grassland easement of native prairie, equal to the amount disturbed that contains obligate plant species to minimize additional loss to suitable habitat or improve existing nearby grassland easements to incorporate obligate plants to provide additional suitable habitat. • Avoid using herbicides or pesticides in the vicinity suitable habitat.	Not likely to jeopardize the continued existence
Cicindela nevadica lincolniana	Salt Creek tiger beetle	Mortality could occur if wind energy facility construction causes flooding and sediment transport that inundates burrows along creek habitats in Nebraska.	Do not site turbines, access roads, transmission line towers, or other project facilities in the watersheds of critical habitat locations habitat.	Should wind farms be developed near saline wetlands measures should be taken to: Avoid changing existing surface water flows that would alter existing habitat in the Salt Creek and Rock Creek watersheds. Avoid using herbicides or pesticides in the vicinity suitable habitat.	May affect, but is not likely to adversely affect
	Designated critical habitat for Salt Creek tiger beetle	Critical habitat has been designated for four areas of Salt Creek, totaling approximately 1,933 ac (782 ha) in Lancaster and Saunders Counties, Nebraska. Saline wetland and stream complexes found along Little Salt Creek and Rock Creek comprise the critical habitat designation.	Do not site turbines, access roads, transmission line towers, or other project facilities in critical habitat.		No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Invertebrates (Cont.)					
Leptodea leptodon	Scaleshell mussel	Negative impacts are unlikely because wind energy development would not occur in areas where scaleshell mussels are present.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to aquatic habitat where scaleshell mussels may be present.		No effect
Fish					
Thymallus arcticus	Arctic grayling	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to streams where Arctic grayling occur.	None needed.	Not likely to jeopardize the continued existence
Salvelinus confluentus	Bull trout	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Do not site turbines, access roads, transmission line towers, culverts, or other project facilities in or adjacent to designated core areas, spawning or rearing habitat, and migratory corridors.	For projects that encompass areas within drainages occupied by bull trout: • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Avoid actions that would alter surface water flow in occupied habitat.	No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Fish (Cont.)					
	Designated critical habitat for bull trout	Designated critical habitat within the UGP Region includes approximately 37 mi (59 km) of streams and 4,107 ac (1,662 ha) of lakes within the Saint Mary-Belly River Basins in Glacier County, Montana.	Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to designated critical habitat.		No effect
Scaphirhynchus albus	Pallid sturgeon	Stream flow may be altered by installation of crossing structures or sediments and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to aquatic habitat where pallid sturgeon occurs.	For projects that encompass areas within drainages occupied by pallid sturgeon: • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Ensure that upstream and downstream fish passage is maintained in any areas where stream habitat disturbance occurs. • Avoid actions that would alter surface water flow in occupied habitat.	No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Fish (Cont.)					
Notropis topeka (=tristis)	Topeka shiner	Stream flow may be altered by installation of crossing structures or sediments, fish passage through crossing structures may be precluded with improper sizing/design/installation, and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning. Water withdrawals for construction may reduce available flows and entrain/impinge fish.	Conduct preconstruction evaluations in areas of potential occurrence to identify known or suitable habitat within known occupied Topeka shiner watersheds within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in or adjacent to known Topeka shiner habitat or habitat occupied by Topeka shiner. Avoid actions that would alter surface water flow in known or occupied habitat (i.e., do not withdraw water from suitable habitat)..	For projects that encompass areas within drainages with suitable aquatic habitat for the Topeka shiner: Conduct preconstruction surveys to confirm occupied streams within project boundaries. This requires a permit from the Service. • Employ BMPs during and after construction to control erosion and runoff to aquatic habitats. • Avoid using herbicides or pesticides in the vicinity of aquatic habitats. • Employ measures to minimize the amount of stream habitat disturbance when transmission lines and access roads must be constructed across streams. • Ensure that upstream and downstream fish passage is maintained in any areas where stream habitat disturbance occurs. • Avoid actions that would alter surface water flow in occupied habitat.	May affect, but is not likely to adversely affect
	Designated critical habitat for Topeka shiner	Stream flow may be altered by installation of crossing structures or by sediments; fish passage through crossing structures may be precluded with improper sizing/design/installation; and pollutants may enter the water through consumptive use of water for cleaning or erosion and runoff during project development, operation, and decommissioning. Water withdrawals for construction may reduce available flows.	Do not site turbines, transmission line supports, access roads, or other project facilities in or adjacent to designated critical habitat. Avoid actions that would alter surface water flow in occupied habitat (i.e., do not withdraw water from Topeka shiner critical habitat).		No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Reptiles					
Sistrurus catenatus catenatus	Eastern massasauga	Direct mortality may occur from ground-breaking activities associated with construction or from vehicle collisions along access roads.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, access roads, transmission line towers, or other project facilities in occupied habitat.	For projects that encompass occupied habitat or that occur near occupied habitat: • Minimize disturbance (e.g., mowing, burning, excessive foot traffic) in suitable mesic grassland and prairie habitats, especially during the spring months. • Maintain ecological connectivity between parcels of suitable habitat within project boundaries. • Identify and implement strategies to reduce potential for road mortality on access roads (e.g., close roads or limit traffic during migration times, create road diversion structures to detour snakes, or post signs).	Not likely to jeopardize the continued existence

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds					
Centrocercus urophasianus	Greater sage-grouse	Loss and fragmentation of shrub-dominated habitat may occur from construction of access roads, turbine pads, transmission lines, and substations. Sage grouse tend to avoid suitable habitat due to the fragmentation and presence of tall structures such as turbines, construction work crews and equipment, and vehicular traffic. Survival and reproduction can be negatively affected; changes in habitat quality, predator communities, or disease dynamics can negatively impact sage grouse.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat, known core population areas, and lek locations, within project boundaries. Do not site turbines, access roads, transmission lines, or other project facilities within greater sage grouse core population areas. .	For projects that encompass potential (e.g., migration) sage-grouse habitat within the range of the species: • Do not use guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices. • Do not place new meteorological towers within 4 mi (6.4 km) of active sage-grouse leks, unless they are out of the direct line of sight of the active lek. • Restrict surface use activities in suitable sage-grouse nesting habitat located within 4 mi (6.4 km) of a known lek. • Disturbed areas in shrub/ grassland habitat should be maintained with >10% shrub cover and grasses greater than 6–7 in. (15–18 cm) tall. • Decrease habitat fragmentation by limiting the number of access roads through sagebrush habitat. • Bury all project-related collector and distribution lines. • Do not place overhead power lines in suitable sage-grouse nesting habitat located within 2 mi (3.2 km) of a known lek. • Install bird flight diverters on new overhead power lines that are located within occupied sage-grouse habitat. • Do not build new fences in occupied habitat and remove or mark existing fences with bird flight diverters. • Report incidences of mortality or injury of sage-grouse individuals within the project area to the appropriate Service Ecological Services Field Office.	Not likely to jeopardize the continued existence

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Sterna antillarum	Interior least tern	Direct mortality may occur from collision with turbine blades. Loss of habitat may also occur due to erosion along access roads and tern avoidance of suitable habitat near construction.	Do not site turbines, access roads, transmission lines, or other project facilities within 0.50 mi (0.8 km) of suitable sandbar habitat, reservoir shorelines, or other known shoreline nesting, resting, and foraging areas.	Conduct construction activities during the non-breeding season in areas near known occupied habitat. Mark new overhead power lines within 1 mi (1.6 km) of known least tern habitat with bird flight diverters. If least terns nest in the project area during construction, avoid construction activities within 0.5 mi (0.8 km) of nesting areas during late April to August.	May affect, but is not likely to adversely affect
Charadrius melodus	Piping plover	Direct mortality may occur from collision with turbine blades. Habitat loss may occur due to construction of wind energy facilities, access roads, and transmission lines. Erosion due to construction of access roads may affect nesting and foraging habitat.	Do not site turbines, access roads, transmission lines, or other project facilities within 2 mi (3.2 km) of suitable sandbar habitat, reservoir shorelines, alkali wetlands, or other known shoreline nesting, resting, and foraging areas.	Mark new overhead power lines within 1 mi (1.6 km) of known piping plover habitat with bird flight diverters. If piping plovers nest in the project area during construction, avoid construction activities within 0.5 mi (0.8 km) of nesting areas during late April to August.	May affect, but is not likely to adversely affect
	Designated critical habitat for piping plover	Habitat loss may occur due to construction of wind energy facilities, access roads, and transmission lines. Erosion due to construction of access roads may affect nesting and foraging habitat.	Do not site turbines, transmission lines, access roads, or other project facilities in or within 2 mi (3.2 km) of designated critical habitat.		No effect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Anthus spragueii	Sprague's pipit	Fragmentation of habitat from roads, substations, and turbine placement in grassland communities is likely the greatest impact on Sprague's pipits. Direct mortality may occur from collision with turbine blades or overhead transmission lines during aerial breeding displays or during periods of low visibility. Sprague's pipits may also avoid suitable habitat due to vehicular traffic and the presence of tall structures such as turbines. Nesting birds may be affected by construction.	Avoid placement of turbines, access roads, and transmission lines on or within 1,000 ft (304.8 m) of suitable native prairie tracts larger than 70 ac (0.28 km^2).	Design layouts to minimize further fragmentation of native prairie habitats that are suitable for Sprague's pipit. Conserve or restore native prairie habitats to offset impacts on native prairie caused by fragmentation, as determined in tiered site-specific consultation.	Not likely to jeopardize the continued existence

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
Grus Americana	Whooping crane	Mortality may occur from collision with turbine blades or overhead power lines. Suitable wetland habitat may be avoided as a result of construction activities or may be degraded by erosion and runoff from access roads.	For projects that that occur within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings: • Conduct preconstruction evaluations and/or surveys to identify wetlands that provide potentially suitable stopover habitat.[c] • Do not site turbines, transmission lines, access roads, or other project facilities within or adjacent to wetlands that provide suitable stopover habitat or within 5 mi (8 km) of the Platte or Niobrara Rivers.	For projects that that occur within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings: • Place state-of-the-art bird flight diverters on any new or upgraded overhead collector, distribution, and transmission lines located within 1 mi (1.6 km) of suitable stopover habitat. • Establish a procedure for preventing whooping crane collisions with turbines during operations by establishing and implementing formal plans for monitoring the project site and surrounding area for whooping cranes during spring and fall migration periods throughout the operational life of the project and shutting down turbines and/or construction activities within 2 mi (3.2 km) of whooping crane sightings. Specific requirements of the monitoring and shutdown plan will be determined during site-specific ESA consultations, but will include adequate coverage (appropriate dates, times, numbers, and qualifications of observers) based on size of the wind farm. • Instruct workers to avoid disturbance of cranes present near project areas. • Within the portion of the whooping crane migration corridor that encompasses 95% of historic sightings, the acreage of wetlands that are suitable migratory stopover habitat located within a 1 mi (1.6 km) radius of turbines may be mitigated based upon site-specific evaluations.	May affect, but is not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Birds (Cont.)					
	Designated critical habitat for whooping crane	Degradation of designated critical habitat may occur, impacting roosting and feeding behavior and avoidance of that habitat.	Do not site turbines, transmission lines, access roads, or other project facilities within 5 mi (8 km) of designated critical habitat.		No effect
Mammals					
Gulo gulo luscus	North American wolverine	Negative impacts are unlikely, due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development. Negative impacts other than global warming would include disturbance, infrastructure development and roads.	May occur in 29 counties in Montana. However, North American wolverines inhabit habitats with near-arctic conditions wherever they occur. They are dependent on deep persistent snow cover for successful denning. Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in occupied areas.	None needed.	Not likely to jeopardize the continued existence
Mustela nigripes	Black-footed ferret	Potential impacts include loss of habitat and prey, predation by larger carnivores, disease transport, and direct mortality from vehicle collisions.	Coordinate with the Service on any sitings of turbines, transmission lines, access roads, or other project facilities on black-footed ferret reintroduction sites. Conduct preconstruction surveys within 100 miles of reintroduction sites and in areas of suitable habitat, (as per the 1989 survey protocols) within project boundaries.		May affect, but is not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Mammals (Cont.)					
Lynx canadensis	Canada lynx	Negative impacts are unlikely, due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in boreal forested habitats occupied by Canada lynx. Do not site turbines, transmission lines, access roads, or other project facilities in boreal forested habitats that may provide linkage between occupied habitats.		No effect
	Designated critical habitat for Canada lynx		Do not site turbines, transmission lines, access roads, or other project facilities within designated critical habitat.		No effect
Canis lupus	Gray wolf	Wolves may be displaced or migratory corridors may be altered due to fragmentation of previously undeveloped habitats. Mortality may occur from vehicle collisions or shootings due to human access into previously undisturbed areas.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in habitats occupied by gray wolf.		May affect, but is not likely to adversely affect

TABLE 2.3-2 (Cont.)

Scientific Name	Common Name	Potential Impacts	Species-Specific Survey Requirements and Avoidance Measures[b]	Species-Specific Conservation Measures[b]	Effect Determination
Mammals (Cont.)					
Ursus arctos horribilis	Grizzly Bear	Negative impacts are unlikely due to the lack of suitable habitat in the vicinity of areas best suited for wind energy development.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable habitat and areas of occurrence within project boundaries. Do not site turbines, transmission lines, access roads, or other project facilities in habitats occupied by grizzly bear.		No effect
Myotis sodalis	Indiana bat	Mortality may occur from turbine collision or barotrauma.	Conduct preconstruction evaluations and/or surveys in areas of potential occurrence to identify suitable foraging and roosting habitat within project boundaries and to identify the distance from project boundaries to hibernacula used by Indiana bats. Increase turbine cut-in speeds at developments within the counties where the Indiana bat is listed. Do not site turbines in areas within 20 mi (32 km) of hibernacula used by Indiana bats or within 1000 ft (300 m) of suitable foraging and roosting habitat.[d]	Immediately report observations of Indian bat mortality to the appropriate Service office.	May affect, but is not likely to adversely affect

[a] All of the applicable surveys, avoidance measures, and conservation measures are required for a project in order for ESA Section 7 consultation to be completed using the programmatic consultation approach. Otherwise, project-specific consultation would need to be initiated. The effect determination was developed to account for the potential impact after required avoidance and minimization measures were assessed.

[b] The overarching requirement for every species in this table is that any surveys will be coordinated with the Service's Ecological Services Field Office, survey results will be shared, and any adverse impacts effectively avoided for the life of the project.(i.e., efficacy of mitigation measures to avoid impacts are periodically evaluated and updated). Corrective mitigation measures also will be coordinated with the Service.

[c] Potentially suitable migratory stopover habitat for whooping cranes is considered to consist of wetlands with areas of shallow water without visual obstructions (i.e., high or dense vegetation) and submerged sandbars in wide, unobstructed river channels that are isolated from human disturbance (Service 2010b).

[d] Based on guidance developed by the Service. Available at http://www.fws.gov/midwest/endangered/mammals/inba/WindEnergyGuidance.html.

accommodating the majority of wind energy projects likely to occur within the UGP Region. This met one of the agencies' objectives of establishing programmatic processes that would facilitate environmental evaluations for most of the requests for interconnection to Western's transmission system and for most of the requests to accommodate wind energy development on areas under Service easements. The agencies believe that the numbers of wind energy development projects that will be unable to implement the programmatic avoidance measures, minimization measures, or mitigation measures would be small and environmental evaluations could be conducted for such projects using project-specific NEPA evaluations and ESA Section 7 consultations that do not tier from the proposed programmatic environmental evaluation process.

The draft measures were developed by first identifying avoidance areas (e.g., types of habitats or locations) within the UGP Region where specific wind energy development and operational activities would be precluded or restricted in order to protect federally listed species and designated critical habitat within the UGP Region without affecting the ability for most wind energy projects to proceed. Species-specific avoidance measures are intended to limit the potential for most of the direct impacts of wind energy development and operations on designated critical habitats, on habitat areas considered vital to maintaining existing populations of federally listed species, and on individual organisms in areas known to be occupied by federally listed species. If there was information about species-specific threats to survival, habitat use, or behavior that indicated that the avoidance measures alone would not be sufficient to reasonably limit the potential for adverse effects, species-specific minimization measures were identified that would further reduce the potential for adverse effects through implementation of BMPs. For some species (e.g., whooping crane) species-specific mitigation measures were identified to compensate for potentially adverse losses of habitat or habitat use that could result from wind energy development and operation even if avoidance and minimization measures were applied.

Information about wind energy impacts on listed species is in its early stages. The overarching requirement for every species in table 2.3-2 is that any surveys will be coordinated with the Service's Ecological Services Field Office. Survey results will be shared and any adverse impacts (plus the efficacy of mitigation measures to preclude impacts) on species will be reported, and corrective mitigation measures will be coordinated with those offices through the ESA Section 7 consultation. Similar information needs regarding migratory birds will also be coordinated with Service's Ecological Services Field Office.

Nineteen wind energy companies (the Wind Energy Whooping Crane Action Group known as "WEWAG"), convened and coordinated by the American Wind Energy Association, are developing the Great Plains Wind Energy Habitat Conservation Plan (GPWE HCP). WEWAG is collaborating with Region 2 (the Southwest) and Region 6 (Mountain-Prairie) of the Service, as well as each of the nine State wildlife agencies involved, in drafting the plan. The GPWE HCP covers a 200-mi-wide (320-km-wide) corridor across nine States: North Dakota, South Dakota, Montana, Colorado, Nebraska, Kansas, New Mexico, Oklahoma, and Texas. The goal of the GPWE HCP is to comprehensively address potential wind energy development impacts on listed or sensitive species, contributing to more effective conservation efforts and reducing the burden of permit processing on the Service and wind energy developers.

The GPWE HCP is currently analyzing the potential impacts resulting from the development and operation of wind energy facilities on four species: the endangered whooping crane (*Grus americana*), the endangered interior least tern (*Sterna antillarum athalassos*), the endangered piping plover (*Charadrius melodus*), and the lesser prairie-chicken (*Tympanuchus pallidicinctus*), a candidate species. The final list of covered species may include all four of these species, a subset of them, or additional species, based on the outcome of the impact assessment and planning process. Three of these species, the whooping crane, the interior least tern, and the piping plover, occur within the UGP Region and are considered in the PEIS. When completed, the GPWE HCP may provide additional information pertaining to potential impacts to populations of these species from development of wind energy projects and may also identify appropriate BMPs and mitigation measures, in addition to those identified in this PEIS. Additional information pertaining to the GPWE HCP is available at http://www.greatplainswindhcp.org/index.cfm.

Compliance with the Bald and Golden Eagle Protection Act. Wind energy projects within some areas of the UGP Region have a potential to adversely affect bald and golden eagles. On July 9, 2007, the final rule (72 FR 37346) removing the bald eagle in the lower 48 States from the list of endangered and threatened wildlife was published; it became effective on August 8, 2007. Bald and golden eagles continue to be protected by the BGEPA (16 USC 668–668c), and the MBTA (16 USC 703 *et seq.*). Both acts prohibit killing, selling or otherwise harming eagles, their nests, or their eggs. On June 5, 2007, the Service announced a final definition of "disturb," (72 FR 31132), a notice of availability for the final National Bald Eagle Management Guidelines (72 FR 31156), and a proposed regulation that would establish a permit process to allow a limited amount of "take" consistent with the preservation of bald and golden eagles (72 FR 31141). A final rule was published on May 20, 2008 (73 FR 29075) providing a process for permits for disturbance and take. The Service's existing authority to authorize "take" in 50 CFR 22 (e.g., scientific, educational, or religious purposes) is included in this final rule. In September 2009, the Service published a final rule establishing new permit regulations under the BGEPA for nonpurposeful take of eagles (74 FR 46836). These regulations are related to permits to take eagles where the take is associated with, but not the purpose of, otherwise lawful activities. The regulations provide for both standard permits and programmatic permits.

Documented occurrence of eagles can be acquired from the local U.S. Fish and Wildlife Ecological Services office, State wildlife agencies, or State natural heritage databases. In accordance with the Service's *Land-Based Wind Energy Guidelines* (Service 2012), surveys during early project development should identify all important eagle use areas (nesting, foraging, and winter roost areas) within the project's footprint. If eagle use areas occur within a 10-mi (16-km) radius of a project footprint, the project developer would need to develop an Eagle Conservation Plan (ECP) in order to be able to tier off of this Programmatic EIS.

The *Draft Eagle Conservation Plan Guidance* (Service 2011) provides recommendations for the development of ECPs to support issuance of eagle programmatic take permits for wind facilities. Programmatic take permits would authorize limited, incidental mortality and disturbance of eagles at wind facilities, provided effective offsetting conservation measures that meet regulatory requirements are carried out. To comply with the permit regulations, conservation measures must avoid and minimize take of eagles to the maximum degree and, for programmatic permits necessary to authorize ongoing take of eagles, advanced conservation practices (ACPs) must be implemented such that any remaining take is unavoidable. Further, for eagle management populations that cannot sustain additional mortality, any remaining take must be offset through compensatory mitigation such that the net effect on the eagle population is, at a minimum, no change. The *Draft Eagle Conservation Plan Guidance* interprets and clarifies the permit requirements in the regulations in 50 CFR 22.26 and 22.27.

It is recommended that ECPs be developed in five stages. Each stage builds on the prior stage, such that together the process is a progressive, increasingly intensive look at likely effects of the development and operation of a particular site and configuration on eagles. The *Draft Eagle Conservation Plan Guidance* recommends that project developers employ fairly specific procedures in their site assessments so the data can be combined with that from other facilities in a formal adaptive management process. This adaptive management process is designed to reduce uncertainty about the effects of wind facilities on eagles. Project developers are not required to use the recommended procedures; however, if different approaches are used, the developer should coordinate with the Service in advance to ensure that proposed approaches would provide comparable data.

The *Draft Eagle Conservation Plan Guidance* recommends that at the end of each of the first four stages, project developers determine which of the following categories the project, as planned, falls into: (1) high risk to eagles, little opportunity to minimize effects; (2) high to moderate risk to eagles, but with an opportunity to minimize effects; (3) minimal risk to eagles; or (4) uncertain. Projects in category 1 should be moved, significantly redesigned, or abandoned because the project would likely not meet the regulatory requirements for permit issuance. Projects in categories 2, 3, and possibly 4 would be candidates for ECPs. It is recommended that project developers use a standardized approach to categorize the likelihood that a site or operational alternative will meet standards in 50 CFR 22.26 for issuance of a programmatic eagle take permit. Biologists from the Service are available to work with project developers in the development of their ECP.

During project-specific NEPA evaluations, project developers would apply to the Service for a programmatic take permit for bald or golden eagles under 50 CFR 22.26. If granted, a programmatic permit would authorize limited, incidental mortality and disturbance of eagles at wind facilities, provided effective offsetting conservation measures are implemented that meet regulatory requirements. Regardless of when and whether a permit is authorized, the project developer should demonstrate due diligence in avoiding and minimizing take of eagles. Due diligence would be documented through the completion of an ECP and implementing ACPs. This may also entail require development of an Avian and Bat Protection Plan.

Visual Resources. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on visual resources. Refer to section 5.7.1.3 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- The public shall be involved and informed about the visual site design elements of the proposed wind energy facilities. Possible approaches include conducting public forums for disseminating information and using computer simulation and visualization techniques in public presentations.

- Turbine arrays and turbine design shall be integrated with the surrounding landscape. Design elements to be addressed include visual uniformity, use of tubular towers, proportion and color of turbines, nonreflective paints, and prohibition of commercial messages on turbines.

- Other site design elements shall be integrated with the surrounding landscape to the extent practicable. Elements to address include micrositing to take advantage of local topography, minimizing the profile of the ancillary structures, burial of power collection systems, prohibition of commercial symbols, and lighting. Regarding lighting, efforts shall be made to minimize the need for and amount of lighting on ancillary structures.

Soil Resources. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on soil resources. Refer to section 5.2.3.1 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- As feasible, construction and maintenance activities shall be conducted when the ground is frozen or when soils are dry and native vegetation is dormant.

- Disturbed areas that are not actively under construction shall be stabilized using methods such as erosion matting or soil aggregation, as the site conditions warrants.

- Excavation areas (and soil piles) shall be isolated from surface water bodies using silt fencing, bales, or other accepted and appropriate methods to prevent sediment transport by surface runoff.

- Topsoil shall be salvaged from all excavation and construction activities to reapply to disturbed areas once construction is completed.

Water Resources. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on water resources. Refer to section 5.3.2 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- Turbines or transmission support structures shall not be placed in waterways or wetlands.

- New roads shall be sited to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.

- Standard erosion control BMPs shall be applied to all construction activities and disturbed areas (e.g., sediment traps, water barriers, erosion control matting), as applicable, to minimize erosion and protect water quality.

- Drainage ditches shall be constructed only where necessary and shall use appropriate structures at culvert outlets to prevent erosion.

- Alteration of existing drainage patterns shall be avoided, especially in sensitive areas such as erodible soils or steep slopes.

Air Quality. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on air quality. Refer to section 5.4.2 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- All pieces of heavy equipment used during construction shall meet emission standards specified in the appropriate State regulations, and routine preventive maintenance shall be conducted, including tune-ups to manufacturer specifications to ensure efficient combustion and minimum emissions.

- Stockpiles of soils shall be sprayed with water, covered with tarpaulins, and/or treated with appropriate dust suppressants, especially when high-wind or storm conditions are likely. Vegetative plantings may also be used to limit dust generation for stockpiles that will be inactive for relatively long periods.

Ground Transportation.

- A transportation plan shall be developed, particularly for the transport of turbine components, main assembly cranes, and other large pieces of equipment. The plan shall consider specific object sizes, weights, origin, destination, and unique handling requirements and shall evaluate alternative transportation approaches. In addition, the process to be used to comply with unique State requirements, U.S. Department of Transportation (DOT) requirements and to obtain all necessary permits shall be clearly identified.

- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.

Noise. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on noise. Refer to section 5.5.2 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- Developers of a wind energy development project shall take measurements to assess existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.

- A process shall be established for documenting, investigating, evaluating, and resolving project-related noise complaints.

- All equipment shall be maintained in good working order in accordance with manufacturer specifications. Suitable mufflers and/or air-inlet silencers should be installed on all internal combustion engines and certain compressor components.

Noxious Weeds and Pesticides. This subsection provides a summary of BMPs and mitigation measures for controlling noxious weeds and for use of pesticides. Refer to sections 5.6.2 and 5.12.1.4 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation issues, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.

- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be conducted in an appropriate manner and would entail only the use of pesticides registered with the U.S. Environmental Protection Agency (EPA). Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied by a properly licensed applicator in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

Paleontological, Cultural, and Historic Resources. This subsection provides a summary of BMPs and mitigation measures for addressing potential impacts on paleontological, cultural, and historic resources. Refer to sections 5.8.1.6 and 5.9.1.6 for a more extensive listing of BMPs and mitigation measures that may be appropriate and applicable for specific projects.

- As appropriate, the Service and Western shall consult with Native American tribal governments early in the planning process to identify issues regarding the proposed wind energy development, including issues related to the presence of cultural properties, access rights, disruption to traditional cultural practices, and impacts on visual resources important to the tribe(s).

- If cultural resources are known to be present at the site, or if areas with a high potential to contain cultural material have been identified, consultation with the SHPO shall be undertaken by the appropriate Federal agency (e.g., Western, the Service, USFS, BLM). In instances where Federal oversight is not appropriate, developers can interact directly with the SHPO.

- Cultural resource surveys shall be conducted in any area where ground-disturbing activities are planned, unless the area has been previously surveyed within the past 10 years.

- Cultural resources discovered during construction shall immediately be brought to the attention of the lead Federal agency or agencies. Work shall be halted in the vicinity of the find to avoid further disturbance of the resources while they are being evaluated and appropriate mitigation plans are being developed.

- Developers shall determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area; a records search of Federal, State, and local inventories for past paleontological finds in the area; review of past paleontological surveys; and/or a paleontological survey. A paleontological resources management plan shall be developed for areas where there is a high potential for paleontological material to be present.

2.3.3 Alternative 2: Programmatic Regional Wind Energy Development Evaluation Process for Western and No Wind Energy Development on Service Easements

Under Alternative 2, Western would analyze typical impacts of wind energy development and would request implementation of the applicable and appropriate standardized BMPs and mitigation measures for interconnection requests as identified for Alternative 1. Project-specific NEPA evaluations (including analysis of cumulative impacts) would be required by Western for interconnection requests, but those NEPA evaluations would tier off of the analyses in this PEIS as long as the project developer is willing to implement the appropriate BMPs and mitigation. If a developer does not wish to implement the evaluation process, BMPs, or mitigation measures identified for this alternative, a separate NEPA evaluation of the interconnection request that does not tier off the analyses in the PEIS would be required.

Under Alternative 2, the Service would not allow easement exchanges for wind energy development. Consequently, no wind energy development could occur on the particular tract(s) of land that are covered by Service-administered easements.

2.3.4 Alternative 3: Regional Wind Energy Development Evaluation Process for Western and the Service with No Programmatic BMPs or Mitigation Measures

Under Alternative 3, as with the other alternatives considered in this PEIS, projects would be required to meet established Federal, State, and local regulatory requirements. However, no additional BMPs or mitigation measures would be requested of project developers by Western or the Service for wind energy projects. Project-specific NEPA evaluations would be required. If an easement exchange would be necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers, without requiring additional modifications to reduce the environmental impacts.

2.3.5 Alternatives Considered but Eliminated from Detailed Analysis

Western and the Service considered whether additional alternatives beyond those being fully analyzed in this PEIS as described in section 2.3 should be evaluated. This included consideration of the public comments received during the scoping period held in 2008 (see chapter 8 for a discussion of the public scoping activities) and discussions among agency managers and environmental scientists who were familiar with the potential effects of wind energy development and the needs of the agencies relative to wind energy evaluations.

An alternative under which Western would not consider additional interconnection requests from wind energy projects was eliminated from further consideration because allowing nondiscriminatory transmission access to facilities operated by Western is legally mandated under Western's Tariff and because such an alternative would not meet Western's stated purpose and need for the proposed action.

2.4 DESCRIPTION OF POTENTIAL DEVELOPMENT SCENARIOS

In order to evaluate potential impacts associated with the alternatives for this PEIS, two standardized wind energy development scenarios were developed for the UGP Region and considered for the analyses of impacts presented in chapters 5, 6, and 7. The development time frame analyzed is from the present to 2030 to be consistent with modeling conducted by DOE to explore how 20 percent of the Nation's electricity could be generated from wind energy by 2030 (DOE 2008). Two estimates for wind energy development within the region were used to bound analyses of potential natural resource impacts:

1. Projected wind energy development based on extrapolation of the levels of development within the UGP Region States from 2000 through 2010; and

2. Projected wind energy development based on modeling conducted by the National Renewable Energy Laboratory (NREL) to identify how 20 percent of the Nation's electrical generation could be produced by wind energy by the year 2030 (DOE 2008).

The analytical scenarios identify the potential levels of future wind energy development activities that may occur within the UGP Region through the year 2030 and are not specific to particular alternatives. A variety of factors (e.g., economic, social, and political constraints) beyond the control or influence of Western or the Service are likely to limit wind energy development within the UGP Region to some level below that projected in the upper bound of the analytical scenarios. However, the analytical scenarios are evaluated in this PEIS as the range of potential levels of additional wind energy development that could occur within the UGP Region by 2030 in order to describe potential environmental impacts in the PEIS. A detailed description of the methodology used to develop the analytical scenarios is provided in appendix B; projected levels of overall and new generation capacity under the two projection scenarios are presented in table 2.4-1. Estimates of the number of turbines and the amount of

TABLE 2.4-1 Current and Projected Wind Energy Generation Capacity (MW) for the UGP Region States under Different Development Scenarios[a]

		Overall Capacity by 2030		New Capacity by 2030	
State	2010[b]	Projected Trend[c]	20 Percent Wind Energy[d]	Projected Trend[c]	20 Percent Wind Energy[d]
Iowa	3,675	9,597	19,910	5,922	16,235
Minnesota	2,192	5,475	9,940	3,283	7,748
Montana	386	1,115	5,260	729	4,874
Nebraska	213	514	7,880	301	7,667
North Dakota	1,424	3,451	2,260	2,027	836
South Dakota	709	1,274	8,060	565	7,351
UGP Region Total	8,599	21,427	53,310	12,828	44,711

[a] See appendix B for description of methodology used to develop projections.

[b] Installed generation capacity as of the end of 2010. Source: DOE (2011).

[c] Projected wind energy generation capacity based on trend in wind energy development for UGP Region States from 2000 through 2010.

[d] Projected wind energy generation capacity based on estimates for levels of development needed to achieve generation of 20 percent of electricity from wind energy by 2030. Sources: DOE (2008); Kiesecker et al. (2011).

land that would be affected by construction and operation of wind energy facilities within the UGP Region were developed using the projected levels of generation capacity and the assumptions and methods presented in appendix B.

Predicting exactly where future wind energy development is likely to occur within the UGP Region is difficult. While not all of the lands within the UGP Region are suitable for development of wind energy projects because of factors such as lack of suitable wind regimes, unsuitable land cover types, steep slopes, open water and wetland areas, urban development, and Federal and State land use restrictions, most of the area is predicted to have a suitable wind resource for energy development. NREL has modeled and mapped the wind resources in each of the UGP Region States and has determined that wind resources in Wind Power Class 3 and higher could be economically developable by 2030 (i.e., during the time frame under consideration). Therefore, for the purposes of evaluating the impact of the likely wind energy development, the focus is on those areas where the wind resource potential is Wind Power Class 3 or greater (figure 2.4-1).

In addition to the wind resource alone, a number of assumptions regarding other factors that affect the appropriateness of particular locations for wind energy development were used to identify which areas within the UGP Region would be most suitable for wind energy development. A similar analysis was conducted by the Western Governors' Association to evaluate the suitability of lands in the Western United States for development of renewable energy facilities (Western Governors' Association and U.S. Department of Energy 2009) and information and assumptions regarding suitability criteria for utility-scale wind energy development for that analysis were incorporated into the analysis for the UGP Region. In general, the suitability analysis incorporated information about land cover, slope, wind power

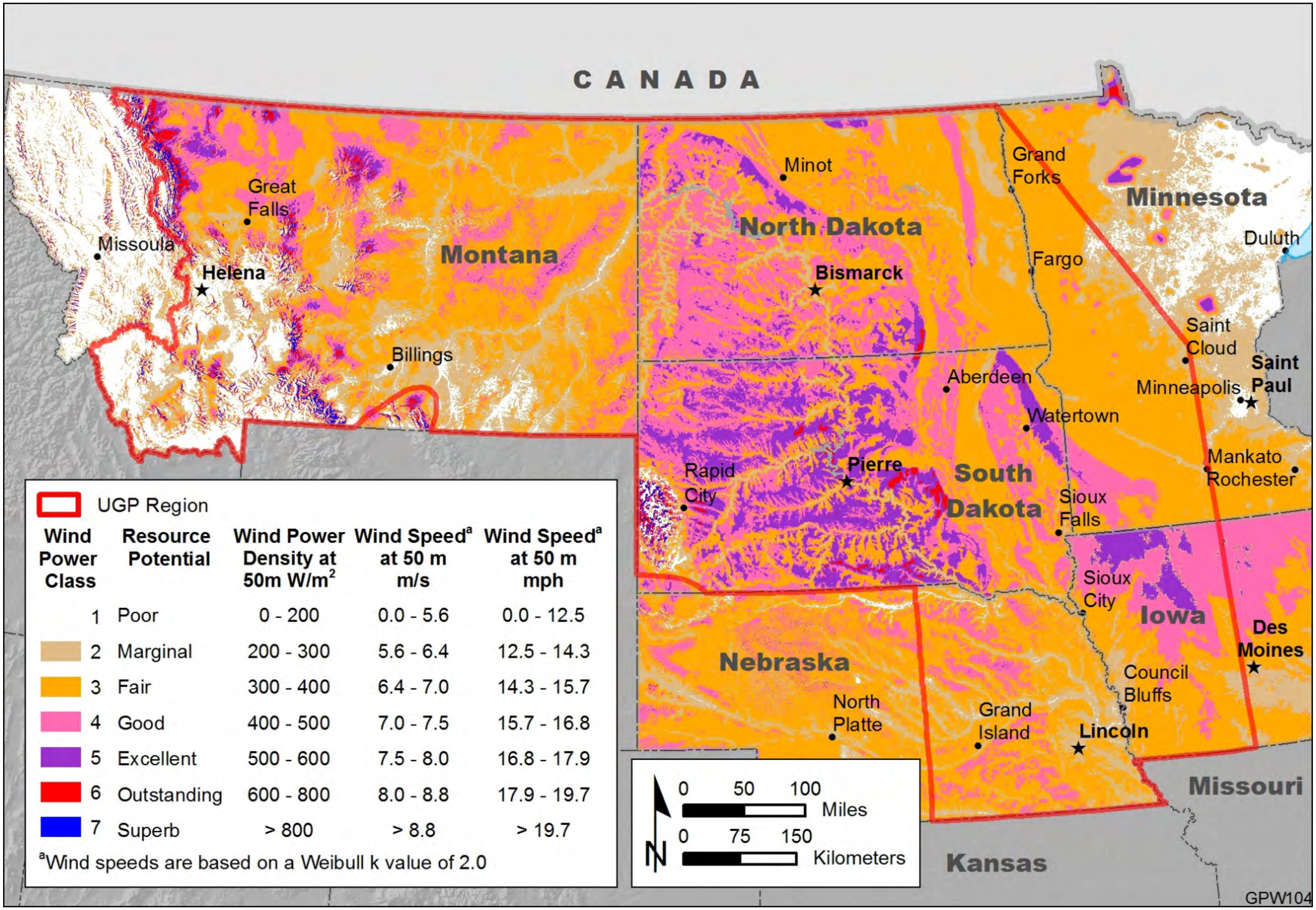

FIGURE 2.4-1 Distribution of Wind Energy Resources in the UGP Region (Source: NREL)

class, protected lands, and proximity to existing energy infrastructure to develop an overall index of wind development suitability for locations within the UGP Region; these index values were categorized as low, medium, and high suitability. The methods for calculating suitability index values are described in appendix E and the results of the analysis are presented in figure 2.4-2.

Due to the cost of acquiring rights-of-way (ROWs) and building transmission lines, the cost of a wind energy project would increase significantly with increasing distance from existing transmission services to which it could connect. Therefore, to further delineate the areas within the UGP Region where wind energy projects are likely to request interconnection to Western's transmission facilities, areas within 25 mi (40 km) of existing transmission infrastructure, particularly substations, operated by Western were identified (figure 2.4-3). In addition, the resources that could be present in areas managed as wetland and grassland easements by the Service (figure 2.4-3) are considered as part of the programmatic alternatives evaluated in the PEIS. Overall, the areas within 25 mi (40 km) of Western's transmission substations encompass more than 92 million ac (151,561 mi^2) (37 million ha [392,541 km^2]) within the UGP Region (table 2.4-2).

Based on the projections for wind energy development for the UGP Region between now and 2030, it is estimated that the land area associated with development of new projects (1.1 to 3.8 million ac [0.4 to 1.5 million ha] for 115 to 400 projects) would encompass about 2.1 to 7.2 percent of the lands identified as having high suitability for wind energy development within the UGP Region (table 2.4-2 and appendix B). Information about generation capacity and number of turbines for 25 wind energy projects built within the UGP Region between 2000 and 2010 is shown in table 2.4-3. With a total capacity of 3,027 MW, these 25 projects represent about 35 percent of the total wind energy generation capacity for all of the UGP Region States as of 2010 (table 2.4-1). It is unknown what proportion of new development within the UGP Region would request interconnection to Western's transmission facilities or would request placement of facilities on easements managed by the Service. Four projects, representing about 15 percent of the generation capacity of the 25 projects identified in table 2.4-3, are interconnected to Western's transmission facilities. To date, portions of four wind energy projects and a total of 33 turbines have been placed on Service easements within the UGP Region. Since it is anticipated that areas with high wind energy potential would be preferred over areas with lower wind development potential and that areas closer to existing transmission capacity would be preferable to areas farther from existing transmission capacity, the areas within 25 mi (40 km) of Western's transmission substations are shown together with wind development potential categories in figure 2.4-4; the acreages of lands in different wind development potential categories are presented in table 2.4-2.

The impact analyses (chapters 5, 6, and 7) address issues related to the different phases of wind energy development at a programmatic level. All phases of wind energy development are included in the analyses: site characterization, construction, operation and maintenance, and decommissioning. Typical activities that occur during each of these phases are described in chapter 3, along with discussions of regulatory requirements; health and safety issues; hazardous materials and waste management considerations; transportation requirements; and relevant, existing mitigation guidance for wind energy projects. Many site-specific issues pertaining to these phases of development cannot be determined at the PEIS level and would be addressed in project-specific NEPA documents as appropriate.

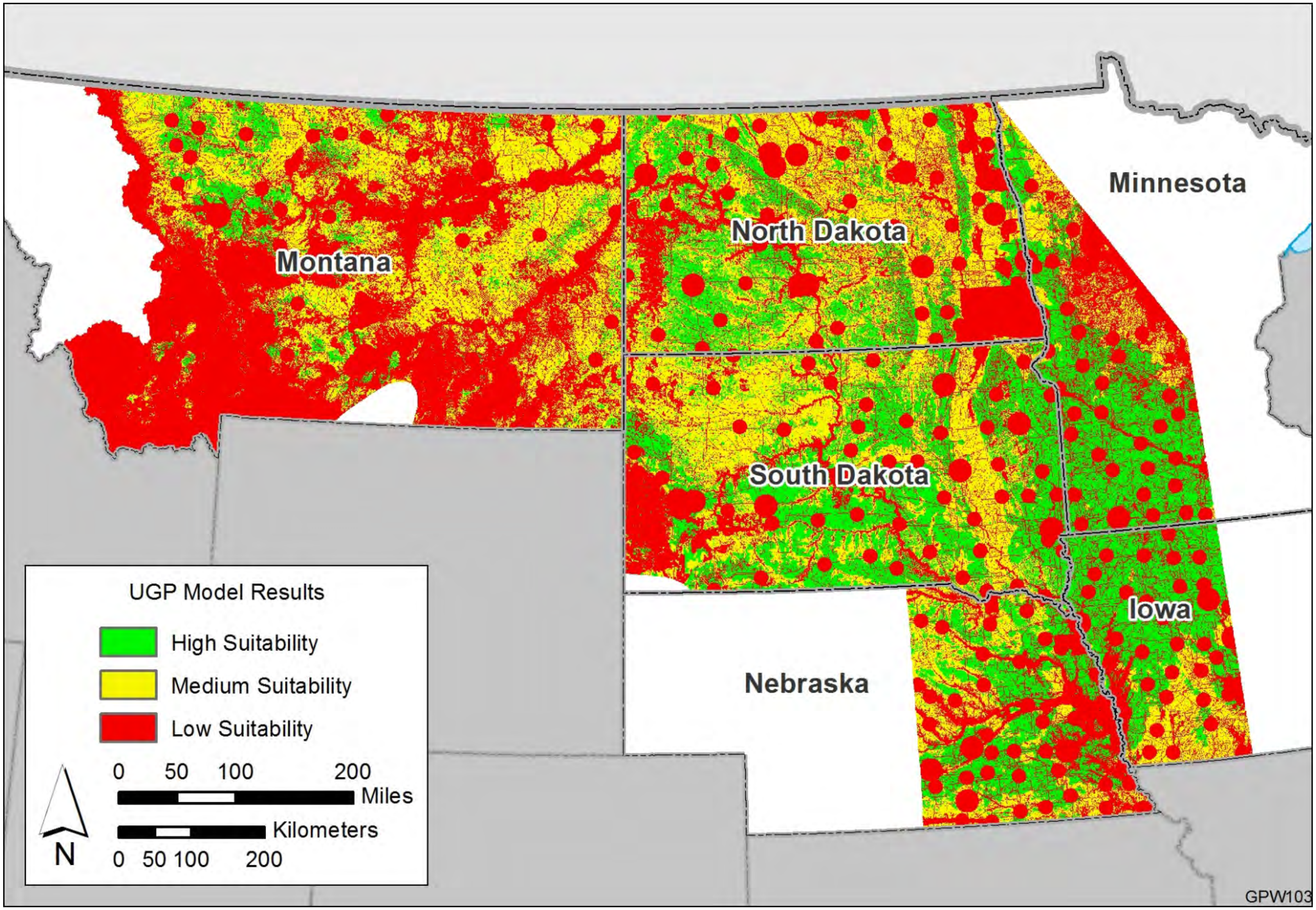

FIGURE 2.4-2 Wind Energy Development Suitability for Lands within the UGP Region (See appendix E for description of methodology.)

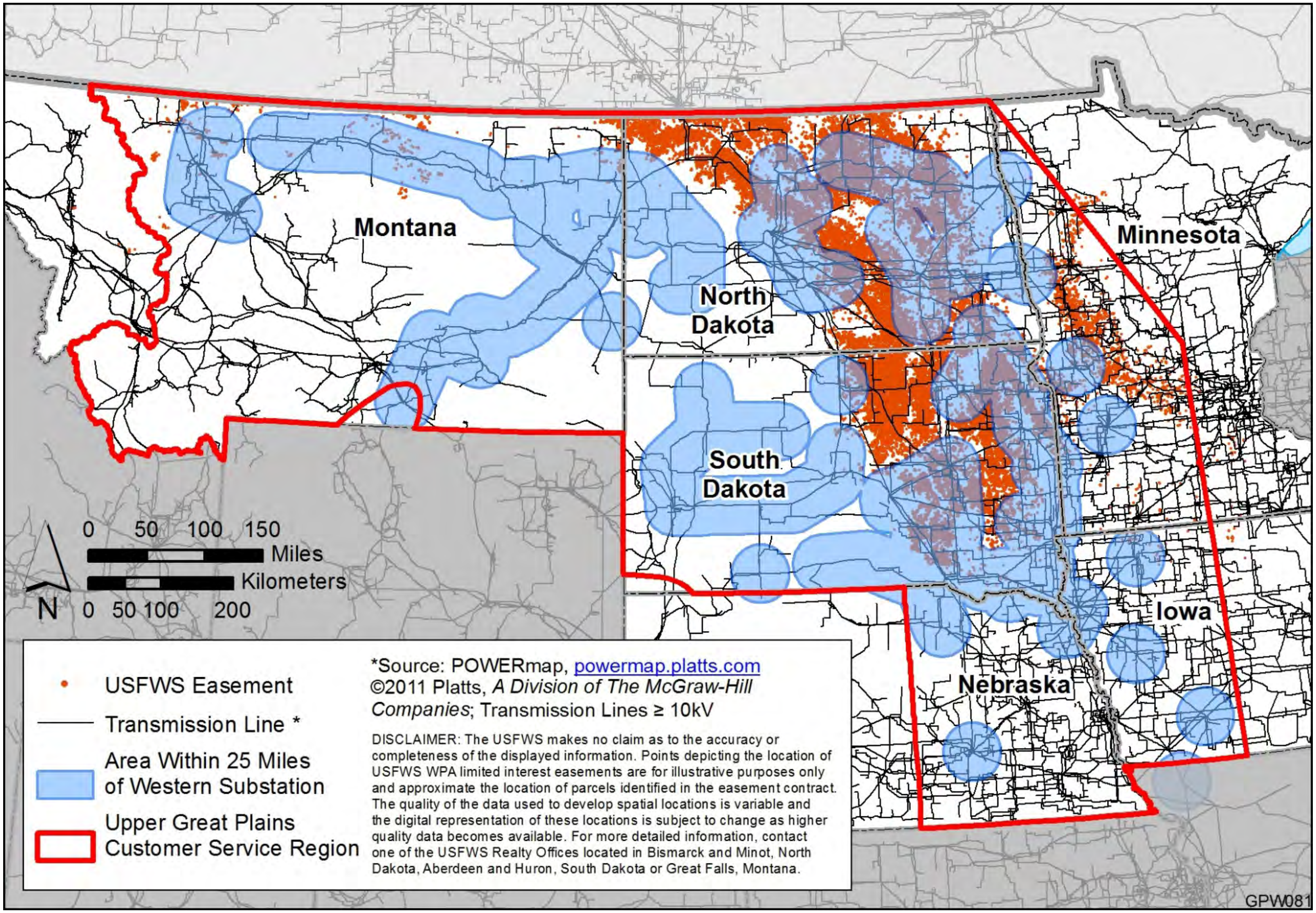

FIGURE 2.4-3 Areas within 25 mi (40 km) of Western's Transmission Substations within the UGP Region, Together with General Locations of Service Easements

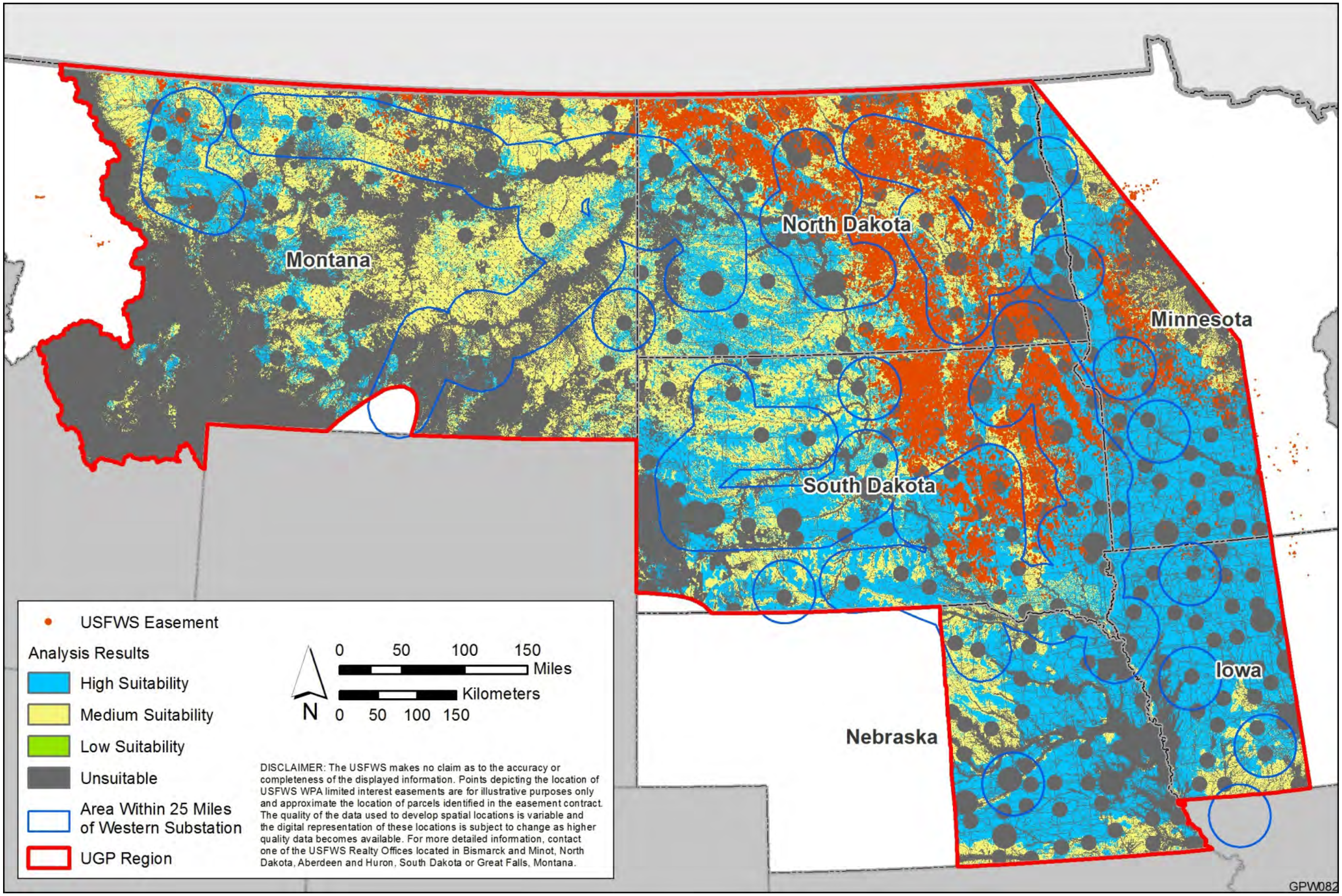

FIGURE 2.4-4 Wind Energy Development Suitability for Lands within the UGP Region, Together with Areas within 25 mi (40 km) of Western's Transmission Substations and General Locations of Service Easements

1 **TABLE 2.4-2 Estimated Acreages of Lands within Wind Development Suitability Categories for the UGP Region[a]**

Potential for Wind Energy Development	UGP Region	Within 25 mi (40 km) of Western Transmission	Portions of States Within Region: Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota
Low[b]	110,868,000	39,847,845	6,796,498	9,973,053	47,537,348	10,380,614	18,756,672	17,394,058
Medium	65,093,977	27,476,285	2,486,997	2,488,954	23,952,728	4,770,103	16,032,379	15,338,596
High	52,621,694	25,101,575	6,546,237	8,429,032	5,288,550	5,765,765	10,457,785	16,126,897
Total	228,583,671	92,425,705	15,829,733	20,891,040	76,778,625	20,916,482	45,246,836	48,859,552

a Units are measured in acres.

b Includes lands classified as unsuitable for wind energy development.

TABLE 2.4-3 Installed Capacity and Number of Turbines for Selected Wind Energy Projects within the UGP Region from 2000 to 2010

State	Project Name	Capacity (MW)	Number of Turbines
IA	Endeavor	100	40
IA	Endeavor II	50	20
IA	Intrepid	160	107
IA	Pomeroy Wind Phase I	123	87
MN	Chanarambie	85	57
MN	Elm Creek Wind Farm	99	66[a]
MN	Elm Creek II	150	62
MN	Trimont Area Wind Farm	100	67
MN	Fenton Wind Farm	205	137
MN	Jeffers Wind Farm	50	20
MN	Moraine Wind	51	34
MN	Moraine Wind II	48	23
MN	Stoneray Wind Power	105	70
NE	Elkhorn Ridge Wind Energy	80	27
SD	Buffalo Ridge	306	204
SD	Wessington Springs[b]	51	34
SD	South Dakota Wind[b]	100	66
SD	MinnDakota Wind II	54	36
ND	Ashtabula Wind Phase II	200	133
ND	Wilton Wind[b]	200	133
ND	Tatanka Wind	180	120
ND	North Dakota Wind[b]	116	77
ND	Langdon Wind	159	106
MT	Glacier McCormick Ranch Phase I	120	60
MT	Judith Gap	135	90
Total within UGP Region		3,027	1,876

[a] Value not reported, but the number of turbines was calculated based on capacity, using an assumption of 1.5 MW per turbine.

[b] Interconnected to Western's transmission system.

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3 OVERVIEW OF A TYPICAL WIND FARM LIFE CYCLE

The following sections describe the activities likely to occur during each of the major phases of a typical wind energy project's life cycle—site testing and monitoring, construction, operation, maintenance, and decommissioning. However, the schedules, time periods, and other engineering dimensions contained in the sections below are no more than estimates, and site-specific plans of development would need to be submitted by the project developer and approved by the appropriate authorities before any of the described actions take place. Nevertheless, the information presented below provides a sufficiently reliable basis for the development of the environmental impact analyses contained in chapter 5. Techniques for wind farm construction are constantly evolving. The information presented here may not, therefore, capture all of the approaches that may be used, but it nevertheless represents experience to date.

3.1 INTRODUCTION

3.1.1 Wind Industry Profile

In recent years, generation of electricity through the use of renewable energy technologies in general and wind energy technology in particular has enjoyed explosive growth. Reports on contributions of renewable energy facilities to the Nation's electricity portfolio by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (DOE/EERE) include the following salient facts:

- Although renewable energy (excluding hydropower) is still a relatively small portion of total energy supply in the United States, renewable energy installations nearly doubled between 2000 and 2007 (DOE 2008).

- Wind energy is the fastest growing renewable energy technology. U.S. wind capacity installations accounted for more than 25 percent of all new electric generation capacity installations in 2010 (DOE 2011).

- Wind energy installed capacity increased more than tenfold between 2000 and 2010 (DOE 2011).

- In 2007, wind accounted for 31 percent of the total 105 billion kWh of electricity generated from renewables (biomass, geothermal, solar, and wind).

- Wind energy generation increased from 5,593 million kWh in 2000 to 30,977 million kWh in 2007 (DOE 2008).

Power generating capacity and utility market share are not the only aspects of the wind energy industry that have experienced recent growth. Both the capacity and the size of wind turbines likely to be used in utility-scale facilities have also grown proportionately. DOE (2008, 2011) notes that average individual wind turbine capacity increased from 0.71 MW in 1999 to

1.79 MW in 2010. With increased capacity came an increase in the physical size of the turbine's rotor, from an average diameter of 60 ft (18 m) for a 0.10-MW turbine to 328 ft (100 m) for currently deployed 3.5-MW turbines. Approximately 99 percent of turbines installed in 2010 had hub heights no greater than 262 ft (80 m) (DOE 2011). Modern turbines are typically mounted on towers that are 200 to 260 ft (61 to 79 m) tall and have rotors 150 to 260 ft (46 to 79 m) in diameter; as a result, blade tips can reach up to approximately 400 ft (122 m) above the surface of the ground.

Despite the significant growth of some aspects of utility-scale wind energy power generating systems and the impressive technological advancements that fuel that growth, the basic principles behind the generation of electricity using modern-day wind turbines have not changed. Those interested in understanding the fundamentals of harnessing the potential of wind energy are invited to consult Appendix D of the BLM programmatic environmental impact statement for development of wind energy facilities on BLM lands, published in June 2005 and available at http://www.windeis.anl.gov (BLM 2005) and any of the excellent wind energy tutorials available through NREL at http://www.nrel.gov/learning/re_wind.html. Valuable learning materials, as well as the latest wind energy industry news are also available from the American Wind Energy Association (AWEA) Web site at http://awea.org.[1]

3.1.2 Wind Energy Industry Evolution

The wind energy industry continues to evolve in both technical sophistication and utility power market penetration, as technical innovations and operational refinements improve utility-scale wind farm operability and reliability. Research, development, and demonstration (RD&D) initiatives are ongoing in both the private and public sectors with respect to virtually all critical aspects of wind energy technology. The DOE/EERE spearheads RD&D for the Federal government.[2] Key elements of enabling research include the following:

- *Advanced Rotor Designs:* This research program will enable blade designers to maximize wind energy capture efficiency of the rotor while minimizing production costs but preserving reliability. The research centers on development of lighter, stronger, adaptive materials for blade construction, as well as research aimed at developing optimal blade shape to minimize aerodynamic noise, while at the same time providing the data that would support an industry-wide noise standard for wind turbines. If successful, wind farms will be able to effectively harvest wind energy from lower wind energy regimes than is now the case.

- *Site-Specific Designs:* This research program is intended to provide alternative turbine and rotor designs matched more precisely to the dynamic wind loadings extant at a particular site. Such site-specific designs that fine

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[1] Although both Western and the Service readily acknowledge the wealth of information available through AWEA, they do so without specific endorsement of AWEA positions on matters critical to wind energy development.

[2] Those interested in more detailed information regarding RD&D in the wind energy sector are invited to review materials available on the DOE/EERE's Wind and Hydropower Technologies Program Web site at http://www1.eere.energy.gov/windandhydro or to consult the DOE publication *Wind Energy Multi-Year Program Plan for 2007–2012*, available through that Web site.

tune turbine components to a site's unique wind regime will maximize operability and reliability of the turbines while controlling production costs and extending blade life.

- *Wind Inflow Characterizations:* This research program is designed to establish a more detailed understanding of a site's wind regime, especially its diurnal cycles. Such an enhanced understanding will allow for designs and architectures that are better resistant to catastrophic damage from wind turbulence.

- *Generator, Drivetrain, and Power Management Research:* Improving the performance of the turbine's drivetrain and electric generator and the wind farm's power conditioning equipment is essential to overcoming the potentially destabilizing characteristics of electric power generated from intermittent wind resources. Advancements will also control costs, minimize turbine downtime, maximize performance, and provide additional protections for the integrity and stability of the nation's electric transmission grid.

- *Systems and Controls Program:* Sophisticated technologies must be supported by equally sophisticated controls for their benefits to be fully realized. Research into blade controls will allow optimization of blade performance while continuously adjusting blade characteristics such as pitch and overspeed control in real time to avoid damaging structural loadings. Such controls will reduce or eliminate blade fatigue that can lead to wholesale blade failures or reduced blade lifetimes. Research into improving the real-time interface between turbine operation and meteorological monitoring will allow wind farm operators to anticipate dramatic changes in a site's wind regime, allowing for more seamless production of power throughout periods of changing wind conditions and for advanced notice to grid operators of expected significant changes in wind farm performance to allow for timely load shifting.

Many wind turbine manufacturers are engaged in technology development efforts similar to the ones specified above. In addition to technology-directed RD&D, EERE and the National Wind Coordinating Committee (NWCC) are also involved in programs that foster acceptance of wind technology and facilitate utility market penetration. Efforts in these areas are designed to overcome barriers that may slow or preempt adoption of wind power through the delivery of reliable information to State and local decision makers and the public. Program elements include outreach activities to public power organizations, such as the National Rural Electric Cooperative, and Native Americans.[3]

[3] In addition to technology research and development directly related to turbine performance, significant efforts are being made to enhance the value of wind-generated power by overcoming its intrinsic interruptible nature and effectively making it a fully fungible power source. Coupling wind turbines with energy storage technologies such as compressed air storage; the use of real-time highly-accurate wind forecasting; the coordinated, centralized operation of numerous wind farms over broad geographic areas in a "virtual power plant" configuration; and incorporation of smart grid technologies all are allowing transmission system operators to increase their reliance on interruptible energy sources such as wind and solar to meet the variable power demands in their service territories. Wind farms are capable of participating in such programs and system enhancements with only incremental changes in their overall physical design.

In his summary of BTM's *World Market Update 2008: Forecast 2009–2013* report, Millford (2009) notes the following trends for the utility-scale wind industry:

- Wind turbines installed in 2008 numbered 19,873 worldwide, a 37 percent increase over the previous year and a nearly 300 percent increase over the number of turbines installed in 2003.

- The average capacity of wind turbines installed in the United States in 2008 is 1.67 MW.

- The size of turbine most frequently installed in the United States in recent years is the 1.5-MW turbine manufactured by GE Energy.[4]

- GE Energy and Vestas are the leading turbine manufacturers for U.S. installations, with the number of GE Energy's turbine installations increasing by nearly 60 percent from 2007 to 2008 and Vestas' increasing by 24 percent.

3.2 SITE MONITORING AND TESTING ACTIVITIES

Site monitoring and testing involve collecting 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, what the appropriate number, type (especially, the ideal rotor hub height), and location of wind turbines should be.

Collecting meteorological data requires erecting 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 proposed project area and the complexity of the terrain, with flat terrain requiring the minimum number of data collection points. 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 telescoping features that allow the tower to be erected to full height without the need for a separate crane. However, composite materials are also being used.[5] Most incorporate anti-perch devices on horizontal surfaces to discourage their use as raptor perches. Heavy-duty all-wheel-drive pickup trucks or medium-duty trucks are usually sufficient to transport the towers to the site; many temporary towers are permanently mounted to their own trailers. It is estimated that it takes less than 1 day to erect each tower. Towers and

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4 Technical details on the GE Energy 1.5-MW wind turbine can be found at http://www.gepower.com/prod_serv/products/wind_turbines/en/15mw/index.htm.

5 Although the classical design for meteorological towers has been the open lattice-type, some manufacturers are now offering smooth-skinned towers (IsoTruss Grid Structures 2009; see also Compositesworld 2003).

instruments are relatively lightweight, and only in some instances would belowground foundations or transformers, bushings, or switches be needed. Some smaller towers are designed to be erected directly from their transport trailer, 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 Federal Aviation Administration (FAA) signal lighting requirements, depending on their proximity to airports. Taller towers or towers that are expected to remain in operation throughout the operating life of the facility may also require subsurface foundations, depending on subsurface conditions. Signal cables used during the site monitoring and testing phase are not likely to be buried. However, signal cables to towers operating throughout the operating phase would likely be buried. When wind forecasting is employed to control turbine operations, additional meteorological towers in locations outside the wind farm footprint may also be required. Such towers would remain operational throughout the wind farm's lifetime.

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 capture trends in annual weather variations. Collected data are generally sent electronically to a remote location, so during site monitoring and testing, there would usually not be humans present, except for occasional visits for instrument inspections and maintenance. Temporary towers are removed at the end of the site monitoring and testing phase.

Also during this phase of development, core samples may be taken in areas generally representative of turbine locations for the purpose of collecting the necessary data on subsurface conditions to support the design of turbine foundations. 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 (typically to be performed at an off-site location). Drilling rigs for such corings could be expected to be mounted on either trailers, light- to medium-duty trucks, or tracked vehicles, and would need no special provisions for access roads or significant site modifications. A sufficient number of samples could be collected within a week's time in most instances, often just off existing roads.

Very little site modification would be 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 or conduct geotechnical sampling, and typically no personnel support facilities are required, given the crew's relatively brief time on site.

3.3 SITE CONSTRUCTION ACTIVITIES

The following sections provide a brief overview of the major steps in constructing a typical wind farm. Those interested in a more detailed treatment of these topics are invited to consult Web sites maintained by the AWEA (http://awea.com) and the DOE's EERE (http://www1.eere.energy.gov/windandhydro). In addition, numerous photographs of wind farms are available through the National Renewable Energy Laboratory Web site (http://www.nrel.gov/data/pix/searchpix.html). An excellent photographic essay on the construction of the Langdon

Wind Energy Center in Langdon, North Dakota, is available on the Otter Tail Power Company's Web site (http://www.otpco.com/AboutCompany/WindLangdonPhotos.asp). Finally, additional information is available through the Web site established for this programmatic environmental impact statement (PEIS) (http://plainswindeis.anl.gov).

Construction activities are very site dependent. However, construction of a typical facility in the UGP Region can be expected to involve the following major actions: establishing site access; performing necessary site grading (necessary to establish a level and safe staging area for erection cranes); establishing borrow areas (on the wind farm site or on remote sites) from which road-building materials (sand, stone, gravel, etc.) would be obtained[6]; constructing laydown areas and an on-site road system; removing vegetation from construction and laydown areas (primarily for fire safety); excavating for turbine tower foundations; installing turbine tower foundations; erecting turbine 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 power conditioning facilities and substations; installing power-collecting cables and signal cables (typically buried); and performing shake-down tests. Additional activities may also be necessary at very remote locations or for very large wind energy projects; they may include borrow areas from which road-building materials (stone, sand, gravel, etc.) would be obtained, constructing temporary offices, sanitary facilities, or a concrete batch plant. Off-site maintenance facilities simultaneously supporting multiple wind farms within a geographic area may also be developed.

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 portion of the site occupied by each phase of facility development 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 turbine towers, and installing the nacelles and rotors.) The major aspects of site development are discussed in detail in the following subsections.

3.3.1 Site Access, Clearing, and Grade Alterations

Specifications for the main access road would be dictated by the expected weights, sizes, and turning radii of the vehicles transporting turbine components and the construction and lifting equipment that would be used during construction.[7] Because some of the turbine components are extremely long (e.g., blades) or heavy (e.g., nacelles containing all drivetrain

[6] Borrow areas located off the wind farm site and expanded or newly established to support the wind farm's development would need to be surveyed and considered as "additional disturbed areas."

[7] It is conceivable that very large sites extending over complex topography would require multiple access paths; however, it is expected that, in most instances, only one main path would be established for each wind farm over which the heavy and/or large construction equipment and turbine components would be brought to the site.

components except the guy wires), right-of-way (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 oversize or excessively long loads (PBS&J 2002). A ROW approximately twice the final width of the road would typically be required; however, to accommodate the turning radii of oversized loads, some additional ROW space may be secured along some portions of the access road, ensuring that all ground disturbances are confined to the designated ROW. Finally, maximum grade becomes a critical road design parameter, because of the anticipated weight of the turbine components and electrical transformers that would be brought to the site. While straight-line access roads would obviously minimize distance and cost, the combination of turning clearance requirements and a maximum tolerable grade of 10 percent can be expected to result in some access roads taking a more circuitous path. Other site-specific factors, such as drainage swales, immovable obstacles (e.g., bedrock outcroppings), and environmentally sensitive areas would also dictate the path. At a minimum, construction of the site access road would require removing vegetative cover, including trees in some instances.[8] 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 site access road is expected to have all-weather capabilities 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 to keep road slopes below a typical maximum of 10 percent. Engineered storm water control may be necessary, and natural drainage patterns are likely to be altered, at least on a local scale. Although wetlands would be avoided, roadways in the vicinity of wetlands may still need to be evaluated for their impacts on the adjacent wetlands (e.g., from altered surface drainage patterns).

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 project developer or the turbine manufacturer (or a transportation subcontractor) would be responsible for securing all necessary permits (Steinhower 2004). Depending on the location of the manufacturer's fabrication plant (including potentially plants in foreign countries), transportation may involve ship, barge, rail, and/or road transport. Transportation-related impacts could result not only from construction of new access roads, but also from necessary upgrades or modifications of existing public and private roads (e.g., fortifying bridges, temporarily removing tall obstructions or turning obstacles). In addition, because many of the loads would be heavy and/or oversize and require special transport permits, some disruption of local traffic patterns is also likely to occur throughout the construction period, and the developer may be liable for repair of road damage resulting from construction of the project.

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 involve crossing streams or creeks. Culverts are likely to be used in instances where the access road crosses small streams or natural drainages. However, if crossing a watercourse would require a more

[8] Trees upwind and in close proximity to proposed wind turbine sites may introduce turbulence that decreases turbine performance. Consequently, even trees not necessarily within the footprint of the access road may also need to be removed as part of construction.

substantial structure, such as a bridge, 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, fortifications of existing bridges on public or private roads would still be within the realm of possibility.

Collective experiences to date suggest that the turbine spacing required to avoid introducing turbulence and interferences results in a collective footprint of permanent structures (turbine towers, control buildings, transformer pads, electric substations, roads, and other ancillary structures) during the operating period that is likely to be no more than 5 to 10 percent of the total acreage of the site. However, land disturbance during the height of construction may constitute two to three times that percentage. Because individual turbines operate independently of other turbines, establishing a level grade throughout the site is not necessary. However, work areas around individual turbines must be made level to safely stage lifting equipment and turbine tower sections and components. Existing level locations are preferentially selected during turbine micro-siting to minimize grading, which is both an increased cost to the developer and more environmentally disruptive.

Component laydown areas and construction areas for the electrical substation and on-site buildings are also likely to preferentially be level, but some minor grading may be necessary for ease of access and material handling. Grades over the remainder of the site are likely to remain unchanged. Given the typical terrain present in the UGP Region, any necessary grade alterations are expected to be minimal in scale and severity, and the majority of the material laydown areas and staging areas for cranes could and would be reclaimed at the conclusion of the construction phase.[9]

The establishment of equipment laydown areas and crane staging areas could involve removing vegetation for purposes of safety, access, and visibility during lifting operations. Although surface soils may not need to be removed from the construction zones, rock and/or gravel may be laid down to give these areas all-weather accessibility and to support the weights of vehicles and lifting equipment. It is estimated that as much as 1 to 3 ac (0.4 to 1.2 ha) of land may need to be cleared for each turbine, and several laydown and crane staging areas can be anticipated over the period of site development. However, depending on the turbine array, the same laydown areas would likely support erection of more than one turbine. Regardless of whether regrading occurs, the soils in these laydown 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.

Impacts from vegetative clearing would include an increased potential for fugitive dust and erosion that would increase sediment loading of surface drainage waters; however, such impacts would be temporary in nature and are expected to be successfully mitigated through the careful scheduling of certain dust-producing activities, the judicious use of dust palliatives, and the development and execution of a Storm Water Pollution Prevention Plan (SWPPP) permit. At the height of construction, the establishment of temporary structures and facilities and material laydown areas could result in as much as 30 percent of the project area undergoing some temporary impacts. However, once construction is complete, the footprints of permanent

[9] Depending on the specific turbine design selected, replacements of major turbine components (rotor, blades, transmission, generator) during their operating life may require the use of a crane similar to the one used to erect the turbine. However, modern tower designs increasingly incorporate appropriate lifting devices for such eventualities.

structures (turbines, support buildings, electrical substations and on-site roads) may occupy as little as 1–3 percent of the site's total land area. As much as 5 percent of the site's area could be permanently impacted throughout the operating period if on-site energy storage features are introduced. The remainder of the site could be returned to its original purposes, including native grass cover and agricultural activities that would disturb the top few feet of the land surface.[10] Electrical substations would be kept free of vegetation throughout the operating period and are also likely to be covered in gravel to promote water drainage for the safety of individuals inspecting or working around energized devices. Since all-weather access is required, on-site roads are likely to be covered in rock or gravel.

3.3.2 Foundation Excavations and Installations

The tall turbine towers anticipated in future wind energy development projects would require substantial foundations. Foundation specifications are based on the requirements of individual turbines and on subsurface stratigraphy, including information obtained from previously completed geotechnical studies. Either "mat" or "pier" foundations could be employed, depending on subsurface conditions (see figures 3.3-1 and 3.3-2, respectively). In a mat foundation, a relatively shallow excavation (6 to 10 ft [1.8 to 3 m] below final grade) roughly the diameter of the tower would be dug and filled with steel-reinforced concrete that is keyed into a surrounding steel-reinforced concrete slab, or mat, that extends the entire footprint of the foundation to as much as five times the diameter of the tower. Although this type of foundation disrupts a larger area, it is relatively shallow and ideally suited to locations with bedrock, saturated zones, or other problematic features near the surface.[11]

FIGURE 3.3-1 Turbine Mat Foundation under Construction (Source: Photo courtesy of RES Americas. See http://www.res-americas.com for more details.)

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[10] Deep-rooted plants or activities involving excavations or borings may need to be controlled to avoid compromising buried cables.

[11] For an example of a mat turbine foundation, see the preliminary plan of development for the China Mountain Wind Power Project (RES 2008).

FIGURE 3.3-2 Installation of Turbine Pier Foundation (Source: Photo courtesy of RES Americas. See http://www.res-americas.com for more details.)

Installation of pier-type tower foundations would involve excavations of approximately the width of the tower base (nominally 15 to 20 ft [5 to 6 m]), to substantially greater depths than for the mat foundation (as deep as 40 ft [12 m] below grade). Topsoils and subsoils removed during foundation excavation would be stockpiled separately on site and either replaced in the excavation or otherwise distributed across the site. For pier foundations, surface disruption is minimized. Once construction is completed, surrounding land areas up to the tower base can be reclaimed for other uses, regardless of the foundation techniques used. The latest pier foundation construction methods involve installing a vertical steel-reinforced concrete ring of a nominal thickness of 1 ft (0.3 m) and an outside diameter equal to the width of the turbine tower base, rather than installing a monolithic concrete pillar with a thickness approximately equivalent to the entire diameter of the tower. Requirements for the pier foundation of a typical turbine[12] include 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 (PBS&J 2002). An average of 6,000 gal (22,712 L) of water would be used to produce this much concrete. Pier foundations incorporating the annular ring design can be expected to use less concrete than analogous mat foundations. 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 or removed from the site.[13] In certain areas, subsurface materials may have the potential of imparting

[12] For example, the NEG Micon Model 1500 turbine installed at the Table Mountain Wind Generating Facility in Nevada.

[13] Because excess soils removed during foundation excavations are expected to be free of contamination, many opportunities present themselves for beneficial uses of such soils such as fill on other construction projects in the general area.

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. Assuming no anthropogenic contamination is encountered, excavation waters would be managed under the terms of the previously mentioned SWPPP permit. Although routine excavation techniques are anticipated in most cases, subsurface conditions may occasionally require the use of drilling or blasting.

Depending on the remoteness of the wind farm and ambient weather conditions during foundation construction, it may be necessary to construct a temporary concrete batch plant on the site, especially if haul distances from existing or specially constructed off-site concrete plants are excessive.[14] On-site concrete batch plants would likely require that dry constituents (sand, aggregate) be hauled to the site from off-site borrow areas that either already exist or are established explicitly to support wind farm development. Likewise, cement would need to be delivered to the site. The required amount of water may be available in sufficient quantities on site or from a nearby source. Electrical power for the batch plant would likely be provided by a portable diesel engine/generator set (nominally, 125-kW capacity). The land area required for a typical batch plant and aggregate material storage areas can be expected to be on the order of 10 ac (4 ha) or less. As with the equipment laydown areas, surface vegetation would need to be removed, some regrading of surface soils might be required, and soils would be heavily compacted as a result of batch plant activities, including storage of raw materials and associated truck traffic.[15] Topsoils may be removed from the active portion of the batch plant, stockpiled elsewhere on site, and replaced once concrete production has been completed and the batch plant dismantled. The batch plant and any excess concrete constituents are expected to be removed at the end of the concrete-pouring phase. In the Table Mountain example (PBS&J 2002), 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. In addition, at the same time as tower foundations are poured, foundations would be poured for the control building and any other on-site material storage buildings, as well as pads for each electrical transformer. It is expected that all on-site buildings would be of modest proportion and require only slab-on-grade foundations, augmented by frost-resistant perimeter footings. At the end of the construction period, concrete batch plants would undergo decommissioning, which would involve, at a minimum, remediating contamination from spills and leaks and removing all equipment, temporary foundations and footings, supporting utilities (electric power cables, water lines, etc.), unused materials, and ancillary equipment such as fuel tanks.

No major maintenance is expected to be performed on site for those construction vehicles that are also road-worthy. However, maintenance and repair of construction and lifting equipment would likely occur on site because it would be impractical or prohibitively expensive to relocate the item to an off-site repair facility. 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.

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[14] The working time for concrete depends on a number of factors, including the 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. High ambient temperatures at the time of the pour may further shorten that working time.

[15] A concrete batch plant capable of producing 50 yd^3 (38 m^3) per hour would require 30 tons (27 t) of sand, 45 tons (41 t) of aggregate, 15 tons (14 t) of cement, and 3,000 gal (11,356 L) of water (RES 2008).

These tanks are expected to be staged at or near the laydown areas and replenished 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). On-site fuel storage areas would have secondary containment and would be inspected regularly, with contamination being remediated promptly. Fuel handling activities would be supported by a site-specific spill response plan. To minimize the impacts of spills at remote locations, the plan would require that adequate spill response capabilities be maintained on-site, including an adequate supply of spill response materials and selected construction workforce personnel trained in, and properly equipped for, spill response.

3.3.3 Tower Erection and Nacelle and Rotor Installation

Various designs have been advanced for turbine towers. However, in recent years, tapered tubular turbine towers constructed of steel have predominated, although some use a lowermost section that is constructed of preformed concrete. The towers are delivered to the site in sections, the lengths and weights of which dictate the site access road's specifications (typically, segments would be no longer than 66 ft [20 m] in length). The same lifting equipment would be used for tower erection and for nacelle and rotor installations. To compress the construction schedule, some developers would employ multiple cranes to simultaneously erect a number of turbines. Smaller cranes would be used to erect the lower sections of turbine towers, leaving the largest crane to complete tower erection and nacelle and rotor installation (see figures 3.3-4 and 3.3-5). Crane availability and cost, as well as logistical support in bringing components to the site, are the primary factors controlling such construction strategies. Like the towers, the large cranes would also be delivered to the site in sections and assembled on site.

Areas for assembly and staging of the erecting cranes, staging of tower sections and turbine components (nacelle, rotor hub, blades), and erecting the turbine would need to be established at each turbine location. Like material and equipment laydown areas, these assembly/erection areas would have their surface vegetation removed and would be regraded to relatively level surfaces. Soils in these areas could be heavily compacted. Depending on the soil types, 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. Assembly/erection areas may be as large as 1 to 2 ac (0.4 to 0.8 ha); however, such areas can be reclaimed as soon as each turbine erection is completed. The nacelles are expected to be delivered to the site containing an already-assembled drivetrain. The rotor and blades would be assembled on the ground and installed following nacelle installation. Figures 3.3-3, 3.3-4, and 3.3-5 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 (not including the time needed to prepare the area, as discussed above, and deliver components). It is anticipated that all surfaces of turbine towers, nacelles, rotors, and blades would arrive at the site with appropriate corrosion-control coatings already applied and only very limited areas would require field dressing. It is also likely that major components of the drivetrain would be complete. An exception to this may be the transmission, which, for weight-saving reasons, would need to be filled with transmission fluid and, in some cases, glycol-based coolant after its nacelle was installed.

FIGURE 3.3-3 Arial View of Preparations to Erect a Wind Turbine Tower at the Public Service of Colorado Ponnequin Wind Farm, Weld County, Colorado (Source: NREL 1999. Photo credit: Warren Getz)

3.3.4 Miscellaneous Ancillary Construction

Additional construction activities would include the installation of electric power conditioning and control equipment in substations and switchyards.[16] For turbines employing a dedicated electrical transformer, the transformer would be installed on a small concrete pad at the base of the tower.[17] Power-conducting cables and signal cables would interconnect the turbine towers with the control building and the electrical substation.[18] Where the soil mantle permits, it is expected that these cables would be installed to a nominal depth of 4 ft (1.2 m) or less, installed in cable trays, or buried directly using a conventional trenching machine.[19] Standard trenching techniques are expected to be sufficient. Regardless of the subsurface conditions, it is unlikely that developers would resort to suspending interconnecting power and signal cables on poles.

[16] Some models of wind turbines have a dedicated transformer installed at the base of their tower for initial power conditioning. Others place the dedicated transformer in the nacelle.

[17] Most turbines will produce electricity initially at 600 to 690 V. Those with dedicated transformers would typically step that voltage up to 34.5 kV before transferring it to the central substation.

[18] 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.

[19] 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.

FIGURE 3.3-4 Wind Turbine Nacelle Installation at Golden Prairie Wind Farm, Lamar, Colorado (Source: NREL 2003. Photo credit: David Jager)

The footprints of substations are expected to be 5 ac (2 ha) or less in size and, except control and storage buildings and on-site roads, would represent the footprint of the greatest contiguous area on the site. For electrical safety, one or more grounding rods may be installed. Alternatively, a metal grounding grid or metal net may be installed under 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. Small concrete pads would be installed for each transformer. With the exception of only the largest units, the transformers and other liquid-filled devices and all gas-filled electrical devices would be sealed at the point of manufacture. For the largest models, installation may involve adding dielectric fluids after they are installed on their foundations. Transformers, bushings, switches, capacitors, and other dielectric fluid-containing electrical devices are likely

FIGURE 3.3-5 Installation of a Rotor on a General Electric 1.5-MW Wind Turbine at the Klondike, Oregon, Wind Farm (Source: NREL 2002. Photo credit: Paul Woodin)

to use mineral-oil-based, organic, or synthetic dielectric oils completely free of 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.[20] Comfort heating of all occupied structures would be provided by propane stored on site or natural gas delivered by pipeline. 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 would be supplied from the grid, emergency power generation would also be available on site via a diesel engine/generator set.

As turbine blades grow larger, transporting them to the site becomes increasingly difficult. Such transportation logistics have prompted studies on the feasibility of fabricating

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

blades on the wind farm site. Typically, large blades are constructed of glass fiber infused in an epoxy resin and cast in one piece. Some blades may also incorporate carbon fiber for additional strength. However, because of the precise environmental controls required for working with such materials, on-site blade manufacturing has not become commonplace. Instead, a variety of alternatives have been pursued by blade manufacturers, including establishing manufacturing facilities geographically close to probable wind farm sites or designing multi-piece blades that are assembled on site using either mechanical fastening techniques or resin bonding techniques. Such multi-piece blades relieve transportation problems, but resin bonding would require additional chemicals on site during construction and temporary facilities to adequately control the resin curing environment.

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

Throughout the construction phase, fugitive dust may have a significant but localized impact. Fugitive dust may result from the disturbance of ground surfaces, removal of vegetative cover, vehicle traffic, and material handling (e.g., sand, aggregate, and cement handled in an on-site concrete batch plant). The issue of fugitive dust may be further exacerbated by the fact that the candidate site is necessarily located in a windy area. Such impacts are typically mitigated by keeping disturbed surface areas to an absolute minimum and by the regular application of water or other palliatives to unpaved access roads, on-site roads, and other disturbed areas throughout the construction phase. Establishing and enforcing speed limits for travel on unpaved access roads and on-site roads can also be effective. The amount of water consumed for dust control may be significant. For example, a 4,500-ac (1,820-ha) site involving over 200 turbines was estimated to use an average of 120,000 gal (454,249 L) of water per day during construction to affect adequate dust control (PBS&J 2002). At such volumes, on-site sources may be insufficient and trucking water to the site may be necessary. Developers are expected to follow local controls and regulations with respect to access to water.

During the construction period, security and safety concerns would require that areas involved in active construction and material laydown areas be fenced to prevent access by wildlife or unauthorized personnel.[21] Once construction is complete, however, many such areas would no longer need that level of security. Access doors to individual turbine towers would be secured against unauthorized entry. Doors to on-site buildings and equipment enclosures would be locked, and physical barriers (fences) would be maintained around hazardous areas such as electrical substations and individual tower transformers to prevent unauthorized entry by individuals or animals.

3.4 SITE OPERATION AND MAINTENANCE

Even though important aspects of the operation of a wind energy project can be monitored and controlled from a remote location, larger sites may be attended during one or two shifts by a small maintenance crew of six or fewer individuals (Steinhower 2004). For smaller

[21] Security and safety requirements contained in Title 29, Part 1910.2C, of the *Code of Federal Regulations* (29 CFR 1910.2C) would apply.

sites, maintenance personnel may be on call but not necessarily at the site. A growing trend is to couple the operations of multiple wind farms across a broad geographic area into what is called a “virtual power plant.” In such as arrangement, operations such as power dispatching from the various wind farms are coordinated through a central facility to ensure load and contractual obligations are satisfied even when calm wind conditions exist at one or more of the wind farms that comprise the virtual power plant. Maintenance activities among the power plants can also be expected to be controlled from a central operations and maintenance facility.

All major components of wind turbines are expected to undergo routine maintenance on schedules established by the component manufacturer. This would involve isochronal replacements of lubricating oils in the drivetrain’s transmission, gear oils in the turbine’s yaw motor, glycol-based coolants present in closed-loop cooling systems of some transmissions, and the use of small amounts of greases, lubricants, paints, and/or coatings for corrosion control. Volumes of used oils generated through routine maintenance could range in the hundreds of gallons for large turbines. Depending on the scale of operations, the wind energy project may include a maintenance shop facility. The frequency of lubricating oil changes would be dictated by manufacturer specifications and by the in-service history of each individual turbine. Transmission fluid would probably be replaced annually. Gear oil in yaw motors and hydraulic fluids used to control blade pitch and other aspects of turbine operation are not expected to require replacement throughout the expected life of the turbine.

It is anticipated that modern wind turbines will have a life span of 20 to 30 years. Over the life of the turbine, some mechanical components may need repair or replacement. However, 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 components from the site to a designated off-site repair facility. Because most turbine 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.

Other activities expected to occur during the operating period would potentially include regrading of on-site roads, ground and equipment maintenance activities including herbicide applications for the control of noxious weeds or the use of pesticides to control rodents or other pests,[22] and routine preventative maintenance testing of on-site emergency power generators, as well as maintenance of fuel levels in on-site propane and diesel fuel tanks (that would support the emergency generator or provide heat to on-site buildings and enclosures).

Technical advancements over the active life of a wind farm may result in the owner repowering some turbines or making other facility reconfigurations to accommodate technological changes. Reconfigurations may involve changing turbine management systems, replacing meteorological monitoring equipment to improve short-term weather forecasting capabilities, or replacing some electrical power management and conditioning equipment to meet changing demands of the grid operator. While it is impossible to predict the types of wind farm changes that might occur, it is reasonable to expect that changes would occur. Although many of the changes would be evolutionary rather than revolutionary and would likely result in little change to overall environmental impacts or facility footprints, all proposals to repower or

[22] Only Federal- and State-registered pesticides and herbicides would be allowed. Applications would be performed by licensed applicators in conformance with agency or landowner restrictions and in compliance with all label directions.

otherwise modify a site over its operating life would be reviewed and evaluated and could result in a requirement to prepare supplemental NEPA documentation.

As noted above, wind farm developers are considering combining wind farms with energy storage technologies to increase their value as reliable and available power sources, irrespective of whether wind is blowing at a time when their power is required. The energy technology most frequently considered is compressed air storage. In such a coupling, wind farm–generated power produced during periods of low demand is used to power compressors that compress air and deliver it to engineered or geological storage. Later, such compressed air can be used to improve the efficiency of combustion turbines for power generation. In most instances, it is likely that neither the compressed air storage facility nor the combustion turbines would be collocated with the wind farm; the wind farm's participation in such an arrangement would simply involve delivery of power during periods of reduced demand to the compressor facility collocated with compressed air storage tanks or above geologic conditions appropriate for compressed air storage, and either type of compressed air storage facility would be collocated with the combustion turbines it would support.

3.5 SITE DECOMMISSIONING

It is anticipated that individual turbines will have a life span of 20 to 30 years. However, the life span of a wind energy project could be longer, as long as equipment is maintained, repaired, and replaced. With some exceptions, site decommissioning would involve the reverse of site development. Typical decommissioning procedures are described below.

Areas would be established for the temporary storage of dismantled components and other materials recovered for later recycling, and would likely include some of the original laydown areas. Areas used during operation for the storage of operating wastes may be expanded to accommodate the additional volumes of wastes generated as equipment is drained and purged. Petroleum storage areas would likely be expanded to accommodate the additional construction vehicle and equipment fuel needs.

All turbines and their towers would be dismantled and either recycled (whole or in part) at other wind energy projects, sold for scrap, or disposed of off site as solid waste after fluid removal. Liquid-containing components such as transmissions, yaw motors, and dedicated transformers may be drained and purged before dismantlement and storage to await recycling or disposal. Turbine towers constructed partially of concrete would be broken up, as would turbine base pedestals, building foundations, and equipment pads. Broken concrete could be disposed of in an authorized construction and demolition landfill or used by highway departments for road base or bank stabilization.

Electrical control devices would be recycled or disposed of, in some cases as hazardous waste because of the heavy metals present. Transformers and other control devices would either be reused in other applications or sold as scrap after fluid removal. Turbine foundations below approximately 3 ft (0.9 m) and belowground cable runs are expected to be left in place.[23]

[23] However, to support the unencumbered future use of the land, or to accommodate revegetation with native plants 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. Likewise, cables buried at shallow depths may also need to be removed.

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. The surface aggregate would be removed and soil compaction adjusted as required, and the areas reseeded, replanted with indigenous vegetation, or returned to agricultural use.

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

3.6 TRANSMISSION LINES AND GRID INTERCONNECTIONS

3.6.1 General Information Regarding the Transmission Grid

In order to provide a complete evaluation of the impacts of establishment of wind farms in the UGP Region, this PEIS also addresses the potential impacts of the construction and operation of transmission lines that would connect those wind energy facilities to Western's high-voltage electric transmission grid. For the purpose of this analysis, it is assumed that the maximum distance of required transmission line construction for any individual wind farm would be 25 mi (40 km). This section provides additional information on the major components of high-voltage transmission lines and the potential environmental impacts associated with their construction and operation. The primary factors influencing the design and performance of transmission lines are also briefly discussed. However, site-specific impacts of transmission lines (e.g., impacts on specific species habitats) are not addressed in this section.

Information presented here was taken largely from a Technical Memorandum published by Argonne National Laboratory (Argonne 2007) and from the recently published *Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal Land in the 11 Western States* (BLM and DOE 2008). The reader is invited to refer to those documents, both of which are available electronically at http://corridoreis.anl.gov, for more in-depth information.

The North American electric system includes power generation, storage, transmission, and distribution facilities in Canada, the United States, and northern Mexico (Baja Norte). The high-voltage transmission grid is composed of three main interconnected regions: the Eastern, Western, and Electric Reliability Council of Texas (ERCOT) Interconnections. Within each interconnection region, all electric utilities are interconnected and operate synchronously; that is, the generators are operated such that the peak voltage from all generators occurs simultaneously. Voltage from alternating current (AC) generators varies over time following a sinusoidal wave, reaching a peak or a minimum 60 times per second (60 Hz). If all of the power contributions from generators were not "in phase," the voltage from one would cancel some of the voltage from others. Synchronicity is essential to the transmission grid's reliability and function. Consequently, each segment connecting a generating facility to the transmission grid is supported by substations located either at the generator's facility or at the "point of injection" (or both) at which the necessary power modifications are accomplished. In addition to ensuring proper phase, transformers are present to adjust voltage to match the grid or to provide for efficient transfer of power to the point of injection. Circuit breakers are present to disconnect the facility should upset conditions occur. A detailed discussion of the specific array of power conditioning and control equipment required to safely interconnect a given wind farm to the transmission grid is beyond the scope of this PEIS. Suffice it to say that transmission interconnection agreements would be entered into between Western and each wind farm operator and will include detailed requirements designed to protect both the grid and the facility. Those requirements, while essential to preserving grid stability and reliability, will have only incremental impacts on the environmental footprints of the wind farms, and a discussion of additional details with respect to substation and/or switchyard equipment would not provide additional benefit or perspective to the objectives of this environmental impact analysis.

Although the transmission grid system operator requires the wind operators to provide appropriate power conditioning before interconnection of any power generator, siting the transmission line over which such interconnections are made is principally the responsibility of State utility commissions.[24] However, EPAct expanded the role of FERC in transmission line siting. Under the Act, Section 216(a) of the Federal Power Act was amended to require the DOE to conduct a transmission system congestion study and to designate National Interest Electric Transmission Corridors (NIETCs)[25] where necessary to facilitate transmission grid expansions to relieve identified congestion. FERC is authorized under section 1221 of EPAct to issue construction permits for facilities located within those DOE-designated corridors.[26]

3.6.2 Providing for Transmission Grid Reliability and Stability

FERC is the primary Federal regulatory authority overseeing electric transmission and is responsible for ensuring the reliability of the electricity transmission grid. To further ensure system reliability, EPAct authorized the creation of an independent international Electric Reliability Organization (ERO) and directed FERC to establish rules for EROs as well as a process for certification. In July 2006, FERC approved the North American Electric Reliability Corporation (NERC) as the authorized ERO for the United States.[27]

NERC's mission is to promote reliability of the bulk electricity transmission systems (i.e., electricity transmitted at 100 kV or greater) that serve North America. To achieve that, and in collaboration with all segments of the electric power industry, NERC develops and enforces FERC-approved reliability standards; monitors the bulk power system; assesses future adequacy; audits owners, operators, and users for preparedness; and educates and trains industry personnel. Reliability standards provide for the reliable performance of the North American bulk electric systems without causing undue restrictions or adverse impacts on competitive electricity markets.[28] To ensure consistency in the manner in which individual

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[24] For more details, consult the Web site of the National Association of Regulatory Utility Commissioners at http://www.naruc.org.

[25] See DOE's Web site for more details on NIETCs at http://nietc.evs.anl.gov/.

[26] To date, DOE has designated two NIETCs, the Mid-Atlantic Area Corridor and the Southwest Area Corridor, neither of which extends into Western's UGP Region. However, DOE is required to revisit its transmission grid congestion study triennially and may, as a result, find additional NIETC designations warranted.

[27] More information on NERC can be found at the NERC Web site at http://www.nerc.com.

[28] Currently, there are 94 FERC standards and 185 NERC standards addressing the reliability of all facets of bulk electricity transmission, including design, planning, operations, infrastructure and cyber security, communication, coordination, and operational safety. All NERC reliability standards can be accessed at http://www.nerc.com/files/Reliability_Standards_Complete_Set_2009Feb25.pdf.

generating facilities are granted access to the transmission grid and to ensure that such interconnections do not jeopardize the stability of the grid, FERC has also developed generator interconnection procedures and published model interconnection agreements, both of which are required to be used for generating facilities with nameplate ratings greater than 20 MW. Because of the intermittency and variability of the power being developed by wind farms, a model interconnection agreement unique to wind energy and other alternative technologies has also been developed.[29]

NERC is composed of Regional Reliability Councils (RRCs), each of which is responsible for bulk transmission within its assigned geographic area. The transmission grid segments within the States addressed in this PEIS are under the control of the Western Electricity Coordinating Council (WECC) and the Midwest Reliability Organization (MRO) (see figure 3.6-1). Both RRCs are authorized to promulgate regional reliability standards (that must be approved by NERC and FERC)[30] to develop regional reliability criteria or planning standards that complement the NERC reliability and planning standards, or to establish consistent procedures for ensuring compliance with NERC standards among all WECC transmission system participants. Together, the NERC and WECC reliability standards provide a framework for the design and capabilities of transmission system components, the dimensions and conditions of ROWs, the configurations and capabilities of switchyards and substations, and the monitoring and operating parameters and controls of transmission line segments and interconnections.

3.6.3 Transmission Line Components

As discussed above, reliability standards, together with the characteristics and amount of power expected to be delivered, control every aspect of a wind farm's interconnection to the grid, from the type and size of the electrical devices and controls required at substations, to the design, configuration, and dimensions of line components, including the width of the ROW and the manner in which it is maintained. The more critical components of interconnections are discussed below.

3.6.3.1 Structure Specifications and Construction

The structures support the electrical conductors and provide physical and electrical isolation for energized lines. The voltage; the type, number, weight, and size of the conductors (wires) to be supported (typically, three conductors for each circuit present); and the safe separation distances that must be maintained between energized conductors, structures, and ground obstructions to prevent faulting combine to dictate tower specifications with respect to

[29] The model interconnection agreement for wind energy and other alternative technologies can be found on the FERC Web site at http://www.ferc.gov/industries/electric/indus-act/gi/stnd-gen.asp. See also, FERC Order No. 661, issued June 2, 2005 (18 CFR Part 35), which is available at http://www.ferc.gov/industries/electric/indus-act/gi/stnd-gen/order2003-a.pdf.

[30] As of January 2009, FERC has approved eight WECC reliability standards, which can be accessed electronically at http://www.ferc.gov/industries/electric/indus-act/reliability/WEC-standards.asp. As of December 2007, FERC has approved five MRO reliability standards, which can be accessed at http://www.midwestreliability.org/STA_approved_mro_standards.html.

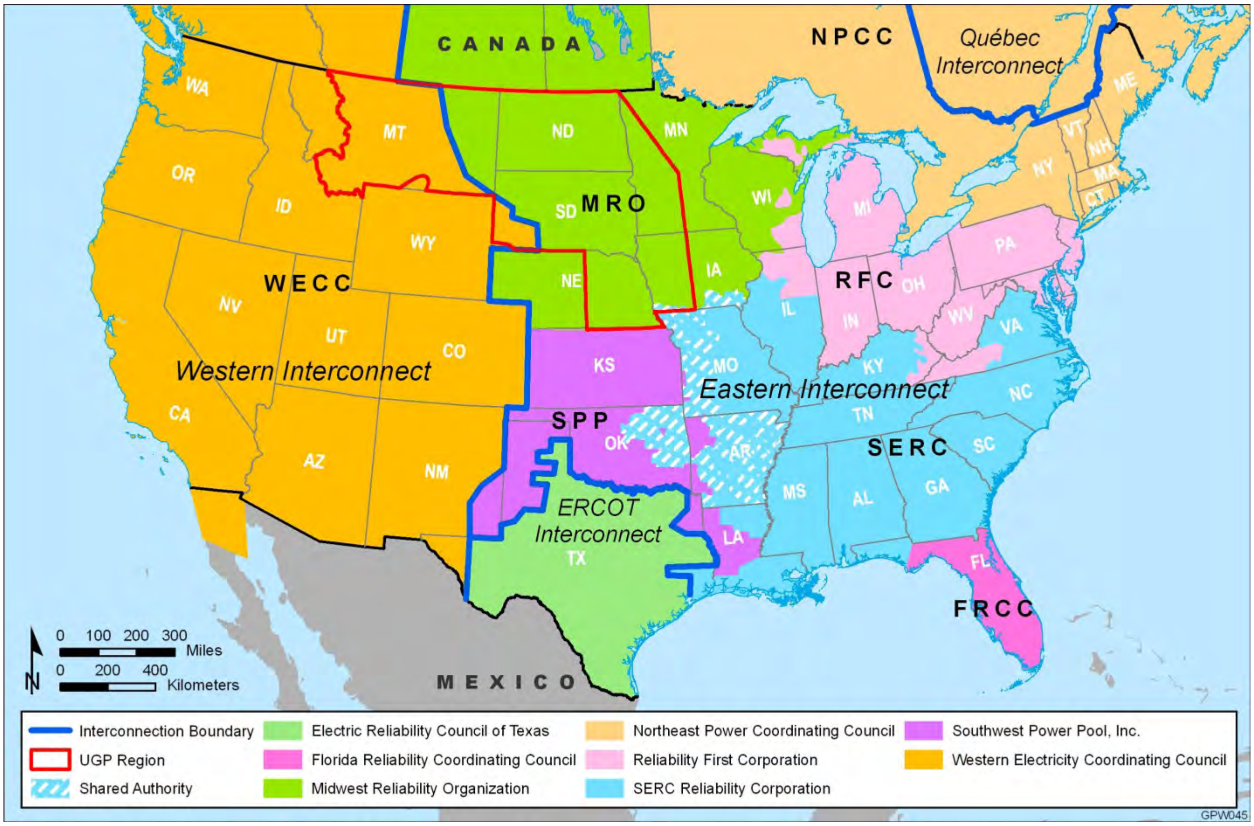

FIGURE 3.6-1 NERC Regions

size, geometry, construction materials, and tower spacing. ROW circumstantial factors such as ground slope, surface and subsurface conditions, wind loading, and weather considerations such as snow and ice loading can impose additional requirements on the specifications of structures, their spacing, and their foundation requirements. The majority of the existing transmission systems within this portion of the Western service area operate at voltages of 115 kV, although segments as high as 345 kV also exist. Structures used to support conductors operating at those voltages are typically constructed of steel, with a lattice or monopole design; in some cases, monopole or H-frame structures may be constructed of wood.

Regardless of the construction materials used, it is reasonable to expect that wind farms developed within this service territory will ultimately connect to a portion of the transmission grid operating at no more than 345 kV. The weight of the tower varies substantially with height, duty (e.g., straight run or change in direction, river crossing), material, number of circuits, and geometry, but typically range from 8,500 to 235,000 lb (3,856 to 106,594 kg). The basic function of the structure is to isolate conductors from their surroundings, including controlling the extent of their sag and slope over the expected operating temperature range. Clearances are specified as phase-to-structure, phase-to-ground, and phase-to-phase. The voltages at which the conductors are operated, as well as other factors such as topography, the expected ambient temperature range the transmission line will be subjected to, and wind and ice loading potential, dictate the necessary clearance dimensions. These distances are maintained by insulator strings and must take into account possible swaying of the conductors. This clearance is maintained by setting the structure height, conductor tensioning, controlling the line temperature to limit sag, and controlling vegetation and structures in the ROW. Typical phase-to-phase separation is also controlled by structure geometry and line motion suppression.[31]

Myriad designs exist for transmission structures, most of which can be comfortably placed into one of two categories: lattice type or monopole. Regardless of their appearance, transmission structures must safely support energized conductors. The voltages for which the conductors are designed dictate the clearances that must be maintained between each conductor and other conductors, the structures, and ground obstructions. Those clearances dictate the physical dimensions of the structures and the necessary minimum dimensions of the operating ROW.

Structure erection involves clearing the construction area (typically as much as 80,000 ft^2 [7,432 m^2]) and an adjacent tower assembly area (100 by 200 ft [30 by 61 m]) of vegetation. Creating level ground for lifting equipment is required. In general, construction ROW widths can be as much as twice the ROW width needed for safe operation. Excavation, concrete pouring, and pile driving are required to establish foundations, some of which can extend to depths as great as 40 ft.[32] Each foundation may require as much as 10 yd^3 (8 m^3) of reinforced concrete. In most instances, ready-mixed concrete is delivered to the site by commercial vendors; however, at particularly remote or rugged sites, special tactics may be employed, such as delivery of the concrete by helicopter or creation of a temporary concrete batch plant near the ROW. Monopole structures use a single reinforced-concrete foundation, formed either as a solid cylinder or in the shape of a donut. Lattice-type structures require somewhat less substantial concrete foundations for each of their four legs.

Transmission structures can reach heights of 150 ft (46 m) and widths of 75 ft (23 m). To ensure adequate clearances of conductors to ground interferences, operating ROW widths could approximately double the width of the structure. Structure spacing on level ground absent special concerns for wind or ice loading on conductors would be 1,000 to 1,200 ft (305 to 366 m) for lattice structures and 800 ft (244 m) for monopole structures. Radical changes in grade (e.g., crossing a deep valley or hilly terrain) or anticipated wind and ice can greatly reduce structure spacing or require the installation of exceptionally tall structures to ensure the conductors between structures maintain an acceptable slope or adequate clearances to ground. However, valleys also provide the opportunity to increase structure spacing without compromising ground clearances.

Structure erection also involves the creation of access roads with specifications (grade, turning radius, width, and weight limits) sufficient to handle large, heavy tower components, earthmoving equipment, tower erection equipment, and maintenance equipment. Laydown areas would also be created for temporary storage of structure components (typically 3 ac [0.01 km^2] in size and roughly every 10 mi [16 km] along the ROW). Structure construction can result in the loss of some vegetation, increased potential for wind- and water-induced soil erosion, impacts on surface waters from increased sediment loads, and possible impacts on groundwater from exceptionally deep foundation excavations. Most structure construction-

[31] Other factors critical to structure and transmission line performance, such as insulator design, lightning protection, and conductor motion suppression, do not introduce additional environmental impacting factors and are not discussed here.

[32] However, the relatively light-duty structures that might be used to provide a lower-voltage interconnection from an individual wind farm to the existing grid are commonly directly buried along with a concrete foundation.

related impacts are of short duration, however, and best management practices have been developed to minimize, if not completely mitigate, most impacts. Importantly, since structure footprints are not continuous along the ROW, there is enough flexibility associated with ROW routing to avoid or minimize placing structures in sensitive environmental areas, thus mitigating the overall impacts. Additional ROWs established for construction are typically returned to their natural state once construction is complete.

3.6.3.2 Conductor Specification and Installation

Transmitting electrical power over a long distance is not an efficient proposition. Even materials considered excellent conductors of electrical current offer some resistance to current flow. Resistance is typically manifested as heat.[33] Power losses as high as 10 percent can result. Various strategies have been pursued to eliminate or at least reduce line loss. Because electrical power (expressed in watts, kilowatts, or megawatts) is the product of voltage times current, and since the amount of power lost to heat is proportional to the amount of current being transferred, transmitting a given amount of electrical power at the highest possible voltage minimizes the current, and therefore the transmission losses due to heat. Alternatively, a variety of conductor compositions and constructions are currently in use to meet a variety of specific requirements. Although the ideal conductor material is one exhibiting the best electrical conductance, the selection of conductor materials typically represents a compromise between performance, cost, and weight. Because of its weight and cost, copper is typically replaced by aluminum, which offers greater strength-to-weight ratios than copper but only 60 percent of the electrical conductivity of copper. Aluminum-steel composites are also in widespread use. Most recently, ceramic fibers in a matrix of aluminum have been used, offering high strength even at the elevated temperatures that often result from high current flows during peak power demand periods.

Conductor specifications dictate tower design, specification, and spacing. Regardless of the materials selected, conductor installation is a formidable task, and conductor stringing requires additional land areas beyond the operating ROW for the staging and operation of installation equipment. A temporary construction ROW would be required to accommodate at least two cable-pulling areas, each approximately 150 ft by 250 ft (46 m by 76 m). As with structure erection areas and laydown areas, conductor-pulling areas would be returned to their native state after installation is complete. In most applications, conductor pulling, splicing, and tensioning activities can occur within the construction ROW. However, where the transmission line makes a radical change in direction, slightly larger ROWs are required for two pulling stations that may need to be positioned 180 degrees from each of the two direction changes of the line.

3.6.3.3 Switchyards and Substations

To minimize power losses over long-distance transfers, existing high-voltage transmission lines of the interconnected grid in the western United States are typically maintained at voltages as high as 500 kV, although lines in the UGP Region are currently operating at 345 kV or less. It is likely that the transmission line to which an individual wind farm

[33] Some power is also lost due to corona discharge, brought on by the ionization of oxygen molecules in the ambient air surrounding a high-voltage conductor.

interconnects will be operated at a substantially greater voltage than that at which power from an individual wind turbine is initially produced and transferred to the wind farm's substation (typically 34.5 kV). Consequently, the collective purpose of all of the equipment in a substation is to condition the power being produced to be compatible with the power present on the grid in both voltage and phase and to provide for immediate isolation of the wind farm from the grid during upset or emergency conditions. For electrical as well as fire safety, substations are typically kept completely free of vegetation, and the area is covered in gravel to promote drainage. Individual pieces of equipment rest on concrete pads or are mounted on metal superstructures. Much of the equipment is filled with as much as hundreds of gallons of dielectric fluids[34] that provide electrical insulation as well as heat dissipation. Although spills or leaks are possible, most equipment is sealed by the manufacturer and remains so throughout its operating life. In addition, some designs allow the outer shells of the devices to provide secondary containment of any leaked fluids. Wind farm facilities with nameplate ratings of hundreds of megawatts can be expected to have one or more power-conditioning areas, each comprising anywhere from 2 to 10 ac (0.8 to 4 ha).

3.6.3.4 ROWs and Access Roads

A ROW is a passive but critical component of a transmission line. It provides a safety margin between the high-voltage lines and surrounding structures and vegetation. Maintenance of the ROW is, therefore, specifically required by code and regulations. The ROW also provides a path for ground-based inspections and access to transmission structures and other line components, if repairs are needed. Failure to maintain an adequate ROW can result in dangerous situations, including ground faults.

A ROW passing through natural or fallow land generally consists of native vegetation or plants selected for favorable growth patterns (slow growth and low mature heights). However, in the UGP Region, the majority of transmission ROWs typically pass over cultivated or pasture agriculture lands. However, access roads often constitute a portion of the ROW, particularly in non-agricultural land, and provide more convenient access for repair and inspection vehicles.

ROW widths are dictated primarily by the width of the structures being installed, which in most instances is directly proportional to the highest voltage of the circuits present, as well as a variety of other circumstantial factors. In some instances, ROW widths are artificially large to allow for avoidance of potentially sensitive or problematic areas along the path. Table 3.6-1 shows the range of minimum ROW widths reported by U.S. utilities for various line voltages (for one line of structures). The number of companies reporting each width provides an indication of the most common size ranges.

The preexisting highway and road infrastructure in the area would likely be sufficient for the task of transporting equipment, components, and construction vehicles to the vicinity of the ROW. However, in some instances, modifications would be required. For example, bridges may need to be strengthened or load height clearances extended, and pathways over water courses may need to be widened and fortified. Access roads will likely need to be built to reach

[34] Oils containing PCBs were once common dielectric fluids. However, modern-day equipment is free of PCBs and instead contains synthetic or mineral-based oils. Some equipment contains a gaseous dielectric material, sulfur hexafluoride (SF_6).

the ROW in most instances; some will be temporary roads constructed only to support certain construction events, while others will remain throughout the operating life of the transmission line and provide access to the ROW for ground-based inspections and vehicles and equipment needed for repairs or replacements of components. Terrain and overall length of the collector/conditioning station–to–interconnection line segment may require multiple access roads. Road specifications are dictated by the equipment and vehicles that will use them. In most instances, access roads lie on separate ROWs, typically 12 to 14 ft (3.7 to 4.2 m) wide (together with a temporary construction ROW of an additional 3 ft [1 m] along either side of the road). Circumstantial factors will dictate road construction techniques, including special techniques required to cross streams, wetlands, or especially rugged terrain in those instances where these areas cannot be avoided by routing. Most transmission line access roads are simply bladed, and at best may have some gravel in low or soft areas prone to rutting. Access roads that provide primary access to the ROW or to substations may have a more permanent, all-weather surface.

TABLE 3.6-1 Minimum ROW Widths

Voltage (kV)	Range of Widths (ft)	No. of Companies Reporting
<230	<50	51
	51 to 125	41
	>125	7
230	<75	40
	76 to 125	36
	>125	30
345	<75	6
	76 to 125	36
	>125	30
500	<125	4
	126 to 175	21
	>175	13

Source: FERC (2004).

3.6.3.5 Additional Structures

For some long-distance transmission line construction projects, additional facilities, such as maintenance or repair facilities, material storage areas, administrative buildings, and operational control centers, could conceivably be constructed. However, it is not likely that such facilities would be necessary for the grid interconnection segments being discussed here, and, if they are, they would likely be the responsibility of the transmission system operator and not the wind farm operator.[35] Multiple independent transmission lines sharing a ROW create some unique issues associated with both construction and operation. Designs would be amended to provide adequate spacing between lines to avoid interferences or to prevent emergencies on one line cascading to the second line. Agreements would be required among the parties involved to establish liability limits and assign responsibility for each aspect of ROW maintenance. Coordination of construction- and operation-related activities would also be addressed to prevent adverse impacts on the safe operation of either line.

[35] As noted previously, for the purpose of this discussion, it is assumed that interconnection transmission line segments would be no more than 25 mi (40 km) in length. This assumption is supported by the existence of state initiatives such as the Renewable Energy Transmission Initiative (RETI) in California that seek to facilitate development of renewable energy resources in remote areas by establishing the necessary transmission infrastructure in those areas. Additional details regarding RETI can be found on the California Energy Commission’s Web site at http://www.energy.ca.gov/reti/documents/index.html. It is further expected that similar initiatives may be pursued in other states within the UGP Region where concentrations of renewable resources exist.

3.6.4 Hazardous Materials and Wastes

The hazardous materials used during construction of transmission lines consist primarily of fluids and other chemicals (lubricating oils, hydraulic fluids, glycol-based coolants, and battery electrolytes) needed to perform primary maintenance on construction vehicles and equipment. Most such materials would be present in portable containers of 55-gal (208-L) capacity or less. Some equipment cannot be easily moved (e.g., exceptionally large lifting cranes that are transported in pieces and assembled on site, or bulldozers used for initial clearing), which may require the establishment of temporary fueling facilities consisting of portable aboveground tanks holding diesel fuel and/or gasoline. Compressed gas cylinders of welding and cutting gases such as oxygen and acetylene and modest amounts of cleaning solvents, paints, and corrosion-control coatings would also be present. Portable sanitary facilities would also be brought to the construction site. Finally, pesticides used for initial clearing of construction areas, and later in the ongoing maintenance of the ROW, may be present. At associated substations, much of the electrical equipment would be filled with dielectric fluids or gases. However, except in the case of major malfunctions that result in arcing or leaks, these dielectric materials would not be expected to require replacement, and no waste dielectrics typically result from routine operation. At the decommissioning of the wind farm–to–grid transmission line segment, however, very large electrical equipment may need to be drained before being relocated.

The majority of construction-related wastes are associated with vehicle and equipment maintenance. These wastes are likely to be containerized and briefly stored at the construction area before being removed to off-site treatment or approved disposal areas. Special arrangements may be necessary for very large quantities of vegetation that result from ROW clearing in some locations, although heavily vegetated areas would likely be considered sensitive environmental areas to be avoided during routing. The expected relatively short length of transmission line interconnections suggests that, even in remote areas, there will be no need to establish employer-provided housing for the construction workforce.

Except for herbicides used in ROW maintenance, virtually no hazardous materials would be required during the operating period of the wind farm–to–grid transmission line segments and related substations, and no operation-related wastes would be generated unless major repairs or replacements are required.

3.6.5 Transmission Line Operation and Maintenance

Transmission lines connecting wind farms to the grid require very little attention and intervention during normal operation. Periodic visual inspections are conducted either by driving or walking the ROW or through aircraft flyovers. Inspection frequencies are dictated largely by experience with similar lines operating in similar environments. Table 3.6-2 shows typical inspection frequencies for such transmission lines.

In rare instances, inspectors may need to climb the transmission structures when close inspections are required to verify the conditions of critical components. ROW vegetation maintenance is conducted in accordance with a preapproved plan. Maintenance may include periodic tree and bush trimming or applications of herbicides, or both. As with inspections, the frequency of ROW maintenance activities is dictated by circumstances and experience.

Substations and switchyards are also inspected regularly, typically at a higher frequency than the transmission line. Periodic replacement of the dielectric fluids in transformers may be required. Replacements of bushings (ceramic insulators that isolate energized wires from the metallic cases of electrical equipment or from the metal superstructures to which they are attached) may also be necessary. Depending on configuration and function, personnel may need to visit the substation or switchyard to make changes to the routing of power.

TABLE 3.6-2 Number of Companies Reporting Various Inspection Frequencies

Frequency	Aerial	Ground
More than twice a year	25	7
Semiannual	34	22
Annual	46	76
Biennial	6	6
Every 3 years	1	6
Less than every 3 years	3	2.5
As needed	8	1
Did not report	38	7

Source: FERC (2004).

During the expected operating lifetime of a transmission line, voltage upgrades, introductions of additional bundled or double circuits,[36] repairs, or replacements of conductor segments or insulators may require the reintroduction of heavy equipment of the type used for initial construction. Depending on where such activity occurs, original construction access roads and clearings that were remediated after completion of construction may need to be reestablished. The terms of ROW leases typically address access for rebuilding/refurbishment that may be required after destructive storms, as well as for technology upgrades. The impacts of such repairs, upgrades, or refurbishments would be similar to those incurred during initial construction. Likewise, upgrades may also involve replacement of equipment at substations or switchyards.

3.6.6 Transmission Line Decommissioning

The expected lifetime of a transmission line is indefinite. It is more likely that the line will undergo upgrades (including replacements of conductors or structures, or both) or the introduction of additional circuits rather than be abandoned. However, in the event that a transmission line segment is abandoned, decommissioning would involve removal of all permanent structures, although subsurface foundations may be allowed to remain if their removal would create more disruption than their retention, or other actions as specified in the lease agreement. Virtually all major components, structures, and conductors are recycled. Equipment at substations or switchyards may be reinstalled in other parts of the transmission grid, retained in inventory as replacements, or recycled. Some large pieces of equipment may need to be drained of their dielectric fluids before removal and transport. Failing that, recycling options would likely exist for all major components. In most areas of the ROW, remediation involves simply allowing native vegetation to reestablish itself. Where all-weather access roads

[36] Multiple conductors on a typical three-phase AC transmission line are called bundled conductors. Each of the three phases can have a single conductor, two conductors (duplex), or three conductors (triplex), the duplex and triplex configurations collectively being called bundled. The multiple conductors are separated by spacer dampers, which are not a uniform distance apart to avoid setting up a vibration resonance within spans. A double-circuit transmission line is just that – it has two separate three-phase circuits on the same structure, or six conductors in all. The voltages of the two circuits do not have to be the same, and one or both circuits could have bundled conductors, but all three phases of a circuit would have the same conductor configuration. Converting from a single conductor to a bundled conductor may or may not be an option on any given transmission line, unless the structures are strong enough and spans suitable for the additional weight of bundled conductors. Unless the structures have been designed for a future second circuit, an existing single-circuit transmission line cannot be converted to a double-circuit line unless the structures are completely removed and replaced.

have been removed or where decommissioning activities have resulted in bare soil, fast-growing, noninvasive species may be planted to provide interim erosion control until native vegetation can be reestablished.

3.7 REGULATORY REQUIREMENTS FOR WIND ENERGY PROJECTS

This section identifies the major laws, regulations, compliance instruments, and policies that may impose environmental protection and compliance requirements on site monitoring and testing, construction, operation, and decommissioning phases of a wind energy project. 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, applicable regulatory jurisdictions, and other pertinent circumstantial factors. In addition to regulations and controls, various incentives are offered at the Federal and State levels.[37] Although such incentives are intended to facilitate market penetration of wind energy, pursuit or acquisition of incentives does not directly affect the environmental footprints or impacts of wind energy facilities; therefore, incentives are considered to be outside the scope of this analysis.

3.7.1 Statutes, Laws, Regulations, and Ordinances Potentially Impacting Wind Farms

Table 3.7-1 provides an overview of enforceable requirements at the Federal, State, or local levels.

3.7.2 Other State Regulations, Requirements, and Initiatives Potentially Impacting Wind Energy Facilities

As noted in various entries throughout table 3.7-1, authority has been delegated to States for many of the listed Federal regulatory programs. State programs must be at least equivalent to the Federal program for such delegations of authority to occur. However, as provided for in some authorizing Federal statutes, in some instances, State programs can be more restrictive or broader in scope than their Federal analogs. Consequently, State laws and regulations may sometimes impose additional requirements. In addition, States may implement programs that have no Federal counterpart. All six States in the UGP Region offer consumer guidelines and wind energy development handbooks, and many have undertaken studies or initiatives aimed at facilitating wind energy development while preempting adverse consequences.

State-level controls are typically under the jurisdictions of environmental control agencies and/or public service commissions and often mimic Federal regulations, requiring the developer to undertake and report on potential environmental and socioeconomic impacts and to submit a detailed plan of development for the project and subjecting the matter to public review and comment. Local governments (counties, cities) can also regulate wind farms through such controls as zoning ordinances, ROW permits, construction permits, and height

[37] Information on Federal and State incentives is available from the Database on State Incentives for Renewables and Efficiency (DSIRE), an ongoing collaboration of the North Carolina Solar Center and the Interstate Renewable Energy Council (funded by DOE). See the DSIRE Web site at http://www.dsireusa.org.

TABLE 3.7-1 Major Requirements for Siting Operation and Decommissioning of a Wind Farm

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
National Environmental Policy Act (NEPA) (42 U.S.C. 4321-4347) • 40 CFR 1500 et seq.	• Federal agencies must make informed decisions regarding the environmental impacts of actions they conduct, permit, authorize, or subsidize. • Assuming that the action is not identical to one that had been previously excluded from required NEPA investigations (a categorical exclusion, CX), an environmental assessment (EA) or environmental impact statement (EIS) may be required.	NEPA applies when a facility: • Is located on Federal land. • Interconnects with a federally owned transmission facility. • Is partially or wholly funded by Federal grants.
• State-equivalent NEPA laws:[a] – Iowa: None – Minnesota: Minn. Stat §§ 116D.01 to 116D.11 – Montana: Montana Code Annotated (MCA). §§ 75-1-201 to 75-1-220 – Nebraska: None – North Dakota: None – South Dakota: S.D. Codified Laws §§ 34A-9-1 to 34A-9-13		State authorities apply when the facility is located within a State's jurisdiction.
Clean Water Act (CWA) (33 U.S.C. 1251 et seq.) • CWA Section 402 33 (U.S.C. 1342) • 40 CFR parts 122 and 123 • U.S. Environmental Protection Agency (EPA) • State-authorized programs	• Permits are required under the National Pollution Discharge Elimination System (NPDES) for discharges to navigable waters of the United States or waters of the State.[b] • A SWPPP permit may be required for management and discharge of storm water.	• An NPDES permit, or State equivalent, is required for storm water discharges from industrial activities or from construction activities disturbing more than 5 ac (2 ha) of land. • Under the Storm Water Phase II Final Rule, small construction activities disturbing between 1 and 5 ac (0.4 and 2 ha) of land are also subject to NPDES permitting requirements. • Permits are typically required for construction, operation, and decommissioning phases of the facility's life cycle. • Most States have received authorization to implement the Federal NPDES programs.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
Safe Drinking Water Act (SDWA): Public Water Supplies • 40 CFR 141 et seq. • EPA • State-authorized programs	• National primary and secondary drinking water standards established by the EPA. • Regulations apply to public water supplies (PWSs). • Programs implemented by States.	• Wind farm developer becomes a PWS if it supplies drinking water directly from either a surface or underground supply to 25 or more individuals for a period of 60 days or more within a 1-yr period. • Wind farm developers who purchase drinking water in bulk from PWSs or who purchase bottled water for consumption are not subject to the regulations. • Water available on the wind farm site for nonconsumptive uses is not subject to SDWA regulations.
SDWA: Protection of Underground Sources of Drinking Water • 42 U.S.C. 300h-7 • State wellhead protection programs	• Wellhead protection programs implemented by State water authorities identify areas of vulnerability around drinking water supply wells or in recharge areas for those aquifers and prohibit certain activities within those areas.	• Wind farms located near wellhead protection areas may be prohibited from using certain hazardous chemicals during construction.
Clean Air Act (42 U.S.C. 7401 et seq.) • Federal Transit Act (49 U.S.C. 53) • 40 CFR part 93 Subpart A (Transportation Conformity Rules) • 40 CFR part 93 Subpart B (General Conformity Rules) • EPA	• Federal agency actions and those of the wind energy developer/operator must conform to State implementation plans that provide for attainment and maintenance of compliance with National Ambient Air Quality Standards (NAAQS) for criteria pollutants.	• General conformity evaluations are required for the construction phase of wind farms constructed in nonattainment or maintenance areas for the NAAQS (especially for fugitive dust). • Transportation conformity evaluations are required for the construction phase of wind farms constructed in nonattainment or maintenance areas for the NAAQS (especially for construction workforce and delivery vehicle travel).
Oil Pollution Act (OPA) (49 U.S.C. 44718) • 40 CFR part 112 • EPA	• Requires the development of a Spill Prevention Control and Countermeasures (SPCC) Plan for facilities containing more than the prescribed amount of petroleum products.	• SPCC are required for fuel storage where circumstances create the potential for spilled product to reach navigable waters. • Most States have received authorization to implement this program.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (i.e., Superfund) (42 U.S.C. 9601–9675) • National Oil and Hazardous Substances Pollution Contingency Plan • 40 CFR part 300 • EPA	• Assigns “joint and several liability” for remediation of contamination.	• Applies to contamination present on the site. • Site operator must conduct due diligence to verify the absence of contamination before acquiring the property to avoid CERCLA liabilities for cleanup. • Some States may have additional regulations regarding site remediation.
Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HSWA) • 42 U.S.C. 321 et seq. • 40 CFR parts 239–258 (solid waste) • 40 CFR parts 260–265 (hazardous wastes) • 40 CFR part 279 (used oil) • 40 CFR part 273 (universal waste) • 40 CFR parts 280–282 • EPA Note: the Toxic Substances Control Act (TSCA) controls the management and disposal of PCBs. However, PCBs are not expected to be present during any phase of a wind farm’s life cycle.	• Establishes controls for the storage, transportation, treatment, and disposal of solid wastes (Subtitle D) and hazardous waste (Subtitle C). • Establishes management and disposal/recycling controls for “universal wastes.” • Establishes management and disposal/recycling controls for used petroleum products. • Establishes design standards, operational controls, and remediation requirements for underground storage tanks (UST) storing petroleum products (Subtitle I).	• Used lubricating oil and hydraulic oil from the maintenance of wind turbine components are subject to used oil regulations. • Other maintenance-related wastes (e.g., spent fluorescent light bulbs, spent lead-acid batteries, specified pesticides) are subject to universal waste regulations. • Disposal of solid waste on the wind farm site would trigger solid waste regulations. • Storage of fuel in a UST triggers UST regulations. • Most States have received authorization to implement these programs. • Some State regulations may be more restrictive than the Federal regulations.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) • 7 U.S.C. 136 • 40 CFR parts 150–189 • EPA	• Establishes requirements for registration and labeling of pesticides. • Establishes training and certification requirements for individuals applying certain pesticides. • Establishes requirements and restrictions for application of certain pesticides. • Pesticide label directions for applicability, use, and disposal have the force of regulation.	• Applies when registered pesticides are used for vegetation management on a wind farm during any phase of the wind farm's life cycle. • May require approval by the Service for use of specific pesticides. • Disposal of residues and rinsates from decontamination of application equipment is subject to controls. • States may have additional pesticide registration requirements and use prohibitions. • Pesticide applications on wind farms are typically by a contracted service.
Occupational Safety and Health Act (OSH Act) • 29 U.S.C. 651 et seq. • 29 CFR part 1926 (construction) • 29 CFR part 1910 (general industry) • 29 CFR 1910.1200 (hazard communication) • 29 CFR 1903.1 (general duty) • OSH Act General Duty Clause, Section 5(a)(1)	• Establishes standards for worker protection. • Establishes labeling and worker training on the use of hazardous materials and on the risks of exposure. • Establishes personal protective equipment and work practices to avoid adverse worker impacts. • Establishes controls to prevent adverse impacts to the public. • "General Duty Clause" requires employers to provide a workplace free from recognized hazards that are causing or are likely to cause harm to employees.	• Relevant regulations in 29 CFR part 1926 apply to wind farm construction and decommissioning activities. • Relevant regulations in 29 CFR part 1910 apply to wind farm operation. • Hazardous materials on site subject to hazard communication regulations. • OSH Act's General Duty Clause requires each employer to furnish to each employee employment and a place of employment that are free from recognized hazards, which are causing or are likely to cause death or serious physical harm. • Most States implement a State-equivalent program.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
National Historic Preservation Act • 16 U.S.C. 470 • 36 CFR part 60 and 36 CFR part 800 • Advisory Council on Historic Preservation • Tribal Historic Preservation Office • State Historic Preservation Office (SHPO)	• Requires Federal agencies to review impacts to historic and tribal resources. • Requires consultation with SHPO and/or Tribal Historic Preservation Office.	• Requires a survey of the site for cultural and historic artifacts. • May require removal and proper curation of discovered artifacts under the auspices of a Federal permit. • Requires consultation with SHPO to determine applicability of Section 106. • Applies when the proposed action may impact listed or eligible properties for the *National Register of Historic Places*. • Applies when the action may impact tribal cultural or historic artifacts.
CWA • 33 U.S.C. 1251 and 33 USC 1344 • 33 CFR parts 320–331 • 40 CFR part 230 • EPA • U.S. Army Corps of Engineers (USACE)	• Requires permits issued by the USACE for removal of dredged or fill materials from or discharge into the waters of the United States. • Controls the disposal of dredged materials.	• Actions that occur on or impact designated wetlands may be subject to permits. • Replacement or remediation of impacted wetlands may be required.
Rivers and Harbors Act of 1899 • 33 U.S.C. 401 et seq. • 33 U.S.C. 403, Section 10 • 33 CFR parts 320–331	• Requires a Section 10 permit issued by the USACE for building or modifying bridges over waters of the United States. • Authorizes USACE to control or remove hazards to navigation on waters of the United States.	• Fortifying bridges along site access route may trigger a Section 10 permit requirement. • Consultation with USACE is required.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
FAA Reauthorization Act of 1996 • U.S. Department of Transportation Subpart VII • Obstruction Evaluation/Airport Airspace Analysis • 49 U.S.C. 44718 • 14 CFR part 77 • FAA • FAA Circular 70/7460-2K (FAA 2000)	• Requires notification to FAA of structures that might affect navigable airspace (FAA Form 7460-1, Hazard Determination). • Requires lighting of structures over a certain height within proximity to an airport. • Requires notification to FAA for turbines located within line of sight of air defense radars. • Does not extend to a consideration of interferences with weather radars.	• Construction or alteration of wind turbines and/or meteorological towers greater than 200 ft [61 m] high located close to airports (distance varies based on length of nearest runway and ground slope) requires notification to FAA at least 30 days prior to construction or alteration. • Tall structures close to airports may require marker lights. • Notification to FAA may also be required prior to alterations of bridges or overpasses on roadways or railroads proximate to airports to accommodate transport of exceptionally tall loads to the wind farm site. • Aeronautical study by FAA includes evaluation of aviation safety as well as radar interference potential.
Endangered Species Act (ESA) (16 U.S.C. 1531–1544) • 50 CFR part 13 and 50 CFR part 17 promulgated by the Council on Environmental Quality	• Consultation with the Service may be required for projects that could affect federally listed species or designated critical habitat. • Permit for “incidental take” may also be required.	• Proposed activities could have an impact on federally listed endangered species or could adversely impact their habitats.
Migratory Bird Treaty Act (16 U.S.C. 703–712) • 50 CFR parts 13 and 21 promulgated by the Service	• Prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. • Consultation with the Service may be required.	• Action has the potential to impact specified migratory bird species or their habitats. • Project modifications to minimize impacts may be needed.

TABLE 3.7-1 (Cont.)

Statutes/Laws/Regulations/Ordinances and Implementing Authorities	Description	Applicability
Bald and Golden Eagle Protection Act • 16 U.S.C. 668-668d • 50 CFR part 13 and 50 CFR part 22 • The Service	• Prohibits harm, possession, or take of bald and golden eagles or their nests. • Requires consultation with the Service for facilities that might adversely affect bald and golden eagle habitats. • May require an incidental take permit from the Service.	• Requirements apply whenever the wind farm contains, or is proximate to, bald or golden eagle habitat or nests.

[a] Only relevant laws in the States within the UGP Region (Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota) are listed.

[b] 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.

restrictions. Other aspects of utility-scale wind farms that could come under local regulatory controls include minimum property setback distances, lighting (both color and intensity), fencing, screening, signs, erosion controls, interference with communication devices, decommissioning, dispute resolution, protection of public roads, bonding and liability insurance, sound levels, and visual appearance.[38] Brief overviews of potentially relevant State-level regulations and wind energy initiatives follow.

3.7.2.1 Iowa

There are no regulations specifically governing the siting, operation, or decommissioning of wind energy facilities in Iowa beyond those specified or implied in table 3.7-1. However, the Iowa Department of Natural Resources (IDNR) sponsors a Wildlife Diversity Program (see http://www.iowadnr.gov/wildlife/diversity/windwildlife.html for details). In the context of that program, there exists an ad hoc discussion group dedicated to educating would-be developers on the potential adverse impacts of wind farms on wildlife. The group has issued a report highlighting appropriate designs and best siting, construction, and operating practices that can prevent adverse impacts, and has developed a map showing particularly sensitive areas within the State to be avoided (IDNR undated).

Iowa's Source Water Assessment and Protection Program is a collaborative effort between IDNR and operators of PWSs that rely on groundwater. IDNR will perform hydrogeologic surveys of water supplies, assess their vulnerabilities to contamination, and delineate an appropriate zone of protection. IDNR will also use existing databases to develop an initial inventory of potential contaminant sources within the protected area. PWSs are then

[38] A more detailed discussion of state and local requirements has been published by the National Research Council (NRC 2007).

assisted by the IDNR in developing more accurate inventories of potential contaminants and developing wellhead protection plans, some of which can be enforced by local ordinance. Details of the State's source water protection program are documented in an implementation plan published by IDNR (2000).

Finally, Iowa has made an income tax credit available to electric utilities of up to $2.00/gal for up to 20,000 gal (76,000 L) when conventional mineral oil dielectric fluids are replaced with soy bean oil–derived dielectric fluids (see Iowa Administrative Code 701-42.33 et seq.). This may affect utility-owned electrical devices present in wind farm substations and switchyards.

3.7.2.2 Minnesota

Sections 216F.04 and 216E of the 2008 Minnesota Statutes require the developer of a large wind energy conversion system (LWECS) (defined by statute as capable of producing 5,000 kW of electrical power or more) to obtain a permit from the State's Public Utilities Commission. The scope of the permit's requirements can extend to the full complement of the rules adopted by the Commission and may include additional conditions at the Commission's discretion. The full text of Sections 216F.04 and 216E can be found at https://www.revisor.leg.state.mn.us/statutes/?id=216F and https://www.revisor.leg.state.mn.us/statutes/?id=216E, respectively.

Section 500.30 of the 2008 Minnesota Statutes establishes the opportunity for establishment of an easement to guarantee a property owner's continued unimpeded access to wind energy. Easements must be formally recorded on the deeds of the affected properties and are enforceable by injunction or by proceedings in an equity or civil action. The full text of Section 500.30 can be found at https://webrh12.revisor.leg.state.mn.us/statutes/?id=500.30.

Minnesota Administrative Rules 4410 and 7849 require an EIS to be produced for a large electric power generating plant with nameplate ratings greater than 50,000 kilowatts (50 MW). Promulgated by the Minnesota Environmental Quality Board in February 2002, the rules require a site permit before initial construction or subsequent expansion of a LWECS. Successful applicants must demonstrate how their LWECS furthers State policies with respect to environmental preservation, sustainable development, and efficient use of resources. In addition to providing engineering details of the facility and meteorological details of the proposed site, the applicant must assess the potential for adverse impacts to the environment and to humans from the facility and identify appropriate mitigative actions. Although a formal EIS (as defined by Minnesota statutes) is not specifically required, the information necessary to satisfy state permit requirements is essentially the same as would be included in the EIS. Detailed plans of development, operation, and decommissioning are also required. The draft permit is subject to full public review and comment. Final permits take effect only after the applicant provides evidence that a power purchasing agreement or other enforceable mechanism for the sale of power is in place. Full-text versions of Rules 4410 and 7849 are available at https://www.revisor.leg.state.mn.us/rules/?id=4410 and https://www.revisor.leg.state.mn.us/rules/?id=7849.7020, respectively.

Minnesota Rules Chapter 4720-5100-5590 establishes standards for wellhead protection planning. The Minnesota Department of Health is authorized to conduct vulnerability assessments of the State's underground sources of drinking water and delineate appropriate wellhead protection areas. Wellhead protection plans are the purview of operators of public water supplies.

3.7.2.3 Montana

Numerous State statutes potentially impose requirements on wind farms. Implementation authority rests with the Montana Department of Environmental Quality (Montana DEQ):

- The Montana Environmental Policy Act (MEPA) (MCA 75-1-101 et seq.) is patterned after NEPA. MEPA requires the development of EISs, EAs, or categorical exclusions, and is enforced through administrative rules of the Montana DEQ (ARM 17.4.601 through 725, Subchapter 6).

- The Montana Natural Streambed and Land Preservation Act (MCA 75-7-101 et seq.) requires a Section 310 permit for construction activities in or near perennial streams on public and private lands.

- The Montana Floodplain and Floodway Management Act (MCA 76-5-401 through 76-5-406) requires a floodplain development permit for construction in a 100-year floodplain.

- The Montana Property Act (MCA 70-17-403) Wind Easements rule allows a property owner to grant a wind easement for the purpose of preserving access to wind resources. The rule, enacted in 1983, requires easements to be negotiated with neighboring property owners.

- The Montana Major Facility Siting Act (MCA 75-20-101 et seq.) requires applicants obtain a Certificate of Environmental Compatibility, together with a 10-year utility plan for construction and operation of power plants of 50 MW and greater, transmission lines with a design capacity greater than 69 kV, and other energy-related facilities.

- Section 318 of the Montana Water Quality Act (75-5-101) authorizes a short-term exemption from surface water quality turbidity standards.

- The Montana Water Quality Act (75-6-112) requires plan review and approval for a new public water supply that serves more than 25 people daily for a period of at least 60 days in a 1-year period.

- The Montana Open Cut Mining Act (84-4-401 et seq.) requires a permit for excavation 10,000 yd^3 (7,600 m^3) or more total aggregate from one or more pits, regardless of surface ownership.

In addition to the above, Montana has joined California, Washington, and Oregon in developing consolidated energy facility siting programs. For more details, see http://www.oregon.gov/ENERGY/SITING/compare.shtml.

Additional details regarding Montana regulations can be found at http://www.deq.state.mt.us/Energy/Renewable/WindWeb/DEQpermitsForWindEnergyPlan.htm.

3.7.2.4 Nebraska

Nebraska Revised Statutes 66-901, 66-902, 66-909, and 66-911 to 66-914 provide for the opportunity to establish an easement on adjacent properties to prohibit future developments that would preempt or hinder full access to wind resources. Easements are formally recorded on property deeds and enforceable by injunction or equity proceedings or other civil actions. Easements can be established for wind energy facilities of any capacity. Full text of the relevant sections of Chapter 66 of the Nebraska Revised Statutes is available at http://uniweb.legislature.ne.gov/laws/browse-chapters.php?chapter=66.

3.7.2.5 North Dakota

North Dakota Century Code Chapter 49-22 requires an applicant for a wind farm with a rating capacity of 500 kW or greater to apply to the North Dakota Public Service Commission (PSC) for a Certificate of Site Compatibility. The application must contain detailed information on the facility, including the environmental impact, the need for the facility, a comprehensive analysis supporting why the proposed location is the best suited for the facility, and mitigative measures for foreseen adverse impacts. The PSC's evaluation of the application extends to a wide variety of issues, including the effects on public health and welfare, natural resources and the environment, adverse direct and indirect impacts that cannot be avoided, direct and indirect socioeconomic benefits, existing plans for other developments in the area, the facility's impact on visual resources, and the presence of rare or endangered species on the proposed site that may be impacted. To the extent that the Commission is encouraged to "cooperate with and receive and exchange technical information and assistance from and with any department, agency, or officer of any state or of the federal government to eliminate duplication of effort, to establish a common database, or for any other purpose relating to the provisions of this chapter and in furtherance of the statement of policy contained herein," it is reasonable to presume that the information required of an applicant to successfully secure the necessary Certificate of Compatibility would be generally the same as that required to support an analysis in an EIS. The PSC's draft decision is subject to public review and comment. Additional details are available at http://www.legis.nd.gov/assembly/60-2007/docs/pdf/99021.pdf.

3.7.2.6 South Dakota

South Dakota Administrative Rules Chapter 20:10:22 et seq. require proponents of wind farms to apply for a permit to the South Dakota Public Utilities Commission. Applications must, in part, address the purpose and need for the facility; provide general descriptions of facility components, of the impacts on the physical environment and terrestrial and aquatic ecosystems, and of the impacts on water and air quality; and provide additional information related to wind turbines such as noise, reliability, warning lights, setbacks, clearing required, tower configurations, and interconnections to the transmission grid. The regulations also require the establishment of an escrow account sufficient to cover the cost of facility decommissioning. Additional details can be found at http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=20:10:22.

3.7.3 Other Relevant Federal Policies, Guidance, Executive Orders, and Proposed Rules

3.7.3.1 Department of Defense

On March 21, 2006, the Department of Homeland Security (DHS) Joint Program Office announced the formation of a Department of Defense (DOD) Wind Farm Action Team under the direction of the Director of Space and Sensor Technology, Office of the Deputy Secretary of Defense. The team was responsible for completing a congressionally directed report on the effects of windmill farms on the operation of air defense and homeland security primary radars and on possible mitigative actions. Until that report was issued, the DOD/DHS published policy was to “contest any establishment of windmill farms within radar line of sight of the National Air Defense and Homeland Security Radars” (DHS 2006).

On January 29, 2007, DOD revised its policy: “The DOD does not oppose the development of wind farms and other sources of renewable energy that do not adversely impact military readiness or training of U.S. Armed Forces.” The DOD promised further collaboration with the FAA and other regulatory agencies to evaluate wind farms on a case-by-case basis and to raise concerns where interferences are anticipated in order to mitigate or prevent those adverse effects through appropriate technologies and techniques (DOD 2007). No independent policy has been issued by the DHS.

A comprehensive report regarding the DOD position on wind farm interferences with primary and secondary military surveillance radar systems was submitted to Congress in 2006 in satisfaction of Section 358 of the National Defense Authorization Act for fiscal year (FY) 2006 (DOD 2006). Additional details regarding potential interferences to radar operations are provided in section 3.8.2.4.

3.7.3.2 Department of the Interior Bureau of Land Management (BLM)

In June 2005, BLM issued a PEIS for wind energy developments on BLM lands in the 11 western States (BLM 2005). The PEIS ROD addressed amendments to land use plans and established both policies and BMPs for wind energy developments on BLM lands. On December 19, 2008, BLM issued its Instruction Memorandum (IM) No. 2009-043 (BLM 2008), replacing IM No. 2006-216, which delineated BLM’s interim policy regarding wind energy facilities on BLM lands. The current IM provides updated guidance to BLM field offices in processing ROW applications for wind energy development on BLM lands, incorporating the policies and BMPs of the PEIS ROD. Under the current IM, applicants must secure a ROW for site meteorological monitoring (good for a period of 3 years) in accordance with Title V of the Federal Land Policy and Management Act (FLPMA). The applicant must also secure a permit for geotechnical evaluations (to support turbine foundation design decisions) in accordance with 43 CFR part 2920 regulations. A detailed plan of development (POD) must be submitted to secure the required separate ROW grant for facility development and operation (good for a period of up to 30 years). The POD must contain sufficient detail for BLM to conduct the necessary environmental analysis before a development ROW grant is issued.

The BLM has issued many program-specific documents addressing environmental issues relevant to wind energy projects and providing guidance on mitigation. 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), Areas of Critical Environmental Concern (ACECs), hazardous materials and waste management, cultural resource management, Native American consultations, pesticide use and integrated pest management, and occupational health and safety. Electronic copies of some of the BLM directives, manuals, and handbooks are available at http://www.blm.gov/nhp/efoia.

3.7.3.3 The U.S. Fish and Wildlife Service

In 2000, the Service issued interim guidance on the siting, construction, operation, and decommissioning of communication towers (Clark 2000), which has general applicability to meteorological towers. The Service established a Wind Turbine Siting Working Group in 2002 to develop comprehensive national guidelines for siting and construction of wind energy facilities. In October 2007, the Secretary of the Interior formed a Wind Turbine Guidelines Advisory Committee, which provided recommendations to the Department of the Interior in March 2010. Final Land-Based Wind Energy Guidelines based upon those recommendations were released by the Service in March 2012 (Service 2012).

3.7.3.4 Department of Agriculture Forest Service

On September 24, 2007, the U.S. Forest Service (USFS) published proposed directives for wind energy facilities (USFS 2007). When finalized, the directives would constitute two new chapters to the Special Uses Forest Service Handbook 2709.11: Chapter 70, "Wind Energy Uses," and Chapter 80, "Monitoring at Wind Energy Sites." The directives would establish two types of permits required for wind energy facilities, one for site monitoring and evaluation (good for a period of 5 years) and one for facility construction and operation (for a period of 30 years). Applicant proposals must include various resource considerations, including recreation, scenery, tourism, wildlife, fish, and rare plants, as well as specific controls for noise (<10 decibels [dB] at the nearest residence or campsite) and lighting (minimum number and intensity of white strobe lights at night with a minimum number of flashes per minute to satisfy FAA requirements; avoidance of solid or pulsating red incandescent lights; down-shielding security lighting to be confined to site boundaries; and minimizing or eliminating the need for security lighting). The proposed directives would also impose controls on construction (e.g., minimizing disturbed zone, rapid restoration, dust abatement, explosives use confined to certain times and distances to sensitive species, avoidance of wildlife reproductive activities). The directives would also require wildlife monitoring plans be developed and executed both before and after wind farm facility development and would require the developer to undertake adaptive management based on newly released scientific evidence and monitoring results. No schedule is available for release of the revised handbook.

3.7.3.5 National Telecommunications and Information Administration (NTIA)

NTIA is responsible for managing the Federal frequency spectrum for radio communications. In that capacity, NTIA works with the Federal Communications Commission (FCC) and with other Federal agencies to identify and resolve technical telecommunication interference issues. Although wind energy developers have no legal obligation to provide information to, or obtain approval from, NTIA, since December 1, 2006, NTIA has voluntarily served as the coordinator and clearinghouse for any interference concerns held by Federal agencies whose radio spectrum activities may be impacted by a proposed wind energy facility (NTIA 2006). Wind farm developers who provide details of their wind farm locations and configurations to NTIA can expect that NTIA will distribute such data to the other Federal agencies represented on the Interdepartment Radio Advisory Committee (IRAC) for comment and will forward comments and concerns, as well as agency points-of-contact information, to the wind farm developer so that any conflicts can be resolved directly between the developer and the IRAC member agency.

3.7.3.6 Executive Orders

Depending on activities, locations, and other circumstances, developers of a wind energy project may be required to consider requirements contained in Executive Orders. For example, the following Executive Orders may be deemed to apply to wind energy facilities for which a Federal permit is issued: Executive Order 11988, “Floodplain Management” (U.S. President 1977a); Executive Order 11990, “Protection of Wetlands” (U.S. President 1977b); Executive Order 12088, “Federal Compliance with Pollution Control Standards” (U.S. President 1978); Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (U.S. President 1994) (amended by Executive Order 12948 [U.S. President 1995]); Executive Order 13045, “Protection of Children from Environmental Health Risks and Safety Risks” (U.S. President 1997); Executive Order 13175, “Consultation and Coordination with Indian Tribal Governments” (U.S. President 2000); and Executive Order 13186, “Responsibilities of Federal Agencies to Protect Migratory Birds” (U.S. President 2001). Although directly applicable only to Federal agencies, Executive Orders often provide direction to those agencies for exercising authorities granted to them by Federal statutes; substantive elements of Executive Orders are, therefore, often reflected in implementing regulations. All Executive Orders can be electronically accessed at http://www.archives.gov/federal-register/executive-orders.

3.7.3.7 EPA Guidance on Noise and Local Nuisance Ordinances

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 dB. These levels are not to be construed as legally enforceable standards at the Federal level. However, State or local authorities may elect to adopt these standards for incorporation into nuisance ordinances. Additional discussions regarding wind farm noise impacts are provided in section 3.8.2.5.

3.8 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 3.2, the following sections identify physical hazards to workers and potential safety and health issues for the general public.

3.8.1 Occupational Hazards

Activities occurring during construction and operation of wind energy facilities typically involve major actions such as establishing site access, excavating and installing turbine tower foundations, erecting turbine towers, constructing the central control building and electrical substations, erecting meteorological towers, constructing access roads, and routine maintenance of the turbines and ancillary facilities. Although it involves a unique set of actions, decommissioning presents many of the same hazards to the workforce as construction. 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 is provided for through the Federal Occupational Safety and Health Act (OSH Act; 29 U.S.C. 651 et seq.) and enforcement of implementing regulations of the Occupational Safety and Health Administration (OSHA) (see CFR Title 29). Through their departments of labor, most States have developed equivalent regulations, as well as additional and sometimes more restrictive State-specific requirements directed at worker safety.

Many of the occupational hazards associated with wind energy projects are similar to those of the heavy construction and electric power industries (i.e., working at heights, exposure to weather extremes including temperature extremes and high winds, exposure to dangerous animals and plants, working around energized systems, working around lifting equipment and large moving vehicles, and working in proximity to 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 electrical burns).

Accident rates have been tabulated for most types of work, and risks can be calculated on the basis of historical industry-wide statistics for use in a site-specific impact assessment.

The U.S. Bureau of Labor Statistics (BLS) maintains data on the annual number of injuries, illnesses, and fatalities by industry type (defined as the North American Industry Classification System, NAICS). While the BLS does not break out wind energy projects as a specific industry type, it can be assumed that, in general, the types of activities required of employees constructing wind farms would be similar to those engaged in by workers in the heavy and civil engineering construction sector, NAICS 2379, “Other Heavy and Civil Engineering Construction.” Workers involved in the operation and maintenance of a wind farm most closely align with workers in the NAICS 221119 sector, “Utilities-Other Electric Power Generation,” and the NAICS 2389 sector, “Other Specialty Contractors.” The most recent data available from the BLS are for calendar year 2007. Table 3.8-1 provides data on fatalities, injuries, and illnesses among the workforces in those NAICS categories for calendar year 2007.

As discussed above, many of the hazards to the workforce during wind farm construction are similar to hazards of other types of construction. Likewise, some of the hazards associated

TABLE 3.8-1 Fatal and Nonfatal Injuries and Illness for Selected NACIS Categories for Calendar Year 2007

NAICS Category	NAICS Code	Total	Annual Average Employment (in thousands)	Total Workforce (in thousands)	Incidence Rate (per 100 full-time workers)
Fatalities					
Heavy and Civil Engineering Construction	237	216	10,001.0	–[a]	0.022
Utility System Construction	2371	97	443.4	–	0.022
Power and Communication Line and Related Structures Construction	23713	36	140.6	–	0.026
Other Heavy and Civil Engineering Construction	2379	20	112.5	–	0.018
Specialty Trade Contractors: Poured Concrete Foundation and Structure Contractors	23811	25	251.3	–	0.010
Utilities	22	11	548.9	–	0.002
Utilities: Other Electric Power Generation	221119		9.1	–	
Utilities: Electric Power Generation, Transmission, and Distribution	22112	4	162.2	–	0.003
Nonfatal Injuries and Illnesses					
Heavy and Civil Engineering Construction	237	49,049	–	1,001.0	4.9
Utility System Construction	2371	20,840	–	443.4	4.7
Power and Communication Line and Related Structures Construction	23713	6,889	–	140.6	4.9
Other Heavy and Civil Engineering Construction	23799	3,938	–	112.5	3.5
Specialty Trade Contractors: Poured Concrete Foundation and Structure Contractors	23811	15,581	–	251.3	6.2
Utilities	22	21,956	–	548.9	4.0
Utilities: Other Electric Power Generation	221119	428	–	9.1	4.7
Utilities: Electric Power Generation, Transmission, and Distribution	22112	7,948	–	162.2	4.9

[a] A dash indicates not applicable.

Sources: BLS (2009a,b).

with wind farm operations (including maintenance) are similar to operational hazards of other power-generating technologies. For those, numerous industry standards apply toward preempting or mitigating adverse impacts. However, additional operational hazards are unique to wind farms. The International Electrotechnical Commission (IEC), a worldwide organization for standardization in the electrical and electronic fields, is involved in developing numerous standards for wind turbine generating systems (WTGSs). While some of these standards are directed toward certifying turbines for their reliability of operation and the quality of the power being produced, many others are directed explicitly at wind turbine safety. Consequently, a review of the topics addressed in these safety-related standards provides a general appreciation of the hazards associated with operation. Safety-related standards published or under development include IEC 60050-415, “Wind Turbine Generator Systems”; IEC 61400-1, “Wind Turbine Safety and Design”; IEC 61400-11, “Acoustic Noise Measurement Techniques”; IEC 61400-13, “Mechanical Load Measurements”; IEC 61400-23, “Blade Structural Testing”; and IEC 61400-24, “Lightning Protection.”[39]

Because many of the operational hazards are in some way related to or exacerbated by local factors, in addition to standards development, the IEC requires WTGS manufacturers to provide an operator’s instruction manual with supplemental information on special local conditions. A typical manual includes system safe operating limits and descriptions, startup and shutdown procedures, alarm response actions, and an emergency procedures plan. The emergency procedures plan should identify possible emergency situations and the actions required of operating personnel. The emergency procedures plan should address, at a minimum, overspeeding, icing conditions, lightning storms, tornadoes, high winds, 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) 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 that produce AC would be used; thus, they would not create sparks like a brushing generator would in making direct current (Robichaud 2004). However, some potential for exposure to ozone exists in the vicinity of the facility’s substation and proximate to the high-voltage AC transmission line that connects the facility to the grid.[40] During facility decommissioning, potential worker exposures to paints and corrosion-control coatings dramatically decrease; however, the potential for exposures to fluids drained from some components (lubricating oils, coolants, dielectric fluids, etc.) and to solvents and cleaning agents used to purge and clean components in preparation for transport or recycling increases. However, the potential for such exposures is by no means excessive and is generally equivalent to the potential for exposure to such chemicals during typical industrial construction activities and generally equivalent to the

[39] All IEC standards are available for purchase from IEC at http://webstore.iec.ch/Webstore/webstore.nsf/mysearchajax?Openform&key=wind%20turbine%20generator%20system&sorting=&start=1. A convenient overview of IEC standards and the agendas of IEC Technical Standards Working Group is available from the AWEA Web site at http://www.awea.org/standards/iec_stds.html.

[40] In most cases, ozone formation is minimal, and only trained and authorized personnel would ever be in the vicinity of those components where ozone might be formed. Consequently, the potential for exposure to ozone is very limited for workers and negligible for the public.

potential during routine preventative maintenance of those same components. Appropriate procedures and properly trained and protected workers would provide adequate controls.

3.8.2 Public Safety, Health, and Welfare Impacts

Because of the expected establishment of adequate access controls that prevent entry to hazardous areas by unauthorized individuals, the great majority of adverse impacts during construction (including decommissioning) and operation of a wind energy facility have the potential to impact only the respective workforces of those phases. However, both positive and adverse impacts to public safety have been identified associated with the operation of wind farms. Positive impacts include an improvement to air quality from the possible displacement of other conventional forms of energy generation technology involving the combustion of fossil fuels. Such benefits are diffuse and may or may not be realized within the areas immediately adjacent to the wind farms. Conversely, adverse impacts from wind farm operations can be expected to accrue to individuals living within the immediate vicinity of a utility-scale wind farm. Those adverse impacts are discussed below.

Finally, some argue that wind farms adversely impact visual resources and property values. Visual impacts (including light pollution) are addressed in section 4.7. Impacts on property values, as well as other socioeconomic impacts, are addressed in section 4.10.

3.8.2.1 Physical Hazards

One of the primary physical 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 occurrences have been extremely rare and have happened mostly with older and smaller turbines (Hau 2000). Sophisticated controls on modern-day turbines (vibration monitors) would suggest that blade throws due to overspeeding are likely to remain a low-probability event. However, 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, historically, blade breakage is a rare event 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). Current quality control standards for blade fabrication for utility-scale wind turbines suggest that blade breakage will continue to remain a rare event.

A related issue, ice throw, can occur if ice builds up on the turbine blades. Unlike the leading edge of an aircraft wing that is equipped with devices such as expanding bellows that can remove accumulated ice, no wind turbine blade is so equipped. Although weather conditions relatively near the ground, where the blades would be working, rarely result in ice buildup on the blades, such buildup can and has occurred. Available data suggest that many factors determine the fate of ice that is thrown from a wind turbine blade. In most instances, ice pieces simply fall from the blade as the air temperature warms and land on the ground near the base of the tower. However, ice pieces as large as 2.2 lb (1 kg) have been found hundreds of meters from the tower base (Tetra Tech 2007; Wahl & Giguere 2006). However, intrinsic design limits the extent to which ice buildup is allowed to progress. As ice begins to form, the blade balance would be altered and monitoring devices would direct stoppage of the blade rotation to prevent damage to the blades or to hub bearings.

The typical response to reduce the risk of ice throw damage is establishment of a sufficient safety zone or setback from residences, roads, and other public access areas; such safety zones are often required by permitting agencies (Manwell et al. 2002). The typical formula for safe setback distance is 1.5 times the sum of the hub height and rotor diameter (Wahl & Giguere 2006). In addition to blade and ice throws, these setbacks may also mitigate potential noise and visual impacts (Gipe 1995). (See additional discussions on noise below.) 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 turbine towers, open electrical panels, or encounter other hazards. Typically, access to the nacelles is via ladders or elevators inside the turbine tower, and tower doors are kept locked. High electrical hazard areas such as switchyards and substations are typically fenced with locked gates and offer unauthorized entry opportunities equivalent to other similar facilities associated with power generating facilities or transmission systems.

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). Conformance with IEC standard requirements, including lightning protection for the turbine towers and for switchyards and substations provides adequate control of any potential fire hazards.

3.8.2.2 Electric and Magnetic Fields

Electric and magnetic fields may exist within substations and switchyards of the wind farm and along the transmission line that connects the facility to the grid. Portions of the wind farm where such fields may exist are generally not accessible to the general public; however, the public may have greater accessibility to transmission-related fields.

Extremely low-frequency electromagnetic fields (ELF-EMFs)[41] from natural and anthropogenic sources are so ubiquitous that there has been concern about potential adverse health effects from residential and occupational exposures (Ahlbom et al. 2001). Exposures to time-varying ELF-EMFs creates currents in the body proportional to the strength of the field. The strength of the field, the frequency involved, and the orientation of the body to the field combine to establish the level of potential risk to individual tissues and organs. Exposures to EMFs at frequencies greater than 100 kHz results in absorption of significant amounts of energy, leading to temperature rises in the affected tissues and other easily observable effects ranging from neural stimulation to adverse effects on nervous system functions and permanent debilitation of some body functions. However, electromagnetic fields in wind farms will be compatible with the frequency of the alternating current in the transmission system, which is maintained at only 60 Hz. On the basis of frequency alone, therefore, it appears that the fields

[41] Electric fields exist wherever an electric charge exists. A magnetic field exists when that charge is in motion (i.e., the flow of electrons to produce an electric current). Electric field strength has the units of volts/meter while magnetic field strength is expressed as volts/ampere. Both are vector quantities; i.e., they exist in specific directions.

likely to be encountered in a wind farm are below levels of concern. However, dose/response relationships associated with exposures to ELF-EMFs are not as readily apparent. At present, there is no scientific consensus regarding a cause-effect relationship between continued exposure to ELF-EMFs and adverse health consequences. The potential for chronic effects from these fields continues to be studied extensively; the National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE. The report by NIEHS (1999) contains the following conclusion: "The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults. While support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of a small, increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia. In contrast, mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although sporadic findings of biological effects have been reported. No indication of increased leukemia in experimental animals has been observed."

> "The NIEHS concludes that ELF-EMF (extremely low frequency-electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or noncancer health outcomes provide sufficient evidence of a risk to currently warrant concern."

A more recent study released by the World Health Organization (WHO) (2007) has come to similar conclusions regarding the health effects of EMF exposure and expresses similar levels of concern, advocating a continuation of similar types of research. Major conclusions of the study include:

- Categorization of ELF[42] magnetic fields as a possible human carcinogen should be retained while additional studies are completed and available data are reviewed.

- Chronic exposures to ELF electric and magnetic fields have not been shown to represent a health hazard. Although acute exposures have been shown to have biological effects, limiting exposures to levels at or below guidelines published by the International Commission on Non-ionizing Radiation Protection (ICNIRP) or the standards developed by the Institute of Electrical and Electronics Engineers (IEEE) (ICNIRP 1998; IEEE 2002) is believed to provide sufficient protection against these effects.

IEEE establishes separate occupational and general public maximum permissible exposures (MPEs) to uniform magnetic fields and to uniform electric fields. The Electric Power

[42] Here, ELF is defined as 0 to 100 Hertz (Hz). In the United States, AC modulates at a frequency of 60 Hz.

Research Institute (EPRI) (EPRI 2003) has provided the following convenient summary of the salient aspects of those standards: MPEs for magnetic fields are based on the field's potential to excite tissues in the brain, heart, and peripheral nerves. For magnetic fields, the whole body (head and torso) MPE for uniform 60-Hz magnetic fields is 2.71 milliTesla (mT) (27.1 gauss [G]), increasing to 63.2 mT (632 G) for arms and legs. For electric fields, because the body's threshold for sensing contact currents and spark discharges and perceiving the presence of an electric field occurs at much lower levels than the levels required for electrostimulation of internal tissues and organs, the MPEs are based not on the body's internal response to the induced field but instead on an individual's sensory responses to external conditions. Thus, MPEs for whole-body electric field exposures are based on empirical data for the external conditions under which aversive shocks from spark discharges and contact currents and annoying field perceptions occur. The MPEs are defined as a function of frequency of the alternating current with exposure limits (expressed as volts/m) increasing with increasing frequency. Up to a frequency of 272 Hz, the worker's MPE is 20 kV/m, and the general public's MPE is 5 kV/m. The general public's MPE anywhere within the ROW of high-voltage transmission lines is 10 kV/m.

Very little definitive data are available regarding the ELF-EMF present in the occupational environment for wind turbine technicians. Four critical areas have been identified within a typical wind farm at which electromagnetic fields exist: (1) at the point of power injection into the high-voltage transmission or distribution grid, (2) in the vicinity of the generator in each turbine's nacelle, (3) in the vicinity of any electrical transformer (i.e., transformers located at individual turbines, as well as those in the central power conditioning facility of the wind farm), (4) or in the vicinity of the power cables connecting the turbines to the central power conditioning facility.

A study conducted in October 2004 measured the electromagnetic fields at these critical locations at a generally representative wind farm outside Toronto, Canada (Iravani et al. 2004). Because the individual turbine generators are typically surrounded by the metallic walls of the nacelle located at the top of the turbine tower, generator-induced electromagnetic fields at ground level are negligible. A magnetic field strength of 0.4 milligauss (mG) was present at the access door of the steel tower of an operating turbine, and no magnetic fields were detected at the ground level at a distance of 25 ft (7.6 m) from the base of the tower. The turbines in this particular wind farm were each equipped with their own step-up transformer located at the base of the tower. Magnetic fields fell to negligible levels outside of 10 ft (3.1 m) from those transformers. Because of the closeness of the phased conductors, the network of buried power collection cables (in this instance, maintained at 600 volts AC) produced virtually no magnetic field at the ground surface immediately above a buried conductor.

The Centers for Disease Control's National Institute for Occupational Safety and Health (NIOSH) has published the median and average daily range of exposures to magnetic fields by various types of workers (table 3.8-2).

Comparison of the measured field strengths of a typical wind farm discussed above with NIOSH's median and average range of field exposures for various types of workers suggests that, during periods of normal operation, magnetic field strengths within a wind farm would be far below the IEEE MPEs for technicians. Likewise, adequate physical barriers preventing access to hazardous areas by unauthorized individuals can be expected to keep exposures of the general public to well below applicable MPEs.

TABLE 3.8-2 Average Magnetic Field Exposures for Types of Workers (in mG)

Type of Worker	Average Daily Exposure	
	Median	Range
Clerical workers without computers	0.5	0.2–2.0
Clerical workers with computers	1.2	0.5–4.5
Machinists	1.9	0.6–27.6
Electric transmission line workers	2.5	0.5–34.8
Electricians	5.4	1.7–34.0
Welders	8.2	1.7–96.0
Workers off the job (equivalent to general public)	0.9	0.3–3.7

Source: NIOSH (1996).

3.8.2.3 Electromagnetic Interference to Communications

Wind turbines have the potential to interfere with electromagnetic signals that make up a large part of modern communication networks (Burton et al. 2001). In addition to radar (discussed separately below), electromagnetic interference (EMI) 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).

The National Research Council (NRC 2007) provides the following additional details. EMI interference from wind turbines can be passive (the wind turbine presents a physical obstacle to the direct-line propagation of an electromagnetic wave, creating a shadow behind the turbine), or it can be the result of destructive interference by electromagnetic emissions from the turbine. Television signals (50 MHz to 1 GHz), radio broadcasts (1.5 MHz amplitude modulated [AM] to 100 MHz frequency modulated [FM]), microwave (3 to 60 GHz), mobile cellular phones (1 to 2 GHz), and radar signals can all suffer interferences; however, the mechanisms of those interference events is subtly, but significantly, different for different types of electromagnetic signals. Television signals tend to be scattered and/or reflected by the tower, nacelle, and especially the blades; however, such disruptions occur only in a relatively small area and only when the turbines are within 328 ft (100 m) of the signal source. Likewise, interference with AM or FM radio signals is typically negligible, occurring only within a short distance of the turbine (within tens of meters). Fixed radio and microwave links that rely entirely on straight-line propagation and uninterrupted line-of-sight between transmitter and receiver can be significantly affected, if the geometries are such that a wind turbine presents a complete physical blockage of the narrow electromagnetic waves of these systems. Further, not only the turbines themselves, but also the areas immediately adjacent to the turbines (the Fresnel zone) can produce signal blockage. Wind turbine impacts on cellular phone signals are entirely the result of physical blockage and are entirely dependent on the relative positions of the transmitter (or repeater), the turbine, and the cell phone; however, interferences are typically minimal or can be mitigated simply by moving the cell phone a short distance.

Finally, the materials of construction can affect the turbine’s interference potential, depending on whether the material absorbs or reflects incident electromagnetic waves. EMI from wind turbines is affected by blade construction and rotational speed (Manwell et al. 2002).

Modern blades made of glass-reinforced epoxy (a nonpolar, nonconducting material similar to fiberglass) would not be expected to create any electrical disturbance. However, lightning protection on blade surfaces, as well as metallic elements within the body of the blade that are part of the blade's pitch control mechanism, can introduce blade EMI (Manwell et al. 2002).

3.8.2.4 Radar Interference

Three primary radar[43] systems are potentially impacted by wind turbines: military readiness radar (also known as air defense radar and/or missile warning radar), air traffic control (ATC) radar operated by the FAA, and weather surveillance radar (WSR)[44] operated by the National Weather Service (NWS).[45] Military radar and ATC radars function as primary surveillance radars (PSRs) designed to identify the position of a target in either two dimensions (range and angle from true north) or three dimensions (additionally, elevation above the earth), using either a single antenna or multifaceted antennae (a phased array). All ATC radar systems also operate in conjunction with a secondary surveillance radar (SSR) (also known as an ATC beacon interrogator [ATCBI] radar) that not only confirms an airplane's position, but recognizes it by tracking a unique radio signal beacon originating from the aircraft.

All radars rely on a line of sight between the radar signal source-receiver and the target being monitored. As they do with other forms of direct line-of-sight electromagnetic communications, wind turbines can interfere with radar by attenuating all or a portion of the radar signal through physical blockage, absorption, reflection, and/or diffraction. Tall buildings, microwave towers, smokestacks, mountains, hills, and other tall objects in the radar line of sight (RLOS)[46] can also have similar interactions with incident radar beams. Each will present a unique "radar cross section" (RCS) based on its dimensions and orientation (both bearing and elevation) to the beam. Radars in almost every location will have to cope with down-range objects that produce interference, what is typically described by the television meteorologist as "ground clutter" or "false echoes," while the real-time Doppler weather radar sweep is displayed on the screen.

All components of the wind turbine contribute to its RCS, with the tower being responsible for 75 percent, the blades 20 percent, the nacelle 4 percent, and the rotor 1 percent of the RCS (of a stationary turbine, all values approximate) (Seifert and Myers 2008). However,

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[43] The term radar originated as an acronym: RAdio Detection And Ranging. However, because of common usage, it is no longer used as an acronym, but simply as a common word in today's vernacular.

[44] Weather surveillance radars are sometimes referred to as Weather Surveillance Radar-1988 Doppler (WSR-88D) or Next Generation Radar (NEXRAD). All WSRs are operated under the authority of the Radar Operations Center (ROC) of the NWS, an office of the National Oceanic and Atmospheric Administration (NOAA), and support the weather-related programmatic interests and responsibilities of the Departments of Commerce, Defense, and Transportation.

[45] Radar used for ship navigation is also potentially affected. However, no circumstance in which this would be the case is possible within the UGP Region under consideration here, so this aspect of radar interference will not be discussed. This interference scenario does have relevance to off-shore wind farms and has been the subject of focused studies. See the report recently submitted to the Coast Guard regarding the Cape Wind Project (MMS 2009).

[46] RLOS is also sometimes referred to as the radar's beam width. The radar beam propagates as an expanding cone such that, at a distance of 60 mi (97 km) from the radar, the RLOS or beam width is approximately 1 mi (1.6 km) wide (Vogt et al. 2008a).

the wind turbine presents a somewhat more complex RCS than a completely stationary structure because of the possible variations in nacelle orientations[47] and the rotation of its blades.[48] Although the rotors of modern-day wind turbines only rotate over a range of 10 to 20 revolutions per minute (rpm), the blade tips of exceptionally long blades can be traveling at velocities of 130 to 260 ft/s (89 to 177 mph) (40 to 80 m/s). The size and speeds of the blades result in a relatively large RCS (in some cases, as large as a wide-body aircraft)[49] and cause the reflected signal to be interpreted as a large moving object. A study completed in 2003 for the Department of Trade and Industry (DTI) of the government of the United Kingdom also established that the RCS of a wind turbine varies significantly over time, with the entire RCS profile repeating three times per rotor revolution (for a front-facing, three-bladed turbine) (DTI 2003). Further complications result from the fact that wind turbines not only reflect but also diffract incident radar beams. Because wind farms typically involve an array of multiple turbines within a relatively small area, these diffracted beams will interact both constructively and destructively with beams diffracted off of other turbines in the wind farm, sending multiple false returns and creating substantial radar shadow zones downrange of the wind farm within which the radar's ability to detect a critical target is compromised.

A report to Congress issued by the Department of Defense (DOD 2006) recounted the various studies conducted in both the United Kingdom and the United States[50] and summarized the collective empirically based conclusions:

- Wind farms degrade the performances of military and ATC PSRs in their ability to detect and track targets, especially in the near field, due to two principal mechanisms: the relatively large diffraction-induced shadow zone and the dramatic increase in the complexity of clutter, both resulting primarily from multiple turbines within a relatively limited zone.

- Increased clutter levels raise detection and tracking thresholds and increase the possibility of false target returns.

- During adverse weather conditions, wind farm–induced clutter may require reducing the sensitivity of the ATC PSR radar to maintain functionality, but nevertheless at degraded levels of performance.

- During adverse weather conditions, wind farm–induced clutter can degrade the performance of ATC PSRs even along flight paths not coincident to the axis of the wind farm to the beam.

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[47] The nacelle is stationary a great majority of the time or rotating slowly enough to be perceived by the radar as stationary. However, nacelles made up of plastic composite materials can be partially transparent to radar signals, allowing the components inside the nacelle to interact with the beam.

[48] Blades can also be made of radar-absorbing or radar-transparent materials, but would typically also have metallic components and would therefore not be invisible to radar, whether rotating or not.

[49] For perspective, the average RCS (in square meters/square ft) for birds is 0.01/0.11; man, 1.0/10.8; jumbo jet, 100/1076; and ocean-going ship, 10,000/107,600. The RCS of small aircraft can vary from 10.76 to 107.6 ft^2 (1 to 10 m^2). Wind turbines' RCSs can vary from >100 m^2 to <10,000 m^2 (DTI 2003).

[50] The described studies were all conducted with the full cooperation and involvement of the wind farm operators. The exact operating conditions of the turbines during the period of the tests are essential inputs into data analyses.

- Diffraction-induced shadow zones, as well as increased clutter complexity, exist within relatively localized areas around the wind farms.

It is important to note, however, that a degradation of PSR capability for ATC radars does not imply an immediate and significant increase in danger since all airports employ PSR (ATC) as well as SSR (ATCBI) to confirm the positions of inbound and outbound aircraft, and aircraft beacons monitored by ATCBI are not impacted by the presence of a wind farm within the monitored space of the PSR.[51] This is not the case for PSRs operated as air defense and missile warning systems that cannot rely on the redundancy of a complementary SSR. Consequently, the missions of these systems, detection of incoming aircraft or missiles of unidentified origin, could be compromised by the presence of wind farms within these PSR-surveilled air spaces.

WSR is also a PSR. However, because of its unique operational mechanism and its lack of SSR redundancy, it is especially vulnerable to wind turbine interferences. WSRs rely on the phenomenon of Raleigh scattering to identify precipitation in the atmosphere and use comparisons and filtering of returns from pulsed signals over time to identify Doppler frequency shifts indicative of the motion and direction of storms. The ROC of the NWS has commissioned numerous studies to investigate potential impacts on NEXRAD[52] performance and has developed programs to collaborate with Federal agencies and private wind farm developers to anticipate and mitigate those impacts. The results of weather radar-related investigations and experiences are summarized below.[53]

NEXRAD WSR-88D radars can be impacted by wind turbines in three ways:

- Simple blockage of all or a portion of the beam by any turbine within the RLOS, resulting in attenuation of data from down-range objects;

- Increased clutter resulting in contamination of critical base radar reflectivity data used by the radar's algorithms (mathematical expressions used by the radar's computer to process and interpret radar return data) to estimate rainfall and detect certain storm characteristics; and

- Impacts on the velocity and spectrum width of data that is also critical to determining the presence of certain storm systems.

Vogt et al. (2008a) confirms that false returns from wind farms can confuse forecasters and lead to anomalous precipitation accumulations or false detection and inaccuracies in mesocyclone and tornado detection. Turbines located within 10 mi (16 km) of NEXRAD radars

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[51] However, a report published by the Department of Commerce's NTIA notes conflicting data regarding possible interference by wind farms with ATCBI performance (Lemmon et al. 2008).

[52] The NEXRAD program is under the joint control of the Departments of Commerce, Defense, and Transportation. The NEXRAD program operates 153 weather radars across the United States that provide critical data regarding the presence and movement of severe weather systems. The data is also distributed to many other users, including emergency managers, the FAA (for air traffic control and routing), television stations, and the general public.

[53] Information on the full spectrum of activities of the NWS's ROC can be found on its Web site at http://www.roc.noaa.gov/nexrad.asp.

can introduce additional complications as a result of inter-turbine scattering and multi-trip/multi-path returns that can extend the apparent range of false wind farm echoes down range for distances up to 25 mi (40 km). Although NEXRAD algorithms are capable of recognizing and discounting stationary objects, weather systems and wind turbines present themselves as objects in motion, so simple subtraction of wind farm-related returns is not possible without risking the loss of returns from critical weather systems (NOAA 2009a). At the least, simultaneous returns from wind turbines and approaching storms can create a dilemma for weather forecasters who are expected to accurately report on approaching severe weather without a loss of credibility that would result from repeated warnings based on false or misinterpreted returns due to wind farm interference.

NWS studies have also determined impacts on wind farms and wind farm personnel from nearby NEXRAD radars. NEXRAD radar operates at a peak power of 750 kilowatts (kW)[54] (NOAA 2009b). Workers on wind turbines located within 600 ft (183 m) of the radar antenna and aligned with the primary radar beam can experience radio frequency energies in the microwave region of the electromagnetic spectrum (frequencies as high as 60 GHz) that exceed the OSHA occupational exposure thresholds. At that distance of separation, full beam blockage can occur, as well as damage to the electronics of both the radar and the turbine (Vogt et al. 2008a), making it highly improbable that a wind turbine would ever be sited that close to a radar installation. A turbine as far away as 10 mi (16 km) can experience interferences due to inductive coupling within the turbine's improperly shielded electronic controls (NOAA 2009b).

In 2006, the ROC began systematic efforts to investigate radar–wind farm interactions and preempt performance-impacting interferences. These efforts have included the formation of Federal interagency working groups to conduct studies of possible technical solutions and improve outreach to and collaboration with the wind industry.[55] Four distinct strategic areas of study have been defined:

- RLOS modifications,

- Wind turbine RCS modifications,

- Radar computer software enhancements, and

- Multiple radars to provide overlapping coverage of critical zones.

RLOS modifications focus on terrain features between the radar and the wind farm. Even on what would be termed "level ground" and despite the fact that the atmosphere refracts the radar beam down toward the earth as it propagates, the curvature of the earth can provide effective masking at sufficient separation distances.[56] Entering the height of the focal length of

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[54] The time-averaged additive power of transmitted and returned signals can be as high as 1,500 W in areas immediately in front of the radar.

[55] See Vogt et al. (2008a) for an overview of the NEXRAD program and more detailed discussion of ROC activities.

[56] Radar practitioners routinely rely on the "4/3 Earth Rule" to account for the effect of atmospheric refraction on RLOS boundaries, which consists of multiplying the earth's radius by a factor of 4/3 to approximate the tangent line that defines the lower portion of the RLOS. Even with refraction bending that tangent line back toward the earth, the curvature of the earth will eventually allow even the tallest wind turbines to remain "below the radar."

the radar beam, the height of the tallest portion of the wind turbine (a blade tip when oriented straight up), the effect of atmospheric refraction, and the curvature of the earth into a relatively straightforward geometric equation in what is termed the “bald earth” approach allows an estimation of the minimum distance at which a wind turbine of a particular dimension would fall below the RLOS. For example, for a radar beam whose focal point is 50 ft above the ground and a wind turbine whose rotor’s apex is 300 ft above the local terrain, a separation distance of approximately 30 nautical mi (34.5 statute mi) (55.6 km) would be sufficient to remove the turbine from the RLOS. Intervening terrain features such as hills or mountains can also provide “terrain masking,” ostensibly at lesser separation distances, although estimating the extent of masking of this type requires a somewhat more complex geometric calculation. Similar to terrain masking, “terrain relief,” which occurs when the radar’s elevation is significantly higher than the ground level at the wind farm, can also be effective.[57]

Wind turbine RCS modifications would involve modifying the shape of some wind turbine components and/or using radar absorbing materials (RAM) in the construction of critical components. Some such modifications can be accomplished with little to no additional cost. For example, it has been found that simply changing the shape of the tower without introducing RAM can result in the blades rather than the tower becoming the dominant contribution to a much reduced RCS (BERR 2008).[58] Preliminary studies into the use of RAM in blade construction have also shown promise; however, field testing of a prototype has not been performed. Full implementation of “stealth technology” is likely to be beyond the economic resources of the wind farm developer, and some changes made to reduce RCS might actually be counterproductive to the wind turbine’s primary function (e.g., changing the shape of the blade or constructing it out of RAM may reduce its energy-capturing efficiency or prevent the application of full blade-length pitch controls).

Enhancements to radar computer software that could provide mitigation would include the use of finer clutter cells[59] to reduce the sensitivity to wind farm-induced clutter, additional or adaptive Doppler filters, and adapting special clutter suppression algorithms developed for other interference scenarios to wind farms. Tests of Lockheed Martin’s TPS-77 radar have demonstrated that new computer software and an architecture that uses multiple vertical radar beams has dramatically reduced wind farm–induced clutter (Lockheed Martin 2010). The new radar was recently deployed (November 2011) in the United Kingdom’s Ministry of Defence surveillance network in the vicinity of one of the world’s largest offshore wind farms to overcome wind turbine interferences (Defense Industry Daily 2012).

Another mitigation approach involves the use of a second radar to eliminate the wind turbine–induced shadow zones observed by the primary radar. Placed to the side of the wind

[57] Radar on a mountain ridge with the wind farm located in an adjacent valley represents an effective terrain relief scenario. Unfortunately, both radar operators and wind farm operations would prefer the mountain ridge location to maximize the performance of their respective systems.

[58] BERR, the Department for Business Enterprise and Regulatory Reform, is an agency of the British government. The enterprise Directorate works with the British central government, regional development agencies, and the private sector to support entrepreneurs and small businesses. More details are available at http://www.berr.gov.uk/whatwedo/enterprise/index.html.

[59] Radar computers divide the surveillance area into “resolution cells” and separately process return signals emanating only from those cells. The size of the resolution cell determines the accuracy with which the radar can locate a target. Radars operate in three primary frequency bands, 10 GHz, 1 GHz, and 3 GHz, with the higher frequency radars providing the greatest resolution (i.e., smallest sized resolution cells).

farm, this second radar can ostensibly monitor the shadow zones of the first radar, or when placed within the footprint of wind farm and operated at a high azimuth angle, it may help remove clutter zones from above the wind farm. Although the approach is geometrically straightforward, synchronizing the observations of two or more radars, dealing with the multiple diffracted returns, and integrating the processing results of multiple radars is a daunting task. Only one field trial of this concept has been attempted, and the preliminary results suggest that substantial and fundamental changes would be required of both radars before such a concept could be successful (DOD 2006).[60]

Finally, practitioners in the field conclude that mitigation techniques developed for other tall objects appear to have the greatest potential for applicability to wind farm impact mitigations, albeit with likely modifications. However, as with those other impact scenarios, there is no universal solution, and mitigation will continue to be a very site-specific exercise that must involve the wind farm operator. Consistent with this conclusion, the DOD, FAA, and NWS offer consultation services at the proposal stage for a new wind farm to identify, avoid, or mitigate adverse impacts on critical radar installations. The FAA's Obstruction Evaluation/Airport Airspace Analysis has recently developed an online tool that wind farm developers can use to obtain an initial evaluation of the potential impacts of their wind farms on Air Defense and Homeland Security radars.[61] A similar evaluation tool is under development for NEXRAD radars (Vogt et al. 2008b).

3.8.2.5 Low-Frequency Sound, Infrasound

In addition to mechanical and aerodynamic sounds produced in the audible range (see section 4.5), wind turbines are capable of generating low-frequency sound waves (Hau 2000). Because wind turbine noise profiles are typically established by measuring sound pressure levels (SPLs), expressed in decibels in the A-weighted scale (dBA) (to coincide with the audible range of a representative healthy individual),[62] the lowest frequencies of the profile often have gone uncharacterized. Low-frequency sound is considered to have frequencies in the range of 20 to 80 Hz, and infrasound frequencies range from 1 to <20 Hz (ACGIH 2001). Infrasound and low-frequency sound are ubiquitous, especially in the urban environment. Both can originate from natural sources (e.g., earthquakes, wind, ocean waves, and any other natural motions that result in the slow oscillations of air) and a variety of anthropogenic sources (e.g., automobiles, industrial machinery, and especially slow-moving fans and household appliances) (Leventhall 2003, 2006). Because low-frequency noise and infrasound have numerous sources and propagate efficiently over long distances without significant attenuation, their effects (including those on human health) can be far-reaching and have been the subject of

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[60] However, weather forecasters now routinely use the results from multiple radars to observe the position and motion of storms from different perspectives. Nevertheless, those radars are operating independently of each other, and their processing results are not integrated.

[61] See https://www.oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp?action=showLongRangeToolForm.

[62] It has been generally held that the frequency range of audible sounds in healthy individuals is from 20 Hz (low tones) to 20,000 Hz (20 kHz). However, 20 Hz is more correctly the lower frequency limit for which standardized equal loudness hearing contours can be distinguished by the average individual. Auditory responses have been documented to frequencies as low as 1.5 Hz. The transition from audible sound to nonauditory perceptions of infrasound is gradual, and the two regions cannot be easily distinguished (Leventhall 2006).

considerable research. Most individuals perceive infrasound as both auditory and tactile (vibration) stimuli.

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). More recently, van den Berg (2005) postulated that one source of low-frequency sound was the result of each rotor blade passing in front of the tower, where it encounters sudden differences in air flow. This causes a modulation of the amplitude of the aerodynamic sound made by the blade, resulting in what is known as blade swish. Further, van den Berg established that the effects of blade swish include a “beat,” described by most observers as a thumping or whooshing, whose frequency generally coincides with the frequency of the rotor blades passing in front of the tower (1 Hz for modern-day turbines whose blades are rotating at approximately 20 rpm) and that this beat is most pronounced during periods of greatest atmospheric stability (e.g., early evening hours when the effects of uneven daytime heating have subsided and other daytime ambient sounds have diminished).[63] However, the AWEA (2009a) disputes the infrasound component of blade swish.

The low-frequency components of blade swish allow propagation over large distances without significant attenuation. Measurements and observations made during quiet nights of noise from a 17-turbine wind park in Germany confirmed that the low-frequency thumping associated with blade swish could be clearly perceived at distances between 500 and 1,000 m from the nearest turbine, while during daytime with the same turbine operating, such noise is barely perceptible at those same locations (van den Berg 2003). Further, the SPLs of infrasounds emanating from each turbine can have an additive effect when their blade rotations are in phase (i.e., each turbine experiencing a blade passing by its tower simultaneously), but at any given location, only a few of the turbines are likely to dominate the observed sound emission.

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 reported a sensory perception of sound, experiencing the sound not only with their ears but also as a vibration in their bodies or in external objects. Conclusions of this study support 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.

As a result of his 2003 review of published literature on the effects of low-frequency sound on humans, Leventhall (2003) concluded that the primary effect of infrasound appears to be annoyance; however, Leventhall (2006) also noted that aural pain can result from displacements of the middle ear system beyond comfortable limits and that the onset of aural pain for most individuals is a loudness level of 165 dB at 2 Hz, reducing to 145 dB at 20 Hz. Static pressure produces pain at 175 to 180 dB, and eardrum rupture occurs at 185 to 190 dB.[64]

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[63] However, during such periods, while winds at the surface tend to be light to nonexistent, winds at the turbine’s rotor hub height are still within the operating (i.e., power-producing) range of the turbine. Further, such atmospheric conditions may also include temperature inversions (i.e., increasing air temperature at higher elevations), causing any sound emitted into the air to bend down toward the earth’s surface.

[64] The use of high-intensity infrasound or ultrasound (frequencies >20 kHz) as a source of pain and incapacitation is the basis for nonlethal acoustic weapons that have been investigated.

A comprehensive study undertaken by the NIEHS (2001) reviewed the results of 69 separate studies conducted on people to that point and concluded that, while most studies reported some effects attributable to infrasound (changes in blood pressure, respiratory rate, and balance as well as some loss of hearing), most such effects were observed at SPLs above 110 dB. NIEHS further concluded that the lack of consistent controls in study methodologies and measurements, including a failure of most studies to properly characterize all critical aspects of the environment being studied (including other sound sources), prevents the studies from being applied collectively to any definitive conclusions regarding safe levels of infrasound exposure.

In his review of the open literature, Waye (2004) identified many studies that established apparent linkages between infrasound and a variety of conditions, including sleep disorders, concentration difficulties, irritability, and tiredness. Waye also reported on both empirical and experimental studies that appeared to confirm these relationships. However, Waye also cautions that the number of studies on which to base conclusions regarding cause-and-effect relationships between low-frequency sound and certain conditions is relatively small and that, further, the lack of international standards results in important differences in how each of the studies described the exposure scenarios, making direct comparisons between the studies sometimes difficult or inappropriate. While the lack of standardized experimental methodologies for studying the effects of low-frequency sounds on sleep prevents conclusions on the effects of objectively measured sounds, subjective data gathered through field observations do support the conclusion that low-frequency noise at sound pressure levels as low as 26 to 36 dBA and 49 to 60 C-weighted decibels (dBC) inside dwellings does disturb sleep.

At the conclusion of a comprehensive review of reports of adverse health impacts on individuals living near wind turbines at least 164 ft (50 m) high with capacities between 0.75 and 2.0 MW, Frey and Hadden (2007) confirmed that myriad circumstantial factors contribute to the generation and propagation of infrasound from wind turbines and concluded that minimum separation distances between utility-scale wind turbines and occupied residences are minimally warranted to prevent adverse health impacts, and should be proportional to the size of the turbine, recommending at least 1.25 mi (2 km) for a 2-MW turbine. Despite the large number of reports of disturbances experienced by individuals living in close proximity to wind turbines, Frey and Hadden also concluded that such reports remain largely anecdotal and that a systematic study to precisely equate infrasound from wind turbines with adverse health impacts was still lacking.

More recently, however, some medical professionals and acousticians have expressed more significant and more pointed concerns regarding exposure to infrasound even at SPLs typically present near wind turbines. It has long been established that exposure to high-intensity levels of infrasound and low-frequency sound can cause physiological damage, manifested by a wide variety of symptoms and maladies often diagnosed collectively as vibroacoustic disease (VAD).[65] Although intensity levels of infrasound from wind turbines are thought to be generally low, others have pointed to evidence that a cause/effect relationship exists between wind

65 VAD has been recognized and studied since 1980. It is thought to be caused by excessive exposure to high-intensity infrasound and low-frequency noise at or below 500 Hz. Symptoms include homeostatic imbalance, interference with behavior and performance, visual performance, epilepsy, stroke, neurological deficiencies, physic disturbances, thromboembolism, central nervous system lesions, vascular lesions, lung fibrosis, mitral valve abnormalities, pericardial abnormalities, malignancy, gastrointestinal dysfunction, rage reactions, and suicide.

turbine–generated infrasound and VAD-like symptoms and conditions observed in individuals living in proximity to utility-scale wind turbines (Alves-Pereira and Castelo Branco 2007a,b; Todd et al. 2008).[66]

Mitigation options are limited. Low-frequency sound emissions that are part of rotor aerodynamic noise can be reduced by careful turbine design that reduces flow velocity and turbulence and optimizes rotor clearance to the tower (Hau 2000). 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). However, the establishment of a sufficient infrasound safety zone or setback from occupied residences is more difficult, given the myriad circumstantial and atmospheric conditions that affect its propagation and attenuation.

There currently are no regulations specific to limitations on infrasound exposure levels; however, there are the following recommendations offered by authoritative bodies.

- The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that except for impulsive sound with durations of less than two seconds, one-third octave levels for frequencies between 1 and 80 Hz should not exceed a SPL ceiling limit of 145 dB, and the overall unweighted SPL should not exceed a SPL ceiling limit of 150 dB; no time limits are specified for these recommended levels (NIEHS 2001).

- The WHO also acknowledges that methodologies that characterize noise profiles but do not fully characterize low-frequency noise and infrasound are deficient and should not be used as a basis for determining acceptable levels of noise exposure. In its publication (WHO 1999) "Guidelines for Community Noise," WHO offers the following observations and recommendations:
  - Governments should consider the protection of populations from community noise as an integral part of their policies for environmental protection.
  - Governments should consider implementing action plans with short-term, medium-term, and long-term objectives for reducing noise levels.
  - Governments should adopt the health guidelines for community noise as targets to be achieved in the long term.
  - Governments should include noise as an important issue when assessing public health matters and support more research related to the health effects of noise exposure.
  - Legislation should be enacted to reduce SPLs, and existing legislation should be enforced.
  - Municipalities should develop low-noise implementation plans.
  - Cost-effectiveness and cost-benefit analyses should be considered as potential instruments when making management decisions.
  - Governments should support more policy-relevant research into noise pollution.

[66] However, a survey completed by the Canadian Wind energy Association (CanWEA) in 2008 noted that the most recent studies published in peer-reviewed journals have failed to confirm cause/effect relationships between wind turbine sound and adverse human health impacts (CanWEA 2008). Skeptics of VAD persist; see the discussions later in this section.

While not offering a limit for safe exposure to infrasound, WHO also acknowledges that noise occurring at night (when there are low background noise levels), especially noise with significant low-frequency components, may have significant psychological impacts even at SPLs as low as 30 dB (indoors) and 45 dB (outdoors).

Pierpoint (2006) defines the term “wind turbine syndrome” to refer to the collection of symptoms most often observed in individuals living near wind farms:

- Sleep problems, either audible noise or physical sensations of pulsation or pressure making sleep difficult and causing frequent awakening;

- Headaches occurring in frequency or severity;

- Dizziness, unsteadiness, and nausea;

- Exhaustion, anxiety, anger, irritability, and depression;

- Problems with concentration and learning; and

- Tinnitus (ringing in the ears).

Pierpoint further points out that not everyone displays these symptoms, while others living as much as a mile away are affected, suggesting differences in sensitivity and susceptibility within the general population. However, epidemiologic studies that could quantify the fraction of the population at risk in any given scenario have not been completed.

During the most recent review of this matter, in 2009, AWEA and the Canadian Wind Energy Association (CanWEA) established a scientific advisory panel comprised of medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom to undertake a comprehensive study of currently available literature and data regarding wind turbine syndrome and other sound-related impacts thought by some to be associated with wind turbines. The study (Colby et al. 2009) included reviews, analyses, and discussions of peer-reviewed literature on sound and health effects in general and on sound produced by wind turbines, focusing in particular on the data assembled by Pierpoint in formulating the “wind turbine syndrome” hypothesis, which at this point is not a recognized medical diagnosis. Regarding Pierpoint’s studies and conclusions, the panel found the supporting methodology biased in its selection of individuals to be included in surveys and in its failure to establish a control group. The panel conceded that an annoyance response to wind turbine noise no doubt exists, but with great individual variability, and dismissed the case series of ten families’ experiences on which Pierpoint based her hypothesis as being of limited value in drawing causal connections between sound exposures to wind turbines and health effects. The panel’s consensus conclusions included the following:

- There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.

- The ground-borne vibrations from wind turbines are too weak to be detected by humans or to affect them.

- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

Establishing setback distances appears to be the most immediately available mitigation of adverse infrasound exposures that may result from one's proximity to utility-scale wind turbines. However, because of the low attenuation of infrasound with distance, establishing such setbacks may be impractical in some instances. A better understanding of the actual sources of infrasound would necessarily precede development of other mitigations. If, as some suggest, infrasound waves are created as each blade passes through the turbulent area in front of the tower, redesign of the turbine to extend the plane of the blades a greater distance from the front of the turbine tower may provide some improvement. However, since most noise profiles extend only to the audible spectrum, characterization of the infrasound profiles of utility-scale wind farms (i.e., measurements taken in the G-weighted scale rather than the A-weighted scale) may also be a necessary first step toward mitigation. As suggested by Colby et al. (2009), the variability of the extent of individual annoyances may suggest that no mitigations would be warranted in some situations.

3.8.2.6 Shadow Flicker and Blade Glint

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 AWEA (2009b) 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, and for how many hours in a year, a flickering shadow will fall on a given location near a wind farm (AWEA 2009b). While the flickering effect may be considered an annoyance, there is also concern that the variations in light frequencies may trigger epileptic seizures in a 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, which is below the threshold frequency of 2.5 Hz, indicating that seizures should not be an issue (Burton et al. 2001).

The spatial relationships between a wind turbine and a receptor dictate the potential for the receptor experiencing shadow flicker. Nielsen (2003) suggests that when turbine and receptor are separated by distances of 1,000 ft (305 m), shadow flicker potential exists only in a few hours after sunrise and before sunset. Obviously, shadow flicker is nonexistent during cloudy periods or when the blades are not rotating. Nielsen summarizes shadow flicker influences:

- When the turbine is sufficiently close so as to have the thickest portion of the blade (near the hub) obscuring most of the sun's disc, the shadow is widest and the flicker is the most intense (i.e., greatest difference in light levels inside the shadow and out).

- Shadow flicker intensity changes as the blade rotates, and is lowest when the blade tip is forming the shadow and greatest when the portion of the blade nearest the rotor is causing the shadow.

- At longer turbine-receptor separation distances, the blade shadows become out of focus; although intensity does not diminish, the shadow becomes less noticeable.

- Shadows are fainter in a lighted room.

- Blocking the shadow from entering an occupied residence through shades or natural obstructions such as trees or topographic features can significantly reduce or even eliminate adverse impacts of shadow flicker.

Nielsen notes that blades of modern-day wind turbines typically rotate at approximately 20 rpm, resulting in a blade of a three-bladed turbine passing in front of the sun approximately 60 times per minute, or 1 Hz, and that such a frequency of a passing shadow is too low to result in adverse health effects, citing the Epilepsy Foundation's assertion that frequencies below 10 Hz are not likely to cause epileptic seizures.

3.8.2.7 Voltage Flicker

Because of the manner in which wind turbines generate power and the intermittency of that power, interconnecting wind farms with the high-voltage transmission grid requires unique considerations and controls to avoid disruptions of the grid that can lead to its wholesale failure or to a variety of problems experienced by retail electric customers. For example, voltage flicker that can occur during turbine startups, during periods when wind farm power outputs vary significantly, or as a result of frequent automatic switching of the turbine's generator on and off when winds are at the turbine's "cut-in" speed can result in significant damage to electrical appliances. Changes in line voltage of the power supplied to retail customers can result in lights flickering (especially fluorescent lights), malfunctions of certain appliances and devices such as computers, failures of the electronic controls of some devices, and irreparable damage to certain other household appliances. Such events would obviously impact the welfare, and in some cases the health and safety, of electrical customers (e.g., if the impacts were to comfort heating systems or medical equipment). Technical issues of wind farm grid interconnection can be expected to be addressed in any power purchasing agreements involving the wind farm and resolved through the installation of special electric power control equipment (e.g., static or adaptive reactive power compensators, automatic isolation switches) or the application of appropriate operational controls. Finally, voltage flicker problems experienced by retail customers almost always occur when the wind turbines are directly connected to a distribution grid, and rarely, if ever, occur when the wind farm connects to the transmission grid, since, in that scenario, there are numerous opportunities to correct the condition before electricity is provided to retail customers.

3.8.2.8 Aviation Safety and Potential for Light Pollution

The FAA guidelines in 14 CFR part 77 for the marking and lighting of wind farms (defined as developments with more than three turbines with heights over 200 ft above ground level) require lights that flash white during the day and at twilight and red at night (FAA 2007). All marker lights within a wind farm are also required to flash simultaneously. The lights are to be positioned at such a location on the nacelle to be visible to approaching aircraft from a 360° vantage. However, the guidelines also allow for only the perimeter turbines of a wind farm needing such markings, provided that there is no unlighted gap within the footprint of the wind farm that is greater than 0.5 mi (0.81 km). Terrain, weather, and other location factors allow for adjustments to the manner in which FAA requirements are applied. Wind farm developers are required to file a notice with the FAA for any construction that could present an obstruction to air navigation due to height and/or location relative to airports.[67] Obstruction analyses of wind farms (conducted by the FAA) are required for:

- Construction or alteration of any structures that exceed elevations of 200 ft (61 m) above the ground.

- Any construction or alteration to a structure that is:
  - Within 20,000 ft (6,100 m) of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with at least one runway more than 3,200 ft (975 m).
  - Within 10,000 ft (3,050 m) of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 ft (975 m).
  - Within 5,000 ft (1,524 m) of a public use heliport which exceeds a 25:1 surface.

- When requested by the FAA.

Although aircraft warning lights are designed to be more visible to aircraft than to observers on the ground, the presence of the lights would cause a change in views from nearby residential areas and roadways. They would increase visibility of the turbines, particularly in dark nighttime sky conditions typical of rural areas. Because of intermittent operation, marker beacons would likely not contribute to sky glow from artificial lighting; however, the emission of light to off-site areas could be considerable and could be considered an impact to quality of life of individuals living near the wind farms. Additional discussions on the visual impacts of marker lighting are provided in section 5.7.

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[67] Notifications are made electronically through the completion and submittal of FAA Form SF-7460-1 and would be followed by a site-specific analysis of obstruction potential by the FAA.

3.9 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

3.9.1 Hazardous Materials

For the purposes of this discussion, hazardous materials are defined as those chemicals that can cause adverse impacts on the public, wind farm workers, or the environment if managed or disposed of improperly. Hazardous materials include those chemicals and commercial commodities 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; however, 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 (expected to be necessary only in rare instances for excavations of turbine foundations, and possibly to complete some demolition during decommissioning). Table 3.9-1 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.

3.9.2 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 the 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 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 maintenance crews who might be present on the site during business hours. All such wastes are expected to be nonhazardous; they are typically 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

TABLE 3.9-1 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. Hydraulic fluid is used in the rotor driveshaft braking system and other controls. Gear oil and/or grease are used in the drive train transmission and yaw motor gears.	Limited quantities stored in portable containers (capacity of 55 gal [208 L] or less); stored on site during operational phase.
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, operation, 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 3.9-1 (Cont.)

Hazardous Material	Uses	Typical Quantities Present
Lead-acid storage batteries and electrolyte solution	Present in construction and transportation equipment.	Limited quantities of electrolyte solution (<20 gal [76 L]) for maintenance of construction and transportation equipment during construction and decommissioning phases.
	Backup power source for control equipment, tower lighting, and signal transmitters.	Limited quantities of electrolyte solution (<10 gal [38 L]) for maintenance of control equipment during operational phase.
Other batteries (e.g., nickel-cadmium 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.	Limited quantities (<55 gal [208 L]) on site during construction and decommissioning to maintain construction and transportation equipment.
	Where feasible, water-based cleaning and degreasing solvents may be used.	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.	Limited quantities equal only the amount necessary to complete the task.
	May be necessary for construction of access and/or on-site roads or for grade alterations on site.	On-site storage expected to occur only for limited periods of time as needed by specific excavation and construction activities.
Herbicides	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 3.9-1 (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 (approx. 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 the 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 storing 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 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 contain 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) rather than liquid dielectric fluids. Newer electrical equipment may also use dielectric oils made up of esters formulated from vegetable oils. Such fluids are reported to extend the life of electrical devices by providing better protection against degradation of the paper (cellulosic) insulating elements that some devices contain (a typical cause of failure). Vegetable oil-derived dielectric fluids also have higher flash points, thus lessening the potential for fires in the event of electrical failures.

off-road construction equipment would also be generated. However, it is anticipated that such on-site maintenance activity would be limited to what 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 on site for those large construction vehicles that are not themselves roadworthy, and in cases when transporting such vehicles to offsite facilities for routine maintenance would be impractical.

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 based on the calendar. 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 and blade pitch hydraulic systems (see, for example, the studies reported on by C.C. Jensen Group at http://www.cjc.dk/industries/wind/wind-turbines). 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 every 2 to 3 years on average (of turbine operation, not calendar time). Coolant systems for transmissions typically contain 20 to 30 gal (76 to 114 L) of a 50 percent 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 slightly alter these maintenance schedules. 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 offsite recycling or 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, the 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 a 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 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 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 (in most cases, without the need for removing dielectric fields) and, due to their age, likely to be scrapped and components recycled when possible. 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.

3.9.3 Wastewater

Sanitary wastewater is generated by work crews or maintenance personnel present on site, especially during the construction and decommissioning phases, and, to a lesser extent, during the operational phase. During the construction and decommissioning phases, work crews of 50 to 100 individuals may be present. During the operational phase, a maintenance crew of six 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.

3.9.4 Storm Water and Excavation Water

Except in those instances of spills or accidental releases,[68] storm water runoff from the site and excavation waters is not expected to have industrial contamination, although it may contain sediment from disturbed land surfaces. Established sediment controls routinely employed at large construction sites can be expected to limit sediment transport to acceptable levels.

3.9.5 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.

3.10 TRANSPORTATION CONSIDERATIONS

A variety of transportation operations are necessary to support wind energy development. Table 3.10-1 summarizes representative transportation requirements for each phase of development. The majority of transportation operations would involve material and

[68] Storm water could also become contaminated from contamination present on the site prior to development of the wind energy facility. Such contamination should have been identified during “due diligence” investigations of the property by the developer prior to the start of construction and remediated as necessary by those identified as the responsible parties.

TABLE 3.10-1 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, less than 80,000 lb (36,287 kg).
Road, pad, and laydown 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, less than 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, less than 80,000 lb (36,287 kg).

TABLE 3.10-1 (Cont.)

Project Phase/Activity	Equipment/Material	Transportation Requirements	Access Road Requirements	Special Requirements
General	Water (potable, dust suppression, concrete batch plant)	Tens of thousands 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, less than 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. Expanded turning radius and limited 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.
WTGS interconnections and transmission lines	Trenching or augering equipment, line trucks	WTGS design dependent.	Improved access road.	None. Loads expected to be legal weight, less than 80,000 lb (36,287 kg).

TABLE 3.10-1 (Cont.)

Project Phase/Activity	Equipment/Material	Transportation Requirements	Access Road Requirements	Special Requirements
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.

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, turbine 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.

Transportation logistics have become a major consideration for wind energy development projects; the trend is toward larger rotors and taller turbine 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). 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 turbine 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. Technological advancements may increase component sizes and weights in the future, requiring proportional adjustments to the size and capacity of equipment used for component transport and turbine installation.

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.

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.

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4 AFFECTED ENVIRONMENT

4.1 LAND COVER AND LAND USE

This section describes the land cover types and land uses that occur within the Upper Great Plains Region (UGP Region). Land cover refers to the physical material at the surface of the earth, while land use addresses how people use the land. Land cover types within the UGP Region include agricultural fields, rangeland, forests, wetlands and water bodies, barren land, and developed land (e.g., urban areas). Land uses include recreation, conservation, mining, agriculture and livestock grazing, industrial activities (e.g., manufacturing, mining, and energy generation), ROW corridors (e.g., roads, railroads, transmission lines, and pipelines), and urban and rural development. In some instances, land cover and land use can be viewed as the same, particularly with agricultural lands. The following discussion presents general descriptions of land cover types and land uses that may be affected by wind energy development projects within the UGP Region.

4.1.1 Land Cover

There are various types of land cover that occur within the UGP Region. Land cover type distributions within each of the six States that encompass the UGP Region are summarized in table 4.1-1. The most prevalent land cover types are cropland (over 122 million ac [49 million ha]) and rangeland (nearly 93 million ac [38 million ha]).

4.1.2 Land Use

4.1.2.1 Federal Lands

The Federal Government owns and leases about 653.3 million ac (264.4 million ha) (about 29 percent) of the land in the United States. Each Federal land managing agency manages its lands and resources according to its mission and responsibilities. Table 4.1-2 displays the acreages of public lands administered by these four agencies within the six States that encompass the UGP Region. Other Federal agencies that also own or manage lands within the UGP Region include the U.S. Department of Defense (DOD), Western Area Power Administration (Western), the Bureau of Reclamation (Reclamation), and the U.S. Department of Agriculture's (USDA's) Agricultural Research Service (ARS). Figure 4.1-1 shows the Federal land within the six States.

BLM. The BLM currently manages over 245 million surface ac (99.1 million ha) of land, and 700 million subsurface ac (283 million ha) (BLM 2011). These lands are often intermingled with other Federal or private lands. Most BLM-administered lands within the UGP Region (Table 4.1-2) are found in Montana, with lesser amounts in the Dakotas. Little to no BLM-administered surface lands occur within Nebraska and Minnesota. There are no BLM-administered surface lands in Iowa. The following information about land use on BLM-administered lands is focused on Montana and the Dakotas.

TABLE 4.1-1 Land Cover Types and Acreage of Non-Federal Lands within the Six States of the UGP Region

Land Cover Type[a]	Acres (in thousands)						
	Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota	Total
Cropland	25,511.1	21,099.6	14,526.6	19,552.3	24,266.5	17,086.6	122,042.7
CRP land	1,480.6	1,422.7	3,254.1	1,083.2	3,203.5	1,296.9	11,741.0
Pastureland	3,460.5	3,590.6	3,594.4	1,849.9	951.2	1,985.4	15,432.0
Rangeland	0.0	0.0	36,697.9	23,077.7	11,078.1	22,054.3	92,908.0
Forest land	2,301.3	16,356.5	5,402.0	812.1	466.5	503.1	25,841.5
Other rural land	833.2	2,741.3	1,437.6	779.4	1,408.6	1,458.2	8,658.3
Developed land	1,779.3	2,321.8	1,069.1	1,233.9	1,007.3	981.2	8,392.6
Water areas	478.1	3,141.3	1,036.3	473.5	1,084.2	880.1	7,093.5
Total	35,844.1	50,673.8	67,018.0	48,862.0	43,465.9	46,245.8	292,109.6

[a] Land cover types are defined as follows:

- Cropland: land used for the production of crops adapted for harvest.
- CRP land: Conservation Reserve Program (CRP) land that includes land under CRP contract that assists private landowners in converting highly erodible cropland to vegetative cover for 10 yr.
- Pastureland: land managed primarily for producing forage plants for livestock grazing.
- Rangeland: land on which the climax or potential plant cover is composed primarily of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland.
- Forest land: land that is at least 10 percent woody species that are at least 13 ft (4 m) tall at maturity.
- Other rural land: includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
- Developed land: includes large urban and built-up areas, small built-up areas, and rural transportation land.
- Water areas: areas of permanent open water.

Source: NRCS (2007a,b).

Land use within BLM-administered lands is managed within a framework of numerous laws, the most comprehensive of which is the Federal Land Policy and Management Act (FLPMA). FLPMA established the "multiple use" management framework for public lands, so that "public lands and their various resource values … are utilized in the combination that will best meet the present and future needs of the American people" (from Section 103(c) of FLPMA). Multiple uses of BLM-administered lands (and resources) within Montana and the Dakotas include domestic livestock grazing; fish and wildlife habitat; mineral exploration, development, and production; wilderness; rights-of-way (ROWs); outdoor recreation; and timber production.

Uses for BLM-administered lands in Montana and the Dakotas include the following (BLM 2008, 2009):

- *Rangeland management*: 4,111 cattle/buffalo operators, 163 horse/burro operators, and 206 sheep/goat operators, totaling 1,037,713 authorized annual unit months;

TABLE 4.1-2 Acreage of Federal Lands Administered by the BLM, the USFS, the NPS, and the Service in the Six States of the UGP Region

State	BLM[a]	USFS	NPS[b]	Service
Iowa	0	0	0 (0)	112,794
Minnesota	1,447	2,839,693	282 (0)	547,421
Montana	7,969,338	16,923,153	1,082,817 (52,578)	1,328,473
Nebraska	6,354	352,252	205 (6)	178,331
North Dakota	58,837	1,105,977	71,728 (922)	1,566,026
South Dakota	274,437	2,103,447	263,892 (43,885)	1,300,465
Total	8,308,966	23,324,522	1,418,926 (97,391)	5,033,510

[a] Numbers are surface acres.

[b] Acreage includes Federal and non-Federal lands administered by NPS.

Sources: BLM (2007a); USFS (2006a); NPS (2008a); Service (2007); Vincent (2004).

- *Wilderness*: 36 wilderness study areas totaling 447,327 ac (181,027 ha);
- *Forestry*: 400,000 ac (162,000 ha) of commercial forest land and 138,000 ac (56,000 ha) of noncommercial forest land;
- *Solid minerals*: 13 producing Federal and Native American coal leases on 32,740 ac (13,249 ha);
- *Fluid minerals*: 5,894 Federal oil and gas leases on nearly 5.3 million ac (2.1 million ha) (including 2,198 producing leases on 1.17 million ac [0.47 million ha]); and
- *Area of Critical Environmental Concern (ACECs):* 54 ACECs totaling 366,795 ac (148,437 ha).

ACECs are lands requiring special management attention and direction to prevent irreparable damage to important historic, cultural, and scenic values; fish or wildlife resources; or other natural systems or processes; or to ensure human protection from natural hazards.

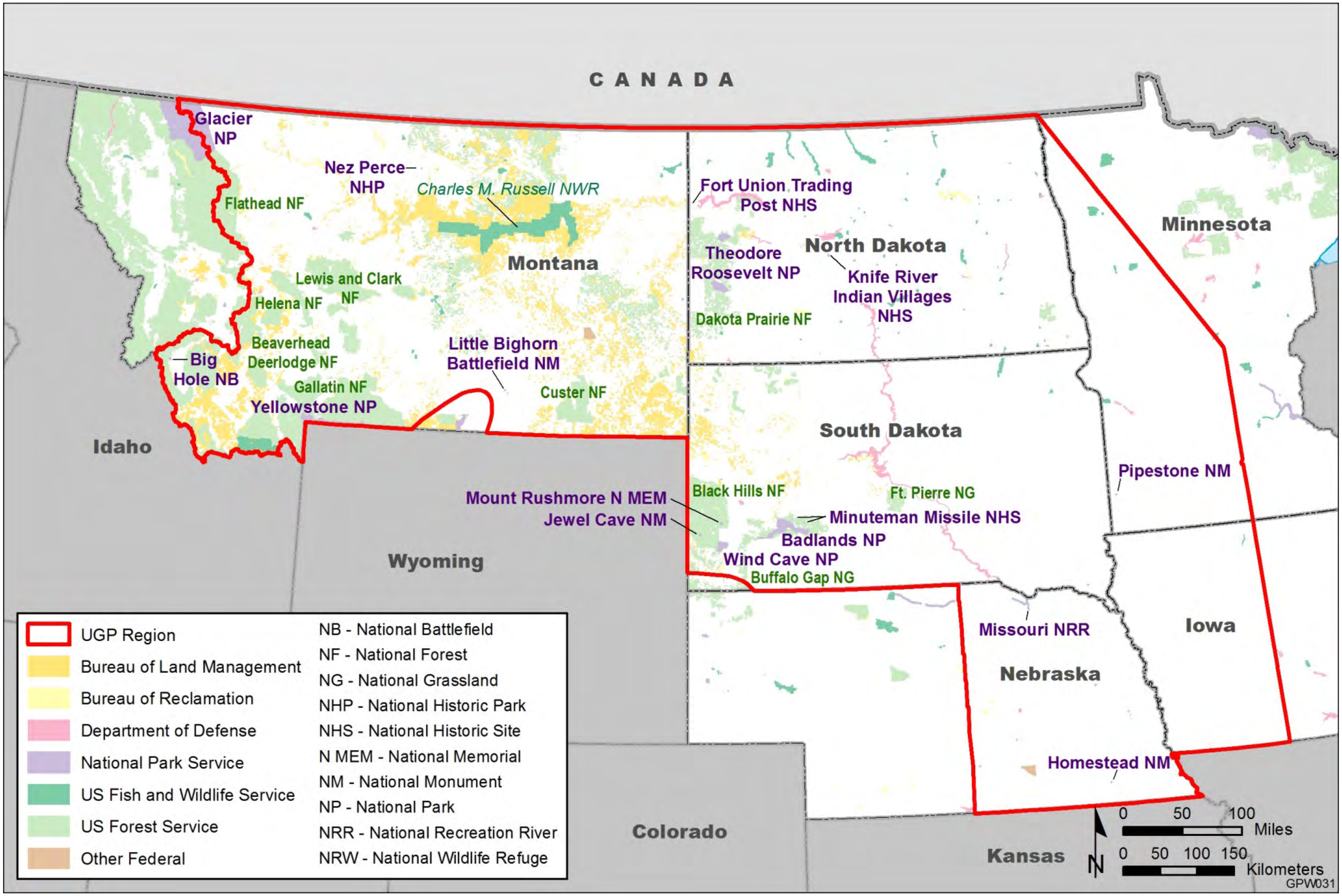


FIGURE 4.1-1 Federal Lands within the UGP Region

ACEC designation indicates that the BLM recognizes the significant values of the area and intends to protect and enhance the resource values. Land use plans outline management objectives and prescriptions for each ACEC. ACECs will pose special constraints for and possibly denial of applications for land uses that cannot be designed to be compatible with the management objectives and prescriptions for the ACEC. Of the 51 ACECs in Montana and South Dakota, 46 occur within the UGP Region. The total acreage of ACECs in the two States is about 280,000 ac (113,311 ha) (BLM 2006).

The BLM also administers the National Landscape Conservation System (NLCS), which in Montana includes two national monuments (375,027 ac [151,768 ha]), one wilderness area (6,347 ac [2,569 ha]), 36 wilderness study areas (447,327 ac [181,027 ha]), one wild and scenic river (149 mi [240 km], 89,300 ac [36,138 ha]), two national historic trails (323 mi [520 km]), and one national scenic trail (10 mi [16 km]) (BLM 2008).

BLM manages other special management areas (non-NLCS) in Montana to preserve and protect threatened and endangered species; wild and free-roaming horses; significant archaeological, paleontological, and historical sites; and three national natural landmarks. A discussion of wild horses is presented in section 4.6.2.3.

Recreation and leisure activities on BLM-administered lands center around unstructured recreation and tourism. Camping and picnicking account for about 43 percent of recreation and leisure activities on BLM lands. Other important activities include off-highway travel; non-motorized travel; water-based activities such as boating, fishing, and swimming; specialized sports and events; hunting; resource viewing; and snow-based activities (e.g., snowmobiling) (BLM 2007a). Recreational visits to public lands administered by the BLM in Montana and the Dakotas totaled 3,932,000 in FY 2007 (BLM 2007a).

U.S. Forest Service (USFS). The National Forest System (NFS), which consists of 155 national forests and 20 national grasslands, makes up most of the lands managed by the USFS. The NFS encompasses aquatic and terrestrial ecosystems, including tropical and boreal forests, grasslands, and important wetlands. Other lands, including purchase units, research and experimental areas, and land utilization projects, make up the remainder of USFS-managed lands. Within the UGP Region, there are portions of nine national forests, six national grasslands, two purchase units, and one research and experimental area (USFS 2008).

Table 4.1-3 provides a breakdown of the types and numbers of lands managed by the USFS in the six States that encompass the UGP Region. These include:

- *National forests.* A unit of land formally established and permanently set aside and reserved for national forest purposes (e.g., as rangeland, timberland, and recreation land).

- *National grasslands.* A unit of land designed by the Secretary of Agriculture and permanently held by the Department of Agriculture Title III of the Bankhead-Jones Farm Tenant Act of 1937.

TABLE 4.1-3 Types of Lands Managed by the USFS in the Six States That Encompass the UGP Region

	Types of Land (acres)[a]						
State	National Forests	National Grasslands	Land Utilization Projects	Purchase Units	Research and Experimental Areas	National Preserves	Other
Iowa	–[b]	–	–	–	–	–	–
Minnesota	–	–	–	–	–	–	–
Montana	8,562,734	–	–	–	–	–	–
Nebraska	–	–	–	–	–	–	–
North Dakota	–	1,105,291	–	703	40	–	–
South Dakota	1,150,134	867,223	–	–	–	–	–
UGP Region Total	9,712,868	1,972,514	–	703	40	–	–
National Totals	188,058,225	3,837,875	1,876	389,666	64,727	89,716	299,071

[a] Except for national totals, only areas within the UGP Region are included.

[b] A dash indicates no acreage.

Source: USFS (2008).

- *Land utilization projects.* A unit of land designed by the Secretary of Agriculture for conservation and utilization under Title III of the Bankhead-Jones Farm Tenant Act of 1937. No land utilization projects occur within the UGP Region.

- *Purchase units.* A unit of land designed by the Secretary of Agriculture or previously approved by the National Forest Reservation Commission for purposes of Weeks Law acquisition.

- *Research and experimental areas.* A unit of land reserved and dedicated by the Secretary of Agriculture for forest and range research and experimentation.

- *National preserves.* A unit of land established to protect and preserve scientific, scenic, geologic, watershed, fish, wildlife, historic, cultural, and recreational values, and to provide for multiple use and sustained yield of its renewable resources. No national preserves occur within the UGP Region.

The USFS uses a multiple-use land management approach based on the principles outlined in the Multiple Use Sustained Yield Act of 1960 (16 USC 528) to sustain healthy ecosystems, repair damaged ecosystems, and address the need for resources and commodities. Multiple uses include outdoor recreation, livestock grazing, timber harvest, watershed protection, and fish and wildlife habitats (Vincent 2004).

The USFS authorizes and administers the use of lands by individuals, companies, organized groups, other Federal agencies, and State or local levels of government to protect natural resource values and public health and safety. Among the land uses authorized by the USFS are those relating to infrastructure for wind and electricity transmission facilities (USFS 2004).

About 6.8 million ac (2.8 million ha) of the NFS lands within the UGP Region are classified as “roadless areas” (table 4.1-4). Roadless areas contain critical watersheds, wildlife habitat, and unique ecosystems and are protected by an administrative rule known as the Roadless Area Conservation Rule, issued by the USFS in January 2001.

The top five recreation and leisure activities on National Forest System lands administered by the USFS are viewing natural features, general relaxation, hiking, viewing wildlife, skiing, and driving for pleasure (USFS 2006b). About 7.9 million visitors made use of the national forests that occur within the UGP Region during FY 2006 (USFS 2006b).

The National Park Service (NPS). The NPS was created in 1916 to protect the national parks and monuments managed by the DOI (35 at that time) and those yet to be established. Its mission is to (1) conserve, preserve, protect, and interpret the natural, cultural, and historic resources for the public; and (2) provide for the enjoyment of these resources by the public. These can be contradictory missions in some cases (Vincent 2004). The agency currently manages a network of about 390 natural, cultural, and recreational sites across the United States, including national parks, national monuments, battlefields, military parks, historical parks, historical sites, lakeshores, seashores, recreation areas, reserves, preserves, and scenic rivers and trails (Vincent 2004). Table 4.1-5 summarizes the acreages of the 15 sites managed by the NPS that are located within the UGP Region. In 2008, there were over 6.3 million recreation visits to the 15 NPS sites within the UGP Region (NPS 2008a).

TABLE 4.1-4 Roadless Areas within the National Forest System in the Six States That Encompass the UGP Region

	Roadless Areas (acres)[a]		
State	Total Areas within National Forest System	Areas Allowing Road Construction and Reconstruction	Areas Not Allowing Road Construction and Reconstruction
Iowa	0	0	0
Minnesota	62,000	0	62,000
Montana	6,397,000	2,553,000	3,844,000
Nebraska	0	0	0
North Dakota	266,000	0	266.000
South Dakota	80,000	0	80,000
Total	6,805,000	2,553,000	4,252,000

[a] Statewide total may include areas outside the UGP Region in Minnesota and Montana.

Source: USFS (2006a).

TABLE 4.1-5 Designated Lands (Both Federal and Non-Federal) Managed by the NPS in the UGP Region

Area Name	State	Federal Land Acres	Non-Federal Land Acres	Total Acres
Badlands National Park	SD	232,822	9,934	242,756
Big Hole National Battlefield	MT	656	355	1,011
Ft. Union Trading Post National Historic Site	ND-MT	432	12	444
Glacier National Park	MT	1,012,905	418	1,013,333
Homestead National Monument of America	NE	205	6	211
Jewel Cave National Monument	SD	1,274	0	1,274
Knife River Indian Village National Historic Site	ND	1,594	165	1,759
Little Bighorn National Battlefield	MT	765	0	765
Minuteman Missile National Historic Site	SD	15	0	15
Missouri National Recreational River	SD-NE	248	33,911	34,159
Mt Rushmore National Memorial	SD	1,238	40	1,278
Nez Perce National Historic Park[a]	MT	NA	NA	NA
Pipestone National Monument	MN	282	0	282
Theodore Roosevelt National Park	ND	69,702	745	70,447
Wind Cave National Park	SD	28,295	0	28,295
Total		1,350,433	45,586	1,396,019

[a] Nez Perce NHP contains 38 separate park units, several of which are within the UGP Region.

Source: NPS (2008a).

U.S. Fish and Wildlife Service (the Service). The Service was established in a 1940 reorganization plan when the Department of the Interior consolidated the Bureau of Fisheries and the Bureau of Biological Survey into one agency. The Service manages 925 sites nationwide. The primary lands managed by the Service are:

- *National wildlife refuges.* Any area of the National Wildlife Refuge System (NWRS), excluding coordination areas and waterfowl production areas. Includes wilderness areas (Service land managed in accordance with the terms of the Wilderness Act of 1964) and migratory waterfowl refuges (Service land managed for the benefit of migrating waterfowl and other wildlife under the Fish and Wildlife Coordination Act).
- *Waterfowl production areas.* Any wetland or pothole area acquired pursuant to the Migratory Bird Hunting and Conservation Stamp Act or other statutory authority and administered as part of the NWRS and identified by county designation.

- *Coordination areas.* Any area administered as part of the NWRS and managed by the State under cooperative agreements between the Service and the State's fish and wildlife agency.

- *National fish hatcheries.* Facilities where fish are raised. Hatchery objectives are to replenish depleted stocks, mitigate Federal water projects, assist with the management of fishery resources on Federal (primarily the Service) and tribal lands, and enhance recreational fisheries.

Table 4.1-6 lists the types of lands managed by the Service within the UGP Region.

The NWRS was dedicated primarily for the conservation of plants and animals through habitat preservation. However, hunting, fishing, recreation, timber harvesting, grazing, and other uses are permitted, if compatible with the purpose for which the refuge was created (Vincent 2004). Figure 4.1-2 shows the locations of national wildlife refuges within the UGP Region. The numbers and total acreages of national wildlife refuges in the six UGP States are provided in table 4.1-6. Some of the refuges occur across two States.

In addition to national wildlife refuges, the NWRS also includes waterfowl production areas and wildlife coordination areas. Waterfowl production areas primarily provide breeding habitat for migratory waterfowl. Some of these areas are federally owned, but most are managed by private landowners under leases, easements, or agreements with the Service (see section 4.6.2.2.3). Most of these occur in the prairie potholes and interior wetlands of the North Central States (Vincent 2004) that encompass much of the UGP Region. Most wildlife coordination areas are owned by the Service and are managed by State wildlife agencies under cooperative agreements with the Service (Vincent 2004).

Figure 4.1-3 shows the counties of the UGP Region within the 30 Wetland Management Districts that are contained wholly or partially within the UGP Region. Wetland Management Districts are comprised of counties in which the Service has acquired or is leasing wetland or pothole habitats and is managing them as waterfowl production areas (Service 2007). Most of

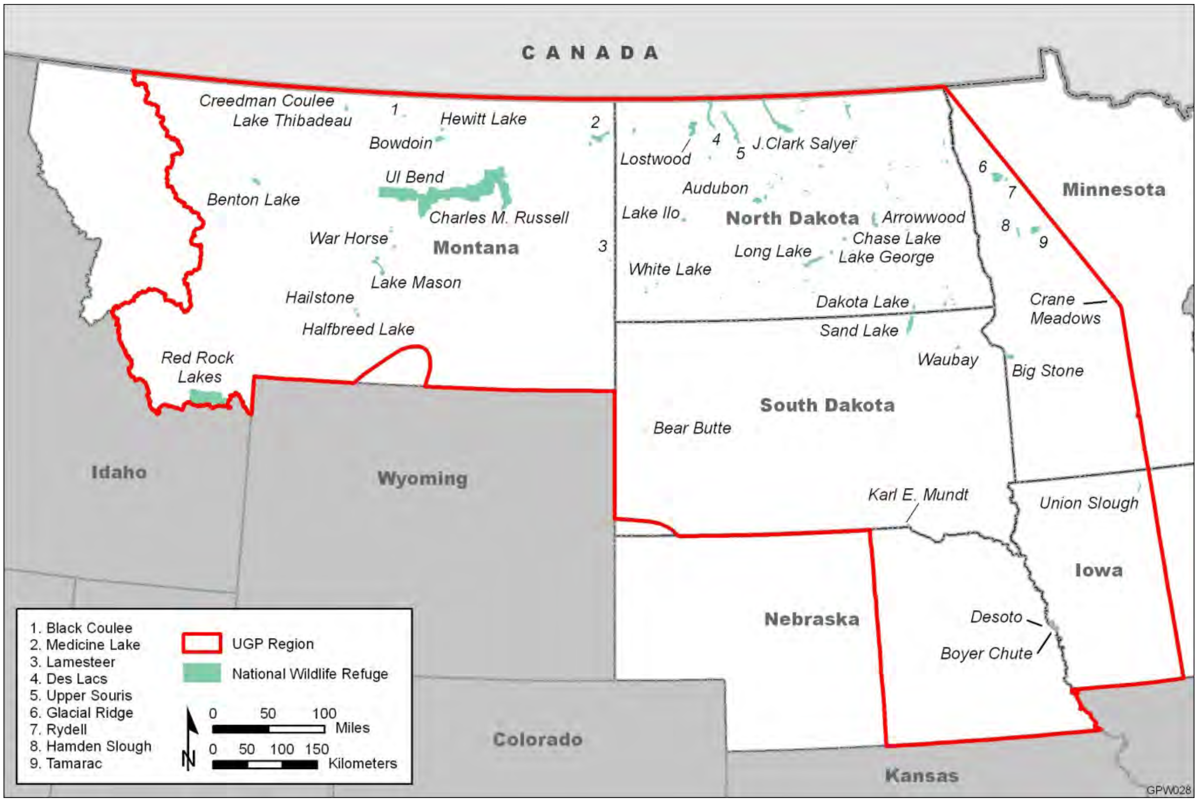
TABLE 4.1-6 Types of Lands Managed by the Service in the Six States Encompassing the UGP Region

	Number per Land Type (acres)			
State	National Wildlife Refuges	Waterfowl Production Areas[a]	Coordination Areas	National Fish Hatcheries
Iowa	3 (6,579)	16 (19,240)	–[b]	–
Minnesota	8 (64,032)	31 (223,777)	1 (118)	–
Montana	17 (1,138,183)	21 (171,680)	6 (6,693)	1 (173)
Nebraska	5 (13,256)	9 (18,456)	–	–
North Dakota	66 (343,145)	40 (1,400,116)	1 (4)	3 (297)
South Dakota	8 (102,155)	44 (1,383,777)	–	2 (592)
Total	107 (1,667,350)	161 (3,217,046)	8 (6,815)	6 (1,062)

[a] Number of counties with waterfowl production areas (acres of waterfowl production areas).

[b] A dash indicates no sites.

Source: Service (2007).



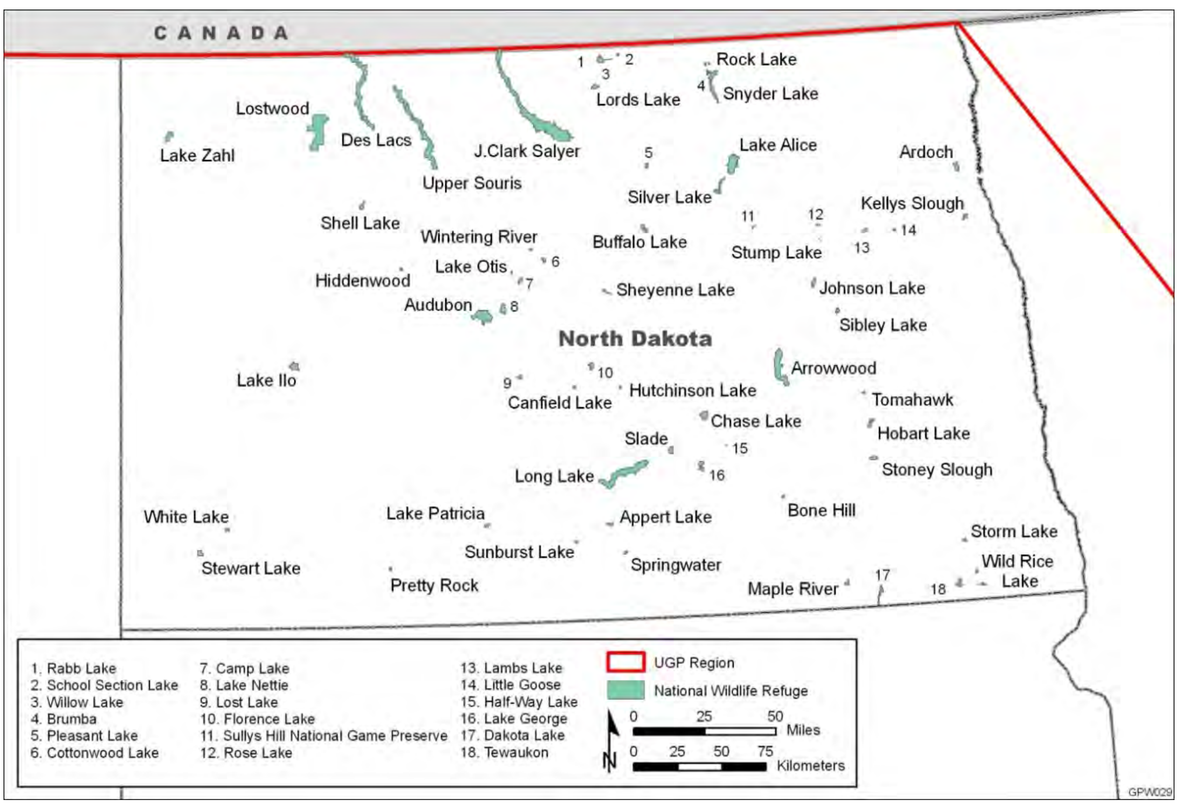


FIGURE 4.1-2 Location of National Wildlife Refuges within the UGP Region (top) with a Focus on the Many National Wildlife Refuges in North Dakota (bottom)

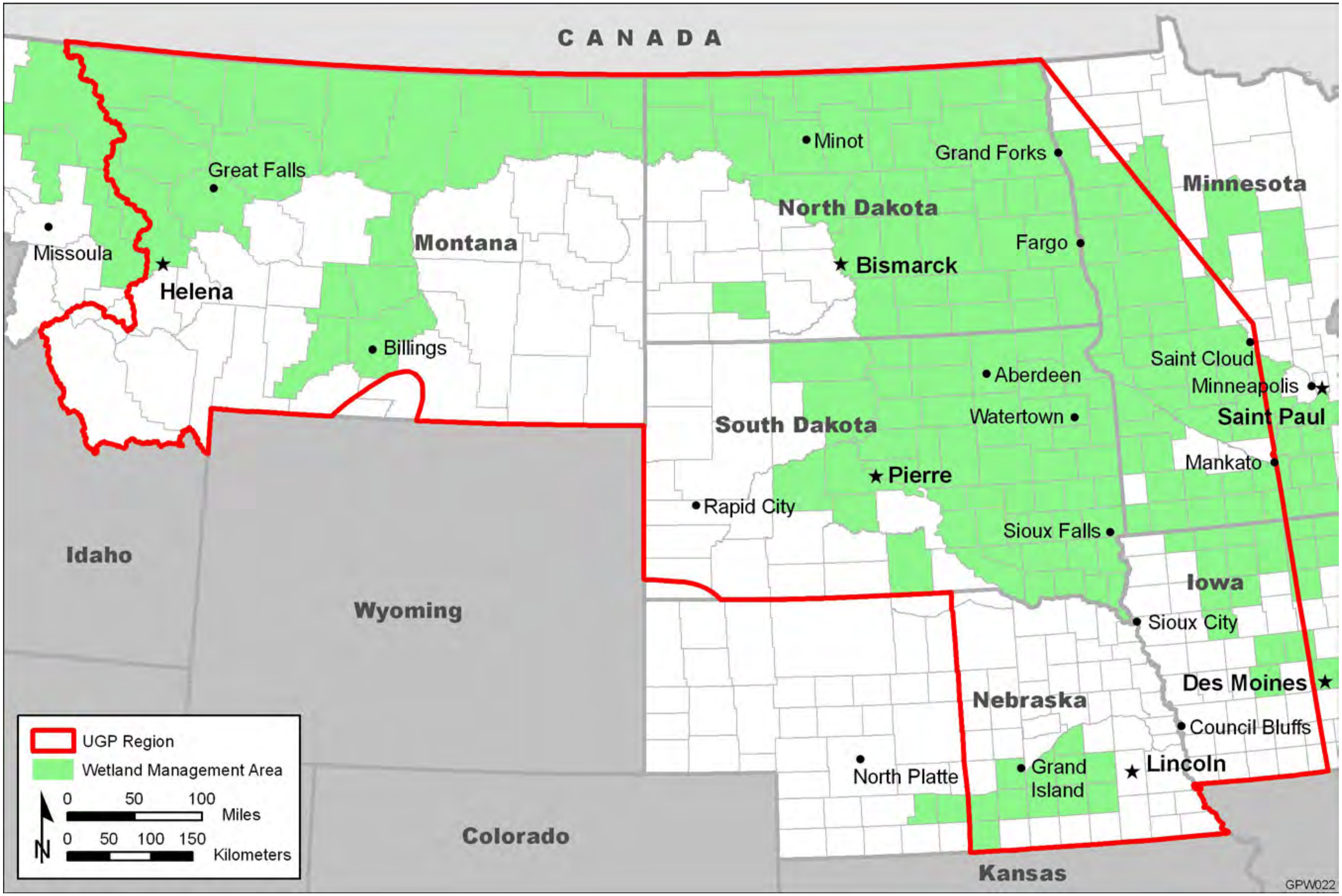


FIGURE 4.1-3 Counties within the UGP Region That Are Contained within Wetland Management Districts

the Wetland Management Districts occur within the UGP Region, although a few of the Districts and counties are outside of the UGP Region (Service 2007). Table 4.1-6 summarizes the number of counties that contain waterfowl production areas and the total acreage of easements or leases for the UGP Region by State.

Department of Defense (DOD). In the six States that encompass the UGP Region, the DOD owns and manages 111 small, medium, and large installations on about 210,000 ac (85,000 ha) of land (DOD 2008). Table 4.1-7 provides a breakdown of the number of installations by military service.

Western (DOE). Western is an agency under DOE that markets and transmits wholesale electrical power through an integrated 17,000-mi (27,400-km) high-voltage transmission system across 15 western States. Within the UGP Region, Western owns 7,800 mi (12,553 km) of transmission lines and 100 substations (Western 2012). The transmission lines are located on transmission easements on both public and private lands, while the substations are located on land owned in fee. Western sells more than 12 billion kilowatt-hours of firm power generated from eight dams and power plants of the Pick-Sloan Missouri Basin Program--Eastern Division.

Reclamation. Reclamation owns and administers 8.7 million ac (3.5 million ha) of land and has stewardship management over 5.6 million ac (2.3 million ha) of land

TABLE 4.1-7 Number of DOD Facilities by Military Service in the Six States That Encompass the UGP Region

	Military Service[a]						
State	Army	Navy	Air Force	Marine Corps	Army National Guard	Total Number	Total Acreage
Iowa	3 (29)	0 (4)	2 (1)	0 (0)	21 (31)	26 (65)	48,686
Minnesota	4 (41)	3 (2)	2 (3)	0 (0)	20 (53)	29 (99)	6,427
Montana	5 (13)	0 (2)	2 (235)	0 (0)	8 (26)	15 (276)	60,942
Nebraska	6 (15)	0 (2)	3 (90)	0 (0)	6 (32)	15 (139)	23,432
North Dakota	8 (30)	0 (3)	5 (338)	0 (0)	6 (36)	19 (407)	54,940
South Dakota	1 (48)	0 (1)	3 (22)	0 (0)	3 (66)	7 (137)	16,466
Total	27 (161)	3 (14)	17 (689)	0 (0)	64 (244)	111 (1,123)	210,893

[a] Numbers represent small, medium, and large installations with at least 10 ac and a plant replacement value of at least $10 million. For the Army National Guard, these criteria are 5 ac and a plant replacement value of at least $5 million. Other sites that do not meet these criteria are in parentheses. Installations include active, guard, and/or reserve components.

Source: DOD (2008).

(Reclamation 2009) and operates a large number of Federal facilities. Within the UGP Region, Reclamation facilities include the following:

- Montana—14 dams and 14 projects;
- Nebraska—3 dams and 3 projects;
- North Dakota—3 dams and 8 projects; and
- South Dakota—5 dams and 5 projects.

In addition to the dams and projects, there are two hydroelectric power plants within the Montana portion of the UGP Region: Canyon Ferry Powerplant (50,000 kW) on the Missouri River and the Yellowtail Powerplant (250,000 kW) on the Bighorn River. The electricity generated by both of these power plants is marketed by Western as wholesale power (Reclamation 2008). Recreation and leisure activities on Reclamation lands center around the agency's many reservoirs and dam facilities. There are 289 recreational areas and 350 campgrounds managed by Reclamation (Reclamation 2009). It is estimated that there are about 90 million visits annually to Reclamation recreation areas (Reclamation 2009).

Agricultural Research Service (USDA). The ARS is the USDA's chief scientific research agency. ARS has three large research locations within the UGP Region: (1) the U.S. Sheep Experiment Station, Beaverhead County, Montana; (2) the Fort Keogh Livestock and Range Research Laboratory, Custer County, Montana; and (3) the Roman L. Hruska U.S. Meat Animal Research Center, Adams and Clay Counties, Nebraska. Research is conducted on cattle, sheep, and swine (ARS 2009b). Because the land base of this agency is so small, and because of the nature of its use, it is not a likely candidate to be affected by wind energy or associated development and it will not be considered further in this EIS.

Wetlands Reserve Program (USDA). The Wetlands Reserve Program is a USDA program offering payments to landowners for restoring and protecting wetlands on their property. By signing a Wetlands Reserve Program easement, a landowner transfers most land use rights to the USDA. However, some uses, such as haying or grazing, can be granted back to the landowner at USDA's discretion (Service 2009c). The Farm Security and Rural Investment Act of 2002 set the national aggregate cap for the Wetlands Reserve Program at 2,275,000 ac (920,660 ha) nationwide (Ducks Unlimited 2009b).

Special Management Systems. There are three special management systems that include lands managed by more than one Federal agency. These are the National Wilderness Preservation System, the National Wild and Scenic Rivers System, and the National Trails System (Vincent 2004).

National Wilderness Preservation System. The Wilderness Act of 1964 established the National Wilderness Preservation System. National wilderness areas are untrammeled (free from man's control), undeveloped, and natural areas that offer outstanding opportunities for solitude and primitive recreation (Service 2008a). National wilderness areas are managed by the BLM, USFS, NPS, and the Service to protect and preserve their natural conditions. Permanent improvements and activities that would significantly alter existing conditions (e.g., timber harvesting) are generally prohibited (Wilderness.net 2009). The names and acreages of the national wilderness areas within the UGP Region are provided in table 4.1-8.

National Wild and Scenic Rivers System. The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law [P.L.] 90-542) to protect certain free-flowing rivers with outstanding natural, cultural, and recreational values. Rivers (which may be only river segments and can include tributaries) may be designated by Congress or, under certain conditions, by the Secretary of the Interior (Interagency Wild & Scenic Rivers Coordinating Council 2009). For federally administered rivers within the continental United States, the designated boundaries average 0.25 mi (0.4 km) on either bank. Rivers are classified as follows:

TABLE 4.1-8 Acreages of National Wilderness Preservation System Lands within the Six States That Encompass the UGP Region

National Wilderness Area[a]	BLM	USFS	NPS	Service	Total
Minnesota					
Tamarac	–	–	–	2,180	2,180
Montana					
Absaroka-Beartooth[b]	–	920,343	–	–	920,343
Anaconda Pintler[b]	-	158,615	–	–	158,615
Bob Marshall[b]	-	1,009,356	–	–	1,009,356
Gates of the Mountains	–	28,562	–	–	28,562
Lee Metcalf (4 units)	6,347	248,288	–	–	254,635
Medicine Lake	–	–	–	11,366	11,366
Red Rock Lakes (2 units)	–	–	–	32,350	32,350
Scapegoat[b]	-	239,936	–	–	239,936
UL Bend	–	–	–	20,819	20,819
North Dakota					
Chase Lake	–	–	–	4,155	4,155
Lostwood	–	–	–	5,577	5,577
Theodore Roosevelt (2 units)	–	–	29,920	–	29,920
South Dakota					
Badlands (2 units)	–	–	64,144	–	64,144
Black Elk	–	13,426	–	–	13,426
Total	6,347	2,331,826	94,064	79,447	2,511,684

[a] There are no wilderness areas within the UGP Region in Iowa and Nebraska.

[b] Only a portion of the wilderness area is within the UGP Region.

Sources: Wilderness.net (2012); GIS mapping.

- *Wild rivers*. Those rivers or river segments that are free of impoundments and generally inaccessible except by trail, watersheds or shorelines are essentially primitive, and the waters are unpolluted;

- *Scenic rivers*. Those rivers or river segments that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible by roads; and

- *Recreational rivers*. Those rivers or river segments that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past (Interagency Wild & Scenic Rivers Coordinating Council 2009).

As of 2008, more than 11,000 mi (17,700 km) of 166 rivers in 38 States and the Commonwealth of Puerto Rico have been designated as wild and scenic rivers. Within the UGP Region, only the Missouri River in Montana, South Dakota, and Nebraska and the Niobrara River in Nebraska have segments designated as wild, scenic, or recreational (figure 4.1-4). Table 4.1-9 summarizes the information for these two rivers.

National Trails System. The National Trails System Act of 1968 (P.L. 90-543) authorized the creation of the National Trail System comprised of national historic trails, national scenic trails, and national recreation trails. Within the United States, there are 18 national historic trails, 8 national scenic trails, and 1,053 national recreation trails. (There are also two connecting or side trails that provide access to or among the other classes of trails; neither of these are within the UGP Region.) National historic and scenic trails may be designated only by an act of Congress, while national recreation trails may be designated by the Secretary of the Interior or the Secretary of Agriculture (American Trails 2009). National historic trails are protected trails and surrounding areas of historic importance; national scenic trails are protected for their natural beauty; and national recreation trails provide outdoor recreational activities in urban, rural, and remote areas. Most national historic and scenic trails are several hundred to several thousand miles long, while most national recreation trails are less than 30 mi (48 km) long, ranging countrywide from less than a mile to 485 mi (781 km) long (American Trails 2009). Several national historic and scenic trails pass through one or more of the States within the UGP Region (table 4.1-10). The numbers of national recreation trails that occur within the States that encompass the UGP Region are 19 in Iowa, 14 in Minnesota, 58 in Montana, 8 in Nebraska, 16 in North Dakota, and 17 in South Dakota (American Trails 2009).

4.1.2.2 Non-Federal Lands

Non-Federal lands in the United States include privately owned lands, tribal and trust lands, and lands controlled by State and local governments.

A breakdown of the land cover types of non-Federal lands in the six States that encompass the UGP Region is provided in table 4.1-1. Table 4.1-11 summarizes the amount of cultivated and noncultivated cropland for the States within the UGP Region. Over 89 percent falls under the category “cultivated.” Non-Federal lands that are classified as supporting grazing are shown in table 4.1-12.

FIGURE 4.1-4 Location of Wild and Scenic River Segments within the UGP Region

TABLE 4.1-9 River Mileage Classifications for Components of the National Wild and Scenic Rivers System within the UGP Region

		Miles by Classification			
River (States)	Administering Agency	Wild	Scenic	Recreation	Total Miles
Missouri (MT)	BLM	64.0	26.0	59.0	149.0
Missouri (NE, SD)	NPS	0.0	0.0	59.0	59.0
Missouri (NE, SD)	NPS	0.0	0.0	39.0	39.0
Niobrara (NE)[a]	NPS	0.0	68.0	28.0	96.0
Niobrara (NE)	Service	0.0	8.0	0.0	8.0

[a] Includes areas outside the UGP Region (see figure 4.1-5).

Source: Interagency Wild & Scenic Rivers Coordinating Council (2009).

TABLE 4.1-10 National Historic and Scenic Trails within the UGP Region

Trail	States Containing Portions of the Trail
Continental Divide National Scenic Trail	MT
Lewis and Clark National Historic Trail	IA, MT, NE, ND, SD
Mormon Pioneer National Historic Trail	IA, NE
Nez Perce National Historic Trail	MT
North Country National Scenic Trail	MN, ND
Oregon National Historic Trail	NE
Pony Express National Historic Trail	NE

Prime farmland covers about 71 million ac (28.7 million ha) of non-Federal rural land in the six States that encompass the UGP Region (table 4.1-13). Between 1982 and 1997, prime farmland acreage has declined by about 2.9 percent nationwide (NRCS 2000). Prime farmlands are subject to protection under the Farmland Protection Policy Act (FPPA; P.L. 97–98, 7 USC 4201 et seq.).

4.1.2.3 Tribal Lands

The Bureau of Indian Affairs (BIA) holds in trust and administers for Indian tribes about 55.7 million ac (22.5 million ha) of land across the United States; of this total, about 45 million ac (18 million ha) are tribally owned and 10 million ac (4 million ha) are individually owned. Another 205,521 ac (83,171 ha) are “stewardship lands” administered for recreation, conservation, and functions vital to the culture and livelihood of Native Americans.

There are 46 tribal land areas administered as Native American reservations, communities, and trust lands within the six States that encompass the UGP Region.

TABLE 4.1-11 Cultivated and Noncultivated Croplands on Non-Federal Lands within the States That Encompass the UGP Region

	Acres		
State	Cultivated Cropland[a]	Noncultivated Cropland[b]	Total Cropland
Iowa	24,151,600	1,259,500	25,511,100
Minnesota	19,094,600	2,005,000	21,099,600
Montana	11,408,800	3,117,800	14,526,600
Nebraska	17,745,200	1,807,100	19,552,300
North Dakota	22,011,100	2,255,400	24,266,500
South Dakota	14,463,000	2,623,600	17,086,600
Total	108,874,300	13,068,400	121,942,700

[a] Cultivated cropland comprises land in row crops or close-grown crops and other cultivated cropland (e.g., hay land or pastureland) that is in rotation with row or close-grown crops.

[b] Noncultivated cropland includes permanent hay land and horticultural cropland.

Source: NRCS (2007a).

Table 4.1-14 summarizes the areas acreage of tribal lands within the six States; figure 4.1-5 shows the locations of the tribal lands. A listing of the reservations and trust lands is presented in section 4.9.1.1, table 4.9-2. Land use on tribal lands is as varied as land use on non-tribal lands, and includes livestock production, mining, timber production, oil and gas production, and residential and recreational use.

4.1.3 Land Use Considerations

4.1.3.1 Recreation

Table 4.1-15 summarizes the number of Federal recreation areas within the UGP Region. In addition to the federally managed recreational areas, there are many State parks, recreation areas and sites, or other points of interest located throughout the UGP Region. Table 4.1-16 lists the number of State parks in each of the six States. Some States categorize their State parks (e.g., for Montana, they are grouped into cultural, natural, and recreational parks), while several of the State park sites also describe recreational sites in addition to State parks. For example, North Dakota also has recreation areas, nature areas, public water access areas, and lakeside use areas. In addition to State parks, each State has other established recreation areas such as hiking, off-highway vehicle, snowmobile, and canoe trails.

The National Rivers Inventory (NRI) is a listing of more than 3,400 free-flowing river segments in the United States that are believed to possess one or more “outstandingly

TABLE 4.1-12 Grazing Land on Non-Federal Land within the States That Encompass the UGP Region

	Acres			
State	Pastureland[a]	Rangeland[b]	Grazed Forest Land[c]	Total
Iowa	3,460,500	0	776,000	4,236,500
Minnesota	3,590,600	0	796,700	4,387,300
Montana	3,594,400	36,697,900	3,190,400	43,482,700
Nebraska	1,849,900	23,077,700	561,200	25,488,800
North Dakota	951,200	11,078,100	238,100	12,267,400
South Dakota	1,985,400	22,054,300	413,900	24,453,600
Total	15,432,000	92,908,000	5,976,300	114,316,300

[a] Land managed primarily for the production of introduced forage plants for livestock grazing; land may contain a single species in a pure stand, a grass mixture, or a grass-legume mixture. However, pastureland values are based on land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether it is being grazed by livestock.

[b] Land on which the plant cover is composed mainly of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. Rangeland includes grasslands, savannas, many wetlands, and some deserts. Some communities of low forbs and shrubs such as mesquite, chaparral, mountain shrub, and pinyon-juniper are also included.

[c] Land that consists mainly of forest, brush-grown pasture, woodlands, and other areas within forested areas that have grass or other forage growth.

Source: NRCS (2007a).

remarkable" natural or cultural values judged to be of more than local or regional significance (NPS 2008b). These river segments have not been designated as part of the national Wild and Scenic Rivers System. The NRI is managed by the Rivers, Trails, and Conservation Assistance Program, which is the community assistance arm of the NPS. In order to be listed on the NRI, the free-flowing river segment must possess one or more of the following outstandingly remarkable values: scenery, recreation, geology, fish, wildlife, prehistory, history, cultural, or other values (NPS 2008b). The number and total mileage of NRI segments within the UGP Region are (NPS 2008b):

- Iowa—2 segments totaling 40 mi (64 km);
- Minnesota—7 segments totaling 789 mi (1,270 km);
- Montana—56 segments totaling 564 mi (908 km);
- Nebraska—4 segments totaling 404 mi (650 km);
- North Dakota—8 segments totaling 508 mi (818 km); and

TABLE 4.1-13 Prime Farmland on Non-Federal Land by Land Use in the Six States That Encompass the UGP Region[a]

	Acres (in thousands)						
State	Cropland	CRP Land	Pastureland	Rangeland	Forest Land	Other Rural Land	Total
Iowa	16,466.1	406.0	918.1	0.0	345.2	477.1	18,612.5
Minnesota	15,375.2	658.5	1,078.7	0.0	3,015.5	589.4	20,717.3
Montana	836.9	0.0	117.7	7.3	3.6	19.6	985.1
Nebraska	10,514.1	207.7	465.2	729.6	108.8	343.6	12,369.0
North Dakota	10,301.4	464.8	177.1	446.9	65.3	302.0	11,757.5
South Dakota	5,347.1	196.1	291.0	473.8	4.9	238.4	6,551.3
Total	58,840.8	1,933.1	3,047.8	1,657.6	3,543.3	1,970.1	70,992.7

[a] Prime farmland is designated independently of current land use, but it cannot be in areas of water or urban or built-up land as defined by the NRI. Maps showing areas of prime farmland and related data and statistics can be accessed at Natural Resources Conservation Service's (NRCS's) National Cartography and Geospatial Center (http://www.ncgc.nrcs.usda.gov/products/nri/index.html) and the Farmland Information Center (http://www.farmlandinfo.org/farmland_technical_resources).

Source: NRCS (2000).

TABLE 4.1-14 Area of Tribal Lands in the Six States Encompassing the UGP Region

State(s)[a]	Acres
Iowa–Nebraska	199,679
Minnesota	2,065,528
Montana	7,919,008
Montana–South Dakota	448,190
Nebraska	221,631
Nebraska–Kansas	15,360
Nebraska–South Dakota	2,219,767
North Dakota	1,094,972
North Dakota–South Dakota	3,299,699
South Dakota	4,908,524
Total	22,392,357

[a] Statewide data may include areas outside of the UGP Region in Iowa, Minnesota, Montana, and Nebraska.

Source: U.S. Census Bureau (2009a).

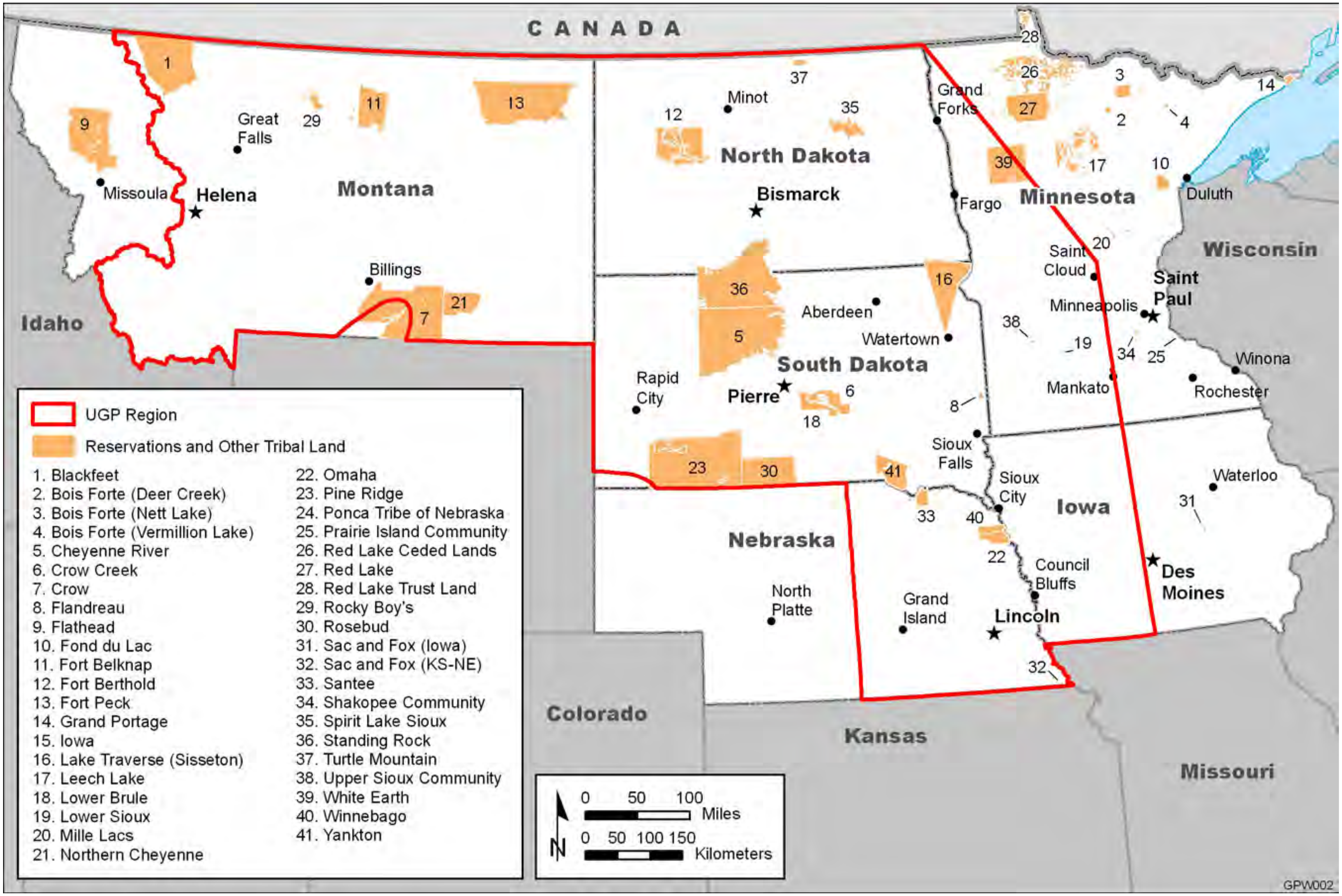


FIGURE 4.1-5 Location of Tribal Lands within the UGP Region

TABLE 4.1-15 Number of Recreation Areas Managed by Federal Agencies within the UGP Region

	Managing Agency[a,b]								
State	BLM	USFS	NPS	Service	Reclamation	DOT	USACE	SIAP	Total
Iowa	0	0	0	3	0	1	0	0	4
Minnesota	0	0	1	13	0	1	3	0	18
Montana	10[c]	96	3	17	13	0	4	2	145
Nebraska	0	0	3	2	4	0	16	1	26
North Dakota	1	0	5	29	6	2	16	0	59
South Dakota	1	18	6	12	6	2	6	1	52

[a] Only includes recreation areas located within the UGP Region.

[b] Abbreviations: BLM = Bureau of Land Management; DOT = U.S. Department of Transportation; USFS = U.S. Forest Service; NPS = National Park Service; Reclamation = Bureau of Reclamation; SIAP = Smithsonian Institution Affiliations Program; USACE = U.S. Army Corps of Engineers; Service = U.S. Fish and Wildlife Service.

[c] Includes one area co-managed with the USFS.

Source: Recreation.gov (2009).

TABLE 4.1-16 Number of State Parks Located within the UGP Region

State	Number of State Parks[a]
Iowa	30
Minnesota	21
Montana	29
Nebraska	5
North Dakota	18
South Dakota	12

[a] Includes only those State parks that occur within the boundary of the UGP Region.

Sources: IDNR (2009a); MDNR (2009a); MTFWP (2009a); NDPRD (2009); NGPC (2009a); South Dakota DGFP (2004a).

- South Dakota—10 segments totaling 971 mi (1,563 km).

Portions of some of the NRI segments extend outside of the UGP Region.

Based on Service and U.S. Census Bureau (Service and U.S. Census Bureau 2006a–f) surveys of recreation and leisure activities, over 5.2 million U.S. residents 16 years old and older participated in wildlife-related recreational activities (fishing, hunting, and wildlife watching) in the six States that encompass the UGP Region (table 4.1-17). A discussion of the ecological

TABLE 4.1-17 Number of Participants by Recreation Activity in the Six States Encompassing the UGP Region

	Number of Participants[a]			
State	Fishing Only	Hunting Only	Fishing and Hunting	Wildlife Watching
Iowa	301,000	115,000	137,000	1,205,000
Minnesota	1,000,000	144,000	391,000	2,093,000
Montana	181,000	88,000	110,000	755.000
Nebraska	141,000	61,000	57,000	490,000
North Dakota	62,000	84,000	44,000	148,000
South Dakota	80,000	116,000	54,000	432,000
Total	1,765,000	608,000	793,000	5,123,000

[a] Values are Statewide, which includes areas outside the UGP Region for Iowa, Minnesota, Nebraska, and Montana.

Source: Service and U.S. Census Bureau (2006a–f).

resources within the UGP Region that contribute to these recreational activities is provided in section 4.6.

4.1.3.2 Aviation

The number of public, private, and military airports located within the UGP Region are provided in table 4.1-18 and shown in figure 4.1-6. The majority of the airports are small private facilities. Most public airports are small municipal facilities, with only a few larger regional and international airports occurring in each State (AirNav.com 2009). The FAA manages commercial and general aviation activities, while the military manages military aviation activities with FAA oversight (GlobalSecurity.org 2005). There is a general air navigation concern associated with tall structures such as commercial wind turbines; for this reason, there could be siting concerns relative to the locations of airports, flight patterns, and air spaces associated with the airports because of the turbines and meteorological towers located at wind energy sites and the transmission lines associated with those projects. The FAA must be contacted for any proposed construction or alteration of objects within navigable airspace under any of the following conditions:

- A proposed object is more than 200 ft (61 m) above ground level at the structure's proposed location;

- A proposed object is within 20,000 ft (6,096 m) of an airport or seaplane base that has at least one runway longer than 3,200 ft (975 m), and the proposed object would exceed a slope of 100:1 horizontally from the closest point of the nearest runway;

TABLE 4.1-18 Number of Airports within the UGP Region

State[a]	Private	Public	Military	Total
Iowa	50	61	0	111
Minnesota	125	67	0	192
Montana	92	84	2	178
Nebraska	107	55	2	164
North Dakota	213	92	2	307
South Dakota	108	79	1	188
Total	695	438	7	1,140

[a] Only the portions of the States within the UGP Region are included.

Source: BTS (2008).

- A proposed object is within 10,000 ft (3,048 m) of an airport or seaplane base that does not have a runway more than 3,200 ft (975 m) in length, and the proposed object would exceed a 50:1 horizontal slope from the closest point of the nearest runway; and/or

- A proposed object is within 5,000 ft (1,524 m) of a heliport, and the proposed object would exceed a 25:1 horizontal slope from the nearest landing and takeoff area of that heliport (FAA 2000).

The FAA could recommend marking and/or lighting a structure that does not exceed 200 ft (61 m) above ground level, or that is not within the distances from airports or heliports mentioned above, because of its particular location (FAA 2000).

The U.S. military uses airspace for its operations. These involve airspace restrictions under the designations of Military Training Routes (MTRs) and Special Use Airspace (SUA), which include Military Operating Areas (MOAs). One or more of the MOAs in each State are approved for lights-out operations that allow aircraft to fly at night without any lights (AOPA 2005). Some of the military operations occur at low elevations. Within the UGP Region, there are over 30 million ac (12 million ha) of land over which MTRs and SUAs are located and that have operational elevations at 1,000 ft (305 m) or below (table 4.1-19). This includes about 1.2 million ac (500,000 ha) where MTRs and SUAs overlap. The majority of the MTRs and SUAs occur in Montana, including over 19.7 million ac (7.8 million ha). No MTRs or SUAs occur in Iowa or Minnesota, and no SUAs occur in Nebraska. Figure 4.1-7 shows the extent of military airspace restrictions of 1,000 ft (305 m) or less within the UGP Region. Military operations could be adversely affected by wind energy developments, if they were to intrude into designated restricted airspace. Consultation with DOD would be required during project planning to ensure that wind energy projects do not conflict with DOD training activities.

Other aviation concerns relate to BLM's National Office of Aviation and the USFS' Office of Fire and Aviation Management, which provide aircraft support for wildfire suppression and resource management missions on public lands.

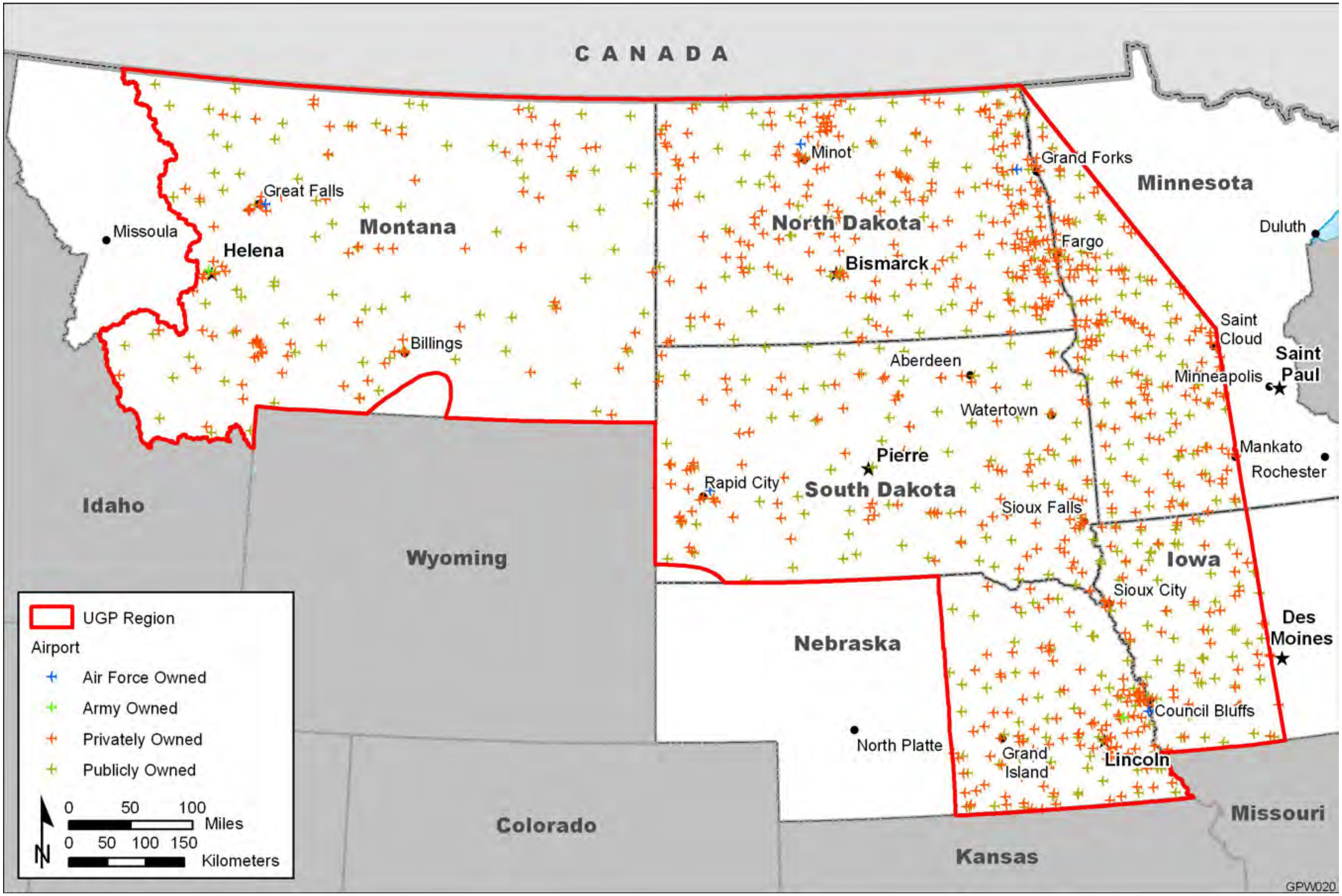


FIGURE 4.1-6 Location of Airports within the UGP Region

TABLE 4.1-19 Acreage of Military Training Routes and Special Use Airspace at 1,000 ft (305 m) or Less within the UGP Region

State	MTR	SUA	MTR/SUA Overlap
Montana	13,209,678	7,228,057	1,052,548
Nebraska	37,168	–	–
North Dakota	5,917,459	598,280	65,910
South Dakota	4,212,248	376,827	98,772
Total	23,376,553	8,203,164	1,217,230

Source: National Geospatial-Intelligence Agency (2005).

4.1.3.3 Radar

Wind turbines can be a source of radar clutter that can interfere with both ground and airborne civil and military radar operations. For example, tracking an aircraft flying over a wind energy project could be difficult, since the radar responses from the aircraft and turbines may not be distinguishable from one another. Wind development projects could also interfere with aircraft radar target identification, terrain-following radar, and with Doppler radar used for weather forecasting. Figure 4.1-8 shows the locations and associated lines of site for weather surveillance Doppler radar sites within the UGP Region. Consultation would be necessary for site-specific projects where radar interference may be an issue.

4.1.3.4 Transportation and Electric Transmission Considerations

An extensive network of railroads and interstate, State, county, and local roads occur within the UGP Region. Figure 4.1-9 shows the railroads within the UGP Region, while figure 4.1-10 shows the interstate, State highways, and other major roads. Construction traffic and delivery of turbine and transmission line components and other equipment could cause an impact on the existing transportation system. Most roads are paved, but some near a potential wind energy development may be surfaced with packed gravel or may even be dirt-covered roads.

The U.S. Secretary of Transportation recognizes certain roads as National Scenic Byways or All-American Roads based on their archaeological, cultural, historic, recreational, and scenic qualities. Byways that occur within the States that encompass the UGP Region are shown in figure 4.1-12 (National Scenic Byways Online 2009). In addition to the above, some Federal agencies and States have also identified scenic roads and byways. Within the UGP Region, there are three BLM Back Country Byways; the USFS has four Scenic Byways (National Scenic Byways Online 2009). The locations of these byways and All-American Roads are also shown in figure 4.1-11.

An extensive network of transmission lines occurs within the UGP Region. Figure 4.1-12 shows the transmission lines of 230 kV and greater within the UGP Region. Figure 4.1-13

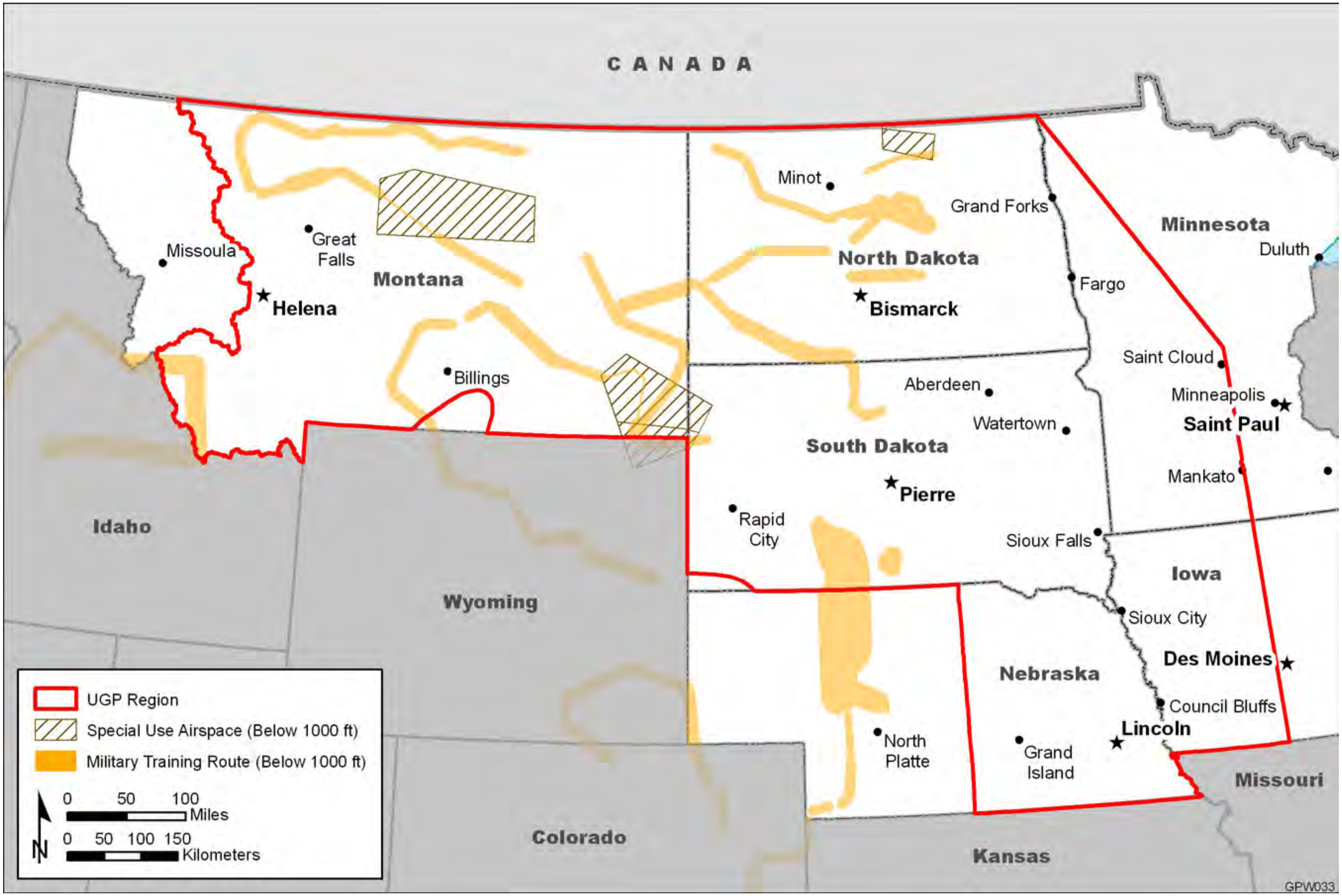


FIGURE 4.1-7 Military Flight Routes and Special Use Airspace below 1,000 ft (305 m) within the UGP Region

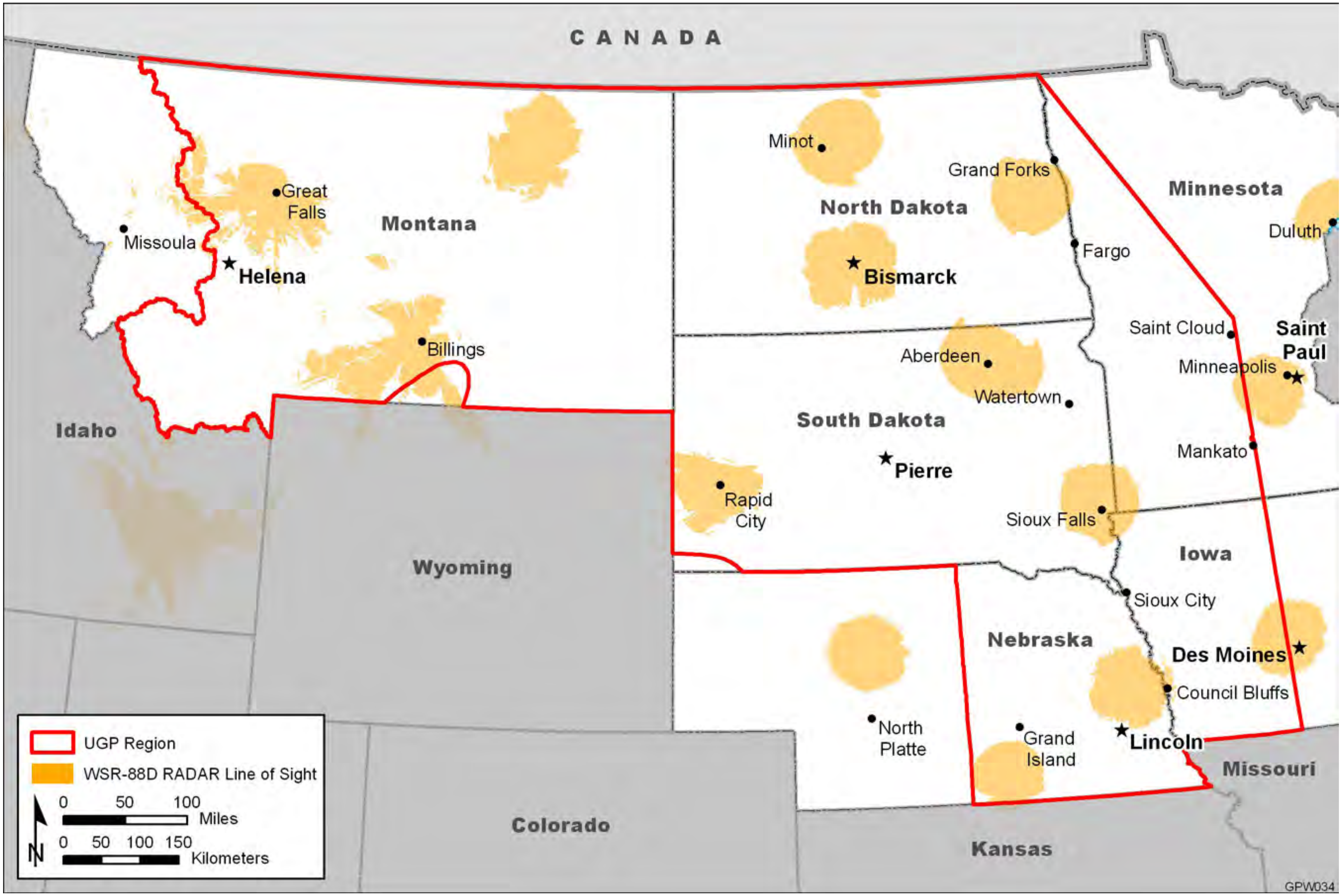


FIGURE 4.1-8 Doppler Radar Locations within the UGP Region

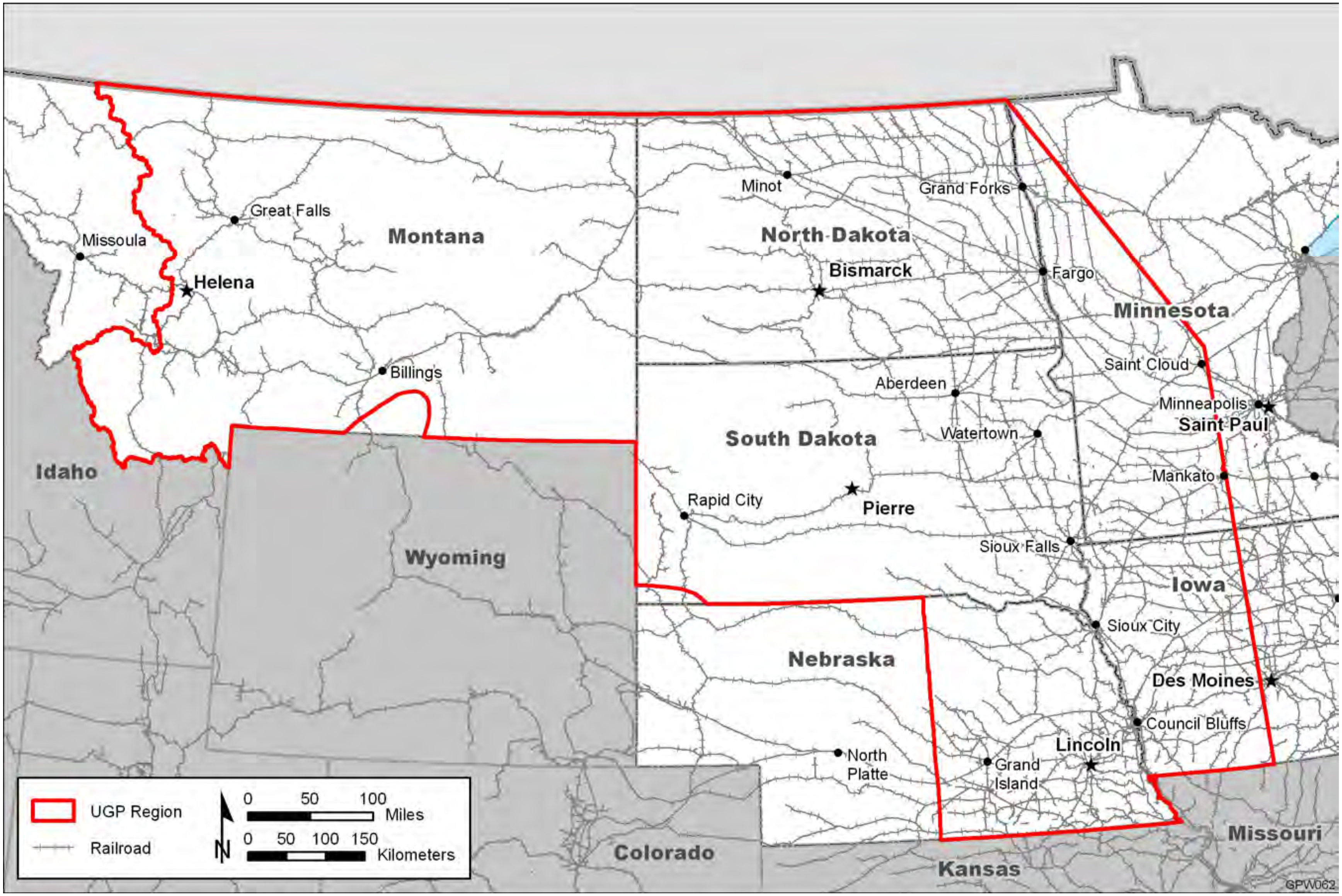


FIGURE 4.1-9 Location of Railroads within the UGP Region

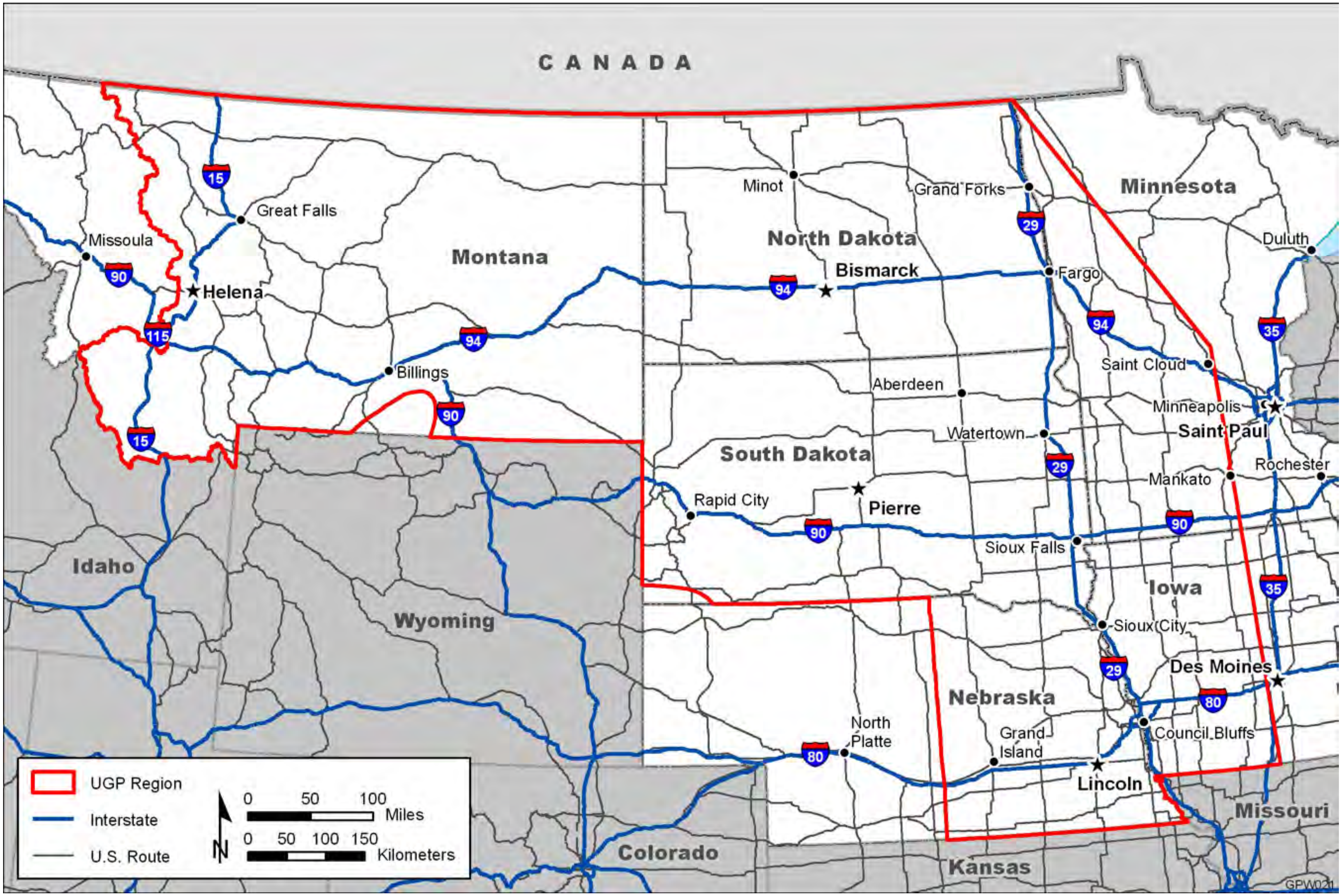


FIGURE 4.1-10 Location of Interstates, State Highways, and Other Major Roads within the UGP Region

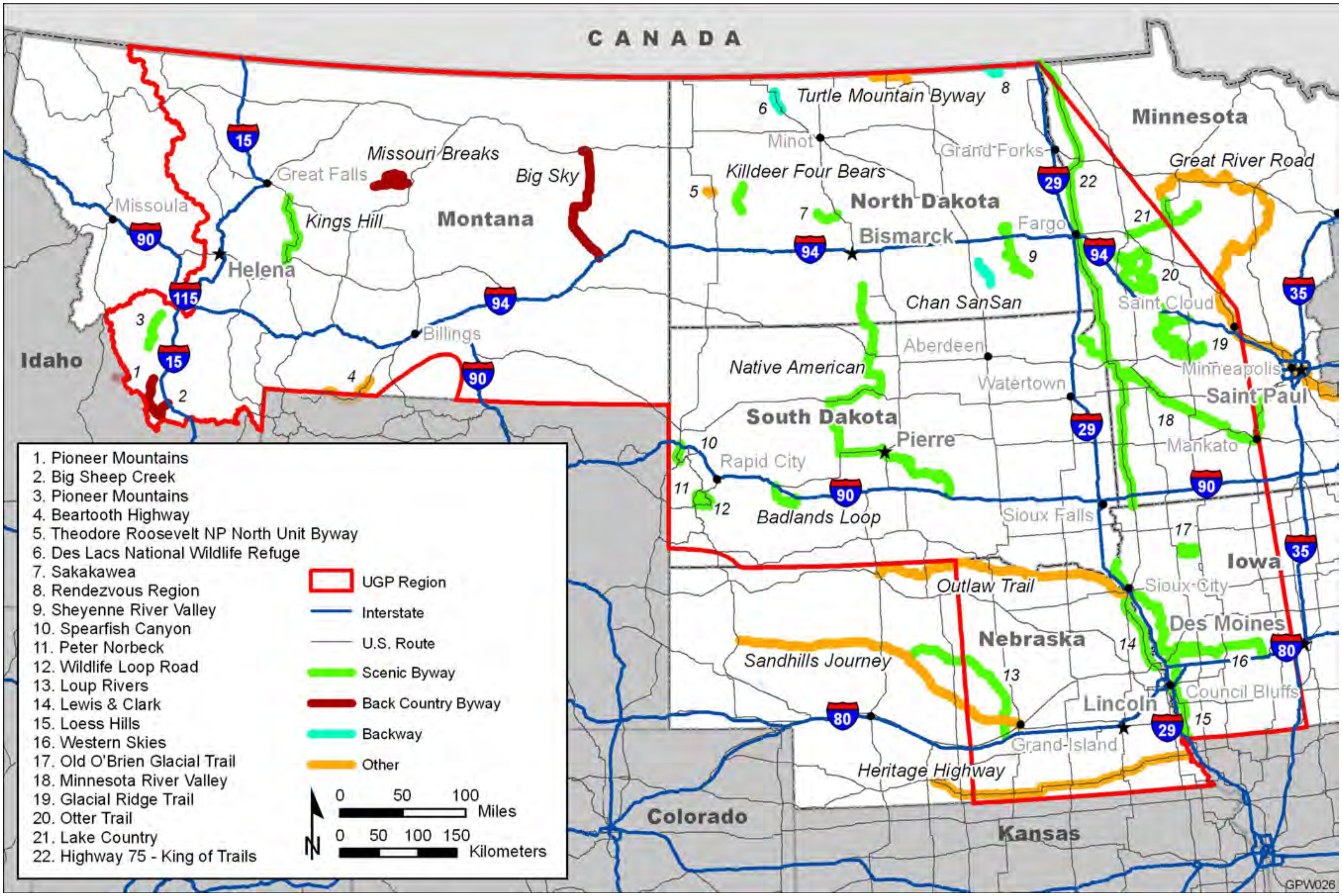


FIGURE 4.1-11 Location of Byways and All-American Roads within the UGP Region

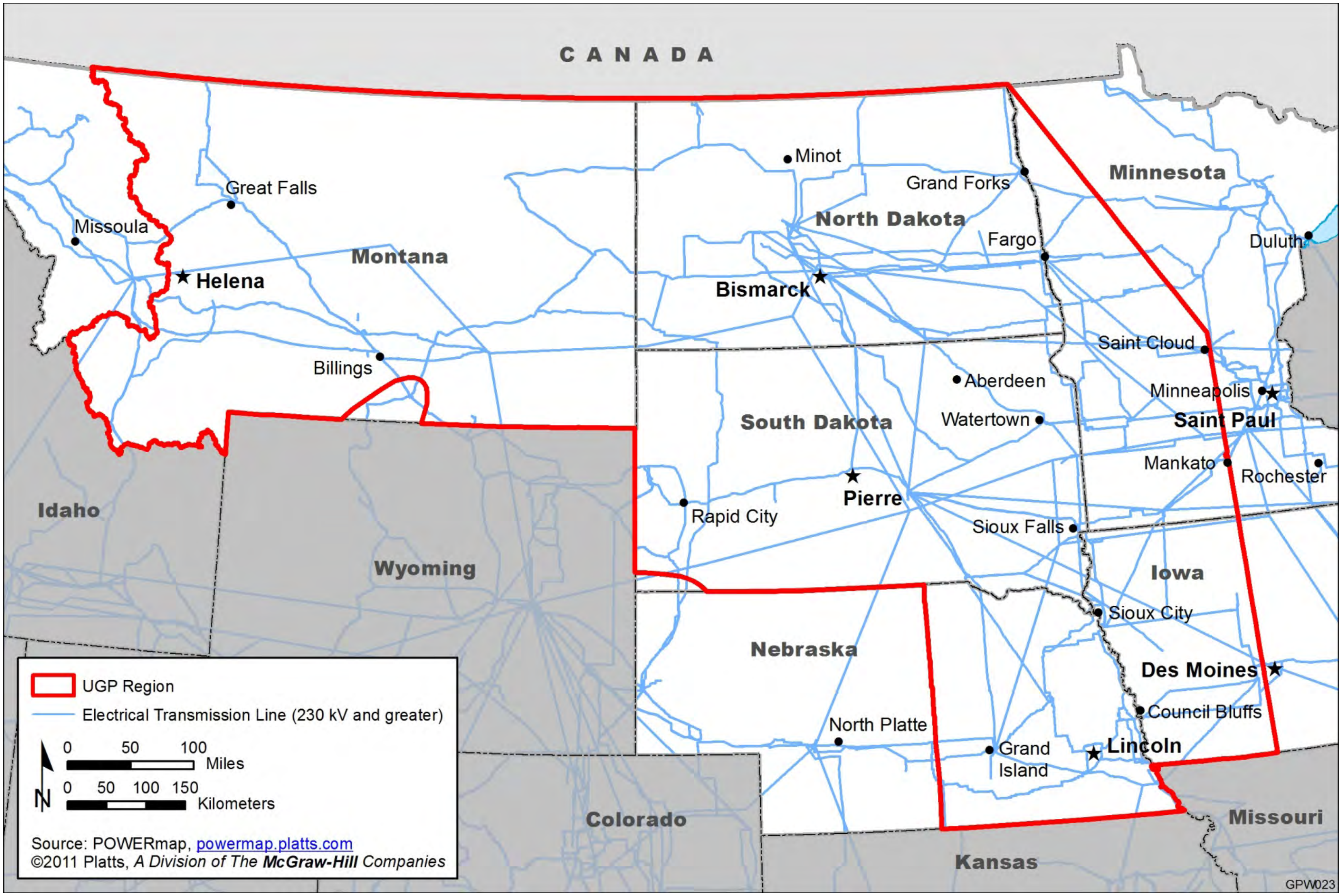


FIGURE 4.1-12 Location of Transmission Lines 230 kV and Higher within the UGP Region

FIGURE 4.1-13 Areas within 25 mi (40 km) of Western Substations within the UGP Region

shows the location of 230-kV and greater lines located within 25 mi (40 km) of Western substations in the UGP Region.

4.2 GEOLOGIC SETTING

4.2.1 Physiography

The UGP Region lies within three physiographic provinces.[1] From west to east, the physiographic provinces are (1) the Northern Rocky Mountains, (2) the Great Plains, and (3) the Central Lowland (figure 4.2-1). The Northern Rocky Mountains, part of the Rocky Mountain chain, extend from southwestern Montana to the northwest into Canada. The province consists of several mountain ranges, with peaks greater than 11,150 ft (3,400 m), separated by alluvial valleys. The ranges of the Northern Rocky Mountains are geologically complex, consisting of folded and faulted Precambrian, Paleozoic, and Mesozoic sedimentary rocks; Tertiary volcanic and plutonic rocks; and metamorphic rocks. Many of the ranges were heavily glaciated about 10,000 years ago. Glacial meltwaters have left behind a complex mixture of unconsolidated sediments, some of which extend into the intermontane valleys (MNRIS 2009; Radbruch-Hall et al. 1982).

The Great Plains province is the western part of the Interior Plains, an extensive lowland stretching from the Rocky Mountains on the west to the Appalachians on the east. In the northern part of the UGP Region, the Great Plains province slopes eastward from about 5,500 ft (1,680 m) at the foot of the Rocky Mountains to about 2,000 ft (610 m) at its eastern boundary. The province consists of a series of plateaus and isolated buttes and small mountain masses, referred to collectively as the Missouri Plateau (figure 4.2-1). The Missouri Plateau ranges from 2,000 to 3,000 ft (610 to 915 m) in elevation and is heavily dissected by the Missouri River and its tributaries. The Missouri River valley is just over 1 mi (1.6 km) wide; its floor is about 300 to 600 ft (90 to 180 m) below the tops of steep dissected bluffs. To the east of the river valley is an area known as the Missouri Coteau. The Missouri Coteau extends from South Dakota through central North Dakota and into northeastern Montana. It is characterized by a rolling hummocky surface with numerous closed depressions, most of them filled by lakes (also referred to as prairie potholes). The landscape of the coteau represents a “dead ice” moraine, formed from the last glacial advances. The Missouri Coteau and the plains in northern Montana make up the glaciated portion of the Missouri Plateau (Bluemle and Biek 2007; Trimble 1980; Hunt 1973).

The highest point in the Great Plains province is Harney Peak at 7,242 ft (2,207 m) in the Black Hills of South Dakota (figure 4.2-1). The Black Hills form an elliptical-shaped domed area, about 125 mi (190 km) long and 65 mi (105 km) wide. Uplift of the dome caused tilting and erosion of the overlying marine sedimentary rocks, exposing the metamorphic and igneous rocks forming the core of the dome. The tilted sedimentary strata (hogbacks) are arranged concentrically around the spires and peaks of the central dome. Other distinctive landscapes in the southern part of the UGP Region include the steep ravines and colorful buttes and pinnacles

[1] Physiographic provinces are broad-scale geographic subdivisions based on topography, rock type, and geologic structure and history. In the UGP Region, the areal distribution of wind power classes is related to the characteristics of physiographic features and landforms. For example, a high percentage of the land surface on the Missouri Plateau — an area of high open plain — falls within wind power Classes 4 and 5 (see also figure 2.4-1).

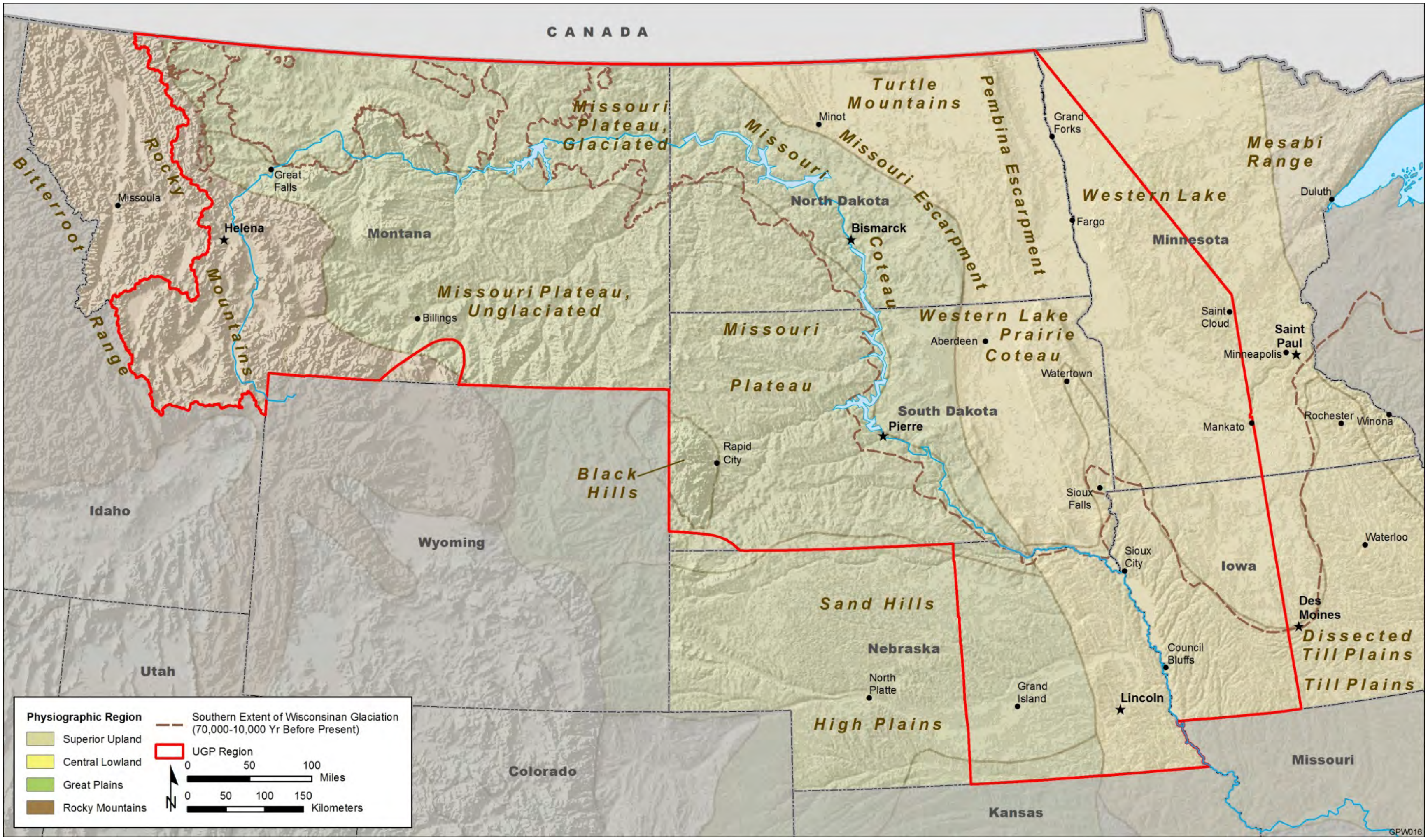


FIGURE 4.2-1 Physiographic Provinces Encompassing the UGP Region (modified from USGS 2009a and Trimble 1980)

of the Badlands of South Dakota and the Sand Hills, a series of rolling sand dunes interspersed with low, swampy areas in southern South Dakota and northern Nebraska (Trimble 1980).

Marking the eastern boundary of the Great Plains province is a prominent east-facing scarp called the Missouri Escarpment. The Missouri Escarpment is several hundred feet high, rising in places to 600 ft (180 m) above the nearly level terrain of the glaciated plains of the Central Lowland province to the east. Its sloping surface has been modified by glaciers and is covered with boulders (Hunt 1973; Bluemle and Biek 2007).

The Central Lowland province makes up the northeastern part of the Interior Plains (figure 4.2-1). Its glaciated plains, also known as drift prairie, are very gently sloping with numerous glacial features, including ice-thrust hills, moraines, and eskers, formed during the most recent glaciation (the Wisconsinin Glaciation, about 70,000 to 10,000 years ago). Elevations of the plains range from about 1,300 to 1,400 ft (400 to 430 m). Marking the eastern boundary of the glaciated plains is the Pembina Escarpment. In northeastern North Dakota, the Pembina Escarpment rises 400 to 500 ft (120 to 150 m) above the flat floor of the Red River Valley to the east (Bluemle and Biek 2007).

The Red River Valley is a flat plain that marks the former floor of glacial Lake Agassiz (figure 4.2-1). Until it drained about 8,500 years ago, Lake Agassiz was the largest freshwater lake in North America. The valley is about 20 to 40 mi (30 to 65 km) wide on either side of the Red River in North Dakota and Minnesota. Its central portion is covered with lake-bottom sediments of silt and clay. Numerous beaches and wave-eroded scarps also are visible along the valley margins, marking the former shorelines of the ancient glacial lake. In southeastern North Dakota, these scarps coincide with the Pembina Escarpment (Bluemle and Biek 2007).

To the south of the Red River Valley lies a glaciated highland area, called the Prairie Coteau, which extends into northeastern South Dakota. Elevations of the coteau range from about 1,600 to 2,000 ft (490 to 610 m), with the highest elevations to the north. The Prairie Coteau is covered by glacial drift and drained by the Big Sioux River. Numerous lakes and depressions (prairie potholes) occur on the Prairie Coteau, especially to the west of the river (Bluemle and Biek 2007).

4.2.2 Soil and Geologic Resources

4.2.2.1 Soil Resources

Soil formation results from the complex interactions between parent (geologic) material, climate, topography, vegetation, organisms, and time. The classification of soils is based on their degree of development (into distinct layers or horizons) and their dominant physical and chemical properties. For the purpose of this report, soils in the UGP Region are described according to their soil order (the highest category of soil taxonomy used by the Natural Resources Conservation Service [NRCS]). The soil orders shown in figure 4.2-2 and described below are based on the descriptions provided in BLM (2007b) and NRCS (1999, 2008a,b).

Mollisols. Mollisols are the predominant soils in the UGP Region. These soils are commonly very dark-colored, organic-rich, mineral soils that are found in the plains of North and

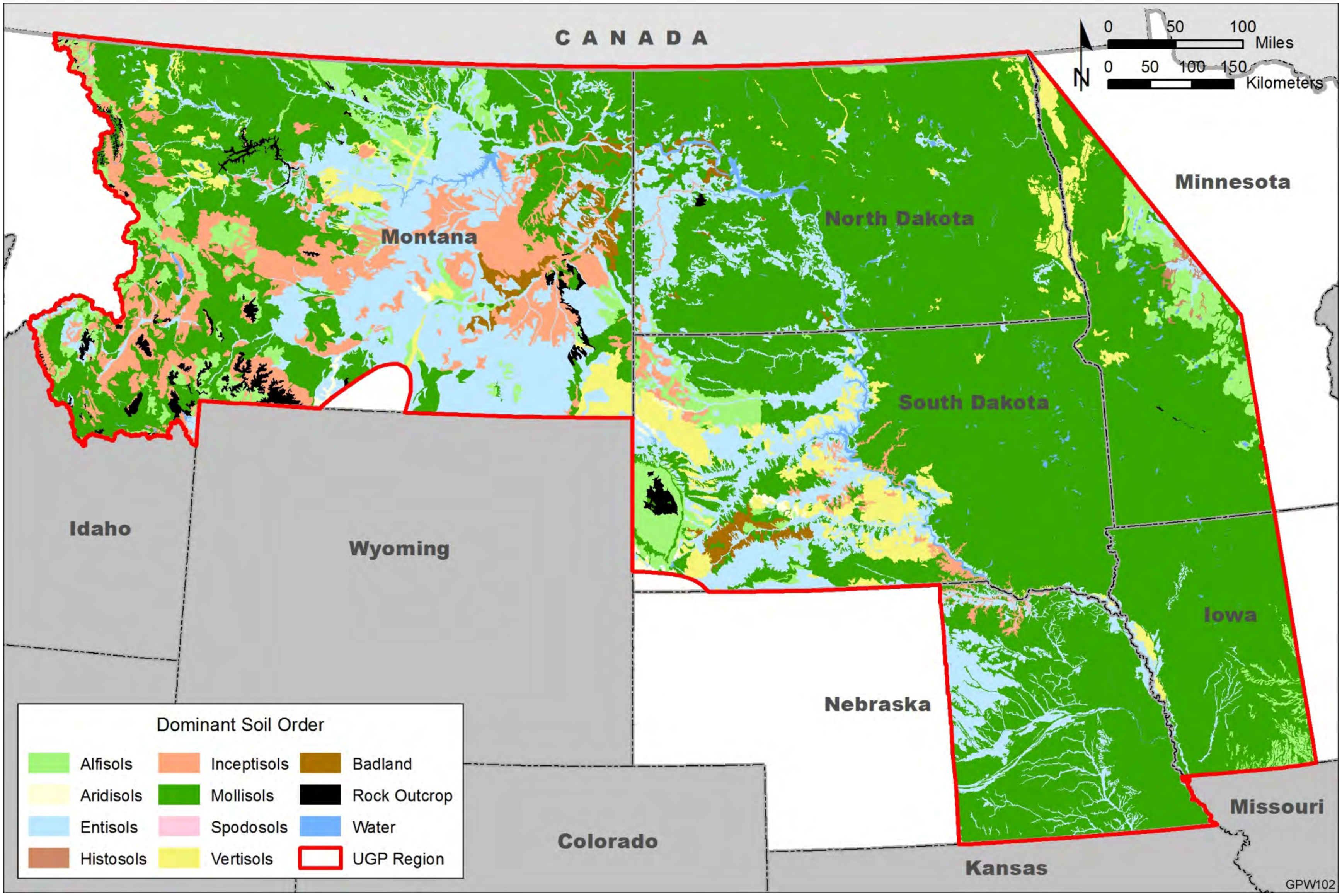


FIGURE 4.2-2 Dominant Soil Orders in the UGP Region (NRCS 2006)

South Dakota and northern Montana where they have developed from loess parent materials. Mollisols are base-rich throughout and highly fertile. These soils typically develop under grasslands, although some have formed under a forest ecosystem, in subhumid to subarid climates that have a moderate to pronounced seasonal moisture deficit. Wet mollisols occur in the more humid climates on the glaciated plains of North Dakota, Minnesota, and Iowa. Some of these soils are freely drained; others have been artificially drained. Mollisols are mainly used as cropland and pasture or rangeland.

Entisols. Entisols are young, weakly developed mineral soils that exhibit little or no horizon development. These soils tend to occur in areas of recently deposited parent material. In eastern Montana and western North and South Dakota, entisols include recent alluvium, sands, soils on steep slopes, and shallow soils. Where entisols occur in Nebraska and Minnesota, they are sandy in all layers and, if bare, are subject to soil blowing and drifting. Entisols also form in recently deposited sediments on floodplains, fans, and deltas along rivers and small streams; some of the largest occur along the Missouri River and its tributaries in western Iowa. These soils are used mainly as wildlife habitat and pasture or rangeland but can support trees in areas of high precipitation.

Inceptisols. Inceptisols are generally young mineral soils showing only moderate degrees of soil development and weathering (more than entisols). They occur in a range of climates, from semiarid to humid and, in the UGP Region, are found mainly in eastern Montana and parts of northern Nebraska. Inceptisols develop where the native vegetation is grass, but some support trees. These soils are used mainly as pasture or cropland, although some are also used as rangeland, forest, or wildlife habitat.

Vertisols. Vertisols occur in the Red River Valley along the North Dakota-Minnesota border. These soils are characterized by a high content of expanding clay and swell when wet. Because of their swelling capacity, vertisols transmit water very slowly and have undergone little leaching. Vertisols support natural vegetation that is predominantly forest, grass, or savannah. These soils are used mainly as cropland, rangeland, or forest, although they present a drainage problem for croplands because of their low hydraulic conductivity when wet.

4.2.2.2 Geologic Resources

Sand, gravel, and crushed stone suitable for use in construction occur throughout the UGP Region. These resources would likely be mined from river valleys, glacial outwash areas, quarries, and alluvial fans close to project sites.

4.2.3 Seismic Activity and Related Hazards

Seismic activity and related hazards, such as liquefaction and landslides, pose a low to moderate risk to wind energy development in some areas of the UGP Region. The following sections describe geologic hazards in terms of their probability and location in the UGP Region. It is important to note that the scales of the accompanying maps are small because their purpose is to show the general locations of hazardous areas (not individual faults or landslides) and how they correlate to the physiography described in section 4.2.1. The risk of local hazards would be assessed during the planning and preparation phases of specific wind energy projects since site-specific hazard conditions could influence turbine foundation designs.

4.2.3.1 Quaternary Faults, Earthquakes, and Ground-Shaking Hazards

Quaternary Faults. In the UGP Region, Quaternary faults (i.e., faults with evidence of movement or deformation within the past 1.8 million years) occur predominantly in the Intermountain Seismic Belt, a zone of seismicity extending from southwestern Montana (near Yellowstone National Park, Wyoming) to the northwestern corner of the State (figure 4.2-3). The U.S. Geological Survey (USGS) Quaternary fault and fold database categorizes 87 faults in this region as Class A (i.e., showing strong geologic evidence of a fault of tectonic origin either observed at the surface or inferred from liquefaction or other deformational features). An additional 34 faults (Classes C and D) may be present. Class C faults do not demonstrate sufficient geologic evidence of Quaternary slip or deformation, or that they are of tectonic origin. Class D faults are surface features, such as joints, that resemble faults but are not of tectonic origin. Class C and D faults also occur in South Dakota (Pierre faults, Class C), Nebraska (Harlan County fault and the Ord Escarpment, both Class D), and Iowa (the Plum River fault zone, Class C) (USGS and Montana Bureau of Mines and Geology 2009).

Earthquake History. Montana is one of the most seismically active States in the United States. Historic earthquakes with Richter Scale magnitudes greater than 6.0 occurred in 1925 (Clarkston Valley, M 6.6), 1935 (Helena, M 6.3 and 6.0), and 1947 (Madison County, M 6.3). The largest earthquake in the State’s history occurred on August 17, 1959, at Hebgen Lake in southwestern Montana, just west of Yellowstone National Park. The earthquake measured 7.3 on the Richter Scale and resulted in the death of at least 26 people who were buried by a landslide in a Madison Canyon campground. No earthquakes exceeding 6.0 on the Richter Scale have occurred in Montana since 1959; however, earthquakes with magnitudes greater than 4.0 occurred in the western part of the State in 2005, 2006, and 2007 (USGS 2009b).

Historically, earthquake activity in the Great Plains and Central Lowland provinces has been minor, although recent earthquakes of magnitude 3.0 or greater on the Richter Scale have been recorded. Earthquakes occurring elsewhere also have been felt within these provinces (USGS 2009b).

Ground-Shaking Hazards. Earthquake-prone areas are subject to various earthquake hazards, such as ground shaking, liquefaction, landslides, soil compaction, and surface rupture. Figure 4.2-4 presents the peak horizontal acceleration, as a percentage of acceleration due to the force of gravity (g), which has a 10 percent probability of exceedance in 50 years. The peak horizontal acceleration ranges from 0 g (insignificant ground shaking) to 1 g (strong ground shaking).[2] The highest ground-shaking hazard in the UGP Region occurs in the Northern

[2] Gravity (g) is a common value of acceleration equal to 32.2 ft/s^2 (9.8 m/s^2) (the acceleration due to gravity at the earth’s surface).

FIGURE 4.2-3 Quaternary Faults in Western and Southwestern Montana (Source: USGS and Montana Bureau of Mines and Geology 2009)

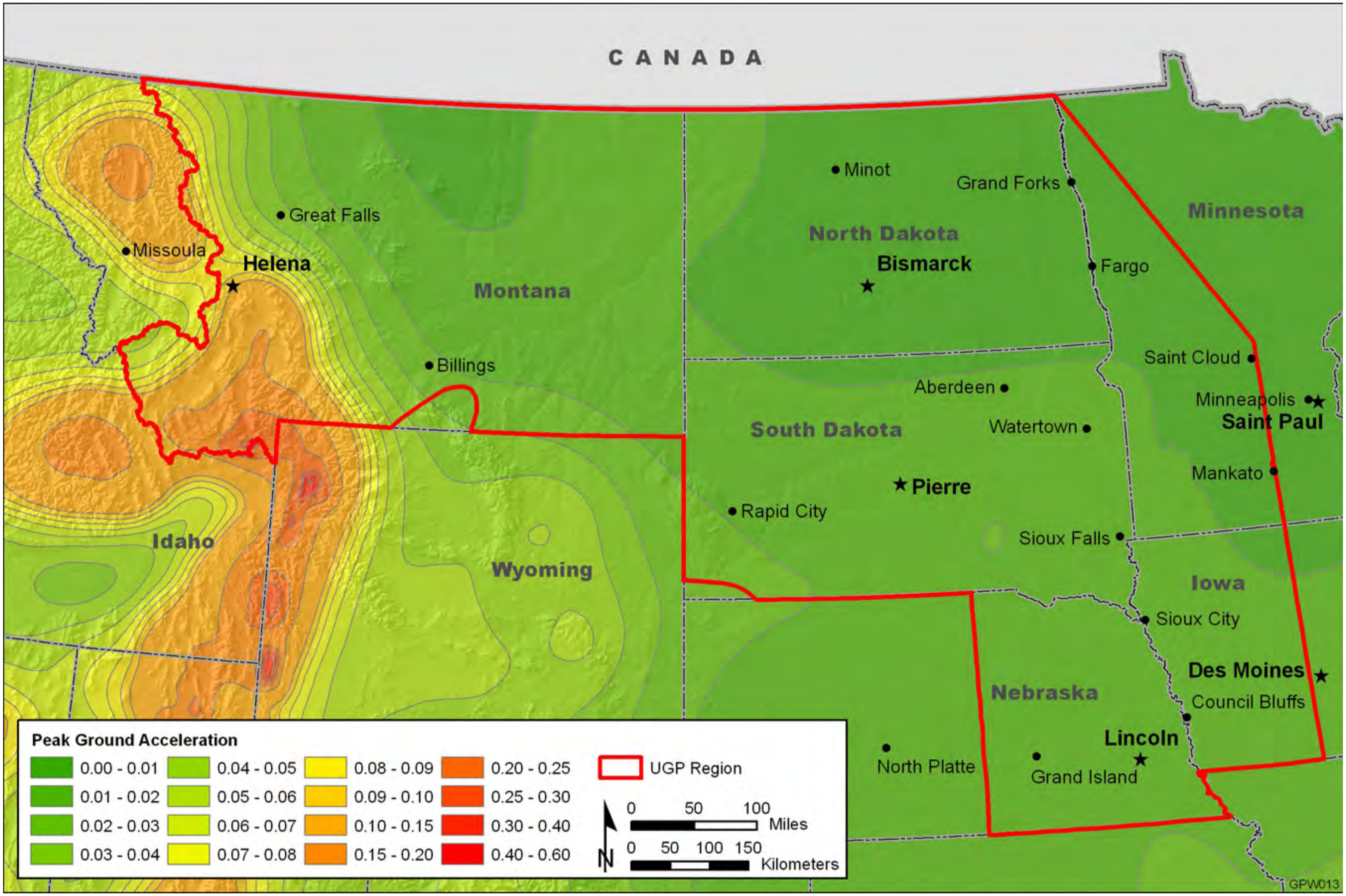


FIGURE 4.2-4 Peak Horizontal Acceleration with 10 Percent Probability of Exceedance in 50 Years in the UGP Region (Source: Petersen et al. 2008)

Rocky Mountains; the highest probable peak acceleration (greater than 0.2 g, or 20 percent of g) occurs in southwestern Montana (near Yellowstone Park, Wyoming). In the Great Plains and Central Lowland provinces, the probable peak acceleration is very low, in the range of 0 g to 0.03 g (equal to or less than 3 percent of g), since active seismic areas and major fault systems are some distance away.

4.2.3.2 Volcanic Activity

There are no active volcanoes within the UGP Region; the closest source of potential volcanic activity is Yellowstone National Park, in northwestern Wyoming (figure 4.2-1).

4.2.3.3 Liquefaction

Liquefaction[3] of sediments is a potential hazard during or immediately following large earthquakes. Liquefaction hazards are associated with sandy and silty soils with low plasticity; therefore, the potential to liquefy tends to be higher in recent deposits of fluvial, lacustrine, or eolian origin than in glacial till and older deposits. Saturated soils are more susceptible to liquefaction, and the hazards of liquefaction are most severe in near-surface soils (less than 50 ft [15 m] below the ground surface) and on slopes. Given the relatively low incidence of historic seismicity in most of the UGP Region, liquefaction is not a hazard of great concern. However, some earthquake-prone areas in western and southwestern Montana (e.g., the Lake Helena region) are highly susceptible to liquefaction (Jaffe 2002).

4.2.3.4 Slope Stability

The major determinants of slope stability are rock types, structure, topography, precipitation, landslide susceptibility, and landslide incidence. Steep slopes increase the susceptibility to landsliding but are not the only determining factor. For example, steep slopes in hard, unfractured, homogeneous rocks may be very stable, while slopes steepened by faulting, wave-cut cliffs, or eroding streams may be very unstable. Areas of moderate to high landslide susceptibility occur within the UGP Region (figure 4.2-5). In the Northern Rocky Mountains, rock falls and debris flows commonly occur along unstable cliffs at the mountain front. Large and rapid slope failures in fractured rock pose significant hazards in these areas, as illustrated by the Madison River Canyon landslide triggered by the Hebgen Lake, Montana, earthquake in 1959 (Radbruch-Hall et al. 1982).

Landslide incidence and susceptibility are lower across the large expanse of glaciated plains characterized by low relief; however, loess along major river valleys and their tributaries and clayey till on slopes underlain by shale are susceptible to slumps and earth flows. Areas of moderate and high susceptibility occur on the rolling to hilly plains of the Missouri Plateau and along the valley walls of the Missouri River and its principal tributaries (figure 4.2-5). Glacial lake deposits along the Missouri River (e.g., near Great Falls, Montana) are moderately to

[3] Liquefaction refers to a sudden loss of strength and stiffness in loose, saturated soils. Liquefaction causes a loss of soil stability and can result in large, permanent displacements of the ground.

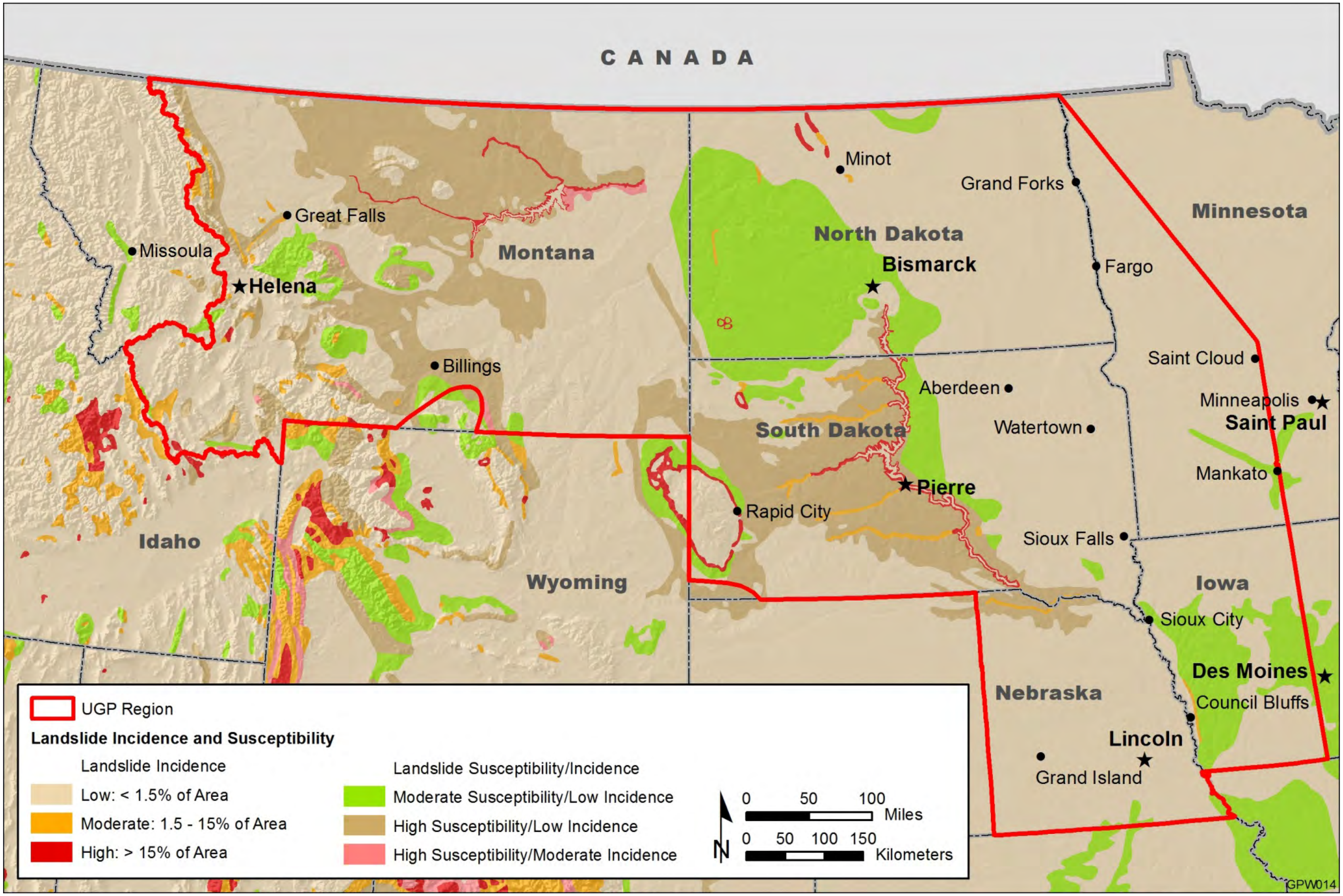


FIGURE 4.2-5 Landslide Incidence and Susceptibility in the UGP Region

highly susceptible to slope failure. Sliding is also common around the perimeters of buttes in southwestern North Dakota and northwestern South Dakota, and the belt of tilted sedimentary rocks surrounding the Black Hills dome (Radbruch-Hall et al. 1982).

4.3 HYDROLOGIC SETTING AND WATER RESOURCES

The following sections provide a general overview of the hydrologic setting and water resources in the UGP Region. The locations and availability of water resources would be taken into account during the planning phases of specific wind energy projects.

4.3.1 Surface Water Resources

The UGP Region lies within three hydrologic regions: (1) Missouri, (2) Souris-Red-Rainy, and (3) Upper Mississippi. The hydrologic regions shown in figure 4.3-1 are based on the USGS classification system. Each hydrologic region encompasses either the drainage area of a major river or the combined drainage areas of a series of rivers (Seaber et al. 1987). Table 4.3-1 lists the hydrologic regions in the UGP Region and their major river basins. The major river basins within each hydrologic region are described in the following sections. Surface waters classified as wild and scenic rivers are identified and described in section 4.1.

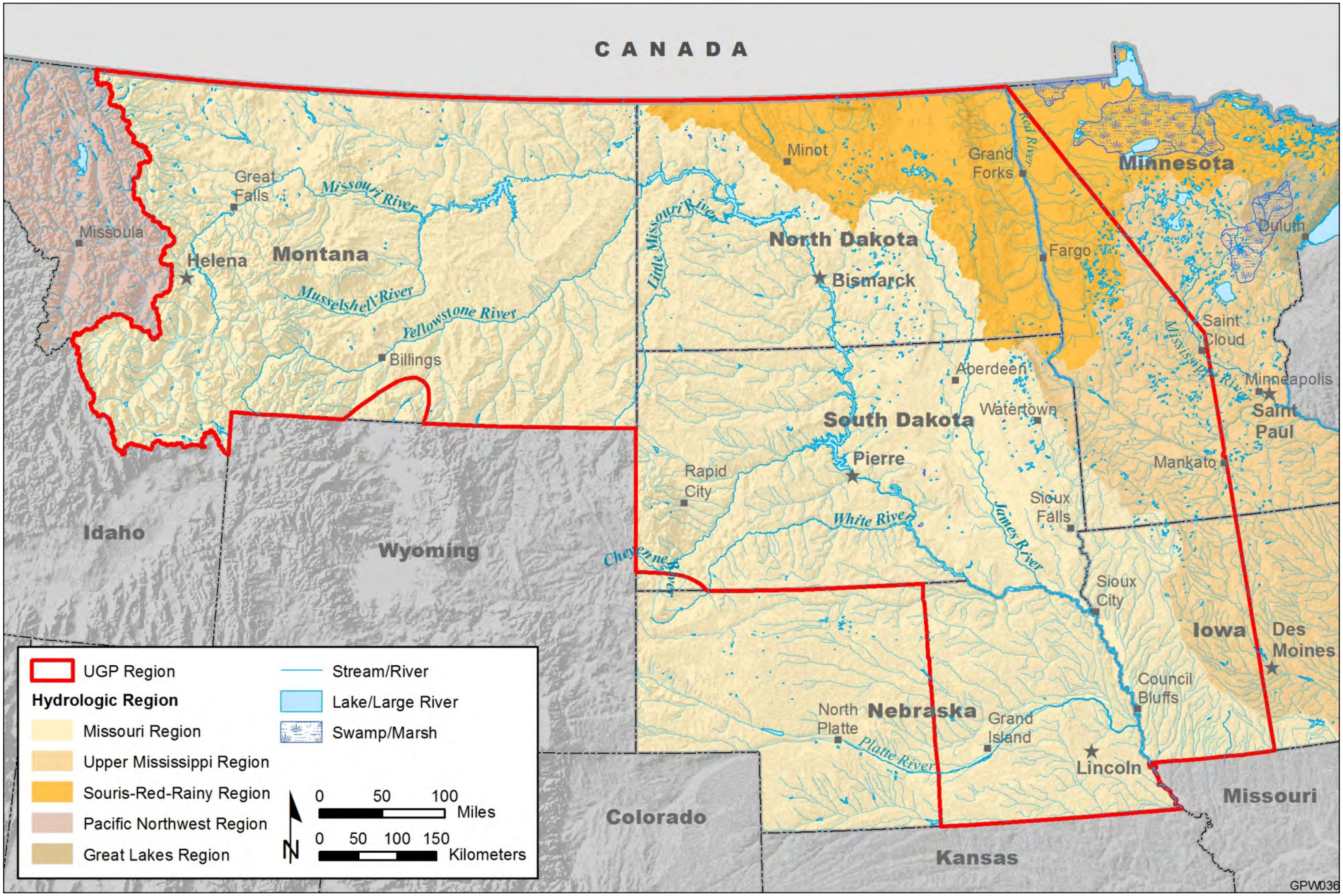
4.3.1.1 Missouri Hydrologic Region

The Missouri Hydrologic Region encompasses the drainage of the Missouri River Basin, the Saskatchewan River Basin (Canada), and several small closed basins (or potholes). Within the UGP Region, it includes all of Nebraska and parts of Montana, North Dakota, South Dakota, Iowa, and Minnesota. Because all of the Saskatchewan River and all but a very small portion of the Saskatchewan River Basin are in Canada, the Saskatchewan River Basin is not discussed further in this section.

Missouri River Basin. The Missouri River originates near Three Forks, Montana, and flows about 2,500 mi (4,023 km) to discharge into the Mississippi River just north of St. Louis, Missouri. The river basin covers an area of about 530,000 mi^2 (1,372,694 km^2) over all or parts of 10 States and small portions of southern Alberta and Saskatchewan. In the UGP Region, it drains high mountain regions in western Montana (Northern Rocky Mountain physiographic province) and the Missouri Plateau of the Great Plains province. Surficial deposits in the Great Plains province are highly erodible glacial till with a gently rolling topography and belts of glacial moraines; the Missouri River and its tributaries are entrenched in these sediments. The Missouri Coteau, a highland area covered with glacial deposits, is located just east of the river in this area (Benke and Cushing 2005; MRBA 2009).

Within the UGP Region, the Missouri River Basin consists of seven smaller drainage basins (Cross et al. 1986): the Upper Missouri River Basin, the Yellowstone River Basin, the

1



2 **FIGURE 4.3-1 Hydrologic Regions in the UGP Region**

TABLE 4.3-1 Major River Systems within the Hydrologic Regions of the UGP Region

Hydrologic Region	Major River Systems	UGP Region within Hydrologic Region	Mean Annual Precipitation	Land Use and Hydrology
Missouri	Missouri River Basin	Parts of Montana, North and South Dakota, Iowa, and Minnesota, and all of Nebraska	19.7 in. (50.1 cm); seasonal pattern with lows in January and February and highs in June	Land use within 3.1 mi (5 km) of the river is primarily cropland (33 percent) and grassland (26 percent), with about 10 percent shrub, 6 percent forest, and 17 percent undeveloped. Runoff to the river is low due to semiarid climate; mean annual discharge ranges from 7,063 ft^3/s (200 m^3/s) (Fort Benton, MT) to 31,183 ft^3/s (883 m^3/s) (Omaha, NE). Turbidity historically high, but currently reduced by sedimentation in reservoirs. Water quality is hard to very hard, alkaline, and high in total dissolved solids. Macronutrient and some metals (e.g., arsenic and selenium) concentrations are naturally high.
Souris-Red-Rainy	Rainy River Basin and Lake of the Woods drainage	Northern Minnesota	24.4 in. (62 cm); seasonal pattern with lows in February and highs in June and July	Land use (overall) is primarily forest (30 percent) with less than 5 percent devoted to agriculture (mixed farm and grazing) and less than 1 percent urbanized. Waters tend to be nutrient-poor, but relatively high in dissolved organic carbon. Given low population densities, river system relatively unaffected by domestic waste or nonpoint-source pollutants.
	Red River of the North Basin	Parts of North Dakota, South Dakota, and Minnesota	19.3 in. (48.9 cm); seasonal pattern with highs in June and July	Land use within U.S. portion of river basin is primarily cropland (66 percent) and forest (26 percent), with about 8 percent pasture land. Runoff to river is low. Mean annual discharge at Lockport (Manitoba) is 8,334 ft^3/s (236 m^3/s), including flow of the Assiniboine River. Turbidity relatively high. Water quality is hard and alkaline. Pesticides and herbicides present in low concentrations (less than drinking water standards).

TABLE 4.3-1 (Cont.)

Hydrologic Region	Major River Systems	UGP Region within Hydrologic Region	Mean Annual Precipitation	Land Use and Hydrology
Souris-Red-Rainy (Cont.)	Souris River Basin	Northern part of North Dakota	17.9 in. (45.4 cm; estimate based on Assiniboine River)	Land use (overall) is primarily forest land (46 percent), with 39 percent devoted to agriculture. Water quality problems include eutrophication and anoxic events, fish kills, bacterial contamination, and shellfish closures.
Upper Mississippi	Upper Mississippi River Basin	Parts of South Dakota, Minnesota, and Iowa	37.8 in. (96 cm); seasonal pattern with lows in January and February and highs from April to July	Land use within the river basin is primarily agricultural (70 percent) and forest (25 percent), with about 5 percent urbanized. Mean annual discharge (including tributaries) is 126,285 ft^3/s (3,576 m^3/s). Water quality is hard and slightly alkaline. Nitrate-N and total phosphorus (from fertilizers) are low in the headwaters and increase downstream.

1 Sources: Seaber et al. (1987); Benke and Cushing (2005).

White-Little Missouri River Basin, the Sioux-James River Basin, the Platte-Niobrara River Basin, the Kansas River Basin, and the Chariton-Nishnabotna River Basin (figure 4.3-2; table 4.3-2).

Prairie Pothole Region. The Prairie Pothole Region covers about 276,063 mi^2 (715,000 km^2) in North America and extends from north-central Iowa into central Alberta. The region is characterized by a landscape dotted with small water-holding depressions, called potholes or sloughs, left behind during the last glacial retreat about 12,000 years ago. In the UGP Region, prairie potholes dot the Missouri Coteau, the eastern part of the Missouri Plateau located mainly in North Dakota within the Great Plains physiographic province. Prairie potholes are also characteristic features on the Prairie Coteau, which extends into northeastern South Dakota within the Central Lowland province. The potholes function as groundwater recharge sites, receiving most of their water via precipitation and runoff from snowmelt with little or no groundwater inflow. Water loss is predominantly through evapotranspiration with little overflow or seepage outflow. Water in the potholes ranges from freshwater to brine, depending on the inflow-outflow dynamic. The primary land use of the Prairie Pothole Region is agriculture (including livestock watering), with some urban development. The region also provides important wetlands that support waterfowl breeding (see section 4.6.2.2) (USGS 2009c; Sloan 1972; Bluemle and Biek 2007).

4.3.1.2 Souris-Red-Rainy Hydrologic Region

The Souris-Red-Rainy Hydrologic Region encompasses the drainages of the Lake of the Woods, Rainy, Red River of the North, and Souris River Basins that ultimately discharge into Lake Winnepeg and Hudson Bay. Within the UGP Region, it includes parts of North Dakota, South Dakota, and Minnesota.

Rainy River Basin and Lake of the Woods. The Rainy River Basin drains an area of about 11,400 mi^2 (29,526 km^2) and forms part of the international border separating northern Minnesota and Ontario, Canada. The river flows about 85 mi (140 km) west-northwest from Rainy Lake toward Lake of the Woods, about 12 mi (19 km) northwest of Baudette, Minnesota. The lower westerly run of the Rainy River flows through and drains the clay and silt sediments of ancient glacial Lake Agassiz. The upper easterly segment is characterized by many small lakes in granite basins. The lakes spill through either fractured or glaciated channels (Benke and Cushing 2005).

Red River of the North Basin. The Red River of the North Basin is a flat lake bed formed from sediment deposited on the bottom of ancient glacial Lake Agassiz, which occupied the basin between 12,000 and 7,000 years ago. The source of the river is the confluence of the Otter Trail and Bois de Sioux Rivers in Wahpeton, North Dakota, and Breckenridge, Minnesota, in the southern part of the basin. The river flows northward about 550 mi (885 km) and discharges into Lake Winnepeg (Canada). In the United States, the drainage area of the Red River of the North is about 40,200 mi^2 (104,118 km^2), with most of it in North Dakota within the Central Lowlands physiographic province. Because of sediment deposits left behind by the river's frequent flooding, the Red River of the North Basin is one of the most agriculturally productive areas in the United States (Macek-Rowland et al. 2004; MDNR 2009c).

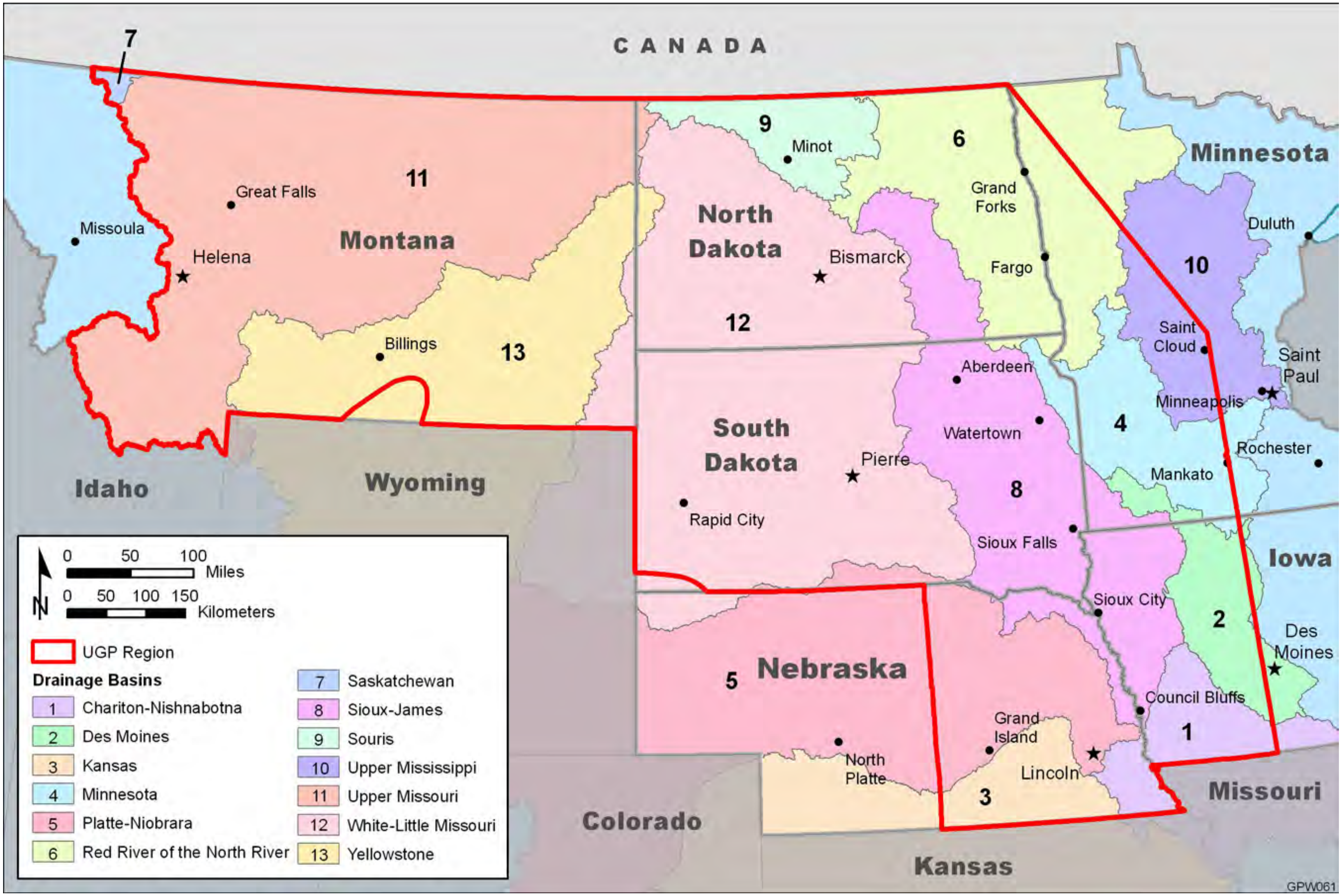


FIGURE 4.3-2 Drainage Basins within the UGP Region

TABLE 4.3-2 Drainage Basins within the Missouri River Basin

Drainage Basin	Corresponding USGS Hydrologic Subregion	Description
Upper Missouri River	1002, 1003, 1004, 1005, and 1006	Includes the Missouri River Basin headwaters, the Gallatin, Jefferson, Madison, Marias, and Milk River Basins in Montana and Wyoming, to the confluence with the Yellowstone River Basin in Montana. Drains a total area of about 84,000 mi^2 (217,560 km^2).
Yellowstone River	1007, 1008, 1009, and 1010	Includes the Upper Yellowstone River Basin and the Bighorn, Powder, and Tongue River Basins in Montana and Wyoming, and the Lower Yellowstone River Basin in Montana and North Dakota. Drains a total area of about 70,000 mi^2 (181,300 km^2).
White-Little Missouri River	1011, 1012, 1013, and 1014	Includes the Missouri River Basin below the confluence with the Yellowstone River Basin, and the Cheyenne River Basin, in Montana, Wyoming, North and South Dakota, and Nebraska, to the Fort Randall Dam in southeastern South Dakota. Drains a total area of about 99,200 mi^2 (256,930 km^2).
Sioux-James River	1016, 1017, and 1023	Includes the James River Basin in North and South Dakota and the Missouri River Basin from Fort Randall Dam to the confluence with the Platte River Basin, including the Big Sioux River Basin, in North and South Dakota, Iowa, Minnesota, and Nebraska. Drains a total area of about 44,540 mi^2 (115,360 km^2).
Platte-Niobrara River	1015, 1018, 1019, 1020, 1021, and 1022	Includes the Niobrara River and Ponca Creek Basins in Nebraska, South Dakota, and Wyoming; the North and South Platte River Basins in Colorado, Nebraska, and Wyoming; and the Platte River Basin to the confluence with the Loup and Elkhorn River Basins in Nebraska. Drains a total area of about 98,810 mi^2 (255,920 km^2).
Kansas River	1025, 1026, and 1027	Includes the Republican and Smoky Hill River Basins in Colorado, Kansas, and Nebraska and the Kansas River Basin in Kansas, Nebraska, and Missouri. Drains a total area of about 59,500 mi^2 (154,100 km^2).
Chariton-Nishnabotna River	1024 and 1028	Includes the Missouri River Basin below the confluence with the Platte River Basin to the confluence with the Kansas River Basin in Iowa, Kansas, Missouri, and Nebraska; and the Chariton and Grand and Little Chariton River Basins in Iowa and Missouri. Drains a total area of 24,200 mi^2 (62,680 km^2).

Sources: Cross et al. (1986); USGS (2009c).

Souris River Basin. The Souris River originates in southeastern Saskatchewan, Canada, and flows southeasterly to Sherwood, North Dakota, then loops back to reenter Canada near Westhope, North Dakota, just west of the Turtle Mountains. It eventually discharges to the Red River, via the Assiniboine River in Canada. Large areas within the Souris River Basin are poorly drained and do not contribute to streamflow. In the United States, the river basin drains an area of about 9,130 mi^2 (23,647 km^2) in northern North Dakota, a region covered by glacial drift. Major tributaries are the Des Lacs, Wintering, and Deep Rivers and Willow and Boundary Creeks (Winter et al. 1984).

4.3.1.3 Upper Mississippi Hydrologic Region

The Upper Mississippi Hydrologic Region encompasses the drainage of the Mississippi River Basin above its confluence with the Ohio River, excluding the Missouri River Basin. Within the UGP Region, it includes parts of South Dakota, Minnesota, and Iowa. The main stem of the Upper Mississippi River begins at Lake Itasca in northern Minnesota and flows 1,248 mi (2,008 km) before it merges with the Missouri River just north of St. Louis, Missouri. The basin drains an area of 171,501 mi^2 (444,185 km^2), almost entirely within the Central Lowland physiographic province. The Upper Mississippi Hydrologic Region also includes the Minnesota and Des Moines River Basins (figure 4.3-2; table 4.3-3).

TABLE 4.3-3 Drainage Basins within the Upper Mississippi River Basin

Drainage Basin	Corresponding USGS Hydrologic Subregion	Description
Upper Mississippi River (excluding Missouri River)	0701	Includes the Mississippi River Basin headwaters above the confluence with the St. Croix River Basin (excluding the Minnesota River Basin) in Minnesota. Drains a total area of about 20,200 mi^2 (53,320 km^2).
Minnesota River	0702	Includes the Minnesota River Basin in Minnesota and South Dakota. Drains a total area of about 16,800 mi^2 (43,510 km^2).
Des Moines River	0704, 0706, 0708, and 0710	Includes the Upper Mississippi River Basin below the confluence with the St. Croix River Basin and the Root, La Crosse, and Des Moines River Basins in Iowa, Minnesota, Wisconsin, and Illinois. Drains a total area of 53,010 mi^2 (137,290 km^2).

Sources: Cross et al. (1986); USGS (2009c).

4.3.2 Groundwater Resources

4.3.2.1 Principal Aquifers and Aquifer Systems

Several principal aquifers or aquifer systems (composed of two or more aquifers) occur in the UGP Region (figure 4.3-3). Groundwater in the UGP Region occurs primarily in basin-filled sediments, sandstone, and carbonate bedrock. Local productive aquifers also occur in glacial deposits of sand and gravel (the general distribution of glacial deposits is indicated by the dot-patterned area in figure 4.3-3). Recharge to these aquifer systems occurs mainly through infiltration of precipitation and seepage through streambeds or irrigated lands. Groundwater discharges to local streams, rivers, and springs in valleys of low-lying areas and in alluvial fans. During the summer season, groundwater discharges contribute significantly to streamflows in low-lying arid and semiarid regions. Groundwater quality (in terms of dissolved solid concentration, hardness, and salinity) is significantly affected by the mineral composition and depth of the host bedrock. Descriptions of the principal aquifers and aquifer systems in the UGP Region are provided in table 4.3-4.

4.3.2.2 Sole Source Aquifers

The Sole Source Aquifer (SSA) program was authorized by Section 1424(e) of the Safe Drinking Water Act (SDWA) in 1974 and is one of the EPA's formal groundwater protection programs (EPA 2009a). Aquifers eligible for SSA designation are nominated by petition by local groups and organizations. An SSA aquifer is defined as one that supplies at least 50 percent of the drinking water in the petitioned area and for which there is not a reasonably available alternative source to supply drinking water to all those who depend on the aquifer (EPA 2009a). Currently, no SSAs have been designated within the UGP Region. The Missoula Valley aquifer in western Montana lies just to the west of the UGP Region; another SSA, the Mille Lacs aquifer, lies just to the east in central Minnesota (EPA 2009b,c).

Proposed federally funded projects that have the potential to contaminate a SSA are subject to EPA review. Most projects referred to the EPA for review meet all Federal, State, and local groundwater protection standards and are approved without imposing additional conditions. Occasionally, site- or project-specific concerns for groundwater quality protection lead to specific recommendations or pollution prevention requirements as a condition of funding. In rare cases, Federal funding has been denied when the applicant has been either unwilling or unable to modify the project (EPA 2009a). The Service ensures compliance with the SDWA through policies outlined in its Service Manual (Pollution Control, Part 561, Chapter 4) (Service 2009a).

SSA designation is not meant to imply that an aquifer is more or less valuable or vulnerable to contamination than other aquifers that have not been designated. Many valuable and sensitive aquifers have not been designated simply because they have not been nominated for SSA status or due to patterns of drinking water consumption. Therefore, SSA status should not be the sole or determining factor in making land use decisions that may impact groundwater quality. Site-specific hydrogeological assessments should be conducted and taken into account along with other project-specific factors such as project design, construction practices, and site management.

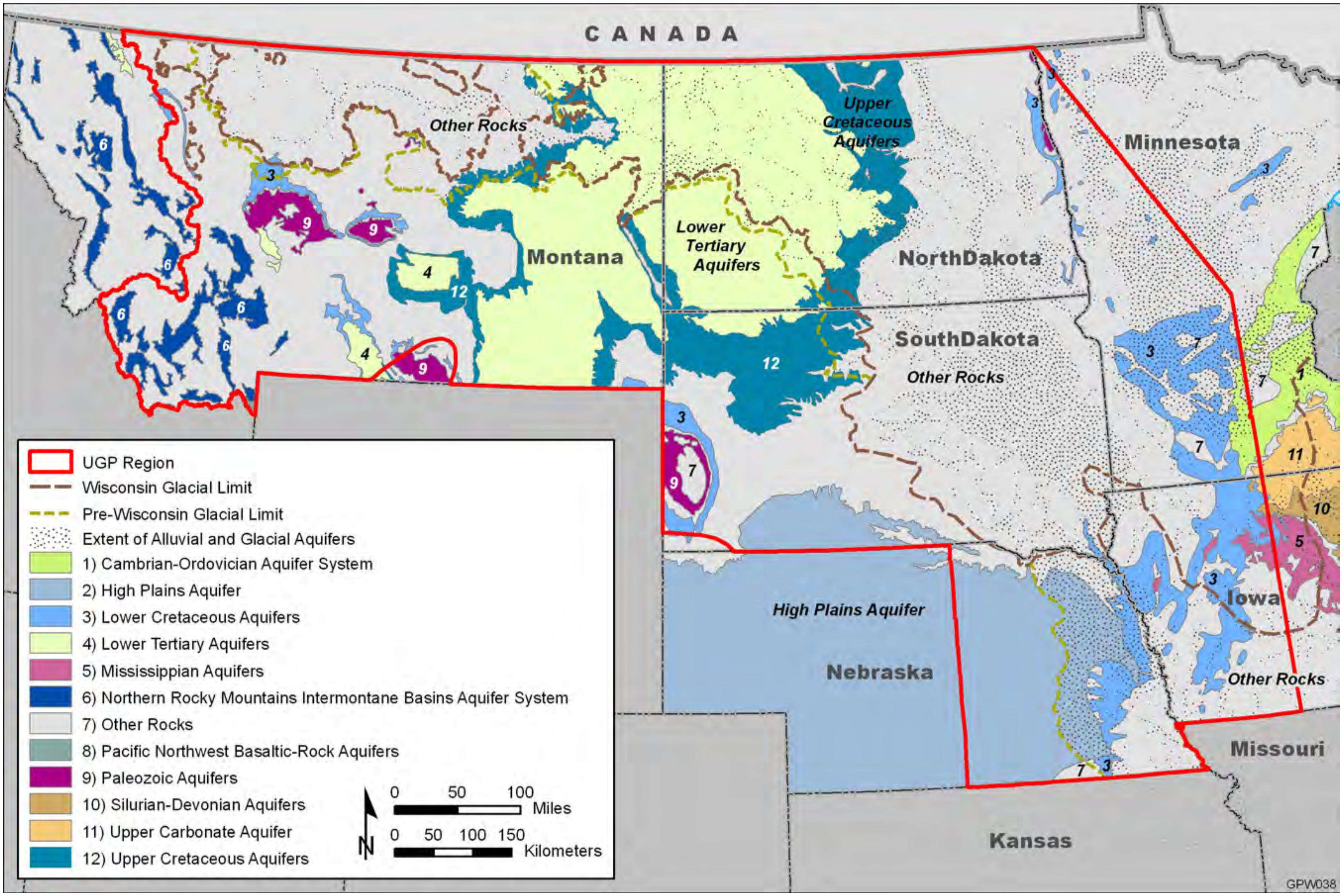


FIGURE 4.3-3 Principal Aquifers and Aquifer Systems in the UGP Region

TABLE 4.3-4 Principal Aquifers and Aquifer Systems in the UGP Region

Principal Aquifer System	Geographic Area	Aquifer Type	Description
Northern Rocky Intermontane Basins aquifer system	Western Montana	Unconsolidated sand and gravel	Consists primarily of unconsolidated basin-fill deposits of Quaternary age alluvium (and local glacial material) that overlie upper Tertiary aquifers in structural intermontane basins. Coalescing alluvial fans comprise much of the valley fill near mountain fronts. Most of the basins that compose the aquifer system are not hydraulically connected, but share common hydrologic and geologic characteristics. Recharge is through infiltration from precipitation and snowmelt runoff. Yields adequate for domestic use and livestock-watering purposes. Deeper wells yield adequate volumes of water for irrigation, industrial purposes, and public supply. Several cities in western Montana obtain water supplies from the basin-fill aquifers.
High Plains aquifer system	Southern South Dakota and most of Nebraska	Unconsolidated sand and gravel	Consists of siltstone, sandstone, and unconsolidated sediments ranging from the upper Tertiary to Quaternary in age. Major aquifers include the Arikaree Group (Miocene and Oligocene), the Ogallala aquifer (Miocene), and overlying saturated Quaternary sediments. Aquifer system is the principal source of groundwater for the High Plains region. Unconfined conditions; water generally moves from west to east. Recharge enters the aquifer system as direct infiltration of precipitation and as seepage through the beds of streams or from irrigated land. Water quality generally good, although more mineralized near discharge areas. Contamination at shallow depths due to fertilizers and organic pesticides to cropland in some locations.
Northern Great Plains aquifer system	Central and eastern Montana, western North and South Dakota	Sandstone	The aquifer system is mostly within the Williston Basin, a large structural trough that extends from Montana into North Dakota, South Dakota, and Canada, and areas of structural uplifts that flank these basins. Major aquifers are sandstones of Lower Tertiary and Cretaceous age and carbonate rocks of Paleozoic age (described below).

TABLE 4.3-4 (Cont.)

Principal Aquifer System	Geographic Area	Aquifer Type	Description
Lower Tertiary aquifers	Montana, North and South Dakota	Sandstone	Consist of semi- to consolidated sandstone with interbeds of shale, mudstone, siltstone, lignite, and coal (Oligocene to Paleocene age). Unconfined conditions; general movement of water is northward and northeastward from recharge areas in northeastern Wyoming, eastern Montana, and southwestern North Dakota. Their wide extent makes these aquifers an important water source.
Upper Cretaceous aquifers	Central and eastern Montana, western North and South Dakota, and Nebraska	Sandstone	Consist of interbedded sandstone, siltstone, claystone, and local thin beds of coal or lignite. Water moves from aquifer recharge areas at higher altitudes toward discharge areas along major rivers. Directly underlie the High Plains aquifer system in large parts of Nebraska. Yields quantities of water large enough for irrigation purposes. Aquifers are the sources of supply for several small communities in southeastern Montana and northwestern South Dakota.
Lower Cretaceous aquifers	Central and eastern Montana, North and South Dakota, and eastern Nebraska	Sandstone	Separated from the Upper Cretaceous aquifers by several thick shales that form an effective confining unit. Exposed at the surface in Montana and North and South Dakota mostly as wide to narrow bands that completely or partly encircle basins or uplifted areas (e.g., the artesian Dakota aquifer exposed on the flanks of the Black Hills Uplift). General movement of water is northeastward from aquifer recharge areas at high altitudes to discharge areas in eastern North Dakota and South Dakota. Directly underlie the High Plains aquifer system in parts of eastern Nebraska. Hydraulic properties highly variable. Provides water for irrigation. Water from deeper units highly mineralized.
Paleozoic aquifers	Central and eastern Montana, western North and South Dakota	Sandstone and carbonate	The Paleozoic aquifers are extensive and deeply buried in most places; they contain little freshwater. Recharge areas are on the flanks of structural uplifts where the aquifers have been warped upward and subsequently exposed by erosion. Water generally moves northeastward from these recharge areas toward the deep parts of Williston Basin. Deeper parts of the basin contain brine where there is little or no water movement. Upward leakage to overlying aquifers creates saline springs and seeps in places.

TABLE 4.3-4 (Cont.)

Principal Aquifer System	Geographic Area	Aquifer Type	Description
Mississippian aquifers	Iowa	Sandstone and carbonate	Consist mainly of limestone and dolomite with some sandstone and siltstone. In places, overlain either by Pennsylvanian or younger rocks that confine the aquifers; where they form the bedrock surface, the aquifers are overlain by the Cretaceous or surficial aquifer system. Recharge occurs mainly where aquifers form the bedrock surface. Provide water supply in these areas. Aquifers overlain by Cretaceous units tend to have high dissolved solids. Water used mainly for agricultural purposes, primarily stock watering.
Silurian-Devonian aquifers	Underlies all but the northern part of Iowa	Carbonate	Consist of limestone and dolomite with local interbeds of sandstone, shale, and evaporites. Generally overlain by a surficial aquifer system, especially in northern Iowa. Shale units in the Yellow Spring Group confine the aquifer. Groundwater movement occurs primarily through secondary joints and fractures. Water quality is good where water circulates readily, but deteriorates downdip where aquifer is confined and circulation is slow.
Cambrian-Ordovician aquifer system	Minnesota (crops out in the southeastern part of State) and Iowa (except for northwestern corner)	Sandstone	Consists primarily of sandstone in the lower part and sandstone and shale interbedded with limestone or dolomite in the upper part. Made up of at least three principal aquifers; the Maquoketa confining unit also is considered to be part of the Cambrian-Ordovician aquifer system; where this confining unit is present, it overlies and confines the entire system as a leaky artesian aquifer system. Water quality varies regionally and with depth. Overlain by a surficial aquifer system consisting of stratified sand and gravel, ice-contact deposits, and alluvium.

TABLE 4.3-4 (Cont.)

Principal Aquifer System	Geographic Area	Aquifer Type	Description
Upper carbonate aquifer	Southeastern Minnesota and northeastern Iowa	Carbonate	Consists of limestone, dolomite, and dolomitic limestone. Overlies an effective confining unit of shale; overlain by a surficial aquifer system except adjacent to the Driftless Area where it thins. Rocks are extensively fractured and jointed, with numerous solution-enlarged rock openings, including sinkholes, solution cavities, and caves. Regional groundwater flow is generally outward toward the periphery of the aquifer. The aquifer is recharged through the overlying surficial aquifer system that also acts as a leaky confining unit where it contains large quantities of clay and silt. Water movement is along short flow paths toward the many rivers that drain the area eastward to the Mississippi River, northwestward toward the Minnesota River, and southward into streams flowing into Iowa. Water quality is generally good; potential for contamination high where glacial till is thin or absent.

Sources: Olcott (1992); Whitehead (1996); Miller and Appel (1998).

4.3.3 Water Use

The USGS defines eight categories of water use in the United States: public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power. Table 4.3-5 provides a summary of water uses by category for each of the six States in the UGP Region in 2005 (the latest year for which annual statistics are available at publication). The greatest water consumption in the States with highest usage (Montana and Nebraska) was in the category of freshwater for irrigation. Freshwater usage for thermoelectric power was highest in Nebraska (3,550 Mgal per day, or about 28 percent of its total usage), Iowa (2,530 Mgal per day, or about 75 percent of its total usage), and Minnesota (2,450 Mgal per day, or about 61 percent of its total usage). Consumption of freshwater via the public supply generally is proportional to the State population. The highest per capita usage in 2005 occurred in Nebraska (187.5 gal per day), followed by Montana (151.7 gal per day) and Iowa (134.0 gal per day). Surface water accounted for 69 percent of total water withdrawals in States within the UGP Region, although surface water withdrawals in Montana (about 97 percent of total) and North Dakota (about 90 percent of total) were much higher. More than half of the water withdrawals in Nebraska (about 61 percent) and South Dakota (54.2 percent of total) were from groundwater sources (table 4.3-6).

Activities that use water resources or have the potential to impact the quality of water resources must be reviewed in the context of local and regional water concerns. Detailed studies of water resources would need to be conducted to define the affected environment for individual wind energy projects. In this PEIS, section 3.7 provides a discussion of regulatory requirements for wind energy projects.

4.4 AIR QUALITY AND CLIMATE

4.4.1 Meteorology

The UGP Region consists of six States: the western parts of Iowa and Minnesota, the eastern parts of Montana and Nebraska, and all of North and South Dakota. Elevation gradually increases from east to west over the area, with higher elevations in the westernmost part of South Dakota (e.g., Black Hills National Forest) and the western part of Montana (i.e., the foothills of Rocky Mountains). Climate varies substantially across the UGP Region and is influenced by variations in elevation, latitude, topographic features, and moisture sources, including water bodies. In general, the UGP Region is widely open from the central plains of Canada to the Gulf of Mexico, and wind speeds are relatively stronger in this region than in any other locations in the United States. Cold and dry air masses from Canada and warm and moist air masses from the Gulf of Mexico conflict in the UGP Region, causing a wide variety of weather, including violent and extreme weather patterns. The UGP Region generally has a continental climate, characterized by cold winters and mild to hot summers, while the western part that is closer to the Rocky Mountains tends to be drier as a result of the rain shadow effect of the mountains.

TABLE 4.3-5 Total Water Withdrawals (in million gallons per day) by Water Use Category, 2005[a]

						Industrial		Mining		Thermoelectric		
State	Public Supply Fresh	Domestic Fresh	Irrigation Fresh	Livestock Fresh	Aquaculture Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total
Iowa	398	34.6	33.3	116	16.4	190	0	47.4	0	2,530	0	3,370
Minnesota	537	77.8	244	60.4	113	139	0	426	0	2,450	0	4,040
Montana	142	23.5	9,670	39.0	42.0	67.0	0	35.4	5.12	89.9	0	10,100
Nebraska	330	52.1	8,460	108	82.7	11.3	0	10.3	0.09	3,550	0	12,600
North Dakota	67.1	8.09	151	22.6	6.21	14.7	0	5.66	0	1,060	0	1,340
South Dakota	100	7.67	292	47.7	33.2	4.41	0	10.5	0	4.69	0	500

[a] Figures may not add up to totals because of independent rounding.

Source: Kenny et al. (2009).

TABLE 4.3-6 Total Water Withdrawals by Source, 2005[a,b]

State	Population (thousands)	Groundwater	Surface Water	Total[c] (million gal/day)	Total (thousand ac-ft/yr)
Iowa	2,970	683	2,680	3,370 (20.3)	3,770
Minnesota	5,130	863	3,180	4,040 (21.3)	4,530
Montana	936	288	9,830	10,100 (2.85)	11,300
Nebraska	1,760	7,710	4,890	12,600 (61.2)	14,100
North Dakota	637	142	1,200	1,340 (10.6)	1,500
South Dakota	776	271	230	500 (54.2)	561
Total	12,209	9,957	22,010	31,950 (31.2)	35,761

[a] Figures may not add up to totals because of independent rounding.

[b] Totals for groundwater and surface water include both fresh and saline sources.

[c] Number in parentheses represents percent groundwater.

Source: Kenny et al. (2009).

General meteorological conditions for each State,[4] extracted from historic climatic information in National Climatic Data Center (NCDC) (2009a), are briefly described below, followed by a summary of temperature, precipitation, wind patterns, and severe weather conditions across the six-State UGP Region.

4.4.1.1 Iowa

The topography of Iowa is characterized by rolling prairies with a slight elevation increase from the southeast to the northwest. Strong seasonal variations are the result of Iowa's latitude and interior continental location. Rainfall reaches a maximum during the summer from a prevailing warm and moist southerly flow from the Gulf of Mexico, while winters tend to be cold and relatively dry from northwesterly flow from Canada. Air masses from the Pacific Ocean intermittently penetrate the State, causing mild and dry weather. Unusually high temperatures during the summer are produced occasionally by hot and dry winds from the Desert Southwest. Annual average temperature ranges from 45°F (7°C) to 52°F (11°C) across the State, while extreme temperatures have varied from –47°F (–44°C) to 118°F (48°C). The annual average precipitation is approximately 34 in. (86 cm), ranging from 26 in. (66 cm) in the northwest to 38 in. (97 cm) in the southeast. A majority of the annual precipitation (three-fourths) falls between April and September. The snow season begins in late October, extending to mid-April, with an average snowfall of 32 in. (81 cm) across the State, varying from 40 in. (102 cm) in the northeast to 20 in. (51 cm) in the southeast.

[4] The climate for the entire State was provided in the reference, and thus discussions in sections 4.4.1.1 to 4.4.1.6 are for the entire State and not only the part of the State that is within the UGP Region. However, all other discussions in Section 4.4 are limited to counties of each State within the UGP Region.

4.4.1.2 Minnesota

Flat prairie is the prime topographic feature of Minnesota, with lower elevations along the major rivers (e.g., Red, Minnesota, and Mississippi) and higher elevations (e.g., Iron Range, Buffalo Ridge, and Lake Itasca). Nearly 12,000 lakes greater than 10 ac (4 ha) dot the State. Minnesota experiences temperature extremes characteristic of its continental climate, with cold winters, warm to hot summers, and frequent outbreaks of continental polar air. Warm air pushing northward from the Gulf of Mexico and the southwestern United States can cause occasional periods of prolonged heat during the summer, especially in the southern regions. Mild and dry weather is experienced in all seasons when air masses from the Pacific Ocean move across the western United States. Mean annual temperatures range between 36°F (2°C) in the far north and 49°F (9°C) in the southeast. Extreme temperatures have been recorded as low as –60°F (–51°C) and as high as 114°F (46°C). Mean annual precipitation ranges from 19 to 35 in. (48 to 89 cm), with highest amounts in the southeast, gradually decreasing toward the northwest. Snowfall averages around 70 in. (178 cm) in the northeast section and gradually decreases to 40 in. (102 cm) in the south and west.

4.4.1.3 Montana

Because of its large size and complex terrains, Montana experiences wide climatic variations across the State. The southwestern part of the State is very mountainous, while the northeastern half is similar to Great Plains country, with occasional wide valleys and hills. The climate of adjacent areas is strongly influenced by the Continental Divide, which cuts through the western half of Montana in a north-south direction. To the west of the divide, the climate is similar to that of the north Pacific Coast; to the east, the climate is continental. West of the mountain barrier, winters are milder, summers are cooler, precipitation tends to be more evenly distributed throughout the year, and winds are lighter than to the east. The west also has more cloud cover and higher humidity than in the east. Cold waves occur over northeastern parts of the State on average 6 to 12 times per winter, causing temperatures to plummet lower than –50°F (–46°C), with a –70°F (–57°C) record. Along the eastern slope of the divide, the "Chinook wind" brings warm and dry winds in winter. Summers can be hot in the eastern part of the State, with temperatures reaching 100°F (38°C) at lower elevations (with a record of 117°F [47°C]). However, summer nights are generally cool and pleasant. Precipitation varies widely and is influenced by topography. The western portion of the State and areas near mountains tend to be wettest, with exceptions caused by the rain shadow effect, and the north-central area is the driest. Annual snowfall varies from 300 in. (762 cm) in some mountainous regions in the western half of the State to about 20 in. (51 cm) east of the divide.

4.4.1.4 Nebraska

The topography of Nebraska is characterized in the east by gently rolling prairies, changing to sandy hills in the north-central region and high plains in the western area. Nebraska experiences typical continental climate, with hot summers, cold winters, and large variations in temperature and precipitation both seasonally and from year to year. Changes in weather are often frequent and sudden since Nebraska lies in an area where air masses, arriving from various sources with largely different characteristics, alternate and interact. The State is profoundly affected by the Rocky Mountains. Downslope winds (Chinooks) off the

Rockies lose moisture on the windward side, which become warmer and drier on the leeward side during the winter, and can occasionally cause large and rapid increases in temperature. Maximum temperatures sometimes exceed 115°F (46°C), and minimum temperatures of –40°F (–40°C) and lower have been recorded. The average annual precipitation over the eastern, central, and western third of the State is about 27, 21, and 18 in. (69, 53, and 46 cm), respectively. Year-to-year precipitation variations and the westward decrease in precipitation across the State are the result of the State's distance from the Gulf of Mexico and the variability of gulf winds. Average snowfall amounts range from 21 in. (53 cm) in the south to 45 in. (114 cm) in the northwest.

4.4.1.5 North Dakota

The landscape of North Dakota is separated into four distinct physiographic regions: (1) the flat Great Plains of the southwest; (2) the wide and steeply rolling Missouri Coteau, extending 30–70 mi (48–113 km) from the northwest corner to the south-central border; (3) the gently rolling Glaciated Plains, covering most of the remaining land surface of the State; and (4) the extremely flat Red River Valley, a 20- to 40-mi (32- to 64-km) glacial lake plain extending westward from the eastern border of the State. Located in the center of North America, North Dakota's temperature extremes are characteristic of a continental climate, with cold winters and mild to hot summers. With no barriers, air masses from the north and south readily overflow the State with little change in temperature and water content. Throughout the year, cold and dry air from the far north converges with warm and humid air from the tropics, mixed intermittently with modified mild and dry air from the northern Pacific. During all seasons, continuous winds and their associated day-to-day large temperature fluxes are the result of this air mass movement and affiliated frontal boundaries. The lowest recorded temperature was –60°F (–51°C), and the highest was 121°F (49°C). In particular, very low temperatures are common when Arctic air masses combine with widespread snow cover. Average annual precipitation depends on the distance to the Gulf of Mexico and ranges from about 14 to 22 in. (36 to 56 cm). Annual snowfall amounts tend to be lower than in other northern States, despite its northern latitude.

4.4.1.6 South Dakota

South Dakota is covered with rolling plains, with nearly level landscapes to regions covered in hilly ridges. The Black Hills, located in the southwest portion of the State, have separate climate characteristics since they are an isolated region of forest-covered mountains. The Missouri River, which flows in a southerly direction, roughly bisects the State. Canyons; broad, upland flats; and buttes sit to the west of the river, while numerous ponds and lakes exist to the east. Located in central North America, South Dakota is within the path of many cyclones and anticyclones. The State has a typical continental climate with extreme summer heat and winter cold. Temperature extremes have ranged from –58 °F (–50 °C) to 120 °F (49 °C). Large ranges of daily, monthly, and annual temperatures are a result of the State's remote location from large water bodies. During winter, the warmest portion of the State is within the Black Hills as a result of warm Chinook winds and frequent sunny skies. However, during the summer, the Black Hills experience cooler temperatures within the higher elevations as compared to the rest of the State. Annual precipitation patterns tend to decrease northwestward and range from about 25 in. (64 cm) in the southeast to less than 13 in. (33 cm) in the northwest. In the Black

Hills, precipitation ranges from 16 to 25 in. (41 to 64 cm). Occasional heavy snowfall with considerable depth can occur in winter.

4.4.1.7 Overview across the UGP Region

Temperature and precipitation in the UGP Region vary widely with elevation, latitude, season, and time of day. Table 4.4-1 presents historical average temperatures and precipitation at selected locations within the UGP Region (NCDC 2009b). As shown in the table, annual average temperatures and snowfall tend to decrease and increase, respectively, with increasing latitude, while rainfall tends to decrease with increasing distance from the Gulf of Mexico. Annual average temperatures range from 40.9°F (4.9°C) to 51.1°F (10.6°C). Average monthly temperatures range from a low of –3.3°F (–19.6°C) in Williston, North Dakota, to a high of 89.6°F (32.0°C) in Lincoln, Nebraska. Des Moines, Iowa, receives an average of 34.72 in. (88.2 cm) of precipitation each year, three times more than Glasgow, Montana. Lincoln, Nebraska receives approximately 26.3 in. (66.8 cm) of snowfall, while Great Falls, Montana, receives about 60.9 in. (154.7 cm) annually.

The predominant prevailing wind aloft is from the west, as in most of the United States. However, surface winds are greatly modified by local terrain and ground cover. The wind roses at selected locations in figure 4.4-1 demonstrate the variation in surface winds over the UGP Region (NCDC 1997). As shown in the figure, the prevailing wind directions vary from site to site, and the distribution of wind frequencies between the various directions is also highly localized. The figure shows a wide variation in prevailing wind direction between sites, as well as substantial variation in wind speeds. Except in Helena and Billings, Montana, which are strongly influenced by drainage winds from the Rockies, general wind patterns in the UGP Region are generally characterized by two distinct wind directions, north or northwest and south or southeast. At most of the meteorological stations within the UGP Region, average surface wind speeds range between 9 and 11 mph (4 and 5 m/s) and are calm (under 1.1 mph [0.5 m/sec]) from 3 percent to 7 percent of the time, which demonstrates favorable wind energy potentials.

Wind Rose

A *wind rose* summarizes wind speed and direction graphically as a series of bars pointing in different directions. The direction of each bar shows the direction *from* which the wind blows. Each bar is divided into segments, which represent wind speeds in a given range, for example, 0.5 to 2.1 m/s (1.1 to 4.7 mph). The length of a segment represents the percentage of the summarized hours that winds blew from the indicated direction with a speed in the given range.

Severe weather in the UGP Region includes drought, wind storms, thunderstorms, hail, tornadoes, flooding, and blizzards. The large distance of the area from the Gulf of Mexico means that hurricanes do not directly hit the UGP Region, although the remnants of hurricanes do come into the southeastern UGP Region and result in heavy rains. Tornadoes are the most common type of severe weather in the region and can cause severe damage.

With the exception of Montana, the UGP Region is within or just outside Tornado Alley, which extends from the Texas Gulf Coastal Plain northward through the eastern half of South Dakota. Tornadoes in Tornado Alley are more frequent and destructive than those in any other region. Convergence between cold, dry air from central Canada and warm, moist air from

TABLE 4.4-1 Temperature and Precipitation Summaries at Selected Meteorological Stations in the UGP Region[a]

	Temperature (°F)			Average Annual Precipitation (in.)	
Station[b]	Lowest Minimum[c]	Highest Maximum[c]	Mean	Water Equivalent	Snowfall
Iowa					
Des Moines	11.7	86.0	50.0	34.72	36.4
Sioux City	8.5	86.2	48.3	25.99	31.4
Minnesota					
Saint Cloud	–1.2	81.7	41.8	27.13	47.6
Montana					
Billings	15.1	85.8	47.4	14.77	59.0
Glasgow	1.8	83.8	42.6	11.23	30.8
Great Falls	11.3	82.0	43.7	14.89	60.9
Havre	3.7	84.6	43.0	11.46	45.4
Helena	9.9	83.4	44.0	11.32	43.3
Nebraska					
Grand Island	12.2	87.1	49.9	25.89	32.9
Lincoln	11.5	89.6	51.1	28.37	26.3
Norfolk	9.6	86.5	48.7	26.66	31.3
Omaha	11.6	87.4	50.7	30.22	27.1
North Dakota					
Bismarck	–0.6	84.5	42.3	16.84	50.3
Fargo	–2.3	82.2	41.5	21.19	46.7
Williston	–3.3	83.4	40.9	14.16	43.4
South Dakota					
Aberdeen	0.6	84.7	43.8	20.22	38.6
Huron	3.5	86.1	45.3	20.90	42.1
Rapid City	11.3	85.5	46.6	16.64	40.9
Sioux Falls	2.9	85.6	45.1	24.69	40.6

[a] Based on climate normals, which are 30-yr averages for the 1971–2000 period.

[b] Locations of meteorological stations are shown in figure 4.4-1.

[c] "Lowest Minimum" denotes the lowest monthly average of the daily minimum, which normally occurs in January. "Highest Maximum" denotes the highest monthly average of the daily maximum, which normally occurs in July.

Source: NCDC (2009b).

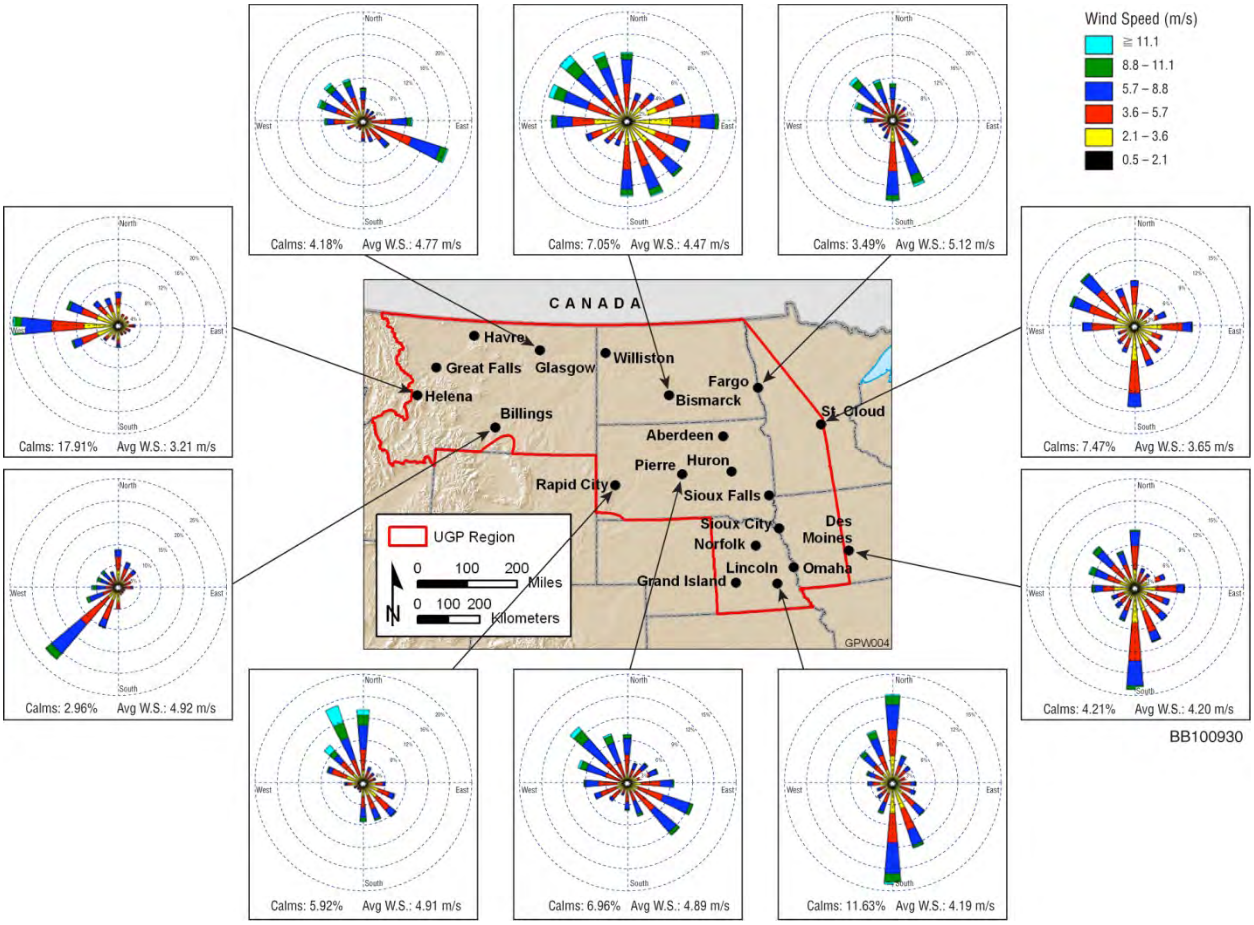


FIGURE 4.4-1 Wind Roses for Selected Meteorological Stations in the UGP Region, 1990–1995 (Source: NCDC 1997)

the Gulf of Mexico is frequent in Tornado Alley, making conditions favorable for the development of severe thunderstorms that engender tornadoes. Between January 1950 and November 2008, a total of 6,907 tornadoes, with an annual average of 117, were reported in the UGP Region area as shown in table 4.4-2 (NCDC 2009c). The annual average number of tornadoes in the UGP Region was about 3.09 per 10,000 mi^2 (1.19 per 10,000 km^2), with the highest average number (7.12 per 10,000 mi^2 [2.75 per 10,000 km^2]) in Iowa and the lowest (0.46 per 10,000 mi^2 [0.18 per 10,000 km^2]) in Montana. About 81 percent of tornadoes that occurred in the UGP Region were relatively “weak” (F1 or lower; see table 4.4-2 for a description of the Fujita tornado scale) or “not categorized.” About 18 percent of tornadoes were classified as “strong” (F2 and F3). Ninety-six F4 and seventeen F5 “violent” tornadoes occurred, mostly in Iowa and Nebraska.

TABLE 4.4-2 Number of Tornadoes by Fujita Tornado Scale[a] in the UGP Region[b] for the Period of January 1, 1950, to November 30, 2008

State	Number of Tornadoes by Fujita Tornado Scale								Number of Tornadoes per Year	
	F[c]	F0	F1	F2	F3	F4	F5	Total	Mean	per 10,000 mi^2 (25,900km^2)
Iowa	53	452	339	246	58	29	3	1,180	20.0	7.12
Minnesota	5	464	329	137	35	10	6	986	16.7	4.07
Montana	52	190	59	36	4	0	0	341	5.8	0.46
Nebraska	133	636	462	207	64	40	4	1,546	26.2	6.64
North Dakota	100	734	295	117	36	11	3	1,296	22.0	3.19
South Dakota	140	815	322	213	61	6	1	1,558	26.4	3.48
Total	483	3,291	1,806	956	258	96	17	6,907	117.2	3.09

[a] Fujita tornado scale is classified with the fastest 0.25-mi (0.40-km) wind speeds:

F0 (gale): 40–72 mph (18–32 m/s)
F1 (moderate): 73–112 mph (33–50 m/s)
F2 (significant): 113–157 mph (51–70 m/s)
F3 (severe): 158–206 mph (71–92 m/s)
F4 (devastating): 207–260 mph (93–116 m/s)
F5 (incredible): 261–318 mph (117–142 m/s).

Note: The new Enhanced Fujita (EF) scale based on a 3-second wind gust was implemented on February 1, 2007. Since that date, all tornadoes in the United States have been rated by using EF categories. Similar to the original Fujita scale, it has ratings from EF0 to EF5. However, historical tornadoes recorded on or before January 31, 2007, are still categorized with the original Fujita scale.

[b] All counties in North and South Dakotas and parts of Iowa, Minnesota, Montana, and Nebraska are within the UGP Region (see figure 4.4-1).

[c] Not categorized by the Fujita tornado scale because damage level was not reported.

Sources: NCDC (2009c); U.S. Census Bureau (2009b).

4.4.2 Existing Emissions and Air Quality

This section provides general descriptions for existing emissions of criteria pollutants and volatile organic compounds (VOCs)[5] and the federally based air quality programs likely to affect activities associated with wind energy development:

- National Ambient Air Quality Standards (NAAQS) and State Ambient Air Quality Standards (SAAQS),

- Prevention of Significant Deterioration (PSD),

5 VOCs are organic vapors in the air that can vaporize readily and participate in atmospheric photochemical reactions (e.g., react with NO_x to form ozone [O_3] in the presence of sunlight).

- Visibility Protection, and

- General Conformity.

4.4.2.1 Existing Emissions

Table 4.4-3 presents criteria pollutant and VOC emission totals for all counties within the UGP Region by State (EPA 2009d). The data represent two source categories: point and nonpoint/mobile sources. Point sources include large industrial facilities (e.g., power plants, refineries). Nonpoint sources (also known as area sources) include a myriad of small point sources (businesses and residences), wildfires, and dirt roads, while mobile sources include roadway vehicles, construction equipment, trains, airplanes, and ships. Minnesota has the highest total emissions of criteria pollutants and VOCs combined, and South Dakota has the lowest, but total emissions in other States are relatively comparable. Sulfur dioxide (SO_2) emissions from point sources account for about 49 percent to 93 percent of the total SO_2 emissions in each State, primarily from coal-fired power plants in the UGP Region (data not shown). Nitrogen oxide (NO_x) emissions from point sources range from 23 percent to 49 percent, with major contributions from power generation. For other pollutants, including carbon monoxide (CO), VOCs, and particulate matter (PM_{10}/$PM_{2.5}$), nonpoint and mobile sources are major contributors, while point sources are minor contributors, accounting for about 10 percent or less.

TABLE 4.4-3 Annual Total Emissions of Criteria Pollutants and VOCs (for 2002) and of CO_2 (for 2005) for Counties within the UGP Region, by State

	Annual Emissions (10^3 tons/yr)[a]						
State	SO_2	NO_x	CO	VOCs	PM_{10}	$PM_{2.5}$	CO_2
Iowa[b]	71	150	653	99	238	42	37,667
Minnesota[b]	44	149	636	125	425	64	27,028
Montana[b]	42	117	472	84	294	56	29,251
Nebraska[b]	74	157	544	85	342	49	41,126
North Dakota	168	176	337	48	380	67	54,189
South Dakota	28	87	335	52	284	48	14,538
Total	427	836	2,976	493	1,964	326	203,799

[a] CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter ≤2.5 μm; PM_{10} = particulate matter ≤10 μm; SO_2 = sulfur dioxide; VOCs = volatile organic compounds.

[b] Total emissions only for counties within the UGP Region. Currently, no county-level CO_2 emissions are available, so emissions for counties within the UGP Region are estimated from available State-total fuel oil combustion CO_2 emissions based on population.

Sources: EPA (2009d,e).

4.4.2.2 National Ambient Air Quality Standards (NAAQS)

The EPA has set NAAQS for six criteria pollutants, including SO_2, nitrogen dioxide (NO_2), CO, ozone (O_3), PM_{10} and $PM_{2.5}$,[6] and lead (Pb), as shown in table 4.4-4 (EPA 2012a). Primary NAAQS specify maximum ambient (outdoor air) concentration levels of the criteria pollutants, with the aim of protecting public health with an adequate margin of safety. Secondary NAAQS specify maximum concentration levels with the aim of protecting public welfare. The NAAQS specify different averaging times as well as maximum concentrations. Some of the NAAQS with averaging times of 24 hr or less allow the standard values to be exceeded a limited number of times per year, while others specify alternative procedures for determining compliance.

An area where air quality does not meet NAAQS levels is called a nonattainment area. Nonattainment areas in which air quality has subsequently improved to meet the NAAQS can be redesignated as maintenance areas and are subject to an air quality maintenance plan. Because of low levels of population density and industrial activities, most of the UGP Region is in compliance with NAAQS, but parts of the UGP Region have been in nonattainment and/or maintenance for one or two of the NAAQS. As of May 2012, all counties within the UGP Region, except those in Montana and Iowa, complied with the NAAQS for all six criteria pollutants (EPA 2012b). In Montana, two counties (Lewis and Clark, and Yellowstone) are in nonattainment for SO_2, one county (Rosenbud) is in nonattainment for PM_{10}, and one county (Lewis and Clark) is in nonattainment for the 1978 Pb standard. In Iowa, Pottawattamie County is in nonattainment for the 2008 Pb standard. In addition, Wright County in Minnesota and Cascade and Yellowstone Counties in Montana are designated as maintenance areas for CO, and Douglas County in Nebraska is in maintenance for the 1978 Pb standard.

States can have their own SAAQS, as shown in table 4.4-4. SAAQS must be at least as stringent as the NAAQS and can include standards for additional pollutants (e.g., hydrogen sulfide or fluoride in Minnesota, Montana, Nebraska, and North Dakota). If a State has no standard corresponding to one of the NAAQS or SAAQS that is not more stringent than the NAAQS, the NAAQS apply. Currently, Iowa and South Dakota have adopted the NAAQS as SAAQS, and North Dakota's SAAQS are exactly the same as the NAAQS for criteria pollutants.

4.4.2.3 Prevention of Significant Deterioration

While the NAAQS (and SAAQS) place upper limits on the levels of air pollution, PSD limits the total increase in ambient pollution levels above established baseline levels for SO_2, NO_2, PM_{10}, and $PM_{2.5}$ to prevent "polluting up to the standard" (see table 4.4-5). The allowable increase is smallest in Class I areas, such as national parks and wilderness areas. The rest of the country is subject to larger Class II increments. States can choose a less stringent set of Class III increments, although currently no State has done so. Major (large) new and modified

[6] Particulate matter, or PM, is dust, smoke, and other solid particles and liquid droplets in the air. The size of the particulate is important and is measured in micrometers (μm). A micrometer is 1 millionth of a meter (0.000039 in.). PM_{10} is PM with an aerodynamic diameter less than or equal to 10 μm, and $PM_{2.5}$ is PM with an aerodynamic diameter less than or equal to 2.5 μm.

TABLE 4.4-4 NAAQS and SAAQS for Criteria Pollutants in the UGP Region[a]

		NAAQS							
Pollutant[b]	Averaging Time	Value	Type[c]	Iowa[d]	Minnesota[e,f]	Montana[g]	Nebraska[e,h]	North Dakota[i]	South Dakota[d]
SO_2	1-hour	75 ppb[j]	P	*	1,300 µg/m^3 (0.5 ppm)[k]	0.50 ppm	–[l]	0.075 ppm (196 µg/m^3)	*
	3-hour	0.5 ppm	S	*	1,300 µg/m^3 (0.5 ppm)[k] 915 µg/m^3 (0.35 ppm)[m] 1,300 µg/m^3 (0.5 ppm)[n]	–	1,300 µg/m^3 (0.5 ppm)[o]	0.5 ppm (1,309 µg/m^3)	*
	24-hour	–	–	*	365 µg/m^3 (0.14 ppm)	0.10 ppm	365 µg/m^3 (0.14 ppm)[k]	–	*
	Annual	–	–	*	80 µg/m^3 (0.03 ppm)[k] 60 µg/m^3 (0.02 ppm)[o]	0.02 ppm	80 µg/m^3 (0.03 ppm)[k]	–	*
NO_2	1-hour	100 ppb	P	*	–	0.30 ppm	–	0.100 ppm (188 µg/m^3)	
	Annual	53 ppb	P, S	*	0.05 ppm (100 µg/m^3)	0.05 ppm	100 µg/m^3 (0.05 ppm)	0.053 ppm (100 µg/m^3)	*
CO	1-hour	35 ppm	P	*	30 ppm (35 mg/m^3)	23 ppm	40 mg/m^3 (35 ppm)	35 ppm (40 mg/m^3)	*
	8-hour	9 ppm	P	*	9 ppm (10 mg/m^3)	9 ppm	10 mg/m^3 (9 ppm)	9 ppm (10 mg/m^3)	
O_3	1-hour	–	–	*	–	0.10 ppm	235 µg/m^3 (0.12 ppm)	–	*
	8-hour	0.075 ppm[p]	P, S	*	0.08 ppm (157 µg/m^3)	–	0.08 ppm	0.075 ppm (147 µg/m^3)	*
PM_{10}	24-hour	15 µg/m^3	P, S	*	150 µg/m^3	150 µg/m^3	150 µg/m^3	150 µg/m^3	*
	Annual	–	–	*	50 µg/m^3	50 µg/m^3	–	–	
$PM_{2.5}$	24-hour	35 µg/m^3	P, S	*	65 µg/m^3	–	35 µg/m^3	35 µg/m^3	*
	Annual	15.0 µg/m^3	P, S	*	15.0 µg/m^3	–	15.0 µg/m^3	15.0 µg/m^3	
Pb	Calendar quarter	–	–	*	1.5 µg/m^3	1.5 µg/m^3	1.5 µg/m^3	–	*
	Rolling 3-month	0.15 µg/m^3 [q]	P, S	*	–	–	–	0.15 µg/m^3	

[a] Detailed information on attainment determination criteria for NAAQS and reference method for monitoring is available in 40 CFR Part 50. Attainment determination criteria for each State are similar to those for the NAAQS.

Footnotes continued on next page.

TABLE 4.4-4 (Cont.)

[b] CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter $\leq$2.5 μm; PM_{10} = particulate matter $\leq$10 μm; SO_2 = sulfur dioxide.

[c] P = Primary standard whose limits were set to protect public health; S = Secondary standard whose limits were set to protect public welfare.

[d] An asterisk indicates same as the NAAQS.

[e] Primary and secondary standards unless otherwise noted.

[f] The State of Minnesota has standards for additional pollutants such as hydrogen sulfide and PM, which are not been presented in this table; also refer to MAR 7009.0080 for additional pollutants for Minnesota.

[g] The State of Montana has standards for additional pollutants such as hydrogen sulfide, settled PM, visibility, and fluoride in forage, which are not presented in this table; also refer to ARM 17.8.2 for additional pollutants for Montana.

[h] The State of Nebraska has standards for additional pollutant such as total reduced sulfur, which is not presented in this table; also refer to NDEQ Title 129, Chapter 4 for additional pollutants for Nebraska.

[i] The State of North Dakota has standards for additional pollutant such as hydrogen sulfide, which is not presented in this table; also refer to NDCC Chapter 33-15-02 for additional pollutants for North Dakota.

[j] 1 ppb = 0.001 ppm.

[k] Primary standard.

[l] A dash indicates that no standard exists.

[m] Secondary standard in Air Quality Control Regions 127, 129, 130, and 132.

[n] Secondary standard in Air Quality Control Regions 128, 131, and 133.

[o] Secondary standard.

[p] Effective May 27, 2008, the EPA revised the 8-hour ozone standards from 0.08 ppm to 0.075 ppm. The 1997 standard of 0.08 ppm and related implementation rules remain in place. In 1997, the EPA revoked the 1-hour O_3 standard of 0.12 ppm in all areas, although some areas have continuing obligations under that standard (“anti-backsliding”).

[q] Effective January 12, 2009, the EPA revised the Pb standard from a calendar-quarter average of 1.5 $\mu g/m^3$ to a rolling 3-month average of 0.15 $\mu g/m^3$. The 1978 Pb standard (1.5 $\mu g/m^3$ as a quarterly average) remains in effect until 1 yr after an area is designated for the 2008 standard; however, in areas designated as being in nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

Sources: Administrative Rules of Montana (ARM) 17.8.2, “Ambient Air Quality”(available at http://www.mtrules.org/gateway/Subchapterhome.asp?scn=17.8.2); EPA (2012a); Iowa Administrative Code (IAC) 567.28.1, “Statewide Standards” (available at http://www.legis.state.ia.us/aspx/ACODocs/DOCS/3-11-2009.567.28.1.pdf); Minnesota Administrative Rules (MAR) 7009.0080, “State Ambient Air Quality Standards” (available at https://www.revisor.leg.state.mn.us/rules/?id=7009.0080); Nebraska Department of Environmental Quality (NDEQ) Title 129, Chapter 4, “Ambient Air Quality Standards” (available at http://www.deq.state.ne.us/RuleAndR.nsf/dd5cab6801f1723585256474005327c8/13c412500b561a86862565e700771bb1?OpenDocument); North Dakota Century Code (NDCC) Chapter 33-15-02, “Ambient Air Quality Standards” (available at http://www.legis.nd.gov/information/acdata/html/..%5Cpdf%5C33-15-02.pdf); South Dakota DENR (2011).

TABLE 4.4-5 Federal PSD Increments

Pollutant	Averaging Time	PSD Increment ($\mu g/m^3$) Class I	Class II
SO_2	3-hour	25	512
	24-hour	5	91
	Annual	2	20
NO_2	Annual	2.5	25
PM_{10}	24-hour	8	30
	Annual	4	17
$PM_{2.5}$	24-hour	2	9
	Annual	1	4

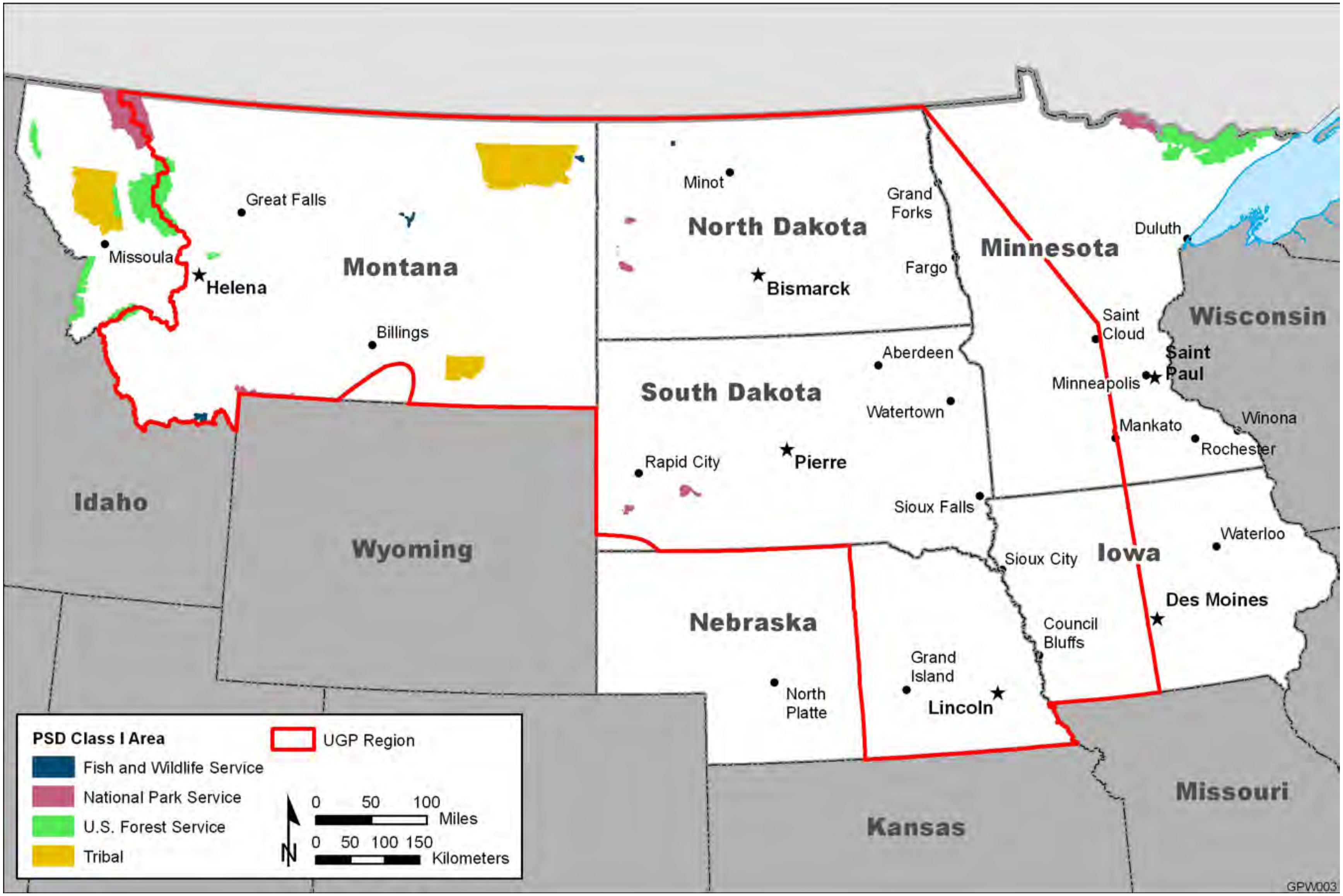
Source: 40 CFR 52.21; 75 CFR 64864.

stationary sources must meet the requirements for the area in which they are located and the areas they impact. For example, a source locating in a Class II area in close proximity to a Class I area would need to meet the more stringent Class I increment in the Class I area and meet the Class II increment elsewhere, in addition to any other applicable requirements.

In addition to capping increases in criteria pollutant concentrations below the levels set by the NAAQS, the PSD program mandates stringent control technology requirements for new and modified major sources. In addition, in Class I areas, Federal land managers are responsible for protecting the areas' air quality-related values (AQRVs), such as scenic, cultural, biological, and recreational resources. As stated in the Clean Air Act, the AQRV test requires the Federal land manager to evaluate whether the proposed project will have an adverse impact on the AQRVs, including visibility. However, even if the Federal land manager determines that there could be an impact on an AQRV, the permit may still be issued. Figure 4.4-2 shows the locations of Class I PSD areas scattered over the UGP Region.

4.4.2.4 Visibility Protection

Visibility was singled out for particular emphasis in the Clean Air Act Amendments of 1977. Visibility in Class I areas is protected under two sections of the Clean Air Act Amendments. Section 165 provides for the PSD program (described above) for new sources. Section 169(A), for older sources, describes requirements for both reasonably attributable single sources and regional haze that address multiple sources. Federal land managers have a particular responsibility to protect visibility in Class I areas. Even sources located outside a Class I area may need to obtain a permit to assure there are no adverse impacts on visibility within the Class I area, and existing sources may need to retrofit controls. The EPA's 1999 Regional Haze Rule set goals to prevent future and remedy existing impairments to visibility in Class I areas. States had to revise their State Implementation Plans (SIPs) to establish emission reduction strategies to meet a natural conditions goal by 2064.



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2 **FIGURE 4.4-2 PSD Class I Areas in the UGP Region (Source: EPA 2009f)**

4.4.2.5 General Conformity

Federal departments and agencies are prohibited from taking actions in nonattainment and maintenance areas unless they first demonstrate that the actions would conform to the SIP as it applies to criteria pollutants. Transportation-related projects are subject to requirements for transportation conformity. General conformity requirements apply to stationary sources. Conformity addresses only those criteria pollutants for which the area is in nonattainment or maintenance (e.g., VOCs and NO_x for O_3). If annual source emissions are below specified threshold levels, no conformity determination is required. If the emissions exceed the threshold, a conformity determination must be undertaken to demonstrate how the action will conform to the SIP. The demonstration process includes public notification and response and may require extensive analysis.

In 1993, the EPA issued general conformity regulations in Part 93, Subpart B, and Part 51, Subpart W, of Title 40 of the *Code of Federal Regulations* (40 CFR 93 Subpart B and 40 CFR 51 Subpart W). These regulations require Federal agencies to complete a conformity analysis for their actions taking place in nonattainment and maintenance areas. Since issuing the 1993 regulations, the EPA has revised them twice. The first revision included de minimis levels for $PM_{2.5}$ (71 FR 40420). Subsequently, a more substantial revision to Subpart B and a deletion of most of subpart W were issued (75 FR 17254, "40 CFR 51 and 93 *Revisions to the General Conformity Regulations*," April 5, 2010). With the possible exception of dust during construction, wind energy facilities are unlikely to exceed the emission thresholds established by these regulations and hence are likely to be exempt. However, the responsible Federal agency must still complete, document, and retain an applicability analysis to substantiate that the conformity thresholds are not exceeded. If a threshold is exceeded, a detailed conformity determination would be required.

4.4.3 Greenhouse Gas Emissions

The "greenhouse effect" is a natural phenomenon occurring when certain gases (greenhouse gases, or GHGs) in the air absorb much of the long-wave thermal radiation emitted by the land and ocean and reradiate it back to earth, making the atmosphere warmer than it otherwise would be without GHGs. Atmospheres, including water vapor and clouds, are also major contributors to the greenhouse effect. Without the greenhouse effect, the earth would not be warm enough to support existing biota. However, as the greenhouse effect becomes stronger, the earth's average temperature will rise, resulting in global climate change. Even a slight increase in temperature may cause problems for humans, plants, and animals. Historic data indicate that the global surface temperature has increased by 1.33 ± 0.32 °F (0.74 ± 0.18 °C) during the last 100 years, and that the rate of warming has accelerated over the last 50 years (IPCC 2007). Warming can occur as a result of natural influences; however, anthropogenic emissions of GHGs have occurred at an accelerated rate since the Industrial Revolution. For example, concentrations of CO_2, a primary GHG in the atmosphere, have continuously increased from approximately 280 ppm in pre-industrial times to 379 ppm in 2005, a 35 percent increase (IPCC 2007).

The GHGs include water vapor, O_3, CO_2, methane (CH_4), nitrous oxide (N_2O), and trace amounts of fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Along with clouds, water vapor, the most abundant GHG, accounts for the largest percentage of the greenhouse effect. However, water vapor concentrations fluctuate regionally, and human activity does not directly affect water vapor concentrations except at a local scale, such as near irrigated fields. Typically, water vapor is not included in global warming analyses.

The contribution of a given gas to the greenhouse effect is affected by both its abundance and its characteristics, which include how efficient the molecule is at absorbing long-wave radiation and its atmospheric lifetime. Global warming potential (GWP) is a relative measure of how much a GHG is estimated to contribute to global warming relative to CO_2 (therefore, the GWP of CO_2 is 1). A GWP is calculated over specific time horizons, usually 20, 100, or 500 years. GHGs are removed from the atmosphere naturally over time, and most GHGs generally have lower GWPs over longer horizons. For example, CH_4 has a GWP of 72 over a 20-year period but a GWP of 25 over a 100-year period (IPCC 2007). Over the 100-year time horizon, N_2O has a GWP of 298. Some GWPs, such as fluorinated gases, are emitted in smaller quantities relative to CO_2 but have high GWPs because they have long atmospheric lifetimes. SF_6 has the highest GWP, 22,800.

GHGs are emitted into the atmosphere through natural processes and human activities. CO_2 occurs naturally and enters the atmosphere through the burning of fossil fuels, solid wastes, and trees and wood products, and also as a result of chemical reactions (EPA 2009e). CH_4 is emitted during the production and transport of fossil fuels and is also released to the environment as emissions from microbes, livestock, agricultural practices, and volcanoes. Natural emissions of N_2O primarily result from bacterial breakdown of nitrogen in soils and in the earth's oceans. N_2O is also emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Fluorinated gases are powerful GHGs that are emitted from various industrial activities.

In general, GHG emissions are inventoried for CO_2, CH_4, N_2O, and high-GWP gases in terms of "CO_2 equivalent," which is computed by multiplying the weight of the gas being measured (e.g., CH_4) by its estimated GWP (e.g., 25 for CH_4). CO_2 equivalent (or CO_2e) emissions are available for the GHGs listed above for the entire United States during the 1990–2007 period (EIA 2008a). CO_2 emissions from fossil fuel combustion are available by State for the 1990–2005 period (EPA 2009e). Statewide emissions of all GHGs are also available for some States, but the recent inventory years are different and the units used differ among States. Therefore, only CO_2 emissions by State for 2005 are presented in this analysis.[7] For the 1996–2005 period, CO_2 emissions account for about 83 percent of the total GHG emissions in terms of CO_2 equivalent, followed by CH_4 at about 10 percent (EIA 2008a). N_2O and high-GWP gases are minor contributors (about 5 percent and 2 percent, respectively) to total GHG emissions because of their relatively low concentrations. Accordingly, total GHG emissions are about 20 percent higher than CO_2 emissions, discussed below, and thus should be interpreted in that context.

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7 County-level CO_2 emissions are unavailable, so estimation of CO_2 emissions for part of the State (e.g., Iowa) was made on the basis of available State-level CO_2 emission and population data.

Because CO_2 is emitted worldwide, uniformly mixed throughout the troposphere, and stable, its climatic impact does not depend on the geographic location of sources. Therefore, a comparison between U.S. and global emissions and the total emissions from the UGP Region is useful in understanding whether CO_2 emissions are a significant contributor of GHGs. As shown in table 4.4-3, North Dakota is the largest contributor to CO_2 emissions among the UGP Region States (about 27 percent of the total six-State emissions) because of its higher electric power generation (EPA 2009e). For 2005, total CO_2 emissions from the UGP Region are about 3.1 percent of the U.S. total. In 2005, CO_2 emissions in the United States account for 21 percent of worldwide emissions (EIA 2008b); current emissions for the UGP Region were about 0.66 percent of global emissions.

On October 30, 2009, the EPA issued the Mandatory Reporting of GHGs Rule (74 FR 56260), which requires reporting of GHG emission data and other relevant information from large sources and suppliers in the United States, the reporting threshold for which is 25,000 metric tons CO_2e or more. The purpose of the rule is to collect accurate and timely GHG data to inform future policy decisions. In addition, the EPA established permitting requirements for GHG emissions under the Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas Tailoring Rule (75 FR 31514), effective on August 2, 2010. If GHG emissions exceed 100,000 metric tons CO_2e for a new plant or 75,000 metric tons CO_2e for modification of an existing facility, the facility is subject to the EPA's PSD regulations, which could require the facility to limit its GHG emissions by applying best available control technology (BACT). The facility would also be subjected to the EPA's Title V operating permit program.

4.5 ACOUSTIC ENVIRONMENT

This section provides general descriptions of noise and vibration and the existing acoustic environment in the six-State UGP Region.

4.5.1 Noise

First, the fundamentals of acoustics are introduced, which will help facilitate an understanding of the noise impact analysis. Next, the characteristics of wind turbine noise are briefly discussed, followed by outdoor sound propagation processes. Noise regulations are then presented, followed by estimates of background noise levels in the UGP Region.

4.5.1.1 Fundamentals of Acoustics

Any pressure variation that the human ear can detect is considered sound; noise is unwanted sound. Noise (and sound) can be characterized in terms of amplitude (perceived as loudness), frequency (perceived as pitch), and time pattern. The normal hearing for a healthy young person ranges in frequency from approximately 20 Hz to 20 kHz. In particular, frequencies in the 20 to 200 Hz range are called "low-frequency noise," while frequencies less than 20 Hz are called "infrasound." Wind turbines emit a wide range of noise frequencies, including low and infrasound frequencies.

The human ear can detect sounds with a very wide range of pressure amplitudes. A direct application of a linear scale to the measurement of sound pressure leads to a large and unwieldy number. In addition, because of a protective mechanism of the human ear, the ear responds logarithmically rather than linearly to sound amplitude. Accordingly, it is practical to express acoustic parameters ("sound pressure level") as a logarithmic ratio of the measured value to a reference level, or "decibel" (dB). Audible sounds range from 0 dB ("threshold of hearing") to about 140 dB ("threshold of pain"). Another measure of the magnitude of sounds is "sound power level." The sound power level is a measure of the acoustic power radiated by the source. The sound pressure level reflects not only the power of the source but the distance from the source and the acoustical characteristics of the intervening space between the source and the receptor.[8] Sound power level is not measured directly; it is calculated from sound pressure measurements. Sound power level is used to estimate how far sound will travel and to predict the sound levels at various distances from the source. Although they use different reference levels, sound power and pressure levels are expressed in dB.

A human's perception of noise depends on not only the dB scale but also on the frequency distribution. To reflect a human's perception of noise, "weighting" scales are used that represent a single number rather than a spectrum. For addressing wind turbine noise, three weightings scales of A, C, and G are appropriate. The frequency response of the A-, C-, and G- weightings are shown in figure 4.5-1. The A scale, denoted by dBA, gives greater emphasis to the sounds between 1 and 5 kHz and less emphasis to the lower and much higher frequencies. The A scale is reasonably correlated with a human's subjective reaction to medium-intensity (<60 dBA) and mid-to-high frequency (>100 Hz) sounds. The A scale is most widely used for the assessment of environmental and industrial noise, as well as potential occupational hearing damage and other health effects. Currently, the Audiogenic Response Score scale is stipulated for most governmental and industrial regulations in the United States and abroad. To provide a frame of reference for typical noise levels, a whisper has a decibel level of 20 dBA; conversational speech, 60 dBA; heavy truck traffic, 80 dBA; and a rock concert, 120 dBA (Claflin 2008). The C scale is fairly flat, with a small attenuation at both low and high frequencies. This C-weighting is used particularly when evaluating very loud or very low-frequency sounds, such as artillery firing. The G scale is designed to reflect human response to infrasound, which is perceived as a mixture of auditory and tactile sensations. The relative response of the G scale falls off rapidly above 20 Hz and below 20 Hz, with a peak gain of 9 dB at 20 Hz. The practicality and the importance of using the G scale for measuring noise are controversial, and thus the G scale is not widely used to evaluate wind turbine noise.

The A-weighted sound level may adequately indicate the level of environmental noise at any instant in time, but community noises vary continuously. To account for the duration of sound and allow for the effective description of how intensity varies with time, various sound descriptors are used. These descriptors are used to summarize how people perceive sound and to quantify the impact of environmental noise for regulatory and noise control purposes. To describe the time-varying characteristics of environmental noise, statistical noise descriptors such as L_{10}, L_{50}, and L_{90} are commonly used. They are A-weighted noise levels; the numeric values represent the amount of time in a defined time period that the reported level is exceeded. L_{10} represents the level that is exceeded 10 percent of the time (often defined as the "intrusive"

[8] As an analogy, an electrical heater (viewed as sound power level) has a certain power rating, which is the heat that it can produce, and is independent of the surroundings. However, the temperature (viewed as sound pressure level) at a particular point away from the heater depends on many factors, for example, power rating of the heater, distance from the heater, atmospheric conditions, and proximity from reflecting surfaces.

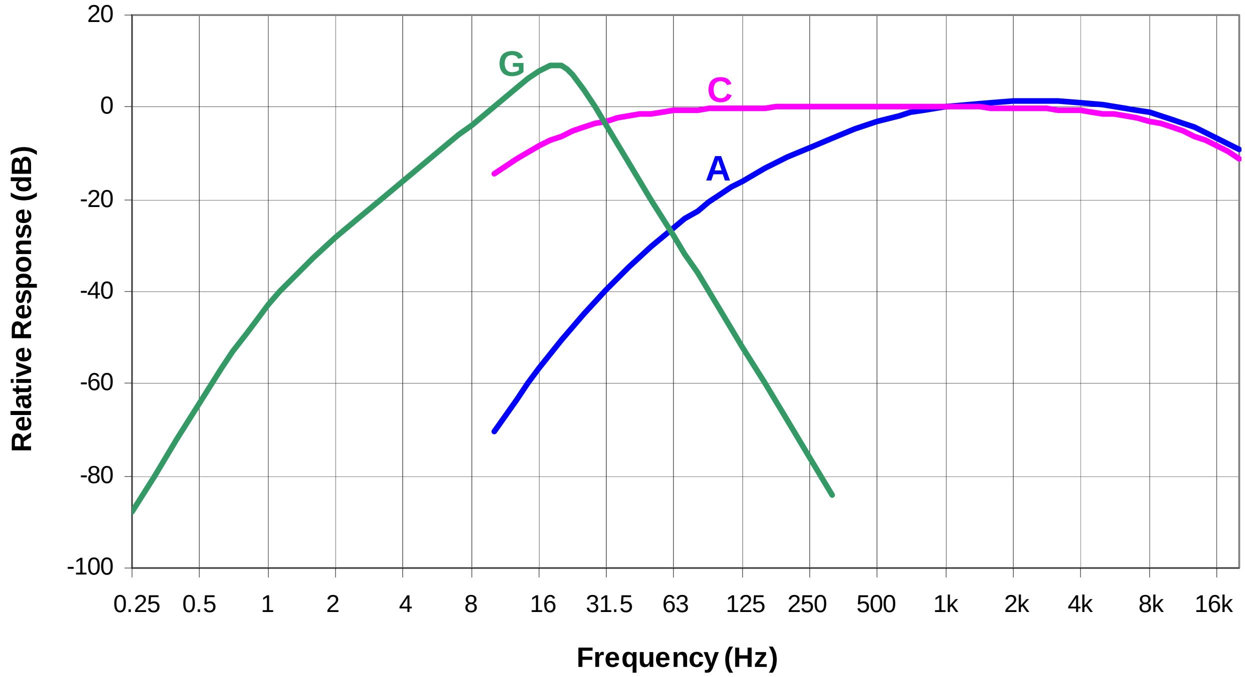


FIGURE 4.5-1 Frequency Responses of A-, C-, and G-Weighting (Sources: ASA 1983, 1985; ISO 1995)

level), while L_{90} is the sound pressure level exceeded 90 percent of the time (often defined as the "background" level). L_{50} represents the median noise level, that is, the level exceeded 50 percent of the time. The equivalent continuous sound level (L_{eq}) is the continuous sound level during a specific time period (e.g., 1 hour) that would contain the same total energy as the actual time-varying sound. In addition, human responses to noise differ depending on the time of the day; for example, humans experience more annoyance from noise during nighttime hours. The day-night average sound level (L_{dn}) is the average noise level over a 24-hour period, after the addition of 10 dB to sound levels from 10 p.m. to 7 a.m. to account for the greater sensitivity of most people to nighttime noise. The Community Noise Equivalent Level (CNEL) was introduced in the early 1970s by the State of California and gives 5-dB weighting to evening hours (7 p.m. to 10 p.m.), whereas L_{dn} has no weighting. Since the CNEL and L_{dn} are nearly equivalent, usually differing by less than 1 dB, they can be used interchangeably.

Individuals respond differently to various sounds. Whether the sound is desirable or not is quite subjective. Noise effects on people generally fall into three categories (Rogers et al. 2002):

- Subjective effects such as annoyance, nuisance, and dissatisfaction;

- Interference with activities such as speech, sleep, and learning; and

- Physiological effects such as anxiety, tinnitus, or hearing loss.

In most cases, effects resulting from the sound levels associated with environmental noise and wind turbines are limited only to the first two categories, with modern wind turbines typically producing only the first. Employees who work in industrial plants and around aircraft for a prolonged period can experience noise effects in the last category, which is the most clearly measurable health hazard.

Both objective and subjective factors can be considered when evaluating the community reaction to a noise (Miller et al. 1984). Objective factors include absolute level and background noise, character of noise, and temporal and seasonal factors. Subjective factors include history of previous exposure, community attitude, and type of neighborhood. The most important factor in human annoyance is the magnitude of the intruding noise relative to existing sound environments. Discrete tones (tonal noise) are more noticeable and annoying than broadband noise at the same loudness level because they stand out against the background noise. Impulsive noises such as blasting also tend to be considered particularly objectionable. High-level low-frequency noise, typical of large diesel engines in trains, ships, and power plants, is hard to muffle, spreads easily in all directions with less attenuation, and is considered more annoying than its A-weighted level would indicate. During the night, people seek quiet for relaxation and sleep, and thus usually judge an intruding noise as more disturbing at night than during the day. In moderate climates, people spend more time outdoors and leave doors and windows open, so noises are usually more disturbing. New noises that exceed the previously existing ambient noise level become less acceptable to hearers. However, local residents are more tolerant to the noise source if it is considered important to the economic or social well-being of the community, or if they believe that the generator of the noise is responsive to community interests and is trying to resolve the noise issues. Local residents will be more inclined to complain about the noise if it does not seem suitable for its surroundings.

Human responses to changes in sound levels generally exhibit the following characteristics (NWCC 2002):

- Except under laboratory conditions, a 1-dB change in sound level is not perceptible;

- A 3-dB change in sound level (twice the sound energy) is considered barely noticeable;

- A 5-dB change in sound level (more than three times the sound energy) will typically result in a noticeable community response; and

- A 10-dB change in sound levels (10 times the sound energy), which is generally judged to be a doubling in loudness, will almost certainly cause an adverse community response.

4.5.1.2 Wind Turbine Noise

Wind turbines have many noise-generating moving parts. The two main types of noise from a wind turbine are mechanical and aerodynamic. Mechanical noises include tonal noises, while aerodynamic noise includes broadband (>100 Hz), low-frequency (20–100 Hz), and impulsive noises. The following discussion on mechanical and aerodynamic noise was extracted from Rogers et al. (2002) and Wagner et al. (1996).

Mechanical noise is associated with the rotation of mechanical and electrical components; thus, it tends to be tonal, although a broadband component exists. Mechanical noise is primarily originated by the gearbox and also by other moving parts, such as generators, yaw drives, cooling fans, and auxiliary equipment (e.g., hydraulics). Mechanical noise has a dominant energy within frequencies below 1 kHz and contains a discrete tonal component. Pure tones can be emitted at the rotational frequencies of shafts and generators and the meshing frequencies of the gears. In contrast to aerodynamic noise, mechanical noise can be avoided or highly damped through the special finishing of gear teeth, low-speed cooling fans, acoustic insulation, vibration isolators, etc. In general, mechanical noise can be viewed as an indication of poor design. In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical noise and radiating it. The transmission path of the noise can be airborne (directly propagated from the component surface or interior into the air) or structure-borne (transmitted along other structural components before it is radiated into the air). Recent improvements in the mechanical design of large wind turbines and vibration damping have resulted in significantly reduced mechanical noise from both broadband and pure tones. Thus, the noise emission from modern utility-scale wind turbines is dominated by broadband aerodynamic noise. This is also due, in part, to the fact that turbine size has increased; mechanical noise does not increase with the dimensions of the turbine as rapidly as aerodynamic noise.

Aerodynamic noise from wind turbines originates mainly from the flow of air over and past the blades; therefore, the noise generally increases with rotor tip speed. It is directly linked to the production of power, and, therefore, is inevitable, although blade design can influence aerodynamic noise characteristics. The aerodynamic noise has a broadband character and is typically the dominant part of wind turbine noise today. Broadband noise is characterized by the continuous distribution of sound pressure with frequencies greater than 100 Hz, which is caused by the interaction of wind turbine blades with atmospheric turbulence, and is also described as a characteristic “swishing” sound. The swishing sound, which many people mistakenly recognize as low-frequency noise, is amplitude-modulated blade-tip turbulence at the frequency of the passing blade tip (every 1.1 s for a newer model turbine rotating at 18 rpm). Low-frequency and impulsive noise are primarily associated with downwind turbines with blades on the downwind side of the tower. Low-frequency noise in the range of 20 to 100 Hz is caused when the turbine blade encounters localized flow deficiencies due to the flow around a tower and wakes produced by the other blades. Sometimes this noise can cause structural vibration. Impulsive noise is caused by the interaction of wind turbine blades with disturbed airflow around the tower. This is characterized by short acoustic impulses or thumping sounds that vary in amplitude as a function of time. Airfoil-related noise can create a tonal component that is caused by nonlinear boundary instabilities interacting with the blade surface; vortex shedding at blunt trailing edges; or noise from flow over holes, slits, and intrusions, which can be avoided with good engineering design. Recent efforts to reduce aerodynamic noise have been made through the use of a lower tip speed ratio,[9] lower blade angle of attack, variable-speed operation, and most recently, the introduction of specially designed blade trailing edges.

9 The tip speed ratio is the ratio between the rotational speed of the blade tip and the actual wind speed. A higher tip speed ratio generally means a higher efficiency, but is also related to higher noise levels and a need for heavier, stronger blades.

At higher wind speeds, the noise from the wind can mask the noise from the turbine. However, lower background noise conditions make turbine noises more noticeable. Accordingly, fixed-speed turbines are most likely to have noticeable aerodynamic noise just above cut-in wind speeds before the wind-induced background noise increases enough to mask the noise of the turbine (Alberts 2006). Some earlier downwind wind turbines, which are rarely seen in modern utility-scale wind turbines, emit significant levels of infrasound. Upwind turbines also emit low-frequency noise and infrasound, but their levels are below the human perception threshold. No reliable evidence exists to indicate that infrasound below the human perception threshold causes physiological and psychological effects (Rogers et al. 2002).

4.5.1.3 Sound Propagation

To predict the noise level at receptor locations from a known power level, sound propagation mechanisms by which noise reaches our ears from a source should be considered. Because of inhomogeneities in the atmosphere, there will be a multitude of variations in the noise transmission paths, which result in a wide fluctuation in sound level at the listener's ears. Several important factors affecting the propagation of sound in the outdoor environment include (Anderson and Kurze 1992):

- Source characteristics, such as sound spectrum (sound power as a function of frequency), directivity, and configuration;

- Geometric spreading as the sound moves away from the source, which does not depend on frequency, and 6- and 3-dB reductions per doubling of distance from point (e.g., fixed equipment) and line (e.g., road traffic) sources, respectively;

- Air absorption, which depends strongly on frequency (e.g., low frequencies are not well attenuated by air absorption) and relative humidity;

- Ground effects, which include absorption and reflection of sound on the ground, depending on source/receptor height, intervening land cover, ground acoustical properties, incoming frequencies, etc.; the sound reflected by the ground can constructively or destructively interfere with direct sound;

- Meteorological effects due to turbulence and variations in vertical wind speed and temperature; and

- Screening effects by topography, structures, dense vegetation, and other natural or man-made barriers.

Among the factors listed above, meteorological effects along with geometric spreading are likely the most important in noise propagation for wind turbine analysis. Other effects would be minimal: ground effects due to the relatively high elevation of noise sources (around 330 ft [100 m] tall for a utility-scale wind turbine); air absorption due to low frequency ranges; and screening effects due to the turbine's location in wide-open flat terrain or rolling hills. Because of surface friction, wind speed increases with height, which will bend the path of sound to "focus" it on the downwind side and make a "shadow" on the upwind side of the source ("wind gradient effects"). On a clear night, temperature increases with height due to radiative cooling of surface air; this is called the "nocturnal temperature inversion." Another type of inversion occurs when cold air underlies warmer air during the passage of a cold front or invasions of a cooler onshore sea/lake breeze. This temperature inversion could focus sound on the ground surface ("temperature gradient effects"), with effects exerted uniformly in all directions from the source. During clear nights, both wind and temperature gradient effects occur frequently, allowing noise from the wind turbine to bend toward the ground and potentially impact the neighboring communities, which currently have relatively lower background levels.

Terrain features may affect wind turbine noise impacts. For example, wind turbines located on ridges and hills where relatively high wind speeds prevail can disturb residences that are positioned in a deep valley or sheltered from the wind in other ways, since the noise from the turbines cannot be masked. Valleys can sometimes serve as natural channels for noise propagation, allowing turbine noise to be heard as being louder than it otherwise would be on flat terrain.

A refined noise analysis would employ a sound propagation model that integrates most of the sound attenuation mechanisms noted above, along with detailed source-, receptor-, and site-specific data. In many screening applications, however, geometric spreading with or without other effects (e.g., air absorption or ground effects) is considered when predicting noise levels.

4.5.1.4 Noise Regulations

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, USC 42 4901–4918), delegates authority to the States to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Many local noise ordinances are qualitative, such as prohibiting excessive noise or noise that results in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce. However, several States and counties have established quantitative noise-level regulations specifying, for example, environmental noise limits based on the land use of the property receiving the noise. Other methods for specifying noise limits include (Alberts 2006):

- Specifying a single all-encompassing maximum limit;

- Determining preexisting ambient noise levels and specifying that a new noise source may not increase the ambient noise by more than a particular amount (e.g., 10 dB);

- Setting a base limit, with adjustments for district types and time of day or night; and

- Specifying maximum sound levels for each octave range.

Currently, a set of permissible limits for wind turbine noise that can be uniformly applicable throughout the country is not available in the United States. Instead, the U.S. Environmental Protection Agency (EPA) recommends that local governments develop their own noise regulations or zoning ordinances based on the guidelines suggested by the EPA and the American Wind Energy Association. The State of Minnesota has a wind ordinance that requires compliance with the State noise ordinance discussed in Minnesota Administrative Rules, Chapter 7030 (https://www.revisor.leg.state.mn.us/rules/?id=7030) (table 4.5-1). The South Dakota Public Utilities Commission developed a draft model wind ordinance for communities to use as guidance, which suggests that noise levels not exceed 55 dB. Currently, wind energy ordinances exist in rural communities throughout the country (Oteri 2008). Some of the counties in the UGP Region—six counties in Minnesota (Big Stone, Brown, Lyon, Martin, Nicollet, and Swift) and one county in South Dakota (Brookings)—have wind energy ordinances. All six counties in Minnesota must comply with Minnesota Administrative Rules, Chapter 7030, governing noise, as shown in table 4.5-1. For Brookings County, South Dakota, the noise level shall not exceed 50 dBA, including constructive interference effects at existing off-site residences, businesses, and public buildings. Other counties in the UGP Region are in the process of developing wind ordinances (e.g., Lawrence and Hughes in South Dakota; Stutsman in North Dakota). However, these simple A-weighted limits may be insufficient to protect people from the effects of noise, or even to address the annoyance level, due in part to not accounting for low-frequency noise.

TABLE 4.5-1 Minnesota Noise Standards

	Daytime, 7 a.m. to 10 p.m. (dBA)		Nighttime, 10 p.m. to 7 a.m. (dBA)	
NAC[a]	L_{50}[b]	L_{10}[b]	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

[a] Noise Area Classification (NAC) is based on what activity is being conducted at the location of each receiver. NAC 1 applies to household units, hospitals, religious services, correctional institutions, and entertainment gatherings; NAC 2 applies to land use activities consisting of mass transit terminals, automobile parking, and retail trade; NAC 3 applies to manufacturing facilities, highway and street rights-of-way, and utilities.

[b] L_{10} = sound pressure level that is exceeded 10 percent of the time period; L_{50} = sound pressure level that is exceeded 50 percent of the time period.

Source: Minnesota Administrative Rules, Chapter 7030, “Noise Pollution Control” (https://www.revisor.leg.state.mn.us/rules/?id=7030).

The EPA has a noise guideline that recommends an L_{dn} of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas (EPA 1974). For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq} of 70 dBA or less over a 40-year period. These levels are not regulatory goals but are “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety” (EPA 1974).

4.5.1.5 Background Noise Levels in the UGP Region

Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors along highways and railways, airports, industrial facilities, and construction activities. Because no measurement data are available for the UGP Region, countywide day-night sound levels were estimated on the basis of population density (Miller 2002; U.S. Census Bureau 2009b).[10] Because of the low population and industrial

[10] The estimated levels represent those associated with general community activity, assuming that no major highways or airports are affecting the sound environment.

activities, noise levels are estimated to be relatively low over the UGP Region. About 50.5 percent of counties in the UGP Region have noise levels less than 33 dBA L_{dn}, which corresponds to wilderness natural background. About 48.6 percent of counties have a L_{dn} in the range of 33 to 47 dBA, which is typical of rural and undeveloped areas (Eldred 1982). One county containing Des Moines, Iowa, and one county containing Omaha, Nebraska, are classified as quiet suburban residential areas, which fall in the 48 to 52 dBA range. Among the counties in the UGP Region, the highest level of 54 dBA L_{dn} is estimated to occur in Douglas County, which contains Omaha, Nebraska.

4.5.2 Vibration

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Construction activities that typically generate the most severe vibrations are blasting and impact pile driving. These activities are unlikely and, if they occur, would probably be limited. The need for blasting could preclude a site from development and pile driving is not typically a feature of wind turbine construction. However, pile driving and blasting are included here to cover the unlikely possibility that they will occur at particular sites.

Three ground-borne vibration impacts are of general concern: (1) human annoyance, (2) interference with vibration-sensitive activities, and (3) damage to buildings. In evaluating ground-borne vibration, two descriptors are widely used:

- The peak particle velocity, measured as a distance per time (such as in./s), is the maximum peak velocity of the vibration and correlates with the stresses experienced by buildings.

- The vibration velocity level represents a 1-second average amplitude of the vibration velocity. It is typically expressed on a logarithmic scale in decibels (VdB) just as noise is measured in dB. This descriptor is suitable for evaluating human annoyance because the human body responds to the average vibration amplitude.

In the United States, there are no widely adopted standards for acceptable levels of ground vibration generated by construction activities, although some jurisdictions elect to adopt vibration standards.

A background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans, which is around 65 VdB (Hanson et al. 2006). However, vibration levels would typically be higher in the immediate proximity of transportation corridors or construction/demolition sites. Human response is not usually significant unless the vibration exceeds 70 VdB. For evaluating interference with vibration-sensitive activities, the vibration impact criterion for general assessment is 65 VdB. For residential and institutional land uses (primarily daytime use only, such as a school or church), the criteria range is from 72 to 80 VdB and from 75 to 83 VdB, respectively, depending on event frequency. For potential structural damage effects, guideline vibration damage criteria for various structural categories are provided in Hanson et al. (2006). Damage to buildings, however, would occur at much higher levels (0.12 in./s or higher, approximately 90 VdB or higher) than human annoyance and interference with vibration-sensitive activities.

4.6 ECOLOGICAL RESOURCES

This section provides general descriptions of ecological resources within Western's UGP Region (i.e., all or parts of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota), including the Service's grassland and wetland easements in North Dakota, South Dakota, and Montana, that may be affected by wind energy development.

4.6.1 Plant Communities

The UGP Region extends from the Rocky Mountains in western Montana to the hardwood forests of Minnesota and south to the Central Great Plains. Plant communities occurring within this region encompass a variety of ecosystems, from grasslands to coniferous and hardwood forests. Each plant community is distinct in its species composition, species diversity, and structure. The development of the various types of plant communities is influenced by a wide range of environmental factors, including precipitation, temperature, elevation, aspect, and soil type. Because of the great variety of plant communities in the region, the area is best represented by ecoregions.

Ecoregions have been developed to provide a spatial framework for the research, assessment, management, and monitoring of ecosystems and their components (EPA 2007a). An ecoregion represents a geographic area having a general similarity in ecosystems. Each ecoregion is characterized by the spatial patterning and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography, climate, soils, land use, and hydrology. Within an ecoregion, there is a similarity in the type, quality, and quantity of environmental resources present (EPA 2007b). Ecoregions of North America have been mapped in a hierarchy of four levels, with Level I being the highest and broadest classification level. The Level III ecoregion classification used in this study consists of subdivisions of Level II. Level III includes 15 ecoregions within the UGP Region (figure 4.6-1). Ecoregion descriptions and maps are presented in appendix C.

4.6.1.1 Upland Plant Communities

These 15 ecoregions include a variety of upland plant community types. The UGP Region primarily supports grassland habitats; however, coniferous and deciduous forest and woodland, shrub, and shrub-steppe communities also occur in the region. The Rocky Mountains support extensive areas of coniferous forest, such as the subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*) forests of the Canadian Rockies and Middle Rockies ecoregions (Woods et al. 2002). Sagebrush-steppe communities, composed of sagebrush (*Artemisia* sp.) and grasses, occur on semiarid hills, valleys, and basins. Many of the lower eastern slopes and foothills of these ecoregions, as well as the far western portions of the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions, support foothills prairie (Woods et al. 2002). The dominant species in these semiarid prairies are fescues (*Festuca* spp.), usually rough fescue (*Festuca scabrella*); however, when disturbance occurs, the abundance of rough fescue decreases and Idaho fescue (*Festuca idahoensis*) increases (Risser et al. 1981).

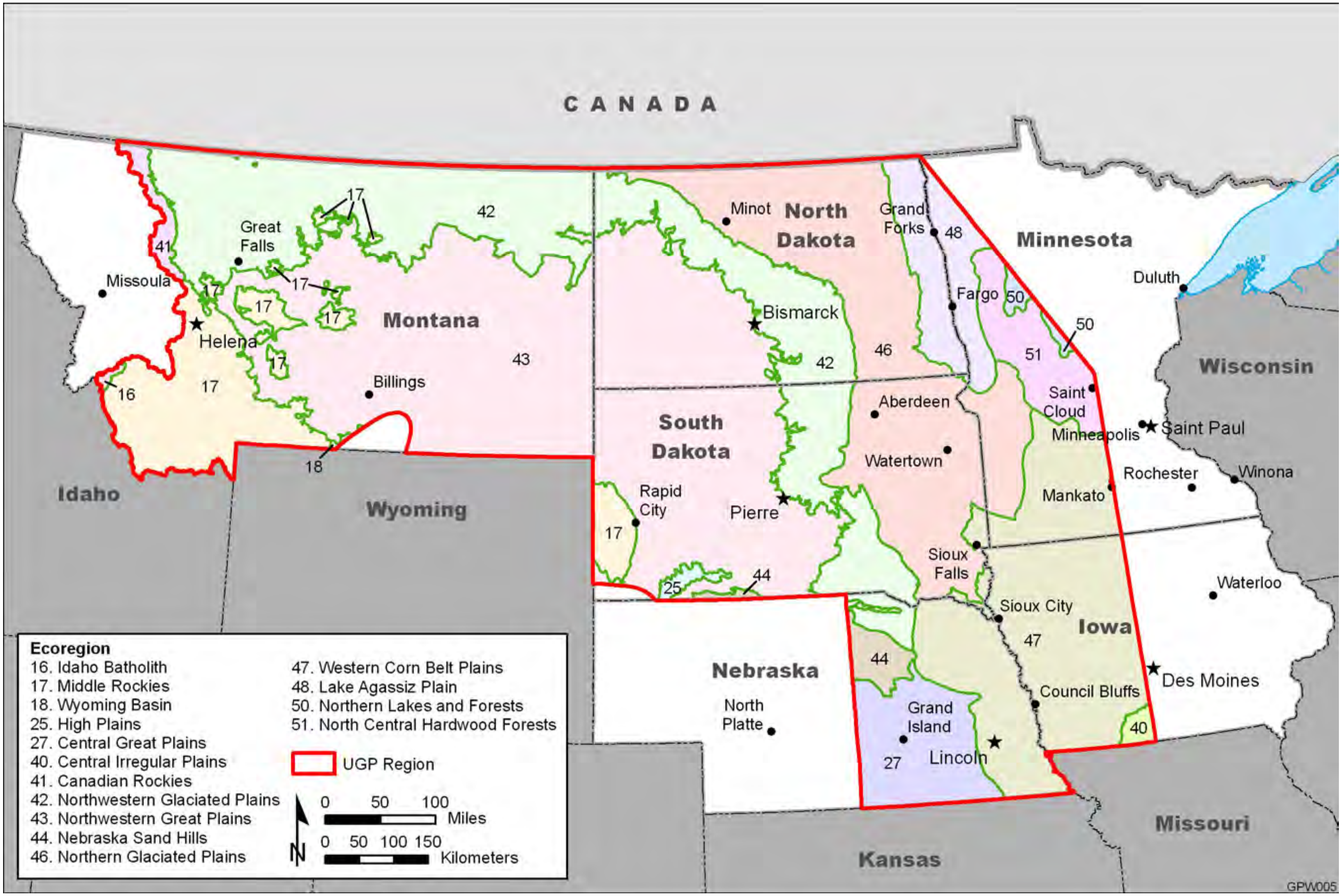


FIGURE 4.6-1 Level III Ecoregions within the UGP Region

Annual precipitation gradually increases from west to east across the UGP Region, resulting in a transition from shortgrass prairie east of the Rocky Mountains to mixed-grass prairie in the central portion of the region and tallgrass prairie in the east. Shortgrass prairie, characterized by grasses that reach about 6 to 20 in. (15 to 60 cm) in height, extends through central and eastern Montana, and south to Texas, New Mexico, and Arizona (Risser et al. 1981). Within the UGP Region this includes the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions of Montana and the far western areas of North and South Dakota (Woods et al. 2002). This prairie type has low annual precipitation, ranging from about 11 in. (28 cm) to about 16 in. (41 cm). The UGP Region also has a relatively short growing season, with approximately 90 to 135 frost-free days within the region (Woods et al. 2002). The dominant species of the northern shortgrass prairie is blue grama (*Bouteloua gracilis*), with needle-and-thread (*Hesperostipa comata*) and western wheatgrass (*Pascopyrum smithii*) as commonly associated species (Risser et al. 1981). The shortgrass prairie is predominantly treeless; however, some rugged, sloped areas in the Northwestern Great Plains ecoregion support some ponderosa pine and Rocky Mountain juniper (*Juniperus scopulorum*) forests or woodlands or ponderosa pine savannas (Woods et al. 2002).

Mixed-grass prairie extends across most of North and South Dakota, north into Canada, and south into Texas. Within the UGP Region, this area includes the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions of North and South Dakota, small portions of eastern Montana, and northeastern Nebraska; the Northern Glaciated Plains of the Dakotas; the Western High Plains in South Dakota; and the Central Great Plains in Nebraska (Bryce et al. 1996; Chapman et al. 2001; Woods et al. 2002). Annual precipitation in the mixed-grass prairie within the UGP Region ranges from about 14 to 25 in. (36 to 64 cm), and the growing season varies widely, ranging from 80 frost-free days in the north to 170 in the south (Bryce et al. 1996; Chapman et al. 2001; Woods et al. 2002). The dominant species vary across this prairie type; however, within the northern portion of the mixed-grass prairie, as in the UGP Region, western wheatgrass, thickspike wheatgrass (*Elymus lanceolatus* ssp. *lanceolatus*), porcupine needlegrass (*Hesperostipa spartea*), little bluestem (*Schizachyrium scoparium*), needle-and-thread, prairie junegrass (*Koeleria macrantha*), and blue grama generally are dominant (Risser et al. 1981). Along the western transition to shortgrass prairie, shortgrasses comprise the dominant species, and tallgrasses are generally absent, while tallgrasses generally predominate in the east near the transition to tallgrass prairie (Risser et al. 1981). The stabilized sand dunes of the Nebraska Sand Hills ecoregion in South Dakota and Nebraska support a mixed-grass prairie, with species such as sand bluestem (*Andropogon hallii*) and sand lovegrass (*Eragrostis trichodes*) in addition to many that occur elsewhere in mixed prairie (Bryce et al. 1996; Chapman et al. 2001). Woodlands occur occasionally in the mixed-grass prairie, such as on some north-facing slopes. In the Turtle Mountains of North Dakota and Prairie Coteau Escarpment of South Dakota (both in the Northern Glaciated Plains), deciduous forests and woodlands of bur oak (*Quercus macrocarpa*), aspen (*Populus tremuloides*), and other species occur (Bryce et al. 1996).

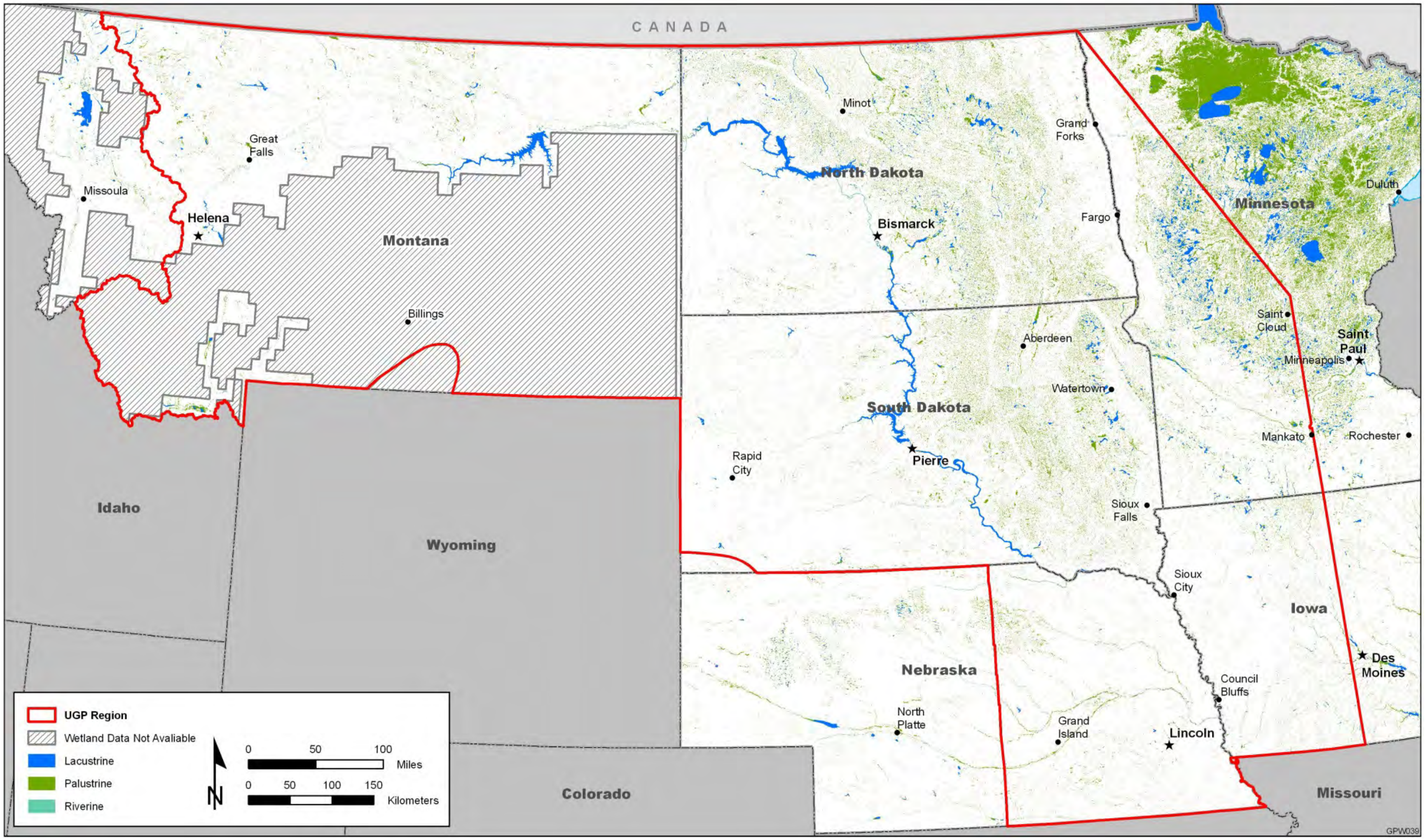
Tallgrass prairie extends from Canada into eastern North and South Dakota, Western Minnesota, eastern Nebraska, Iowa, and south into Texas. Tallgrass prairie reaches east into Indiana, with isolated patches extending much farther east (Risser et al. 1981). The ecoregions that include tallgrass prairie within the UGP Region include the Lake Agassiz Plain and Northern Glaciated Plains in the Dakotas and Minnesota; the Western Cornbelt Plains of South Dakota, Nebraska, Minnesota, and Iowa; the Central Irregular Plains in Iowa; and the Central Great Plains in eastern Nebraska (Bryce et al. 1996; Chapman et al. 2001, 2002). This prairie type is characterized by grasses that exceed 47 in. (120 cm) in height, although several of the dominant grasses may reach 7 to10 ft (2 to 3 m) (Risser et al. 1981). Annual precipitation in the tallgrass prairie within the UGP Region ranges from about 18 to 31 in. (46 to 79 cm), and the growing season varies widely, ranging from 95 frost-free days in the north to 170 in the south (Bryce et al. 1996; Chapman et al. 2001, 2002). The dominant plant species of tallgrass prairie vary across the region, as well as by topographic position. The major dominant tallgrasses include big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) (Risser et al. 1981). In some areas, dominant species may include mid-grasses or short grasses. Oak woodlands and savannas, mostly with bur oak, occur in portions of the tallgrass prairie in the Western Cornbelt Plains of South Dakota, Minnesota, and Iowa, and Central Irregular Plains of Iowa (Bryce et al. 1996; Chapman et al. 2001, 2002).

Most of the original native tallgrass prairie has been lost, primarily resulting from conversion of lands to agricultural use. Estimated losses of tallgrass prairie within the UGP Region vary by State and range from 98% (Nebraska) to 99.9% (Iowa and North Dakota) (Mac et al. 1998). These losses surpass those of any other major ecological community in North America. Approximately 68.3% (North Dakota) to 75.3% (Nebraska) of mixed grass prairie has been lost, while approximately 35% of shortgrass prairie has been lost in South Dakota (Mac et al. 1998). Impacts on shortgrass prairie include dryland farming and overgrazing, which has contributed to the introduction of invasive species in many prairie areas (Mac et al. 1998). While losses of native prairie have continued, prairie restorations have also increased, such as those associated with wetland conservation programs. Grassland easements established by the Service have contributed to the conservation of native prairie in the UGP Region.

Invasive non-native plant species, often originating in Europe and Asia, occur within the upland plant communities of the UGP Region. These species tend to establish high densities, in many cases reducing the abundance and diversity of native species. Disturbance of native plant communities often provides opportunities for the introduction and establishment of invasive plant species.

4.6.1.2 Wetlands

Wetlands occur throughout the UGP Region in each of the ecoregions. These wetlands include a wide variety of wetland types, such as lakes, ponds, marshes, bogs, fens, vernal pools, forested, and scrub-shrub wetlands. Figure 4.6-2 shows the wetlands within the UGP Region as mapped by the National Wetlands Inventory (NWI) (Service 2009b). NWI wetland identification and classification are based on the system of Cowardin et al. (1979), which defines wetlands as “lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.” Wetland areas generally support plant communities that are characterized by a predominance of plant species that are adapted to saturated soil conditions. Some wetlands, such as those that may be located on rocky or sandy shorelines, or in river channels, lakes, or ponds, may have few plants visible during most of the growing season in most years. These include permanent surface water stock



1

2 **FIGURE 4.6-2 Wetlands in the UGP Region**

3

impoundments constructed in areas of low wetland density. Some wetland areas with relatively permanent surface water may support only submerged aquatic plants. Some wetlands, such as vernal pools, contain surface water only for a short period early in the growing season. The wetland types that occur in the UGP Region are palustrine, lacustrine, and riverine wetlands and are given in table 4.6-1, along with the total area of each. In addition to wetlands, some lakes, ponds, or rivers may also include deepwater habitats, the margins of which are typically located 6.6 ft (2 m) below the low water level (Cowardin et al. 1979). These are included in table 4.6-1. Wetlands provide important services within the landscape, such as providing habitat for fish and wildlife, maintaining water quality, and providing flood control.

As defined in Cowardin et al. (1979), Lacustrine wetland (littoral) and deepwater (limnetic) habitats (1) are situated in a topographic depression or a dammed river channel; (2) lack trees, shrubs, persistent emergent vegetation, emergent mosses, or lichens with greater than 30% areal coverage; and (3) have a total area exceeding 20 ac (8 ha). Palustrine wetlands are dominated by trees, shrubs, emergents, mosses or lichens, or, if lacking such vegetation, (1) are less than 20 ac (8 ha), (2) do not have an active wave-formed or bedrock shoreline feature, and (3) have at low water a depth less than 6.6 ft (2 m) in the deepest part of the basin. Riverine wetlands and deepwater habitats are contained in natural or artificial channels that periodically or continuously contain flowing water or that form a connecting link between two bodies of standing water.

Many of the wetlands within the UGP Region lie in shallow depressions, known as “potholes,” and receive water by direct precipitation or runoff, or from shallow groundwater discharge. These marshes and ponds are predominantly isolated wetlands, lacking a surfacewater connection to streams or rivers. A high concentration of these potholes occurs across Iowa, Minnesota, the Dakotas, Montana, and north into Canada. Portions of this Prairie Pothole Region exceed 150 wetland basins per square mile. The prairie pothole region includes all or portions of the Northwestern Glaciated Plains, Northwestern Great Plains, Northern Glaciated Plains, Lake Agassiz Plain, Northcentral Hardwood Forests, and Western Cornbelt Plains ecoregions. The Rainwater Basin in south-central Nebraska also includes numerous wetlands. These shallow marshes are supported by precipitation and runoff, have an impermeable clay soil layer, and occasionally are dry for short to extended periods. Surfacewater flows provide the water source for some wetlands, such as floodplain wetlands along rivers and streams. These wetlands, many of which support deciduous forests, occur along rivers and streams throughout the region. Wetlands supported predominantly by groundwater flow include fens, springs, and seeps; bogs have no groundwater or surfacewater inflow. The wetland density and percentage of land surface area for each State in the UGP Region, derived from NWI data, is given in table 4.6-2 and within each ecoregion in table 4.6-3.

The types of plant communities that develop in wetlands are greatly influenced by the hydrologic regime, which affects the frequency, depth, and duration of flooding or soil saturation. Some wetlands, such as lakes, ponds, or perennial streams, are associated with relatively permanent water sources. Many of these wetlands in the UGP Region, particularly river corridors and lake margins, support deciduous forest or woodland plant communities with species such as cottonwood (*Populus* spp.), aspen (*Populus* spp.), willow (*Salix* spp.), green ash (*Fraxinus pennsylvanica*), elm (*Ulmus* spp.), or box elder (*Acer negundo*). Marshes along these wetlands often include prairie cordgrass (*Spartina pectinata*). Many wetlands, however, have seasonal or intermittent sources of water, resulting in inundation or saturation near the soil surface for part of the growing season, usually in the spring. Many of the prairie pothole

TABLE 4.6-1 Density and Percent of State Area of NWI Mapped Wetlands and Deepwater Habitats of the Six-State Region

	Iowa		Minnesota		Montana[a]		Nebraska		North Dakota		South Dakota		Total	
Wetland Type	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area	Density (Number per mi^2)	Percent of State Area
Lacustrine	0.00	0.00	0.00	0.00	0.01	0.07	0.01	0.11	0.05	0.79	0.02	0.26	0.01	0.19
Aquatic bed[b]	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Emergent[c]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rocky shore[d]	0.01	0.55	0.14	5.06	0.01	0.49	0.02	0.18	0.01	1.68	0.02	1.01	0.03	1.45
Unconsolidated bottom[e]	0.01	0.01	0.00	0.00	0.01	0.04	0.01	0.01	0.02	0.13	0.02	0.02	0.01	0.04
Unconsolidated shore[f]	0.01	0.00	0.01	0.00	0.34	0.06	0.78	0.13	0.93	0.24	1.58	0.35	0.58	0.12
Palustrine	3.18	0.93	8.08	5.43	1.49	0.50	3.87	1.02	22.90	4.82	11.51	3.32	7.58	2.45
Aquatic bed	0.85	0.92	3.41	8.05	0.02	0.01	0.13	0.17	0.14	0.05	0.18	0.06	0.73	1.47
Emergent	0.20	0.07	4.14	5.27	0.12	0.07	0.16	0.11	0.08	0.03	0.06	0.03	0.78	0.92
Forested[g]	2.26	0.29	1.49	0.40	0.02	0.00	0.45	0.05	0.13	0.01	0.19	0.02	0.61	0.11
Scrub/shrub[h]	0.02	0.01	0.00	0.00	0.04	0.01	0.25	0.02	0.05	0.00	0.10	0.01	0.07	0.01
Unconsolidated bottom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unconsolidated shore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riverine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aquatic bed	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.03	0.02	0.04	0.04	0.01	0.01
Emergent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Intermittent streambed[i]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Intermittent unconsolidated	0.00	0.00	0.00	0.00	0.01	0.07	0.01	0.11	0.05	0.79	0.02	0.26	0.01	0.19
Rock bottom[j]	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Rocky shore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unconsolidated bottom	0.02	0.31	0.02	0.17	0.01	0.09	0.01	0.07	0.01	0.10	0.01	0.09	0.01	0.13
Unconsolidated shore	0.20	0.03	0.03	0.00	0.09	0.02	0.15	0.08	0.06	0.02	0.07	0.03	0.09	0.03
Not Classified	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Totals	6.78	3.13	17.33	24.49	2.16	1.37	5.84	1.98	24.40	7.90	13.79	5.24	10.53	6.94

Footnotes on next page.

TABLE 4.6-1 (Cont.)

[a] NWI mapping for Montana is incomplete; therefore, wetland density was determined from completed areas of that State.

[b] Aquatic bed: Dominated by plants that grow principally on or below the water surface for most of the growing season in most years.

[c] Emergent: Erect, rooted, herbaceous hydrophytes, excluding mosses and lichens; present for most of the growing season in most years; usually dominated by perennial plants.

[d] Rocky shore: Bedrock, stones, or boulders which singly or in combination have an areal cover at least 75%, and less than 30% vegetation cover.

[e] Unconsolidated bottom: At least 25% cover of particles smaller than stones (6-7 cm) and less than 30% vegetation cover.

[f] Unconsolidated shore: Unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock, and less than 30% vegetation cover.

[g] Forested: Woody vegetation at least 20 ft (6 m) tall.

[h] Scrub/shrub: Woody vegetation less than 20 ft (6 m) tall; includes true shrubs, sapling trees.

[i] Intermittent streambed: Channels that contain flowing water only part of the year; may contain isolated pools.

[j] Rock bottom: Substrates having an areal cover of stones, boulders, or bedrock of at least 75%, and less than 30% vegetation cover.

TABLE 4.6-2 Wetland Density within the UGP Region by State[a]

State	Wetlands per mi^2	Wetland Percentage of Land Surface (%)
Iowa	7.31	2.37
Minnesota	14.76	10.41
Montana[b]	5.19	3.05
Nebraska	6.62	2.15
North Dakota	24.40	7.90
South Dakota	13.87	5.28

[a] Includes only those portions of States within the UGP Region.

[b] NWI mapping for Montana is incomplete; therefore, wetland density was determined from completed areas of that State.

Source: Service (2009b).

TABLE 4.6-3 Wetland Density within the UGP Region by Ecoregion

Ecoregion	Wetlands per mi^2	Wetland Percentage of Land Surface (%)
Central Irregular Plains	13.61	2.88
Northern Glaciated Plains	32.68	9.10
Western Corn Belt Plains	6.17	2.62
Lake Agassiz Plain	9.07	3.36
North Central Hardwood Forests	28.51	20.98
Northern Lakes and Forests	34.80	26.96
Canadian Rockies	3.60	2.10
Idaho Batholith	0	0
Middle Rockies	3.59	2.12
Northwestern Glaciated Plains	14.71	5.17
Northwestern Great Plains	4.10	4.34
Wyoming Basin	0	0
Central Great Plains	5.97	2.26
Nebraska Sand Hills	18.49	4.60
High Plains	1.25	0.25

Source: Service (2009b).

wetlands, particularly smaller, shallower wetlands, contain surface water for only a brief part of the year or only in wet years. Wet prairie and marsh communities associated with many of these wetlands are dominated by grasses, such as prairie cordgrass or reedgrass (*Calamagrostis* spp.), sedges (*Carex* spp.), or other herbaceous plants.

In the past, many of these pothole wetlands were drained for agricultural use. Wetland losses is some States were extensive. In Iowa, for example, 95–98 percent of wetlands have been lost (Dahl 2006). However, a number of Federal and State programs across the region are protecting wetlands and restoring previously drained wetlands, often including adjacent upland grasslands. Wetland easements established by the Service in Montana, North Dakota, and South Dakota, have contributed to the conservation of wetlands in the UGP Region. Between the 1950s and 1990s the average annual wetland losses across the United States steadily declined (Dahl 2006). The total area of freshwater wetlands increased slightly (0.2 percent) between 1998 and 2004, due primarily to the creation of freshwater ponds (Dahl 2006). Ponds increased by 12.6 percent, while freshwater emergent marshes decreased by 0.5 percent in spite of restorations. Increases in forested wetlands (1.1 percent) were due primarily to changes from scrub-shrub wetlands (4.9 percent decrease).

Riparian communities occur along perennial and intermittent streams, rivers, and reservoirs. These communities form a zone along the water margin, with a species composition and density that are distinct from the adjacent upland area. These may be emergent marsh, scrub-shrub, or forest communities. Riparian communities may include wetlands; however, the upper margins of riparian zones may be inundated only infrequently and include non-wetland species.

4.6.2 Wildlife

As discussed in the previous section and appendix C the various ecoregions within the UGP Region include a diversity of plant communities and species that, in turn, provide a wide range of habitats supporting diverse assemblages of terrestrial wildlife species (table 4.6-4). The species that may occur at a particular wind energy development project would depend on the location of the project and the plant communities and habitats present at the site. The following discussion presents general descriptions of the wildlife species that may be affected by wind energy development projects within the UGP Region.

4.6.2.1 Amphibians and Reptiles

The six States that encompass the UGP Region support a number of amphibian (frog, toad, and salamander) and reptile (snake, lizard, and turtle) species. The number of amphibian species reported from these States ranges from 11 species in North Dakota to 19 species in Iowa. The number of reptile species ranges from 15 in North Dakota to 34 in Iowa (table 4.6-3). Widely distributed amphibian species that occur within the UGP Region include the tiger salamander (*Ambystoma tigrinum*), plains spadefoot (*Spea bombifrons*), Woodhouse's toad (*Bufo woodhousii*), Great Plains toad (*B. cognatus*), boreal chorus frog (*Pseudacris maculata*), and northern leopard frog (*Rana pipiens*). Reptile species common or widely distributed within the region include the snapping turtle (*Chelydra serpentina*), northern painted turtle (*Chrysemys picta*), western hog-nosed snake (*Heterodon nasicus*), racer (*Coluber constrictor*),

TABLE 4.6-4 Number of Wildlife Species in the States That Encompass the UGP Region[a]

State	Amphibians	Reptiles	Birds	Mammals
Iowa	19	34	420	58
Minnesota	15	18	429	61
Montana	15	20	431	102
Nebraska	13	41	445	69
North Dakota	11	15	400	79
South Dakota	15	31	426	90

[a] Excludes native species that have been extirpated and not subsequently reintroduced into the wild and feral domestic species. The number of bird species presented is based on numbers for the entire State; the number of amphibian, reptile, and mammal species is limited to numbers within the boundaries of the UGP Region (i.e., does not include portions of Iowa, Minnesota, Montana, or Nebraska that are outside the UGP Region).

Sources: ASM (1999); HerpNet (2009a,b); Hoberg and Gause (1992); Iowa Gap Analysis Program (2007); Kiesow (2006); LeClere (2009); Lepage (2009); MTFWP (2009b); NatureServe (2009); South Dakota Gap Analysis (2001); Stebbins (2003); University of Nebraska (2007).

gophersnake (*Pituophis catenifer*), and common gartersnake (*Thamnophis sirtalis*). The prairie rattlesnake (*Crotalus viridis*) is the most widely distributed poisonous snake species that occurs within the UGP Region (although it is absent from Minnesota, most of Iowa, and southeastern Nebraska). While most amphibians and reptiles are generally considered to be nongame species, most States do classify some species, such as bullfrogs (*Rana catesbeiana*) and snapping turtles, as game species. Threatened, endangered, and other special status amphibian and reptile species are addressed in section 4.6.4.

4.6.2.2 Birds

Several hundred species of birds have been reported from the UGP Region, ranging from 400 species in North Dakota to 445 species in Nebraska (table 4.6-4). The following subsections describe important groups of bird species, major bird migratory routes, significant and important bird habitats, and management plans that address bird conservation within the UGP Region. Federal regulations related to bird protection and conservation are also described. It is important to identify species and habitats that may be present in the UGP Region because many bird species could be susceptible to impacts from wind energy development and operations due to habitat disturbance or direct mortality associated with construction and maintenance activities, strikes from turbines, or collisions with power lines.

Bird Species Groups. This section describes various groups of bird species that that occur within the UGP Region, are important to humans (e.g., waterfowl and upland game species), and/or are representative of other species that share important habitats. Threatened, endangered, and other special status bird species are addressed in section 4.6.4.

Waterfowl, Wading Birds, Shorebirds, and Other Waterbirds. Waterfowl (ducks, geese, and swans), wading birds (egrets, herons, cranes, bitterns, rails, and coots), shorebirds (plovers, sandpipers, and similar birds), and other waterbirds (grebes, gulls, terns, cormorants, and pelicans) represent some of the most abundant and important groups of birds from the UGP Region. Many of these species exhibit extensive migrations from breeding areas in Alaska and Canada or within the UGP Region to wintering grounds in Mexico and southward (Lincoln et al. 1998). Most of the waterfowl and shorebirds are ground-level nesters, and many forage in flocks on the ground or water. Wading birds generally nest and roost in trees; however, the sandhill crane (*Grus canadensis*) and the whooping crane (*Grus Americana*) nest on tundra or in marshes and grasslands (National Geographic Society 2000). The whooping crane is federally listed as an endangered species and is described further in section 4.6.4.

Common to abundant duck species in the UGP Region include the mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), American wigeon (*A. americana*), green-winged teal (*A. crecca*), blue-winged teal (*A. discors*), northern shoveler (*A. clypeata*), northern pintail (*A. acuta*), redhead (*Aythya americana*), canvasback (*A. valisineria*), lesser scaup (*A. affinis*), and greater scaup (*A. marila*). Geese species common to the area, at least seasonally, include Canada goose (*Branta* canadensis), snow goose (*Chen caerulescens*), and greater white-fronted goose (*Anser albifrons*). The trumpeter swan (*Cygnus buccinator*) can be locally common in its breeding areas (National Geographic Society 2000).

Dabbling ducks (e.g., mallard, gadwall, American wigeon, teals, northern shoveler, and northern pintail) are the most abundant and widespread group of ducks in North America and are of greatest importance to sport hunting and viewing (North American Waterfowl Management Plan Committee 1998). Diving ducks (e.g., canvasback, redhead, and scaup) tend to use deeper inland marshes, rivers, and lakes for breeding and migration, and coastal bays, estuaries, and offshore waters for wintering (North American Waterfowl Management Plan Committee 1998). The 2012 duck breeding population estimates for individual species within Montana and the Dakotas were as follows: mallard—793,000; gadwall—254,000; American widgeon—85,000; green-winged teal—19,000; blue-winged teal—661,000; northern shoveler—341,000; northern pintail—244,000; redhead—20,000; canvasback—10,000; and scaup—18,000 (Service 2008c). These numbers fluctuate annually depending on annual precipitation and temperatures. The long-term average for each species can be found in the Waterfowl Populations Status reports issued by the Service (Service 2012a). Habitat conditions during the 2012 Waterfowl Breeding Population and Habitat Survey were characterized by average to below average moisture, a mild winter, and an early spring across the southern portion of the traditional and eastern survey areas. Northern habitats of the survey areas generally experienced average moisture and temperatures (Service 2012a).

Most populations of geese and swans (Canada goose, brant, snow goose, Ross' goose, emperor goose, white-fronted goose, and tundra swan) in North America nest in the Arctic and subarctic regions of Alaska and northern Canada, but several Canada goose populations nest in the temperate regions of the United States and southern Canada (Service 2008b). All of these species, except for brant, occur within portions of the UGP Region. The trumpeter swan also nests within portions of Montana and South Dakota (National Geographic Society 2000).

Waterfowl populations can vary annually depending upon a number of factors. One of the most important factors is the amount of water present in the breeding grounds (i.e., duck numbers tend to decrease during years of drought). A large portion of initial nesting attempts by breeding ducks fail, often due to predators. Most hens that renest shift to a new site, with some moving to new regions. Expansive, unfragmented grasslands enable waterfowl to disperse their nests, which makes them less vulnerable to predators (Ducks Unlimited 2009c). Even in intact prairies, up to three-quarters of waterfowl nests may be lost to predators. Hens most commonly re-nest where the habitat provides adequate food and cover (Checkett 2009). Within the PPR, grasslands are as important as the potholes to breeding waterfowl. A number of upland-nesting duck species, such as northern pintail, mallard, blue-winged teal, and gadwall, will nest up to a mile away from wetlands, if grassland habitat is adequate.

Continuing loss of important habitat is the most critical threat faced by waterfowl. Degraded habitat conditions in the Midwest have led to decreases in scaup numbers, as the birds are unable to store enough of the fat and other nutrients necessary for nesting. Continuing declines in some waterfowl species, such as the northern pintail, are partly attributed to habitat and nest destruction from farming (Ducks Unlimited 2009d).

Common wading bird species within the UGP Region include American bittern (*Botaurus lentiginosus*), black-crowned night-heron (*Nycticorax nycticorax*), great blue heron (*Ardea herodias*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), American coot (*Fulica americana*), and sandhill crane (*Grus canadensis*). A hunting season for the sandhill crane occurs in Montana and the Dakotas. A number of wading bird species depend on emergent wetlands for feeding and/or nesting. Some will also feed in open water or herbaceous uplands. Herons and egrets tend to nest in trees and shrubs. Wading birds that nest in trees and shrubs tend to have colonial nesting habits, while species that nest in emergent marshes or herbaceous uplands tend to be solitary nesters (NRCS 2005). Current stressors to wading birds include wetland habitat loss and degradation and the effects of herbicides and pesticides (NRCS 2005).

Common shorebird species within the UGP Region include the semipalmated plover (*Charadrius semipalmatus*), killdeer (*C. vociferus*), American avocet (*Recurvirostra americana*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*T. flavipes*), spotted sandpiper (*Actitis macularius*), long-billed curlew, upland sandpiper, willet (*T. semipalmata*), Wilson's snipe (*Gallinago delicata*), and Wilson's phalarope (*Phalaropus tricolor*). Generally, shorebirds can be grouped into three habitat guilds: (1) those tied to grassland habitats (e.g., marbled godwit, willet, upland sandpiper, and Wilson's phalarope); (2) those that exclusively or primarily use unvegetated wet mud/shallow water (<2 in. [5 cm]) habitats (e.g., semipalmated sandpiper [*Calidris pusilla*] and white-rumped sandpiper [*C. fuscicollis*]); (3) and those that are associated with agricultural lands and meadows (e.g., American golden-plover [*Pluvialis dominica*], buff-breasted sandpiper [*Tryngites subruficollis*], and pectoral sandpiper [*Calidris melanotos*]) (Skagen and Thompson 2009).

Morrison et al. (2006) provide population estimates for 75 taxa (among 52 species) of North American shorebirds. Population trends indicated that 42 taxa were decreasing, 2 taxa were increasing, and 31 taxa had unknown or stable population trends. Shorebirds generally have low rates of reproduction (e.g., clutch sizes mostly four or less, and very few species will re-nest after a successful first attempt); therefore, it is difficult to reverse past declines and recover populations rapidly (Brown et al. 2001). The PPR provides breeding habitat for 13 of

20 shorebird species that breed in the contiguous United States, and offers important stopover habitat for 30 species that are arctic breeders (Ringelman 2005). Most forage in water less than 4 in. (10 cm) deep, although some forage in upland areas (e.g., curlews, upland sandpiper, and American woodcock) or deeper water by swimming (e.g., phalaropes). Most feed on insects, molluscs, other aquatic invertebrates, and small fish (Plauny 2000). Shorebirds use a wide range of habitat types, including dry grasslands, sand and gravel beaches, natural freshwater and alkaline wetlands, lake margins, and shallowly flooded agricultural fields. During migration, the unvegetated shallow waters and moist mudflats of wetlands are especially important (Skagen and Thompson 2009). Peak spring migration for shorebirds occurs from March through May, while fall migration primarily occurs from July through September (Plauny 2000). Loss of grassland and wetland habitat can be assumed to be the cause of drastic reduction or elimination of some breeding shorebird species from all or portions of the PPR (Ringelman 2005). Wilson's snipe and American woodcock are the only shorebird species still legally hunted (Brown et al. 2001).

Waterbird species common or widespread over the UGP Region include common loon (*Gavia immer*), pied-billed grebe (*Podilymbus podiceps*), horned grebe (*Podiceps auritus*), double-crested cormorant (*Phalacrocorax auritus*), Franklin's gull (*Leucophaeus pipixcan*), ring-billed gull (*Larus delawarensis*), common tern, black tern (*Chlidonias niger*), and American white pelican (*Pelecanus erythrorhynchos*) (Beyersbergen et al. 2004). The wading bird species discussed above are often included among waterbirds, especially in waterbird conservation plans. Thus, the more encompassing waterbird grouping includes the following bird families: Gaviidae (loons), Podicipedidae (grebes), Pelecanidae (pelicans), Phalacrocoracidae (cormorants), Ardeidae (herons, night-herons, bitterns, and egrets), Threskiornithidae (ibises), Rallidae (rails, coots, and moorhens), Gruidae (cranes), and Laridae (gulls and terns). Threats to waterbirds include loss of habitat (e.g., from wetland drainage and conversion of grassland to cropland) and pesticide-induced loss of invertebrate populations (Ringelman 2005).

Neotropical Migrants. Neotropical migrants are birds that breed in North America during spring and early summer and that winter in Mexico, the Caribbean, and Central and South America. More than 300 species of bird that breed in North America are neotropical migrants. The neotropical migrants exhibit a wide range of seasonal movements; some species are year-round residents in some areas and migratory in other areas, while other species migrate hundreds of miles or more (Lincoln et al. 1998). Many of the neotropical migrants use riparian areas and corridors for nesting and migration purposes. Nesting occurs in vegetation from near ground level to the upper canopy of trees. Some species, such as thrushes and chickadees, are relatively solitary throughout the year; other species, such as swallows and blackbirds, may occur in small to large flocks at various times of the year. Foraging may occur in flight (e.g., swallows and swifts), in vegetation, or on the ground (e.g., warblers, finches, and thrushes).

Neotropical migrants include perching birds (often referred to as songbirds), shorebirds, waterfowl, wading birds, other waterbirds (previously discussed), and some raptors (discussed later). Most of the neotropical migrants include birds in the order Passeriformes, which are often referred to as perching birds or songbirds. Perching birds include flycatchers, shrikes, vireos, jays and crows, larks, swallows, chickadees and titmice, nuthatches, wrens, mockingbirds and thrashes, starlings, pipits, warblers, tanagers, towhees, sparrows, cardinals, grosbeaks, blackbirds, orioles, and finches. Most of the Passeriformes are landbirds. Other neotropical migrants include nighthawks, swifts, hummingbirds, kingfishers, and woodpeckers. These birds are also considered to be landbirds.

Gallinaceous Birds. Gallinaceous birds (often referred to as upland gamebirds) of the order Galliformes include grouse, turkeys, pheasants, partridge, and prairie-chickens. All of the gallinaceous birds are year-round residents. They are ground-dwelling birds, and their flight is generally brief but strong. Males perform elaborate courting displays, which for some species occur yearly at the same strutting grounds, known as leks. Some of the species, such as the wild turkey (*Meleagris gallopavo*) and ruffed grouse (*Bonasa umbellus*), inhabit forested or open forest habitats. Species that inhabit sagebrush, prairies, and grasslands include the greater sage-grouse, sharp-tailed grouse (*Tympanuchus phasianellus*), greater prairie-chicken, and gray partridge (*Perdix perdix*). A few of the species, such as the ring-necked pheasant (*Phasianus colchicus*), chukar (*Alectoris chukar*), and gray partridge, were introduced from Europe or Asia to be game birds. Most concerns over gallinaceous birds, particularly in the West, have focused on the greater sage-grouse because of its dependence on sagebrush. Because the greater sage-grouse is now a candidate for listing under the ESA, this species is discussed further in section 4.6.4.

Birds of Prey. The birds of prey include raptors (hawks, falcons, eagles, kites, and osprey), owls, and vultures. Many of these species are the top avian predators. Common raptor species within the UGP Region include the northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), and American kestrel (*Falco sparverius*). Owl species common to the UGP Region include the short-eared owl (*Asio flammeus*) and great horned owl (*Bubo virginianus*). The only vulture that occurs within the area is the turkey vulture (*Cathartes aura*). It is a large soaring scavenger that feeds on carrion.

The bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) are also raptor species of concern within the UGP Region, partly because these species are protected by the BGEPA (see section 4.6.2.2.4). The bald eagle is a permanent resident of western and eastern Montana, and a non-breeding resident within the remainder of Montana, the southwest corner of North Dakota, the western third of South Dakota, a portion of Nebraska, most of Minnesota within the UGP Region, and the eastern portion of Iowa within the UGP Region. It is essentially absent from the prairie pothole region of the Dakotas and Nebraska. The golden eagle is a permanent resident of Montana and the western Dakotas and is a non-breeding resident throughout the remainder of the UGP Region.

The raptors forage on a variety of prey, including small mammals, reptiles, other birds, fish, invertebrates, and, at times, carrion. They typically perch on trees, utility support structures, highway signs, and other structures that provide a broad view of the surrounding topography. They forage either from a perch or on the wing (depending on the species), and all forage during the day. The owls also perch on elevated structures and forage on a variety of prey. Forest-dwelling species typically forage by diving on a prey item from a perch, while open country species hunt on the wing while flying low over the ground. Most owls are nocturnal, although some species, such as the great horned owl, burrowing owl, snowy owl, and short-eared owl, may be occasionally or routinely active during the day.

Migratory Routes. Many of the bird species reported from the UGP Region exhibit seasonal migrations. These birds include waterfowl, shorebirds, raptors, and neotropical songbirds. Three of the major North American migration flyways pass through the UGP (Lincoln et al. 1998):

- The Mississippi Flyway (crosses mainly through Minnesota and Iowa, although birds associated with this flyway can occur in all of the UGP Region States except for Montana);
- The Central Flyway (crosses through all of the States except Iowa and Minnesota); and
- The Pacific Flyway (crosses through the western portion of Montana).

As indicated above, there is some overlap among the flyways. Even some birds that migrate along the Atlantic Flyway cross through portions of North Dakota, Minnesota, and Iowa. Birds migrating north from wintering areas to breeding areas use these pathways in the spring, while those migrating southward to wintering areas use them in the fall. Each flyway encompasses broad geographic areas and includes principal routes and routes that merge with other routes, the use of which varies by species. Consideration of these more specific routes would be important for identifying site-specific concerns related to migratory birds.

Many smaller birds including rails, shorebirds, flycatchers, orioles, most sparrows, warblers, vireos, and thrushes typically migrate during the night. Many waterfowl also migrate at night (Lincoln et al. 1998). Species that migrate during the day include some ducks and geese, loons, cranes, gulls, pelicans, hawks, vultures, swallows, and swifts. Many wading birds and waterbirds migrate either by day or by night. Most migratory flights occur at altitudes under 3,000 ft (914 m) (Lincoln et al. 1998).

Significant and Important Bird Habitats.

Bird Conservation Regions. The North American Bird Conservation Initiative (NABCI) is a committee of government agencies, private organizations, and bird initiatives that help partners across North America to meet common bird conservation objectives (U.S. NABCI Committee 2000). The NABCI has mapped Bird Conservation Regions (BCRs) to indicate areas that encompass landscapes that have similar bird communities, habitats, and resource issues (ABC 2007). Portions of six BCRs occur within the UGP Region (figure 4.6-3): Badlands and Prairies (BCR 17), Central Mixed-Grass Prairie (BCR 19), Eastern Tallgrass Prairie (BCR 22), Northern Rockies (BCR 10), Prairie Hardwood Transition (BCR 23), and Prairie Potholes (BCR 11). (The northern tip of the Shortgrass Prairie BCR [BCR 18] extends into southern South Dakota, but is not discussed further, as it comprises only a small fraction of the UGP Region.)

Bird species of conservation concern within the six BCRs (as prioritized by Service [2008b]) are listed in table 4.6-5. These species include migratory and nonmigratory bird species (other than those already designated as federally threatened and endangered) that represent highest conservation priorities. They include nongame birds; gamebirds without hunting seasons; and Endangered Species Act (ESA) candidate, proposed, and recently

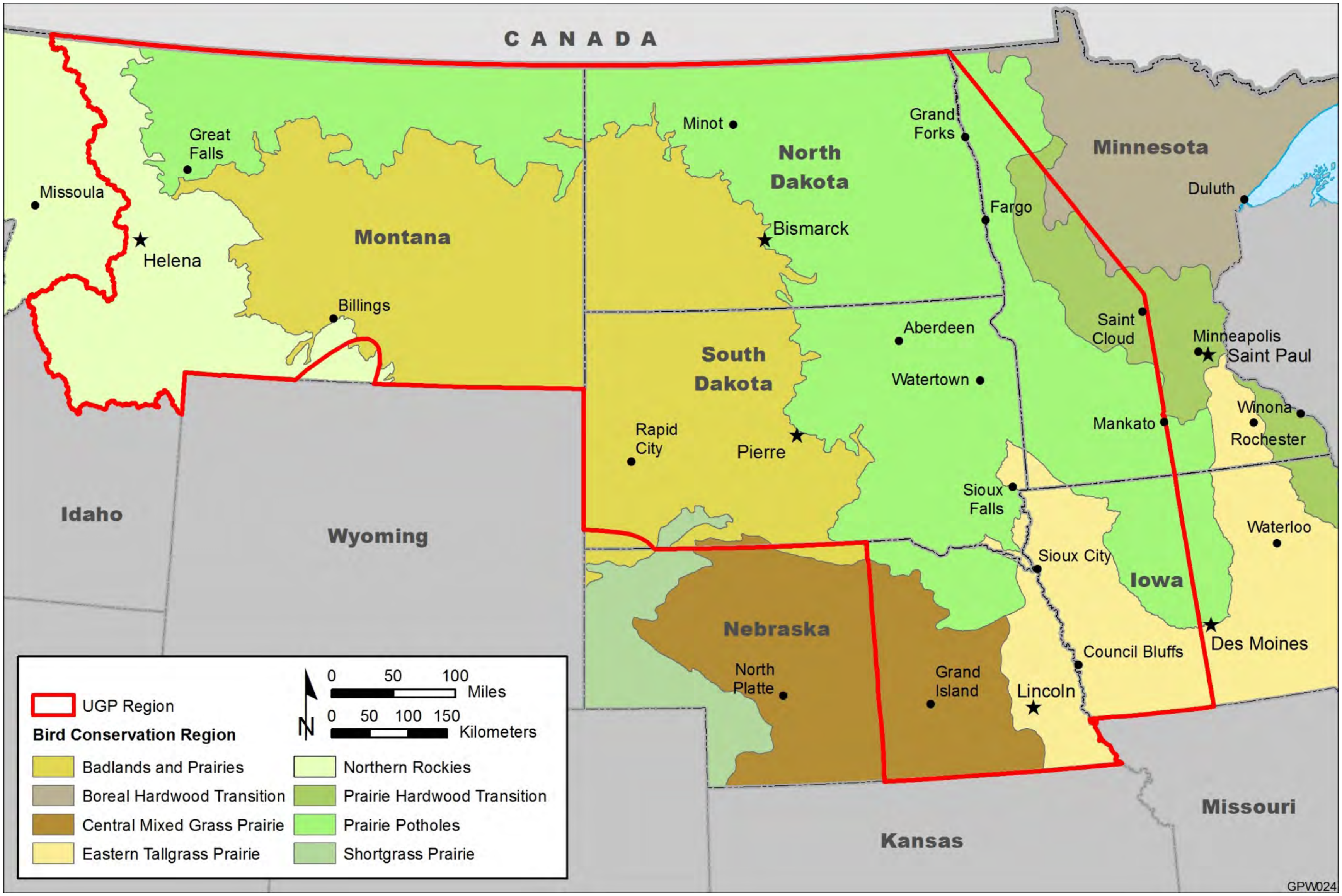


FIGURE 4.6-3 Bird Conservation Regions within the UGP Region

TABLE 4.6-5 Bird Species of Conservation Concern for the Bird Conservation Regions That Occur within the UGP Region

	Bird Conservation Region[a]					
Species	10	11	17	19	22	23
Horned grebe (*Podiceps auritus*)		X	X		X	X
Pied-billed grebe (*Podilymbus podiceps*)					X	X
American bittern (*Botaurus lentiginosus*)		X	X		X	X
Least bittern (*Ixobrychus exilis*)		X			X	
Black-crowned night-heron (*Nycticorax nycticorax*)					X	
Little blue heron (*Egretta caerulea*)				X		
Mississippi kite (*Ictinia mississippiensis*)				X		
Bald eagle (*Haliaeetus leucocephalus*)	X	X	X	X	X	X
Swanson's hawk (*Buteo swainsoni*)	X	X		X		
Ferruginous hawk (*Buteo regalis*)	X		X			
Golden eagle (*Aquila chrysaetos*)			X			
Peregrine falcon (*Falco peregrinus*)	X	X	X		X	X
Prairie falcon (*Falco mexicanus*)			X			
Lesser prairie-chicken (*Tympanuchus pallidicinctus*)				X		
Black rail (*Laterallus jamaicensis*)				X	X	
Yellow rail (*Coturnicops noveboracensis*)		X	X			X
American golden-plover (*Pluvialis dominica*)						
Snowy plover (*Charadrius alexandrinus*)				X		
Mountain plover (*Charadrius montanus*)		X	X	X		
Willet (*Catoptrophorus semipalmatus*)						
Solitary sandpiper (*Tringa solitaria*)		X		X	X	X
Upland sandpiper (*Bartramis longicauda*)	X	X	X	X	X	X
Whimbrel (*Numenius phaeopus*)					X	X
Long-billed curlew (*Numernius americanus*)	X	X	X	X		
Hudsonian godwit (*Limosa haemastica*)		X		X	X	X
Marbled godwit (*Limosa fedoa*)		X	X	X	X	X
Red knot (*Calidris canutus*)					X	X
White-rumped sandpiper (*Calidris fuscicollis*)						
Buff-breasted sandpiper (*Tryngites subruficollis*)		X		X	X	X
Wilson's phalarope (*Phalaropus tricolor*)						
Short-billed dowitcher (*Limnodromus griseus*)		X		X	X	X
Black tern (*Chlidonias niger*)		X			X	X
Common tern (*Sterna hirundo*)					X	X
Black-billed cuckoo (*Coccyzus erythropthalmus*)		X	X		X	X
Yellow-billed cuckoo (*Coccyzus americanus*)	X					
Burrowing owl (*Athene cunicularia*)			X			
Flammulated owl (*Otus flammeolus*)	X					
Short-eared owl (*Asio flammeus*)		X	X		X	X
Whip-poor-will (*Caprimulgus vociferus*)					X	
Black swift (*Cypseloides niger*)	X					
Calliope hummingbird (*Stellula calliope*)	X					
Lewis's woodpecker (*Melanerpes lewis*)	X		X			
Red-headed woodpecker (*Melanerpes erythrocephalus*)		X	X	X	X	X
Northern flicker (*Colaptes auratus*)					X	
Williamson's sapsucker (*Sphyrapicus thyroideus*)	X					

TABLE 4.6-5 (Cont.)

Species	Bird Conservation Region[a]					
	10	11	17	19	22	23
White-headed woodpecker (*Picoides albolarvatus*)	X					
Acadian flycatcher (*Empidonax virescens*)					X	
Olive-sided flycatcher (*Contopus cooperi*)	X					
Scissor-tailed flycatcher (*Tyrannus forficatus*)				X		
Willow flycatcher (*Empidonax traillii*)	X					X
Loggerhead shrike (*Lanius ludovicianus*)	X		X	X	X	
Bell's vireo (*Vireo bellii*)				X	X	
Pinyon jay (*Gymnorhinus cyanocephalus*)			X			
Pygmy nuthatch (*Sitta pusilla*)						
Sprague's pipit (*Anthus spragueii*)		X	X	X		
Bewick's wren (*Thryomanes bewickii*)					X	
Marsh wren (*Cistithorus palustris*)						X
Wood thrush (*Hylocichla mustelina*)					X	
Brown thrasher (*Toxostoma rufum*)						X
Sage thrasher (*Oreoscoptes montanus*)	X		X			
Blue-winged warbler (*Vermivora pinus*)					X	X
Cerulean warbler (*Dendroica cerulea*)						X
Golden-winged warbler (*Vermivora chrysoptera*)						X
Kentucky warbler (*Oporornis formosus*)					X	
Prothonotary warbler (*Protonotaria citrea*)					X	
Virginia's warbler (*Vermivora virginiae*)						
Brewer's sparrow (*Spizella breweri*)	X		X			
Grasshopper sparrow (*Ammodramus savannarum*)		X	X		X	
Baird's sparrow (*Ammodramus bairdi*)		X	X			
Cassin's sparrow (*Aimophila cassinii*)				X		
Field sparrow (*Spizella pusilla*)					X	
Harris's sparrow (*Zonotrichia querula*)				X		
Henslow's sparrow (*Ammodramus henslowii*)				X	X	X
Le Conte's sparrow (*Ammodramus leconteii*)						
Nelson's sharp-tailed sparrow (*Ammodramus nelsoni*)		X				
Sage sparrow (*Amphispiza belli*)	X		X			
Chestnut-collared longspur (*Calcarius ornatus*)		X	X	X		
McCown's longspur (*Calcarius mccownii*)	X	X	X	X		
Smith's longspur (*Calcarius pictus*)				X	X	
Lark bunting (*Calamospiza melanocorys*)				X		
Dickcissel (*Spiza americana*)		X	X		X	X
Bobolink (*Dolichonyx oryzivorus*)						X
Rusty blackbird (*Euphagus carolinus*)					X	X
Black rosy-finch (*Leucosticte atrata*)	X					
Cassin's finch (*Carpodacus cassinii*)	X					

[a] BCR 10 = Northern Rockies (U.S. portion only); BCR 11 = Prairie Potholes (U.S. portion only); BCR 17 = Badlands and Prairies; BCR 19 = Central Mixed-Grass Prairie; BCR 22 = Eastern Tallgrass Prairie, BCR 23 = Prairie Hardwood Transition.

Source: Service (2008b).

delisted species (Service 2008b). Birds of conservation concern that occur within at least five of the BCRs are the bald eagle, peregrine falcon (*Falco peregrinus*), upland sandpiper (*Bartramis longicauda*), marbled godwit (*Limosa fedoa*), and red-headed woodpecker (*Melanerpes erythrocephalus*) (Service 2008b).

Within the UGP Region, the Badlands and Prairies BCR occurs within Montana and the western portion of the Dakotas (figure 4.6-3). This BCR is dominated by a mixed-grass prairie. Due to extensive ranching in the region, many contiguous tracts of grasslands are present. Bird species of conservation concern include mountain plover (*Charadrius montanus*), McCown's longspur (*Calcarius mccownii*), long-billed curlew (*Numernius americanus*), and Sprague's pipit (*Anthus spragueii*) (Service 2008b). The Central Mixed-Grass Prairie BCR encompasses central Nebraska (figure 4.6-3). Within this BCR are extensive agricultural lands and high-quality grasslands. Bird species of conservation concern include Henslow's sparrow (*Ammodramus henslowii*), the buff-breasted sandpiper (*Tryngites subruficollis*), and Sprague's pipit (Service 2008b).

Within the UGP Region, the Eastern Tallgrass Prairie BCR occurs mostly within western and southern Iowa and eastern Nebraska. A small tip of the BCR also extends into eastern South Dakota (figure 4.6-3). Much of this BCR is dominated by agriculture. Bird species of conservation concern include the Henslow's sparrow and the red-headed woodpecker (Service 2008b). The Northern Rockies BCR includes western Montana (figure 4.6-3). This BCR is dominated by a variety of coniferous forest habitats. Lower lying valleys are characterized by sagebrush shrubland and shrubsteppe habitat. Bird species of conservation concern include Lewis's woodpecker (*Melanerpes lewis*), olive-sided flycatcher (*Contopus cooperi*), ferruginous hawk (*Buteo regalis*), Brewer's sparrow (*Spizella breweri*), and sage thrasher (*Oreoscoptes montanus*) (Service 2008b).

Within the UGP Region, the Prairie Hardwood Transition BCR occurs within west-central Minnesota (figure 4.6-3). The western portion of this BCR was historically dominated by prairies. Many pothole wetlands and shallow lakes occur in the region. Bird species of conservation concern include the red-headed woodpecker and bobolink (*Dolichonyx oryzivorus*) (Service 2008b). The Prairie Potholes BCR occurs within northern Montana, much of North Dakota, eastern South Dakota, northeastern Nebraska, western Minnesota, and north-central Iowa (figure 4.6-3). It occurs within a glaciated area that varies from mixed-grass prairie in the west to tallgrass prairie in the east. This BCR is the most important waterfowl production area of North America (U.S. NABCI Committee 2000). Bird species of conservation concern include the yellow rail (*Coturnicops noveboracensis*), marbled godwit, and Sprague's pipit (Service 2008b). Wetland degradation and fragmentation of grassland habitats threaten the suitability of the region for these and other bird species (U.S. NABCI Committee 2000).

***Conservation Easements*.** A number of conservation easements that provide habitat protection for birds and other wildlife occur within the UGP Region. These include grassland and prairie easements, wetland easements, conservation easements, and easements acquired under the Wetland Reserve Program (Service 2009c). Figure 4.6-4 shows the location of wetland and grassland easements managed by the Service within the UGP Region, along with the spatial extent of the Prairie Pothole Region (PPR) of the United States. The PPR covers about 276,000 mi^2 (715,000 km^2), with 100,000 mi^2 (259,000 km^2) occurring within the United States. The region contains about 25 million depressions (potholes) of various size,

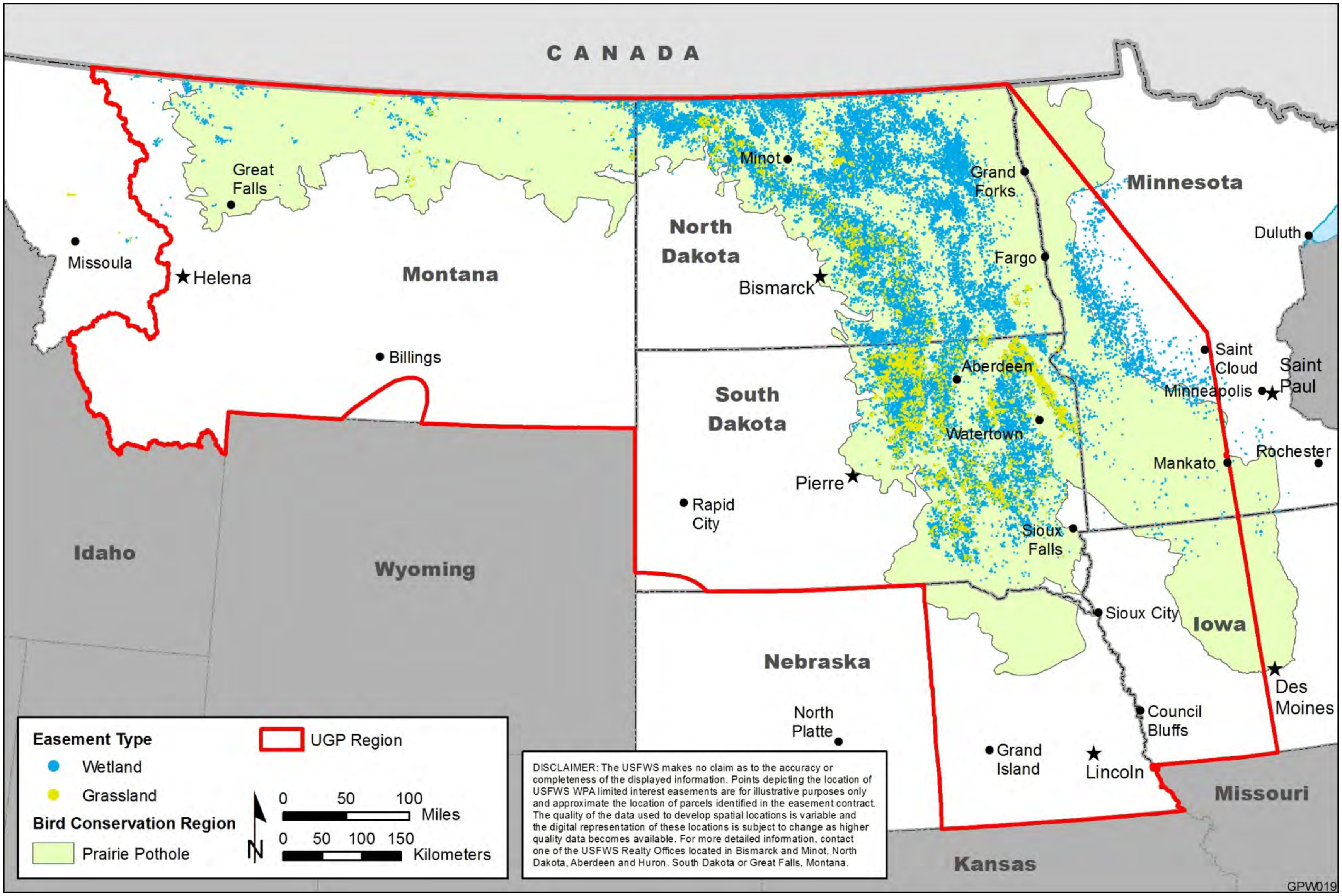


FIGURE 4.6-4 Wetland and Grassland Easements Managed by the Service within the UGP Region Relative to the Prairie Pothole Region

ranging from a few feet across and only inches deep to 500 ac (202 ha) in size and over 10 ft (3 m) deep, and various degrees of permanence (temporary, seasonal, and permanent). On average, there are about 83 potholes/mi^2 (32 potholes/km^2) (Service 2008c) within the PPR. These potholes originally occurred within three types of prairies: (1) tallgrass in Minnesota and Iowa, (2) mixed prairie in North and South Dakota, and (3) shortgrass in Montana (Service 2008c). More than 70 percent of wetlands in the PPR have been drained or severely degraded, while only about 10 percent of the grasslands remain (Ducks Unlimited 2009a). Grassland, prairie, and wetland easements are permanent (perpetual) agreements between the Service and all present and future landowners.

Lands are eligible for grassland easements if the land contains wetlands and the landowner wants to maintain or restore grassland cover. Only lands that are currently covered by native prairie and have never been plowed are eligible for a prairie easement. Grassland and prairie easements are always used in combination with wetland easements. There are four options for grassland and prairie easements:

1. No use (the rights to graze, hay, crop, ditch, and harvest seed are purchased by the government);

2. Haying only (the rights to graze, crop, and ditch are purchased by the Federal Government, while the right to hay and harvest seed is retained by the landowner, but only after July 15 of each year in order to protect ground-nesting wildlife);

3. Grazing only (the rights to hay, crop, ditch, and harvest seed are purchased by the Federal Government, while the right to graze is retained by the landowner, and no grazing restrictions are placed on the land); and

4. Both grazing and haying (the rights to crop and ditch are purchased by the Federal Government, while the rights to hay, graze, and harvest seed are retained by the landowner, but haying and harvesting seed can only be done after July 15) (Service 2009d).

Wetland easements transfer the rights to drain, fill, level, or burn wetlands to the Service. There are no restrictions on farming, grazing, or haying easement wetlands when they are dry from natural causes. The Partners for Fish and Wildlife Program (http://www.fws.gov/partners) restores drained pothole wetlands, which makes them eligible for wetland easement protection. About 20 percent of the wetlands restored through the Partners for Fish and Wildlife Program become permanently protected as wetland easements at the landowner's request (Service 2009c).

The Service can acquire conservation easements to protect Federal trust species habitat on private land. Federal trust species include Federal threatened and endangered species and migratory birds (e.g., waterfowl, wading birds, shorebirds, and neotropical songbirds). Conservation easements are normally used where fee acquisition is not desirable or needed. These easements generally prohibit the subdivision and development of private land, while still permitting traditional agricultural uses (Service 2009c).

The Wetlands Reserve Program is a USDA program offering payments to landowners for restoring and protecting wetlands on their property. By entering into a Wetlands Reserve Program easement agreement, a landowner transfers most land use rights to the USDA. However, some uses, such as haying or grazing can be granted back to the landowner at USDA's discretion (Service 2009c). The Farm Security and Rural Investment Act of 2002 set the national aggregate cap for the Wetlands Reserve Program at 2,275,000 ac (920,660 ha) nationwide (Ducks Unlimited 2009b).

Bird Management and Conservation Plans. Several management plans have been prepared to assist in the conservation of birds and their habitats. The four major bird management plans applicable to the UGP Region include the North American Waterfowl Management Plan, Partners in Flight (a landbird plan), North American Waterbird Conservation Plan, and the United States Shorebird Conservation Plan. The NABCI was established to stimulate coordination among the plans (Ruth 2008).

The North American Waterfowl Management Plan of 1986 (and its updates) was developed as a strategy to restore waterfowl populations through habitat conservation. The plan is implemented regionally in joint ventures comprised of Federal, State, provincial, tribal, and local governments; businesses; conservation organizations; and individual citizens. The joint ventures develop their own implementation plans to protect, restore, and enhance wetland and other habitat resources in their regions (Ruth 2008). Joint ventures are increasingly using BCRs when landscape planning, and the boundaries of newer joint ventures tend to be aligned with BCR boundaries (Soulliere 2005).

The UGP Region lies within portions of five habitat-based joint ventures (figure 4.6-5). Habitat objectives for all of the joint ventures include protection, restoration, and enhancement. The major goals of the individual joint ventures are:

- *Prairie Pothole Joint Venture* (http://www.ppjv.org). Implement conservation programs that sustain populations of waterfowl, shorebirds, other waterbirds, and prairie landbirds at objective levels through targeted wetland and grassland protection, restoration, and enhancement programs.

- *Northern Great Plains Joint Venture* (http://www.fws.gov/mountain-prairie/nawm/ngpjv.htm. Maintain and increase the populations of high-priority wetland, grassland, forest, and riparian bird species.

- *Rainwater Basin Joint Venture* (http://www.rwbjv.org). Restore and permanently protect 37,000 ac (14,973 ha) of high-quality wetlands and 25,000 ac (10,118 ha) of associated uplands with adequate water and distribution to meet the habitat needs of waterfowl and other migratory birds.

- *Intermountain West Joint Venture* (http://www.iwjv.org). Facilitate the long-term conservation of key avian habitat for all groups of birds.

- *Upper Mississippi River and Great Lakes Joint Venture* (http://www.uppermissgreatlakesjv.org). Protection, restoration, and enhancement of 520,000 ac (210,437 ha) of waterfowl breeding habitat and

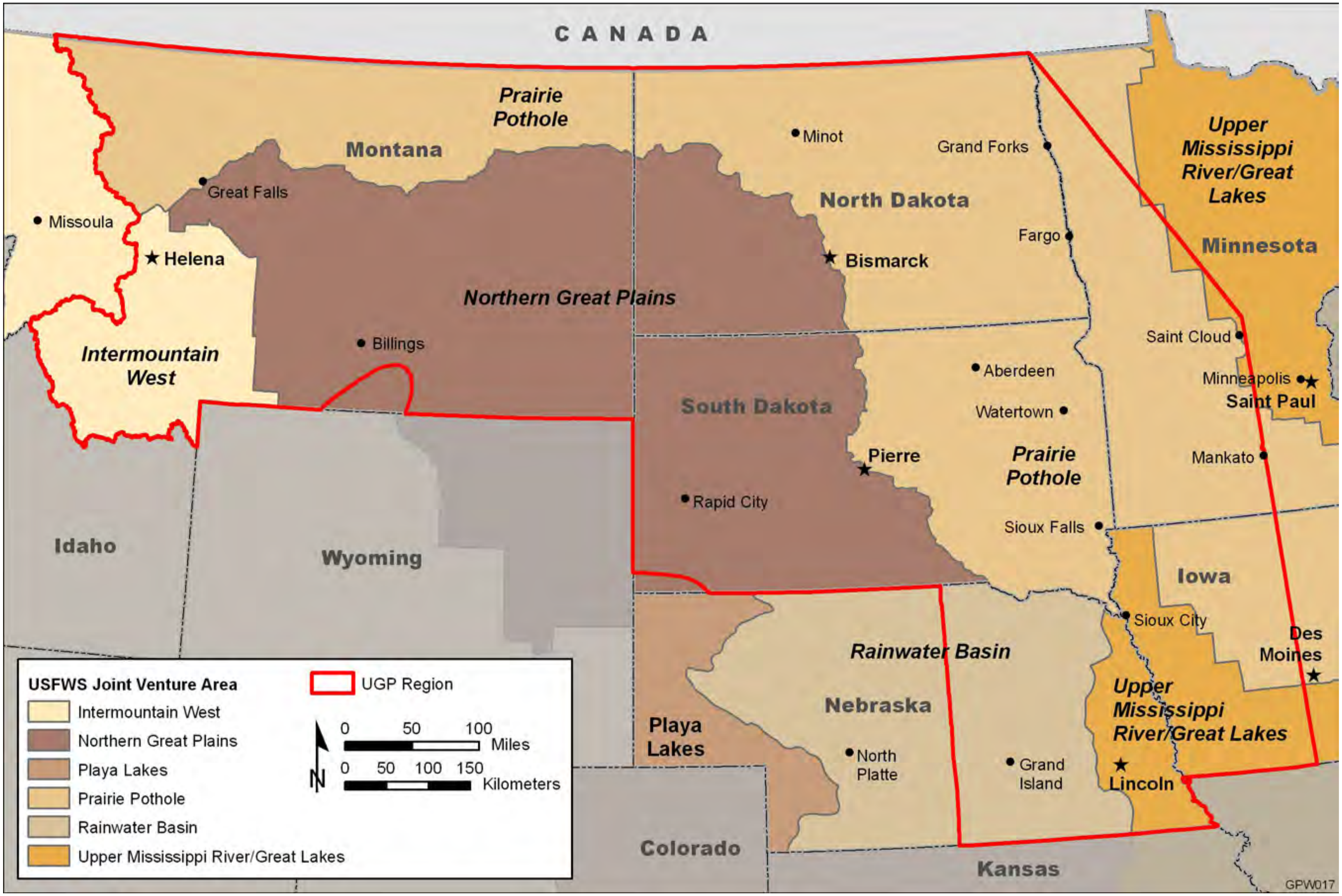


FIGURE 4.6-5 Habitat-Based Joint Ventures for Birds within the UGP Region

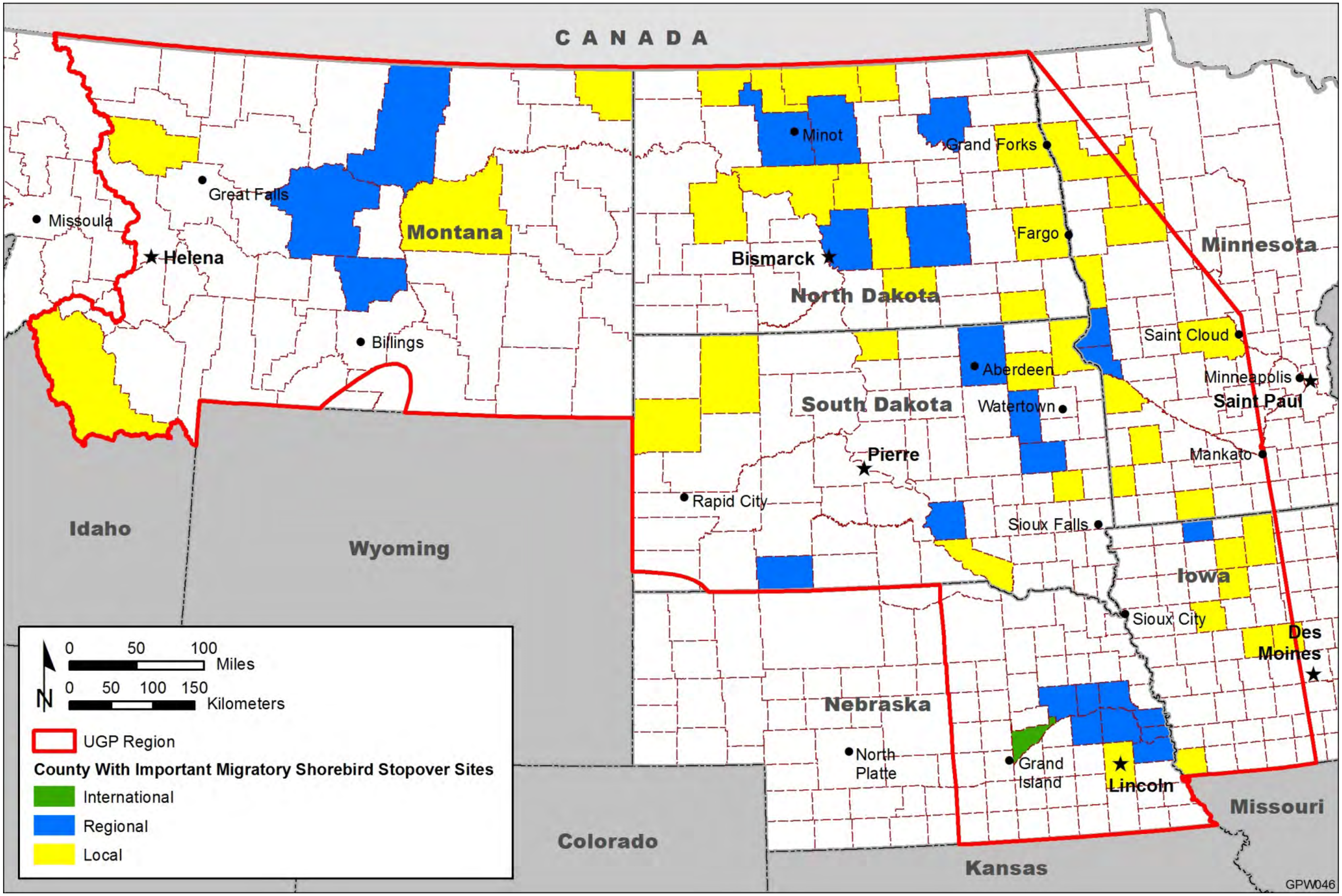
166,500 ac (67,380 ha) of migration habitat, particularly wetlands and associated grasslands. The plan also calls for the protection and/or increase of habitats for wetland and associated upland wildlife species, particularly declining non-waterfowl migratory birds, where the effort does not conflict with waterfowl objectives (Soulliere 2005).

Partners in Flight (http://www.partnersinflight.org) launched in 1990 because of growing concerns about the declines of many landbird populations. Habitat problems affecting landbirds include fragmentation of native cover, loss of wetlands and associated nesting cover, mismanagement of grazing, invasive species, and conversion of native prairie to cropland. Predators and nest parasites have also increased in response to man's activities (Ringelman 2005).The scope of Partners in Flight now includes all landbirds of the United States, Canada, and Mexico (Ruth 2008). The mission of Partners in Flight is to help species at risk, keep common species common, and establish voluntary partnerships for birds, habitat, and people. Bird species whose status is precarious but that are not yet listed are a top priority for Partners in Flight. Partners in Flight includes government agencies, tribes, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals (Ruth 2008).

The Partners in Flight North American Landbird Conservation Plan was completed in 2004 (Rich et al. 2004), and is available at http://www.partnersinflight.org/cont%5Fplan. The plan provides a continental synthesis of priorities and objectives to guide landbird conservation actions at national and international scales for 448 native landbirds that breed in the United States and Canada (Rich et al. 2004). Full participation in the plan by Mexico would add an additional 450 breeding species.

Partners in Flight has also been instrumental in completing a number of physiographic area and State conservation plans across the continent. These plans can be obtained at http://www.partnersinflight.org/bcps/pifplans.htm. The plans assess species and habitats most in need of conservation, setting objectives to achieve their conservation, establishing local working groups to implement each plan, and evaluating the success of conservation efforts. The UGP Region is covered by eight physiographic area plans (Central Rocky Mountains, Northern Shortgrass Prairie, Northern Mixed-Grass Prairie, Northern Tallgrass Prairie, Dissected Till Plains, Central Mixed-Grass Prairie, West River, and Wyoming Basin) and one State plan (Montana).

Completed in 2000, the *U.S. Shorebird Conservation Plan* (http://www.fws.gov/shorebirdplan/USShorebird.htm) was developed as a conservation strategy for migratory shorebirds and the habitats upon which they depend (Ruth 2008). The major goals of the plan are to: (1) understand the status of shorebird populations and how they are changing, (2) determine what is causing population changes, (3) define habitat needs throughout the annual cycle of shorebirds and provide and manage high-quality habitats, and (4) raise public awareness of shorebirds and their conservation needs. Special emphasis is placed on the conservation of migratory stopover sites (Ruth 2008). A number of these locations are within the States that comprise the UGP Region. Figure 4.6-6 shows the counties within the UGP Region that contain important stopover sites for shorebirds. Minnewaukan Flats at Devils Lake in Benson County, North Dakota, is the most important stopover for the spring and fall migration periods, with nearly 83,000 shorebirds occurring there in the spring and 64,000 in the fall

1 

2 **FIGURE 4.6-6 Counties with Important Migratory Stopover Sites for Shorebirds within the UGP Region**

(Skagen and Thompson 2009). In addition to the national plan, regional plans and other plan-related documents have been prepared and can be accessed at the Web site cited above.

The Western Hemisphere Shorebird Reserve Network (http://www.whsrn.org) is a conservation strategy launched in 1985. Its mission is the conservation, restoration, and management of critical shorebird habitats throughout the Americas. Over 21,000,000 ac (8,498,412 ha) of shorebird habitat have been purchased under the auspices of the Western Hemisphere Reserve Network, with 67 sites located in 9 countries (Ruth 2008). Several of these sites occur within the UGP Region (table 4.6-6).

Waterbird Conservation for the Americas (http://www.waterbirdconservation.org) has the mission of creating a cohesive, multinational partnership to conserve and mange waterbirds (including seabirds, colonial wading birds, coastal waterbirds, and marshbirds) and their habitats throughout North America (Ruth 2008). Waterbird Conservation for the Americas was initiated in 1998. The *Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1* was published in 2002 (Kushlan et al. 2002). A companion status assessment of noncolonial waterbirds, such as grebes, bitterns, and rails, was developed in 2006 (Ruth 2008). The Prairie Pothole Joint Venture published the *Northern Prairie and Parkland Waterbird Conservation Plan* (Beyersbergen et al. 2004), which describes the current knowledge, biology, and conservation efforts for 40 waterbird species within the PPR of the United States and Canada. The goal of the plan is to maintain and manage healthy populations, distributions, and habitats for waterbirds throughout the Northern Prairie and Parkland Region of North America. The *Northern Plains/Prairie Potholes Regional Shorebird Conservation Plan, Version 1.0* (Skagen and Thompson 2009) encompasses much of the UGP Region plus northeastern Wyoming. Thirteen species of shorebirds breed within the area covered by the plan, and the covered area is a major migration route for another 23 shorebird species. The goals for this plan are to (1) maintain biotic integrity and persistence of breeding shorebird populations, (2) ensure adequate stopover resources exist to support populations of migrating shorebirds, (3) identify and fill informational gaps, and (4) coordinate with other conservation efforts in a cross-border landscape (Skagen and Thompson 2009).

In addition to the four major bird plans, more localized plans also exist. For example, the *South Dakota All Bird Conservation Plan* (Bakker 2005) has the objectives of identifying priority species of concern in South Dakota, presenting their habitat requirements, and identifying possible habitat management options. However, the major conflict in an “all-bird” management

TABLE 4.6-6 Western Hemisphere Shorebird Reserve Network Sites within the UGP Region

Site	Location	Area (acres)
Benton Lake National Wildlife Refuge	Cascade and Choteau counties, MT	12,382
Bowdoin National Wildlife Refuge	Phillips County, MT	15,551
J. Clark Salyer National Wildlife Refuge	Bottineau and McHenry counties, ND	58,999
Kelly’s Slough National Wildlife Refuge	Ramsey County, ND	3,834
Long Lake National Wildlife Refuge	Burleigh County, ND	22,289

Source: WHSRN (2006).

plan is that habitat restoration or enhancement actions aimed at one species may be detrimental to another species (Ringelman 2005).

Generally, the above-mentioned management plans do not specifically contain provisions specific to wind generation development.

Important Bird Areas. Important Bird Areas (IBAs) are sites that provide essential habitat for one or more species of bird. These sites are identified by the National Audubon Society. IBAs include sites for breeding, wintering, and/or migrating birds. IBAs may be a few acres or thousands of acres, but usually they are discrete sites that stand out from the surrounding landscape. IBAs may include public or private lands, or both, and they may be protected or unprotected (National Audubon Society 2010).

More than 2,300 State-level IBAs have been identified by the National Audubon Society, with 340 of these prioritized as global IBAs and 14 identified as continental IBAs (National Audubon Society 2009). IBAs are locations that provide essential habitats for breeding, wintering, or migrating birds. While these sites can vary in size, they are discrete areas that stand out from the surrounding landscapes. IBAs must support one or more of the following:

- Species of conservation concern (e.g., listed species),
- Species with restricted ranges,
- Species that are vulnerable because their populations are concentrated into one general habitat type or ecosystem, or
- Species or groups of similar species (e.g., waterfowl or shorebirds) that are vulnerable because they congregate in high densities.

Bird species of conservation concern at the global level include those that are classified as critical, endangered, vulnerable, or near-threatened on the International Union for Conservation of Nature (IUCN) Red List. Some of the bird species of conservation concern at the global level that are present within the UGP Region include greater sage-grouse (*Centrocercus urophasianus*), greater prairie-chicken (*Tympanuchus cupido*), Northern bobwhite (*Colinus virginianus*), ferruginous hawk, whooping crane (*Grus americana*), piping plover (*Charadrius melodus*), red-headed woodpecker, Bell's vireo (*Vireo bellii*), Brewer's sparrow, and long-billed curlew (National Audubon Society 2009).

Bird species of conservation concern at the continental level include those on the Audubon Red and Yellow Watch Lists, species listed as federally threatened and endangered, and birds of conservation concern at the Federal level. Some of the bird species of conservation concern at the continental level that are present within the UGP Region include bald eagle, northern harrier (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), prairie falcon (*Falco mexicanus*), upland sandpiper, American woodcock (*Scolopax minor*), common tern (*Sterna hirundo*), least tern (*Sternula antillarum*), burrowing owl (*Athene cunicularia*), sedge wren (*Cistothorus platensis*), dickcissel (*Spiza americana*), and whip-poor-will (*Caprimulgus vociferus*) (National Audubon Society 2009). The IBA program has become a key component of many bird conservation efforts. Information on the IBA program and a list of IBAs for each State can be found at http://www.audubon.org/bird/IBA.

Within the portion of Iowa that is within the UGP Region, there are 40 State-level IBAs (Iowa Audubon 2009). Two of these IBAs, the DeSoto National Wildlife Refuge and the Saylorville Reservoir, are also global IBAs. Within Minnesota, nine State-level IBAs occur within the UGP Region (National Audubon Society 2009). None of them are global IBAs (ABC 2007). Of the 37 State-level IBAs in Montana, 29 occur within the UGP Region. Five of these IBAs focus on the greater sage-grouse and sagebrush-shrub steppe lands (Montana Audubon 2008). Nine others are also global IBAs (ABC 2007). Seventeen of Nebraska's 24 State-level IBAs occur within the UGP Region (Audubon Nebraska 2006), and four of these are global IBAs (ABC 2007). Although no State-level IBAs have been identified in the Dakotas, 14 global IBAs have been identified in North Dakota and 2 have been identified in South Dakota (ABC 2007).

Regulatory Framework for Protection of Birds. The Federal regulatory framework for protecting birds includes the ESA, MBTA, BGEPA, and Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds." ESA is discussed in section 4.6.4; the other regulations are discussed below:

The MBTA implements a variety of treaties and conventions among the United States, Canada, Mexico, Japan, and Russia. This treaty makes the take, killing, or possession of migratory birds, their eggs, or nests unlawful, except as authorized under a valid permit. ("Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, collect, molest, or disturb.) Most of the bird species reported from the UGP Region are classified as migratory under this act.

Under Executive Order 13186, each Federal agency that is taking an action that has or is likely to have negative impacts on migratory bird populations must work with the Service to develop an agreement to conserve those birds. The protocols developed by this consultation are intended to guide future agency regulatory actions and policy decisions.

The BGEPA provides for the protection of bald and golden eagles by prohibiting the take, possession, sale, purchase or barter, offer to sell, transport, export, or import of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. Under the BGEPA, important eagle-use areas are defined as areas including nests, biologically important foraging areas, and communal roosts. Overall, these important use areas are particular areas where eagles are more likely to be taken (i.e., disturbed) by the activity because of a higher probability of interference with breeding, feeding, or sheltering behaviors. For the purposes of the BGEPA, "disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle; (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

In addition to the above, the Service has drafted recommendations that provide guidelines that can minimize impacts on birds from wind energy projects. These include the *U.S. Fish and Wildlife Service Land-based Wind Energy Guideline* (Service 2012b) and, as appropriate, the *Draft Eagle Conservation Plan Guidance* (Service 2011d). Several States within the UGP Region have also developed guidelines or recommendations to protect or minimize impacts on wildlife from wind energy projects (e.g., IDNR 2011; Kempema 2009; Nebraska Wind and Wildlife Working Group 2011).

4.6.2.3 Mammals

Over 100 mammal species have been reported from the UGP Region (table 4.6-4). The following discussion emphasizes big game, small game and furbearer, and nongame species that have key habitats that could be impacted by a wind energy development, are important to humans, and/or are representative of other species that share important habitats. Threatened, endangered, and other special status mammal species are addressed in section 4.6.4.

Big Game. Big game species within the UGP Region include elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), mountain goat (*Oreamnos americanus*), moose (*Alces americanus*), cougar (*Puma concolor*), and American black bear (*Ursus americanus*). The American bison (*Bos bison*) also occurs within the UGP Region, but most occurrences are not for free-ranging populations. The herds in Yellowstone National Park (which includes a small portion of Montana) and Wind Cave National Park (in South Dakota) contain the only free-roaming, genetically pure herds within the UGP Region. Limited hunts in select areas surrounding Yellowstone National Park are conducted for individuals that wander outside the park. Mule and white-tailed deer are generally the most abundant, widely distributed, intensely managed, and sought-after big game within the UGP Region. Some of the big game species make migrations when seasonal changes reduce food availability, when local conditions become difficult (e.g., due to snowpack), or where local conditions are not suitable for calving or fawning. Established migration corridors for these species provide an important transition range between seasonal ranges and provide food for the animals during migration (Feeney et al. 2004). Water availability is a major factor affecting the distribution of big game species in some areas.

The following presents a generalized overview of the primary big game species within the UGP Region. Unless otherwise referenced, the information is derived from NatureServe (2009), DOE and BLM (2008), and references cited therein. Table 4.6-7 presents the conservation and hunting status for the big game species.

Elk. Elk are mostly migratory between their summer and winter ranges, although some herds do not migrate (i.e., occur within the same general area year-round). Nonmigratory herds have a home range up to 2.0 mi^2 (5.3 km^2) and rarely move more than 1 mi (1.6 km) in a day. They maintain a high fidelity to their home range and will only abandon it if highly disturbed. Their summer range occurs at higher elevations. Aspen and conifer woodlands provide security and thermal cover, while upland meadows, sagebrush-mixed grass, and mountain shrub habitats are used for forage. Their winter range occurs at mid to lower elevations where elk forage in sagebrush–mixed grass, big sagebrush–rabbitbrush, and mountain shrub habitats. Migratory elk are highly mobile within both summer and winter ranges in order to find the best forage conditions. In winter, they congregate in large herds of 50 to more than 200 individuals. The crucial winter range is considered to be the part of the local elk range in which about 90 percent of the local population is located during an average of 5 winters out of 10 from the

TABLE 4.6-7 State Conservation and Hunting Status for Big Game Species within the UGP Region

	State Conservation and Hunting Status[a,b,c]					
Species	IA	MN	MT	NE	ND	SD
Elk (*Cervus canadensis*)	PE	**V**	**S**	**V**	**NR/UR**	**S**
Mule deer (*Odocoileus hemionus*)	NP	NP	**S**	**S**	**NR/UR**	**S**
White-tailed deer (*Odocoileus virginianus*)	S	**NR/UR**	**S**	**S**	**NR/UR**	**S**
Pronghorn (*Antilocapra Americana*)	PE	PE	**S**	**V**	**NR/UR**	**S**
Bighorn sheep (*Ovis canadensis*)	NP	NP	**AS**	**PE**	**NR/UR**	**AS**
Mountain goat (*Oreamnos americanus*)	NP	NP	**S**	NP	NP	**E**
Moose (*Alces americanus*)	NP	NP	**S**	NP	**NR/UR**	NP
Cougar (*Puma concolor*)	PE	V	**AS**	CI	**I**	**I**
American black bear (*Ursus americanus*)	PE	**NR/UR**	**S**	PE	PE	CI
American bison (*Bos bison*)	PE	PE	**I**	PE	PE	V

[a] A conservation status highlighted in bold indicates that the species is hunted within the State.

[b] State abbreviations: IA = Iowa; MN = Minnesota; MT = Montana; NE = Nebraska; ND = North Dakota; SD = South Dakota.

[c] Conservation status abbreviations and definitions:

PE = presumed extinct (not located despite extensive searches and virtually no likelihood of rediscovery).
CI = critically imperiled (at very high risk of extinction due to extreme rarity, very steep declines, or other factors).
I = imperiled (At high risk of extinction due to very restricted range, very few populations, steep declines, or other factors).
V = vulnerable (at moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors).
AS = apparently secure (uncommon but not rare; some cause for long-term concern due to declines or other factors).
S = secure (common, widespread, and abundant).
E = exotic (not native).
NR/UR = not ranked or under review.
NP = not present.

Source: IDNR (2009b); MDNR (2009b); MTFWP (2009c); NatureServe (2009); NGPC (2009b); North Dakota GFD (2009a); South Dakota DGFP (2009a).

first heavy snowfall to spring greenup. Elk do not use a special calving ground (e.g., they may be born in areas ranging from valleys to alpine tundra). Calving areas are mostly located where cover, forage, and water are in close proximity. Elk require water on all seasonal ranges and generally occur within 0.5 mi (0.8 km) of a water source, although some herds will travel longer distances for water. Elk are susceptible to chronic wasting disease.

Mule Deer. Mule deer occur within most ecosystems, but attain their highest densities in shrublands characterized by rough, broken terrain with abundant browse and cover. Some populations of mule deer, particularly those that occur on plains, are nonmigratory, but those in mountainous areas are generally migratory between their summer and winter ranges. Their summer range occurs at higher elevations that contain aspen and conifer and mountain browse vegetative types. Fawning occurs during the spring while the mule deer are migrating to their summer range. This normally occurs in aspen-mountain browse intermixed vegetation types. Mule deer have a high fidelity to specific winter ranges where they congregate within small areas at high densities. Their winter range occurs at lower elevations within sagebrush and pinyon-juniper vegetation types. Winter forage is primarily sagebrush, with true mountain mahogany, fourwing saltbush, and antelope bitterbrush also being important. Pinyon-juniper provides emergency forage during severe winters. Overall, mule deer habitat is characterized by areas of thick brush or trees (used for cover) interspersed with small openings (for forage and feeding areas); they do best in habitats that are in the early stage of succession. Home range size may vary from 74 to 7,413 ac (30 to over 3,000 ha) and is correlated with the availability of food, water, and cover. Prolonged drought and other factors can limit mule deer populations. Several years of drought can limit forage production, which can substantially reduce animal condition and fawn production and survival. Severe drought conditions were responsible for declines in the population size of mule deer in the 1980s and early 1990s. In arid regions, mule deer seldom occur more than 1.0 to 1.5 mi (1.6 to 2.4 km) from water. Mule deer are also susceptible to chronic wasting disease. When it is present, up to 3 percent of a herd population can be affected by this disease.

White-tailed Deer. White-tailed deer inhabit a variety of habitats, but are often associated with woodlands and agricultural lands. White-tailed deer have a home range of 300 ac (120 ha) or more. Some populations undergo annual migrations of up to 31 mi (50 km). Depending upon environmental conditions, densities of white-tailed deer may approach 5 deer per ac (12.5 deer per ha); although 1 deer per 6 to 46 ac (2.4 to 18.6 ha) is more typical. Where density is high, deer browsing may significantly impact vegetation. Deer inhabit various habitats ranging from forests to fields with adjacent cover. Within more arid regions, they prefer riparian zones and montane woodlands. Young are born in areas protected by thick vegetation. White-tailed deer usually occur in two social groups—adult females and young and adult males (occasionally with yearling males). During the breeding season, adult males tend to be solitary, except when attending females. Hybridization between white-tailed deer and mule deer has occurred in some areas.

Pronghorn. Pronghorn inhabit open vegetated areas such as desert, grassland, and sagebrush habitats. They usually occur in small bands, although herd size can exceed 100 individuals, especially during winter. During the spring and summer, pronghorn form separate bachelor and female-kid groups, with males associating with the females in late summer and early fall. They consume a variety of forbs, shrubs, and grasses, with shrubs being most important in winter. Some pronghorn are yearlong residents and do not have seasonal ranges. Fawning occurs throughout the species range. However, some seasonal movement within their range occurs in response to factors such as extreme winter conditions and water or forage availability. Other pronghorn are migratory. Most herds range within an area 5 mi (8 km) or more in diameter, although the separation between summer and winter ranges has been reported to be as much as 99 mi (159 km) or more. Young have high mortality rates due primarily to predation. Severe winters with deep, crusted snow and below-zero temperatures can cause high pronghorn mortalities. Pronghorn populations have also been adversely impacted in some areas by historic range degradation and habitat loss and by periodic drought conditions.

Bighorn Sheep. Bighorn sheep are considered to be yearlong residents within their ranges; they do not make seasonal migrations like elk and mule deer. However, they do make vertical migrations in response to the increasing abundance of vegetative growth at higher elevations in the spring and summer and when snow accumulation occurs in high-elevation summer ranges. In addition, ewes do move to reliable watercourses or sources during the lambing season; lambing occurs on steep talus slopes within 1 to 2 mi (1.6 to 3.2 km) of water. Males live apart from females and young for most of the year. Bighorn sheep prefer open vegetation types such as low shrub, grassland, and other treeless areas with steep talus and rubble slopes. Their diet consists of shrubs, forbs, and grasses. In the early 1900s, bighorn sheep experienced significant declines because of disease, habitat degradation, and hunting. Bighorn sheep are very vulnerable to viral and bacterial diseases carried by livestock, particularly domestic sheep. Therefore, various land management agencies have adopted specific guidelines regarding domestic sheep grazing in or near bighorn sheep habitat. In appropriate habitats, reintroduction efforts, coupled with water and vegetation improvements, have been conducted to restore bighorn sheep to their native habitat.

Mountain Goat. Mountain goats may migrate up and down mountains between summer and winter ranges. These seasonal ranges may be up to 1.4 mi (2.2 km) apart. Female and young mountain goats form small groups in the summer, while males are often solitary or in small male groups. The males join the female groups in the fall. Their home range has been found to vary between 2.3 and 9.3 mi^2 (6 and 24 km^2). Mountain goats usually occur at the timberline or above, inhabiting alpine and subalpine habitat, steep grassy talus slopes, grassy ledges of cliffs, or alpine meadows. They may seek shelter in spruce or hemlock stands in winter. Young are born on rock ledges or steep cliffs. Predation is a major source of mortality to young mountain goats. Mountain goats feed mainly on grasses and forbs in summer and mosses, lichens, and grasses in winter. They browse on shrubs and conifers throughout the year.

Moose. Although moose range widely among habitat types, they are mainly associated with boreal forests and riparian areas. Their preferred habitat is generally associated with early stages of seral development and shrub growth. Moose also make use of dense stands of conifers for shelter in winter and for thermoregulation in summer. They primarily browse upon trees and shrubs such as willow, fir, and quaking aspen. Grasses, forbs, and aquatic vegetation, however, make up a large portion of their summer diet. Moose habitat is thought to be improved by annual flooding and habitat management techniques such as prescribed burning. Moose generally occur singly or in small groups. Some moose make short elevational or horizontal migrations between summer and winter habitats. Their home range may be up to several thousand hectares, with a population density of 1 to 3 per mi^2 (0.4 to 1.2 per km^2) (higher in unhunted areas). Moose may herd in winter. In addition to predation, snow accumulation may have a controlling effect on moose populations. Habitat degradation resulting from a large number of moose can lead to population crashes.

American Bison**.** The American bison inhabits grasslands, semidesert shrublands, pinyon-juniper woodlands, and alpine tundra. They are grazers, with grasses, sedges, and rushes comprising most of their diet. American bison are diurnal, being especially active during early morning and late afternoon. They have several grazing periods that are interspersed with periods of loafing and ruminating. Within the UGP Region, American bison are often found in managed herds that are often closely confined. The only wild populations that occur in the UGP Region are in Yellowstone National Park and Wind Cave National Park. Pre-1900 herds migrated up to several hundred miles between summer and winter ranges, but herds that currently exist either make short migrations or do not migrate.

Cougar. Cougars (also known as mountain lions or puma) inhabit a wide variety of habitats, but are usually associated with mountainous or remote undisturbed areas. Their annual home range can be more than 560 mi^2 (1,450 km^2), while densities are usually not more than about 10 adults/100 mi^2 (4 adults/100 km^2). Although primarily solitary in some areas, there is extensive overlap of home ranges in other areas. The cougar's main prey species is deer. They also prey upon most other mammals (which sometimes include domestic livestock) and some insects, birds, fishes, and berries. They are active year-round and are hunted on a limited and closely monitored basis within the UGP Region.

Established cougar populations occur throughout the western States, including the western portion of Montana within the UGP Region. Two established populations also exist within the Badlands of southwestern North Dakota and in the North Hills of western South Dakota. Other confirmed sightings of cougar have been reported from a number of locations throughout the Dakotas and Nebraska. The eastern movement of cougars tends to be along riparian corridors. A few confirmed sightings have also been reported for Minnesota (Kittson and Nobles Counties) and Iowa (Sioux and Shelby Counties) within the UGP Region (Cougar Network 2007).

American Black Bear. American black bears are found mostly within forested or brushy mountain environments and woody riparian corridors. They are omnivorous and feed on fruits, insects, small vertebrates, and carrion. Breeding occurs in June or July; the young are born in January or February. American black bears have a period of winter dormancy from November to April. The home range of the American black bear depends on the area in which it lives and the bear's gender; its range has been reported to be from about 1,250 ac (506 ha) to nearly 32,000 ac (12,950 ha). Limited black bear hunting is allowed in Minnesota and Montana under State regulations.

Small Game and Furbearers. A number of mid-size mammal species (e.g., carnivores, rabbits, and squirrels) occur within the UGP Region. Some of these species are hunted or trapped. Small game species that commonly occur within the six States include the eastern cottontail (*Sylvilagus floridanus*) and eastern fox squirrel (*Sciurus niger*). Common furbearers include American badger (*Taxidea taxus*), American beaver (*Castor canadensis*), American mink (*Neovison vison*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and weasels (*Mustela* spp.). Table 4.6-8 presents the conservation and hunting status for the small game and furbearer species within the UGP Region.

Nongame Species. Nongame mammal species generally include small mammals such as bats, mice, voles, moles, and shrews. Among these species, bats are especially susceptible

TABLE 4.6-8 State Conservation and Hunting/Trapping Status for Small Game and Furbearer Species within the UGP Region

	State Conservation and Hunting/Trapping Status[a,b,c]					
Species	IA	MN	MT	NE	ND	SD
American badger (*Taxidea taxus*)	**AS**	NR/UR	**AS**	**S**	**NR/UR**	**S**
American beaver (*Castor canadensis*)	S	NR/UR	**S**	**S**	**NR/UR**	**S**
American marten (*Martes americana*)	NP	AS	**AS**	NP	PE	S
American mink (*Neovison vison*)	**AS**	NR/UR	**S**	**S**	**NR/UR**	**S**
Black-tailed jackrabbit (*Lepus californicus*)	NP	NP	I	S	NP	**AS**
Black-tailed prairie dog (*Cynomys ludovicianus*)	NP	NP	V	V	NR/UR	**AS**
Bobcat (*Lynx rufus*)	**V**	**NR/UR**	**S**	**S**	**NR/UR**	**S**
Canada lynx (*Lynx canadensis*)	NP	NR/UR	**V**	NP	NR/UR	NP
Common muskrat (*Ondatra zibethicus*)	**S**	NR/UR	**S**	**S**	**NR/UR**	**S**
Coyote (*Canis latrans*)	**S**	NR/UR	**S**	S	**NR/UR**	**S**
Eastern cottontail (*Sylvilagus floridanus*)	**S**	**NR/UR**	AS	**S**	NR/UR	**S**
Eastern fox squirrel (*Sciurus niger*)	**S**	**NR/UR**	NP	**S**	NR/UR	**S**
Eastern gray squirrel (*Sciurus carolinensis*)	**S**	**NR/UR**	E	V	NR/UR	NR/UR
Eastern spotted skunk (*Spilogale putorius*)	CI	I	NP	CI	CI	V
Ermine (*Mustela erminea*)	AS	NR/UR	**S**	NP	NR/UR	AS
Fisher (*Martes pennanti*)	PE	NR/UR	**V**	NP	I	NP
Gray fox (*Urocyon cinereoargenteus*)	**AS**	**NR/UR**	NP	**AS**	**NR/UR**	**S**
Least weasel (*Mustela nivalis*)	**V**	V	**AS**	**S**	**NR/UR**	**S**
Long-tailed weasel (*Mustela frenata*)	**AS**	NR/UR	**S**	**I**	**NR/UR**	**S**
North American porcupine (*Erethizon dorsatum*)	PE	NR/UR	AS	AS	NR/UR	**S**
North American river otter (*Lontra canadensis*)	**V**	NR/UR	**AS**	I	CI	I
Northern pocket gopher (*Thomomys talpoides*)	NP	V	S	CI	NR/UR	**S**
Raccoon (*Procyon lotor*)	**S**	NR/UR	**S**	**S**	**NR/UR**	**S**
Red fox (*Vulpes vulpes*)	**AS**	**NR/UR**	**S**	**S**	**NR/UR**	**S**
Snowshoe hare (*Lepus americanus*)	NP	**NR/UR**	AS	NP	NR/UR	NP
Striped skunk (*Mephitis mephitis*)	**S**	NR/UR	**S**	**S**	NR/UR	**S**
Virginia opossum (*Didelphis virginiana*)	**S**	S	NP	**S**	NR/UR	**AS**
White-tailed jackrabbit (*Lepus townsendii*)	**V**	**NR/UR**	AS	**AS**	NR/UR	**AS**
Wolverine (*Gulo gulo*)	PE	PE	**V**	PE	PE	PE
Woodchuck (*Marmota monax*)	**S**	NR/UR	NP	AS	NR/UR	AS
Yellow-bellied marmot (*Marmota flaviventris*)	NP	NP	AS	NP	NP	**S**

[a] A conservation status highlighted in bold indicates that the species is hunted and/or trapped within the State.

[b] State abbreviations: IA = Iowa; MN = Minnesota; MT = Montana; NE = Nebraska; ND = North Dakota; SD = South Dakota.

[c] Conservation status abbreviations and definitions:

PE = presumed extinct (not located despite extensive searches and virtually no likelihood of rediscovery).
CI = critically imperiled (at very high risk of extinction due to extreme rarity, very steep declines, or other factors).
I = imperiled (At high risk of extinction due to very restricted range, very few populations, steep declines, or other factors).

Footnotes continued on next page.

TABLE 4.6-8 (Cont.)

V = vulnerable (at moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors).
AS = apparently secure (uncommon but not rare; some cause for long-term concern due to declines or other factors).
S = secure (common, widespread, and abundant).
E = exotic (not native).
NR/UR = not ranked or under review.
NP = not present.

Sources: IDNR (2009b); MDNR (2009b); MTFWP (2009c); NatureServe (2009); NGPC (2009b); North Dakota GFD (2009a); South Dakota DGFP (2009a,b).

to impacts from wind energy. The bat species that occur within the UGP Region are listed in table 4.6-9. Only species from two of the four bat families occur in the UGP Region: the Molossidae (free-tailed bats) and the Vespertilionidae (vesper bats). Vesper bats represent the majority of bat species reported from the six States (table 4.6-9) and are also the most widespread of the bats. The number of bats species reported from each State ranges from 7 in Minnesota to 16 in Montana. Species reported from every State include the big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), and silver-haired bat (*Lasionycteris noctivagans*).

Some of the bat species are nonmigratory, overwintering in caves, mines, or hollow trees. These include the long-legged myotis, northern myotis, western small-footed myotis, and big brown bat (Genter and Jurist 1995). Other bat species migrate to winter roost sites in southern States, Mexico, or Central America. These include the little brown myotis, silver-haired bat, eastern red bat, and hoary bat (Genter and Jurist 1995). In summer, they will roost in caves, mines, and trees, as well as in man-made structures (e.g., buildings and bridges). Bats are primarily nocturnal, although some species fly early in the evening (sometimes before sunset); occasionally, they will fly during daylight hours (Harvey et al. 1999). While buildings, mines, bridges, and other structures have created suitable roost sites for some species, loss of forests and riparian areas, recreation, and vandalism have eliminated large amounts of potential bat habitat (Genter and Jurist 1995).

Local and continental declines in bat populations are occurring due to habitat loss and fragmentation, roost disturbance, public persecution, and inefficient regulatory measures (South Dakota Bat Working Group 2004). White-nose syndrome, a fungal disease, has caused extensive bat mortality in the eastern States. Although spreading rapidly, it has not yet occurred in the States within the UGP Region (Service 2011e).

4.6.3 Aquatic Biota

Aquatic biota and their habitats occurring in the UGP Region may be affected by wind energy development if wind energy infrastructure (such as a transmission tower or access road)

TABLE 4.6-9 Bat Species That Occur within the UGP Region

	State					
Molossidae (free-tailed bats)	IA	MN	MT	NE	ND	SD
Molossidae (free-tailed bats)						
Big free-tailed bat (*Nyctinomops macrotis*)	X					
Mexican free-tailed bat (*Tadarida brasiliensis*)	X			X		X
Vespertilionidae (vesper bats)						
Big brown bat (*Eptesicus fuscus*)	X	X	X	X	X	X
California myotis (*Myotis californicus* [*myotis*])			X			
Eastern pipistrelle (*Perimyotis subflavus*)	X	X		X		
Eastern red bat (*Lasiurus borealis*)	X	X	X	X	X	X
Evening bat (*Nycticeius humeralis*)	X			X		
Fringed myotis (*Myotis thysanodes*)			X	X		X
Hoary bat (*Lasiurus cinereus*)	X	X	X	X	X	X
Indiana myotis (*Myotis sodalis*)	X					
Little brown myotis (*Myotis lucifugus*)	X	X	X	X	X	X
Long-eared myotis (*Myotis evotis*)			X		X	X
Long-legged myotis (*Myotis volans*)			X	X	X	X
Northern myotis (*Myotis septentrionalis*)	X	X	X	X	X	X
Pallid bat (*Antrozous pallidus*)			X			
Silver-haired bat (*Lasionycteris noctivagans*)	X	X	X	X	X	X
Small-footed dark-nosed myotis (*Myotis melanorhinus*)			X	X	X	X
Spotted bat (*Euderma maculatum*)			X			-
Townsend's big-eared bat (*Corynorhinus townsendii*)			X	X		X
Western small-footed myotis (*Myotis ciliolabrum*)			X	X	X	X
Yuma myotis (*Myotis yumanensis*)			X			

Sources: ASM (1999); Genter and Jurist (1995); Iowa Gap Analysis Program (2007); MTFWP (2009b); NatureServe (2009); South Dakota Gap Analysis (2001); University of Nebraska (2007).

is located directly within or immediately adjacent to a surface water body. In addition to direct injury of biota, placing infrastructure there could alter habitat quality and quantity. Aquatic biota could also be affected by facilities that are located in terrestrial areas where project activities could affect the quality and/or quantity of nearby aquatic habitats as a result of upland erosion and runoff into the habitats, and by the removal of riparian vegetation along shorelines. The nature and extent of potential impacts from wind energy development on aquatic resources is discussed in section 5.6.

Surface waters within the UGP Region fall within three major hydrologic regions: the Missouri, the Souris-Red-Rainy, and the Upper Mississippi Regions (figure 4.6-7). The Missouri Region includes the Missouri River Basin, which encompasses most of the UGP Region, including all of Montana and Nebraska, almost all of South Dakota, the western and southern portions of North Dakota, the western portion of Iowa, and the extreme southwestern corner of Minnesota (figure 4.6-7). The Souris-Red-Rainy Region includes the northern and eastern portions of North Dakota, the extreme northeast corner of South Dakota, and the northwestern portion of Minnesota. Within the UGP Region, the Upper Mississippi Region includes most of the southern and central portions of Minnesota and the eastern half of Iowa (figure 4.6-7). The surface water resources in these three hydrologic regions are discussed in section 4.3. In

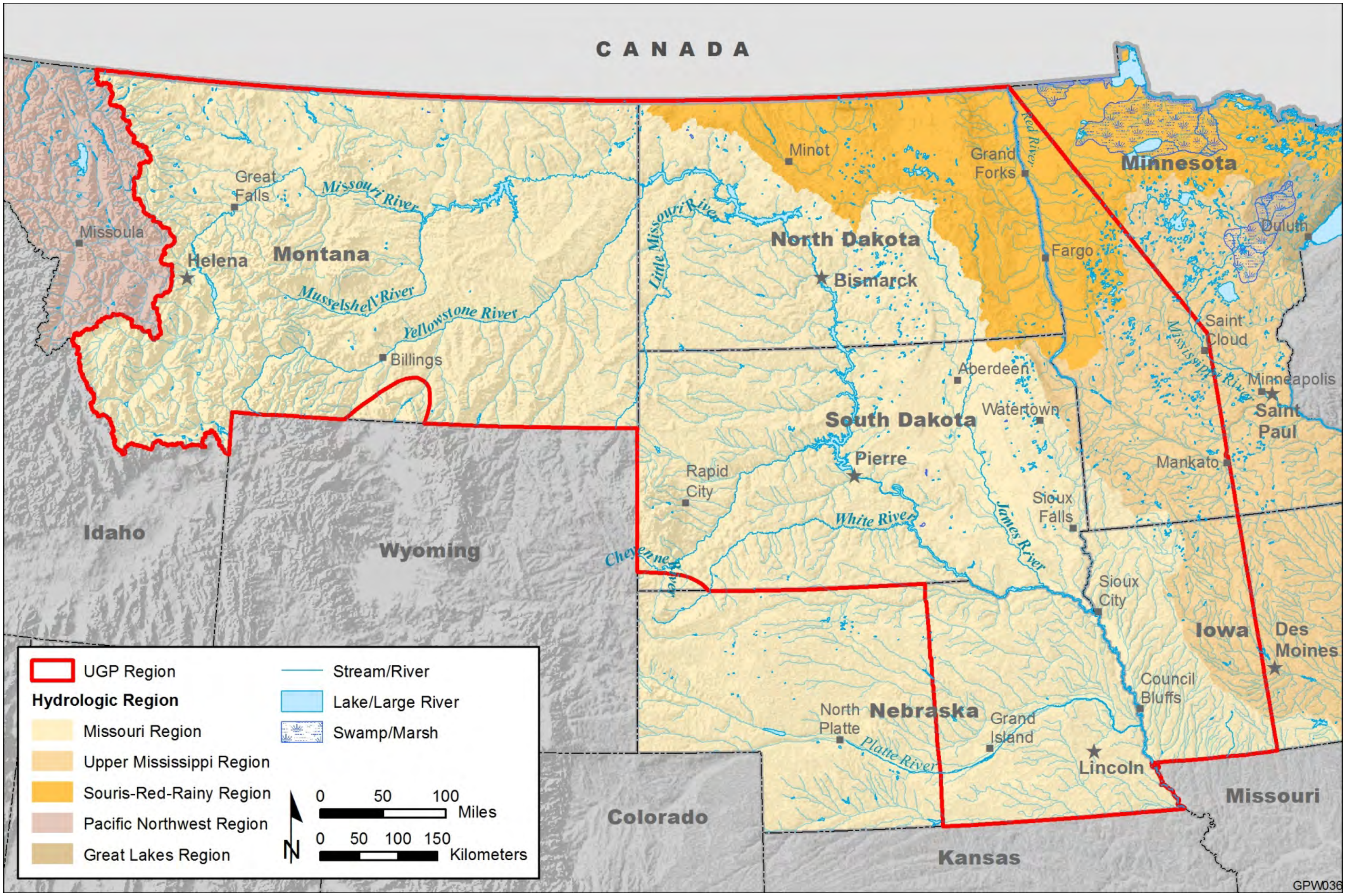


FIGURE 4.6-7 Major Hydrologic Regions of the UGP Region

addition to these hydrologic regions, the St. Mary River Basin, which encompasses (in part) the extreme northwest corner of the UGP Region, is part of the Saskatchewan River Basin which drains into Lake Winnipeg in central Alberta.

These three major hydrologic regions contain a variety of water bodies, including intermittent and perennial streams, prairie potholes, ponds, natural and man-made lakes and reservoirs, and large rivers, which provide a wide variety of aquatic habitats. These surface waters support a high diversity of aquatic biota, some of it unique to a particular region and to specific types of water bodies.

The numbers of fish species reported from each of the 6 UGP States are 89 from Montana (Montana 2009), 96 from North Dakota (USGS 2006), 107 from Nebraska (NGPC 2009c), 109 from South Dakota (USGS 2006), 140 from Minnesota (Hatch and Smith 2004), and 148 from Iowa (IDNR 2009d). Fish species are often categorized as game fish and nongame fish. In some States such as Nebraska, game fish include sport fish, commercial fish, and baitfish (NGPC 2009c). Sport fish throughout the six States include a variety of species, including a variety of salmon and trout, catfish, crappie (*Pomoxis* sp.), sunfish (*Lepomis* sp.), bass (*Micropterus* sp.), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), sauger (*Sander vitreus*), and walleye (*S. canadensis*). Commercial fish species in the UGP Region States include species such as bullheads, freshwater drum (*Aplodinotus grunniens*), and yellow perch. Nongame species are those that generally have no commercial or sportfishing value, although some are sold as baitfish. Nongame species include shiners, minnows, chubs, sculpin, darters, and some of the suckers. Some fishes, such as the sturgeons and the paddlefish (*Polydon spatula*), are restricted to larger rivers and reservoirs. Some species in each State have been either intentionally or unintentionally introduced. Those that have been intentionally introduced have primarily been sport species.

The surface waters of the UGP Region also support a diverse invertebrate biota, some of which may be affected by wind energy development. The aquatic invertebrate fauna found in each of the UGP States is large and diverse. For example, more than 536 species of aquatic insects, 28 species of crustaceans, and 55 species of molluscs have been reported from Montana waters (Montana 2009), while at least 11 species of mussel and 16 species of snails have been reported from the Platte River in Nebraska (Freeman and Perkins 1992). Aquatic invertebrates in the UGP Region may be found in virtually all surface waters of the region, and information on the distribution and abundance of individual species is limited for many species. Because of the limited information on the aquatic invertebrates of the surface waters of the UGP Region, the following discussions focus primarily on the fishes of the UGP Region. Special status aquatic species (invertebrates and fish) present within the UGP Region are discussed in section 4.6.4.

4.6.3.1 Aquatic Biota of the Missouri Hydrologic Region

Missouri River Basin. The Missouri River Basin encompasses the majority of the UGP Region (figure 4.6-7), and includes the Missouri River, its major tributaries (such as the Yellowstone, White, and Platte Rivers), and numerous smaller named and unnamed rivers and streams. In addition, the mainstream of the Missouri River includes six major impoundments. Within the UGP Region, the basin itself consists of seven smaller drainage basins: the Upper

Missouri River Basin, which includes most of Montana, the Yellowstone River Basin in southeastern Montana, the White-Little Missouri River Basin in western North and South Dakota, the Sioux-James Rivers Basin in southeastern North Dakota and eastern South Dakota, the Platte-Niobrara Rivers Basin in northern Nebraska, the Kansas River Basin in south-central Nebraska, and the Chariton-Nishnabotna Rivers Basin in southeastern Nebraska and southwestern Iowa (Cross et al. 1986) (figure 4.6-8). The Missouri River Basin also includes much of the prairie pothole area in the Dakotas. These potholes provide aquatic habitat for a variety of aquatic invertebrate and vertebrate biota.

About 180 species of fish have been reported to inhabit the Missouri River Basin (Cross et al. 1986; Galat et al. 2005a,b). The upper reaches of the Missouri River (especially rivers and streams in the Upper Missouri River and Yellowstone River Basins) support species that require clear and cool water conditions. Species found in such habitats may include rainbow (*Oncorhynchus mykiss*) and cutthroat (*O. clarki*) trout, longnose sucker (*Catostomus catostomus*), and mottled sculpin (*Cottus bairdii*) (Galat et al. 2005b). Cool-water species may also be found farther downstream in deeper portions of reservoirs and below dams. Farther downstream reaches of the Missouri River and its tributaries support species that prefer warm water conditions. These species include sturgeons, esocids (e.g., northern pike), and a variety of cyprinid minnows (e.g., *Notropis* sp.).

Native fishes comprise about 78 percent of the main channel Missouri River fish fauna (106 species) and about 75 percent (138 species) of the species in the entire basin (Cross et al. 1986; Galat et al. 2005a,b). About 54 percent of the Missouri River Basin fish fauna reside in the main channel (73 species); these species are characterized as big river fish. These fish, which are adapted for high turbidity and current conditions, include species such as the pallid sturgeon (*Scaphirhynchus albus*), paddlefish (*Polyodon spathula*), flathead catfish (*Pylodictis olivaris*), and the freshwater drum (Galat et al. 2005a,b). About 20 species are largely restricted to the reservoirs; the majority of these (11 species) are fishes that were introduced for sportfishing (e.g., many of the salmonids) or as forage for sport fishes (e.g., rainbow smelt [*Osmerus mordax*] and emerald shiner [*Notropis atherinoides*]) (Galat et al. 2005a). About 47 species occur only in the smaller named and unnamed streams throughout the Missouri River Basin (Cross et al. 1986). These include numerous species of minnows, shiners, chubs, and dace (Cyprinidae).

Upper Missouri River Basin. Within the UGP Region, the Upper Missouri River Basin encompasses most of central, northern, and southwestern Montana (figure 4.6-8). The fish fauna of this river basin is represented by 66 species from 17 families (table 4.6-9). Four families account for about 67 percent of the total fish fauna in the basin: Cyprinidae (18 species), Salmonidae (11), Catostomidae (8), and Centrarchidae (7). Of all the river basins that occur in the UGP Region, the Upper Missouri River Basin has the lowest diversity of native species (36) and the greatest number of introduced species (30) (Cross et al. 1986). The majority of introduced species in the basin were introduced for sportfishing (e.g., 8 of the 11 salmonids and all 7 of the centrarchids) or as forage for sport fishes (Galat et al. 2005a).

Yellowstone River Basin. The Yellowstone River Basin encompasses the southeastern portion of Montana (figure 4.6-8). Sixty fish species are reported from the basin, of which 35 species are native (table 4.6-10). Four families account for almost 70 percent of the

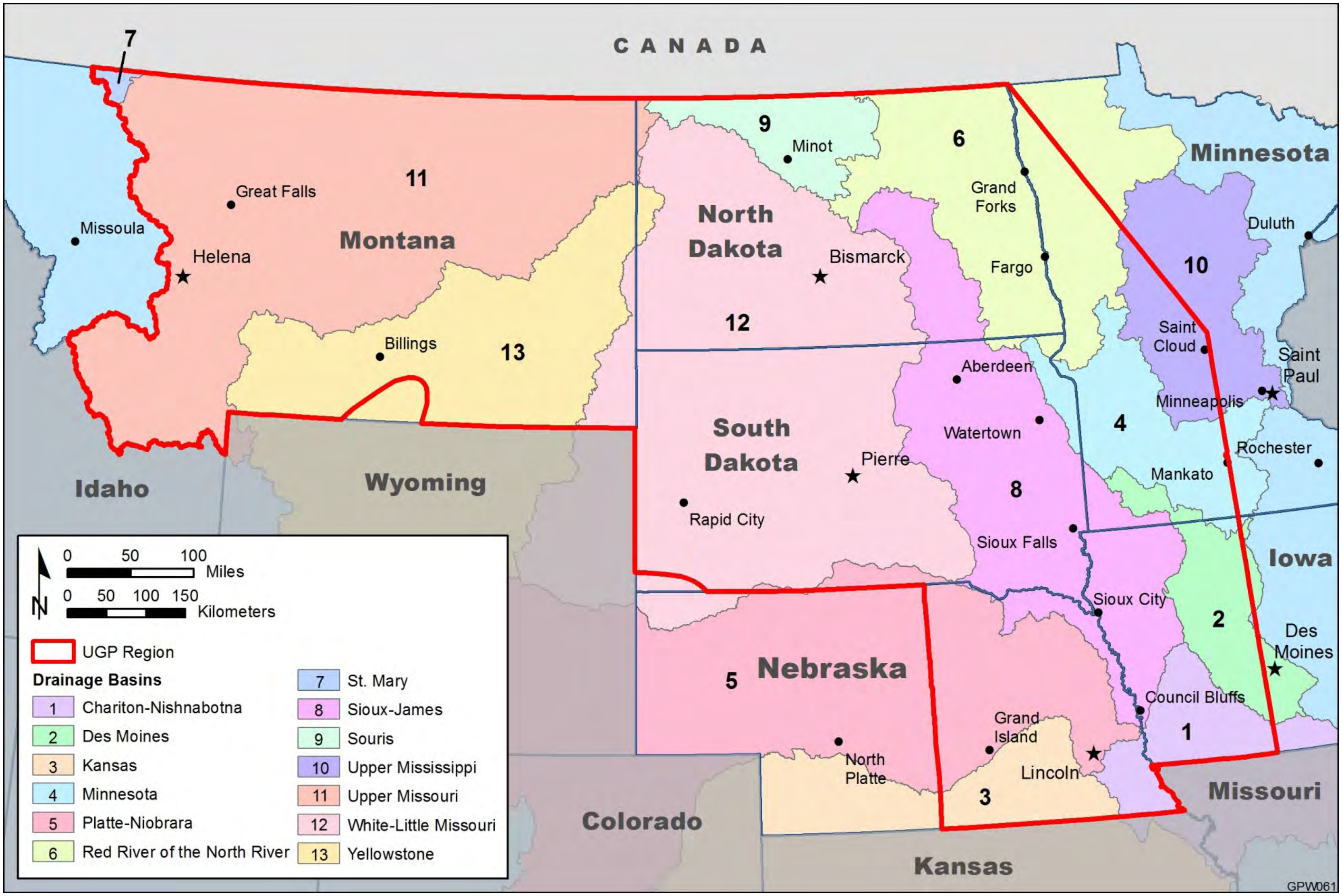


FIGURE 4.6-8 Major Drainage Basins of the UGP Region

TABLE 4.6-10 Number of Fish Species, by Family, Reported from the Major River Basins of the Three Major Hydrologic Regions That Occur within the UGP Region

	Number of Species											
	Missouri Hydrologic Region							Souris-Red-Rainy Hydrologic Region		Upper Mississippi Hydrologic Region		
Family	Upper Missouri River Basin	Yellowstone River Basin	White-Little Missouri River Basin	Sioux-James Rivers Basin	Platte-Niobrara Rivers Basin	Kansas River Basin	Chariton-Nishnabotna Rivers Basin	Souris River Basin	Red River of the North Basin	Upper Mississippi Basin	Minnesota River Basin	Des Moines River Basin
Petromyzontidae			1		1	1	1	1	2		2	
Acipenseridae	2	2	2	1	3	3	3		1		2	1
Polydontidae	1	1	1	1	1	1	1				1	
Lepisosteidae	1		1	2	2	2	2		1	1	2	2
Anguillidae				1	1	1	1			1	1	1
Amiidae						1	1		1	1	1	
Clupeidae			1	1	2	2	2			1	1	1
Hiodontidae	1	1	1	1	1	1	2	2	2		1	1
Salmonidae	11	9	6	1	7	1		1	5	6	3	
Osmeridae	1	1	1		1		1			1		
Umbridae			1	1					1	1	1	
Esocidae	1	1	1	1	2	1	1	2	2	2	1	1
Cyprinidae	18	17	26	27	32	31	27	20	29	26	26	25
Catostomidae	8	8	8	10	8	9	10	5	8	6	13	8
Ictaluridae	4	4	6	7	8	9	9	3	6	7	7	7
Percopsidae				1	1		1	1	1	1		1
Lotidae	1	1	1	1	1	1	1	1	1	1	1	
Cyprinodontidae	1	1	2	2	2	2	1		1	1	1	
Poecillidae	3				1	1						
Atherinidae										1		1
Gasterosteidae	1	1	1	1	1			2	1	2	1	1
Percichthyidae			1	1	3	1	2	1	1		1	2
Centrarchidae	7	8	8	6	8	8	7	4	9	9	9	11
Percidae	4	4	4	7	6	6	4	6	10	7	13	8
Scianidae	1	1	1	1	1	1	1	1	1		1	1
Cottidae									1	2		
Total families	17	16	20	20	22	20	20	14	20	19	21	16
Total species	66	60	74	74	96	83	79	50	84	77	89	72
Native species	36	35	50	67	77	67	67	48	77	68	82	71
Introduced species	30	25	24	7	19	16	12	2	7	9	7	1

Sources: Burr and Page (1986); Cross et al. (1986); Crossman and McAllister (1986); Peterka and Koel (1996); Koel (1997); Hatch and Smith (2004); Iowa Rivers Information System (2009); IDNR (2009d).

species in the basin: Cyprinidae (17 species), Salmonidae (9), Catostomidae (8), and Centrarchidae (8) (Cross et al. 1986). As with the species from the Upper Missouri River Basin, many of the introduced species in the Yellowstone River Basin were introduced for sportfishing (e.g., 7 of the 9 salmonids) or as forage for sport fishes (Galat et al. 2005b).

White-Little Missouri River Basin. The White-Little Missouri River Basin in the UGP Region includes western and southwestern North Dakota, western South Dakota, and extreme southeastern Montana (figure 4.6-8). The fish fauna of this basin is represented by 74 species from 20 families (table 4.6-10), with native species comprising about 67 percent (50 species) of the fish fauna (Cross et al. 1986). Five families account for about 73 percent of all species in the basin: Cyprinidae (26 species), Catostomidae (8), Centrarchidae (8), Ictaluridae, (6), and Salmonidae (6).

Sioux-James Rivers Basin. This basin includes a portion of southeastern North Dakota, the eastern third of South Dakota, and small portions of southwestern Minnesota and northwestern Iowa (figure 4.6-8). The fish fauna of the basin is represented by 74 species from 20 families (table 4.6-10). In contrast to the fish fauna reported for the more western-located basins within the Missouri Hydrologic Region, the fish fauna of the Sioux-James Basin is dominated by native species. Native fishes comprise about 90 percent (67 species) of the fish fauna of the basin. Five families account for about 77 percent of all species from the basin: Cyprinidae (27 species), Catostomidae (10), Percidae (7), Ictaluridae (7), and Centrarchidae (6). Of the seven introduced species, three are sport fish (rainbow trout, yellow bass [*Morone mississippiensis*], and brown bullhead [*Ameiurus nebulosus*]) and two are common bait fish (spotfin shiner [*Cyprinella spilopterus*] and bullhead minnow [*Pimephales vigilax*]).

Platte-Niobrara Rivers Basin. The Platte-Niobrara Rivers Basin includes the northern two-thirds of the Nebraska portion of the UGP Region and a very small portion of south-central South Dakota (figure 4.6-8). The fish fauna of this basin is the most diverse of any of the seven Missouri River basins, being represented by 96 species from 22 families (table 4.6-10). Native species comprise about 80 percent (77 species) of the fish fauna (Cross et al. 1986). Six families account for about 72 percent of all species in the basin: Cyprinidae (32 species), Catostomidae (8), Ictaluridae (8), Centrarchidae (8), Salmonidae (7), and Percidae (6).

Kansas River Basin. Within the UGP Region, the Kansas River Basin includes the southwestern portion of Nebraska that lies within the region (figure 4.6-8). The fish fauna of this basin is represented by 83 species from 20 families (table 4.6-10). Native species comprise about 81 percent (67 species) of the fish fauna (Cross et al. 1986). Five families account for about 76 percent of all species in the basin: Cyprinidae (31 species), Catostomidae (9), Ictaluridae (9), Centrarchidae (8), and Percidae (6).

Chariton-Nishnabotna Rivers Basin. Within the UGP Region, the Chariton-Nishnabotna Rivers Basin includes the southeastern portion of Nebraska and the southwestern portion of Iowa that occur within the region (figure 4.6-8). The fish fauna of this basin is represented by 79 species from 20 families (table 4.6-10). Native species comprise about

85 percent (67 species) of the fish fauna (Cross et al. 1986). Five families account for about 72 percent of all species in the basin: Cyprinidae (27 species), Catostomidae (10), Ictaluridae (9), Centrarchidae (7), and Percidae (4). This basin is the only one of the seven Missouri River basins that does not include salmonids.

Prairie Potholes. Only two native species, the fathead minnow (*Pimephales promelas*) and the brook stickleback (*Culaea inconstans*), are reported to occur in the wetlands (Peterka [1989], as cited in Kantrud et al. [1989], Euliss et al. [1999], and Zimmer et al. [2001]). The limited fish fauna of the potholes is a result of the extreme variability of these habitats with regard to water depth, oxygen levels, winter freezing depths, and total dissolved solids (Euliss et al. 1999). The major aquatic invertebrate fauna of the prairie pothole wetlands includes molluscs (especially snails), amphipods, fairy shrimp, bugs (Hemiptera), beetles (Coleoptera), and dragonflies and damselflies (Odonata) (Kantrud et al. 1989).

The potholes represent relatively shallow aquatic habitats that are environmentally highly variable. Historically, the climate of the PPR alternates between wet and dry periods, with each lasting about 10 to 20 years (Diaz [1983] as cited in Zimmer et al. [2001]). During the dry phase, fish populations inhabiting individual potholes may become greatly reduced or eliminated by lower water depths or by the complete drying of the potholes. Shallow water depths coupled with high summer productivity also promote frequent winterkills. During the dry phase, the absence of connections with other surface waters limits the likelihood that fishless potholes can be recolonized. In contrast, during the wet phase, greater wetland depths and increased overland water flow increase the likelihood that fish populations will persist and that previously fishless potholes may be colonized (Zimmer et al. 2001). Because most of the wetlands are isolated from one another, the dispersal of fishes among the wetlands is limited to periods of heavy precipitation (Peterka [1989] as cited in Euliss et al. [1999] and Zimmer et al. [2001]). In some areas of the PPR, potholes are stocked for commercial baitfish harvest (Carlson and Berry 1990).

4.6.3.2 Aquatic Biota of the Souris-Red-Rainy Hydrologic Region

The Souris-Red-Rainy Hydrologic Region consists of the Souris River Basin, the Red River of the North Basin, and the Rainy River Basin (figure 4.6-8). The Rainy River Basin occurs outside of the UGP Region and will not be discussed with regard to its aquatic biota and habitats.

The Souris River Basin. The Souris River Basin is located in north-central North Dakota, and includes the Souris River (figure 4.6-8). The Souris River is a major tributary of the Assiniboine River in Canada (Rosenberg et al. 2005), which enters the Red River in Canada. The Souris River originates in southern Saskatchewan, Canada, and flows into North Dakota and then back into Canada in Manitoba. As many as 50 species from 14 families may occur in the U.S. waters of the Souris River, and all but two are species native to the basin (table 4.6-10). Eleven of the species have been reported only from U.S. waters, while as many as 43 of the species from the Souris River have also been reported from the Red River of the North (Crossman and McAllister 1986). Five families comprise about 76 percent of all the species reported from the basin: Cyprinidae (20 species), Percidae (6), Catostomidae (5), Centrarchidae (4), and Ictaluridae (3).

In general, the bulk of the species reported from the river are northerly forms that prefer cool waters. The 11 species reported only from U.S. waters of the Souris River are all adapted to warmer waters, and the Souris River represents the northern limits of their respective ranges (Crossman and McAllister 1986). These species include the common carp (*Cyprinus carpio*), the white bass (*Morone chrysops*), the smallmouth bass (*Micropterus dolomieui*), and the black crappie (*Pomoxis nigromaculatus*). Major fishes present in both U.S. and Canadian waters of the drainage include the suckers (e.g., several species of redhorse [*Moxostoma* sp.]), percids (e.g., walleye and sauger), catfish (channel catfish), mooneye (*Hiodon tergisus*) and goldeneye (*H. alosoides*), and a variety of cyprinids (including the common carp). Top-level predators include the walleye and sauger, northern pike, channel catfish (*Ictalurus punctatus*), and Burbot (*Lota lota*). The Souris River Basin also supports a diverse aquatic invertebrate fauna, which includes many species of molluscs, crustaceans, and insects (Rosenberg et al. 2005).

The Red River of the North Basin. The Red River of the North (the Red River) is formed by the junction of the Otter Trail and Boise de Sioux Rivers north of the junction of the boundaries of Minnesota and North and South Dakota (Rosenberg et al. 2005). The river then flows north along the boundary between Minnesota and North Dakota (figure 4.6-8) into Canada, where it flows into Lake Winnipeg. A total of 84 species from 20 families are reported to occur in the Red River, 77 of which are native species (Peterka and Koel 1996; Koel 1997). Among the current fish fauna of the basin, about 76 percent (62 species) are represented by five families: Cyprinidae (minnows and shiners, 29 species), Centrarchidae (sunfishes, 10 species), Catastomidae (suckers, 9 species), and Ictaluridae (catfish, 6 species) (Koel 1997). As with the other surface waters of the UGP Region, the Red River Basin supports a diverse aquatic invertebrate fauna, which includes many species of molluscs, crustaceans, and insects (Rosenberg et al. 2005).

4.6.3.3 Aquatic Biota of the Upper Mississippi Hydrologic Region

Within the UGP Region, the Upper Mississippi Hydrologic Region (figure 4.6-7) includes parts of the Upper Mississippi River Basin and the Minnesota River Basins in central Minnesota and the Des Moines River Basin in central Iowa (figure 4.6-8) (Delong 2005). About 145 species of fish have been reported from the Upper Mississippi Hydrologic Region (Burr and Page 1986).

Upper Mississippi River Basin. A total of 77 species have been reported from the Upper Mississippi River Basin in Minnesota since 1975, 68 of which are native to the basin (Hatch and Smith 2004). The fish fauna of this basin is represented by 19 families, with six families accounting for 79 percent of all species reported in the basin (Cyprinidae, 26 species; Centrarchidae, 9 species; Ictaluridae and Percidae, 7 species each; and Catostomidae and Salmonidae, 6 species each). Seven of the nine introduced species are fishes that were introduced for sportfishing (e.g., lake trout, rainbow trout) or as forage for sport fishes (e.g., rainbow smelt). The remaining two introduced species are the common carp and goldfish (*Carassius auratus*).

Minnesota River Basin. A total of 89 species from 21 families have been reported since 1975 from the Minnesota River Basin in Minnesota, 81 of which are native to the basin (Hatch and Smith 2004). Six families account for about 80 percent of all reported species from the basin: Cyprinidae (26 species), Catostomidae (13), Percidae (13), Centrarchidae (9), Ictaluridae (7), and Salmonidae (3). Two of the four introduced species are sport fishes (rainbow trout and brown trout [*Salmo trutta*]); the other two are the common carp and goldfish (Hatch and Smith 2004).

Des Moines River Basin. Within the UGP Region, the fish fauna of the Des Moines River Basin is currently comprised of 72 species from 16 families (Iowa Rivers Information System 2009; IDNR 2009d). Five families comprise almost 82 percent of the species reported from the basin: Cyprinidae (25 species), Centrarchidae (11), Catostomidae (8), Percidae (8), and Ictaluridae (7). All but one of the 72 reported species are native to the basin, with the lone introduced species being the common carp (Burr and Page 1986).

4.6.3.4 Aquatic Biota of the St. Mary River Basin

The St. Mary River Basin is located within the extreme northwest corner of the UGP Region (figure 4.6-8). This basin drains northward into the Saskatchewan River Basin in Canada. The river originates within Glacier National Park and flows northeastward for about 43 mi (69 km) until reaching the Canadian border (MTFWP 2009d). The fish fauna of this stream is relatively small (13 species) and dominated by cold water forms including salmonids, whitefish, suckers, and sculpins, and dace (Schultz 1941).

4.6.4 Threatened, Endangered, and Special Status Species

The six-State UGP Region is used by many species of plants and animals that are listed as threatened or endangered under the ESA, or that are proposed or candidates for listing under the ESA. In addition, the UGP Region also supports hundreds of special status species (i.e., State-listed or of concern and have been placed on some form of watch list).

4.6.4.1 Federally Listed Species

Twenty-one species listed under the ESA and five species that are candidates for listing under ESA have been reported from the six-State UGP Region under consideration in this PEIS (table 4.6-11). These species could be present in the vicinity of future wind energy projects, depending on the location of the projects. The following definitions are applicable to the species listing categories under the ESA:

- *Endangered:* any species that is in danger of extinction throughout all or a significant portion of its range.

- *Threatened:* any species that is likely to become endangered within the foreseeable future throughout all or a significant part of its range.

TABLE 4.6-11 Species Listed, Proposed for Listing, or Candidates for Listing under the ESA That Occur in the Six-State UGP Region

Scientific Name	Common Name	Listing Status[a]	State in Which Species Could Occur[b]	Designated Critical Habitat (Y/N or Proposed)[c]	Recovery Plan (Y/N or Draft)
Plants					
Asclepias meadii	Mead's milkweed	T	IA	N	Y
Lespedeza leptostachya	Prairie bush-clover	T	IA, MN	N	Y
Pinus albicaulus	Whitebark pine	C	MT	N	N
Platanthera leucoaea	Eastern prairie fringed orchid	T	IA	N	Y
Platathera praeclara	Western prairie fringed orchid	T	IA, MN, NE, ND, SD[d]	N	Y
Spiranthese diluvialis	Ute ladies'-tresses	T	MT	N	Draft
Molluscs					
Lampsilis higginsii	Higgins eye (pearlymussel)	E	SD	N	Y
Leptodea leptodon	Scaleshell mussel	E	NE, SD[e]	N	Draft
Arthropods					
Cicindela nevadica lincolniana	Salt Creek tiger beetle	E	NE	Y	N
Hesperia dacotae	Dakota skipper	C	IA, MN, ND, SD	N	N
Nicrophorus americanus	American burying beetle	E	NE, SD	N	Y
Oarioma poweshiek	Poweshiek skipperling	C	IA, MN, ND, SD	N	N
Fishes					
Notropis topeka (=tristis)	Topeka shiner	E	IA, MN, NE, SD	Y	N
Salvelinus confluentus	Bull trout	T	MT	Y	Draft
Scaphirhynchus albus	Pallid sturgeon	E	IA, MT, NE, ND, SD	N	Y
Thymallus arcticus	Arctic grayling	C	MT	N	N
Reptiles					
Sistrurus catenatus catenatus	Massasauga rattlesnake	C	IA, NE	N	N
Birds					
Anthus spragueii	Sprague's pipit	C	MN, MT, ND, SD	N	N
Centrocereus urophasianus	Greater sage-grouse	C	MT, ND, SD	N	N
Charadrius melodus	Piping plover, except Great Lakes watershed	T	IA, MT, NE, ND, SD	Y	Y
Grus americana	Whooping crane	E	MT, NE, ND, SD	Y	Y
Numenius borealis	Eskimo curlew	E	May be extinct	N	N
Sterna antillarum	Least tern	E	IA, MT, NE, ND, SD	N	Y

TABLE 4.6-11 (Cont.)

Scientific Name	Common Name	Listing Status[a]	State in Which Species Could Occur[b]	Designated Critical Habitat (Y/N)[c]	Recovery Plan (Y/N or Draft)
Mammals					
Canis lupis	Gray wolf (lower 48 States)	E	ND, SD	N	Y
Gulo gulo luscus	Wolverine	C	MT	N	N
Lynx canadensis	Canada lynx	T	MN, MT	Y	N
Mustela nigripes	Black-footed ferret	E[f]	MT, NE, ND, SD	N	Y
Myotis sodalist	Indiana bat	E	IA	N	Draft
Ursus arctos horribilis	Grizzly bear	T	MT	N	Y

[a] C = candidate for listing, E = listed as endangered, T = listed as threatened.

[b] Some species also occur in other States outside of the six-State UGP Region.

[c] Indicates designated critical habitat in the States in the UGP Region; some species have designated habitat that is outside of the six-State UGP Region.

[d] Currently, there are no known populations of this species in South Dakota. Status surveys have been completed for the orchid in South Dakota. However, because of the ecology of this species, there is the possibility that plants may be overlooked (Service 2011a).

[e] Shells of this species have been found, but no populations have been located (Service 2011a).

[f] Some black-footed ferret populations have been reestablished as nonessential experimental populations and are treated as a proposed species for Section 7 consultation purposes.

Sources: Service (2010b,c, 2011a–c, 2012c).

- *Candidate:* species for which the Service or the National Marine Fisheries Service (NMFS) has sufficient information on their biological status and threats to their continued existence to propose them as threatened or endangered under ESA but for which development of a proposed listing regulation is precluded by other higher-priority listing actions. For the purposes of the evaluations in the PEIS, species that are candidates for Federal listing as threatened or endangered are treated as if they are proposed for listing.

- *Critical habitat:* specific areas within the geographical area occupied by the species at the time it is listed, on which are found physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Except when designated, critical habitat does not include the entire geographical area that can be occupied by the threatened, endangered, or other special status species.

In the six-State UGP Region, there are five plant species and 16 animal species that are federally listed as threatened or endangered under the ESA. Included in the total number of listed animals are two species of molluscs, two species of arthropods, three species of fishes, four species of birds, and five species of mammals. Candidates for listing under the ESA include two arthropod species, one fish species, one reptile species, two bird species, and one mammal species (table 4.6-11).

South Dakota has the largest number of federally listed threatened, endangered, and/or candidate species (14), whereas Minnesota has the fewest (5). Critical habitat has been designated for five species, and recovery plans have been developed for 13 species; these plans must be followed where Federal projects might affect those species (table 4.6-11). Draft recovery plans have been developed for four other species (table 4.6-11).

The federally listed and candidate species have different distributions (several because of specific habitat requirements) within the UGP Region. Which species may be affected by any particular wind energy project will depend on the specific location of the project and its supporting infrastructure (i.e., access roads, power lines) relative to the habitats of the species, as well as project size and design characteristics (e.g., number of turbines). Additional information on all of the listed species can be found in the Biological Assessment that has been prepared for interagency consultation under Section 7 of the ESA.

Plants. Six species plants that are listed or candidates for listing have been reported to occur in the UGP Region: Mead's milkweed, prairie bush-clover, Ute ladies'-tresses, the eastern and western prairie fringed orchids, and whitebark pine (table 4.6-12). Most of these species have specific and limited habitat requirements in the UGP Region, and these habitats may not have characteristics favorable for wind generation development. The eastern prairie fringed orchid and Mead's milkweed are the least widely distributed of the listed plants, occurring only in the extreme southeastern corner of the UGP Region in Iowa. The former species is reported from only a single county, while the latter occurs in four counties (table 4.6-12; figure 4.6-9). The Ute ladies'-tresses exhibits a similar very limited distribution within the UGP Region, being reported from only five counties in extreme southwestern Montana. Thus, these three species would not be expected to be affected by wind energy development projects that might be located in most other areas of the UGP Region. The prairie bush-clover has been reported only from the eastern portion of the UGP Region, in eight counties in Iowa and eight counties in southwestern Minnesota (table 4.6-12; figure 4.6-10). This species would not be expected to be encountered in parts of the UGP Region outside of these portions of Iowa and Minnesota. The whitebark pine, which is considered a candidate for listing, occurs in 20 counties of Montana within the UGP Region (table 4.6-12).

In contrast to the relatively limited distributions within the UGP Region of the previously discussed species, the western prairie fringed orchid has been reported from 75 counties in 5 States (figure 4.6-10). Most of these counties (47) are located in Nebraska, while the others are in Iowa (11 counties), Minnesota (10 counties), and North Dakota (2 counties). Thus, these areas represent those portions of the UGP Region where development could affect the western prairie fringed orchid. This species has not been reported from Montana or South Dakota (table 4.6-12), and thus would not be expected to be affected by wind energy development in these two States.

For all of the listed plant species, potential impacts would be associated most with site clearing for project infrastructure and access road and transmission tower ROWs, which would result in direct injury or loss of individuals, herbicide applications around infrastructure, and introduction of invasive species in areas disturbed during construction.

TABLE 4.6-12 Known Occurrence of Federally Listed Species and Presence of Federally Designated Critical Habitat in Counties within the UGP Region

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Plants				
Asclepias meadii	Mead's milkweed	T	IA – Adair, Clarke, Decatur, Ringgold	
Lespedeza leptostachya	Prairie bush-clover	T	IA – Buena Vista, Clarke, Clay, Dickinson, Emmet, Kossuth, O'Brien, Osceola MN – Brown, Cottonwood, Jackson, Martin, Nobles, Redwood, Renville, Rock	
Pinus albicaulis	Whitebark pine	C	MT – Broadwater, Carbon, Cascade, Chouteau, Gallatin, Glacier, Jefferson, Judith Basin, Lake, Lewis and Clark, Madison, Meagher, Park, Pondera, Powell, Silver Bow, Stillwater, Sweet Grass, Teton, Wheatland	
Platanthera leucoaea	Eastern prairie fringed orchid	T	IA – Decatur	
Platanthera praeclara	Western prairie fringed orchid	T	IA – Adair, Buena Vista, Cherokee, Clay, Crawford, Guthrie, Kossuth, Mills, Pocahontas, Taylor MN – Clay, Kittson, Lincoln, Nobles, Norman, Pennington, Pipestone, Polk, Red Lake, Rock NE – Antelope, Boone, Boyd, Buffalo, Burt, Butler, Cass, Cedar, Clay, Colfax, Cuming, Dakota, Dixon, Douglas, Dodge, Fillmore, Gage, Garfield, Greeley, Hall, Hamilton, Holt, Howard, Jefferson, Johnson, Knox, Lancaster, Madison, Merrick, Nance, Nemaha, Otoe, Pawnee, Pierce, Platte, Polk, Richardson, Saline, Sarpy, Saunders, Seward, Sherman, Stanton, Thurston, Valley, Washington, Wayne, Wheeler, York ND – Ransom, Richland SD[b] – Possible in: Bennett, Brookings, Clay, Hutchinson, Lake, Lincoln, McCook, Miner, Minnehana, Moody, Roberts, Shannon, Todd, Turner, Union, Yankton	
Spiranthese divuvialis	Ute's ladies tresses	T	MT – Beaverhead, Broadwater, Gallatin, Jefferson, Madison	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Molluscs				
Lampsilis higginsii	Higgins eye (pearlymussel)	E	SD[c] – Yankton	
Leptodea leptodon	Scaleshell mussel	E	NE – Cedar SD[c] – Clay, Union, Yankton	
Arthropods				
Cicindela nevadica lincolniana	Salt Creek tiger beetle	E	NE – Lancaster, Saunders	NE – Lancaster, Saunders
Hesperia dacotae	Dakota skipper	C	IA – Dickinson MN – Big Stone, Chippewa, Clay, Cottonwood, Lac qui Parle, Kittson, Lincoln, Murray, Norman, Pipestone, Polk, Pope, Swift, Traverse, Yellow Medicine ND – Bottineau, Burke, Dunn, Eddy, McHenry, McKenzie, McLean, Mountrail, Oliver, Ransom, Richland, Rolette, Sargent, Stutsman, Ward, Wells SD – Brookings, Brown, Coddington, Day, Devel, Edmunds, Grant, Hamlin, Marshall, McPherson, Moody, Roberts	
Nicrophorus americanus	American burying beetle	E	NE – Antelope, Boone, Boyd, Garfield, Greeley, Holt, Knox, Valley, Wheeler SD[d] – Bennett, Brookings, Gregory, Haakon, Todd, Tripp, Union	
Oarisma poweshiek	Poweshiek skipperling	C	IA – Dickinson, Emmet, Hancock, Kossuth, Osceola MN – Becker, Big Stone, Chipewa, Clay, Cottonwood, Douglas, Kandiyohi, Kittson, Lac qui Parle, Lincoln, Lyon, Mahnomen, McLeod, Murray, Norman, Pipestone, Pope, Stearns, Swift, Traverse, Wilkin, Yellow Medicine ND – Cass, Ransom, Richland, Sargent SD – Brookings, Clark, Codington, Day, Deuel, Grant, Hamlin, Marshall, Roberts	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Fishes				
Notropis Topeka (=tristis)	Topeka shiner	E	IA – Boone, Buena Vista, Calhoun, Carroll, Dallas, Greene, Hamilton, Hancock, Humboldt, Kossuth, Lyon, Osceola, Pocahontas, Sac, Sioux, Webster, Wright MN – Lincoln, Murray, Nobles, Pipestone, Rock NE – Madison SD[e] – Aurora, Beadle, Bon Homme, Brookings, Brown, Clark, Clay, Codington, Davison, Deuel, Douglas, Grant, Hamlin, Hanson, Hutchinson, Jerauld, Kingsbury, Lake, Lincoln, McCook, Miner, Minnehaha, Moody, Sanborn, Spink, Turner, Union, Yankton	IA – Calhoun, Carroll, Dallas, Greene, Hamilton, Lyon, Osceola, Sac, Webster, Wright MN – Lincoln, Murray, Nobles, Pipestone, Rock NE – Madison
Salvelinus confluentus	Bull trout	T	MT – Deer Lodge, Glacier, Lewis and Clark, Silver Bow	MT – Deer Lodge, Glacier, Lewis and Clark
Scaphirhynchus albus	Pallid sturgeon	E	IA – Freemont, Harrison, Mills, Monona, Pottawattamie, Woodbury MT – Blaine, Chouteau, Custer, Dawson, Fergus, Garfield, McCone, Petroleum, Phillips, Prairie, Richland, Roosevelt, Rosebud, Valley, Wibaux NE – Boyd, Burt, Butler, Cass, Cedar, Colfax, Dakota, Dixon, Dodge, Douglas, Knox, Nemaha, Otoe, Platte, Richardson, Sarpy, Saunders, Thurston, Washington ND – Burleigh, Dunn, Emmons, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Sioux, Williams SD – Bon Homme, Brule, Buffalo, Campbell, Charles Mix, Clay, Corson, Dewey, Gregory, Hughes, Hyde, Lincoln, Lyman, Potter, Stanley, Sully, Union, Walworth, Yankton	
Thymallus arcticus	Arctic Grayling	C	MT – Beaverhead, Deer Lodge, Madison, Silver Bow	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Reptiles				
Sistrurus catenatus catenatus	Massasauga rattlesnake	C	IA – Mills, Pottawattamie	
Birds				
Anthus spragueii	Sprague's pipit	C	SD – Butte, Campbell, Corson, Custer, Dewey, Fall River, Haakon, Harding, Jackson, Jones, Lawrence, Lyman, McPherson, Meade, Pennington, Perkins, Shannon, Stanley, Ziebach MT – Big Horn, Blaine, Broadwater, Carbon, Carter, Cascade, Chouteau, Custer, Daniels, Dawson, Fallon, Fergus, Gallatin, Garfield, Glacier, Golden Valley, Hill, Jefferson, Judith Basin, Lewis and Clark, Liberty, Madison, McCone, Meagher, Musselshell, Park, Petroleum, Phillips, Pondera, Powder River, Prairie, Richland, Roosevelt, Rosebud, Sheridan, Stillwater, Sweet Grass, Teton, Toole, Treasure, Valley, Wheatland, Wibaux, Yellowstone ND – Adams, Barnes, Benson, Billings, Bottineau, Bowman, Burke, Burleigh, Cavalier, Dickey, Divide, Dunn, Eddy, Emmons, Foster, Golden Valley, Grant, Hettinger, Kidder, Lamoure, Logan, McHenry, McIntosh, Mckenzie, McLean Mercer, Morton, Mountrail, Oliver, Pembina, Pierce, Ramsey, Ransom, Renville, Rolette, Sargent, Sheridan, Sioux, Slope, Stark, Stutsman, Towner, Walsh, Ward, Wells, Williams MN – Clay, Polk	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Birds (Cont.)				
Centrocercus urophasianus	Greater sage-grouse	C	SD – Butte, Fall River, Harding MT – Beaverhead, Big Horn, Blaine, Carbon, Carter, Chouteau, Custer, Dawson, Fallon, Fergus, Gallatin, Garfield, Golden Valley, Hill, Liberty, Madison, McCone, Meagher, Musselshell, Park, Petroleum, Phillips, Powder River, Prairie, Richland, Rosebud, Silver Bow, Stillwater, Sweet Grass, Treasure, Valley, Wheatland, Wibaux, Yellowstone ND – Bowman, Golden Valley, Slope	
Charadrius melodus	Piping plover, except Great Lakes watershed	T	IA – Pottawattamie, Woodbury MT – Garfield, McCone, Phillips, Pondera, Richland, Roosevelt, Sheridan, Valley NE – Boyd, Buffalo, Butler, Cass, Cedar, Colfax, Cuming, Dixon, Dodge, Douglas, Hall, Hamilton, Holt, Howard, Kearney, Knox, Madison, Merrick, Nance, Platte, Polk, Sarpy, Saunders, Sherman, Stanton, Valley ND – Benson, Burke, Burleigh, Divide, Dunn, Eddy, Emmons, Foster, Kidder, Logan, McHenry, McIntosh, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Pierce, Renville, Sheridan, Sioux, Stutsman, Ward, Wells, Williams SD – Bon Homme, Brule, Buffalo, Campbell, Charles Mix, Clay, Corson, Day, Dewey, Gregory, Haakon, Hughes, Hyde, Kingsbury, Lyman, Potter, Stanley, Sully, Union, Walworth, Yankton, Ziebach	MT – Garfield, McCone, Phillips, Richland, Roosevelt, Sheridan, Valley NE – Boyd, Buffalo, Butler, Cass, Colfax, Dodge, Douglas, Hall, Hamilton, Holt, Howard, Kearney, Knox, Merrick, Nance, Platte, Polk, Sarpy, Saunders ND – Benson, Burke, Burleigh, Divide, Dunn, Eddy, Emmons, Kidder, Logan, McHenry, McIntosh, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Renville, Sheridan, Sioux, Stutsman, Ward, Williams SD – Bon Homme, Campbell, Charles Mix, Clay, Corson, Dewey, Gregory, Hughes, Potter, Stanley, Sully, Walworth, Yankton

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Birds (Cont.)				
Grus americana	Whooping crane	E	MT – Custer, Daniels, Dawson, Fallon, McCone, Phillips, Prairie, Richland, Roosevelt, Sheridan, Valley, Wibaux, Yellowstone NE – Adams, Antelope, Boone, Boyd, Buffalo, Butler, Clay, Fillmore, Franklin, Garfield, Greeley, Hall, Hamilton, Holt, Howard, Jefferson, Johnson, Kearney, Knox, Madison, Merrick, Nance, Nuckolls, Platte, Polk, Saline, Seward, Sherman, Thayer, Valley, Webster, Wheeler, York ND – Adams, Barnes, Benson, Billings, Bottineau, Bowman, Burke, Burleigh, Cass, Cavalier, Dickey, Divide, Dunn, Eddy, Emmons, Foster, Golden Valley, Grand Forks, Grant, Griggs, Hettinger, Kidder, LaMoure, Logan, McHenry, McIntosh, McKenzie, McLean, Mercer, Morton, Mountrail, Nelson, Oliver, Pembia, Pierce, Ramsey, Ransom, Renville, Richland, Rolette, Sargent, Sheridan, Sioux, Slope, Stark, Steele, Stutsman, Towner, Traill, Walsh, Ward, Wells, Williams SD – Aurora, Beadle, Bennett, Bon Homme, Brown, Brule, Buffalo, Butte, Campbell, Charles Mix, Clark, Codington, Corson, Custer, Davidson, Day, Dewey, Douglas, Edmunds, Faulk, Gregory, Haakon, Hamlin, Hand, Hanson, Harding, Hughes, Hutchinson, Hyde, Jackson, Jerauld, Jones, Kingsbury, Lawrence, Lyman, McCook, Marshall, McPhearson, Meade, Mellette, Miner, Pennington, Perkins, Potter, Sanborn, Shannon, Spink, Stanley, Sully, Todd, Tripp, Turner, Walworth, Ziebach	NE – Buffalo, Kearny
Numenius borealis	Eskimo curlew	E	May be extinct	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Birds (Cont.)				
Sterna antillarum	Least tern	E	IA – Woodbury, Pottawattamie MT – Custer, Dawson, Garfield, McCone, Prairie, Richland, Roosevelt, Rosebud, Valley, Wibaux NE – Boyd, Buffalo, Butler, Cass, Cedar, Colfax, Cuming, Dixon, Dodge, Douglas, Hall, Hamilton, Holt, Howard, Kearney, Knox, Madison, Merrick, Nance, Platte, Polk, Sarpy, Saunders, Sherman, Stanton, Valley ND – Burleigh, Dunn, Emmons, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Sioux, Williams SD – Bon Homme, Brule, Buffalo, Campbell, Charles Mix, Clay, Corson, Dewey, Gregory, Haakon, Hughes, Hyde, Lyman, Meade, Pennington, Potter, Stanley, Sully, Union, Walworth, Yankton, Ziebach	
Mammals				
Gulo gulo luscus	North American Wolverine	C	MT – Beaverhead, Broadwater, Carbon, Cascade, Deer Lodge, Gallatin, Glacier, Golden Valley, Granite, Jefferson, Judith Basin, Lewis and Clark, Madison, Meagher, Park, Pondera, Silver Bow, Stillwater, Sweet Grass, Teton, Wheatland	
Myotis sodalist	Indiana bat	E	IA – Adair, Adams, Audubon, Boone, Carroll, Cass, Clarke, Dallas, Decatur, Greene, Guthrie, Madison, Page, Ringgold, Taylor, Union	

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Mammals (Cont.)				
Canis lupis	Gray wolf, Lower 48 States	E	ND – Adams, Barnes, Benson, Billings, Bottineau, Bowman, Burke, Burleigh, Cass, Cavalier, Dickey, Divide, Dunn, Eddy, Emmons, Foster, Golden Valley, Grand Forks, Grant, Griggs, Hettinger, Kidder, LaMoure, Loga, McHenry, McIntosh, McKenzie, McLean, Mercer, Morton, Mountrail, Nelson, Oliver, Pembina, Pierce, Ramsey, Ransom, Renville, Richland, Rolette, Sargent, Sheridan, Sioux, Slope, Stark, Steele, Stutsman, Towner, Traill, Walsh, Ward, Wells, Williams NE – Adams, Antelope, Boone, Boyd, Buffalo, Burt, Butler, Cass, Cedar, Clay, Colfax, Cuming, Dakota, Dixon, Dodge, Fillmore, Franklin, Gage, Garfield, Greeley, Hall, Hamilton, Holt, Howard, Jefferson, Kearney, Johnson, Knox, Lancaster, Madison, Merrick, Nance, Nemaha, Nuckolls, Otoe, Pawnee, Pierce, Platte, Polk, Richardson, Saline, Sarpy, Saunders, Seward, Sherman, Stanton, Thayer, Thurston, Valley, Washington, Wayne, Webster, Wheeler, York SD – Bennett, Custer, Dewey, Fall River, Gregory, Haakon, Harding, Jackson, Jones, Lawrence, Lyman, Meade, Mellette, Pennington, Perkins, Shannon, Stanley, Todd, Tripp, Ziebach	
Lynx canadensis	Canada lynx	T	MN – Cass, Clearwater, Marshall MT – Carbon, Gallatin, Glacier, Jefferson, Lewis and Clark, Madison, Park, Pondera, Stillwater, Sweet Grass, Teton	MT – Carbon, Gallatin, Glacier, Lewis and Clark, Park, Pondera, Stillwater, Sweet Grass, Teton

TABLE 4.6-12 (Cont.)

Scientific Name	Common Name	Listing Status[a]	Counties within the UGP Region from Which the Species Have Been Reported	Counties within the UGP Region in Which Critical Habitat for the Species Is Located
Mammals (Cont.)				
Mustela nigripes	Black-footed ferret	E	MT – Big Horn, Blaine, Carbon, Carter, Chouteau, Custer, Fergus, Garfield, Golden Valley, Hill, Jefferson, Lewis and Clark, Liberty, McCone, Musselshell, Petroleum, Phillips, Powder River, Prairie, Rosebud, Stillwater, Sweet Grass, Toole, Wheatland, Valley, Yellowstone NE[f] – Adams, Antelope, Boone, Boyd, Buffalo, Butler, Clay, Colfax, Fillmore, Franklin, Garfield, Greeley, Hall, Hamilton, Holt, Howard, Jefferson, Kearney, Knox, Madison, Merrick, Nance, Nuckolls, Pierce, Platte, Polk, Saline, Seward, Sherman, Thayer, Valley, Webster, Wheeler, York ND[f] – Adams, Billings, Bowman, Dunn, Golden Valley, Grant, Hettinger, McKenzie, Mercer, Morton, Oliver, Slope, Sioux, Stark SD – Corson, Custer, Dewey, Gregory, Jackson, Lyman, Mellette, Pennington, Shannon, Todd, Tripp, Ziebach	
Ursus arctos horribilis	Grizzly bear	T	MT – Beaverhead, Carbon, Gallatin, Glacier, Lewis and Clark, Madison, Park, Pondera, Stillwater, Sweetgrass, Teton	

[a] C = Candidate, E = listed as endangered, T = listed as threatened.

[b] Currently there are no known populations of this species in South Dakota. Status surveys have been completed for the orchid in South Dakota. However, because of the ecology of this species, there is a possibility that plants may be overlooked (Service 2011a).

[c] One or more shells of these species have been found, but no populations have been located (Service 2011a).

[d] The American burying beetle is presently known to occur in Bennett, Gregory, Tripp, and Todd Counties. A comprehensive status survey has never been completed for this beetle in South Dakota. Until status surveys have been completed, the beetle could and may occur in any county with suitable habitat. Suitable habitat is considered to be any site with significant humus or topsoil appropriate for burying carrion (Service 2011a). Historic records for this species also included Brookings, Haakon, and Union Counties.

Footnotes continued on next page.

TABLE 4.6-12 (Cont.)

[e] Although the Topeka shiner has not been formally documented within Clark, Douglas, Grant, Jerauld, Kingsbury, Lake, Spink, or Yankton Counties, the species may still occur in these areas because the counties contain portions of known Topeka shiner-inhabited rivers and/or tributary streams (Service 2011a).

[f] No populations (introduced or wild) are known to occur in NE or ND. These counties have been identified by the Service field offices in each State as having black-footed ferret (Service 2010b,c).

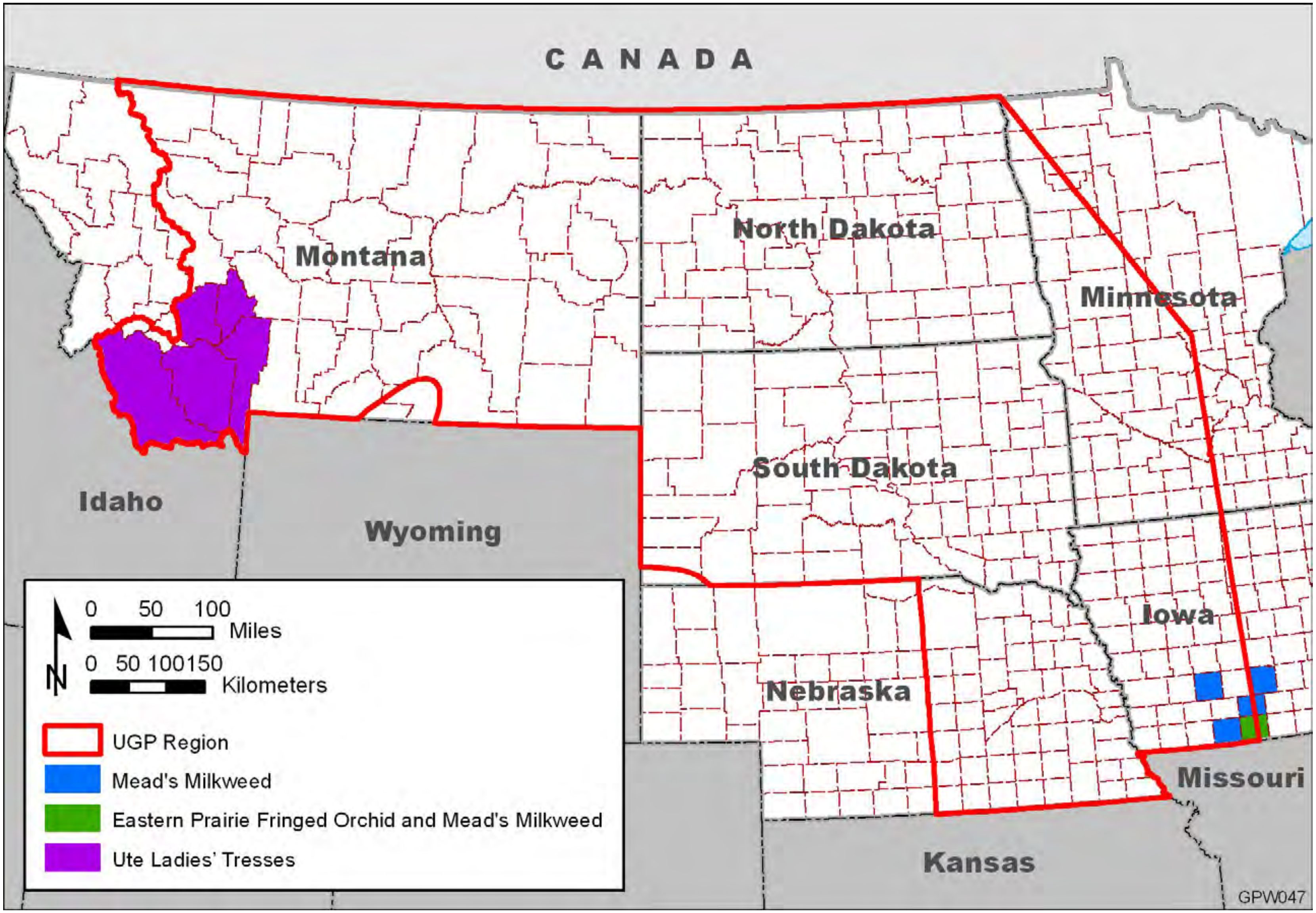


FIGURE 4.6-9 Reported County Distributions of Mead's Milkweed, Ute Ladies'-Tresses, and the Eastern Prairie Fringed Orchid in the UGP Region (Sources: Service 2010b,c, 2011a–d)

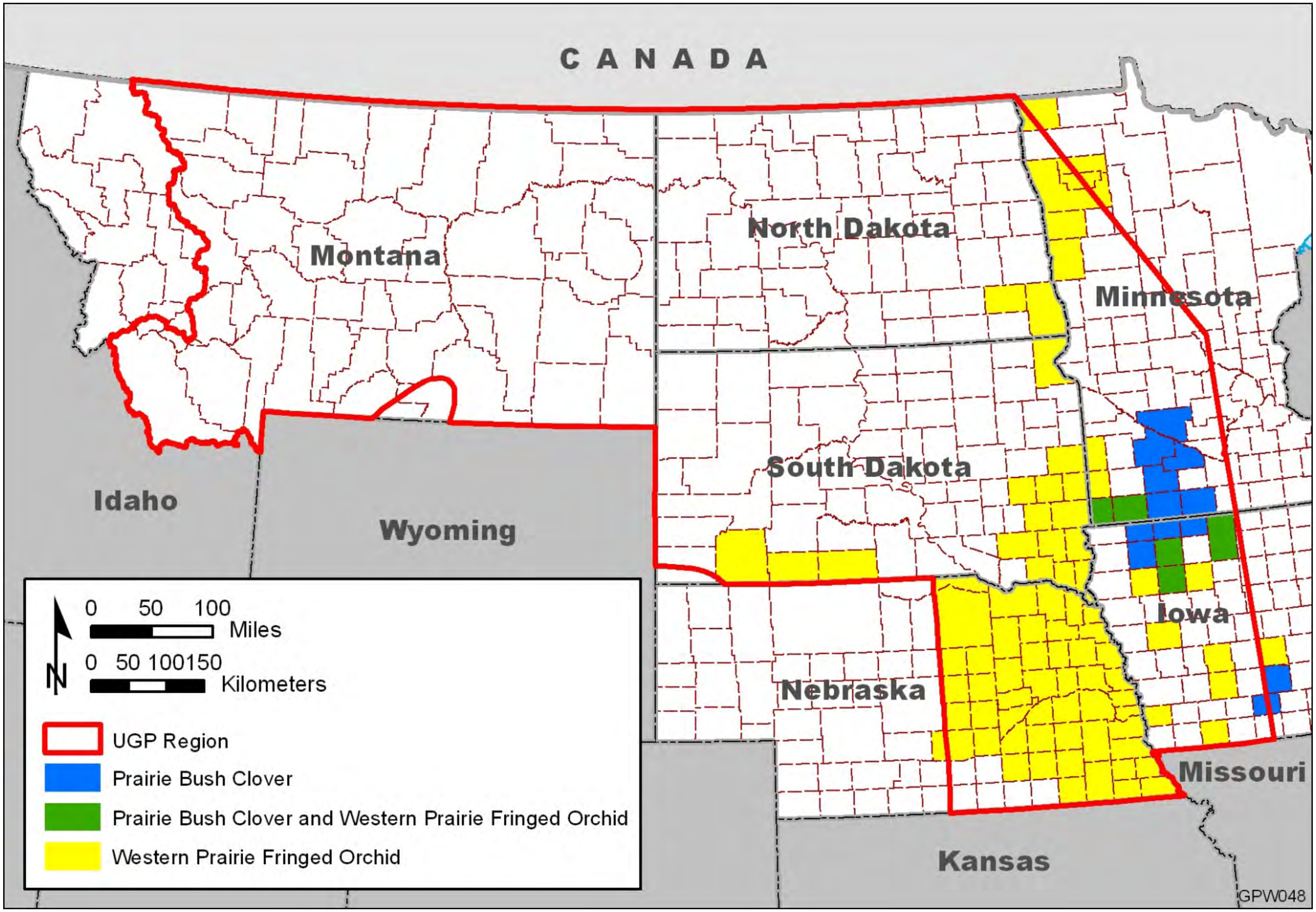


FIGURE 4.6-10 Reported County Distributions of the Prairie Bush Clover and the Western Prairie Fringed Orchid in the UGP Region (Sources: Service 2010b,c, 2011a–d)

Molluscs. Two listed or candidate mollusc species have been reported from the UGP Region — the Higgins eye (pearlymussel) and the scaleshell mussel (table 4.6-12). The sheepnose mussel, which is currently proposed for listing as an endangered species, historically occurred within the UGP Region in Iowa (figure 4.6-11). However, this species is no longer considered to occur in any counties in the UGP Region (Service 2011a).

There currently are no known populations of the endangered Higgins eye (pearlymussel) in the UGP Region (Service 2011b). However, shells of this species have been reported from one county in extreme southeastern South Dakota (figure 4.6-11). The endangered scaleshell mussel has been reported from two States in the UGP Region: shells have been reported from three counties along the Missouri River in southeastern South Dakota and two counties along the same stretch of the Missouri River in northeastern Nebraska.

Because wind energy infrastructure (i.e., turbines and support buildings) would not be located within surface water bodies, the direct placement of such facilities would not be expected to affect any of these molluscs. However, these species may be affected if associated project infrastructure, such as access roads, are located in or near surface water bodies and project activities affect water quality (e.g., from erosion and runoff, accidental spills, or herbicide applications) or quantity (e.g., from reductions in surface water or groundwater flow and discharge due to site grading and stream crossings).

Arthropods. Three species of arthropods that are listed or are candidates for listing under ESA occur within the UGP Region: the endangered American burying beetle and Salt Creek tiger beetle and the candidate Dakota skipper (table 4.6-12).

Within the region, the endangered American burying beetle is reported from nine counties in eastern and central Nebraska and from four counties in eastern and south-central South Dakota (figure 4.6-12). It inhabits forests, grasslands, and shrublands. The Salt Creek tiger beetle has been reported in the UGP Region from only two counties in southeastern Nebraska (figure 4.6-12). This species inhabits saline wetlands in open grassland environments. Critical habitat for the Salt Creek tiger beetle occurs in portions of the Little Salt Creek and Rock Creek in Lancaster and Saunder Counties, Nebraska (Service 2010a). The Dakota skipper and Poweshiek skipperling are both candidates for listing under the ESA that inhabit tallgrass and mixed grass prairie communities in the Great Plains. The Dakota skipper is reported from a number of counties throughout North Dakota and South Dakota, several counties in western Minnesota, and a single county in northwestern Iowa (figure 4.6-13). The Dakota skipper is not expected to occur in Montana. The Poweshiek skipperling is reported from a number of counties in Iowa, Minnesota, North Dakota, and South Dakota. The Poweshiek skipperling is not expected to occur in Montana or Nebraska within the UGP Region.

Fish. Four species of fish listed as candidate, threatened, or endangered are reported from the UGP Region: the endangered pallid sturgeon and Topeka shiner, the threatened bull trout, and the Arctic grayling (candidate for federal listing) (table 4.6-12). Designated critical habitat for the Topeka shiner and the bull trout also occurs within the UGP Region. The pallid sturgeon, a large river fish, has been reported from the Missouri River and portions of its major watersheds (e.g., the lower Yellowstone River) in each of the UGP Region States except Minnesota (figure 4.6-14). Within the UGP Region, this species could be affected by wind energy development only along those river corridors.

FIGURE 4.6-11 Reported or Suspected County Distributions of the Higgins Eye (Pearlymussel), Scaleshell Mussel, and Sheepnose in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

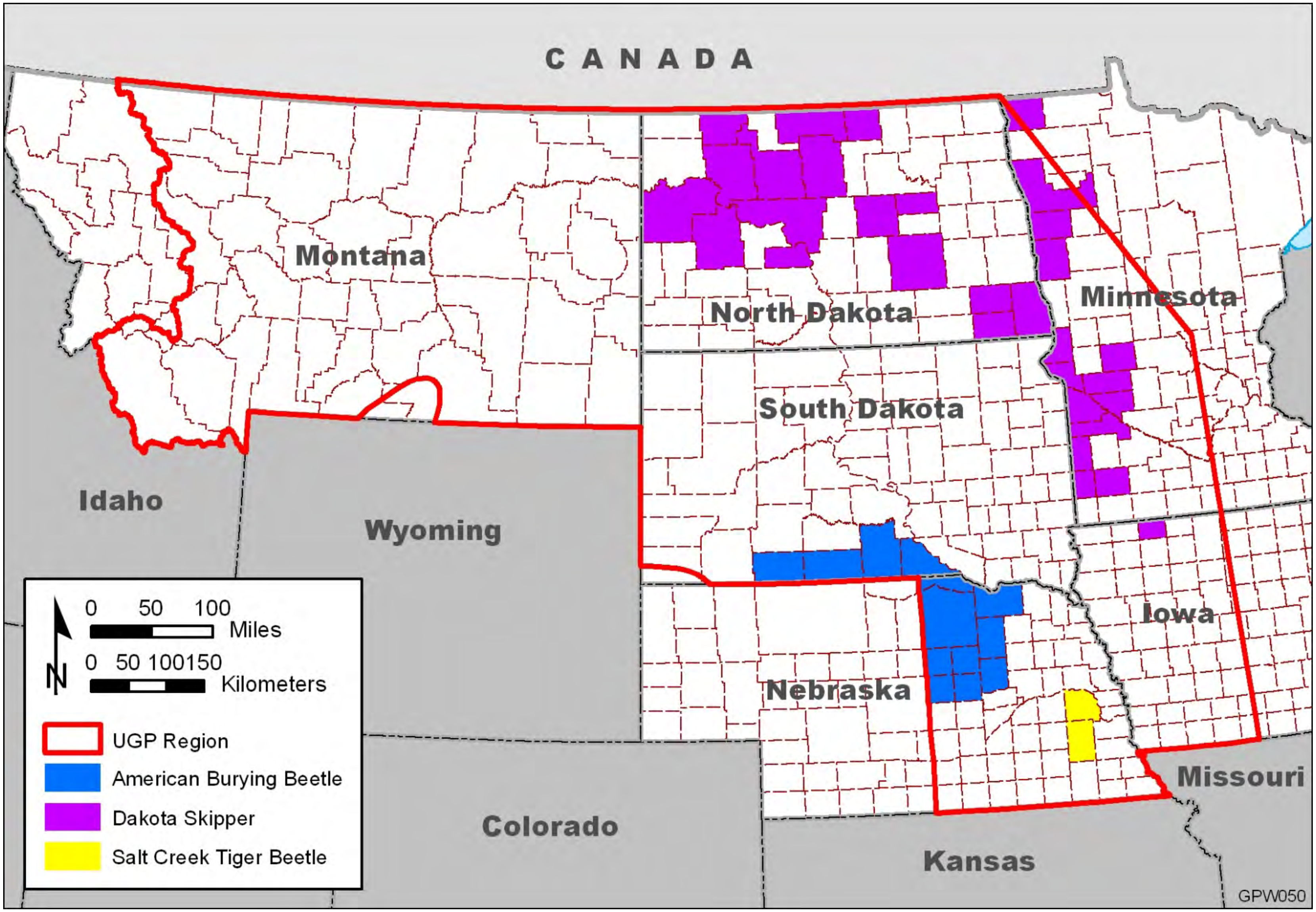


FIGURE 4.6-12 Reported County Distributions of the American Burying Beetle and Salt Creek Tiger Beetle in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

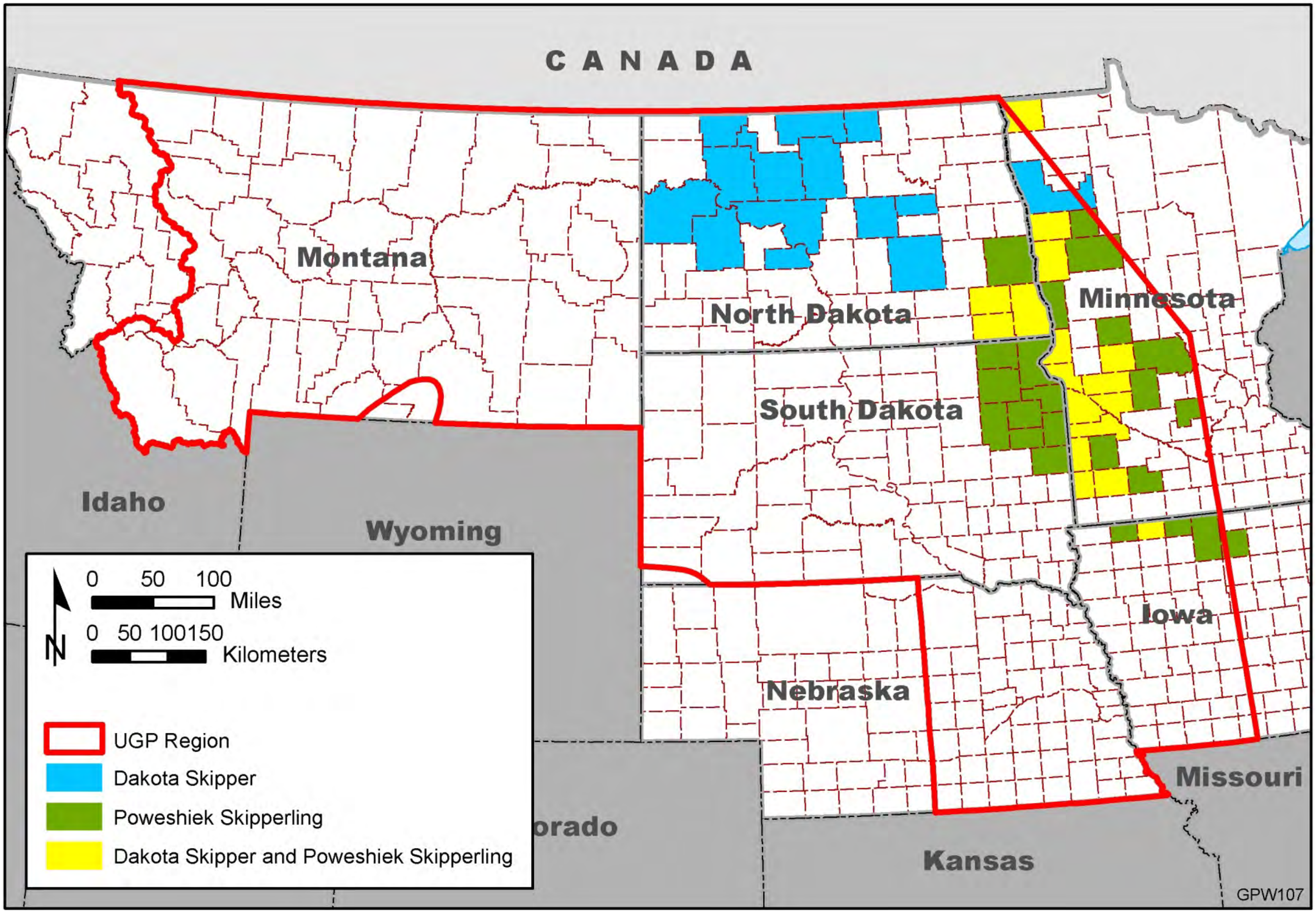


FIGURE 4.6-13 Reported County Distributions for the Dakota Skipper and Poweshiek Skipperling in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

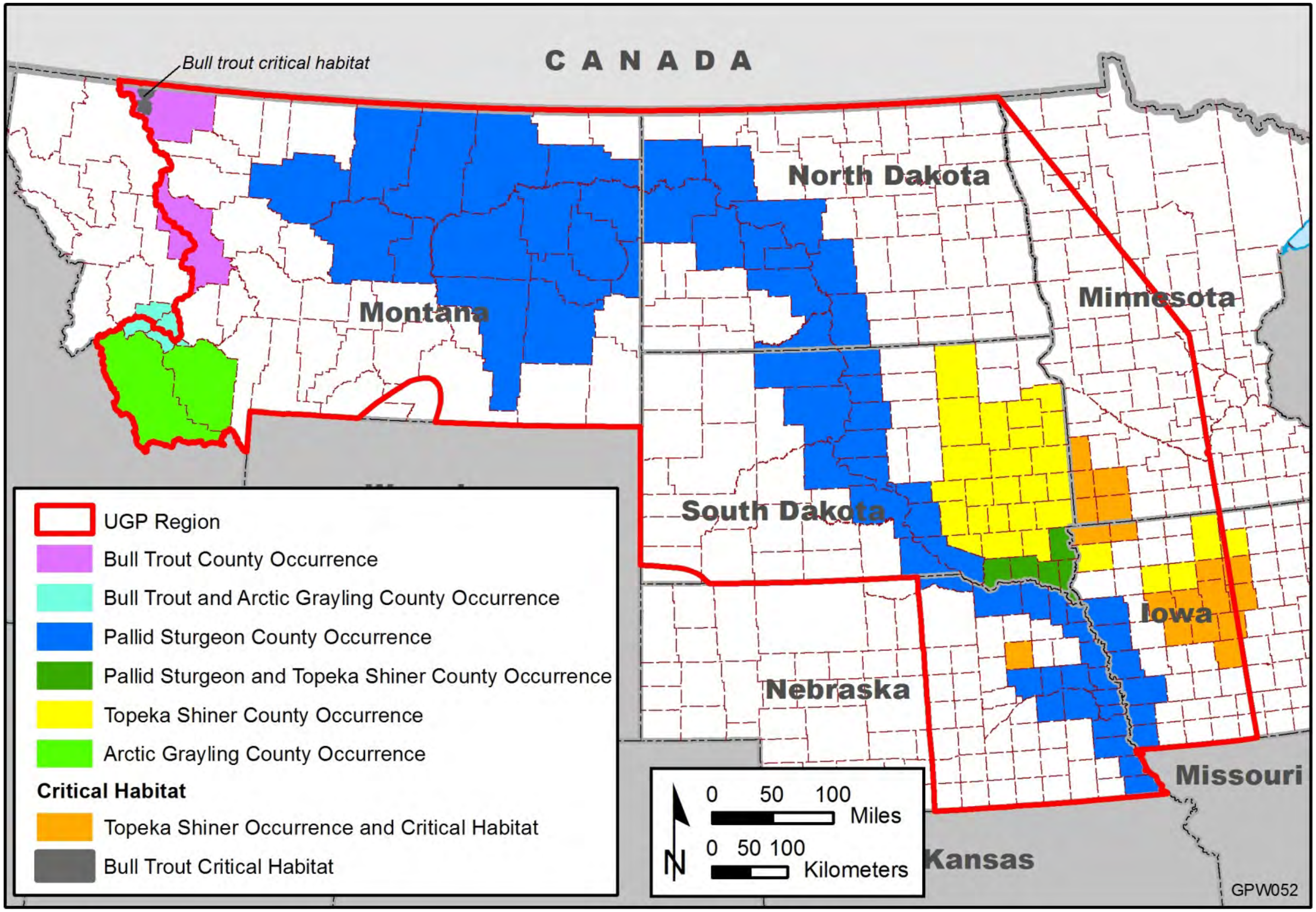


FIGURE 4.6-14 Reported County Distributions and Areas of Designated Critical Habitat of the Arctic Grayling, the Bull Trout, the Pallid Sturgeon, and the Topeka Shiner in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

The Topeka shiner is associated with tributaries of the Mississippi River, and has been reported within the UGP Region from a single county in eastern Nebraska, 13 counties within north-central Iowa, 5 counties in southwestern Minnesota, and 28 counties in eastern and north-central South Dakota (figure 4.6-14). Critical habitat for this species has been designated in southwestern Minnesota. The bull trout has limited distribution within the UGP Region: this species and its designated critical habitat occur in only a handful of counties in western Montana (figure 4.6-14). The Arctic grayling is a cool- to coldwater fish in the same family as trout and salmon. The Missouri River distinct population segment of the grayling now resides solely in the Big Hole River watershed, upstream from Divide, Montana; within the UGP Region, the Arctic grayling may occur in 4 counties in Montana (table 4.6-12; figure 4.6-14). Thus; wind energy development in most of the UGP Region would not be expected to occur near suitable habitat or critical habitat for these two limited range species.

Reptiles. No threatened or endangered reptile species are reported from the UGP Region. A single candidate species, the eastern massasaugua rattlesnake, has been reported in the region, from two counties in Iowa and six counties in Nebraska (figure 4.6-15). Because of its very limited distribution, wind project development in most portions of the region would not be expected to affect this species. Snakes could be injured or killed during clearing and grading activities for turbines, support buildings, electric transmission towers, and access roads.

Birds. Four listed bird species have been reported from the UGP Region: the piping plover, the whooping crane, Eskimo curlew, and interior least tern (table 4.6-12). The piping plover has been reported from Montana, North Dakota, South Dakota, eastern Nebraska, and western Iowa, primarily from counties along the Missouri River and its major tributaries. Critical habitat for this species within the region has been designated in each State except Iowa and Nebraska (figure 4.6-16).

The endangered whooping crane has been reported from each of the UGP Region States except Iowa and Minnesota (table 4.6-11). This species has been reported from throughout North Dakota and most of South Dakota, the eastern half of the portion of Nebraska in the UGP Region, and eastern Montana (figure 4.6-17). This area represents the major north-south flyway for this species, and the reports represent sightings of individuals as they are migrating between summer breeding grounds in Canada and wintering grounds on the Gulf Coast of Texas (Canadian Wildlife Service and Service 2007). The migration corridor for the whooping crane population that passes through the UGP Region follows an approximately straight path; the cranes travel through Alberta, Saskatchewan, extreme eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. The migration route approximately follows the Missouri River corridor through the Midwestern United States. The primary migration corridor can be over 200 mi (320 km) wide as cranes are pushed east or west by winds. The portion of the migration corridor in the UGP Region where most whooping cranes have been observed is shown in figure 4.6-18. Based on an analysis of the observation data, approximately 75 percent of the whooping crane sightings occur in an 80-mi-wide (129-km-wide) area around the centerline for all observations and approximately 95 percent of the sightings occur in a 220-mi-wide (354-km-wide) area around the centerline (figure 4.6-18). Critical habitat for this species is designated in four counties in Nebraska, associated with the Platte River (figure 4.6-17).

FIGURE 4.6-15 Reported County Distribution of the Eastern Massasauga Rattlesnake in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

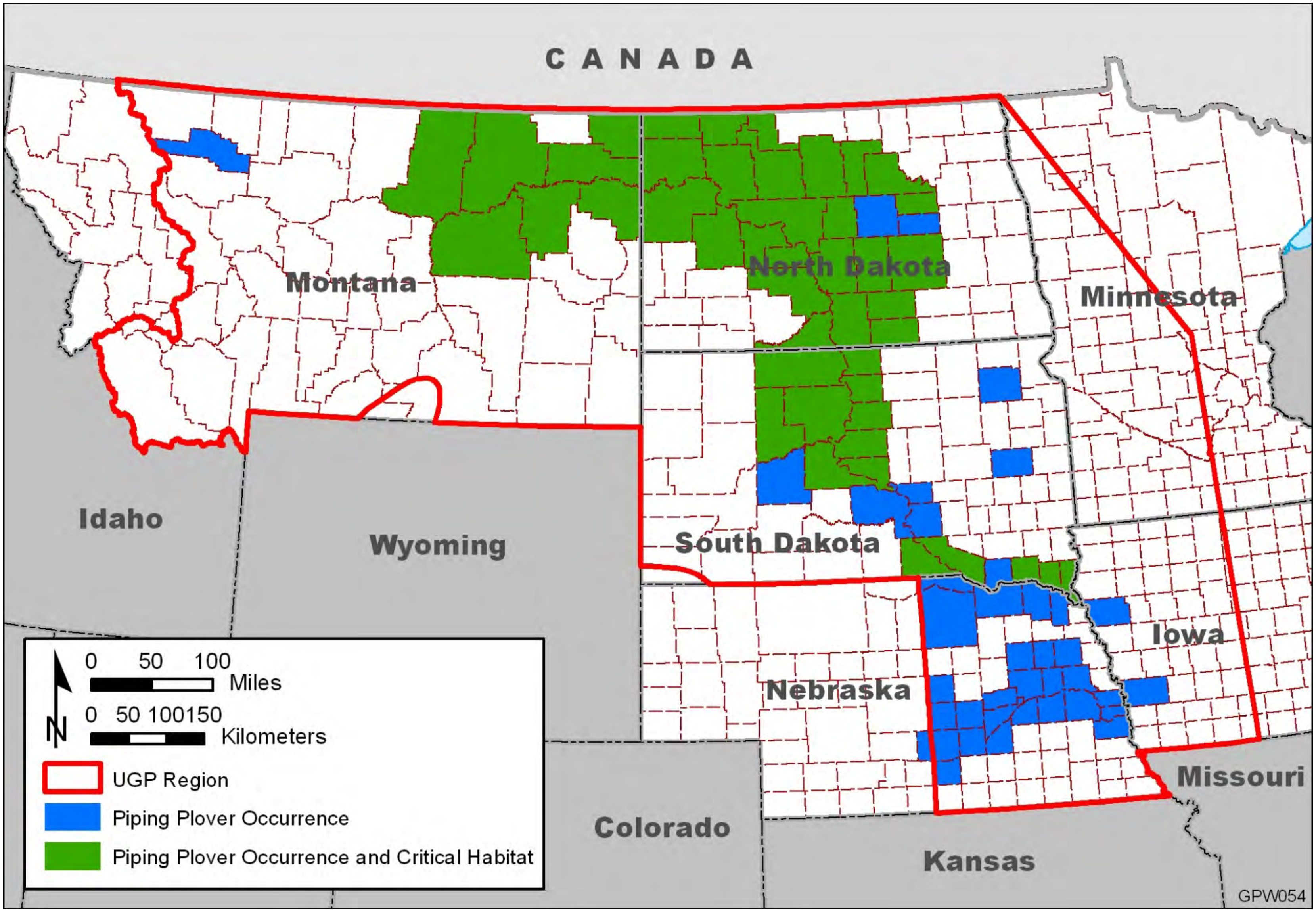


FIGURE 4.6-16 Counties in the UGP Region from Which the Piping Plover Has Been Reported and Where Critical Habitat for the Piping Plover Has Been Designated (Sources: Service 2010b,c, 2011a–c, 2012c)

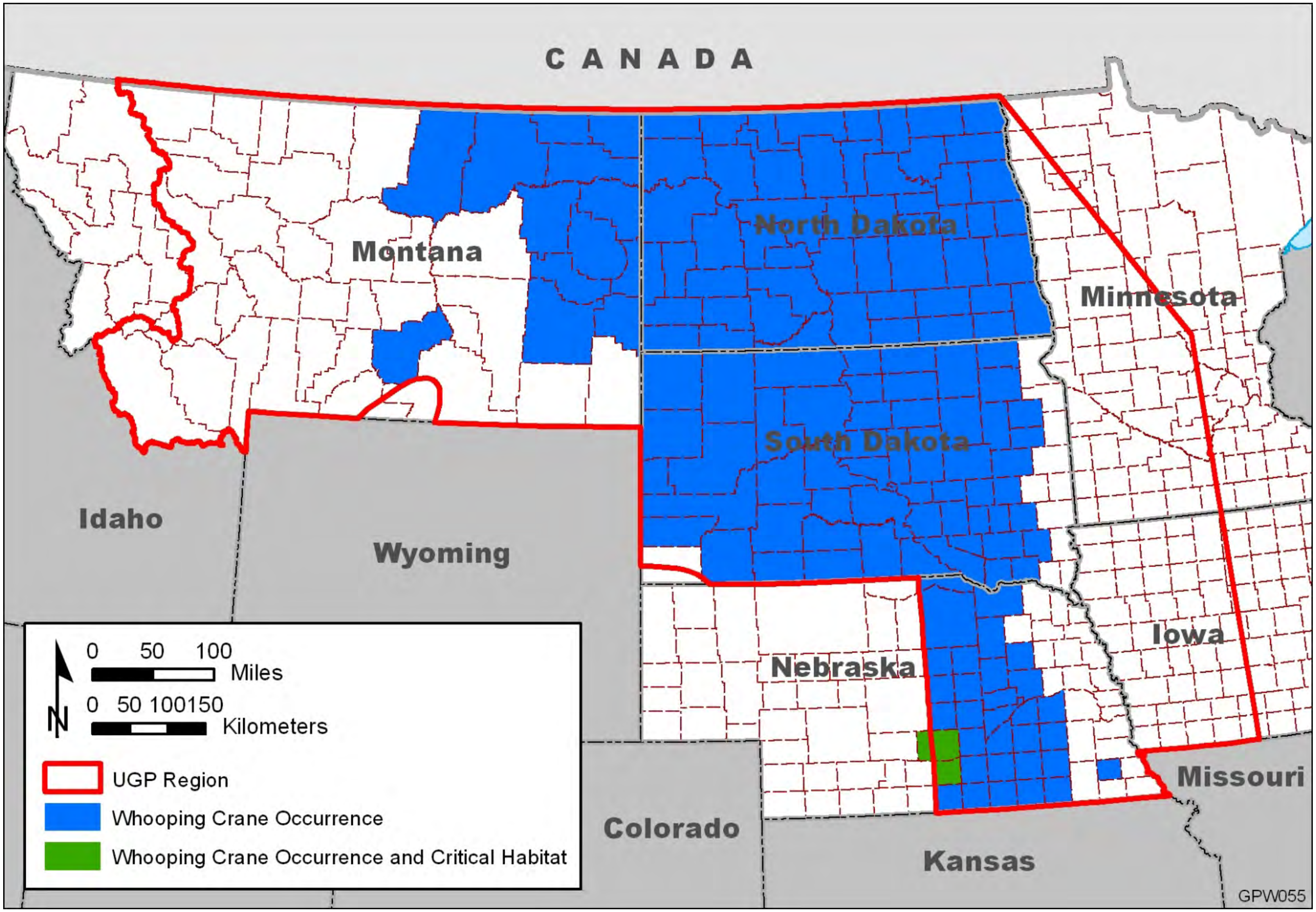


FIGURE 4.6-17 Counties in the UGP Region from Which the Whooping Crane Has Been Reported and Where Critical Habitat for the Whooping Crane Has Been Designated (Sources: Service 2010b,c, 2011a–c, 2012c)

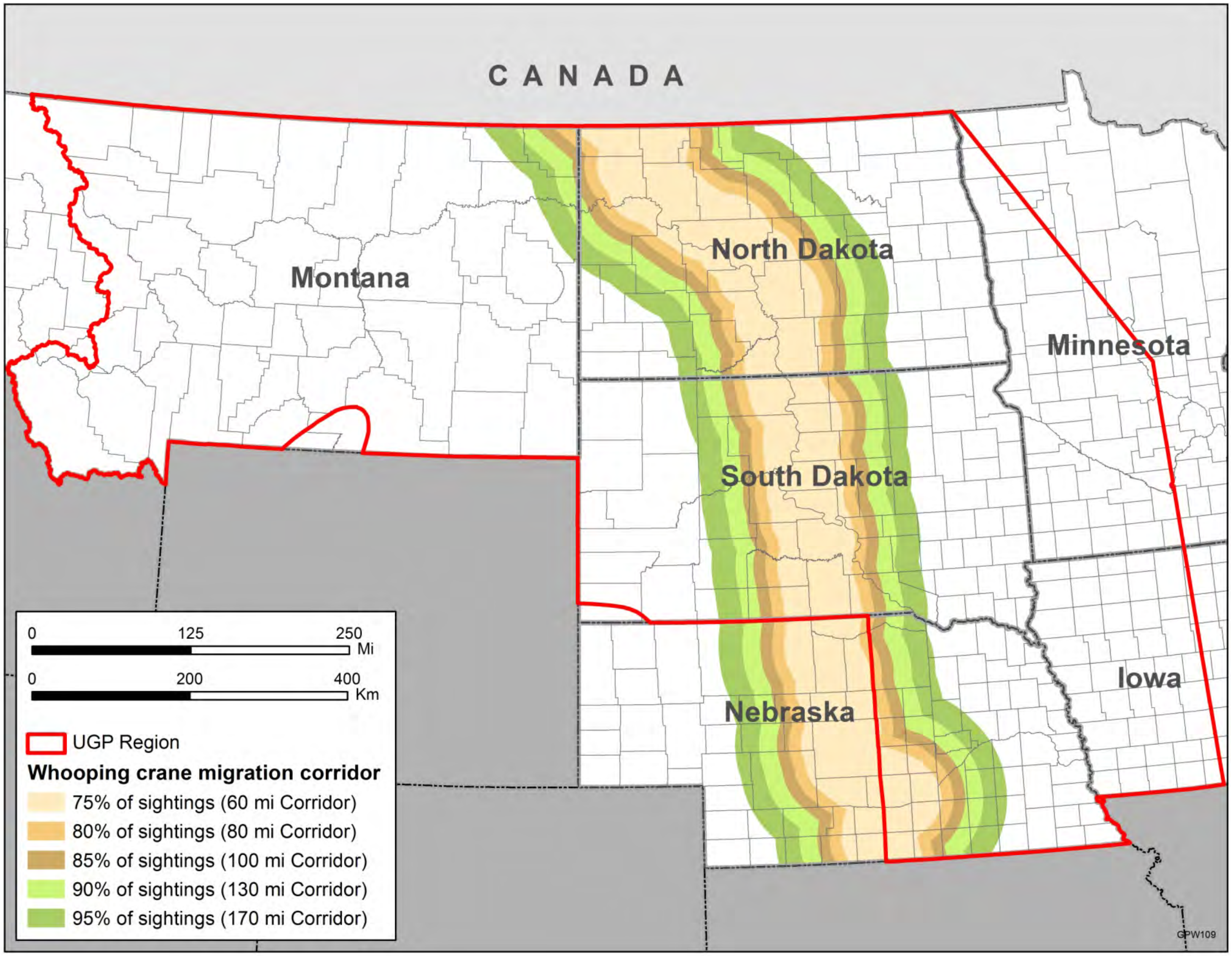


FIGURE 4.6-18 Percent of Whooping Crane Observations in the UGP Region as a Function of Distance from the Migration Corridor Centerline (Sources: Shelley 2011; Service 2009e)

The interior least tern has been reported from numerous counties throughout eastern Montana, western North Dakota, western and southeastern South Dakota, eastern Nebraska, and two counties in western Iowa (figure 4.6-19). These areas coincide primarily with the Missouri River and its major tributaries (such as the Platte and Yellowstone Rivers).

The Eskimo curlew is considered to be extirpated from much of its historic range and may be extinct. Historically, this species nested in the Arctic and wintered in South America, passing through the UGP Region during its spring and fall migrations. The last confirmed sighting of this species was in 1963, although unconfirmed reports continue (Faanes and Senner 1991). The possibility of the Eskimo curlew appearing at a wind energy facility in the UGP Region is highly unlikely.

The greater sage-grouse and Sprague's pipit are both candidates for listing under the ESA. Within the Upper Great Plains study area, the greater sage-grouse occurs within sagebrush-dominated habitats in Montana and the western portions of the Dakotas (figure 4.6-20). Populations of greater sage-grouse can vary from nonmigratory to migratory and can occupy an area that exceeds 1,040 mi^2 (2,694 km^2) on an annual basis. The distance between leks (strutting grounds) and nesting sites can exceed 12.4 mi (20.0 km) (Connelly et al. 2000).

Within the Upper Great Plains study area, the Sprague's pipit occurs in grasslands and prairies of Montana, North Dakota, and South Dakota (figure 4.6-20). The pipit is known to occur in various grassland environments, including exotic vegetation such as crested wheatgrass (*Agropyron cristatum*), but it is significantly more abundant in native prairie grassland (Dechant et al. 2001). They appear to avoid areas with low visibility and low litter cover and have been observed using dry lake bottoms and alkali lake borders (Dechant et al. 2001).

Mammals. Six mammal species listed as candidate, threatened, or endangered have been reported from the UGP Region (table 4.6-12): the gray wolf, the Canada lynx, the black-footed ferret, the Indiana bat, the grizzly bear, and the North American wolverine. Among these, the grizzly bear and the Indiana bat are the least widely distributed across the UGP Region (figure 4.6-21). The grizzly bear has been reported from eleven counties in the far western portion of the UGP Region in Montana, while the Indiana bat has been reported from six counties in the far southeastern corner of the region in Iowa.

The Canada lynx also exhibits a limited distribution within the UGP Region (figure 4.6-22). Within the region, this species has been reported only from northern Minnesota (3 counties) and western Montana (11 counties). Critical habitat for the lynx has also been designated within the UGP Region, specifically within nine counties in western Montana (figure 4.6-22). The North American wolverine is listed as a candidate in high-elevation alpine and boreal forests in areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the warm season; there are 20 counties within the UGP Region where the North American wolverine may occur (table 4.6-21; figure 4.6-22).

The Northern Rocky Mountain (NRM) population of the gray wolf (*Canis lupus*), occurring in the lower 48 States outside of Minnesota and areas where the species is considered experimental or nonessential, was delisted under the ESA in September of 2012. Western Great Lakes (WGL) populations of the gray wolf, occurring within Minnesota, were

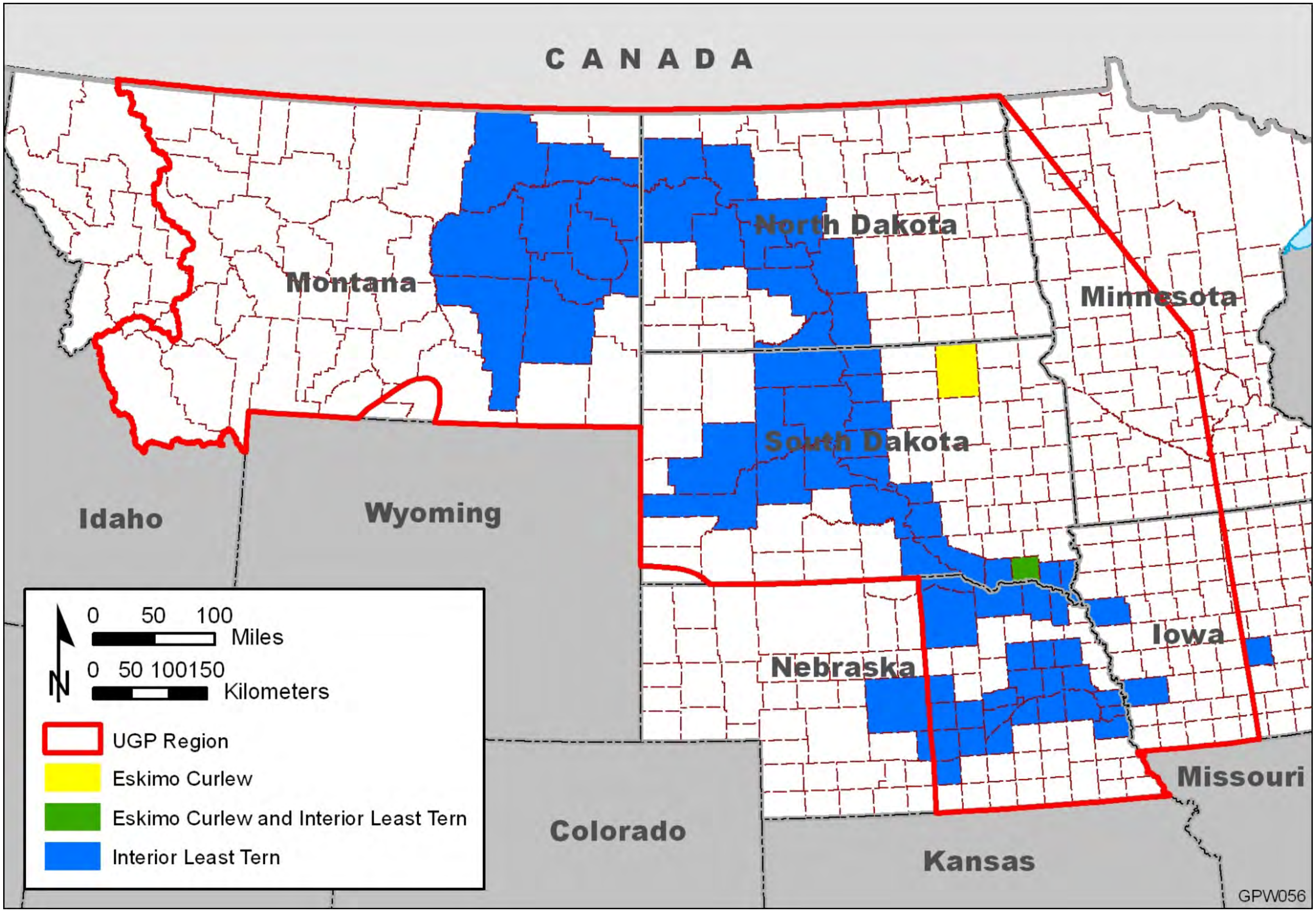


FIGURE 4.6-19 Reported County Distribution of the Interior Least Tern in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

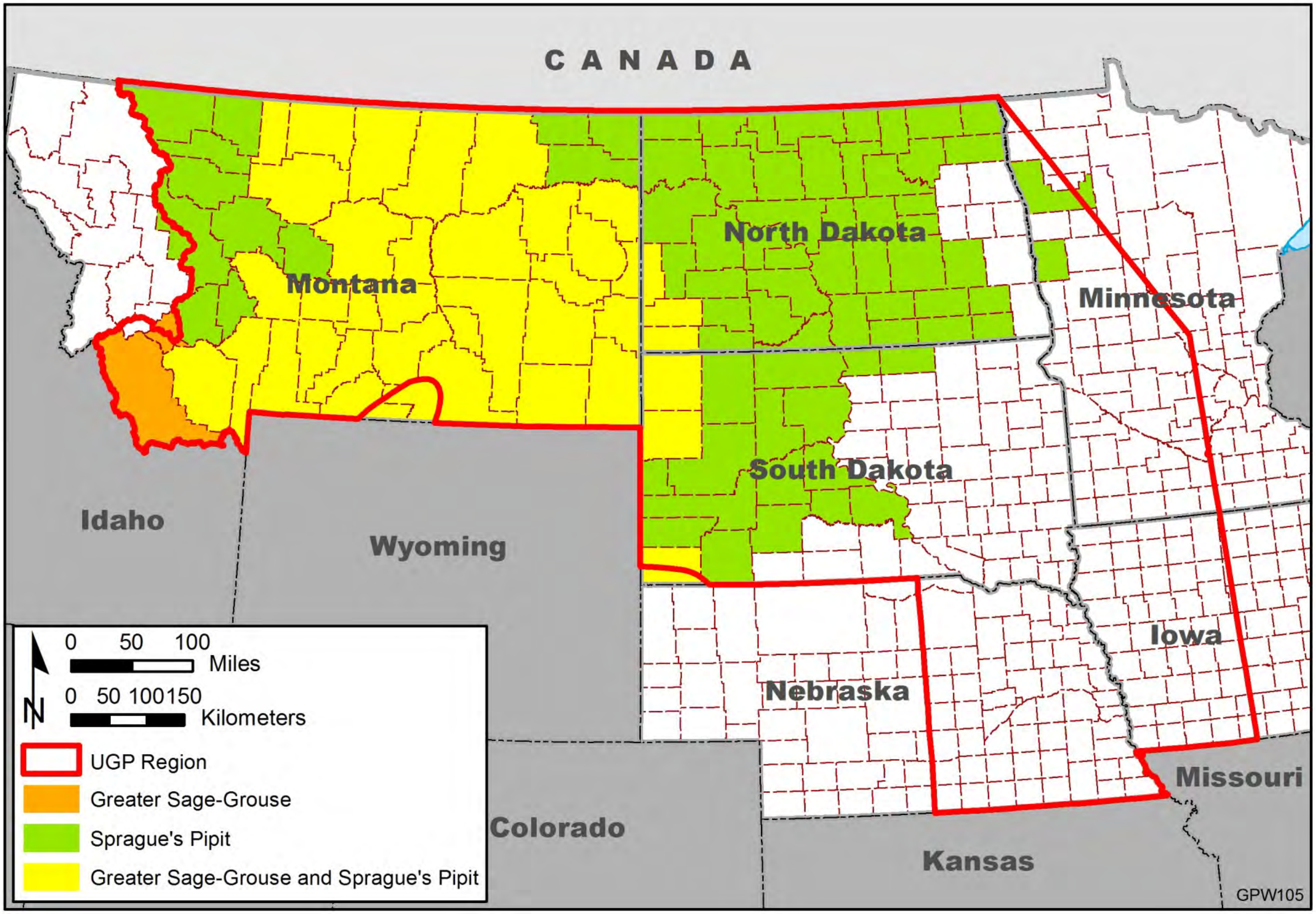


FIGURE 4.6-20 Reported County Distributions of the Greater Sage-Grouse and Sprague's Pipit in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

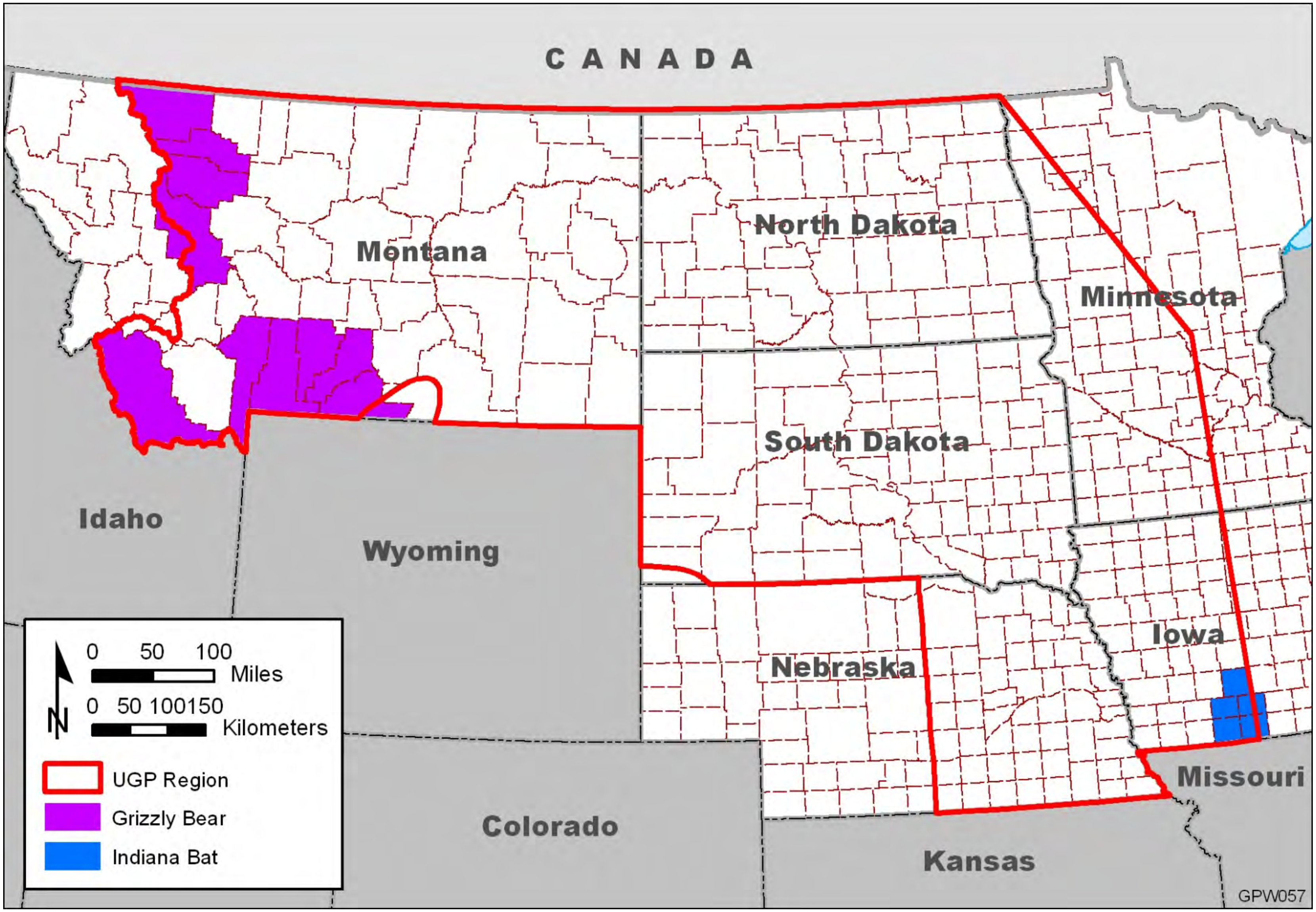


FIGURE 4.6-21 Reported County Distributions of the Grizzly Bear and the Indiana Bat in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

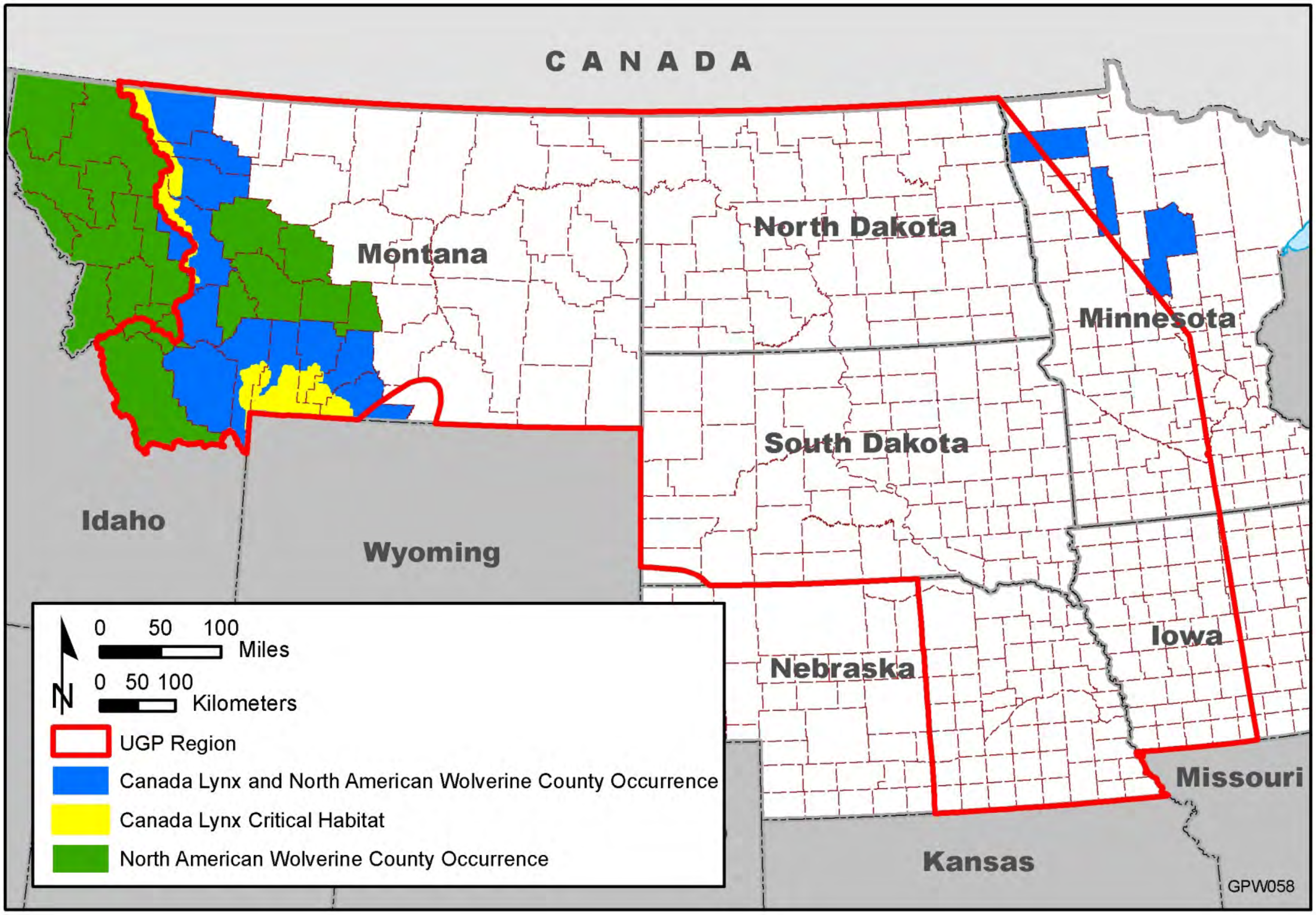


FIGURE 4.6-22 Reported County Distributions for the Canada Lynx and the North American Wolverine and Designated Critical Habitat for the Canada Lynx within the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

delisted under the ESA in December 2011. Within the UGP Region, the gray wolf is still listed as endangered in western North Dakota (south and west of the Missouri River upstream to Lake Sakakawea and west of the centerline of Highway 83 from Lake Sakakawea to the Canadian border), western South Dakota (south and west of the Missouri River), and throughout Nebraska (figure 4.6-23). Gray wolves have very large and highly variable home ranges. Wolves have no particular habitat preference, but they avoid human developments. The wide range of habitats in which wolves can thrive includes temperate forests, mountains, tundra, taiga, and grasslands.

The black-footed ferret has been considered extirpated as recently as 1979 (Service 2008d). In 1981, a population was discovered in Wyoming. Service field offices in Montana and South Dakota (Service 2010b,c) have identified a number of counties as potentially supporting black-footed ferrets (figure 4.6-23). Following a disease outbreak, all surviving wild black-footed ferrets were removed between 1985 and 1987 to establish a captive breeding program; no wild populations of black-footed ferrets have been found since that time. Through the breeding program, 18 specific black-footed ferret reintroductions have been conducted since 1991. Within the UGP Region, reintroduction sites were established in Montana (4 sites) and South Dakota (6 sites) (figure 4.6-24). Two of the four Montana reintroduction sites have been classified as unsuccessful (declining population or extirpated, or no documentation of recent litters). In South Dakota, successful populations have been established at two reintroduction sites, while increasing populations are being reported from two other reintroduction sites in the State. There are no known wild populations in Nebraska or North Dakota; however, recent information indicates that a reintroduced population from South Dakota is spreading across State lines into North Dakota (Shelley 2011).

4.6.4.2 Non-Federal Special Status Species

Each of the six UGP Region States also has species that are of State concern. Four of the six UGP Region States (Iowa, Minnesota, Nebraska, and South Dakota) have statutes that provide protection for specific plants and nongame fish and wildlife (table 4.6-13). Some of the State-listed species are also listed under the ESA. Among these States, Iowa has the greatest number of listed species (239), and South Dakota has the fewest (23). Species designated for protection under State statutes are listed in appendix F, tables F-1 through F-4. Project-specific assessments would consider impacts to these State-listed species prior to project development.

All six States have placed species on some form of watch list. While these species are not afforded protection under State statutes, these species are tracked with regard to their abundance and distribution within each State by such organizations as the State Natural Heritage Programs. In general, these species are considered at risk of becoming threatened or endangered because they are not common within a State, may require unique or highly specific habitats that are declining in abundance or are at risk from anthropogenic activities, or have been found to exhibit downward trends in abundance within a State. Species on the periphery of their range that are not State listed as threatened or endangered may be included in this category, along with those species that were once State listed as threatened or endangered but are no longer listed because of increasing or stable populations. Among the six States, Nebraska has the fewest species of concern (98), while Montana has the most (795) (table 4.6-14). In all of the States, plants comprise the largest group of species of concern.

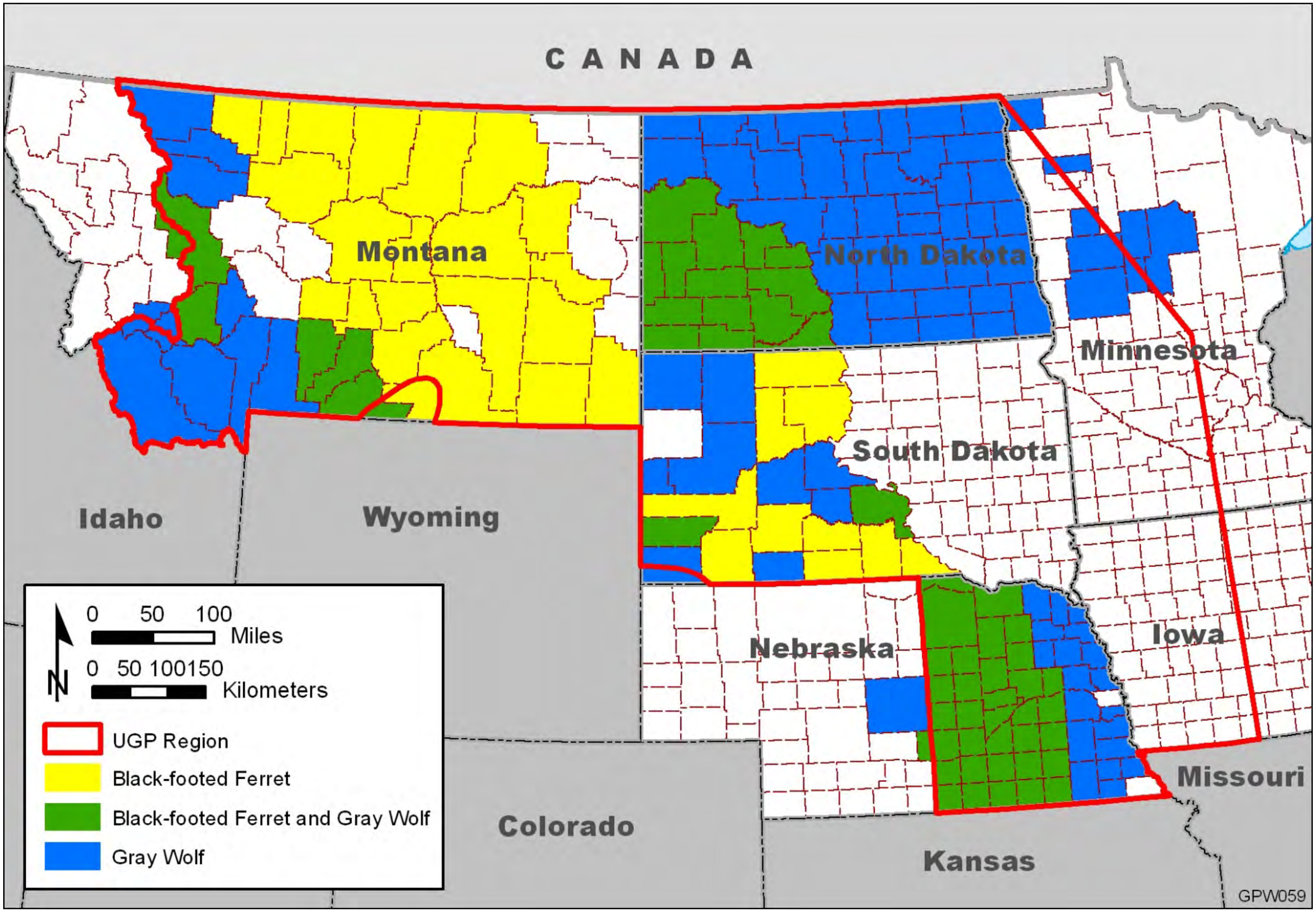


FIGURE 4.6-23 Reported County Distributions of the Black-Footed Ferret and Grey Wolf in the UGP Region (Sources: Service 2010b,c, 2011a–c, 2012c)

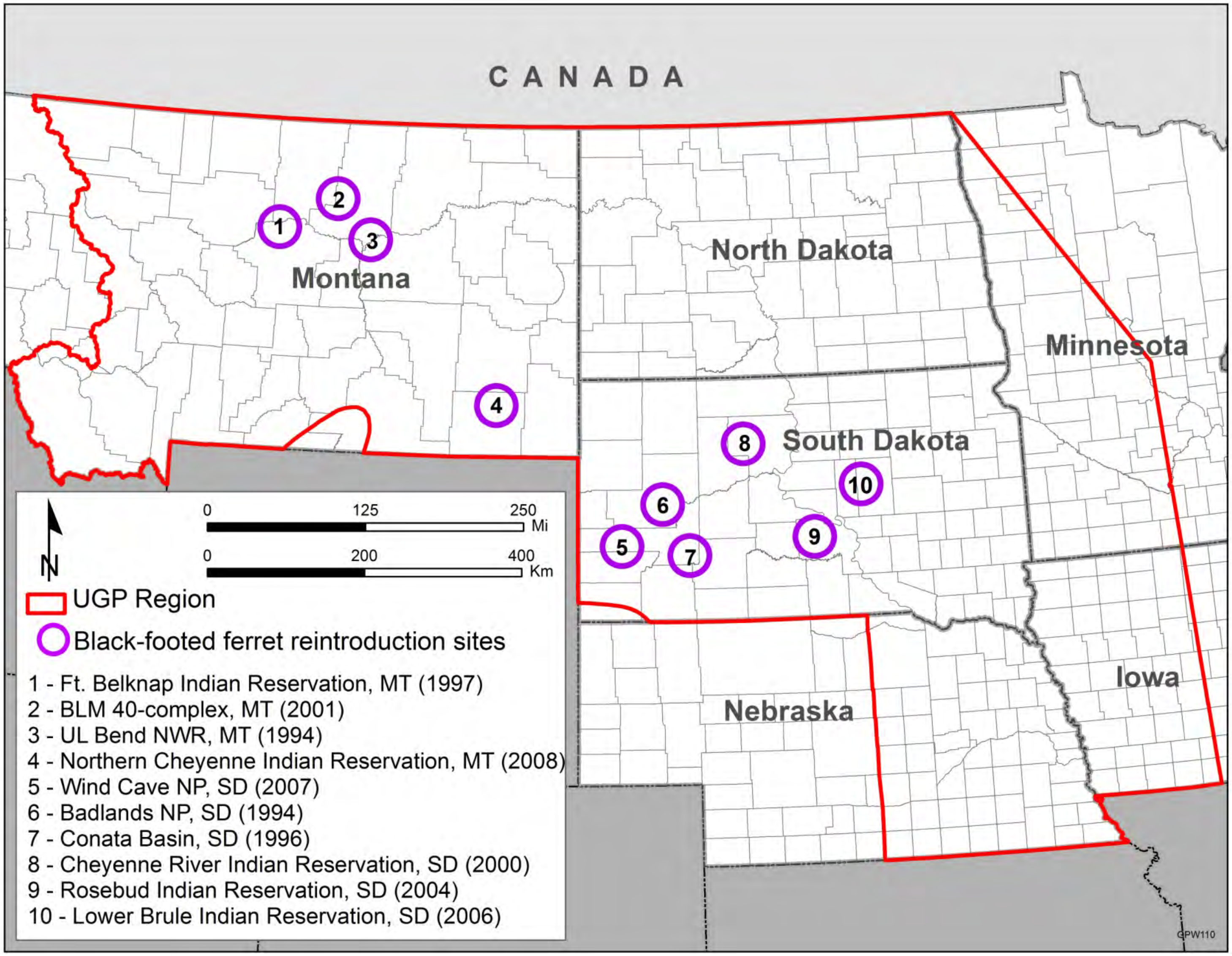


FIGURE 4.6-24 Black-Footed Ferret Reintroduction Sites in the UGP Region (Source: Service 2008e)

TABLE 4.6-13 Numbers of Species Listed for Protection under Individual State Statutes in the UGP Region[a]

Type of Species	Iowa[b]	Minnesota[c]	Nebraska[d]	South Dakota[e]
Plants	153	123[f]	7	–
Molluscs	24	25	1	–
Other Invertebrates	7	14	2	–
Fish	17	1	7	9
Amphibians	4	1	–	–
Reptiles	17	4	1	3
Birds	11	13	6	8
Mammals	6	1	5	3
Total	239	182	29	23

a For specific listing categories and definitions, see the referenced sources.

b IDNR (2009c).

c MDNR (2007).

d NGPC (2011).

e South Dakota DGFP (2010).

f Includes vascular plants, lichens, mosses, and fungi.

TABLE 4.6-14 Numbers of Species of Concern Listed by Each State in the UGP Region[a]

Type of Species	Iowa[b]	Minnesota[c]	Montana[d]	Nebraska[e]	North Dakota[f]	South Dakota[g]
Plants	233	159	585	382	–	213
Molluscs	–	5	22	12	7	31
Other Invertebrates	25	35	59	27	–	13
Fish	2	20	19	18	22	26
Amphibians	–	1	6	3	2	6
Reptiles	2	8	9	21	9	17
Birds	2	15	65	97	44	75
Mammals	1	14	30	30	15	24
Total	265	257	795	590	98	405

a For specific listing categories and definitions, see the referenced sources.

b IDNR (2009c).

c MDNR (2007).

d Montana Natural Heritage Program (2009).

e NGPC (2005).

f North Dakota GFD (2009b).

g South Dakota DGFP (2004b, 2008).

4.7 VISUAL RESOURCES

Visual resources refer to all objects (man-made and natural, moving and stationary) and features (e.g., landforms and water bodies) that are visible on a landscape. These resources add to or detract from the scenic quality of the landscape, that is, the visual appeal of the landscape. A visual impact is the creation of an intrusion or perceptible contrast that affects the scenic quality of a landscape. A visual impact can be perceived by an individual or group as either positive or negative, depending on a variety of factors or conditions (e.g., personal experience, time of day, and weather/seasonal conditions).

The UGP Region analyzed in this PEIS encompasses a wide variety of landscape types determined by geology, topography, climate, soil type, hydrology, and land use. Included in this vast region encompassing 359,346 mi^2 (930,702 km^2) are diverse and spectacular landscapes such as the Bighorn Canyon and Rocky Mountains in Montana and the Badlands of South Dakota. Much of the UGP Region, however, consists of the relatively flat and visually monotonous landscapes of the upper Midwest. Although much of the region is sparsely populated, human influences have altered much of the visual landscape, especially with respect to land use and land cover, and, in some places, intensive human activities, particularly agriculture, have seriously altered visual qualities. With the exception of western Montana, the Black Hills and the Badlands, much of the UGP Region consists of flat to rolling plains, in most areas with few trees (except in draws), used extensively for cropping and grazing. There are very few urban areas with populations of more than 50,000, and, overall, the region has a rural character, with many widely scattered small towns and individual farms connected by relatively widely spaced roads. The relatively flat or rolling landscape, the lack of trees and urban settlements, and extensive crop and grazing lands create an open, strongly horizontal landscape. In many areas, the landscape is dominated by the colors and geometries of croplands and pastures, contrasting with the sky and clouds, which are particularly noticeable visual elements. In cropland areas, the strong horizon line is punctuated by grain elevators and much lower buildings and trees of the widely spaced small towns. While there are relatively few rivers, parts of the region have numerous wetlands and other small water bodies that add visual interest to the landscape.

The air quality in many areas is high and the humidity is often low, and given the general lack of vertical relief and absence of trees and buildings, it is possible to see for great distances in many parts of the region. In general, the region has dark night skies, with relatively few sources of light pollution.

Utility-scale wind energy projects are found throughout the region, as shown in figure 4.7-1. Utility-scale wind energy projects are more common in the eastern portions of the UGP Region, particularly western Iowa and Minnesota. In these portions of the region, it would be common for inhabitants and visitors to have frequent views of wind energy projects as they travel area roads. The density of utility-scale wind energy projects is much lower in Nebraska, the western portions of South Dakota, and eastern Montana, and it would be much less common for inhabitants and visitors to see utility-scale wind farms in these areas. There is a slightly higher density of wind energy projects in western portion of the UGP Region in Montana.

In general, the western portion of the UGP Region is higher in elevation, in some areas mountainous (Montana). Logging, mining, and recreation are increasingly important land uses that may impact visual characteristics of the landscape. Because of the greater topographic

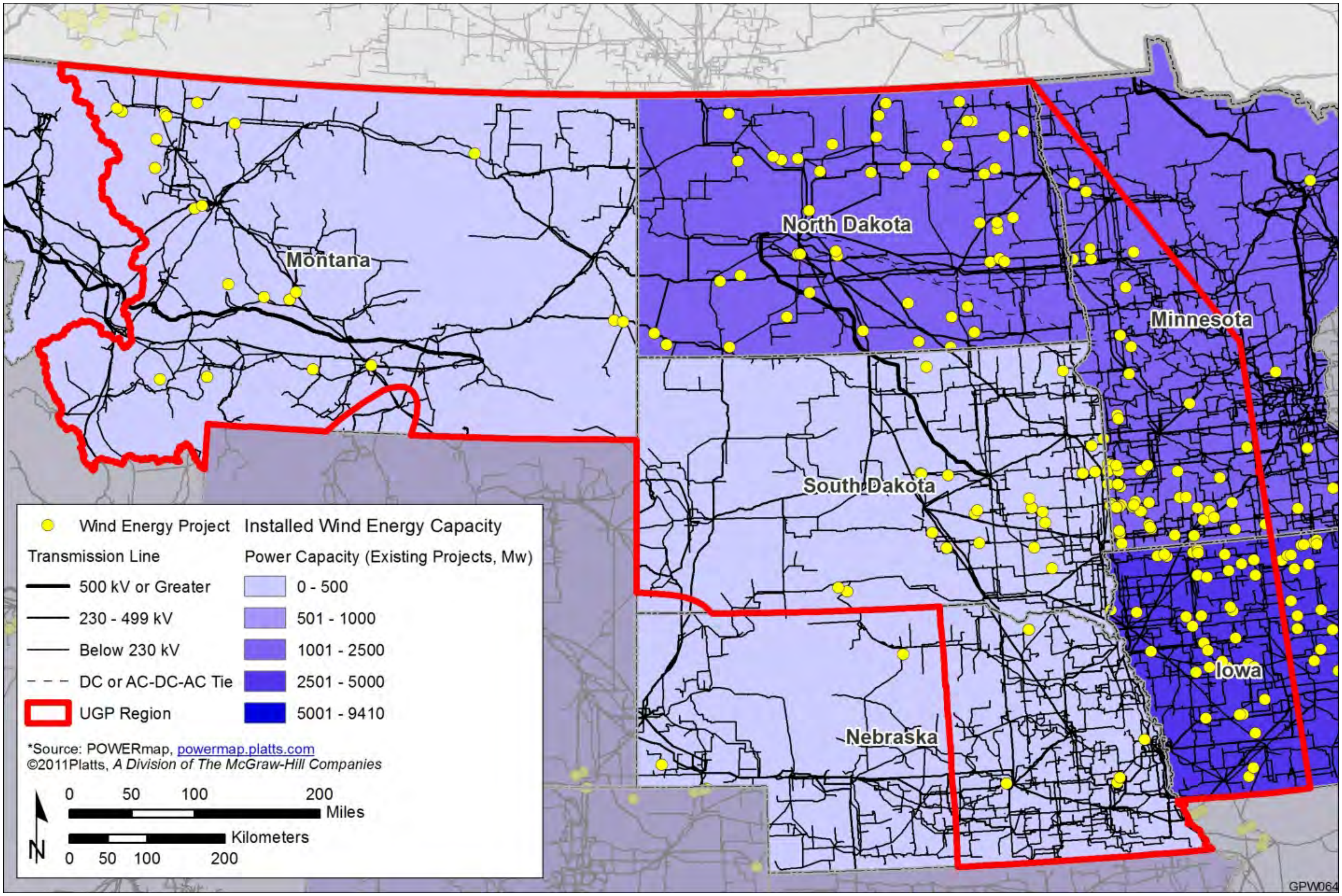


FIGURE 4.7-1 Existing Utility-Scale Wind Energy Projects within the UGP Region

relief and diversity of vegetation and the presence of mountains, buttes, rock outcroppings, and mountain streams, the visual diversity of the landscape is generally higher than in the eastern portion of the UGP Region, and visual quality generally is also higher. In some areas, particularly in the extreme western portion of the UGP Region, visual quality is very high, making it extremely attractive to tourists and other recreational users.

The various scenic attractions of the six-State area draw tourists to the region each year and contribute to making tourism a component of some regional and local economies. For many individuals, however, their experience of the visual character of the region is limited to the views from their automobiles from the interstate highways that cross the region, particularly I-94, I-90, and I-80, lending particular importance to the viewsheds of these roadways. While there are relatively few major natural visual attractions (e.g., the Badlands and Bighorn Canyon), there are a number of cultural features that have sensitive viewsheds, such as Mt. Rushmore National memorial, several national historic trails that cross the region, and several national scenic highways and all-American roads.

Table 4.7-1 summarizes selected scenic resources, such as national parks, monuments, and recreation areas; national historic sites, parks, and landmarks; national memorials and battlefields; national wild and scenic rivers, national historic trails, national scenic highways, and national wildlife refuges; and other national scenic resources that occur within the UGP Region. In addition, many other scenic resources exist on Federal, State, and other non-Federal lands, including traditional cultural properties important to tribes and State- or locally designated scenic resources, such as State-designated scenic highways, State parks, and county parks.

Because scenic resources in a given area are largely determined by geology, topography, climate, soil type, and vegetation, scenic resources are generally homogenous within an ecoregion, defined as an area that has a general similarity in ecosystems and is characterized by the spatial pattern and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography, climate, soils, land use, and hydrology (EPA 2007b). The UGP Region encompasses 15 ecoregions (figure 4.6-1), each of which contains a characteristic set of visual resources. The areal coverage of an ecoregion within the UGP Region varies greatly. The Idaho Batholith ecoregion accounts for as little as 283 mi^2 (732 km^2) within the UGP Region. In contrast, the portion of the Northwestern Great Plains ecoregion within the UGP encompasses about 115,000 mi^2 (298,000 km^2). The general environmental setting of the 15 ecoregions and the States in which the ecoregions occur are discussed in appendix C.

4.8 PALEONTOLOGICAL RESOURCES

Paleontological resources are the fossilized remains of ancient life forms, their imprints, or behavioral traces (e.g., tracks, burrows, residues), and the rocks in which they are preserved. These are distinct from human remains and artifacts, which are considered archaeological or historical materials. Fossil energy resources, such as coal or oil, are also generally excluded from the definition of paleontological resources.

Fossils have scientific and educational value because they are important in understanding the history of life on earth and the biodiversity of the past and in developing new ideas about ecology and evolution. Greater attention is paid to vertebrate fossils and to

1 **TABLE 4.7-1 Selected Sensitive Visual Resource Areas (with Acreages) within the UGP Region**

Sensitive Visual Resource Area	State(s)	Area (acres)	Length (miles)
Grenville M. Dodge House	Iowa	1.8	
Col. William Peters Hepburn House	Iowa	0.9	
Rev. George B. Hitchcock House	Iowa	1.1	
Loess Hills National Scenic Byway	Iowa		223.0
Old O'Brien Glacial Trail Scenic Byway	Iowa		35.1
Sergeant Floyd	Iowa	0.9	
Sergeant Floyd Monument	Iowa	0.9	
Union Slough National Wildlife Refuge	Iowa	3,316.8	
Western Skies Scenic Byway	Iowa		132.3
Woodbury County Courthouse	Iowa	0.9	
Lewis and Clark National Historic Trail	Iowa, Montana, Nebraska, North Dakota, South Dakota		2,246.5
Boyer Chute National Wildlife Refuge	Iowa, Nebraska	9,899.9	
Desoto National Wildlife Refuge	Iowa, Nebraska	8,365.3	
Mormon Pioneer National Historic Trail	Iowa, Nebraska		395.9
Big Stone National Wildlife Refuge	Minnesota	14,689.3	
Crane Meadows National Wildlife Refuge	Minnesota	4,452.7	
Glacial Ridge National Wildlife Refuge	Minnesota	35,737.2	
Glacial Ridge Trail Scenic Byway	Minnesota		227.5
Great River Road National Scenic Byway	Minnesota		52.2
Hamden Slough National Wildlife Refuge	Minnesota	5,300.9	
Highway 75- King of Trails Scenic Byway	Minnesota		386.9
Lake Country Scenic Byway	Minnesota		34.9
Sinclair Lewis Boyhood Home	Minnesota	0.9	
Charles A. Lindbergh House and Park	Minnesota	17.0	
Minnesota River Valley National Scenic Byway	Minnesota		194.9
Otter Trail Scenic Byway	Minnesota		155.6
Pipestone National Monument	Minnesota	284.2	
Rydell National Wildlife Refuge	Minnesota	2,032.3	
Tamarac National Wildlife Refuge	Minnesota	21,716.4	
Andrew John Volstead House	Minnesota	0.9	
North Country National Scenic Trail	Minnesota, North Dakota		669.4
Bannack Historic District	Montana	1,720.0	
Beartooth National Scenic Byway	Montana		33.5
Benton Lake National Wildlife Refuge	Montana	12,341.9	
Big Hole National Battlefield	Montana	671.3	
Big Sheep Creek Back Country Byway	Montana		55.5
Big Sky Back Country Byway	Montana		115.6
Black Coulee National Wildlife Refuge	Montana	1,355.6	
Bowdoin National Wildlife Refuge	Montana	15,698.8	
Camp Disappointment	Montana	640.0	
Charles M. Russell National Wildlife Refuge	Montana	1,005,402.5	
Chief Joseph Battleground of the Bear's Paw	Montana	360.0	
Chief Plenty Coups (Alek-Chea-Ahoosh) House	Montana	190.0	
Continental Divide National Scenic Trail	Montana		454.5
Creedman Coulee National Wildlife Refuge	Montana	3,040.6	
Fort Benton	Montana	120.0	
Glacier National Park	Montana	372,181.7	
Great Falls Portage	Montana	7,700.0	

2

TABLE 4.7-1 (Cont.)

Sensitive Visual Resource Area	State(s)	Area (acres)	Length (miles)
Great Northern Railway Buildings	Montana	0.7	
Hailstone National Wildlife Refuge	Montana	2,249.7	
Halfbreed Lake National Wildlife Refuge	Montana	4,455.6	
Hewitt Lake National Wildlife Refuge	Montana	1,678.2	
Kings Hill Scenic Byway	Montana		71.3
Lake Mason National Wildlife Refuge	Montana	18,026.7	
Lake Thibadeau National Wildlife Refuge	Montana	4,671.8	
Lamesteer National Wildlife Refuge	Montana	807.7	
Little Bighorn Battlefield National Monument	Montana	780.0	
Many Glacier Hotel Historic District	Montana	75.6	
Medicine Lake National Wildlife Refuge	Montana	33,423.3	
Missouri Breaks Back Country Byway	Montana		54.7
Nez Perce National Historic Trail	Montana		429.4
Nez Perce National Historical Park	Montana	513.4	
Pictograph Cave	Montana	35.4	
Pioneer Mountains Scenic Byway	Montana		36.7
Pompey's Pillar	Montana	6.0	
Pompeys Pillar National Monument	Montana	51.3	
Rankin Ranch	Montana	90.0	
Red Rock Lakes National Wildlife Refuge	Montana	221,851.6	
Rosebud Battlefield--Where the Girl Saved Her Brother	Montana	2,680.0	
Charles M. Russell House and Studio	Montana	2.0	
Two Medicine General Store	Montana	0.3	
Ul Bend National Wildlife Refuge	Montana	60,438.5	
Upper Missouri River Breaks National Monument	Montana	270,310.1	
Virginia City Historic District	Montana	20,000.0	
War Horse National Wildlife Refuge	Montana	3,424.6	
Yellowstone National Park	Montana	155,575.3	
Missouri Wild and Scenic River	Montana, Nebraska, South Dakota		264.8
Fort Union Trading Post National Historic Site	Montana, North Dakota	441.8	
Arbor Lodge	Nebraska	60.0	
California National Historic Trail	Nebraska		823.3
Captain Meriwether Lewis (dredge)	Nebraska	0.9	
Cather House	Nebraska	0.5	
Fairview	Nebraska	0.9	
Father Flanagan's Boys' Home	Nebraska	1,310.0	
Fort Atkinson	Nebraska	156.6	
Heritage Highway	Nebraska		52.2
Homestead National Monument	Nebraska	223.8	
Lewis & Clark Scenic Byway	Nebraska		78.1
Loup Rivers Scenic Byway	Nebraska		86.9
Nebraska State Capitol	Nebraska	15.0	
Oregon National Historic Trail	Nebraska		142.5
Outlaw Trail	Nebraska		163.2
Dr. Susan Picotte Memorial Hospital	Nebraska	0.9	
Pony Express National Historic Trail	Nebraska		141.6
Sandhills Journey Scenic Byway	Nebraska		51.6
USS Hazard (AM-240) National Historic Landmark	Nebraska	0.9	
Missouri National Recreation River	Nebraska, South Dakota	28,905.2	
Niobrara Wild and Scenic River	Nebraska, South Dakota		37.4
Appert Lake National Wildlife Refuge	North Dakota	1,168.3	

TABLE 4.7-1 (Cont.)

Sensitive Visual Resource Area	State(s)	Area (acres)	Length (miles)
Ardoch National Wildlife Refuge	North Dakota	2,988.3	
Arrowwood National Wildlife Refuge	North Dakota	19,522.5	
Audubon National Wildlife Refuge	North Dakota	14,778.4	
Frederick A. and Sophia Bagg Bonanza Farm	North Dakota	11.6	
Big Hidatsa Village Site	North Dakota	15.0	
Bone Hill National Wildlife Refuge	North Dakota	637.9	
Brumba National Wildlife Refuge	North Dakota	1,977.8	
Buffalo Lake National Wildlife Refuge	North Dakota	2,091.0	
Camp Lake National Wildlife Refuge	North Dakota	1,215.5	
Canfield Lake National Wildlife Refuge	North Dakota	452.8	
Chan SanSan Backway	North Dakota		24.5
Chase Lake National Wildlife Refuge	North Dakota	4,354.1	
Cottonwood Lake National Wildlife Refuge	North Dakota	1,025.6	
Dakota Lake National Wildlife Refuge	North Dakota	2,790.0	
Des Lacs National Wildlife Refuge	North Dakota	30,360.7	
Des Lacs National Wildlife Refuge Backway	North Dakota		40.1
Florence Lake National Wildlife Refuge	North Dakota	1,890.6	
Half-Way Lake National Wildlife Refuge	North Dakota	158.5	
Hiddenwood National Wildlife Refuge	North Dakota	577.5	
Hobart Lake National Wildlife Refuge	North Dakota	2,006.8	
Huff State Historic Site (32MO11)	North Dakota	14.0	
Hutchinson Lake National Wildlife Refuge	North Dakota	445.3	
International Peace Garden	North Dakota	852.7	
J. Clark Salyer National Wildlife Refuge	North Dakota	62,130.5	
Johnson Lake National Wildlife Refuge	North Dakota	2,003.3	
Kellys Slough National Wildlife Refuge	North Dakota	1,631.9	
Killdeer Four Bears Scenic Byway	North Dakota		28.5
Knife River Indian Villages National Historic Site	North Dakota	1,782.8	
Lake Alice National Wildlife Refuge	North Dakota	12,646.2	
Lake George National Wildlife Refuge	North Dakota	3,046.1	
Lake Ilo National Wildlife Refuge	North Dakota	4,471.1	
Lake Nettie National Wildlife Refuge	North Dakota	3,312.8	
Lake Otis National Wildlife Refuge	North Dakota	322.5	
Lake Patricia National Wildlife Refuge	North Dakota	1,437.1	
Lake Zahl National Wildlife Refuge	North Dakota	3,917.7	
Lambs Lake National Wildlife Refuge	North Dakota	1,326.6	
Little Goose National Wildlife Refuge	North Dakota	361.2	
Long Lake National Wildlife Refuge	North Dakota	27,086.7	
Lords Lake National Wildlife Refuge	North Dakota	1,895.7	
Lost Lake National Wildlife Refuge	North Dakota	961.3	
Lostwood National Wildlife Refuge	North Dakota	34,978.6	
Maple River National Wildlife Refuge	North Dakota	1,134.4	
Pleasant Lake National Wildlife Refuge	North Dakota	1,024.9	
Pretty Rock National Wildlife Refuge	North Dakota	786.5	
Rabb Lake National Wildlife Refuge	North Dakota	256.2	
Rendezvous Region Backway	North Dakota		14.7
Rock Lake National Wildlife Refuge	North Dakota	5,592.7	
Rose Lake National Wildlife Refuge	North Dakota	843.8	
Sakakawea Scenic Byway	North Dakota		22.5
School Section Lake National Wildlife Refuge	North Dakota	352.1	
Shell Lake National Wildlife Refuge	North Dakota	1,827.0	

TABLE 4.7-1 (Cont.)

Sensitive Visual Resource Area	State(s)	Area (acres)	Length (miles)
Sheyenne Lake National Wildlife Refuge	North Dakota	777.4	
Sheyenne River Valley National Scenic Byway	North Dakota		76.3
Sibley Lake National Wildlife Refuge	North Dakota	1,073.1	
Silver Lake National Wildlife Refuge	North Dakota	3,335.6	
Slade National Wildlife Refuge	North Dakota	2,998.3	
Snyder Lake National Wildlife Refuge	North Dakota	1,564.6	
Springwater National Wildlife Refuge	North Dakota	646.5	
Stewart Lake National Wildlife Refuge	North Dakota	2,232.2	
Stoney Slough National Wildlife Refuge	North Dakota	1,997.9	
Storm Lake National Wildlife Refuge	North Dakota	687.7	
Stump Lake National Wildlife Refuge	North Dakota	26.9	
Sunburst Lake National Wildlife Refuge	North Dakota	495.4	
Tewaukon National Wildlife Refuge	North Dakota	2,864.2	
Theodore Roosevelt National Park	North Dakota	70,382.7	
Theodore Roosevelt National Park North Unit Byway	North Dakota		8.2
Tomahawk National Wildlife Refuge	North Dakota	438.3	
Turtle Mountain Byway	North Dakota		32.2
Upper Souris National Wildlife Refuge	North Dakota	33,091.4	
White Lake National Wildlife Refuge	North Dakota	1,044.4	
Wild Rice Lake National Wildlife Refuge	North Dakota	776.4	
Willow Lake National Wildlife Refuge	North Dakota	2,585.2	
Wintering River National Wildlife Refuge	North Dakota	402.5	
Native American National Scenic Byway	North Dakota, South Dakota		349.3
Badlands Loop Scenic Byway	South Dakota		38.1
Badlands National Park	South Dakota	111,469.4	
Bear Butte	South Dakota	NA	
Bear Butte National Wildlife Refuge	South Dakota	402.0	
Deadwood Historic District	South Dakota	NA	
Fort Pierre Chouteau Site	South Dakota	33.6	
Frawley Historic Ranch	South Dakota	4,750.0	
Jewel Cave National Monument	South Dakota	1,244.9	
Karl E. Mundt National Wildlife Refuge	South Dakota	1,366.1	
La Verendrye Site	South Dakota	4.5	
Minuteman Missile National Historic Site	South Dakota	6.6	
Mount Rushmore National Memorial	South Dakota	1,293.0	
Peter Norbeck National Scenic Byway	South Dakota		67.7
Sand Lake National Wildlife Refuge	South Dakota	26,693.6	
Spearfish Canyon Scenic Byway	South Dakota		21.4
Waubay National Wildlife Refuge	South Dakota	3,952.1	
Wildlife Loop Road Scenic Byway	South Dakota		12.0
Wind Cave National Park	South Dakota	28,323.2	
Totals		2,930,931.3	8,582.7

uncommon invertebrate and plant paleontological resources than to common invertebrate and plant fossils. Vertebrate fossils form only under very specific conditions and are very rare. All fossils can be found only in sedimentary rock formations.

Various statutes, regulations, and policies govern the management of paleontological resources on public lands; few laws, however, address paleontological resources on private or State lands. Most wind development projects that would trigger involvement by either Western or the Service would take place on private land or on easements or refuges. The National Environmental Policy Act (NEPA) is the primary law that would address paleontological resources during a wind development project that has a Federal nexus. NEPA requires that the effects of a Federal project on significant paleontological resources be disclosed for the decision maker's consideration. In 2009, Congress passed the Vertebrate Paleontological Resource Protection Act. However, this Act only addresses paleontological resources found on public lands managed by the DOI and USDA. Two other laws that could apply to wind development projects are the Federal Cave Resources Protection Act (P.L. 100–691, 102 Stat. 4546; codified at 16 USC 4301) and the Archaeological Resources Protection Act (16 USC 470(aa) et seq.), which protect fossils found in significant caves and/or in association with archeological resources. Paleontological finds are also covered by some State laws. State laws generally apply only to actions occurring on State-owned lands.

The UGP Region addressed in this PEIS is composed of sedimentary rocks that have produced significant paleontological remains. All of the States being discussed in this PEIS have the potential to contain significant fossils; however, fossils are very rare. Montana, North and South Dakota, and Nebraska have the highest potential to contain vertebrate fossils. Most of the deposits found in the UGP Region date to the late Mesozoic and early Cenozoic periods. Geologic time periods and the associated fossil resources and geologic units within the UGP Region are listed in table 4.8-1. Inland seas formed over the northern plains several times during the geologic past. As a result, the paleontological resources found in the region consist of both marine and nonmarine fossils. The geologic deposits in the UGP Region yield important vertebrate fossils, including fish, frogs, salamanders, turtles, crocodiles, pterosaurs, mammals, birds, and dinosaurs. Invertebrate fossils (e.g., ammonites) are also abundant.

4.9 CULTURAL RESOURCES

Cultural resources include archaeological, historic, and architectural sites or structures, or places that are significant in understanding the history of the United States or North America, and may include definite locations (sites or places) of traditional cultural or religious importance to specified social or cultural groups, such as Native American tribes ("traditional cultural properties"). Cultural resources can be either man-made or natural physical features associated with human activity and, in most cases, are unique, fragile, and nonrenewable. Cultural resources that meet the eligibility criteria (see text box) for listing on the *National Register of Historic Places* (NRHP) are termed "historic properties" under the National Historic Preservation Act (NHPA).

TABLE 4.8-1 Geologic Time Scale and Paleontological Resources

Era	Period (Ma)[a]	Epoch (Ma)[a]	Distinctive Fossils[b]	Examples of Geologic Units in the UGP Region
Cenozoic	Quaternary (0–1.8)	Pleistocene (0.01–1.8)	Mammoths Bison and cows Horses Deer Squirrels and rabbits Invertebrates	Alluvium and colluvium Dune sand Eolian deposits (loess) Glaciofluvial deposits Terrace and flood gravels
	Tertiary (1.8–65.0)	Pliocene (1.8–5.3)	Mammals Birds (eggs) Warm climate plankton (marine) Invertebrates	Alluvium and colluvium Dune sand Eolian deposits (loess) Glaciofluvial deposits Terrace and flood gravels
		Miocene (5.3–23.8)	Mammals (rodents) Birds (eggs) Invertebrates	Flaxville gravel Ogallala Formation Arikaree Formation White River Group Wasatch Formation Golden Valley Formations
		Oligocene (23.8–33.7)	Mammals (early horses, primates, marsupials, carnivores) Crocodilians, alligators Lizards and turtles Amphibians and fish Invertebrates Birds (eggs) Plants and pollen	Flaxville gravel Ogallala Formation Arikaree Formation White River Group Wasatch Formation Golden Valley Formations

TABLE 4.8-1 (Cont.)

Era	Period (Ma)[a]	Epoch (Ma)[a]	Distinctive Fossils[b]	Examples of Geologic Units in the UGP Region
Cenozoic (Cont.)		Eocene (33.7–54.8)	Mammals (early horses, primates, marsupials, carnivores, grazers) Crocodilians, alligators Lizards and turtles Amphibians and fish Invertebrates Birds (eggs) Plants and pollen	Flaxville gravel Ogallala Formation Arikaree Formation White River Group Wasatch Formation Golden Valley Formations
		Paleocene (54.8–65.0)	Small mammals Reptiles Amphibians and fish Birds (eggs) Insects Plants and pollen	Denver Formation Fort Union Formation Canyon Formation Raton Formation
Mesozoic	Cretaceous (65.0–144)		Terrestrial flora and fauna: – dinosaurs – birds – early mammals – diverse insects – flowering plants – freshwater fish and invertebrates Marine flora and fauna: – plankton and diatoms – cephalopods (ammonites, belemnites) – marine reptiles – fish – sharks and rays	Hell Creek Formation Lance Formation Fox Hills Sandstone Vermejo Formation Laramie Formation Trinidad Formation Dakota Sandstone Lakota Formation

TABLE 4.8-1 (Cont.)

Era	Period (Ma)[a]	Epoch (Ma)[a]	Distinctive Fossils[b]	Examples of Geologic Units in the UGP Region
Mesozoic (Cont.)	Jurassic (144–206)		Terrestrial flora and fauna: – dinosaurs – early mammals – seed plants – ferns Marine flora and fauna: – plankton – cephalopods (ammonites) – marine reptiles – fish – sharks and rays	Sundance Formation Ellis Group Unkpapa Sandstone Morrison Formation
	Triassic (206–248)		Terrestrial flora and fauna: – dinosaurs – early mammals – seed plants – conifers	predominantly red rocks
Paleozoic	(248–290)		Terrestrial flora and fauna dominate: – anapsids (turtles) – diapsids – archosaurs – gymnosperms (conifers)	Paleozoic rocks, undivided
Precambrian	(543–2,500)		Soft bodied fauna Carbon film Microbial mats (stromatolites)	Precambrian rocks, undivided

[a] Ma = millions of years before the present.

[b] Distinctive fossils are those characteristic of the geologic period listed and may or may not be present in the geologic units (formations) in the study area.

Sources: Adapted from Palmer and Geissman (1999) and University of California Museum of Paleontology (2007).

4.9.1 Legal Framework

Cultural resources are addressed by a suite of laws, regulations, and policies that apply to actions taken by Federal agencies. Major laws and policies concerning cultural resources are summarized in table 4.9-1. NEPA, the Archaeological Resource Protection Act, and NHPA are the primary cultural resource laws that would apply to a wind energy development project having a Federal nexus in the UGP Region.

The NHPA is a comprehensive law that creates a framework for managing cultural resources in the United States. The law expands the NRHP; establishes State Historic Preservation Offices (SHPOs), Tribal Historic Preservation Offices (THPOs), and the Advisory Council on Historic Preservation (ACHP); and provides a number of mandates for Federal agencies. Section 106 of the NHPA directs all Federal agencies to take into account the effects of their undertakings (actions or authorizations) on cultural resources included in or eligible for the NRHP ("historic properties"). Section 106 also requires that the agency afford the ACHP a reasonable opportunity to comment with regard to the undertaking. Section 106 is implemented by regulations of ACHP (36 CFR Part 800).

Five primary participants are involved in the application of cultural resource laws. First is the Federal agency that is either conducting or permitting the activity. Second are the SHPOs that oversee cultural resource information for the States. Third is the ACHP, which provides Federal oversight for the application of cultural resources laws. Fourth are the federally recognized tribes who have cultural ties to the lands being affected by a project, and fifth is the general public on whose behalf the resources are being considered.

4.9.1.1 Section 106 Responsibilities

Section 106 of the NHPA (36 CFR Part 800) outlines a process whereby Federal agencies can determine whether an undertaking would affect historic properties. An undertaking can be either an activity conducted by a Federal agency or one permitted or licensed by a Federal agency. The Section 106 process consists of a number of steps, including (1) identifying the lead Federal agency with jurisdiction over the project, (2) establishing the Area of Potential Effect (APE), (3) identifying which SHPO(s) would have jurisdiction for the UGP Region, (4) determining which Native American tribes would have an interest in the UGP Region, (5) identifying whether historic properties are in the APE, (6) determining whether the project would impact historic properties, and (7) mitigating any adverse impacts. Table 4.9-2 lists the Native American tribes with cultural affiliation to the UGP Region.

Western Area Power Administration. Western has responsibilities under the NHPA and NEPA for considering cultural resources. Western relies on the process identified in Section 106 of the NHPA for determining whether a project would affect cultural resources. For a wind energy development project, Western, in conjunction with the project developer, reviews all aspects of the project for the potential to affect cultural resources. Western is only responsible for considering the potential effects of proposed projects that would interconnect with Western's transmission system. Projects not interconnecting with Western would be reviewed by other State or Federal agencies, as appropriate. To this end, consultation is

TABLE 4.9-1 Cultural Resource Laws and Regulations

Law or Order Name	Intent of Law or Order
Antiquities Act of 1906	This was the first law to protect and preserve cultural resources on Federal lands. It makes it illegal to remove cultural resources from Federal land without a permit, establishes penalties for illegal excavation and looting, and allows the President to establish historical monuments and landmarks.
National Historic Preservation Act (1966) (NHPA)	This law created the legal framework for considering the effects of Federal undertakings on cultural resources in the United States. The law expands NRHP, establishes the Advisory Council on Historic Preservation, State Historic Preservation Offices, and Tribal Historic Preservation Offices. Section 106 and its accompanying regulations direct all agencies to take into account the effects of their actions on properties included in or eligible for NRHP, and establishes the process for doing so.
Executive Order 11593, "Protection and Enhancement of the Cultural Environment" (1971)	Executive Order 11593 directs Federal agencies to inventory their cultural resources and to record to professional standards any cultural resource that may be altered or destroyed.
Archaeological and Historic Preservation Act (1974) (AHPA)	The AHPA addresses impacts on cultural resources resulting from Federal activities and provides a funding mechanism to recover, preserve, and protect archaeological and historical data.
Archaeological Resources Protection Act of 1979 (ARPA)	ARPA establishes civil and criminal penalties for the unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources, prohibits trafficking in resources from public lands, and directs Federal agencies to establish educational programs on the importance of archaeology.
American Indian Religious Freedom Act of 1978 (AIRFA)	AIRFA protects First Amendment guarantees to religious freedom for American Indians. It requires Federal agencies to consult when a proposed land use might conflict with traditional Indian religious beliefs or practices, and to avoid interference to the extent possible.
Native American Graves Protection and Repatriation Act of 1990 (NAGPRA)	NAGPRA establishes the rights of Native American tribes to claim ownership of certain "cultural items," including human remains, funerary objects, sacred objects, and objects of cultural patrimony. It requires Federal agencies and museums to identify holdings of such remains and work toward their repatriation. Excavation or removal of such cultural items requires consultation, as does discovery of these items during land use activities.
Executive Order 13007, "Indian Sacred Sites" (1996)	Executive Order 13007 defines sacred sites and directs agencies to accommodate Indian religious practitioners' access to and use of sacred sites, avoid adverse effects, and maintain confidentiality. It does not create new rights but strongly affirms those that exist.
Executive Order 13287, "Preserve America" (2003)	Executive Order 13287 encourages the Federal Government to take a leadership role in the protection, enhancement, and contemporary use of historic properties and establishes new accountability for agencies with regard to inventories and stewardship.
National Environmental Policy Act (NEPA) (1969)	This law requires Federal agencies to analyze the impacts of an action on the human environment, to ensure that Federal decision makers and the public are aware of the environmental consequences of a project before implementation.

TABLE 4.9-2 Federally Recognized Tribal Groups with Ties to the UGP Region

Iowa Tribes
Flandreau Santee Sioux Tribe of South Dakota
Ho-Chunk Nation of Wisconsin
Iowa Tribe of Kansas and Nebraska
Iowa Tribe of Oklahoma
Lower Sioux Indian Community in the State of Minnesota
Omaha Tribe of Nebraska
Otoe-Missouria Tribe of Indians, Oklahoma
Prairie Island Indian Community in the State of Minnesota
Sac and Fox Nation of Missouri in Kansas and Nebraska
Sac and Fox Nation, Oklahoma
Sac and Fox Tribe of the Mississippi in Iowa
Santee Sioux Nation, Nebraska
Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
Spirit Lake Tribe, North Dakota
Upper Sioux Community, Minnesota
Winnebago Tribe of Nebraska
Yankton Sioux Tribe of South Dakota

Minnesota Tribes
Bad River Band of the Lake Superior Tribe of Chippewa Indians of the Bad River Reservation, Wisconsin
Bois Forte Band (Nett Lake) of the Minnesota Chippewa Tribe, Minnesota
Flandreau Santee Sioux Tribe of South Dakota
Fond du Lac Band of the Minnesota Chippewa Tribe, Minnesota
Grand Portage Band of the Minnesota Chippewa Tribe, Minnesota
Keweenaw Bay Indian Community, Michigan
Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin
Lac du Flambeau Band of Lake Superior Chippewa Indians of the Lac du Flambeau Reservation of Wisconsin
Lac Vieux Desert Band of Lake Superior Chippewa Indians, Michigan
Leech Lake Band of the Minnesota Chippewa Tribe, Minnesota
Lower Sioux Indian Community in the State of Minnesota
Mille Lacs Band of the Minnesota Chippewa Tribe, Minnesota
Minnesota Chippewa Tribe, Minnesota
Prairie Island Indian Community in the State of Minnesota
Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
Red Lake Band of Chippewa Indians, Minnesota
Santee Sioux Nation, Nebraska
Shakopee Mdewakanton Sioux Community of Minnesota
Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
Sokaogon Chippewa Community, Wisconsin
Spirit Lake Tribe, North Dakota
St. Croix Chippewa Indians of Wisconsin
Turtle Mountain Band of Chippewa Indians of North Dakota
Upper Sioux Community, Minnesota
White Earth Band of Minnesota Chippewa Tribe, Minnesota

TABLE 4.9-2 (Cont.)

Montana Tribes
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
Blackfeet Tribe of the Blackfeet Indian Reservation of Montana
Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
Chippewa-Cree Indians of the Rocky Boy's Reservation, Montana
Coeur D'Alene Tribe of the Coeur D'Alene Reservation, Idaho
Confederated Salish and Kootenai Tribes of the Flathead Reservation, Montana
Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
Crow Tribe of Montana
Fort Belknap Indian Community of the Fort Belknap Reservation of Montana
Kalispel Indian Community of the Kalispel Reservation, Washington
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
Nez Perce Tribe of Idaho
Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation, Montana
Oglala Sioux Tribe of the Pine Ridge Reservation, South Dakota
Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
Santee Sioux Nation, Nebraska
Shoshone Tribe of the Wind River Reservation, Wyoming
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho
Standing Rock Sioux Tribe of North and South Dakota
Three Affiliated Tribes of the Fort Berthold Reservation, North Dakota

Nebraska Tribes
Arapaho Tribe of the Wind River Reservation, Wyoming
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
Cheyenne-Arapaho Tribes of Oklahoma
Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
Iowa Tribe of Kansas and Nebraska
Iowa Tribe of Oklahoma
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation, Montana
Oglala Sioux Tribe of the Pine Ridge Reservation, South Dakota
Omaha Tribe of Nebraska
Otoe-Missouria Tribe of Indians, Oklahoma
Pawnee Nation of Oklahoma
Ponca Tribe of Indians of Oklahoma
Ponca Tribe of Nebraska
Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
Sac and Fox Nation of Missouri in Kansas and Nebraska
Sac and Fox Nation, Oklahoma
Sac and Fox Tribe of the Mississippi in Iowa
Santee Sioux Nation, Nebraska
Standing Rock Sioux Tribe of North and South Dakota
Winnebago Tribe of Nebraska
Yankton Sioux Tribe of South Dakota

TABLE 4.9-2 (Cont.)

North Dakota Tribes
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
Flandreau Santee Sioux Tribe of South Dakota
Fort Belknap Indian Community of the Fort Belknap Reservation of Montana
Leech Lake Band of the Minnesota Chippewa Tribe, Minnesota
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
Lower Sioux Indian Community in the State of Minnesota
Minnesota Chippewa Tribe, Minnesota
Oglala Sioux Tribe of the Pine Ridge Reservation, South Dakota
Prairie Island Indian Community in the State of Minnesota
Red Lake Band of Chippewa Indians, Minnesota
Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
Santee Sioux Nation, Nebraska
Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
Spirit Lake Tribe, North Dakota
Standing Rock Sioux Tribe of North and South Dakota
Three Affiliated Tribes of the Fort Berthold Reservation, North Dakota
Turtle Mountain Band of Chippewa Indians of North Dakota
Upper Sioux Community, Minnesota
White Earth Band of Minnesota Chippewa Tribe, Minnesota
South Dakota Tribes
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
Flandreau Santee Sioux Tribe of South Dakota
Iowa Tribe of Kansas and Nebraska
Iowa Tribe of Oklahoma
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
Lower Sioux Indian Community in the State of Minnesota
Oglala Sioux Tribe of the Pine Ridge Reservation, South Dakota
Omaha Tribe of Nebraska
Otoe-Missouria Tribe of Indians, Oklahoma
Ponca Tribe of Indians of Oklahoma
Ponca Tribe of Nebraska
Prairie Island Indian Community in the State of Minnesota
Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
Sac and Fox Nation of Missouri in Kansas and Nebraska
Sac and Fox Nation, Oklahoma
Sac and Fox Tribe of the Mississippi in Iowa
Santee Sioux Nation, Nebraska
Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
Spirit Lake Tribe, North Dakota
Standing Rock Sioux Tribe of North and South Dakota
Upper Sioux Community, Minnesota
Yankton Sioux Tribe of South Dakota

undertaken with the SHPO and all federally recognized tribes who have an interest in the UGP Region. File searches and cultural resource surveys are required for all locations associated with the project, including, for example, turbine locations, laydown areas for equipment, collection line trenches, and access roads. The potential for visual impacts on cultural resources such as historic districts and traditional cultural properties is also examined. When it is determined that the project could affect historic properties, Western and the project developer work with the SHPO, tribes, and the public to avoid, minimize, or mitigate the impacts on historic properties resulting from the project.

NRHP Criteria for Significance

"The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association," and meet one or more of the following four criteria for evaluation: A, B, C, or D.

Criterion A: Associative Value – Event. "Properties can be eligible for the *National Register* if they are associated with events that have made a significant contribution to the broad patterns of our history."

Criterion B: Associative Value – Person. "Properties can be eligible for the *National Register* if they are associated with the lives of persons significant in our past."

Criterion C: Design or Construction Value. "Properties can be eligible for the *National Register* if they embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction."

Criterion D: Information Value. "Properties can be eligible for the *National Register* if they have yielded, or may be likely to yield, information important in prehistory or history."

Also applicable is a special criteria consideration:

Criteria Consideration G: Properties That Have Achieved Significance within the Last Fifty Years. "A property achieving significance within the last fifty years is eligible if it is of exceptional importance." (36 CFR 60.4)

The Service. The Service is responsible for considering cultural resources on its easements and refuges. The Service relies on staff archaeologists familiar with cultural resource legislation and the types of resources found on the lands under its jurisdiction to review and assist each project in the application of the Section 106 process. The Service is only responsible for considering the potential effect of activities located on easements and refuges. Project activities occurring off of easements and refuges would be reviewed by other State or Federal agencies, as appropriate. Staff archaeologists interact with the appropriate SHPO(s) and federally recognized tribes in determining whether a project would affect cultural resources within the APE. Service staff review existing cultural resource information on the UGP Region to determine whether additional archaeological surveys are necessary. When possible, the staff conducts any fieldwork necessary for the project. If the project is too large for the staff, contractors may be hired to conduct the surveys. All contractors must receive ARPA permits from the Service prior to beginning their investigations. Consultation with federally recognized tribes with an interest in the UGP Region is ongoing throughout the project. If cultural resources are identified, Service staff work with the SHPO(s) and federally recognized tribes to avoid, minimize, or mitigate any impacts on historic properties.

4.9.2 Cultural Context

Cultural resources are the physical remains of past human activities. These resources are found throughout the Great Plains region. Through past archaeological and historical research, the history of the Great Plains has been developed. Some knowledge of past activities that occurred on the Great Plains allows one to understand the types of resources that may be encountered during a wind energy development project. The following is a very brief overview of what is known about the settlement and past use of the Great Plains region.

The history of Native Americans in North America is commonly approached by dividing the continent into cultural regions: Great Basin, Southwest, Great Plains, Plateau, California, Northwest Coast, Northeast, and Southeast. These cultural areas generally correspond to the major physiographic regions of North America. The Native groups in a given cultural region had to adapt to the regional climate and environment in order to survive. As a result, there are certain shared ways of life that characterize each region.

The UGP Region lies primarily within the Great Plains cultural region. Small portions of the Plateau, Great Basin, and Northeast cultural regions are also in the UGP Region. The following discussion focuses mostly on the Great Plains cultural region. The Great Plains cultural region extends from the Rocky Mountains to the Mississippi River and from the Saskatchewan River in southern Canada to the Rio Grande in Texas (figure 4.9-1). Grasslands dominate the Great Plains landscape, with short-grass prairie toward the west, tall-grass prairie toward the east, and a mixed zone extending through portions of the Dakotas, Nebraska, Kansas, and Oklahoma. The Great Plains include portions of Montana, North Dakota, South Dakota, Minnesota, Wyoming, Colorado, Iowa, Nebraska, Kansas, Oklahoma, and Texas.

Climatic changes throughout prehistory required constant modification of the subsistence strategies for those living in the Great Plains cultural region. Early strategies involved nomadic hunting of large game; however, as the climate warmed and dried, a focus solely on large game was no longer possible. Exploitation of floral resources increased during the Archaic Period. This resulted in a seminomadic population that would engage in seasonal movements to exploit available resources. This pattern was followed by an increasing reliance on horticulture. Concurrently, habitat for the modern bison continued to improve, which allowed herds to swell to millions. The increases in game and plant resources allowed human populations to expand as well. Villages became common by the end of the first millennium AD in some areas. Table 4.9-3 presents the important time periods that have been identified for the Great Plains cultural region and the types of cultural resources that are associated with each time period.

By the eighteenth century, European influences had vastly altered life on the Great Plains for Native Americans. One of the most important factors affecting Native American lifeways was the introduction of the horse. Large numbers of horses became available on the Great Plains after the Pueblo Revolt of the 1680s, in which native groups banded together to temporarily expel the Spanish from the Southwest. Horses were well-suited to the Great Plains habitat and allowed a more mobile subsistence base focused on bison herds. A fully mobile Great Plains lifestyle quickly evolved within many tribes, featuring new social institutions, toolkits, and settlement patterns. Tribes typifying the new Great Plains culture included Blackfoot, Atsina, Assiniboin, Teton Dakota, Crow, Arapaho, Cheyenne, Kiowa, and Comanche

FIGURE 4.9-1 Upper Great Plains Native American Cultural Areas

TABLE 4.9-3 Examples of Characteristic Cultural Resources from Various Prehistoric Time Periods at Culture Areas in the UGP Region

Culture Area	Paleoindian	Middle Period or Archaic	Late or Sedentary Period
Northeast	*9500+ to 8000 BC* Open campsites Lithic processing sites Animal kill or processing sites	*8000 to 1000 BC* Plant processing sites Fishing sites Lithic processing sites Animal kill or processing sites	*1000 to AD 1650* Village sites Plant processing sites Burial mounds Storage pits Lithic processing sites Animal kill or processing sites
Great Basin	*9500+ to 6000 BC* Open campsites Cave occupation sites Lithic processing sites Animal kill or processing sites	*6000 to 2000 BC* Cave or rockshelter occupation sites Pithouse villages Plant processing sites Fishing sites Lithic processing sites Animal kill or processing sites	*2000 to AD 1750* Cave or rockshelter occupation sites Tipi ring sites Cave burials Cairns and cairn lines Small pithouse villages Plant processing sites Storage pits Lithic processing sites Pictograph and petroglyph sites Animal kill or processing sites Prehistoric roads
Great Plains	*10,000 to 6000 BC* Open campsites Cave or rockshelter occupation sites Animal kill or processing sites Lithic processing sites	*6000 to 1 BC* Open campsites Cave or rockshelter occupation sites Pithouses and storage pits Tipi ring sites Cairns and cairn lines Animal kill or processing sites Lithic processing sites Plant processing sites	*AD 1 to 1750* Open campsites Tipi ring sites Wattle-and-daub structures Earthlodge villages Burial mounds Storage pits Cave or rockshelter occupation sites Small pithouse villages Cairns and cairn lines Animal kill and processing sites Lithic processing sites Plant processing sites Pictograph and petroglyph sites Prehistoric trails

TABLE 4.9-3 (Cont.)

Culture Area	Paleoindian	Middle Period or Archaic	Late or Sedentary Period
Plateau	*10,000 to 6000 BC* Open campsites Cave or rockshelter occupation sites Fishing sites Lithic processing sites Animal kill or processing sites	*6000 to 2000 BC* Open campsites Small pithouse villages Cave occupation sites Animal or fish processing sites Plant processing sites Animal kill or processing sites	*2000 to AD 1750* Pithouse and longhouse villages, often with burials Tipi ring sites Cave burials Cairns and cairn lines Open campsites Cave occupation sites Storage pits Animal or fish processing sites Lithic processing sites Plant processing sites Pictograph and petroglyph sites Animal kill or processing sites Prehistoric trails

Source: Modified from BLM (2007b).

(Turner 1979). Figure 4.9-2 shows the distribution of the Native American tribes in the Great Plains cultural region.

The Spanish were the first Europeans to explore the Great Plains region, arriving in the early 1500s. They were followed by several other expeditions led by the French and British. The United States acquired French claims to the Great Plains region in 1803 as part of the Louisiana Purchase. After the Lewis and Clark expedition of 1804–1806 created the first reliable maps of the region, Euro-American settlement began to increase. At first, most Euro-Americans crossed the Great Plains looking for rich lands farther west. The number of people heading west grew with the discovery of gold in California in 1849. Homesteading laws passed during the 1860s encouraged new settlement; however, much of the Great Plains was not suitable for agriculture. By the late nineteenth century, ranching and farming came to dominate the economy of the Great Plains. The economic landscape further altered with the introduction of railroads in the late nineteenth century. Railroads allowed the goods from the Great Plains region to be sold on both the East and West Coasts. Table 4.9-4 provides a State-by-State overview of the types of historic resources found in the Great Plains cultural region. The table is not comprehensive but is intended to provide a sample of the types of resources in each State.

4.10 SOCIOECONOMICS

The socioeconomic environment potentially affected by the development of wind resources in the UGP Region includes six States—Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. In the following sections, 10 key measures of economic development are described. These are employment, unemployment, personal income, State sales and income tax revenues, population, vacant rental housing, State and local government expenditures and employment, and recreation. For each State development measure, projected data are presented for 2010, the first year during which construction impacts

FIGURE 4.9-2 Native American Tribes of the Great Plains (Source: DeMallie 2001)

TABLE 4.9-4 Major Culture Areas and Historic Period Site Types (AD 1550 to present) by State

State	Culture Areas	Range of Historic Resources
Iowa	Great Plains, Northeast	Fur trade sites, trading posts, military outposts, farming sites, ranching sites, mining sites, railroads
Minnesota	Great Plains, Northeast	Fur trade sites, trading posts, military outposts, farming sites, ranching sites, mining sites, railroads
Montana	Great Plains, Plateau, Great Basin	Fur trade sites, trading posts, military outposts, historic trails, farming sites, ranching sites, mining sites, railroads
Nebraska	Great Plains	Fur trade sites, trading posts, military outposts, farming sites, ranching sites, railroads
North Dakota	Great Plains	Fur trade sites, trading posts, military outposts, historic trails, farming sites, ranching sites, mining sites, railroads
South Dakota	Great Plains	Fur trade sites, trading posts, military outposts, agricultural sites, ranching sites, mining-related sites, military outposts, railroads

associated with wind developments are assessed, and for a recent preceding period. Forecasts for each measure are based on population forecasts produced by the U.S. Census Bureau for the period 2009–2030 (U.S. Census Bureau 2009e).

4.10.1 Key Measures of Economic Development

4.10.1.1 Employment

In 2008, more than 45 percent (2.8 million) of all employment in the six States (6.2 million) was concentrated in Minnesota (table 4.10-1). Employment in Iowa and Nebraska stood at 1.6 million and 1.0 million, respectively; the remaining States support 1.3 million jobs. Employment in the six States as a whole was projected to increase to 6.3 million in 2010.

Over the period 1990–2008, annual employment growth rates were higher in North Dakota (1.4 percent) and Montana (1.3 percent) than elsewhere in the six States. At 1.1 percent, the growth rate in Minnesota was somewhat higher than the average rate of 1.0 percent.

4.10.1.2 Unemployment

For the six States, unemployment rates are higher than the average in each of the States for the period 1990 to 2008 (table 4.10-2), and the current average for all the States is currently higher than the six-State average for the preceding 18-year period. Current unemployment rates in Minnesota (7.6 percent) and Montana (5.6 percent) are slightly higher

TABLE 4.10-1 State Employment (millions)

State	1990	2008	Average Annual Growth Rate, 1990–2008	2010 (projected)
Iowa	1.4	1.6	0.8%	1.6
Minnesota	2.3	2.8	1.1%	2.8
Montana	0.4	0.5	1.3%	0.5
Nebraska	0.8	1.0	1.0%	1.0
North Dakota	0.3	0.4	1.4%	0.4
South Dakota	0.3	0.4	0.9%	0.4
Total[a]	5	6.2	1.0%	6.3

[a] Totals may not be exact because of rounding.

Source: DOL (2009a).

TABLE 4.10-2 Unemployment Data

State	Average 1990–2008 (percent)	Current Rate[a] (percent)	Currently Unemployed Persons[a]
Iowa	4.0	4.8	69,005
Minnesota	4.4	7.6	159,825
Montana	5.2	5.6	22,704
Nebraska	3.2	4.3	33,217
North Dakota	3.5	4.4	13,511
South Dakota	3.7	4.2	11,670
Average	4.0	5.2	–

[a] Note: Data for current unemployment rates and the number of unemployed persons are for January 2009.

Sources: DOL (2009a–c).

than those in the remaining four States. With the exception of Minnesota, relatively small labor forces exist in each of the States. However, there are fairly large numbers of local workers who are presently unemployed in each State and therefore potentially available to work on the proposed energy developments within the States.

4.10.1.3 Personal Income

Minnesota generated more than 46 percent of personal income in the six States, producing almost $213.1 billion in 2006 (table 4.10-3). The State is expected to generate more than $221.2 billion in 2010. For the six States as a whole, personal income is expected to rise from $462.4 billion in 2006 to $473.4 billion in 2010.

TABLE 4.10-3 State Personal Income ($ billions 2007)

State	1990	2006	Average Annual Growth Rate, 1990–2006	2010 (projected)
Iowa	79.4	104.5	1.7%	105.5
Minnesota	143.3	213.1	2.5%	221.2
Montana	20.3	31.0	2.7%	32.0
Nebraska	46.7	64.6	2.1%	65.3
North Dakota	18.5	26.9	2.4%	27.3
South Dakota	16.7	22.2	1.8%	22.2
Total[a]	324.8	462.4	2.2%	473.4

[a] Totals may not be exact because of rounding.

Sources: DOC (2009); DOL (2009d).

Annual growth in personal income was highest in Montana over the period 1990 to 2006 at 2.7 percent. Elsewhere in the six-State region, personal income growth rates in Minnesota (2.5 percent) and North Dakota (2.4 percent) were higher than the six-State average rate of 2.2 percent.

4.10.1.4 Sales Tax Revenues

Sales tax revenues are projected to grow for the six States as a whole from $14.6 billion in 2002 to $15.3 billion in 2010 (table 4.10-4). Growth is also expected for each individual State over the period 2002 through 2010, with revenues in the largest generating State, Minnesota, projected to reach $7.6 billion in 2010.

Higher than average annual growth in sales tax revenues during the period 1992 to 2002 occurred in Iowa (7.9 percent) and Minnesota (7.7 percent). The average annual growth rate for the six States as a whole during the period 1992 to 2002 was 7.4 percent.

4.10.1.5 Individual Income Tax Revenues

In 2002, Minnesota generated almost 60 percent of State individual income tax revenues in the six States, producing $6.5 billion (table 4.10-5). Iowa was the second largest State income tax producer, with $2.2 billion in 2002. Revenues for the entire region are projected to increase from $10.9 billion in 2002 to $11.5 billion in 2010. Revenues in Minnesota are expected to reach $7.0 billion in 2010.

With the exception of Iowa, where individual income tax growth was negative (–0.8 percent), the six States experienced moderately large annual increases in State income tax revenues during the period 1992–2002. Growth rates in Minnesota (3.1 percent) and Nebraska (2.7 percent) were higher than the average for the six-State region of 2.1 percent.

TABLE 4.10-4 State Sales Taxes ($ billions 2007)

State	1992	2002	Average Annual Growth Rate 1990–2002	2010 (projected)
Iowa	1.6	3.4	7.9%	3.5
Minnesota	3.4	7.1	7.7%	7.6
Montana[a]	–	–	–	–
Nebraska	1.2	2.2	6.3%	2.2
North Dakota	0.6	1.1	6.7%	1.1
South Dakota	0.4	0.8	7.0%	0.8
Total[b]	7.2	14.6	7.4% ave.	15.3

[a] There is currently no State sales tax in Montana.

[b] Totals may not be exact because of rounding.

Sources: U.S. Census Bureau (2009c); DOL (2009d).

TABLE 4.10-5 State Individual Income Taxes ($ billions 2007)

State	1992	2002	Average Annual Growth Rate 1990–2002	2010 (projected)
Iowa	2.8	2.2	–0.8%	2.2
Minnesota	4.8	6.5	3.1%	7.0
Montana	0.5	0.6	1.9%	0.6
Nebraska	1.1	1.4	2.7%	1.4
North Dakota[a]	–	–	–	–
South Dakota	1.2	0.2	2.1%	0.2
Total[b]	8.9	10.9	2.1% ave.	11.5

[a] There is currently no State individual income tax in North Dakota.

[b] Totals may not be exact because of rounding.

Sources: U.S. Census Bureau (2009c); DOL (2009d).

Montana had relatively slow growth in individual income tax revenues during this period (1.9 percent).

4.10.1.6 Population

Total population in the six States stood at 11.9 million in 2000, and is expected to reach 12.6 million by 2010 (table 4.10-6). Population in the region is concentrated in Minnesota, which at 4.9 million had more than 40 percent of total regional population in 2000. Population in

TABLE 4.10-6 State Population (millions)

State	1990	2000	Average Annual Growth Rate 1990–2000	2010 (projected)
Iowa	2.8	2.9	0.5%	3.0
Minnesota	4.4	4.9	1.2%	5.4
Montana	0.8	0.9	1.2%	1.0
Nebraska	1.6	1.7	0.8%	1.8
North Dakota	0.7	0.8	0.8%	0.8
South Dakota	0.6	0.6	0.1%	0.6
Total[a]	10.9	11.9	0.9%	12.6

[a] Totals may not be exact because of rounding.

Source: U.S. Census Bureau (2009d,e).

Minnesota is expected to increase to 5.4 million by 2010. With the exception of Iowa (2.9 million) and Nebraska (1.7 million), the remaining States had less than 1 million persons in 2000.

Population in the six States grew at an annual average rate of 0.9 percent over the period 1990 to 2000. Growth within the region was fairly uneven over the period, with slightly higher annual growth rates in Minnesota and Montana (1.2 percent). Growth rates in Nebraska and North Dakota (0.8 percent) were less than the average for the region (0.9 percent), with a lower than average rate in South Dakota (0.1 percent).

4.10.1.7 Vacant Rental Housing

With the largest population in the six-State region, Minnesota also has the largest housing market and the largest number of vacant rental housing units (table 4.10-7). The total vacant rental units in the State stood at 36,700 in 2000 (38 percent of the six-State total), and is expected to reach 40,500 in 2010. Elsewhere in the region, Iowa (20,400 units) and Nebraska (15,500) had larger numbers of vacant rental units than the Dakotas and Montana. The number of units in the region as a whole stood at 96,200 in 2000, and is expected to reach 101,900 by 2010.

There has been a slight increase in the number of vacant rental units over the period 1990–2000, with an overall annual growth rate of 1.0 percent. A number of States, notably North Dakota (–2.2 percent), Nebraska (–1.4 percent), and Iowa (–1.3 percent), have seen declines in the number of vacant units, while among the remaining States, Minnesota (6.0 percent) has experienced a relatively large increase in vacant rental units.

4.10.1.8 State and Local Government Expenditures

Funding for State and local government services is concentrated in Minnesota, with $48.3 billion in government expenditures in 2002, representing almost 47 percent of all

TABLE 4.10-7 Vacant Rental Housing Units (thousands)

State	1990	2000	Average Annual Growth Rate 1990–2000	2010 (projected)
Iowa	23.3	20.4	–1.3%	21.0
Minnesota	20.5	36.7	6.0%	40.5
Montana	9.2	9.6	0.5%	10.3
Nebraska	18.0	15.5	–1.4%	16.1
North Dakota	8.0	6.4	–2.2%	6.7
South Dakota	7.6	7.5	–0.2%	7.4
Total[a]	86.6	96.2	1.0%	101.9

[a] Totals may not be exact because of rounding.

Source: U.S. Census Bureau (2009d).

government expenditures in the six-State region (table 4.10-8). Expenditures in Minnesota are expected to reach $52.0 billion in 2010. Other States with relatively large State and local government expenditures are Iowa ($23 billion), and Nebraska ($14.9 billion). Expenditures in the six-State region were $103 billion in 2002 and are expected to reach $107.8 billion by 2010.

Annual growth rates in State and local government expenditures have been moderately high throughout the region, with an overall annual average rate of 3.1 percent over the period 1990–2002. A number of States, notably Minnesota (3.4 percent) and North Dakota (3.1 percent), had growth rates higher than the regional average, while the growth rate in South Dakota (1.9 percent) was significantly lower than the six-State average during the period.

4.10.1.9 State and Local Government Employment

Of State and local government employment in the six-State region in 2006, 39 percent was centered in Minnesota (table 4.10-9). Government employment in the State stood at 280,800 in 2002 and is projected to reach 288,700 in 2010. Other States with fairly large government employment in 2006 were Iowa (182,400) and Nebraska (113,600). Total employment in the six-State region was 771,500 in 2006, and is expected to reach 729,200 in 2010.

Growth in government employment in the six States has varied over the period 1990–2006. While the average for the region stood at 0.8 percent over the period, governments in South Dakota, for example, increased their employment by 1.2 percent, with a smaller increase in Montana (1.0 percent). The majority of the States were within half a percentage point of the regional average.

TABLE 4.10-8 Total State and Local Government Expenditures ($ billions 2007)

State	1992	2002	Average Annual Growth Rate 1990–2002	2010 (projected)
Iowa	17.1	23.0	3.0%	23.4
Minnesota	34.6	48.3	3.4%	52.0
Montana	5.1	6.7	2.8%	7.0
Nebraska	11.3	14.9	2.8%	15.2
North Dakota	3.7	5.1	3.1%	5.2
South Dakota	4.1	5.0	1.9%	4.9
Total[a]	76.0	103.0	3.1%	107.8

[a] Totals may not be exact because of rounding.

Sources: U.S. Census Bureau (2009c); DOL (2009d).

TABLE 4.10-9 Total State and Local Government Employment (thousands)

State	1997	2007	Average Annual Growth Rate 1997–2007	2010 (projected)
Iowa	168.5	182.4	0.8%	183.6
Minnesota	260.2	280.8	0.8%	288.7
Montana	50.9	56.0	1.0%	57.2
Nebraska	105.0	113.6	0.8%	114.5
North Dakota	39.8	43.4	0.9%	43.9
South Dakota	36.6	41.3	1.2%	41.4
Total[a]	661.2	717.5	0.8%	729.2

[a] Totals may not be exact because of rounding.

Source: U.S. Census Bureau (2009c).

4.10.1.10 Recreation

Recreation is of particular importance in many areas where wind technologies may be located; the various natural, ecological, and cultural resources attract visitors who use these resources for a range of activities, including hunting, fishing, boating, canoeing, wildlife watching, camping, hiking, horseback riding, mountain climbing, and sightseeing.

Although visitation statistics are collected for the more popular recreational activities and by the major Federal land administering agencies, specific locations where wind developments may be located are not available, meaning that the number of visitors to potentially affected recreational resources and the value of recreational resources in these areas cannot be estimated using this approach. In addition to visitation rates, the significance of certain natural resources can also be assessed in terms of the potential recreational destination for current and future users, that is, their non-market value. Another method is to estimate the economic impact of the various recreational activities supported by natural resources in States where wind developments may occur.

Economic Valuation of Public Lands Used for Recreation. A simple way to quantify the value of recreation on public land would be to measure revenue generated by user fees and other charges for public use. However, visitation statistics are often incomplete, and, in many cases, Federal and State agencies do not charge visitors a fee for entrance to recreational resources on public lands. Even where these are charged, they may be nominal compared to the value of the visit to recreational users. Recreation undertaken using privately owned facilities, such as golf clubs or horse ranches, or fishing on private waters, has a quantifiable market value, with the user paying rates for visiting these facilities that reflect the value of the resource to its owners and the cost of providing access to it to visitors. With the majority of the types of recreation in the immediate vicinity of proposed wind projects likely to occur on public lands, however, the economic value of these resources is more difficult to quantify, as no valuation of the use of these resources can be made through the marketplace.

A number of methods have been used to determine the use value of non-marketed recreational goods, or the value of recreational resources on public lands that may be used for recreation. As recreational resources on public land are scarce, and recreational activities provide enjoyment and satisfaction, the amount visitors would pay over the actual cost of using these resources represents the value of the benefit of these resources to the public. One method of estimating the net willingness to pay, or consumer surplus, associated with resources on public lands used for recreation is the travel cost method. This method uses variation in the cost of traveling different distances and the number of trips taken over each distance as a way to represent the demand for recreational resources in any given location (Loomis and Walsh 1997).

In addition to use values, a certain portion of the value of resources used for recreation may lie in the passive use of a resource, or the availability of the resource to current and future generations. Attempts to establish passive use values, or the willingness to pay for or accept compensation for the loss of, different levels of non-marketed recreational resources on public lands have used contingent valuation methods, which rely on telephone interviews or questionnaire surveys. Typically, a description of a particular resource is presented to respondents, who are then asked to place a dollar value on their use of the resource, or on the preservation of the resource (Loomis 2000). Although the travel cost and contingent valuation methods have weaknesses, particularly with regard to the accuracy of questions asked and respondents self-reporting errors, both have been used widely by government agencies in benefit-cost analyses of outdoor recreation. Reclamation, for example, used contingent valuation to place a value on the impact of hydropower activities in Utah and Colorado on fishing and rafting (Reclamation 1995), the DOI used the method in establishing the value of natural resources damaged by oil spills in Alaska (DOI 1994), and various State agencies have used the travel cost and contingent valuation methods for valuing wildlife-related recreation (Loomis 2000).

Loomis (2000) reports the results of various studies that used survey data and travel cost and contingent valuation methods to estimate the value of recreation in wilderness areas in Colorado and Wyoming. Based on data reported in these studies, the average value per day of visiting a wilderness area for recreation was estimated to be $26 (1996 dollars), meaning that a visitor would be willing to pay this amount more than trip travel cost rather than lose a day visiting an area for recreation. Multiplying this number by the number of visitors to a specific wilderness resource would give the value of the resource to the public (Loomis 2000). Contingent valuation has also been used to establish the willingness to pay to preserve existing wilderness areas and additional acreage that might be designated as wilderness. Based on two surveys of Colorado and Utah residents, Walsh et al. (1984) and Pope and Jones (1990) found that passive use values varied with the level of wilderness already designated in a State, but at a decreasing rate. Passive use value was also found to represent about half of the economic value of a resource, equaling the use value of the resource to a household as a place for recreation. The same surveys found that residents in Colorado and Utah and in the rest of the United States would pay between $220 per additional acre, if 5–10 million ac of wilderness resources were to be preserved in the two States, and $1,246 per acre, if only 1.2 million additional acres were preserved. Passive use values in the western United States were estimated to be $168 per acre, or about $7.2 billion when applied to all wilderness land in the West.

Economic Impact of Recreational Activities. The economic value of recreation in each State in which wind developments may be located can be estimated by measuring the impact recreation has on the economy of each State by identifying sectors in each State economy in which expenditures on recreational activities occur. Although not all activities in these sectors are directly related to recreation on Federal lands, with some activity also occurring on private land (dude ranches, golf courses, bowling alleys, movie theaters, etc.), it is likely that the majority of individuals drawn to recreational activities in these sectors are primarily attracted by the prospect of visiting recreational resources located on adjacent Federal land.

Expenditures associated with recreational activities form an important part of the economy of the States in which they are located. In 2006, there were more than 250,000 people employed in Minnesota in the various sectors identified as recreation, constituting nearly 10 percent of total State employment (table 4.10-10). Recreation spending also produced almost $5 billion in income in the State in 2006. Recreational activities in Nebraska supported 91,234 jobs in 2006 and produced $1.5 billion in income, with smaller totals in Montana (67,884 jobs and $1.1 billion in income), South Dakota (48,409 jobs and $0.8 billion in income), and North Dakota (36,871 jobs and $0.6 billion in income). Recreation employment in most of the six States was between 10 percent and 14 percent of total State employment, with larger shares in Montana (14 percent) and South Dakota (11 percent).

4.11 ENVIRONMENTAL JUSTICE

Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (February 16, 1994), formally requires Federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs them to address, as appropriate, any disproportionately high and adverse human health or

TABLE 4.10-10 State Recreation Sector[a] Activity, 2006

State	Employment	Share of State Employment (percent)	Income ($m)
Iowa	15,156	9.5	2,421
Minnesota	266,247	9.5	4,912
Montana	67,884	14.2	1,097
Nebraska	91,234	9.7	1,477
North Dakota	36,871	10.5	567
South Dakota	48,409	11.4	763

[a] The recreation sector includes Amusement and Recreation Services, Automotive Rental, Eating and Drinking Places, Hotels and Lodging Places, Museums and Historic Sites, RV Parks and Campsites, Scenic Tours, and Sporting Goods Retailers.

Source: MIG, Inc. (2009).

environmental effects of their actions, programs, or policies on minority and low-income populations.

The analysis of the impacts of solar energy projects on environmental justice issues follows guidelines described in the Council on Environmental Quality's (CEQ's) *Environmental Justice Guidance under the National Environmental Policy Act* (CEQ 1997). The analysis method has three parts: (1) a description of the geographic distribution of low-income and minority populations in the affected area is undertaken; (2) an assessment is made of whether the impacts of construction and operation would produce impacts that are high and adverse; and (3) if impacts are high and adverse, a determination is made as to whether these impacts disproportionately affect minority and low-income populations.

Construction and operation of wind energy projects in the six States could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development are significantly high, and if these impacts would disproportionately affect minority and low-income populations. If the analysis determines that health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. In the event that impacts are significant, disproportionality would be determined by comparing the proximity of any high and adverse impacts to the locations of low-income and minority populations.

Analysis of environmental justice issues associated with the development of wind facilities considered impacts at the State level in six western States: Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. A description of the geographic distribution of minority and low-income groups was based on demographic data from the 2000 census (U.S. Census Bureau 2009d) to describe the minority and low-income composition in the affected area. The following definitions were used to define minority and low-income population groups:

- **Minorities.** Persons are included in the minority category if they identify themselves as belonging to any of the following racial groups: (1) Hispanic,

(2) Black (not of Hispanic origin) or African-American, (3) American Indian or Alaska Native, (4) Asian, or (5) Native Hawaiian or Other Pacific Islander.

Beginning with the 2000 census, where appropriate, the census form allows individuals to designate multiple population group categories to reflect their ethnic or racial origins. In addition, persons who classify themselves as being of multiple racial origins may choose up to six racial groups as the basis of their racial origins. The term *minority* includes all persons, including those classifying themselves in multiple racial categories, except those who classify themselves as not of Hispanic origin and as White or "Other Race" (U.S. Census Bureau 2009d).

The CEQ guidance proposed that minority populations should be identified where either (1) the minority population of the affected area exceeds 50 percent, or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

This PEIS applies both criteria in using the Census Bureau data for census block groups, wherein consideration is given to minority populations that are both over 50 percent and 20 percentage points higher than in the State (the reference geographic unit).

- **Low-Income Populations.** Individuals who fall below the poverty line are included in this category. The poverty line takes into account family size and age of individuals in the family. In 1999, for example, the poverty line for a family of five with three children below the age of 18 was $19,882. For any given family below the poverty line, all family members are considered to be below the poverty line for the purposes of analysis (U.S. Census Bureau 2009d).

Table 4.11-1 shows the minority and low-income composition of total population located in the six States based on 2000 census data and CEQ guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals also identifying themselves as being part of one or more of the population groups listed in the table.

While there is a relatively large number of minority individuals in Minnesota, Iowa, and Nebraska, the minority percentage of total population does not exceed 50 percent in any of the six States likely to host wind energy developments. In addition, the percentage of minority individuals does not exceed the six-State average (10.6 percent) by 20 percentage points or more in any of the States. Therefore, according to CEQ guidelines, these States do not have minority populations. The number of low-income individuals does not exceed the six-State (9.5 percent) average by 20 percentage points or more in any of the States, and does not exceed 50 percent of the total population in any of the States, meaning that there are no low-income populations in these States, according to CEQ guidelines. Individual wind energy projects and associated transmission lines would be subject to additional NEPA reviews, based

TABLE 4.11-1 State Minority and Low-Income Populations

Parameter	Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota
Total Population	2,926,324	4,919,479	902,195	1,711,263	642,200	754,844
White, Non-Hispanic	2,710,344	4,337,143	807,823	1,494,494	589,149	664,585
Hispanic or Latino	82,446	143,382	18,081	94,425	7,786	10,903
Non-Hispanic or Latino Minorities	133,534	438,954	76,291	122,344	45,265	79,356
One Race	108,062	368,650	62,523	104,648	38,599	70,396
Black or African-American	60,744	168,813	2,534	67,537	3,761	4,563
American Indian or Alaskan Native	7,955	52,009	54,426	13,460	30,772	60,988
Asian	36,345	141,083	4,569	21,677	3,566	4,316
Native Hawaiian or Other Pacific Islander	888	1,714	425	647	218	219
Some Other Race	2,130	5,031	569	1,327	282	310
Two or More Races	25,472	70,304	13,768	17,696	6,666	8,960
Total Minority	215,980	582,336	94,372	216,769	53,051	90,259
Low-Income	258,008	380,476	128,355	161,269	73,457	95,900
Percent Minority	7.4%	11.8%	10.5%	12.7%	8.3%	12.0%
Percent Low-Income	9.1%	7.9%	14.6%	9.7%	11.9%	13.2%

Source: U.S. Census Bureau (2009d).

on the location of specific projects. Because individual project reviews would be based on the analysis of populations within a 50-mi (80-km) area around proposed project locations, these reviews would analyze the distribution of low-income and minority populations at the local level, and would describe environmental justice populations that could be significantly different from those described at the six-State level in the PEIS.

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5 ENVIRONMENTAL CONSEQUENCES

The following sections discuss potential positive and negative environmental impacts of wind energy development for a broad range of resource areas of concern.

The purpose of this chapter is to present the broadest possible range of impacts for wind energy developments, associated transmission facilities, and other off-site infrastructure that might be required to support development related to the proposed action. Because this is a programmatic evaluation, site-specific and species-specific issues associated with individual wind energy development projects cannot be assessed in detail. Rather, this chapter identifies the range of possible impacts on resources present in the portion of the six-State area that falls within the UGP Region (figure 1-2). The assessment considers both direct and indirect impacts. Direct impacts are those effects that could result solely and directly from wind energy projects, such as soil disturbance, habitat fragmentation, or noise generation. Indirect impacts are impacts that may occur later in time or be farther removed in distance, but are still reasonably foreseeable. Indirect impacts are those effects that are related to construction and operation of wind energy projects but that are the result of some intermediate step or process, such as changes in surface water quality because of soil erosion at a construction site. Any specific project would not be expected to cause all of the environmental impacts discussed in this section since impacts are largely dependent on the resources and conditions present at a project site. However, the impacts of most projects should fall within the type and range of impacts identified in this analysis.

Depending upon which resource is being evaluated, direct and indirect impacts may (1) be confined to a specific long-term footprint for a wind energy project, (2) extend beyond the immediate project area (e.g., an area within which habitat fragmentation, population-level effects, or regional effects may occur), or (3) extend over a much larger area (e.g., reductions in greenhouse gas [GHG] emissions; county-level effects on socioeconomics; visual impacts). This assessment discusses potential impacts and mitigation measures across all of these spatial areas as they are relevant to specific resources. The impact assessment is discussed in terms of common impacts (impacts that could occur for almost any wind energy development project). Potential impacts associated with development of transmission and access road corridors for projects are described generically, without assumptions on the length of the transmission corridors or the new roadways that would be required.

There is about 228.6 million ac (92.5 million ha) of land within the 6 States in the UGP Region study area, with non-Federal lands comprising about 90 percent of that acreage. Of this area 52.6 million ac (21.3 million ha) of all lands are classified as being highly suitable for utility scale wind energy development (see appendix E for description of the suitability model). Within this acreage is a smaller subset of highly suitable lands of about 25.1 million ac (10.2 million ha) that are located within 25 mi (40 km) of Western's transmission and substation facilities (which is called Western's Transmission Area hereafter) and that are considered to be the most likely areas for connections to Western's facilities to occur. The analyses presented in this section recognize that wind energy development could occur anywhere within the UGP Region, but assume that such development is most likely to take place in the areas with the highest suitability. While Federal lands comprise about 10 percent of the study area, about 40 percent of those Federal lands are not available for potential wind energy development because of

Congressional or other Federal agency decisions. Examples of this include units of the National Park System, National Wildlife Refuges, designated wilderness, and wild and scenic rivers.

The types of impacts of wind energy development generally would be expected to be the same on non-Federal and Federal lands (e.g., impacts on wildlife habitats, land cover, and erosion); however, development on Federal lands generally requires mitigation that may not be required for non-Federal lands. For example, where land included in a Service-administered easement would be affected by accommodation of wind energy development, replacement land would be required, through an easement exchange to offset the anticipated losses in conservation value (see section 2.1.2). In addition, because there is a much smaller amount of Federal land compared to non-Federal land within Western's UGP Region, and because of the additional environmental review and mitigation requirements to be satisfied before utilizing Federal lands, it is likely that development of Federal lands will not be as common. At the time of preparation of this draft PEIS, only 33 wind turbines from four different wind energy projects had been placed on Service easements within the UGP Region, and no wind energy developments had been constructed on BLM-administered lands in Montana or the Dakotas as of the date of this PEIS.[1] This is compared to an estimated 5,733 turbines installed as of 2010 within the 6 States overlaid by the UGP Region.

Although the types of impacts of wind energy development generally would be the same on Federal and non-Federal lands, because much of the anticipated development is expected to occur on private lands, some impacts are expected to be substantially less significant on non-Federal lands. For example, Federal lands are generally open to a wide array of public recreation uses (e.g., hunting, hiking, and camping) while non-Federal lands, especially private lands, are not generally available to the general public for these uses. For that reason, wind energy development on private lands would not have a substantial effect on these uses where they are not currently allowed by the landowner. On Federal lands, there might be a significant loss of recreation opportunities.

Appendix B provides an analysis of the projected wind energy development in the UGP Region by 2030, including estimates of the number of turbines that would be constructed and the land areas needed for the projected levels of development. Based on information for 27 wind energy projects within the UGP Region and information developed by Denholm et al. (2009) about the land areas affected by wind energy projects, it is estimated that an average project would be composed of approximately 75 turbines and would encompass an area of about 9,500 ac (3,845 ha) (including permanently disturbed, temporarily disturbed, and undisturbed lands[2]). Combined with the estimates for wind energy installation by 2030 presented in section 2.4, it is anticipated that approximately 115 to 400 new wind energy projects, encompassing a total area of about 1.1 to 3.8 million ac (0.4 to 1.5 million ha) could be developed within the UGP Region States by 2030; most of the identified land area would not be

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1 Based on information from the BLM Montana/Dakotas Renewable Energy Web site, available at http://www.blm.gov/mt/st/en/prog/energy/renewable.html#Geothermal. Accessed June 17, 2011.

2 Project area refers to the entire land encompassed by a polygon connecting the outermost turbine towers. Within that project area, there are lands that will remain undisturbed (i.e., no surface disturbance). Temporarily disturbed areas refer to the land within the project area that will have surface disturbance during characterization and construction activities, but will be restored once construction has been completed. Permanently disturbed areas refer to the land within the project area upon which project facilities, such as turbine towers and access roads, will be placed; such lands will typically be unavailable for other uses until the project has been decommissioned and post-project restoration activities have been completed.

directly disturbed by project activities. Assuming about 0.7 ac (0.3 ha) of permanent surface disturbance per MW (including the footprints of turbine towers, access roads, substations, and other associated infrastructure) (Denholm et al. 2009), the total permanent surface disturbance from new projects over this period could range from approximately 9,500 to 33,000 ac (3,845 to 13,355 ha). In addition to permanently disturbed areas, Denholm et al. (2009) estimated that development of wind energy projects temporarily disturbs, on average, about 1.7 ac (0.7 ha) of land per MW of capacity. Using this estimate, approximately 22,200 to 77,300 ac (8,984 to 31,282 ha) of land could be temporarily disturbed by new wind energy projects within the UGP Region States by 2030. The estimated total land area that would be encompassed by new projects needed to meet the projected build-out levels by 2030 would be about 2.1 to 7.2 percent of the area classified as having a high suitability for wind energy development within the UGP Region. It is estimated that about 0.02 to 0.06 percent of the lands classified as having a high suitability for wind energy development within the UGP Region would be permanently disturbed and about 0.04 to 0.15 percent would be temporarily disturbed at the projected level of new project development.

Construction of transmission lines to connect wind farms to Western's transmission and substation facilities as part of a proposed project would have to be analyzed as part of the NEPA analysis for a project. Because the siting and construction of new transmission facilities is expensive, difficult, and time consuming, minimizing the amount of new transmission line is a high priority for developers. Consequently, there are many instances where wind energy developments have been sited next to existing transmission facilities; however, opportunities like these are not unlimited and as the wind energy industry matures, these opportunities will decrease. Just as is the case with the location of wind farms, the location of future transmission facilities also cannot be predicted, but to provide some boundaries for the analysis in this PEIS some assumptions have been made based on the information above and in chapter 3: (1) since Western's Transmission Area contains about 50 percent of the lands rated as highly suitable for wind energy development in the UGP Region, it is assumed that from 58 to 200 of the anticipated new wind energy projects in the UGP Region by 2030 would connect to Western's facilities; (2) for the average-sized wind energy facility, a 69-kV capacity transmission line with a 50-ft (15-m) permanent transmission line ROW width would be required, along with a 20-ft (6-m) construction road ROW width, and together these require about 8.5 ac/mi of surface area; and (3) the average length of a transmission line would be 12.5 mi (20 km). Based on these assumptions, it is estimated that about 6,163 to 21,200 ac (2,494 to 8,579 ha) of land would be encompassed by transmission-related ROWs. This is likely a conservative estimate for most projects, since it assumes a construction-width road ROW for the full length of the average transmission line (a permanent road is not required for the full length of a transmission line in many cases), and a permanent road ROW is usually only 12–14 ft (3.6–4.3 m) wide. In addition, the largest long-term disturbance associated with a transmission line in prairie country most likely would be for any permanent access road, because almost all of the land in the transmission ROW is either never disturbed or is restored following temporary disturbance during construction.

Each of the following resource sections also provides a list of potential mitigation measures that could be used to eliminate, avoid, or minimize impacts from wind energy development projects. These potential mitigation measures were derived from reviews of past wind energy development activities (as described in chapter 3); published data regarding wind energy development impacts; existing, relevant mitigation guidance; and standard industry practices. Most of these measures are accepted practices that are considered effective when implemented properly at the project level, and many likely would be incorporated into proposed project descriptions. The applicability and effectiveness of many of these mitigation measures cannot be fully assessed except at a project-specific level when the project location and design are known.

Many of the potential mitigation measures indicate the need for project-specific plans. The content of such plans will depend on specific project requirements and locations, and their applicability and effectiveness also need to be evaluated at the project-specific level. The responsible agency or agencies (i.e., Western and/or the Service) would need to determine the adequacy of such plans when evaluating interconnection requests for wind energy or when reviewing applications to accommodate wind energy structures within existing easement projects. In many cases, other permitting authorities or land management agencies that would be affected by a proposed project would have to be consulted regarding the adequacy of proposed mitigation plans.

A complete description of the four alternatives analyzed in sections 5.1 through 5.13 is included in chapter 2.

5.1 LAND COVER AND LAND USE

This section identifies the types of environmental impacts that are commonly associated with the various phases (site characterization, construction, operations and maintenance, and decommissioning) of wind energy development projects on land cover and land use. For many of the potential impacts, the specific magnitude of effects would depend on the size of the project (e.g., number of turbines, miles of transmission line), location and configuration of a particular project, ownership of the land involved, and whether any of the identified impacts could be avoided, minimized, or offset through a combination of project planning considerations, BMPs, and mitigation measures.

The analysis focuses on potential impacts in 25.1 million ac (10.2 million ha) of Western's Transmission Area, which is considered to be highly suitable for wind energy development and the area in which newly constructed wind energy projects are most likely to request interconnection to Western's facilities (see Appendix E). It is also possible that there could be visual impacts on communities and sensitive areas located adjacent to or within sight of this highly suitable portion of the Western Transmission Area. There is no way to predict with certainty how much of the future wind energy development within the UGP Region might be connected to Western's Transmission System, because there are about 27.5 million ac (11.1 million ha) of high-suitability land outside of Western's Transmission Area and there are additional utilities in the region that could also provide connection services.

Inventoried land cover and land uses within the UGP Region (section 4.1), were used to identify impacts that could occur from wind energy developments. A wind energy project would have an impact on land cover if it would change or modify the existing land cover classification. Impacts on land use would occur if a wind energy development (1) conflicts with existing land use plans and community goals; (2) conflicts with Native American cultural or religious values or with existing recreational, agricultural, scientific, or other uses of the land; (3) conflicts with conservation goals; or (4) precludes future uses or alters the existing land use of the area (e.g., mineral extraction, recreation, agriculture). The land use analysis also considers potential indirect impacts on special status lands such as units of the National Park System, State parks, airports, and BLM-administered ACECs that could be adjacent or near to lands developed for wind energy production. In this analysis impacts are considered at three different levels: disturbance caused by the construction footprint of the turbines and associated facilities, the total area occupied by the wind farm, and the viewshed of the wind farm.

5.1.1 Common Impacts

5.1.1.1 Land Cover

Site Characterization. Site characterization for wind projects could include the installation of up to 10 meteorological towers to obtain data on pertinent weather conditions. Additional site characterization activities could include the collection of ecological and hydrological data, floodplain and wetland mapping, slope evaluations, seismic and soil stability studies, and the identification of archaeological and paleontological sites. Very little site modification would be necessary during this phase. Only a small work crew having no personnel support facilities would be required (section 3.2). A remote site could require construction of an access road, but new road development would not be needed during the characterization phase for most projects. Due to the limited amount of ground-disturbing activities that would be conducted during the site characterization phase, negligible changes in land cover classification would be expected for any project.

Construction. As described in section 3.3, construction of a wind energy project would involve activities including: site clearing and grading (including temporary laydown areas); establishment of an access road and an on-site road system; construction of turbines and an interconnection line; installation of permanent meteorological towers; construction of a control building, electrical power conditioning facilities and a substation, and other infrastructure; and installation of power-conducting and signal cables (typically buried). An on-site concrete batch plant and associated aggregate material storage area may also be required. Heavy equipment and a sizable workforce would be needed during the construction phase. While many wind energy developments could be constructed within 1 year or less, very large projects consisting of hundreds of turbines may be developed in phases and over several years (section 3.3).

The construction of a wind energy facility and its associated facilities would modify the existing land cover for a small proportion of a wind farm site over the life a project. In this PEIS it is assumed that there would be a long-term loss of land cover for all facilities within a wind farm equal to about 0.7 ac (0.3 ha) per MW of capacity. In most cases, between 2 and 5 percent of the land cover of a wind farm area is affected by permanent or temporary land disturbance, since project-related facilities do not require large-scale clearing of a project site. Temporary roads, laydown areas, and other areas that are disturbed but that are not needed for long-term operations would be restored after construction and would likely be quickly returned to their original use. It is estimated that 9,500 to 33,000 ac (3,845 to 13,355 ha) of existing land within the UGP Region would be permanently affected during the analysis period. For example, it is estimated that construction activities for the Wessington Springs Wind Project in Jerauld County, South Dakota, would alter up to 129 ac (52.2 ha) (approximately 4 percent) out of a total project area of 3,560 acres (1,441 ha) (Western and Service 2007). Of those areas affected by construction activities, up to 94 ac (38 ha) (approximately 74 percent) would be restored to the original condition (pastureland). In this particular case, about 42 ac (17 ha) (approximately 1 percent) of the land cover on the overall, project site would be affected long-term by construction and operation of the facility.

Accommodation of wind energy development on lands currently managed by the Service under wetland or grassland easements could also result in both temporary and permanent impacts on land cover, although, based on experience to date (only 33 turbines installed on grassland easements), it is anticipated this will not result in a significant amount of land cover disturbance. In addition, the conservation value of easements is affected indirectly by wind projects, because these developments can fragment habitat and result in adverse impacts on the behaviors of some wildlife species. These indirect effects will be evaluated and mitigation may be adjusted for impacts to conservation value outside the project footprint. The Sprague's pipit (currently a candidate species) is one such species adversely affected by fragmentation; this grassland bird prefers relatively large intact tracts of grass, preferably native prairie (Jones 2010). The pipit is also listed in the Birds of Conservation Concern 2008 publication by the Service (Service 2008), along with other grassland species; some of these, such as the grasshopper sparrow (*Ammodramus savannarum*), are sensitive to wind energy development of grassland habitats (Shaffer et al. 2012). Waterfowl can also be affected by establishment of turbines on easements (Loesch and Niemuth 2011). If the Service continues its policy of accommodating requests for wind energy development through easement exchanges for areas affected by turbine tower construction, the direct and indirect impacts on land cover and consequences to the conservation value of fragmented easements will need to be evaluated. Mitigation may be required to offset indirect impacts (i.e., outside the project footprint) caused by fragmentation.

Effects of wind energy projects sited within forested land cover could be more drastic since trees would need to be removed within and adjacent to the wind energy development in order to allow wind currents to reach turbines in an efficient manner. Restoration of the original forested land cover type in disturbed forested areas would be a long-term process, and in some cases, it might be impossible to reestablish the original cover type. Because of the higher level of environmental impacts, increased costs associated with tree removal, and the availability of large amounts of treeless lands within the Western Transmission Area, it is anticipated there would not be any wind energy development on heavily forested sites in the near future.

Transmission line construction also permanently impacts only a small percentage of the land included in a ROW. The major variable is whether a permanent access road must be constructed to access the line and support structures. For planning purposes, it is assumed that about 8.5 ac (3.4 ha) are temporarily disturbed per mile of ROW during construction of an access road, transmission line, and construction areas. After construction, depending on the type of land cover over which a transmission line has been constructed, most of the area would be revegetated. In the case of cultivated farmland, it is assumed the area within the ROW would continue to be farmed. In the case of construction in a forested area, the ROW would be managed to prevent regrowth of trees but would be stabilized with low-growing grasses and shrubs. Long-term disturbance would be associated with the transmission line poles/structures and any access roads needed to access and maintain structures. Prime farm land could be lost due to transmission line construction, but the amount lost would depend on the specific transmission line alignment. Western is required to evaluate the effect of any such loss and consider whether an alternate route should be adopted to avoid these areas.

Operations and Maintenance. Activities that would occur during operation of a wind energy facility would primarily include the operation of the turbines and transmission line and the maintenance of the turbines and wind facility grounds, including the associated access roads and transmission lines (section 3.4). Generally no additional ground disturbance over that disturbed during construction would occur. During operation, areas that were disturbed but not occupied by structures would likely be returned to the original land cover type. Areas occupied by structures would be classified as developed lands. Cultivated crop, grassland, or pastureland land cover types would likely be maintained over the majority of a wind energy project site.

Decommissioning. Decommissioning activities and the types of impacts for a wind energy development and associated transmission facilities would be much the same as for construction, although the dismantling and removal of infrastructure and the restoration and revegetation of the site to pre-project conditions would generally result in smaller levels of impacts since excavating and backfilling for tower foundations would not generally be needed during decommissioning. Access roads and other facilities would be removed and the disturbed areas restored and revegetated unless landowners prefer to retain roads or facilities for their use. Specific decommissioning treatments would be subject to landowner negotiations and the provisions of lease agreements. Facilities constructed on Federal lands would likely be removed.

As a result of decommissioning and revegetation of a wind energy development, the altered land cover classification established by the construction of a project could be changed, depending upon subsequent use of the area. Surrounding land cover may dictate what would be established at a decommissioned wind energy development site, but in the UGP Region it is likely that the land cover would remain cultivated crops, grasslands, or pastureland.

Mitigation. Generally, it is anticipated that land cover impacts would not be significant enough to require other than restoration of the land cover of temporarily disturbed areas following construction and restoration of ground cover at locations of towers during decommissioning; however, there could be important plant assemblages, unique habitats, or areas important to Native Americans that could require special consideration and that could affect a whole project or component locations within a project. In these types of instances, alternate siting would be a possible mitigating measure. Roads serving the site would need to be properly maintained to avoid erosion impacts.

5.1.1.2 Land Use

Lands within the UGP Region where wind energy development could occur include mostly non-Federal lands and some Federal lands that are currently used for a wide variety of activities, including agriculture and livestock grazing, conservation, recreation, mining, hunting, oil and gas production, wild horse management, military training, and right-of-way (ROW) corridors (e.g., roads, pipelines, and power lines) (section 4.1.2). Wind energy development activities could have direct or indirect effects on these uses, preventing or altering existing land use activities in the area of the wind energy development. On Federal lands, land use plans, policies, goals, regulations, or other land uses may also prevent or alter future wind development. Valid existing rights represented by existing permits or leases may convey superior rights to the use of public lands, depending upon the terms of the permits or leases. For instance, areas where there are existing mineral rights or oil and gas or other mineral leases may be precluded from wind energy development.

Development on non-Federal lands is subject to Federal, State, and local laws and regulations, but individual landowners have wide latitude in deciding how to manage their private lands. Where Federal lands are available for consideration for development, their use may be more restricted than private lands and is subject to Federal law and regulations and agency land use plans.

Areas on Federal land that are excluded from wind energy developments because of existing law, policy, or land use planning decisions include wilderness study areas; national monuments, natural landmarks, historic sites, memorials, and battlefields; wild and scenic rivers; and scenic and historic trails. Such lands would not incur direct land use impacts associated with utility-scale wind energy development, but they might incur indirect impacts from a wind energy development located on adjacent lands. Depending on the individual situation, visual impacts from wind energy development could affect specially designated areas and other sensitive resources at distances of 25 mi (40 km) or greater, since in most cases wind energy development would introduce an industrial character into areas that previously were undeveloped or rural in character, creating a stark contrast from the current situation. The distance at which transmission lines might affect nearby lands is less than that of wind farms, but their impact would need to be assessed on an individual basis. Section 5.7.1 discusses impacts on visual resources.

The specific impacts on land uses from wind energy developments would depend on the specific development location, development size and scale of operations, and proximity to roads and transmission lines. The following sections discuss the common impacts on different types of land uses during the various phases of a wind energy project and mitigation measures that may be applicable. Most potential impacts that are addressed under construction would carry over through the life of the development until decommissioning activities are completed and the development site is restored to pre-development conditions.

Site Characterization. Due to the limited activities that would occur during the site characterization phase, only minimal and short-term impacts on land uses would be expected. For example, disturbance of wildlife near the area of characterization activities could affect various recreational activities such as wildlife viewing and photography. Recreation uses would not be precluded, although recreational experiences based on undisturbed landscapes may be reduced due to the presence of equipment and possibly an access road. Depending on the height of temporary meteorological towers, there could be impacts to low-level military flights.

During site characterization, transportation activities would be largely limited to very low volumes of heavy-duty all-wheel-drive pickup trucks, medium-duty trucks, or personal vehicles.

It is likely that existing access roads would be used; thus, no special requirements or significant impacts related to transportation are anticipated for most projects.

Construction. Impacts to land use would depend on the type and level of use existing on and near the site. For example, if the land is privately owned, there may be little or no public use allowed, and for that reason there would be little or no loss of use if the land is developed for wind energy production. If there is no legal access to or through the development area, there would be no loss of public access. If there is federally administered land present and legal access to that land, some existing uses of the land could be affected or lost as a result of energy development. These potential impacts would all be site-specific and could only be quantified at the site-specific level.

Some existing uses of the land may be only temporarily disrupted during construction including the removal of livestock from areas and cessation of farming activities. On private land, both of these activities likely would continue after construction is complete. In the case of Federal lands, grazing would also continue, as would general access to the area. Temporary off-site or indirect impacts would also occur, including construction noise, dust, traffic, and the presence of a construction workforce that would temporarily affect the rural and undeveloped character of an area. Nearby parks and campsites may experience increased use by construction workers seeking temporary accommodations during project construction, which could displace recreational users from these sites, particularly on weekdays. Local community housing and services could also be stressed by additional population during the construction period.

Longer term impacts would occur to uses not compatible with wind energy and associated development. It is anticipated that the recreation value of lands used for wind energy development could be reduced because of the change in the overall character of the area from one that is rural and undeveloped to one that is more developed. There might be an increased interest in recreational driving on public roads that provide access to or through a wind energy facility because some people find these facilities of interest and may seek them out. Access to a wind energy site may have differential impacts on an area. In one instance, additional or better access to an area may open more area to use; alternatively, additional use of an area may further degrade values associated with hunting and backcountry opportunities. Impacts of transmission lines likely would be substantially less than for wind farm development because of their relative size and level of disturbance, but depending on the visual sensitivity of the area through or near which they pass, visual impacts could also occur.

Private lands have supported almost all of the wind development in the UGP Region, and private lands are normally not available for public uses such as those described above, so it is possible that the overall impact on these land uses could be very small. It cannot be assumed that private lands currently support significant amounts of public use or access, although it is not uncommon for these lands to be made available on a limited basis for hunting or other recreation activities. This could include access provided through lease agreements, especially hunting leases. Whether this kind of use would continue once construction has been completed would depend on the agreement between the landowner and the wind farm operator and the remaining attractiveness of the area for this type of use. Access, especially on private land, is not affected by most wind farm developments because new fences are not usually put in place and wind farms are usually not gated off. Lease agreements do not generally restrict landowner use of the land outside of substations, maintenance facilities, or the turbines themselves. Even if recreation access is not continued, it is not anticipated that this would result in a significant loss of use, because most areas suitable for wind energy development are not heavily used for recreation activities.

Utility-scale wind energy development could be incompatible with mineral development activities and could preclude these activities once wind energy facilities are developed. An exception to this could occur if oil and gas resources could be accessed under a wind energy facility utilizing offset drilling technologies or if there is adequate spacing between turbine installations to allow safe access for well development and operation. The eventual impact on mineral development would necessarily be determined at the site-specific level. The authorization of ROWs for transmission lines serving wind energy developments would be unlikely to affect mineral development activities.

The Federal lands that may be available for wind energy development, principally those managed by the Service, the USFS, and BLM, are open to public use; a key factor in that use is the presence or absence of reasonably available public access. While it is likely that these areas support higher levels of public recreation use and access than private lands, it is expected that most of these areas would still have relatively low levels of use. Exceptions to this likely exist within the high-suitability area, but they would be determined during a site-specific evaluation and/or may be identified by their proximity to areas that are excluded from wind energy development such as wild and scenic rivers, wilderness areas, wildlife refuges, or units of the National Park System.

Transmission line construction on Federal and non-Federal lands would not exclude most other uses of the land, although the scenic value of areas through which a transmission line would pass would be adversely affected. Maintenance roads associated with the transmission lines could provide additional access to Federal lands with both positive and negative impacts depending on the type of experience individuals are seeking. Depending on the specific location, because of their linear and generally less intrusive nature, transmission line ROWs likely would cause fewer impacts on recreational users than would the wind farms. Access to the land in the wind energy ROWs on Federal lands would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape and potential noise impacts associated with turbines and transmission lines. Access to ROWs on private land would be managed by private landowners and would not be expected to be generally available for public use.

The BLM and the USFS have policies in place for considering applications for commercial wind energy development that are considered in the context of the legal and regulatory authorities of each agency. Wind energy developments would not be constructed on lands managed or owned by the National Park Service and are not likely to be constructed on Department of Defense (DOD)- or Reclamation-administered lands, although the authority does exist for the latter two agencies to consider such requests.

The Service in Region 6 (which includes Montana, the Dakotas, and Nebraska in this PEIS) currently considers requests for wind energy development on grassland easements, although, as cited in the introduction to this section, only 33 turbines have been installed on such lands to date. Region 6 does not consider requests for use of lands in wetland easements, and Region 3 (which includes Iowa and Minnesota in this PEIS) does not consider requests for use on either wetland or grassland easements. In Region 6, the current approach is to review requests, determine the potential impact on the Service's conservation program, and if there is a way to accomplish the Service's program and accommodate the developer's request (perhaps with mitigation), the Service will consider approving a request. In the few instances where Service approvals have been given, it appears that mitigation requirements have offset direct loss of habitat due to the final project footprint incurred on areas that were developed. The affected footprints are to be restored upon project decommissioning. Offsite easement purchases were made to offset the temporal loss, but fragmentation and degradation of the remaining habitat(s) occurred. As recent research has shown (e.g., Shaffer et al. 2012; Loesch and Niemuth 2011), fragmentation and avoidance of wind facilities by wildlife is a known result of this development, which reduces its conservation value and the reason for which it was acquired. Thus, mitigation measures on future projects may include offsets for impacts on the entire conservation value of the habitat remaining on impacted easements and not just the footprint of the disturbed area. The Service does not consider wind energy development requests within national wildlife refuges.

Federal land areas such as wilderness study areas; national monuments; natural landmarks; historic sites, memorials, and battlefields; wild and scenic rivers; and scenic and historic trails can be especially sensitive to visual impacts caused by wind energy development located in proximity to them. Because of the relative scarcity of Federal lands within Western's Transmission Area, there may be few instances where such impacts would have to be considered, but there are 41 areas containing almost 400,000 ac (162,000 ha)[3] that could be adversely affected within Western's Transmission Area and within a 10-mi (16-km) area around that area. The 10-mi (16-km) area around Western's Transmission Area is included because of the potential visibility of wind energy developments. Especially sensitive units could include designated wilderness, units of the National Park System, National Historic and Scenic Trails, USFS roadless areas, recreation areas, and BLM ACECs that could be susceptible to adverse impacts if wind energy development is sited in such a way as to damage the setting in which these areas are located. State and local parks and other attractions could be similarly affected. Depending on the individual situation, wind energy developments may be visible from 25 mi (40 km) or more; the closer they are to sensitive areas, the more likely they are to adversely affect the setting and possibly the level of public use. The potential for these types of indirect impacts needs to be assessed on a case-by-case basis.

There are 538 public, private, and military airfields that are located in the high-suitability portions of the Western Transmission Area; there are 10.5 million ac (4.2 million ha) of MTRs/SUA that overlay portions of the Western Transmission Area and that support military training operations at elevations below 1,000 ft (305 m) above ground level (AGL); there are also 14.2 million ac (5.7 million ha) covered by line-of-sight Doppler weather radar coverage and an unknown number of acres covered by air traffic control and military radar sites located in or that have line-of-sight coverage over portions of the Western Transmission Area. All of these uses could be affected by the presence of wind energy developments within or near the Transmission Area. Impacts on aviation could occur if a wind energy development would be located within 20,000 ft (6,096 m) of an existing airport or if project components are more than 200 ft (61 m) in height. It is required that the Federal Aviation Administration (FAA) be notified if

[3] Includes 21 roadless areas, 182,294 ac (73,771 ha); 4 wilderness areas, 112,772 ac (45,637 ha); 2 wilderness study areas, 37,477 ac (15,166 ha); and 14 ACECs, 65,729 ac (26,599 ha).

either of these two conditions are met, with the agency determining whether the proposed development could adversely affect commercial, military, or private air navigation safety. Because of their generally shorter height, transmission facilities are less likely to cause adverse impacts on airport operations, but they still need to be considered. The general requirements regarding structures near airports are discussed in section 4.1.3.2. Placement of wind energy or related facilities near military airfields would require consultation with the military and the FAA. Based on the existing regulatory requirements administered by the FAA, it is anticipated there would be no effect on airport operations from construction of wind energy and transmission facilities within the Western Transmission Area.

Military aircraft operations within MTRs/SUA are sensitive, national defense related activities. The construction of wind turbines within these areas has the potential to affect the ability of the military to train and fly safely within existing training areas. Wind turbines also have the potential to interfere with both ground and airborne civilian and military radar operations. Military operations, civilian aviation, and weather tracking can be affected by radar interference associated with the operating turbines. For example, locations preferred for weather radar (e.g., few obstructions, nearby but not in populated areas) are also desirable sites for wind energy development. Wind energy development within about 12 mi (20 km) of weather radar will very likely cause some radar interference, and is almost guaranteed to cause conflicts within 6 mi (10 km) (Donaldson et al. 2008). Section 3.8.2.4 addresses radar interference. The potential impact on military use of training areas and on radar operations must be determined at the project-specific level. However, it is assumed that interference issues would be resolved through moving individual turbines or the entire wind farm and the impacts would be small.

Section 3.9 addresses transportation considerations related to the construction of a wind energy development. Impacts on the existing transportation system could occur if increases in traffic exceed established service levels, traffic delays affect other motorists, or roads are damaged. Short-term increases in traffic levels on local roadways would occur while equipment and materials are transported to the project area. Shipments of overweight and/or oversized loads could be expected to cause temporary disruptions on the secondary and primary roads used to access a construction site. Between 5 and 15 truck shipments would be necessary to transport each wind turbine generator. Also, 15 to 20 truckloads would be needed to transport the components of the main crane required to erect and assemble the wind turbine generators. Specified requirements could be needed for required ROWs, turning radii, and fortified bridges for shipment of the turbine components and main crane. Where a wind energy development would be located on a hilltop, access to the site with overweight and/or oversized loads may require that the access road climb the hill along a serpentine path due to grade restrictions. Visual impacts associated with such an access road are addressed in section 5.7.1.

Operations and Maintenance. Activities that would occur during operation of a wind energy facility would primarily include the operations and maintenance of the turbines, interconnection line, wind facility grounds, and access road. No additional ground disturbance beyond that required for construction would be expected, although maintenance activities might cause areas disturbed during initial construction to be disturbed and reclaimed again. Operation and maintenance of wind energy development would be compatible with a number of land uses and generally would not preclude recreational activities (including hunting), habitat conservation, livestock grazing, or other activities that may currently occur within the area.

Access requirements for inspection and maintenance along transmission line routes would be minimal, but access would take place on a scheduled basis. These activities would cause no additional surface disturbance outside of the ROW that could affect other uses of the land. Much of the inspection would be done using aircraft.

Because of surface disturbance, traffic, and revegetation activities during the construction phase, there will be a risk of noxious weeds becoming established and expanding during the operations and maintenance phase. If uncontrolled, noxious weeds could lead to a general reduction in vegetative condition throughout the wind farm and surrounding areas and could degrade conditions for agriculture, wildlife, and recreation uses.

No transportation-related impacts would be expected during most of the operational phase of a wind energy development. Only a small number of daily trips by pickups, medium-duty vehicles, or personal vehicles would be required by a maintenance crew of six or fewer individuals. Infrequent shipments of large components could be required for equipment replacement.

Decommissioning. The types of impacts that would occur during decommissioning of a wind energy development would be similar to those associated with construction, although they would disturb less area and the level of impacts would likely be considerably smaller. Removal of turbines would be conducted in essentially the reverse order from construction. However, whereas construction required large excavations and many truckloads of concrete and rebar for each foundation, decommissioning would need fewer hauling trips and less materials transport because in most cases only the small aboveground pedestal and a shallow portion of the underground foundation would be removed. Activities primarily include the dismantling and removal of infrastructure and the restoration and revegetation of the site to pre-project conditions, as feasible. Individual landowners could decide to maintain any access roads on their lands. Following decommissioning, land use impacts resulting from construction and operation of a wind energy development would be largely reversible and no additional permanent land use impacts likely would occur during this phase.

Transportation activities during decommissioning would be similar to, but likely less than, those described for construction. Major turbine components could be dismantled, segmented, or reduced in size prior to shipment. Therefore, the only oversized and/or overweight shipments expected would be for the main crane that would be needed to disassemble the turbines. The number of equipment trips during decommissioning would be greatly reduced compared to the construction phase.

Best Management Practices and Mitigation Measures. The direct and indirect impacts on land use from wind energy and related facilities development could be mitigated to some extent by a number of actions, including project design and layout, application of specific engineering practices, and applicable BMPs. The effectiveness of these potential mitigation measures and the extent to which they are applicable would vary from project to project and would need to be examined in detail in future NEPA reviews of specific proposed projects. The following are mitigation measures that could be used to minimize impacts on land use from wind energy development. They are categorized as either general mitigation measures or according to the most applicable land use that would be mitigated.

General. Plan and site the wind energy development to minimize impacts on other land uses. Consult with Federal, State, and county agencies; tribes; property owners; and other stakeholders as early as possible in the planning process to identify potentially significant land use conflicts and issues and State and local rules that govern wind energy development.

- Avoid locating wind energy developments in areas of unique or important recreation, wildlife, or visual resources. When feasible, a wind energy development should be sited on already altered landscapes.

- Consolidate infrastructure wherever possible to maximize efficient use of the land and minimize impacts. Existing transmission and market access should be evaluated and use of existing facilities should be maximized.

- Develop restoration plans to ensure that all temporary use areas are restored.

Agricultural and Grazing Lands. Construction activities should be coordinated with landowners to minimize interference with farming or livestock operations. Issues that would need to be addressed could include installation of gates and cattle guards where access roads cross existing fencelines, access control, signing of open range areas, traffic management (e.g., vehicle speed management), and location of livestock water sources.

- Construction debris should be removed from the site.

- Excess concrete (excluding belowground portions of decommissioned turbine foundations intentionally left in place) should not be buried or left in active agricultural areas.

- Vehicles should be washed outside of active agricultural areas to minimize the possibility of the spread of noxious weeds.

- Topsoil should be stripped from any agricultural area used for traffic or vehicle parking—segregating topsoil from excavated rock and subsoil—and replaced during restoration activities.

- Drainage problems caused by construction should be corrected to prevent damage to agricultural fields.

- Following completion of construction and during decommissioning, subsoil should be decompacted (Brower 2005).

Recreation. Ensure that adequate safety measures (e.g., access control and traffic management) are established for recreational visitors to adjacent properties.

Wetland and Grassland Easements. Coordinate closely with the Service or USDA during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.

Military Operations. Consult with the DOD during initial project planning to evaluate the potential impact of a proposed development on military airspace in order to identify and address any DOD concerns.

Aviation Operations. Prepare the FAA-required notice of proposed construction during initial project planning in order to identify any air safety issues and required mitigation measures.

Radar Interference. Mitigation measures pertaining to radar interference are provided in section 3.8.2.4. The only way to completely avoid any adverse impacts on radar involves methods that avoid locating turbines in the radar line of sight (e.g., achieved by distance, terrain masking, or terrain relief; DOD 2006). An additional solution could be to replace aging radar equipment with modern and flexible equipment that can better distinguish wind farm clutter from aircraft or weather (Brenner et al. 2008). Turbine operations could also be curtailed during significant weather events. Western generally advises developers submitting interconnection requests to avoid areas that would potentially conflict with radar facilities.

Transportation. Existing roads should be used to the extent possible, but only in safe and environmentally sound locations. If new access roads are necessary, they should be designed and constructed to the appropriate standard necessary to accommodate their intended function (e.g., traffic volume and weight of vehicles) and minimize erosion. Access roads that are no longer needed should be recontoured and revegetated.

A transportation plan should be prepared that identifies measures the developer will implement to comply with State or Federal requirements and to obtain the necessary permits. This will typically address the transport of turbine components, main assembly crane, and other large pieces of equipment. The plan should consider specific object size, weight, origin, destination, and unique handling requirements and should evaluate alternative means of transportation (e.g., rail or barge).

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

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

During construction, operations and maintenance, and decommissioning phases, traffic should be restricted to designated project roads. Use of other unimproved roads should be restricted to emergency situations.

5.1.2 No Action Alternative

5.1.2.1 Land Cover and Land Use

Under the No Action Alternative, Western would continue to process and evaluate interconnection requests as described in section 2.1.1, and the Service would continue to process and evaluate requests to accommodate wind energy facilities on grassland and wetland easements as described in section 2.1.2. Development could occur anywhere on unrestricted lands in the UGP region, but would be more likely to occur on the lands with the highest suitability for wind energy development. It is anticipated there would be a greater likelihood of requests to interconnect to Western's transmission facilities where lands with high wind energy suitability are located within 25 mi (40 km) of Western's facilities. The major land cover types within the UGP Region are presented in section 4.1-1, and of these, the types considered to have the highest potential for wind energy development include cropland, pastureland, and rangeland.

Based on the assumptions included in the beginning of chapter 5 there would be from 58-200 wind energy projects constructed and connected to Western's substation and transmission facilities in the UGP Region by 2030. This could result in the following predicted impacts to land cover: 4,750–16,500 ac (1,922–6,678 ha) of long-term surface disturbance, and 11,000–38,500 ac (4,451–15,580 ha) of temporary surface disturbance associated with wind energy related facilities; and 725–2,500 mi (1,166–4,023 km) of transmission lines to connect to the existing grid with 6,148–21,200 ac (4,100–15,650 ha) of surface disturbance associated with transmission line ROW. As described at the beginning of chapter 5 the surface disturbance figure for transmission ROW is likely a conservative estimate used for analysis purposes. This disturbance could occur within the 25.1 million ac (10,158,000 ha) that are located within 25 mi (40 km) of Western's existing transmission facilities.

Potential impacts to existing land uses on both Federal and non-Federal lands would be as described in sections 5.1.1.1 and 5.1.1.2 above; however, the actual impacts will have to be determined on a site specific basis taking into account the resources present on and near future wind energy development sites.

Based on recent history of wind energy development within the UGP Region it is anticipated that almost all development will occur on non-Federal lands.

5.1.3 Alternative 1

Under Alternative 1, Western and the Service would process and evaluate requests as described in section 2.3.2. Western and the Service propose to standardize their procedures for considering interconnection requests and for the accommodation of wind energy facilities on easements, respectively. In addition, both agencies would utilize tiering from this PEIS for both NEPA and Section 7 consultation, as long as applicants agreed to adopt the applicable BMPs and mitigation measures specified for this alternative.

Standardization of processes is generally helpful to applicants as long as the proposed approach is understandable, is fair, provides some certainty regarding success, and can be completed in a timely manner. By specifying a willingness to tier from existing environmental documentation if certain programmatic procedures are adopted, Western is committing to streamline its processes consistent with the analysis in this PEIS in order to arrive at a decision on interconnection requests more quickly; and this may make development within Western's service area more attractive. In addition, the agencies anticipate that environmental impacts would be minimized under this alternative. The final evaluation of this approach will be made by potential developers who would better know the type of information they will need to provide, be able to more readily assess their chances of being successful, and in what timeframe a decision can be made.

In terms of potential impacts on land cover and land uses, this alternative could result in less environmental impact for individual projects because it could encourage siting of projects in more suitable and less sensitive areas. There might be a slight overall increase in potential impacts within the high-suitability development area identified in the PEIS if Western's standardized approach makes development more likely. In that case, it would mean only that the same sorts of impacts would happen with more frequency within this area than in another area. Based on the programmatic level of analysis, it does not appear there is enough differential impact on land cover or land uses to distinguish between the impacts on land use from the No Action Alternative and Western's interconnection environmental evaluation process under Alternative 1. Overall, the actions of Western and the Service, as identified in the proposed action, would probably be less important in determining decisions made by developers than other external market and energy planning factors.

By identifying a standardized approach and a standardized set of BMPs, mitigation requirements, and monitoring requirements to be implemented by developers, the Service could make development on areas currently managed by the Service under easements in the UGP Region somewhat more attractive than at present. However, because there has been so little development on these lands in the past (33 turbines), it is anticipated there would not be any great increase in the future even under the approach proposed under Alternative 1. Assuming the Service continues to process requests for easement exchanges to accommodate wind energy structures on Service easements using current procedures (see section 2.1.2), it is anticipated there would be no additional significant impacts on either land cover or land uses under Alternative 1 compared to the No Action Alternative. However, the scale of easement exchanges will be determined on a project-by-project basis for either alternative. The complexity of site development, including the numbers of turbines, roads, and power lines, and indirect effects on habitat fragmentation, will factor into the determination of site impacts and mitigation requirements.

5.1.4 Alternative 2

Under this alternative, Western's approach for environmental evaluation of interconnection requests and the BMPs and mitigation measures that developers would be requested to implement would be the same as under Alternative 1. Based on the programmatic level of analysis presented for Alternative 1, it is anticipated that there would not be a differential impact on land cover or land uses among Alternative 2, Alternative 1, and the No Action Alternative.

The Service would not allow easement exchanges for wind energy development under this alternative. As indicated in the analysis above, there has been very little authorization of wind turbine placement on Service easements in the UGP Region, and removing this as a possibility would not be anticipated to have a significant impact on either land cover or land uses within the UGP Region; however, to the extent that any development on existing Service easements is foregone, there would be a slight positive effect, in terms of fewer changes in current land cover or land uses on easements themselves compared to Alternative 1, Alternative 3, and the No Action Alternative.

5.1.5 Alternative 3

For Western, the major differences between this alternative and Alternatives 1 and 2 is the reliance on separate project-specific NEPA and Section 7 processes and no BMPs or mitigation beyond those required in Federal, State, and local regulatory requirements. It differs from the No Action Alternative in not utilizing individually developed BMPs and site-specific mitigation. Compared to the No Action Alternative and Alternative 1, this alternative would reduce uncertainty associated with the environmental evaluation process for interconnection requests because it would be easier for developers to know in advance what BMPs and mitigation measures would be required for a specific project. It seems reasonable to assume that implementation of this alternative could result in a larger number of requests for interconnections to Western's system. However, it is not anticipated that this would result a net change in wind energy development within the UGP Region as a whole. Because BMPs and mitigation measures beyond those required under Federal, State, and local regulatory requirements may not implemented for some projects, it is anticipated that this alternative could result in greater impacts on land cover and land uses.

If an easement exchange was necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers, without requiring additional modifications to reduce the environmental impacts. The Service would rely on individual NEPA and Section 7 actions for each exchange, potentially resulting in more uncertainty regarding the ultimate success of the exchange request and the time it takes to complete. It is difficult to conceive that the amount of development on easements would increase in an atmosphere of increased uncertainty; therefore it is anticipated there would be slightly less impact on easement lands under this alternative. Ultimately, however, the land cover and land use changes resulting from the relatively small number of easement exchanges expected to occur within the UGP Region would be small.

5.2 GEOLOGIC SETTING AND SOIL RESOURCES

Wind energy development would have a number of impacts on soils in and around the project sites, most of which relate to the effects of ground-disturbing activities. Section 5.2.1 identifies the types of common impacts and the impacts associated with each phase of project development. The types of geologic hazards that may be encountered in the UGP Region are described in section 5.2.2. Mitigation measures to address soil impacts and geologic hazards are discussed in section 5.2.3. Impacts associated with the No Action Alternative and Alternatives 1 through 3 are discussed in sections 5.2.4 through 5.2.7.

5.2.1 Common Impacts

Common impacts on soil resources encompass a range of impacts that would be expected to occur mainly as a result of ground-disturbing activities, especially during the construction phase of a wind energy project. Common impacts include soil compaction, soil horizon mixing, soil erosion and deposition by wind, soil erosion by water and surface runoff, sedimentation, and soil contamination, as described below. Mitigation measures for avoiding or minimizing soil impacts are presented in section 5.2.3. Implementing mitigation measures to preserve the health and functioning of soils at the project site would reduce the likelihood of soil impacts becoming impacting factors on other resources, such as air, water, vegetation, and wildlife and would contribute to the success of future reclamation efforts.

- *Soil compaction.* Soil compaction occurs when soil particles are compressed, increasing their density by reducing the pore spaces between them (NRCS 2004). It is both an intentional engineering practice that uses mechanical methods to increase the load-bearing capacity of soils underlying roads and site structures and an unintentional consequence of project activities. Unintentional soil compaction is usually caused by vehicular (wheel) traffic on unpaved surfaces, but it can also result from animal and human foot traffic. Soils are more susceptible to compaction when they are moist or wet. Other factors, such as low organic content and poor aggregate stability, also increase the likelihood that compaction will occur. Soil compaction can directly affect vegetation by inhibiting plant growth because reduced pore spaces restrict the movement of nutrients and plant roots through the soil. Reduced pore spaces can also alter the natural flow of hydrological systems by causing excessive surface runoff, which in turn may increase soil erosion and degrade the quality of nearby surface water. Because soil compaction is difficult to correct once it occurs, the best mitigation is prevention to the extent possible.

- *Soil horizon mixing.* Soil horizon mixing is another form of soil damage that occurs as a result of construction activities such as excavation and backfilling that displace topsoil and disturb the existing soil profile. When topsoil is removed, stabilizing matrices can be destroyed, increasing the susceptibility of soils to erosion by both wind and water. Such disturbances also directly affect vegetation by disrupting indigenous plant communities and facilitating the growth of invasive plant species.

- *Soil erosion and deposition by wind.* Exposed soils are susceptible to wind erosion. Wind erosion is a natural process in which the shear force of wind is the dominant eroding agent, resulting in significant soil loss across much of the exposed area. Project-related activities such as vegetation clearing, excavating, stockpiling soils, and truck and equipment traffic (especially on unpaved roads and surfaces) can significantly increase the susceptibility of exposed soils to wind erosion.

- *Soil erosion by water and surface runoff.* Exposed soils are also susceptible to erosion by water. Water erosion is a natural process in which water (in the form of raindrops, streams, and rills) is the dominant eroding agent. The degree of erosion by water is generally determined by the amount and intensity of rainfall, but is also affected by the cohesiveness of the soil (which increases with organic content), its capacity for infiltration, vegetation cover, and slope gradient and length (NRCS 2004). Activities such as vegetation clearing, excavating, and stockpiling soils significantly increase the susceptibility of soils to runoff and erosion, especially during heavy rainfall events. Surface runoff caused by soil compaction also increases the likelihood of erosion. Soil erosion by surface runoff is an important impacting factor for the natural flow of hydrological systems, surface water quality (due to increased sediment loads), and all wildlife. State and local governments may also have specific flood control requirements that directly affect what surface runoff is allowed and how it should be controlled.

- *Sedimentation.* Soil loss during construction (by wind or water erosion) is a major source of sediment that ultimately makes its way to surface water bodies such as reservoirs, irrigation ditches, river, lakes, streams, and wetlands. When sediment settles out of water (a process called sedimentation) it can clog drainages and block navigation channels, increasing the need for dredging. By raising streambeds and filling in streamside wetlands, sedimentation increases the probability and severity of floods. Sediment that remains suspended in surface water can degrade water quality, damaging aquatic wildlife habitat and commercial and recreational fisheries. Sediment in water also increases the cost of water treatment for municipal and industrial users (NRCS 2004).

- *Soil contamination.* Soil contamination in the UGP Region could result from the general use of trucks and mechanical equipment (fuels, oils, coolants, and spent batteries) during all project phases. Project-specific operations may involve the use of hazardous materials such as dielectric fluids and cleaning solvents and could generate waste streams such as industrial and sanitary wastewater. Improper storage and handling of hazardous materials could result in accidental spills, leaks, and fires (sections 5.12 and 5.13). Maintenance-related activities could also contaminate soils in the project areas. These activities include the applications of herbicides (for noxious weed and vegetation control) to the soil surface. Contaminated soil can become a source of contamination for other resources, including vegetation (through uptake), wildlife (through inhalation and ingestion), and water quality (surface water through aerial deposition and runoff, and groundwater through leaching and infiltration).

5.2.1.1 Site Characterization

Site characterization activities are described in section 3.2. These activities would be of short duration and would not require significant site modifications. Implementing BMPs and mitigation measures to reduce soil compaction and control soil erosion and surface runoff would be sufficient to ensure that impacts would be negligible.

5.2.1.2 Construction

Site construction activities are described in section 3.3. Construction of a wind facility would result in impacts on soil resources in an area equivalent to the sum of the footprint areas for all structures (i.e., wind tower foundations, cable trays or trenches, control building, equipment storage areas, conditioning facilities and substations, and roads). Some wind projects may also require temporary laydown areas, offices, sanitary facilities, or a concrete batching plant. Direct adverse impacts of ground-disturbing activities relate mainly to the increased potential for soil compaction, soil horizon mixing, erosion (by wind and water), surface runoff, sedimentation of nearby lakes, rivers, and streams, and soil contamination. The degree of impact also depends on site-specific factors such as soil properties, slope, vegetation, weather, and distance to surface water. Erosional gullies formed on regraded land and the drainage along roads may also contribute to soil erosion as surface runoff is channeled into natural drainages. Compaction by vehicles or heavy equipment reduces infiltration and promotes surface runoff. Wind erosion of soil is also enhanced by ground disturbance. Ground disturbance and soil erosion rates would be potentially high during construction, but would be temporary and local. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid climates. Implementing BMPs and mitigation measures to limit undesirable soil compaction (i.e., unintended soil compaction not associated with access roads or foundations) and control soil erosion and surface runoff (section 5.2.3) would reduce soil erosion rates to preconstruction levels.

5.2.1.3 Operations and Maintenance

After construction, the soil would stabilize with time, particularly if BMPs and mitigation measures (section 5.2.3) were implemented during the construction phase. Once the project area regains equilibrium, adverse impacts are expected to be small, since operations and maintenance activities would not substantially increase the potential for soil erosion, surface runoff, and sedimentation of nearby lakes, rivers, and streams. Soil erosion could still occur, however, along roads as surface runoff is channeled into natural drainages. Soil compaction could also occur, but would not be significant, since most routine vehicle traffic would be limited to paved or gravel roads. Implementing BMPs and mitigation measures to reduce soil compaction and control soil erosion and surface runoff would reduce soil-related impacts to negligible or low levels.

5.2.1.4 Decommissioning

Decommissioning would involve ground-disturbing activities that could increase the potential for soil compaction, soil erosion (by wind and water), surface runoff, and sedimentation of nearby lakes, rivers, and streams. Ground disturbance and soil erosion rates would be potentially high (though less than during the construction phase), but would be temporary and local. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid and semiarid climates. Implementing BMPs and mitigation measures (section 5.2.3) to reduce soil compaction and control soil erosion and surface runoff would reduce soil-related impacts during decommissioning to negligible or low levels.

5.2.1.5 Transmission Lines

The construction of transmission lines within designated ROWs to connect new wind energy projects with regional utilities would result in the permanent or long-term effects on surface soils in an area equivalent to the sum of the footprint areas for all pole footings plus areas occupied by access roads needed to maintain the transmission line facilities. Direct adverse impacts of ground-disturbing activities relate mainly to the increased potential for soil compaction, soil horizon mixing, erosion (by wind and water), surface runoff, sedimentation of nearby lakes, rivers, and streams, and soil contamination. The degree of impact also depends on site-specific factors such as soil properties, slope, vegetation, weather, and distance to surface water. Erosional gullies formed on regraded land and drainages along access roads may also contribute to soil erosion as surface runoff is channeled into natural drainages. Compaction by vehicles or heavy equipment reduces infiltration and promotes surface runoff. Wind erosion of soil is also enhanced by ground disturbance. Ground disturbance and soil erosion rates would be potentially high during transmission line and access road construction, but would be temporary and localized in areas surrounding power poles and equipment laydown areas. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid climates. Implementing BMPs and mitigation measures (e.g., revegetation) to control soil erosion, surface runoff, and sedimentation would reduce soil erosion rates to preconstruction levels.

After construction, the soil conditions would stabilize with time, particularly if mitigation measures were implemented during the construction phase. Once the soil conditions within the ROWs regain equilibrium, adverse impacts are expected to be small, since operations would mainly entail periodic inspections and maintenance activities that would not increase the potential for soil erosion, surface runoff, and sedimentation of nearby lakes, rivers, and streams to a significant degree. Soil erosion could still occur, however, along roads as surface runoff is channeled into natural drainages. Soil compaction could also occur, but would not be significant, since most routine vehicle traffic would be limited to paved or gravel roads.

As during the construction phase, ground disturbance and soil erosion rates would be potentially high during decommissioning, but would be temporary and local. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid climates. Implementing BMPs and mitigation measures (section 5.2.3) to reduce soil compaction and control soil erosion and surface runoff would reduce soil-related impacts.

5.2.2 Geologic Hazards

Although the presence or magnitude of most geologic hazards is not generally affected by wind energy developments, it is important for wind energy projects to be cognizant of the potential for geologic hazards to affect the viability of specific aspects of project development or operation and to consider these hazards in project design and placement of towers and other structures. Geologic hazards that could potentially occur at wind energy project sites in the UGP Region include:

- *Seismic Ground Shaking.* Ground shaking occurs as seismic waves are propagated by a fault rupture and travel outward in all directions from the initial point of rupture (focus). Ground motion is calculated as "acceleration" and expressed as a fraction of the gravitational acceleration rate. There are both vertical and horizontal components to the ground motion; however, it is the horizontal movement that causes the most damage to structures. The pattern of motion depends on the magnitude of and distance from the earthquake, as well as the thickness and composition of surface and near-surface sediments. For example, areas underlain by unconsolidated alluvium or basin fill will amplify the strength and duration of strong ground motion. Ground shaking has the potential to trigger soil liquefaction, landslides, and other land failures, which also can cause damage and collapse (Christensen 1994). For project sites located in seismic zones (mainly in western and southwestern Montana), a seismic study would be needed to determine the probability of a seismic event and the design basis for structures built at the site.

- *Ground Rupture.* Ground rupture refers to the break and slip that occur along a fault plain, which can cause damage to nearby structures. Ground rupture is most often associated with earthquakes; however, fissures along the ground surface also occur as a result of subsidence caused by high rates of groundwater withdrawal, which cause differential settling and compaction of the underlying aquifer.

- *Liquefaction.* Liquefaction is a soil condition in which soil loses its shear strength and behaves like a liquid when shaken by an earthquake. Liquefaction potential is highest in earthquake-prone areas where loose, granular soils and shallow groundwater are present. Liquefaction can cause settlement of the ground surface in uneven patterns that can damage buildings, roads, and other infrastructure (USGS 2008).

- *Slope Instability.* Slope instability is not likely to be a significant hazard for wind energy projects, since projects would be located in relatively flat areas; however, excavation and blasting activities to create roads or other infrastructure could result in hill cuts that add to the instability of nearby slopes. This potential hazard is generally mitigated by siting roads and other infrastructure along natural topographic contours, limiting the slope of cuts, and avoiding hill cutting to the extent possible. A site reconnaissance prior to construction would identify natural areas of active or inactive landslides to be avoided when siting turbines and other structures.

- *Subsidence and Settling.* Ground subsidence and settling can pose significant hazards to project sites from a variety of causes, both natural and man-made. Natural causes include: the presence of deep, collapsible soils (occurring in glacial sediments and along floodplains); seismic activity (and soil liquefaction); karst features (underground solution cavities); and hydrocompaction.[4] Human activities, such as the withdrawal of groundwater or hydrocarbons and underground mining, may also cause subsidence and settling (Cowart 2003). A geotechnical investigation would determine the subsidence potential for project sites and recommend appropriate improvements during construction (including overexcavation and recompaction) to reduce the risk of subsidence and settling. It is assumed that placement of turbines and other facilities would be avoided in areas with high potential for subsidence and settling.

- *Expansive Soils.* Expansive soils are naturally occurring fine-grained soils (e.g., loess and sands and silts with soluble cement) with the potential to shrink and swell in response to changes in moisture. These soils expand as they are wetted (by rainfall or watering) and contract as they are dried, leaving small fissures and cracks in the soil matrix. Excessive wetting and drying can weaken soils and cause differential settlement, which is damaging to structures built on them. Appropriate site improvement during construction (including overexcavation and recompaction) can reduce the soil expansion potential at project sites.

- *Flooding.* Sites with flooding potential should be mapped to determine the location of the 100-year floodplain (an area with a flood elevation that has a 1 percent probability of being equaled or exceeded in any given year; FEMA 2008). For project sites falling within the 100-year floodplain, project structures would need to meet the development criteria for building in a floodplain (e.g., inhabitable structures, collector substations, and interconnection facilities would have to be built above flood elevation). Since floodplains are areas of high erosion potential, the best mitigation measure is avoidance. Since better wind conditions are usually present on higher ground, placement of wind turbines in floodplain areas typically would be avoided.

5.2.3 Mitigation Measures

5.2.3.1 Soil Resources

The main objective of the mitigation measures for soil resources is to preserve the health and functioning of project area soils by minimizing or controlling the ground-disturbing activities that cause the soil impacts described in section 5.2.1. Preserving the health and functioning of project area soils is an essential step in reducing impacts on other important resources,

[4] Hydrocompaction is the settling and hardening of land resulting from the application of large amounts of water, as occurs during irrigation.

especially water quality and vegetation. Erosion-control measures would be based on an assessment of site-specific conditions and would include minimizing the extent of disturbed areas, stabilizing disturbed areas, and protecting slopes and channels in the project area. Measures to control sedimentation would focus on retaining sediment on-site and implementing controls along the project site perimeter.

Specific wind energy projects would require the completion of geotechnical engineering and hydrology reports that characterize site conditions related to drainage patterns, soils (including erosion potential), vegetation, surface water bodies, land subsidence, and steep or unstable slopes. In the geotechnical engineering report, soil properties, engineering constraints, the corrosive potential of construction materials, stability, and facility design criteria would be identified. The hydrology report would present a compilation of data on local water bodies, surface water drainage patterns, floodplains, rainfall, and expected run-on and runoff volumes and flow rates. Many of the mitigation measures listed below would be components of the various plans required by State or local agencies to mitigate the impacts of wind energy facilities, particularly the Drainage, Erosion, and Sedimentation Control Plan; Vegetation Management Plan; Habitat Restoration and Management Plan; and Storm Water Management Plan. Such plans would be revised or amended as necessary to account for changes in site conditions as a project proceeds from construction through operations and maintenance to the decommissioning phase. Project developers would have to obtain all applicable Federal, State, and county permits and meet their requirements.

Mitigation measures for soil resources should include the following:

- Avoid placement of wind energy facilities in areas with unsuitable seismic, liquefaction, slope, subsidence, settling, and flooding conditions.

- Minimize the extent of the project footprint, including improved roads and construction staging areas.

- Minimize ground-disturbing activities, especially during the rainy season.

- Use existing roads and disturbed areas to the extent possible.

- Site new roads to follow natural land contours; excessive slopes should be avoided.

- Site new roads to avoid stream crossings and wetlands and minimize the need to cross drainage bottoms.

- Surface new roads with aggregate materials, wherever appropriate.

- Restrict heavy vehicles and equipment to improved roads to the extent practicable.

- Control vehicle and equipment speed on unpaved surfaces.

- Conduct construction and maintenance activities when the ground is frozen or when soils are dry and native vegetation is dormant.

- Stabilize disturbed areas that are not actively under construction using methods such as erosion matting or soil aggregation, as site conditions warrant.

- Salvage topsoil from all excavation and construction activities to reapply to disturbed areas once construction is completed.

- Dispose of excess excavation materials in approved areas to control erosion.

- Isolate excavation areas (and soil piles) from surface water bodies using silt fencing, bales, or other accepted appropriate methods to prevent sediment transport by surface runoff.

- Use earth dikes, swales, and lined ditches to divert local runoff around the work site.

- Reestablish the original grade and drainage pattern to the extent practicable.

- Reseed disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.

5.2.3.2 Geologic Hazards

The potential geologic hazards that could be significant at wind project sites include seismic ground shaking, ground rupture, liquefaction, slope instability, subsidence (collapse) and settlement, expansive soils, and flooding. Specific wind energy projects would require completion of a geotechnical investigation report to identify and assess these hazards and to propose facility design criteria and site-specific mitigation measures, including avoidance. The mitigation measure to address geologic hazards would be to build project structures in accordance with the design-basis recommendations and mitigation measures specified in the project-specific geotechnical investigation report.

In areas of high seismic activity or in areas that encompass 100-year floodplains, the most effective mitigation measure might be to alter the location or scope of the proposed project.

5.2.4 No Action Alternative

Under the No Action Alternative, potential impacts on soil resources largely would be associated with ground-disturbing activities during construction and could include any of the common impacts (e.g., compaction, erosion, increased sedimentation) identified in section 5.2.1.

Wind energy development within the UGP Region between 2010 and 2030 is projected to affect from 12,828 to 44,711 ac (5,191 to 18,094 ha), with the greatest development occurring in Iowa (section 2.4). Development would be expected to occur primarily within areas identified as having high suitability for wind energy development (section 2.4; figure 2.4-2). While areas of high suitability occur throughout the UGP Region, they are concentrated in the central and eastern portions of the region where soils (Mollisols) are predominantly used as cropland and pasture or rangeland (figure 4.2-2). Development of facilities that would connect to Western's electric grid would likely be located within 25 mi (40 km) of Western's transmission lines and substations, especially where those 25-mi (40-km) buffer areas intersect areas with high suitability for wind energy development. The construction of transmission lines to connect new facilities would not be limited to areas of high suitability.

The main elements in assessing direct impacts on soil resources within the UGP Region are the geographic location and temporal/spatial extent of ground-disturbing activities during each project phase. Typical impacts on soils from wind energy development are described in section 5.2.1. The nature and extent of impacts on soils would depend on the size and design of the project and on site-specific factors such as soil properties, slope, vegetation cover, weather, and distance to surface water bodies. Because the locations and footprints of wind projects to be developed are not currently known, impacts on soil resources cannot be quantified in this PEIS.

Impacts on soil resources from wind energy projects would be avoided or mitigated by implementing BMPs and mitigation measures determined by Western and the Service on a project–specific basis. Project developers would also obtain all applicable Federal, State, and county permits and meet their requirements. However, the benefits of a coordinated approach (e.g., consistency of environmental analyses and mitigation requirements) may not be realized under the No Action Alternative.

5.2.5 Alternative 1

Under Alternative 1, potential impacts on soil resources would be generally similar to those described for the No Action Alternative, but the nature and extent of impacts would depend on the size and design of the project and on site-specific factors such as soil types and properties, slope, vegetation cover, weather, and distance to surface water bodies. The BMPs and mitigation measures identified in section 5.2.3.1 (and summarized in section 2.3.2.2) would be implemented for projects tiering off the analyses in this PEIS. Project developers would also obtain all applicable Federal, State, and county permits and meet their requirements. Thus impacts on soils as a result of wind development under Alternative 1 are expected to be minor.

5.2.6 Alternative 2

Under Alternative 2, potential impacts on soil resources would be generally similar to those described for the No Action Alternative, but the nature and extent of impacts would depend on the size and design of the project and on site-specific factors such as soil types and properties, slope, vegetation cover, weather, and distance to surface water bodies. Because no easement exchanges for wind energy development would occur on easements managed by the Service, no impacts would be expected on soil resources on those easements, beyond those expected to occur from other activities (e.g., agriculture and recreation) that would be allowed under existing easement restrictions. The BMPs and mitigation measures identified in section 5.2.3.1 (and summarized in section 2.3.2.2) would be implemented for future projects tiering off the analyses in this PEIS as part of the evaluation of interconnection requests.

Project developers would also be required to obtain all applicable Federal, State, and county permits and meet their requirements. Thus impacts on soils as a result of wind development under Alternative 2 are expected to be minor.

5.2.7 Alternative 3

Under Alternative 3, potential impacts on soil resources would be generally similar to those described for the No Action Alternative in terms of the types of impacts and the overall acreage of areas disturbed by wind energy development activities. Because no BMPs, mitigation measures, or monitoring requirements would be imposed by Western or the Service beyond those required in Federal, State, and local regulatory requirements, impacts on soil resources on lands other than those managed by the Service could vary from region to region under this alternative; the magnitudes of impacts could potentially be greater in less-regulated jurisdictions.

5.3 WATER RESOURCES

Wind energy development could have some impacts on water resources, particularly surface water in and around the project sites during construction. Section 5.3.1 identifies the types of common impacts and the impacts associated with each phase of project development. BMPs and mitigation measures to address impacts on water resources are discussed in section 5.3.2. Impacts associated with the No Action Alternative and Alternatives 1 through 3 are discussed in sections 5.3.3 through 5.3.6.

5.3.1 Common Impacts

Common impacts on water resources relate to the use of water resources, the degradation of water quality, and the alteration of natural flow systems. Most of these impacts are associated with the construction phase of project development and are localized and short in duration. BMPs and mitigation measures for avoiding or minimizing impacts to water resources are presented in section 5.2.3.

5.3.1.1 Site Characterization

Site characterization activities are described in section 3.2. These activities would be of short duration and would not require significant site modifications. There would be no surface water or groundwater impacts due to water use, since water for this phase (i.e., drinking water for a small crew) would be brought in from an offsite source. Implementing BMPs and mitigation measures to control soil erosion during drilling would be sufficient to ensure that surface water quality impacts due to surface runoff and sedimentation would be negligible. Groundwater quality impacts are not expected, since there would be no wastewater generated during this phase, and therefore no discharging of wastewater to the ground surface.

5.3.1.2 Construction

Use of Water Resources. Water would be needed for various construction activities, including drinking water for site workers, concrete mixing, dust suppression, and vehicle washing. If water is not trucked into the site, the likely source of water during the construction phase would be local surface water bodies or groundwater wells, depending on their availability. Water withdrawals from local streams or rivers could have the effect of reducing streamflow and groundwater recharge; groundwater withdrawals could potentially lower the water table and change the direction of groundwater flow. The magnitude of these impacts would depend on the volume of water required for the construction phase and the capacities of available water resources. Water use impacts during the construction phase, however, would be localized and short in duration.

Water Quality Degradation. Water quality degradation of both surface water and groundwater resources is an important concern for any activity that involves land disturbance. For surface water bodies (rivers, streams, lakes, and wetlands), one of the leading water quality issues is sediment load. Sediment in surface water is mainly a result of soil erosion—a process that is both natural and man-made. When ground is disturbed, there is the potential for increased soil erosion, and, because soil has been loosened, surface runoff in disturbed areas tends to be high in sediment content. When sediment settles out of water (a process called sedimentation), it can clog ditches and irrigation canals and block navigation channels, increasing the need for dredging. By raising streambeds and filling in streamside wetlands, sedimentation increases the probability and severity of floods. Sediment that remains suspended in surface water can degrade aquatic wildlife habitat and damage commercial and recreational fisheries. Sediment in water also increases the cost of water treatment for municipal and industrial users (USDA 2006). Soil erosion can also degrade the quality of surface water by introducing other kinds of contaminants (e.g., crop nutrients like nitrogen and phosphorus, pesticides, and salt) and changing its pH.

Groundwater quality degradation occurs mainly through infiltration at the recharge location. Shallow, unconfined aquifers with a high rate of recharge are generally more susceptible to contamination than are deep aquifers with an overlying (impermeable) confining unit and a low rate of recharge. Recharge typically occurs in areas of high elevation (like hills or plateaus), but can also occur in stream valleys. Recharge areas for a given location may be in close proximity or some distance away; therefore, it is important to understand the groundwater flow regime for aquifers in the vicinity of a construction site, especially if they are sources of drinking water. Recharge rates are generally a function of climate (i.e., how much precipitation occurs in an area) and soil characteristics (e.g., porosity, degree of compaction, and ground slope). In an area where land disturbance has occurred, contamination can be introduced to groundwater directly through the leaching of soils and infiltration of spills or leaks at the surface, or indirectly through recharge by a surface water body that has been contaminated. Soil compaction, which also occurs in disturbed areas (mainly from the weight of heavy vehicles and equipment), tends to reduce infiltration rates and increase surface runoff.

Ground-disturbing activities related to the excavation and installation of wind towers and construction of ancillary structures and related infrastructure could adversely impact surface water quality if they are not mitigated. Ground-disturbing activities that could contribute to adverse water quality impacts include vegetation clearing; excavating, trenching, and grading of soil; dewatering excavation sites; stockpiling excavated soil and other fine-grained materials; and building roads. Building access roads, with associated culverts or concrete arches, across streams could also affect water quality during the construction period due to suspension of sediment and introduction of eroded soils. Accidental spills or leaks from transformers and other liquid-filled devices at substations also have the potential to adversely impact the quality of nearby surface water bodies and shallow aquifers (although the potential for accidental releases is lessened by the standard use of spill containment systems at substations). Increases in surface runoff as a result of soil compaction at the sites of new and modified access roads could affect sediment loads in nearby surface water bodies. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid and semiarid climates; however, implementing BMPs and mitigation measures to minimize soil compaction and control soil erosion and surface runoff would further reduce the likelihood of water quality impacts.

Storm water permits may be required for excavation sites where shallow groundwater is present and dewatering is necessary. Since only portable sanitary facilities would be used by site workers during the construction phase, discharge permits for managing sanitary discharges would not be required.

Alteration of Natural Flow Systems. Natural surface water and groundwater flow systems could be adversely affected by the construction of a wind energy facility, if they are not mitigated. Construction activities are very site dependent (as described in section 3.3); those that could contribute to the alteration of natural flow systems include the following:

- *Vegetation Clearing*. Vegetation naturally functions to hold soils in place; once vegetation is removed from a site, the potential for soil erosion (as surface runoff) increases—as does the potential for increasing sediment loading in nearby surface water bodies. As surface runoff increases, infiltration rates (and groundwater recharge rates) are reduced. Removing vegetation would also reduce the natural rates of evapotranspiration, which transfers groundwater to the atmosphere. In general, impacts associated with vegetation clearing at wind energy project sites are expected to be temporary in nature and easily mitigated. Clearing of vegetation would likely not be needed at project sites in areas previously used for agriculture, or in some areas with short vegetation, such as grassland or pastures.

- *Excavating, Trenching, and Grading*. These activities could result in changes of the natural topography that alter overland flow and channel surface and subsurface flow along new preferential pathways such as towers, roads, and trenches. These activities also have the potential to increase rates of infiltration.

- *Dewatering Excavation Sites*. Dewatering areas around tower foundation sites may be necessary in areas having shallow water tables. Water table levels would be lowered during the dewatering process (creating a cone of depression at the withdrawal site) but would likely recover once excavation is completed. Dewatering of sites would likely occur only rarely, if at all, because wind energy projects are typically located in topographically high areas (where the water table tends to be deep).

- *Building Roads, Staging Areas, and Laydown Areas*. The building of roads, staging areas, and laydown areas involves preparing the ground by grading and compacting soil. Vehicular traffic in these areas also increases the level of soil compaction. Soil compaction decreases the porosity of soils and results in reduced rates of infiltration (and increased surface runoff).

- *Building Multiple Tower Foundations*. Installing multiple tower foundation structures, especially the pier type (which can be as deep as 40 ft [12 m]), could have the effect of interrupting horizontal groundwater flow through an aquifer. Depending on the depth of the underlying aquifer, such a barrier could cause groundwater levels to rise on the upstream side of the wind farm and be lowered on the downstream side, creating a kind of “flow shadow” effect. A flow shadow could reduce groundwater recharge of downstream wetlands, springs, and wells.

Specific wind energy projects would complete reports to characterize site conditions related to drainage patterns, soils, vegetation, surface water bodies, and steep or unstable slopes; and the reports would include plans to identify mitigation measures to protect soil, vegetation, and water quality (see section 5.3.2). Plans would be revised or amended as necessary to account for changes in site conditions as a project proceeds from the construction through the decommissioning phases. Other plans and permits (e.g., storm water plans or stream diversion permits) may also be required by State and local agencies, depending on project location.

5.3.1.3 Operations and Maintenance

Water during the operations and maintenance phase would be used mainly for periodic cleaning of wind turbine rotor blades to eliminate dust and insect buildup. Since water for cleaning blades is generally needed in only arid climates that do not get enough rainfall to keep the blades clean and water for this purpose could be brought in from an offsite source, no surface water or groundwater impacts due to water use are expected. For some wind energy projects, operations and maintenance facilities might be constructed that would necessitate development of wells to provide water for drinking and sanitation purposes. In such cases, the water requirements would likely be relatively small and impacts on surface water or groundwater resources would also be small.

Accidental spills or leaks from transformers and other liquid-filled devices at substations could adversely impact the quality of nearby surface water bodies and shallow aquifers during the operations and maintenance phase. Herbicides, if they are used to control noxious weeds and vegetation growth around towers and access roads, could also degrade water quality in nearby surface water bodies and shallow aquifers.

5.3.1.4 Decommissioning

Decommissioning would involve ground-disturbing activities that could increase the potential for soil compaction, soil erosion, surface runoff, and sedimentation of nearby lakes, rivers, and streams, thus potentially affecting the quality of water in nearby surface water bodies. Ground disturbance and soil erosion rates would be potentially high (although less than during the construction phase), but they would be temporary and local. Erosion rates and runoff potential are naturally lower at project sites located on relatively level terrain and in arid and semiarid climates. If a well was developed to supply drinking and sanitation water for an operations and maintenance facility, it is anticipated that the well would be capped during decommissioning unless the facility was going to continue being used for some other purpose. Implementing BMPs and mitigation measures to minimize soil compaction and control soil erosion and surface runoff, as well as following standard practices for capping wells, would reduce water quality or quantity impacts during decommissioning to negligible or low levels.

5.3.1.5 Transmission Lines

Activities associated with the characterization, construction, operations and maintenance, and decommissioning of transmission lines could adversely affect water resources in ways analogous to those described in sections 5.3.1.1 through 5.3.1.4. There would be no surface water or groundwater impacts due to water use since water for site workers would be brought in from an offsite source.

Ground-disturbing activities that could contribute to adverse water quality impacts include vegetation clearing, excavating and grading of soil, dewatering excavation sites, stockpiling excavated soil and other fine-grained materials, building access roads, and altering surface drainage patterns. Increases in surface runoff as a result of soil compaction at the sites of new and modified access roads could affect sediment loads in nearby surface water bodies. Herbicides, if they are used to control noxious weeds and vegetation growth along the transmission line ROWs and access roads, could also degrade water quality in nearby surface waters. If the appropriate BMPs and mitigation measures are applied to project activities, it is anticipated that the overall impacts on water quality and quantity from a wind energy development would be small.

5.3.2 BMPs and Mitigation Measures

The main objective of the BMPs and mitigation measures for water resources is to protect the quality and quantity of water in natural water bodies in and around a wind energy project. Specific wind energy projects may require the completion of geotechnical engineering and hydrology reports that characterize site conditions related to drainage patterns, soils (including erosion potential), vegetation, surface water bodies, and steep or unstable slopes. In the geotechnical engineering report, soil properties, engineering constraints, the corrosive potential of construction materials, stability, and facility design criteria would be identified. The hydrology report would present a compilation of data on local water bodies, surface water drainage patterns, floodplains, rainfall, and expected run-on and runoff volumes and flow rates. Many of the mitigation measures listed below would be components of the various plans required by State and local agencies to mitigate the impacts of wind energy facilities, particularly the Drainage, Erosion, and Sedimentation Control Plan; Vegetation Management Plan; Habitat Restoration and Management Plan; and Storm Water Management Plan. Such plans would be revised or amended as necessary to account for changes in site conditions as a project proceeded from construction through operations and maintenance to the decommissioning phases. Project developers would have to obtain all applicable Federal, State, and county permits and meet their requirements.

The following BMPs and mitigation measures for water resources would be implemented as appropriate under the proposed action:

- Minimize the extent of land disturbance to the extent possible.

- Use existing roads and disturbed areas to the extent possible.

- Site new roads to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.

- Apply standard erosion control BMPs to all construction activities and disturbed areas (e.g., sediment traps, water barriers, erosion control matting) as applicable to minimize erosion and protect water quality.

- Apply erosion controls relative to possible soil erosion from vehicular traffic.

- Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, high slope angles, and certain geologic landforms).

- Identify areas of groundwater recharge and discharge and evaluate their potential relationship with surface water bodies and groundwater quality.

- Avoid creating hydrologic conduits between two aquifers (e.g., upper and lower).

- Construct drainage ditches only where necessary; use appropriate structures at culvert outlets to prevent erosion.

- Avoid altering existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.

- Clean and maintain catch basins, drainage ditches, and culverts regularly.

- Limit herbicide and pesticide use to nonpersistent, immobile compounds and apply them using a properly licensed applicator in accordance with label requirements.

- Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.

- Reestablish the original grade and drainage pattern to the extent practicable.

- Reseed (non-cropland) disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.

- When decommissioning sites, ensure that any wells are properly filled and capped.

5.3.3 No Action Alternative

Under the No Action Alternative, potential impacts on water resources relate mainly to water quality and typically would result from ground-disturbing activities (that could increase sediment loads to surface water) and the alteration of natural flow systems during construction, but they could include any of the common impacts identified in section 5.3.1.

Wind energy development within the UGP Region between 2010 and 2030 is projected to affect between 12,828 and 53,310 acres (5,191 and 21,574 ha), with the greatest development occurring in Iowa (section 2.4; table 2.4-1). Development would occur primarily within areas identified as having high suitability for wind energy development (section 2.4; figure 2.4-2). While areas of high suitability occur throughout the UGP Region, they are concentrated in the central and eastern portions of the region. Development of facilities that would connect to Western's electric grid would likely be located within 25 mi (40 km) of Western's transmission lines and substations, especially where those 25-mi (40-km) buffer areas intersect high suitability areas. The construction of transmission lines to connect new facilities would not be limited to areas of high suitability. High suitability areas generally coincide with the Missouri Hydrologic Region on the Missouri Coteau and Missouri Plateau of North and South Dakota, and the Souris-Red-Rainy and Great Lakes Hydrologic Regions on the glacial till plains of Minnesota and Iowa (figures 4.2-1 and 4.3-1). These provinces have abundant surface water bodies (rivers, lakes, and wetlands) and, because of their elevation, are important recharge areas for several principal aquifers and aquifer systems in the UGP Region (figure 4.3-3).

The main elements in assessing direct impacts on water resources within the UGP Region are the location (relative to surface water bodies and shallow aquifers) and the temporal/spatial extent of ground-disturbing activities during each project phase (section 5.3.1). Accidental spills or leaks from transformers and other liquid-filled devices at substations also have the potential to adversely impact the quality of nearby surface water bodies and shallow aquifers. The potential impacts that could occur to water resources due to construction activities at a wind energy facility under the No Action Alternative are described in section 5.3.1. The nature and extent of impacts would depend on the size and design of the project and on site-specific factors such as drainage patterns, soil types, vegetation cover, local topography, and project location relative to surface water bodies and aquifers. Because the locations and footprints of wind energy projects to be developed are not currently known, many aspects of potential impacts on water resources cannot be quantified in this PEIS.

Impacts on water resources from wind energy projects would be avoided or mitigated by implementing the BMPs and mitigation measures determined by Western and the Service on a project–specific basis, and would be likely to include, as appropriate, many of the measures identified in section 5.3.2. Project developers would also be required to obtain all applicable Federal, State, and county permits and meet their requirements. However, the benefits of a coordinated approach (e.g., consistency of environmental analyses and mitigation requirements) may not be realized under the No Action Alternative.

5.3.4 Alternative 1

Under Alternative 1, potential impacts on water resources would be generally similar to those described for the No Action Alternative. The environmental evaluation process identified in section 2.3.2.1 would be implemented. Projects desiring to tier off the evaluations in this PEIS for project-specific NEPA evaluations would be required to identify and implement the appropriate BMPs and mitigation measures identified in section 5.3.2 (and summarized in section 2.3.2.2) as necessary to address site-specific conditions. Project developers would also be required to obtain all applicable Federal, State, and county permits and meet their requirements. Under these conditions, impacts on water resources as a result of wind energy development are expected to be minor.

5.3.5 Alternative 2

Under Alternative 2, the types of potential impacts on water resources would be generally similar to those described for the No Action Alternative. Because it is anticipated that the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects on water resources would also be similar.

As with Alternative 1, the environmental evaluation process identified in section 2.3.2.1 would be implemented for projects interconnecting to Western's transmission system. This would include a requirement to identify and implement the appropriate BMPs and mitigation measures identified in section 5.3.2 (and summarized in section 2.3.2.2) as necessary to address site-specific conditions. As a consequence, impacts on water resources from wind energy projects that would interconnect to Western's transmission system are expected to be minor.

Because the Service would not allow easement exchanges for wind energy development under this alternative, the potential for direct impacts on water resources on those easements would be reduced. As a result, it is likely that a small number of future wind energy projects would site wind energy structures on private lands rather than Service easements. Because there is a potential for somewhat lesser levels of environmental evaluation and fewer requirements to implement specific BMPs and mitigation measures on private lands, there may be a somewhat greater potential for adverse effects on water resources under this alternative.

5.3.6 Alternative 3

Under Alternative 3, the types of potential impacts on water resources would be generally similar to those described for the No Action Alternative. Because it is anticipated that the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects on water resources would also be similar. Because no standardized BMPs, mitigation measures, or monitoring requirements would be imposed by Western or the Service beyond those required under established Federal, State, and local regulatory requirements, impacts on water resources on lands other than those permitted by the Service could vary from region to region; such impacts could potentially be greater in less regulated jurisdictions.

5.4 AIR QUALITY AND CLIMATE

This section describes potential impacts on ambient air quality and climate that could occur in the UGP Region from anticipated wind energy development under the proposed action. Section 5.4.1 describes the common impacts on air quality and climate that could occur in the UGP Region during major phases of a typical wind energy development project's life cycle. BMPs and mitigation measures to avoid or reduce impacts from wind energy development on air quality are presented in section 5.4.1.5.

The common impacts discussion is followed by a discussion of potential impacts under the four PEIS alternatives (sections 5.4.2 to 5.4.5). The impact analysis for potential development under the programmatic alternatives is generic in nature because the actual development levels that might occur under the alternatives are estimates, and details on locations, sizes, and configurations of future wind energy facilities are unknown. A detailed assessment of impacts on air quality and climate from specific projects is dependent upon site- and project-specific information pertaining to location, size, and configuration of the proposed project. Potential impacts on specific sensitive receptors, such as Federal Class I areas, would be assessed further as part of site-specific NEPA evaluations that would be conducted for individual proposed projects.

The impact analysis for potential development under the PEIS alternatives assumes that impacts would be generally proportional to the area affected by direct and indirect impacts, and would depend on the BMPs and mitigation measures that are implemented as part of the projects. Among alternatives, levels of potential impacts on ambient air quality and climate are compared with those under the No Action Alternative.

5.4.1 Common Impacts

5.4.1.1 Site Characterization

As described in section 3.2, site characterization activities would primarily involve meteorological data collection and subsurface soil sampling. Meteorological data collection for a candidate site would occur over a period of at least 1 year or as long as 3 years to capture a spectrum of wind pattern variations. Heavy-duty all-wheel-drive pickup trucks or medium-duty trucks are usually sufficient to transport meteorological towers to the site and erect them. Most of the time, meteorological tower data collection activities would not require human presence, except for occasional visits for instrument inspection and maintenance. Subsurface soil sampling would be needed for data collection to support the design of turbine foundations. Associated with these activities, augurs or drilling rigs mounted on trailers, light-to-medium-duty trucks, or tracked vehicles would be needed. In most instances, sampling would be made within a week time frame. During the site characterization phase, a minimum-specification access road would be required. Typically, this would be an existing road that would not be improved during the characterization phase, and characterization activities (e.g., installation of meteorological towers or soil sampling) would occur adjacent to it. Limited brush clearing at tower and soil-sampling sites might be needed.

Emissions associated with these activities would be fugitive dust and engine exhaust from powered equipment and vehicular traffic. The types of air emissions and pollutants would be similar to those described below for other phases of project development. However, potential impacts of the site characterization activities on ambient air quality would be much lower than those of construction or decommissioning activities. Site characterization activities would be of short duration and require minimum site disturbances by a small crew having relatively little heavy equipment. Therefore, potential air quality impacts from site characterization activities would be negligible.

5.4.1.2 Construction

Before any project would begin, a construction permit would generally be required from a State or local agency. Typically, most jurisdictions do not require air dispersion modeling for potential air quality impacts resulting from construction activities, which would be localized and temporary in nature. Instead, agencies stipulate in permits that certain mitigation practices be implemented (e.g., water down disturbed areas to minimize fugitive dust emissions). It is important to consult with the responsible agencies prior to initiating any wind energy facility construction activities.

Major components in a wind energy development project would include wind turbines, electrical collection systems, transmission/interconnection facilities, access roads, operations and maintenance (O&M) facilities, and meteorological towers (AWEA 2008). Typical construction activities would involve a number of separate operations, including mobilization/staging, road and staging/laydown area construction, grubbing/land clearing, topsoil stripping, cut-and-fill operations (i.e., earthmoving), grading, ground excavation, drilling, foundation treatment, wind turbines erection, ancillary building/structure erection, digging the trench for the underground electrical cables, electrical and mechanical installation, and landscaping. Nevertheless, construction activities and concomitant potential air quality impacts for a wind energy development project would greatly vary from project to project, due to the developer, terrain, the size and location of the project, and other site-specific conditions (e.g., local climate, existing air quality, surface soil and subsoil types, availability of the regional power grid nearby, etc.). Construction would largely consist of two phases: site preparation and general construction. For most wind energy facilities, the site preparation phase would be of relatively short duration (a few months) followed by a longer general construction phase (a year or less).

Heavy equipment used in the site preparation phase would include chainsaws, chippers, dozers, scrapers, graders, end loaders, trucks, and rock drills. The equipment used in the general construction phase would include large lifting cranes, end loaders, backhoes, dozers, trucks (including concrete mixer trucks), and trenchers. A temporary concrete batch plant might be needed, if substantial amounts of concrete are needed and/or premix concrete is unavailable from nearby vendors (e.g., for foundations of wind turbine towers or ancillary buildings/structures). In this case, operation of diesel generators for the batch plant and storage piles of sand or aggregates might be additional air emission sources. The operation of ancillary equipment associated with concrete processing, such as small mixers, vibrators, and concrete pumps, would generate air emissions in small amounts.

Construction activities could release air emissions of criteria pollutants, volatile organic compounds (VOCs), greenhouse gases (GHGs) (e.g., CO_2), and small amounts of hazardous air pollutants (HAPs). These emissions would result from fugitive dust from soil disturbances and engine exhaust from heavy equipment and commuter/delivery/support vehicular traffic within and around the project area. Typically, potential impacts of fugitive dust emissions on ambient air quality would be higher than those of engine exhaust emissions.

For most construction projects, soil disturbances during the site preparation phase caused by the intense use of heavy equipment over a short time period have the greatest potential for air emissions and adverse air quality impacts (through release of fugitive dust); implementation of appropriate BMPs can greatly reduce the potential for air quality impacts. Under unfavorable dispersion conditions (e.g., stable atmosphere and calm or light winds), infrequent high concentrations of particulate matter (PM) (aerodynamic diameter ≤ 10 μm [PM_{10}] and aerodynamic diameter ≤ 2.5 μm [$PM_{2.5}$]) resulting from soil disturbances could exceed air quality standards at the site boundaries.[5] Other factors being equal, areas with a high density of development would be more likely to cause high concentrations than areas with low or no development. On a windy day typical of the UGP Region, fugitive dust emissions caused by wind erosion from disturbed surfaces would be greater, potentially contributing to already high background conditions expected to be present on windy days in areas such as the UGP Region, which contain large areas of tilled cropland that also present exposed disturbed soils. Relatively high PM concentrations would be anticipated, although their impacts would be reduced, to some extent, by being diluted by the large air volume associated with high wind speed. Sometimes construction activities could exceed NAAQS/SAAQS levels for PM in areas accessible to the general public around the wind project. For wind energy facilities located in remote areas (which is expected to be the case for most facilities), construction activities could have some impacts at the nearest residence but would be expected to make a negligible contribution to air concentration levels at the nearest population center or businesses. This is especially true given the level of particulates likely to be present from agricultural activities, to which the additional contribution from construction of a wind farm would be very small in comparison.

Only a small percentage of site land (5 percent or less) would be disturbed by construction activities because wind turbines need to be separated from one another in order to maximize energy production and avoid wake turbulences created by upwind turbines. As a result, potential impacts from construction activities of wind energy development projects on ambient air quality would be much lower than those from other types of industries for the development of the same amount of land. Construction activities for a wind energy development project would typically last only a year or less. Accordingly, potential impacts of construction activities on ambient air quality are expected to be minor and temporary in nature. Heavy construction equipment and vehicles would emit GHG emissions. However, considering the amount of heavy equipment, crew size, activity levels, and construction duration, GHG emissions would be anticipated to be negligible.

5 The site boundaries of a wind energy project could be clearly defined because the site would consist of lands leased from individual land owners. However, only a small fraction of the land surface within the site boundaries would be disturbed by construction activities.

The construction of transmission lines within a designated ROW would be needed to connect new wind energy development projects to the nearest regional grid. The sequence of activities for placing electricity transmission lines would generally include surveying, land clearing (grubbing and tree removal), construction of access roads, drilling or excavation for support structures and concrete footings, and backfilling.

Tower structures would be carried to the site in sections by truck, assembled in laydown areas, and lifted into place with a crane. Depending on environmental/logistical factors, or costs, helicopters could be used for tower transport and erection, which would significantly reduce the construction period, but could greatly increase the levels of dust for short periods. Truck-mounted cable-pulling equipment would be used to string the conductors onto the support structures. As in other construction activities, most of these activities would involve fugitive dust emissions from soil disturbance and engine exhaust emissions from heavy equipment and commuter/delivery/support vehicles. Since most wind energy facilities would be located within 25 mi (40 km) of existing transmission lines, transmission line construction could be performed in a short time period (a few months at most); thus, the potential impacts on ambient air quality would be minor and temporary in nature.

5.4.1.3 Operations and Maintenance

Conventional power plants burning fossil fuels (natural gas, coal, fuel oils, coal-derived liquids and gases) are major sources of criteria pollutants, VOCs, and GHGs such as CO_2. The burning of some fossil fuels, such as coal, also results in emissions of HAPs (e.g., mercury [Hg]). There are no direct air emissions from operating wind turbines because no fossil fuels are combusted. Accordingly, wind energy facilities would generate very low levels of air emissions during the operation period. Emissions from wind energy facilities would include minor dust and engine exhaust emissions from vehicles and heavy equipment associated with regular site inspections, infrequent maintenance activities (e.g., overhauls or repairs), and wind erosion from bare ground and access roads. Negligible VOC emissions would be expected during the routine maintenance activities of applying lubricants, cooling fluids, and greases. A small amount of combustion-related emissions would be produced during periodic operation of diesel emergency generators as part of preventative maintenance (e.g., two hours per month) and possibly the heating system for space heating of O&M facilities including the office and maintenance shop. Routine brush clearing might be needed to reduce fire hazards. The types of emission sources and pollutants during operation would be similar to those during construction, but the amounts would be insignificant. These emissions would not cause exceedances of air quality standards or have any impacts on climate change.

The operation phase associated with transmission lines would generate very small amounts of criteria pollutants, VOCs, GHGs, and HAPs from activities such as periodic site inspection and maintenance. Vehicles and other gasoline-powered equipment would be required to perform vegetation maintenance within the ROW. Other maintenance activities would include the repair or replacement of tower/pole components or conductors/insulators, painting of towers/poles, and emergency response (e.g., during power outages) as needed. In addition, transmission lines could produce minute amounts of ozone (O_3) and nitrogen oxides (NO_x) associated with corona discharge (i.e., the breakdown of air near high-voltage conductors). Corona discharge is most noticeable for higher-voltage lines during rain or fog conditions when the ambient O_3 concentration is typically at its minimum. All these emissions during the operation phase would be quite small; therefore, potential impacts on ambient air quality would be negligible.

Wind energy facilities could avoid considerable amounts of criteria pollutants and HAP emissions that would otherwise have been generated from power plants burning nonrenewable and highly polluting fossil fuels. These facilities could substantially reduce adverse impacts on ambient air quality, including visibility impairment, acid rain followed by ecological damage, and elevated O_3 and PM concentrations that are associated with respiratory and cardiovascular diseases. To assess these benefits, emission reductions resulting from operation of a hypothetical wind energy facility through avoided emissions from fossil fuel-fired power plants were estimated. For this analysis, a wind energy facility with a nameplate capacity of 50 to 300 MW and a capacity factor of 30 percent was assumed. Composite emission factors were available for each of six UGP Region States, which were estimated on the basis of all types of fossil-fueled power plants currently in operation in the six UGP Region States, as shown in table 5.4-1 (EPA 2009c).

Operation of a single 50- to 300-MW wind energy facility would result in avoided air emissions from electric power systems ranging from a low of 0.4 to 2.6 percent for North Dakota

TABLE 5.4-1 Composite Emission Factors for Combustion-Related Power Generation[a] in the Six UGP Region States in 2005

	Emission Factors (lb/MWh; lb/GWh for Hg)			
State	SO_2	NO_x	Hg	CO_2
Iowa[b]	7.49	4.11	0.0603	2,277
Minnesota[b]	5.60	4.69	0.0406	2,237
Montana[b]	2.37	4.45	0.0551	2,424
Nebraska[b]	6.84	4.99	0.0322	2,329
North Dakota	9.15	5.08	0.0752	2,445
South Dakota	6.97	9.00	0.0282	2,343
UGP Region average[c]	6.61	4.74	0.0529	2,328

[a] Combustion-related power generation denotes fossil-fired power plants (e.g., coal, oil, and natural gas) and other combustion power plants (e.g., biomass burning).

[b] Statewide emission factors were presented although parts of the State are not within the UGP Region.

[c] Emission factor averages over the six UGP Region States were estimated on the basis of combustion-related emission factors and annual power generation for each State.

Source: EPA (2009c).

to a high of 4 to 24 percent for South Dakota, as shown in table 5.4-2.[6] When compared with emissions from all source categories, power generation from a wind energy facility would avoid up to 9.7 percent for SO_2 emissions and 4.1 percent for NO_x emissions in South Dakota. Fossil-fuel power generation in North Dakota accounts for over 95 percent, the highest among six UGP Region States, mostly by coal power generation. On the other hand, noncombustion-related power generation (e.g., nuclear, hydro, and/or renewable energy) is highest in South Dakota, accounting for about half of power generation, mostly hydropower generation. Accordingly, new wind energy facilities in South Dakota could avoid a higher percentage of air emissions than those in North Dakota. A wind energy facility would avoid up to about 0.8 percent and 0.6 percent of the total SO_2 emissions from electric power systems and from all source categories, respectively, in the UGP Region.

A benefit involving criteria pollutants and HAPs from the operation of wind energy facilities would include a reduction of GHG emissions if a fossil fuel power plant would otherwise be in operation to produce the same amount of electricity. GHGs avoided by a single wind energy facility are presented in table 5.4-2. As explained in section 4.4.3, the benefit analysis was made for CO_2, the primary GHG. During the 1996 to 2005 period, CO_2 emissions accounted for about 83 percent of the total GHG emissions in terms of CO_2 equivalence (EIA 2008). Therefore, total GHG emissions would likely be about 20 percent more than the CO_2 emissions discussed below.

Operation of a 50- to 300-MW wind energy facility could result in avoidance from a low of about 2.6 percent for North Dakota to a high of about 24 percent for South Dakota relative to CO_2 emissions from electric power systems. A wind energy facility could avoid up to 1.8 percent and 6.4 percent of CO_2 emissions from all source categories in North and South Dakota, respectively. Because noncombustion-related power generation in South Dakota accounts for only about half of its power generation, a wind energy facility could avoid CO_2 emissions from electric power generation by a significant proportion. The reverse is true for North Dakota, which depends substantially on combustion-related power generation. A wind energy facility could avoid up to about 0.9 percent and 0.5 percent of the total emissions from electric power generation and from all source categories in the UGP Region, respectively. It should be noted, however, that these emissions offsets would only occur if wind generation actually displaced existing fossil-fueled generation. It is far more likely that any offsets would be of potential future fossil-fueled generation, since wind power would most likely be used to meet growth in generation load needs, and not existing load needs.

5.4.1.4 Decommissioning

Decommissioning would include dismantling wind energy facilities and their support facilities, such as buildings/structures and mechanical/electrical installations; disposal of debris; restoration grading; and revegetation as needed. Belowground structures, such as turbine foundations and collector lines, would probably not be removed. Activities for decommissioning would be similar to those used for construction (section 5.4.1.2) but on a more limited scale and

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[6] Irrespective of air pollutant (SO_2, NO_x, or Hg), the percentage of emissions avoided by a single wind energy facility relative to total emissions from electric power systems for any State would be the same because it is just a ratio of total power generation by a wind energy facility to total power generation from electric power systems in a State.

TABLE 5.4-2 Annual Emissions from Combustion-Related Power Generation[a] Avoided by a Wind Energy Facility in the Six UGP Region States[b]

State	Emission Rates (tons/yr)[c,d]			
	SO_2	NO_x	Hg	CO_2
Iowa[e]	492–2,951 (0.83–5.0%) (0.69–4.1%)	270–1,621 (0.83–5.0%) (0.18–1.1%)	0.004–0.024 (0.83–5.0%) –[f]	149,607–897,642 (0.83–5.0%) (0.40–2.4%)
Minnesota[e]	368–2,207 (1.4–8.6%) (0.83–5.0%)	308–1,850 (1.4–8.6%) (0.21–1.2%)	0.003–0.016 (1.4–8.6%) –	146,975–881,849 (1.4–8.6%) (0.54–3.3%)
Montana[e]	156–935 (0.98–5.9%) (0.37–2.2%)	292–1,753 (0.98–5.9%) (0.25–1.5%)	0.004–0.022 (0.98–5.9%) –	159,243–955,455 (0.98–5.9%) (0.54–3.3%)
Nebraska[e]	449–2,697 (0.70–4.2%) (0.61–3.6%)	328–1,967 (0.70–4.2%) (0.21–1.3%)	0.002–0.013 (0.70–4.2%) –	153,020–918,119 (0.70–4.2%) (0.37–2.2%)
North Dakota	601–3,606 (0.43–2.6%) (0.36–2.1%)	333–2,001 (0.43–2.6%) (0.19–1.1%)	0.005–0.030 (0.43–2.6%) –	160,620–963,723 (0.43–2.6%) (0.30–1.8%)
South Dakota	458–2,748 (4.0–24%) (1.6–9.7%)	591–3,549 (4.0–24%) (0.68–4.1%)	0.002–0.011 (4.0–24%) –	153,934–923,604 (4.0–24%) (1.1–6.4%)
UGP Region Average	434–2,605 (0.14–0.83%) (0.10–0.61%)	311–1,867 (0.14–0.84%) (0.04–0.22%)	0.004–0.021 (0.14–0.83%) –	152,982–917,889 (0.14–0.85%) (0.08–0.45%)

[a] Combustion-related power generation denotes fossil-fired power plants (e.g., coal, oil, and natural gas) and other combustion-related power plants (e.g., biomass burning).

[b] Assumed a wind energy facility with a power generation capacity of 50–300 MW and a capacity factor of 30 percent.

[c] Values in the first row are estimated annual emissions avoided by a wind energy facility. Values in the second row are percent of total emissions from electric power systems (for 2005) for counties within the UGP Region. Values in the third row are percent of total emissions from all sources for counties within the UGP Region (2002 for SO_2 and NO_x and 2005 for CO_2) (see table 4.4-3).

[d] Combustion-related emission factors were presented in table 5.4-1.

[e] Parts of these States are within the UGP Region. No CO_2 emissions from combustion-related power generation were available at the county level, so CO_2 emissions were estimated for counties in the State within the UGP Region using the population distribution.

[f] Not available.

Sources: EPA (2009a–c).

for a shorter duration. Potential impacts on ambient air quality would be correspondingly less than those for construction activities. Therefore, potential impacts on ambient air quality associated with decommissioning activities would be minor and temporary in nature.

5.4.2 BMPs and Mitigation Measures

The UGP Region ranges from a semiarid climate in Montana to a humid climate in Iowa. Footprints, areas of soil disturbances, and the associated construction period for a wind energy project would be less than for other energy generation facilities with the same capacity. However, wind speeds in the UGP Region, as areas of high potential for wind energy development, are higher than for any other regions in the United States. Fugitive dust emissions from vehicle traffic on unpaved roads, soil disturbance activities, and/or wind erosion would be the greatest concerns regarding air quality impacts, especially during construction. Typically, wind-blown dust from the construction area would be negligible compared to other wind-blown dust, especially from agricultural fields. These fugitive dust emissions and other combustion-related emissions would be controlled through stipulations included in the ROW authorization and other permitting processes. The emissions would need to comply with applicable laws, ordinances, regulations, and standards.

5.4.2.1 General

General mitigation measures applicable to multiple phases of project development include the following:

- Use surface access roads, on-site roads, and parking lots with aggregates or that maintain compacted soil conditions to reduce dust generation.

- Post and enforce lower speed limits on dirt and gravel access roads to minimize airborne fugitive dust.

- Minimize potential environmental impacts from the use of dust palliatives by taking the necessary measures to keep the chemicals out of sensitive terrestrial habitats and streams. The application of dust palliatives must comply with Federal, State, and local laws and regulations.

- Ensure that all pieces of heavy equipment meet emission standards specified in the State Code of Regulations, and conduct routine preventive maintenance, including tune-ups to manufacturer specification to ensure efficient combustion and minimum emissions. If possible, equipment with more stringent emission controls should be leased or purchased.

- Employ fuel diesel engines in facility construction and maintenance that use ultra-low sulfur diesel, with a maximum 15 ppm sulfur content.

- Limit idling of diesel equipment to no more than 10 minutes unless necessary for proper operation.

5.4.2.2 Construction

Mitigation measures applicable during construction activities include the following:

- Stage construction activities to limit the area of disturbed soils exposed at any particular time.

- Water unpaved roads, disturbed areas (e.g., scraping, excavation, backfilling, grading, and compacting), and loose materials generated during project activities as necessary to minimize fugitive dust generation.

- Install wind fences around disturbed areas if windborne dust is likely to impact sensitive areas beyond the site boundaries (e.g., nearby residences).

- Spray stockpiles of soils with water, cover with tarpaulins, and/or treat with appropriate dust suppressants, especially when high wind or storm conditions are likely. Vegetative plantings may also be used to limit dust generation for stockpiles that will be inactive for relatively long periods.

- Train workers to comply with speed limits, use good engineering practices, minimize the drop height of excavated materials, and minimize disturbed areas.

- Cover vehicles transporting loose materials when traveling on public roads, and keep loads sufficiently wet and below the freeboard of the truck in order to minimize wind dispersal.

- Inspect and clean tires of construction-related vehicles, as necessary, so they are free of dirt prior to entering paved public roadways.

- Clean (e.g., through street vacuum sweeping) visible trackout or runoff dirt from the construction site off public roadways.

5.4.2.3 Operations and Maintenance

Typically, a utility-scale wind energy facility during normal operation would have few emission sources, as discussed in section 5.4.1.3. Air emission rates would be very small; thus, potential impacts on ambient air quality would be minimal. No additional mitigation measures are considered necessary, but some dust control measures discussed above may be applicable to minimize fugitive dust emissions from bare surfaces and unpaved access roads.

5.4.2.4 Decommissioning

Decommissioning activities generally mirror construction activities; thus, the same mitigation measures should be applied during decommissioning as would be applied during construction.

5.4.2.5 Transmission Lines

Some mitigation measures applied to the construction, operation, maintenance, and decommissioning activities discussed above would also be applicable for activities associated with building, operating, and maintaining transmission lines. Additional mitigation measures include minimizing fugitive dust emissions by accessing transmission lines during construction and maintenance from public roads and designated routes, to the maximum extent possible.

5.4.3 No Action Alternative

Under the No Action Alternative, wind energy facilities would be built independently across private and public lands, following the existing procedures and policies of Western and the Service (as applicable) to avoid or mitigate impacts on air quality and climate on a project-by-project basis. Western would continue to process and evaluate interconnection requests within the UPG Region and the Service would evaluate and make decisions regarding accommodation of wind energy facilities on easements on a case-by-case basis. Separate project-specific NEPA evaluations would be required by both Western and the Service and avoidance, minimization, and mitigation measures for projects would be identified based on those project-specific evaluations. Potential effects on air quality and climate would primarily result from ground-disturbing activities during construction, but could include any of the common impacts identified in section 5.4.1.

As described at the beginning of this chapter, wind energy development within the UGP Region between the present and 2030 is projected to encompass 1.1 to 3.8 million ac (0.4 to 1.5 million ha) of land, with the greatest amount of development expected to occur in Iowa (section 2.4; table 2.4-1). It is anticipated that about 115 to 400 new projects could be developed, with an average of about 75 turbines per project. It is assumed that development would occur primarily within areas identified as having high suitability for wind energy development (section 2.4; figure 2.4-2). While areas of high suitability occur throughout the UGP Region, they are concentrated in the central and eastern portions of the region. It is also anticipated that facilities that would connect to Western's electric grid would likely be located within 25 mi (40 km) of Western's transmission lines and substations, especially where those 25-mi (40-km) buffer areas intersect high-suitability areas. Construction of transmission lines to connect new facilities would not be limited to areas of high suitability.

The main elements in assessing direct impacts on air quality and climate within the UGP Region are the location and the temporal/spatial extent of ground-disturbing activities during each project phase (section 5.4.1). Construction activities could involve a number of separate operations, including mobilization/staging, land clearing (grubbing and tree removal), topsoil stripping, cut-and-fill operations, road construction, ground excavation and trenching, tower foundation treatment, wind turbine/tower transport to the site, wind turbine/tower/building/structure erection, installation of electrical and mechanical components, landscaping, and operational testing. The nature and extent of potential impacts would depend on the size and design of the project, type and level of activity, and site-specific factors such as soil types, local topography, and local meteorological conditions (e.g., wind speed and precipitation). Because the information on locations and footprints of wind projects to be developed are not currently known, specific potential impacts on air quality and climate cannot be quantified in this PEIS. However, past experiences related to development of wind energy projects indicate that the potential impacts of a wind project on ambient air quality and climate during the construction phase would likely be small and localized due to soil disturbances of a relatively small area and short-term use of a small fleet of heavy equipment. During operation and maintenance of a wind energy project, air emissions would be minimal because no fossil fuel is burned for power generation and associated impacts on air quality would be very small.

Development and operation of wind energy facilities would reduce the need to construct fossil fuel–fired power plants, resulting in an overall reduction in air emissions from future power generating facilities, including criteria pollutants, hazardous air pollutants, and GHGs, that would otherwise be released such facilities. Sovacool (2008) estimated a GHG emission factor of about 10 g CO_2 equivalent (CO_2e) per kWh during the lifecycle of wind turbines, which is nearly the lowest among electricity generation facilities. This emission factor is lower by about two orders of magnitude, compared to emissions factors for power plants burning fossil fuels such as natural gas (443 g CO_2e per kWh) or coal (969–1,050 g CO_2e per kWh). Therefore, development and operation of wind facilities in place of fossil fuel generation facilities would have positive impacts on ambient air quality and climate.

Potential impacts on air quality and climate associated with wind energy project development would be avoided or mitigated by implementing the BMPs and mitigation measures identified by Western and the Service on a project-by-project basis. Project developers would be required to adhere to all applicable Federal, State, and/or local air quality permits, and construction and operation would be performed in accordance with all applicable laws, ordinances, regulations, and standards. However, the benefits of a coordinated approach (e.g., consistency of environmental analyses and mitigation requirements) may not be realized under the No Action Alternative.

5.4.4 Alternative 1

Under Alternative 1, potential impacts on air quality would be generally similar to those described for the No Action Alternative. The environmental evaluation process identified in section 2.3.2.1 would be implemented. Projects desiring to tier off the evaluations in this PEIS for project-specific NEPA evaluations would be required to identify and implement the appropriate BMPs and mitigation measures identified in section 5.4.2 as necessary to address site-specific conditions. Project developers would also be required to obtain all applicable Federal, State, and county permits and meet their requirements. Under these conditions, impacts on air quality as a result of wind energy development are expected to be minor, similar to those that would occur under the No Action Alternative.

5.4.5 Alternative 2

Under Alternative 2, the types of potential impacts on air quality would be generally similar to those described for the No Action Alternative. Because it is anticipated that the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects on air quality would also be similar.

As with Alternative 1, project developers would continue to be required to obtain all applicable Federal, State, and/or local air quality permits, and construction and operation would be performed in accordance with all applicable laws, ordinances, regulations, and standards. The environmental evaluation process identified in section 2.3.2.1 would be implemented for projects interconnecting to Western's transmission system. This would include a requirement to identify and implement the appropriate BMPs and mitigation measures identified in section 5.4.2 (and summarized in section 2.3.2.2) that would be needed to address site-specific conditions. As a consequence, impacts on air quality from wind energy projects that would interconnect to Western's transmission system are expected to be minor.

Although the Service would not allow easement exchanges for wind energy development under this alternative, it is anticipated that similar levels of development in the vicinity of easements would be attained by developing projects on non-easement private lands. Assuming that a small number of wind energy projects would be required to site wind energy structures on private lands not managed under Service easements if this alternative was selected, there is a potential for somewhat lesser levels of environmental evaluation, fewer requirements to implement specific BMPs and mitigation measures, and a somewhat greater potential for adverse effects on air quality from those projects. However, given the relatively low levels of air emissions associated with construction, operation, and maintenance of wind energy projects, overall impacts on ambient air quality as a result of wind energy development are anticipated to be minor and comparable to levels of impacts that would result under both the No Action Alternative and Alternative 1.

5.4.6 Alternative 3

Under Alternative 3, the types of potential impacts on air quality would be generally similar to those described for the No Action Alternative. Because the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects on air quality would also be similar. Because no standardized BMPs, mitigation measures, or monitoring requirements would be imposed by Western or the Service under this alternative, beyond those required under established Federal, State, and local regulatory requirements, impacts on air quality could vary from region to region; such impacts could potentially be greater in less regulated jurisdictions.

5.5 NOISE IMPACTS

This section describes potential impacts on the acoustic environment, including nearby sensitive receptors (such as residences or wildlife habitat), that could be located near wind generation projects sited in the UGP Region. Section 5.5.1 describes the common impacts on the acoustic environment that could occur in the UGP Region during major phases of a typical wind energy development project's life cycle. BMPs and mitigation measures to address impacts from noise are presented in section 5.5.2.

The common impacts discussion is followed by a discussion of potential impacts under the four PEIS alternatives (sections 5.5.3 through 5.5.6). The impact analysis for potential development under the four programmatic alternatives is necessarily generic in nature, because the actual development levels that might occur under the alternatives are estimates, and details on locations, sizes, and configurations of future wind energy facilities are unknown. A detailed assessment of impacts on the acoustic environment from specific projects is dependent upon site- and project-specific information pertaining to location, size, and configuration of the proposed project. Potential impacts on specific sensitive receptors, such as residences or wildlife habitat, would be assessed further as part of site-specific NEPA evaluations that would be conducted for individual proposed projects.

The impact analysis for potential development under the PEIS alternatives assumes that acoustic impacts would be generally proportional to the area affected by direct and indirect impacts, and would depend on the BMPs and mitigation measures that are implemented as part of the projects. Among alternatives, levels of potential impacts on the acoustic environment are compared with those under the No Action Alternative.

5.5.1 Common Impacts

5.5.1.1 Site Characterization

As described in section 3.2, site characterization activities would primarily involve meteorological data collection and subsurface soil sampling. Heavy-duty all-wheel-drive pickup trucks or medium-duty trucks would be used to transport the meteorological towers to the site and to erect them. Associated with subsurface soil sampling, augurs or drilling rigs mounted on trailers, light-to-medium-duty trucks, or tracked vehicles would be needed. During the site characterization phase, a minimum-specification access road would be required. Typically, this would be an existing road that would not be improved during the characterization phase, and characterization activities (e.g., installation of meteorological towers or soil sampling) would occur adjacent to it. Limited brush clearing at the tower and soil sampling sites might be needed. If existing roads do not provide adequate site access, noise sources could include a grader or bulldozer for construction of an access road and, if needed, heavy equipment for drilling activities. Other noise sources could include vehicular traffic for commuting or delivery to and from the site and, where siting cannot avoid brush, chainsaws and chippers for brush clearing.

Most noise-generating activities would occur intermittently during the site characterization phase. It is anticipated that all of these activities would be conducted with a small crew and a small fleet of medium to heavy equipment, and would occur during daytime hours when noise is tolerated more than at night because of the masking effect of background noise. Accordingly, potential noise impacts of site characterization activities on neighboring residences would be anticipated to be minor and intermittent in nature.[7]

5.5.1.2 Construction

Major components of a wind energy development project would include wind turbines, electrical collection systems, transmission/interconnection facilities, access roads, O&M facilities, and meteorological towers (AWEA 2008). Construction activities are site-dependent

[7] Noise levels from construction equipment are comparable to those from agricultural equipment, such as tractors, combines, and chainsaws (Murphy et al. 2007). Accordingly, during the life of the wind project, agricultural noise, once in operation, could considerably mask the wind project–related noise.

but would typically involve a number of separate stages, including mobilization/staging, access road, and staging/laydown area construction; grubbing/land clearing; topsoil stripping; cut-and-fill operations (i.e., earthmoving); grading, ground excavation; drilling, if required; foundation treatment; erection of wind turbines; construction of ancillary buildings and structures; digging trenches for underground electrical cables; electrical and mechanical installation; and landscaping (e.g., site cleanup, decompaction, final grading, and reseeding). Construction would, in large part, be divided into two phases: site preparation and general construction. For most wind energy facilities, the site preparation phase would be of relatively short duration (e.g., a few months) followed by a longer general construction phase (e.g., a year or so).

Heavy equipment used in the site preparation phase would include bulldozers, scrapers, graders, end loaders, trucks, and, if needed, rock drills. On sites where brush cannot be avoided, chainsaws and chippers might also be used. The major equipment used in the general construction phase would include large lifting cranes, end loaders, backhoes, bulldozers, trucks (including concrete mixer trucks), and trenchers. A temporary concrete batch plant might be needed if substantial amounts of concrete are needed and/or premix concrete is unavailable from nearby vendors. If an on-site batch plant is used, trucks delivering raw materials and delivering mixed concrete to individual pour sites, as well as operation of diesel generators for the batch plant, would cause noise. Operation of ancillary equipment, such as small mixers, vibrators, and concrete pumps, would generate relatively low noise levels.

Each stage has a specific equipment mix, depending on the work to be accomplished. The noise level generated by each type of construction equipment would vary, depending on such factors as type, model, size, and condition of the equipment; operation schedule; and condition of the area being worked.

In general, the dominant noise source for most construction equipment would be diesel engines. However, in the unlikely event that pile driving and/or pavement breaking would be required, these noises would dominate, but would be of short duration. Except for pile drivers and rock drills, which are louder, most construction equipment would have noise levels ranging from 75 to 90 dBA at a distance of 50 ft (15 m) (Hanson et al. 2006).

Typically, a large construction crane is needed to install a turbine tower and the nacelle and rotor atop the turbine tower. The sound level of this equipment is comparable to a semitrailer truck moving at slow speed. Combined noise levels for typical construction equipment that would likely be used at a wind turbine project site are about 90 dBA at a distance of 50 ft (15 m). For the screening calculation, sound attenuation caused by geometric spreading (i.e., a 6-dB decrease upon doubling the distance from a point source) and ground effects was assumed. In addition, equipment was assumed to be operating at peak load and for a 10-hour workday. Estimated noise levels at a distance of about 770 ft (230 m) would exceed the EPA guideline of a 55-dBA day-night average sound level (L_{dn}) for residential zones (EPA 1974). The noise level at a distance of about three-quarters of a mile (about 1.2 km) would be about 40 dBA, which would be typical of the daytime rural background level. Noise levels at specific distances from activities would be reduced if other noise attenuation mechanisms (e.g., air absorption, terrain, screening, meteorological effects) and realistic load factors were considered.

On-road vehicular traffic, for which the sound level is comparable to a semitrailer truck moving at slow speed, includes hauling rotor blades and nacelles along with tower sections and other large components to the site. The peak pass-by noise levels of a heavy truck operating at 25 and 50 mph (40 and 80 km/h) are estimated to be about 76 and 83 dBA, respectively (Menge et al. 1998). Other on-road traffic would include commuter/visitor/support/delivery traffic. The number of truck trips associated with construction activities would vary, depending on the construction stage. Potential noise impacts would be greatest when heavy-duty truck traffic would be at its peak. Commuter and visitor vehicular traffic, which would consist of mostly light-duty vehicles with lower-level noise sources (roughly ten passenger cars equal one heavy truck on an equivalent-continuous sound level [L_{eq}] basis), would be primarily limited to morning and afternoon rush hours. Other vehicular traffic are anticipated, such as transport of heavy equipment, delivery of general construction materials, and a water truck for fugitive dust control; the noise contribution from these sources, however, would likely be short-lived. Except at receptor locations in close proximity to the road and/or heavy traffic volumes, noise levels at nearby residences would be below the EPA guideline of 55 dBA L_{dn} for residential areas and farms (EPA 1974).

The construction of transmission lines within a designated ROW would be needed to connect a new wind energy development project to the nearest regional grid. The general sequence of activities for placing electricity transmission lines would involve surveying, land clearing (grubbing and tree removal), construction of access roads, drilling or excavation for support structures and concrete footings, and backfilling. Tower structures would be carried to the site in sections by truck, assembled in the ROW or laydown areas, and lifted into place with a crane. Depending on environmental and/or logistical factors (e.g., rugged mountainous terrain), helicopters could be used for tower transport and erection, which would significantly reduce the construction period but increase short-term noise levels. Truck-mounted cable-pulling equipment would be used to string the conductors onto the support structures. As with other construction activities, noise sources would include heavy equipment and commuter/visitor/support/delivery vehicles. Since most wind energy facilities would be located within 25 mi (40 km) of existing transmission lines, transmission line construction could be performed in a short time (a few months at most). The construction site along the transmission line ROW would move continuously; because no particular area would be exposed to noise for a prolonged period, the potential impacts on nearby residences would be minor and temporary.

If helicopters are used to place turbine or transmission towers, exposure to relatively high noise levels from helicopter overflights would result in increased annoyance. The principal noise sources would be the main rotor system (periodic blade slap noise) and the engine. The sound pressure level for a helicopter in level flight and traveling at an altitude of 500 ft (150 m) with an airspeed of about 69 mph (111 km/h) would be 94 dBA when passing directly overhead (Raney and Cawthorn 1991). When setting structures, helicopters would be at lower altitudes and may fly at lower levels between staging areas and erection sites, resulting in higher ground-level noises. However, since helicopters would be used only in sparsely populated areas, the potential for disturbance to a large number of residences is small. Helicopter operations would be infrequent and of short duration, and potential impacts would be limited to staging areas, construction sites, and along flight paths, and would be temporary in nature.

In most cases, backhoes would be used to excavate foundation holes for wind turbines, sometimes using a pneumatic hammer to break up subsoil rock. If bedrock is close to the subsurface, explosive blasting might be needed for wind turbine foundations, although experience in the UGP Region indicates this would be unnecessary and avoided in most cases due to increased costs and potential environmental concerns. Air blast overpressure is manifested as an airborne pressure wave from the detonation of explosives (also called air blast) and, to a much less extent, concussion mechanisms, such as impact pile driving. Low-frequency waves from an air blast are virtually inaudible but have the potential to induce cracking due vibration in structures. Noise is the high-frequency audible portion of the air overpressure, which generates community annoyance. In the unlikely event that blasting should be needed, it should meet acceptable U.S. Occupational Safety and Health Administration (OSHA) and community noise standards. Potential impacts from blasting on nearby residences and noise-sensitive structures would be minor, given the remote nature of most potential wind development projects.

Construction activity could result in various degrees of ground vibration depending on the equipment and construction methods. All construction equipment causes ground vibration to a degree, but activities that typically generate the most severe vibrations are high-explosive detonation and impact pile driving, both of which are unlikely to be used at UGP Region sites. Vibrations diminish in strength with distance. Using a pile driver as a worst-case example, the vibration level at receptors beyond 920 ft (280 m) from an impact pile driver would diminish below the threshold of perception for humans (Hanson et al. 2006). Considering the remote nature of most potential wind development projects, residences or noise-sensitive structures are unlikely to be located in close proximity. Therefore, adverse vibration impacts from construction activities are not anticipated.

Most construction activities would occur during the day, when noise is tolerated better because of the masking effect of background noise. Nighttime noise levels would drop to the background levels of the project area. In general, construction activities for wind energy development would disturb smaller areas than those at other industrial facilities, and would persist for a short period (1 or 2 years at most). However, the periods of noise at any given residence in a project area would probably only be several periods of a few days because as turbine construction in one area is completed construction activities will move elsewhere within the overall project area. Therefore, the potential noise and vibration impacts of construction activities would be local and temporary in nature.

5.5.1.3 Operations and Maintenance

During operation, noise sources would be the wind turbines, the transformer and switchgear from the substation, corona discharges from transmission lines, and the O&M facility. Another noise source would be infrequent operation of a diesel generator (e.g., 2 h per month for mandatory testing) near associated O&M facilities. Routine motorized travel by commuters, visitors, and material delivery vehicles would generate intermittent noises. Maintenance activities involving periodic site visits to wind turbines, transmission lines, substations, and auxiliary structures would involve light- or medium-duty vehicle traffic with relatively low noise levels. Infrequent but noisy activities would be anticipated, such as road maintenance work with heavy equipment or repair or replacement of old or inoperative wind turbines or auxiliary equipment. However, the anticipated level of noise impacts from maintenance activities would be far lower than that from construction activities. Overall, the noise levels of continuous site operation would be much lower than the noise levels associated with short-term construction activities.

Wind Turbine Noise. Wind turbines produce two categories of noise: mechanical and aerodynamic. These categories are associated with four types of noise (tonal, broadband, impulsive, and low-frequency) (Rogers et al. 2002). A brief discussion of each of these noise characteristics follows; a more detailed review is included in Wagner et al. (1996).

Mechanical Noise. Mechanical noise associated with the rotation of mechanical and electrical components tends to be tonal, although a broadband component exists. This type of noise is primarily generated by the gearbox and other parts, such as generators, yaw drives, and cooling fans. The major components of a wind turbine, such as the hub, rotor, nacelle, and tower, may act as loudspeakers, which contribute to transmitting the mechanical noise over increased distances. Recent technological improvements have reduced mechanical noise to a level well below aerodynamic noise.

Aerodynamic Noise. Aerodynamic noise from wind turbines originates mainly from the flow of air over and past the blades; therefore, the noise is generally related to the ratio of blade tip speed to wind speed. It is directly linked to the production of power, and as such is inevitable, even though it could be reduced to some extent by altering the design of the blades (Wagner et al. 1996). Aerodynamic noise has a broadband characteristic, which contains lower frequencies and some infrasound. The broadband “swish” sound, ranging from 500 to 1,000 Hz, is typically the dominant part of wind turbine noise today (Leventhall 2006), sometimes resulting in noise complaints about wind turbines. However, many people mistakenly perceive the swishing sound from wind turbines as being a low-frequency noise or infrasound. That is because people tend to be especially sensitive to even low levels of infrasound. Low-frequency noise and infrasound are perceived as a combination of auditory and tactile sensations, which cause annoyance in three different ways: through a feeling of static pressure, a periodic masking of desirable sounds, and the rattling of windows, doors, or furnishings. Infrasound levels of modern wind turbines are typically 50 to 70 dB, which are below the hearing threshold, and no reliable evidence of adverse effects for these levels have been documented (Leventhall 2006). However, adverse health effects of infrasound, such as fatigue, apathy, hypertension, or physiological damage, could occur at levels higher than 115 dB (Rogers et al. 2002).

Although aerodynamic noise mostly has a broadband character, airfoil-related noise can also have low-frequency and impulsive tonal components. Low-frequency and impulsive noises, caused by localized flow deficiencies and disturbed air flow around a tower, respectively, are associated with downwind wind turbines, whose blades are on the downwind side of the tower. However, these downwind designs are uncommon in modern utility-scale wind turbines. In general, upwind turbines are less noisy than downwind turbines, and their pitch control and lower rotational speed result in lower noise generation. A modern variable-speed wind turbine generates lower noise emissions than an earlier fixed-speed turbine; the market share for this earlier turbine has shown a significant downward trend in recent years. A large variable-speed wind turbine operates at slower speeds in low winds, resulting in much quieter operation in low winds than a comparable fixed-speed wind turbine. As wind speed increases, the wind itself masks the increasing turbine noise.

Sound level data would be needed to determine the potential noise impacts from wind turbine operations at nearby residences. These data are typically provided by the wind turbine manufacturer or vendor, or can be obtained from field measurements or a literature survey. The sound power level from a single wind turbine is approximately 104 dBA for a rotor having a diameter of 328 ft (100 m) (Rogers et al. 2002). Considering only geometric spreading from the turbine, the estimated sound pressure level at a distance of 2,100 ft (630 m) would be 40 dBA, which is typical of the background level in a rural environment. To estimate combined noise levels from multiple turbines, the sound pressure level from each turbine should be estimated and summed. Different arrangements of multiple wind turbines (e.g., in a line along a ridge versus in clusters) would result in different noise levels; however, the resultant noise levels would not vary by more than 10 dB. Typically, wind speed increases with elevation and the wind speed at the top of turbines is greater than wind speed closer to the ground. As a consequence, there is a tendency for the path of sound propagation to bend (or refract) upward on the upwind side and downward on the downwind side of a turbine. Accordingly, a sound shadow zone, into which no direct sound can penetrate, is most commonly encountered upwind of a wind turbine but no shadow zone is produced downwind of a wind turbine.

Potential noise impacts for each wind energy development project should be assessed on the basis of sound pressure level in dBA,[8] all sound attenuation mechanisms (such as ground effects, air absorption, screening effects, and vertical wind and temperature gradient effects), and site-specific conditions. Site-specific conditions would include the number and size of wind turbines, their locations, the distance to the sensitive receptors, land cover, topography, and local meteorological conditions, such as wind speed and direction, temperature, relative humidity, and atmospheric stability. In addition, the additive and masking effects of background sound level should be taken into consideration.

Whether or not turbine noise is intrusive depends not only on its amplitude distribution as a function of frequency but also on the background noise, which varies with the level of human and animal activities and meteorological conditions (primarily wind speed). When wind turbine noise levels are of the same magnitude as the background level, wind turbine noise could be masked by background noise. In general, wind-generated background noise (i.e., noise caused by the interaction between wind and vegetation or structures) tends to increase more rapidly with wind speed than aerodynamic noise from wind turbines. Wind-generated noise would increase by about 2.5 dBA per each 2.2-mph (1-m/s) increase in wind speed (Hau 2000); the noise level of a wind turbine, however, would increase only by about 1 dBA per 2.2-mph (1-m/s) increase in speed. In general, if the background noise level exceeds the noise level of a wind turbine by about 6 dBA, the latter no longer contributes to a perceptible increase in noise. At a wind speed of about 22 mph (10 m/s), wind-generated noise is higher than aerodynamic noise. It is generally known that measurement of wind turbine noise is difficult above a wind speed of 18 mph (8 m/s) because the background wind-generated noise masks the wind turbine noise at that speed. As a result, noise issues are more commonly a concern at lower wind speeds.

Annoyance due to wind turbine noises might be associated with specific meteorological conditions. As an example, on a clear night, radiative cooling of the earth's surface causes a temperature inversion in which the temperature increases with height. This in turn creates stable conditions in which turbulence is suppressed near the ground. With no interaction between air at the surface and that aloft (provided by turbulence), winds become calm near the surface and frictional retardation provided by the earth's surface decreases significantly aloft.

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[8] Sound pressure level in dBA is widely used to determine compliance with noise guidance or regulation. However, sound spectra, either octave band or one-third octave band (preferred), could be needed to identify low-frequency noise for detailed noise impact analysis.

Accordingly, wind speeds may fall to near zero at the surface but remain fast enough at the height of the turbine to turn the blades. Under this condition, sound refracts, bending downward, which is a favorable condition for propagation (i.e., sound will travel farther with less attenuation). Under this condition, residents at ground level could experience increased noise level by 10 dB in areas where low background noise levels (e.g., sheltered valleys) could not mask the wind turbine noise (Stewart 2006). In general, wind effects on sound propagation tend to dominate over temperature effects when both effects are present.

Swishing noise causes most noise complaints about wind farms. Wind farm noise generates more complaints than a comparable level of transportation noise, such as from aircraft, road traffic, and railways (Pedersen and Persson Waye 2004). Pedersen and Persson Waye (2004) report that below an L_{eq} of 32.5 dBA, none of the respondents in their study were annoyed, but 36 percent of respondents were very annoyed at a noise level above 40 dBA. This study for determining a dose-response relationship for wind turbine noise was conducted in different conditions from transportation noise studies in various aspects (e.g., noise levels outdoors vs. indoors, L_{eq} vs. L_{dn}, low vs. medium-to-high background noise levels). Nonetheless, the key finding of this study is that the percent of persons annoyed by wind turbine noise increases with noise level more rapidly than for transportation noises. The unexpected higher proportion of annoyance in comparison with transportation noises is associated with the combined effects of intrusive sound characteristics, shadow flickering, and the visual impacts of wind turbines. However, public perception of noise from wind turbines also depends on the circumstances and sensitivity of the person who hears it. For most of landowners hosting wind turbines, the noise is acceptable and sometimes not objectionable at all.

Noise should be considered when choosing locations for individual wind turbines. In most cases, wind turbines do not cause community-wide noise problems, but some residents in the vicinity of wind farms are adversely affected by wind turbine noise. There is controversy about the levels of low-frequency noise and infrasound from wind turbines and potential health impacts. The most objective factor in determining annoyance is the magnitude of new intruding noise, but residents also judge a new noise in comparison to the existing background level. Wind project operators should recognize that complaints about noise may still occur even when noise levels from the facility do not exceed regulatory levels. Considering that a change in sound level of 5 dB will typically result in a noticeable community response, a sufficient setback distance should be established to minimize neighbor complaints about wind farm noise. This applies to some of the UGP Region, which has relatively low background levels (e.g., a community in a valley). In fact, most areas favored for development in the UGP Region have relatively high background noise level because of consistent high and steady winds. Sufficient setback distance could be achieved through coherent permitting procedures and zoning ordinances established by States or local agencies. As mentioned previously, the fluctuating swish noise is a frequency modulation of an aerodynamic noise in the region of 500–1,000 Hz. The fact that a time-varying noise is more annoying than a steady noise of the same average level should be taken into account in establishing an acceptable noise limit for wind turbine noise (Leventhall 2006).

No heavy equipment capable of causing ground vibration would be used during the operation phase, and no residences or noise-sensitive structures would be located in close proximity. The levels of infrasound and vibration radiated from modern wind turbines are at a very low level. Therefore, there would be no adverse vibrational impacts from operation activities at the wind farm site.

Substation Noise. There are basically two sources of noise associated with substations: transformer and switchgear. Each has a characteristic noise spectrum and pattern of occurrence.

A transformer produces a constant low-frequency humming noise primarily because of the vibration of its core. The core's tonal noise, caused by vibration at twice the line frequency as a result of magnetostrictive forces, is uniform in all directions and is continuous. Core noise consists of discrete tones at even harmonics of line frequency (e.g., 120, 240, 360, up to 1,200 Hz or higher) on 60-Hz lines. The cooling fans and oil pumps at large transformers generate broadband noise only when in operation; in general, this noise is less noticeable than the tonal noise. The average core sound level at a distance of 492 ft (150 m) from a transformer would be about 47 dBA for a power level of 300 million volt-amperes (MVA) (corresponding to 300 MW with a power factor of 1) (Wood 1992). Estimated noise levels at distances of 900 and 2,200 ft (280 and 670 m) would be 40 and 30 dBA, respectively, which are typical of day- and night-time background levels in a rural environment.

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

Transmission Line Noise. Potential transmission line noise can result from corona discharge, which is the electrical breakdown of air molecules into charged particles. Corona noise is composed of broadband noise, characterized as a crackling or hissing noise, and pure tones, characterized as a humming noise of about 120 Hz on 60-Hz lines. Corona noise is primarily affected by weather and, to a lesser degree, by altitude and temperature. It may be generated during all types of weather when air ionizes near isolated irregularities on conductor surfaces of operating transmission lines (e.g., at nicks and scrapes and due to the presence of insects or water droplets). Modern transmission lines are designed, constructed, and maintained so that during dry conditions the lines would generate a minimum of corona-related noise. During dry weather, noise from transmission lines is generally indistinguishable from background noise (Lee et al. 1996). Under wet conditions, however, moisture collecting on the lines provides favorable conditions for corona discharges. Occasional corona humming noise at 120 Hz and higher is easily identified and, therefore, may cause complaints from nearby residents. During rainfall events, the noise level at the edge of the ROW of 230-kV transmission line towers would be about 39 dBA (Lee et al. 1996), which is typical of the daytime background level in a rural environment. The noise level at a distance of 300 ft (91 m) would be about 31 dBA, which would be lost in the background noise typical of a rural environment at night.

A preliminary study by Pearsons et al. (1979) indicated that because of its high-frequency components, corona noise may be judged to be as annoying as other environmental noises even when it is actually 10 dBA lower than those other noises However, corona noise tends to decrease in amplitude faster with distance than other environmental noise because of its higher frequency components. In general, because of the sparsely populated remote location of most potential wind energy development projects, the impact of corona noise during the operation phase is not expected to be significant. Although corona noise could be an issue where transmission lines run through populated areas, it would not likely cause a problem unless a residence is located within 500 ft (152 m) of the transmission lines.

5.5.1.4 Decommissioning

With the exception of the excavation, concrete placement, and backfilling associated with tower foundations, the types and levels of decommissioning activities would be similar but shorter in duration than those associated with construction. Thus, the noise levels would be similar to or less than those for construction activities. As in the construction period, most decommissioning activities would occur during the day, when noise is tolerated better than at night because of the masking effect of background noise. Nighttime noise levels would drop to the background levels of a rural environment because decommissioning activities would cease at night. Like construction activities, decommissioning activities would last for a short period compared with wind turbine operation; potential impacts would be local and temporary in nature.

5.5.2 BMPs and Mitigation Measures

All project-related activities would be expected to comply with applicable laws, ordinances, regulations, and standards. This section presents BMPs and mitigation measures that would be applicable during the site characterization, construction, operations and maintenance, and decommissioning phases to reduce potential noise and vibration impacts on nearby sensitive receptors, including residences.

5.5.2.1 General

BMPs and mitigation measures applicable throughout multiple phases of a wind energy development project include the following:

- Take advantage of topography and the distance to nearby sensitive receptors when positioning potential sources of noise.

- Establish sufficient setback distances from sensitive receptors wherever feasible. Based on previous experience, noise complaints seldom exist for people living more than 1–1.5 mi (1.6–2.4 km) from a wind farm (Stewart 2006).

- Select equipment with the lowest noise levels available and no prominent discrete tones, when possible.

- Maintain all equipment in good working order in accordance with manufacturer specifications. Suitable mufflers and/or air-inlet silencers should be installed on all internal combustion engines and certain compressor components.

- All vehicles traveling within and around the project area should operate in accordance with posted speed limits.

- Establish a process for documenting, investigating, evaluating, and resolving project-related noise complaints.

5.5.2.2 Site Characterization

BMPs and mitigation measures applicable to the site characterization phase are the same as those for the construction phase.

5.5.2.3 Construction

BMPs and mitigation measures applicable during construction of a wind energy project include the following:

- Limit noisy construction activities to the least noise-sensitive times of day (daytime only, between 7 a.m. and 7 p.m.) and weekdays.

- Schedule noisy activities to occur at the same time whenever feasible, since additional sources of noise generally do not greatly increase noise levels at the site boundary. Less-frequent but noisy activities would generally be less annoying than lower-level noises occurring more frequently.

- Locate stationary construction equipment (e.g., compressors or generators) as far as practical from nearby sensitive receptors.

- In the unlikely event that blasting or pile driving would be needed during the construction period, notify nearby residents in advance.

5.5.2.4 Operations and Maintenance

BMPs and Mitigation measures applicable during operation of a wind energy project include:

- If a transformer becomes a noise issue, a new transformer with reduced flux density generating noise levels as much as 10–20 dB lower than National Electrical Manufacturers Association (NEMA) standard values could be installed. Alternatively, barrier walls, partial enclosures, or full enclosures could be adopted to shield or contain the transformer noise, depending on the degree of noise control needed.

5.5.2.5 Decommissioning

The same BMPs and mitigation measures applicable to construction activities are applicable to decommissioning activities.

5.5.3 No Action Alternative

Under the No Action Alternative (see section 2.3.1 and table 2.3-1 for a description of the alternative), potential effects on the acoustic environment would primarily result from heavy equipment during construction and from wind turbines during operation, but could include any of the common impacts identified in section 5.5.1.

The main elements in assessing direct impacts on the acoustic environment within the UGP Region are the location and the temporal/spatial extent of construction and operation of wind turbines during each project phase (section 5.5.1). Construction activities could involve a number of separate operations, including mobilization/staging, land clearing, topsoil stripping, cut-and-fill operations, road construction, ground excavation and trenching, tower foundation treatment, wind turbine/tower transport to the site, wind turbine/tower/building/structure erection, installation of electrical and mechanical components, landscaping, and operational testing. During construction, the nature and extent of potential noise impacts would depend on the size and design of the project, type and level of activity, and site-specific factors such as distances to nearby sensitive receptors, land cover, topography, spatial configuration between wind turbines and receptors, and meteorological conditions such as temperature, relative humidity, and vertical gradients of wind and temperature. During operation, wind turbines generate both aerodynamic noise and mechanical noise; the former dominates over the latter in modern wind turbines. During operation, primary factors determining potential impacts would be similar to those during construction. However, wind turbines may operate at any time of the day and thus vertical gradients of wind and temperature play a more important role in sound propagation, especially during nighttime hours. Because the information on locations and footprints of wind projects to be developed are not currently known, potential impacts on the acoustic environment cannot be quantified in this PEIS. However, past experiences related to development of wind energy projects indicate that the potential impacts of a wind project on nearby sensitive receptors during the construction phase would likely be minor and temporary in nature, due to soil disturbances of a relatively small area and short-term use of a small fleet of heavy equipment. However, during operation of a wind energy project, noise impacts on nearby sensitive receptors would be long term, but would vary widely, depending on the site-specific factors, including the distances and spatial configuration between wind turbines and receptors, and meteorological conditions.

Potential impacts on the acoustic environment associated with wind energy project development would be avoided or mitigated by implementing the BMPs and mitigation measures identified by Western and the Service on a project-by-project basis. Although setback requirements may be based on noise considerations, noise permits are not required from the Federal, State, and/or local agencies. Construction, operation, and maintenance activities would be performed in accordance with all applicable laws, ordinances, regulations, and standards. However, the benefits of a coordinated approach (e.g., consistency of environmental analyses and mitigation requirements) may not be realized under the No Action Alternative.

5.5.4 Alternative 1

The level of wind energy development within the UGP Region between the present and 2030 is projected to be similar to that identified under the No Action Alternative; the potential impacts from noise associated with development of wind energy projects under Alternative 1 would be generally similar as well. The environmental evaluation process identified in section 2.3.2.1 would be implemented. Projects desiring to tier off the evaluations in this PEIS for project-specific NEPA evaluations would be required to implement the appropriate BMPs and mitigation measures identified in section 5.5.2 (and summarized in section 2.3.2.2) in order to address site-specific concerns related to impacts from noise. Project developers would also be required to obtain all applicable Federal, State, and county permits and meet their requirements. Under these conditions, impacts from noise as a result of the construction and operation of wind energy projects are expected to be minor and not substantially different from those that would occur under the No Action Alternative.

5.5.5 Alternative 2

Potential impacts from noise under Alternative 2 would be generally similar to those described for the No Action Alternative. Because it is anticipated that the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects due to noise would also be similar. During construction and operation under Alternative 2 (see section 2.3.3 and table 2.3-1 for a description of the alternative), the nature and extent of potential impacts from noise would depend on many factors, as described in section 5.5.3.

As with Alternative 1, project developers would continue to be required to obtain all applicable Federal, State, and/or local permits, and construction and operation would be performed in accordance with all applicable laws, ordinances, regulations, and standards. The environmental evaluation process identified in section 2.3.2.1 would be implemented for projects interconnecting to Western's transmission system. This would include a requirement to identify and implement the appropriate BMPs and mitigation measures identified in section 5.5.2 that are needed to address site-specific concerns related to impacts from noise. As a consequence, impacts due to noise from wind energy projects that would interconnect to Western's transmission system are expected to be minor and not substantially different from those that would occur under the No Action Alternative.

Because the Service would not allow easement exchanges for wind energy development under this alternative, there is a smaller potential for impacts from noise on wildlife within existing easements; however, under Alternative 1 projects accommodated through easement exchanges would be required to implement the BMPs and mitigation measures identified in section 5.5.2, thereby addressing potential effects of noise. Although there would be no development directly on lands protected by easements under Alternative 2, it is anticipated that similar levels of development in the vicinity of easements would be attained by developing projects on nearby non-easement private lands. Assuming that this alternative would result in a small number of wind energy projects siting wind energy structures on private lands not managed under Service easements, lesser levels of environmental evaluation and fewer requirements to implement specific BMPs and mitigation measures could result in a somewhat greater potential for adverse effects due to noise in the vicinity of those projects.

Region wide, however, overall impacts from noise as a result of wind energy development are anticipated to be minor and comparable to levels of impacts that would result under the No Action Alternative and Alternative 1.

5.5.6 Alternative 3

Under Alternative 3, the types of potential impacts due to noise would be generally similar to those described for the No Action Alternative. Because the overall level of wind development in the UGP Region would remain similar under all the alternatives, the overall potential for effects due to noise would also be similar. Because no additional standardized BMPs or mitigation measures would be requested by Western or the Service under this alternative, beyond those required under established Federal, State, and local regulatory requirements, impacts from noise could vary from region to region; such impacts could potentially be greater in less regulated jurisdictions than those that would occur under the other alternatives.

5.6 ECOLOGICAL RESOURCES

This section describes the potential impacts to ecological resources on lands in the UGP Region that could occur during each phase of development of a wind energy project, identifies BMPs and mitigation measures suitable for avoiding or mitigating potential impacts, and evaluates the impacts that would occur to ecological resources under the alternatives considered in this PEIS.

The types of ecological resources that could be affected by wind energy project development depend on the specific location of the proposed project and its environmental setting. Ecological resources considered include terrestrial and wetland vegetation, wildlife, and aquatic species and their associated habitats. These groups of biota include species that have been designated as threatened, endangered, or species of special concern by Federal (e.g., Service, BLM, or USFS) or State natural resource agencies with jurisdiction for the six States that encompass the UGP Region.

Section 5.6.1 describes potential impacts that could occur to ecological resources in the UGP Region during a typical wind energy project's life cycle. BMPs and mitigation measures to reduce or avoid impacts from wind energy development are presented in section 5.6.2. Discussions of potential impacts to ecological resources under the four PEIS alternatives are presented in sections 5.6.3 through 5.6.6. The impact analysis for potential development under the four PEIS alternatives is necessarily general in nature, because the actual development levels that might occur under the alternatives are estimates, and the alternatives do not identify the precise locations of future wind energy projects or the precise size and configurations of future projects. A detailed assessment of potential impacts to ecological resources is highly site- and project-specific, and is not possible without knowing the precise location, size, and configuration of the proposed project. However, the general types and potential severity of impacts on ecological resources from wind energy development are known from past experience. Under all of the alternatives, additional evaluation of impacts on ecological resource components would be conducted as part of the environmental analysis that would be conducted when a specific project was proposed.

5.6.1 Common Impacts

This section describes potential impacts that could occur to ecological resources in the UGP Region during a typical wind energy development project's life cycle. Activities that occur during development of wind energy projects are described in chapter 3. Although many potential impacts that could result from development activities are presented in this section, the realized impacts of wind energy development on ecological resources would typically be avoided or minimized by siting structures and facilities in areas that would be less sensitive and by applying various other BMPs and mitigation measures during the different phases of development. Experience with wind energy projects in the UGP Region indicates that, with the following measures, many of the possible ecological effects described in this section would either be unlikely to occur or would be negligible or minor for most projects: (1) appropriate identification of the types of ecological resources that could be affected; (2) identification and implementation of siting and project design characteristics that would avoid effects; and (3) application of appropriate BMPs and mitigation measures. BMPs and mitigation measures to reduce or avoid impacts from wind energy development on ecological resources are presented in section 5.6.2.

5.6.1.1 Vegetation

Factors associated with wind energy development that could result in impacts to plant communities are evaluated for each developmental phase. These factors include ground disturbance and modification, hydrologic changes, decreased water quality, changes in soil characteristics, deposition of fugitive dust, and accidental releases of hazardous materials.

Plant communities affected by wind energy development could incur short- or long-term changes in species composition, abundance, and distribution. The plant communities that could be affected by project development and the nature and magnitude of impacts that could occur would depend on the specific locations of the projects, as well as on the specific project design and the BMPs and mitigation measures implemented to address impacts. These impacts would be addressed in site-specific NEPA analyses that would be conducted for individual projects. This discussion considers the typical plant communities of the region and typical wind farm development impacts.

Site Characterization. Little site modification would generally be necessary during site characterization, and impacts to vegetation generally would be minimal. During the site characterization phase, a minimum-specification access road would be required. Typically, this would be an existing road that would not be improved during the characterization phase, and characterization activities (e.g., installation of meteorological towers or soil sampling) would occur adjacent to it; small areas might need to be cleared of vegetation or graded in order to install monitoring equipment or access a site. Vegetation could be directly affected by vehicles transporting drilling or meteorological equipment; however, damage to plants from these activities in grassland communities would generally result only in minor localized (primarily in areas adjacent to existing access roads) and short-term effects on vegetation community characteristics. Impacts in sensitive habitats, such as wetland or shrub communities, may require longer recovery periods. Vehicle operation could promote the introduction and establishment of invasive plant species, which could eventually result in widespread long-term impacts to plant communities. Vegetation removal and soil disturbance from geotechnical sampling or the installation of meteorological towers could result in very small localized losses of habitat, particularly if meteorological tower foundations are required. Construction of new access roads, which would be required for only the most remote sites, would eliminate vegetation within the roadway and could result in indirect impacts to nearby areas due to altered drainage patterns, runoff, and sedimentation.

Construction. Plant communities could experience long-term and short-term direct and indirect impacts resulting from construction activities for a wind energy project, including the construction of turbine towers and ancillary structures such as control buildings, transformer pads, electric substations, and access roads. During construction of a wind energy project and its ancillary facilities (utility and transmission corridors, access roads, staging areas), vegetation may be adversely affected by (1) injury or mortality of vegetation, (2) fugitive dust, (3) exposure to contaminants, and (4) the introduction of invasive vegetation (table 5.6-1).

TABLE 5.6-1 Potential Impacts on Vegetation Associated with Construction of Wind Energy Projects

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

Generally, the significance of vegetation loss associated with a wind energy project depends on the amount of area directly disturbed, the types of plant communities (and the habitats they make up) that would be affected and their floristic quality, the nature of the effect, the capacity for the disturbed habitat to recover (some habitat types may take a much longer time to recover than others), and whether listed or sensitive plants or rare natural communities would be affected. These factors would determine whether the construction impacts to vegetation would be short- or long-term.

Direct impacts would primarily be associated with the mortality of the vegetation and loss of habitat present within the footprint of permanent structures, including turbine towers and access roads. All vegetation would be cleared from the footprint, as well as from construction laydown areas and equipment assembly and staging areas. These areas may also require grading. While the footprint of permanent structures would be expected to occupy less than 1 percent of the project area (Denholm et al. 2009), the area temporarily disturbed by construction activities may be two to three times that. As described at the beginning of this chapter and in greater detail in appendix B and the analyses developed in this PEIS, it is assumed that the average amount of land permanently affected (i.e., within footprints of turbine towers, access roads, substations, and transmission facilities) was estimated to be 0.7 ac (0.3 ha) per MW of generation. The amount of land temporarily affected (i.e., disturbed, but not covered by structure footprints) was estimated to be 1.7 ac (0.7 ha) per MW of generation. Assuming a typical turbine size of 1.5 MW, this would translate into approximately 1 ac (0.4 ha) of permanently disturbed land and 2.6 ac (1 ha) of temporarily disturbed land per turbine. Throughout most of the UGP Region, the non-agricultural plant communities that would be affected would primarily be prairie communities. Deciduous and coniferous forest, woodland, and savanna communities also occur in the region and could be affected by wind energy projects. However, wind generation development would be less likely to occur in forested areas because of factors such as increased costs and potential mitigation requirements (e.g., replacement of trees at specified ratios). Consequently, extensive removal of trees would not be expected.

It is unlikely that turbine towers would be located in wetland areas, because they are normally sited on uplands for wind flow reasons; however, wetlands could be affected by the placement of access roads, collector lines, or other ancillary structures. Executive Order 11990, "Protection of Wetlands," requires all Federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (U.S. President 1977). Impacts to jurisdictional wetlands (those under the regulatory jurisdiction of the Clean Water Act, section 404) would require permitting by the U.S. Army Corps of Engineers; permitting for wetland impacts may also be required by State agencies. Because of these requirements, wetlands are typically considered avoidance areas during siting of project elements. Avoidance of wetland areas is a practical consideration for developers, as construction in these areas is more difficult and has increased costs, more mitigation is required that is more costly, and more regulatory requirements are triggered. Therefore, it is beneficial to developers to avoid wetland areas to the extent practicable and to address the potential for changes in surface water drainage patterns, runoff, erosion, sedimentation, and water quality to alter wetland habitats by implementing appropriate construction management practices.

Indirect impacts to plant communities near construction areas may result from site development activities. Effects of habitat loss and modification include the fragmentation of remaining native habitat. Reductions in the size or number or the isolation of remaining habitat areas can result in long-term changes in species composition or structural changes and reductions in biodiversity. The fragmentation of large undisturbed habitats of high quality by project construction would be considered a greater impact than that from construction in previously disturbed or fragmented habitat. Increased shading in prairie habitats adjacent to permanent structures could result in slight changes in species composition; however, any changes would likely be very small in extent. Changes in forest or woodland interiors from tree removal or clearing of adjacent areas can include increased light levels, reduced soil moisture, increased transpiration, introduction of shade-intolerant species, and increased access of herbivores. Additional decline or mortality of trees near the construction boundary may subsequently occur. However, as noted above, tree removal would generally be limited.

Soils disturbed by construction activities, such as excavations for tower foundations or power-conducting cables, or exposed by land clearing may be a source of fugitive dust or sedimentation during the construction period. Soils excavated for tower foundations would be stockpiled for a period of time before excavations are backfilled. The deposition of airborne dust on plants in nearby habitats may result in reduced growth and reproduction; however, because deposition would generally be temporary, impacts to plant communities would likely be short-term. In agricultural areas, the generation of fugitive dust as a result of wind energy development would be a small incremental contribution to existing dust generation. Erosion of exposed soils may result in sedimentation of wetlands near construction areas or downstream wetlands receiving storm water runoff. The disposal of water from excavations could also contribute to increased erosion and sedimentation. Sedimentation may reduce plant growth, particularly in native species sensitive to disturbance. Biodiversity may be reduced in wetland communities as sensitive species are displaced by species more tolerant of disturbance. Changes in community composition may also include the increase or establishment of invasive plant species. Although the effects of sedimentation associated with a wind energy project may not be widespread, they could result in long-term impacts on local wetland communities in certain circumstances. However, because of regulatory requirements limiting the generation of fugitive dust (see section 5.4.1.2) and release of sediments (see section 5.3.1.2), it is likely that impacts from these factors would be minor.

Plant communities near construction areas could be affected by hydrologic changes such as reduced infiltration and increased runoff from exposed or compacted soils. Reduced infiltration could result in lowered soil moisture, and with increased runoff can result in greater fluctuations in wetland or stream water levels and reduced base flows. Concentrated runoff could result in erosion along receiving streams. Alterations of surface drainage patterns, including stream crossings along on-site roads or access roads, could result in hydrologic changes in wetlands. Hydrologic changes could result in long-term changes in wetland plant community composition, including the establishment or increase of invasive species. Plant communities in isolated wetlands that typically do not receive surface flow, as would be typical of many of the wetlands in the Prairie Pothole Region, could be particularly sensitive to the introduction of additional surface inflow. Changes in local hydrology could also result from water withdrawals for the production of concrete at an on-site batch plant or dewatering excavations for tower foundations. Locally reduced groundwater levels could affect nearby wetlands that are supported by groundwater discharge; however, impacts from water use or dewatering during construction would be localized and temporary. The construction of multiple tower foundations, especially pier-type foundations (which can be as deep as 40 ft [12 m]), could result in changes in groundwater flow patterns and reduce inflows to some wetlands or springs, depending on site-specific conditions (see section 5.3.1). Trenching for the installation of power cables could alter surface and subsurface flows, resulting in long-term changes in the hydrology of wetlands along or near the cable line.

Construction equipment and vehicles brought to a project site may introduce seeds or other propagules of invasive plant species. Such species can become established and spread rapidly, displacing native species and sometimes forming monocultures over extensive areas, thereby decreasing habitat quality. Invasive species could also become established in undisturbed native communities near a project site, or become established on soils disturbed by project activities and spread to adjacent areas.

Temporary use areas, such as concrete batch plants, material laydown areas, and assembly/staging areas, would generally be reclaimed by the reestablishment of plant communities following the completion of facility construction. Soils in these areas would likely be compacted, and reestablishment of plant communities may be difficult due to low infiltration rates. A portion of the subsurface soils excavated for the construction of tower foundations would likely be redistributed on the site. In some locations, restoration of native plant communities on these soils may be difficult due to characteristics such as organic content or pH. Areas disturbed by the burial of a power cable or natural gas pipeline would also be restored. Although native plant communities may be restored on disturbed sites, the species composition may vary considerably from local communities. Revegetation success and timeframe would depend on the climate, soils, and plant community types at a project location. Some communities in semiarid locations, such as shrub steppe habitat in Montana, may be very difficult to establish, and restoration may require considerable periods of time. However, successful restoration in mesic locations, such as tallgrass prairie habitat in Iowa, may be relatively rapid.

Hazardous materials used and stored on the project site may include diesel fuel, transmission fluid, glycol-based coolant, or dielectric fluids, as well as chemicals, such as resins, that may be used in turbine preparation or assembly. Accidental releases of these materials could impact plant communities in the vicinity of the spill or in wetlands located downgradient from the project site. Contaminants that enter groundwater could affect wetlands that receive groundwater discharge. The magnitude of impacts would depend on the type and volume of material spilled, the location, and habitat affected. However, an uncontained spill of hazardous materials would likely be relatively small and affect a limited area because the volume of these materials that may be present at a construction location would be relatively small, and there would be no long-term storage of hazardous materials at construction locations. In addition, the implementation of required spill prevention and response plans would limit potential impacts from a spill, should one occur.

The construction of electric transmission lines to connect wind energy projects to the transmission grid would also result in impacts to plant communities. Such impacts would be similar in nature to those described for facility construction. Habitat would be lost at the locations of the utility poles; however, the area affected would be relatively small. ROWs through prairie areas would generally not require vegetation clearing; however, removal of trees within ROWs may be necessary where the safe operation of the transmission line may be jeopardized. ROWs through wooded areas generally require the removal of all trees that may potentially contact the lines before the next scheduled ROW maintenance. Trees removed within ROWs would be permanently lost to the landscape. Long-term changes in habitats adjacent to the ROWs could subsequently occur. These changes may include changes in species composition due to changes in light and moisture conditions and changes in herbivory patterns due to increased access by herbivores. However, wind energy developers generally minimize tree removal. ROWs may also serve as conduits for the introduction and spread of invasive species into adjacent habitats.

Operations and Maintenance. Potential impacts to vegetation from operation and maintenance of wind energy projects are summarized in table 5.6-2. Activities associated with the operation and maintenance of a wind energy project would likely include some mowing and weed control as part of a site vegetation management program. Mowing would maintain plant communities in early stages of ecological succession and could prevent reestablishment of

TABLE 5.6-2 Potential Impacts on Vegetation Associated with Operations and Maintenance of Wind Energy Projects

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

some desirable species; plant community succession would remain restricted over the lifetime of the facility. The licensed application of herbicides may be used in addition to, or instead of, mowing to control vegetation along access roads and utility and transmission corridors, and around support buildings and turbine towers. Herbicide applications could result in impacts to nontarget species from aerial drift during application or from herbicides transported by surface water runoff. However, requirements that herbicides be applied by properly licensed applicators in accordance with label and application permit directions make it unlikely that such effects would occur.

Hazardous materials, such as transmission lubricating oils, coolants, paints or other corrosion-control coatings, herbicides, solvents, and fuels, would be present on the project site in limited quantities. Spills of these materials could impact upland or wetland habitats adjacent to or downgradient from the spill location. The accidental spill of herbicides could result in environmental concentrations exceeding licensed levels, and these herbicides could migrate off-site and affect native vegetation in surrounding areas. Because of the relatively small amount of fuel and other chemicals expected to be stored and used at a wind energy development project, an accidental release of these materials would be expected to impact only a small area of the site, and the vegetation at the spill locations would likely be vegetation already regularly affected by mowing or herbicide application. Thus, impacts to vegetation from exposure to accidental fuel or pesticide releases are expected to be very localized and minor. Similarly, only relatively small amounts of other hazardous materials could be expected to be generated or stored at a wind energy project, and any accidental releases would be small and affect vegetation primarily at the release location.

The presence of a wind energy project may increase access to adjacent lands that previously had limited access, thereby resulting in increased use of areas adjacent to the wind energy site. Impacts on vegetation at and adjacent to a wind energy project and associated facilities could occur from increased levels of foot and vehicle traffic and use of OHVs. Visitors and OHVs may crush or trample vegetation or destroy roots and other belowground plant structures. Increased human access could also promote the collection of some plant species. Depending on the species involved and the extent and magnitude of the collections, local populations of some species could be affected; however, most plant collecting has minimal impacts (e.g., seed collection for viability studies). Collecting plants for herbarium specimens and collecting wildflower seeds for personal gardens would generally have little impact on populations if conducted responsibly.

The increased access to previously less accessible areas may act to disperse seeds of invasive vegetation. Visitors or workers may carry seeds on their clothing and equipment, and motorized vehicles can carry seeds on tires and in vehicle mud. Establishment of invasive species within an area could result in long-term or permanent changes in vegetation communities and has a potential spread both on-site and off-site. Increased human activity also increases the potential for fires. Grassland fires could be initiated by (1) poorly maintained and extinguished campfires associated with recreational activities, (2) contact with hot engine parts during OHV use, and (3) careless use of matches or cigarettes. The potential for such fires would be greatest during late summer and autumn, when native and invasive grasses have died back and dried out and fuel loads are at their greatest. Fires in prairie communities, which are the predominant habitat in the region and are fire-adapted, would generally result in maintenance of the native species composition. However, fires in habitats that are not fire-adapted, such as sagebrush communities, may result in a greatly reduced cover of native species and long-term alteration of the habitat.

Sediments generated from disturbed areas, on-site or access roads, or work areas could periodically affect streams or wetlands throughout the operational life of the project. However, assuming that vegetative cover becomes established on exposed areas disturbed during the previous construction phase, sedimentation impacts on wetlands during the operations phase would generally be minor. Sedimentation may increase temporarily following regrading or other maintenance activities for on-site or access roads.

The operation and maintenance of transmission lines may also require tree or brush cutting or herbicide use as part of a ROW management program. Maintenance of ROWs in prairie habitats would be expected to require minimal activity and would generally result in little or no change in plant community characteristics; however, ROWs in wooded areas would require periodic tree trimming or removal and may result in a community considerably different from that in adjacent areas. In some areas, ROWs may allow increased public access to remote areas, which could result in effects on vegetation similar to those described above for operational areas of a project site. Much of the development within the UGP Region would occur on private land, where most access by the public would be restricted by landowners.

Decommissioning. Impacts on plant communities during decommissioning would be similar in nature to the impacts resulting from original site development and construction. The disturbance of habitats would be expected to primarily occur in previously disturbed areas. Storage and work areas would likely be required for decommissioning; however, fuel or waste storage areas established for operations may be expanded. Disturbance from excavation would be less than that associated with new construction at those locations where tower foundations and buried power cables are left in place. Disturbed areas would be returned to original grade, compacted soils would be restored, and native plant communities would be reestablished.

The accidental release of fuels, lubricants, solvents, or hazardous materials during decommissioning could impact plant communities in the vicinity of a spill or in wetlands located downgradient from the project site. Contaminants that enter groundwater could affect wetlands that receive groundwater discharge.

5.6.1.2 Wildlife

All utility-scale wind energy facilities that would be constructed and operated within the UGP Region have a potential to affect wildlife. The following factors and operations are known, or presumed, to affect a wind project’s risk to wildlife, particularly birds and bats, which are generally affected more than other wildlife (Canadian Wildlife Service 2006):

- Number of turbines,
- Configuration of turbines (e.g., compact cluster or linear),
- Relative height and elevation of turbines,

- Number and types of meteorological towers (e.g., guyed vs. free-standing),
- Number and types of lights,
- Motion smear (e.g., birds may not recognize quickly turning blades),
- Power lines (e.g., overhead or underground),
- Ancillary habitat loss (e.g., access roads),
- Attraction of wildlife to site (e.g., grassland versus cropland),
- Industrial and other wastes, and
- Decommissioning (e.g., how much of the infrastructure would be removed).

The locations of proposed projects with regard to habitat and migration corridors, as well as the quality and quantity of nearby habitats, are important factors that need to be considered. Several of these factors would also have an effect on wildlife by reducing, modifying, or fragmenting habitat.

Wind facility sites, transmission line ROWs, and access roads could function as (Jalkotzy et al. 1997):

- Specialized habitats for some species;
- Travel lanes that would enhance species movement;
- Barriers to the movement of species, energy, or nutrients (because they would fragment existing habitat);
- Sources of biotic and abiotic effects on the adjacent ecosystem matrix; and
- Sinks—wildlife would enter the facility, ROW, or road and die (e.g., by colliding with turbines or transmission lines or being run over by vehicles).

The following discussion provides an overview of the potential impacts on wildlife that could occur from activities associated with the various phases of a wind energy project. The application of appropriate BMPs and mitigation measures would minimize impacts on wildlife species and their habitats; potential BMPs and mitigation measures for wildlife impacts are included in section 5.6.2.

Site Characterization. Potential impacts on wildlife from site characterization activities would primarily result from disturbance (e.g., due to equipment and vehicle noise and the presence of workers). Impacts would generally be temporary and at a smaller scale than those during other phases of the project. If drilling or limited construction of access roads were necessary during this phase, impacts on wildlife would be similar to, but generally of smaller magnitude than, impacts from similar activities that would occur during the construction phase.

Some bird mortality would be expected at meteorological towers, especially those with guy wires. Bat fatalities due to collisions with meteorological towers at wind energy facilities appear to be very low to nonexistent (Johnson et al. 2004). Meteorological towers are generally up to 165 ft (50 m) tall. Derby (2006) found no bat mortalities and very few bird mortalities at unguyed and unlit cellular communication towers that ranged in height from 150 to 195 ft (46 to 59 m). The meteorological tower at the Buffalo Mountain Wind Farm in eastern Tennessee resulted in an average of 5.8 bird fatalities per year; most fatalities involved songbirds that were killed while migrating at night, and no raptor fatalities were observed (Nicholson et al. 2005). Young et al. (2003a) reported that the average avian mortality rate for guyed meteorological towers at the Foote Creek Rim wind facility was 7.5 birds per tower per year. No bird or bat fatalities were found at the meteorological towers at the Crescent Ridge Wind Power Project in Illinois (Kerlinger et al. 2007). Most meteorological towers would be removed at the end of the site characterization phase, although some could be left in place for the life of the project.

Site characterization may also require geotechnical surveys, including the collection of soil borings. Drilling rigs for these surveys would typically be mounted on light- to medium-duty vehicles that would need no special access roads or significant site modifications. Soil sampling could be completed within a week’s time in most instances. Impacts on wildlife would include short-term, localized disturbance. Some mortality to less mobile wildlife could occur.

Construction. During construction of a wind energy project and its ancillary facilities, wildlife may be adversely affected as a result of various stressors associated with specific construction activities (table 5.6-3). The overall impact of construction activities on wildlife populations at a wind energy site would depend on the type and amount of wildlife habitat that would be affected by a given stressor, the length of time the effect would persist (e.g., complete, permanent reduction because of tower placement, or temporary disturbance in construction support areas), the season of the activity (e.g., nesting or wintering), and the types of wildlife that occupy the project site and surrounding areas. The impacts associated with construction activities can be broadly categorized as those that result from (1) habitat disturbance, (2) wildlife disturbance, and (3) wildlife injury or mortality. Each of these broad categories is discussed in the following subsections.

Habitat Disturbance. The construction of a wind development project and its ancillary facilities would impact wildlife through habitat reduction, alteration, and fragmentation. The amount of habitat affected would be a function of the size of the wind energy project (e.g., the number of turbines), the amount of associated infrastructure, the layout of facilities, and the existing degree of disturbance in the project area. Areas temporarily affected by construction of turbine pads, access and on-site roads, and substations average about 0.4 to 2.6 ac (0.2 to 1.1 ha) per turbine, or 0.6 to 1.7 ac (0.2 to 0.7 ha) per megawatt, while areas affected for longer periods (i.e., following the construction period) average about 0.7 to 1.0 ac (0.3 to 0.4 ha) per turbine, or 0.4 to 0.7 ac (0.2 to 0.3 ha) per megawatt (Strickland 2004). The footprint of permanent structures would be expected to occupy less than 1 percent of the overall project area and the area temporarily disturbed by construction activities would be two to three times that amount (Denholm et al. 2009).

TABLE 5.6-3 Potential Impacts on Wildlife Associated with Construction of Wind Energy Projects

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

TABLE 5.6-3 (Cont.)

Ecological Stressor	Activity	Potential Effect	Extent and Duration
Interference with behavioral activities	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Disturbance of migratory movements; avoidance of construction areas by migrating birds and mammals.	Short term.
	Site clearing and grading; turbine and tower construction; access road and utility corridor construction; construction equipment travel.	Disturbance of foraging and reproductive behaviors; birds and mammals.	Short term for some species; long term for other species that may completely abandon the disturbed habitats and adjacent areas.

Habitat reduction could result in a long-term decrease in wildlife abundance and richness within a project area. Species affected by habitat reduction might be able to shift their habitat use for a short period. For example, the density of several forest-dwelling bird species has been found to increase within a forest stand soon after the onset of fragmentation, as displaced individuals move into remaining habitat (Hagan et al. 1996). However, the habitat into which displaced individuals move may not be able to sustain an increased level of use over the long term. Many of the individuals that would make use of areas adjacent to a development could be subjected to increased physiological stress as a result of complications from overcrowding (e.g., increased competition for space and food, increased vulnerability to predators, and increased potential for the propagation of diseases and parasites). Overcrowding of species such as mule deer (*Odocoileus hemionus*) in winter ranges could cause density-dependent effects, such as increased fawn mortality (Sawyer et al. 2006). Assuming that areas used by wildlife before development were their preferred habitat, an observed shift in distribution because of development would be toward less preferred and presumably less suitable habitats (Sawyer et al. 2006).

Among the most critical threats to waterfowl is the continuing loss of wetlands and upland nesting habitat (Ducks Unlimited 2009). Habitat disturbance can also concentrate ducks and their predators into remaining habitat. Overall, this can lead to low nest success and decreased potential for renesting (Checkett 2009). The major impacts a wind project would have on grassland nesting passerines would be long-term loss of habitat from turbine pads and roads and short-term habitat disturbance in other areas that may last several years until vegetation returns to preconstruction conditions (Erickson et al. 2004). However, construction of the Judith Gap Wind Energy Project in Wheatland County, Montana, was not found to negatively impact numbers of breeding grassland birds (TRC Environmental Corporation 2008).

Although habitats adjacent to wind energy projects and their ancillary facilities might remain unaffected, wildlife might tend to make less use of these areas (primarily because of the disturbance that would occur within the project site). This impact could be considered an indirect habitat loss, and it could be of greater consequence than a direct habitat loss (Sawyer et al. 2006). For example, the loss of effective habitat (amount of habitat actually available to wildlife) was reported to be 2.5 to 3.5 times as great as the actual habitat loss due to roads (Reed et al. 1996). During the construction period, some species, such as the common raven (*Corvus corax*), might become more abundant along roads because of vehicle-generated carrion. During project operation, wildlife deaths due to vehicle collisions are expected to decrease compared to those during construction, because vehicle activity will diminish. Common ravens and some birds of prey might become more common along power lines because of the presence of perch and nest sites (Knight and Kawashima 1993). Road construction could create habitat for the horned lark (*Eremophila alpestris*), a grassland species that is common along dirt roadways where it can forage on windblown seeds (Ingelfinger and Anderson 2004). This could account, in part, for the horned lark often being found among the most affected bird species at wind energy projects.

Construction of wind energy production, transmission, and ancillary facilities could also result in habitat fragmentation. Habitat fragmentation is the creation of a complex mosaic of spatial and successional habitats from formerly contiguous habitat (Lehmkuhl and Ruggiero 1991). For example, habitat fragmentation can result from roads, trails, staging areas, power lines, or the construction of new structures on the landscape, and from soil or vegetation disturbance. Connectivity between fragmented habitat segments decreases with increased spacing between the segments (Jalkotzy et al. 1997). In extreme situations, which are not expected at wind energy projects, habitat fragmentation could cause a loss of genetic interchange among populations (Templeton et al. 1990; Mills et al. 2000; Wang and Schreiber 2001; Willyard et al. 2004; Epps et al. 2005; Dixon et al. 2007).

Construction of transmission lines through forest habitats has been found to decrease the quality of habitat for forest interior species for distances up to 300 ft (91 m) from the edge of the ROW (Anderson et al. 1977). Wildlife migration corridors would also be vulnerable to project development, particularly at pinch points where physiographic constrictions force herds through relatively narrow corridors (Berger 2004). Loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindzey 2001; Thomson et al. 2005). Conversely, species that prefer open habitats, such as the red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), osprey (*Pandion haliaetus*), brown-headed cowbird (*Molothrus ater*), and yellow warbler (*Dendroica petechia*), might increase in numbers. An increase in brown-headed cowbird populations could adversely affect other bird species, since the cowbird is a brood parasite, laying its eggs in the nests of other species, especially warblers, vireos, and sparrows.

Although most fragmentation research has focused on forest habitats, similar ecological impacts have been reported for arid and semiarid landscapes, particularly shrub-steppe habitats that are dominated by sagebrush or salt desert scrub communities. Increasing attention is being paid to the potential impacts associated with reduction, fragmentation, and modification of grassland and shrubland habitats by wind energy projects and their associated infrastructure (Manes et al. 2002). In this regard, the greater prairie-chicken (*Tympanuchus cupido*), sharp-tailed grouse (*T. phasianellus*), and greater sage-grouse (*Centrocercus urophasianus*) are of concern with respect to the reduction and fragmentation of grassland and sagebrush habitat within the UGP Region. Habitat fragmentation, combined with habitat degradation, has been shown to be largely responsible for declining populations of sage-grouse species (Strittholt et al. 2000).

Areas along the transitional zones between two or more vegetation cover types provide edge habitats. Construction of a wind energy project (particularly its associated transmission line and access road) could establish edge habitat where none existed previously. The presence of these habitat edges could have both adverse and beneficial effects on wildlife, and effects may include the following: (1) increasing predation and parasitism of animals in the vicinity of edges; (2) modifying wildlife distribution and dispersal patterns; (3) reducing habitat size and possible isolation of habitat patches and corridors (habitat fragmentation); and (4) increasing local wildlife diversity and abundance. The ecological importance of edge habitat largely depends on how different it is from the regional landscape. For example, the influence of the edge is less ecologically important where landscapes already have a high degree of heterogeneity. Landscapes with a patchy composition (e.g., tree-, shrub-, and grass-dominated cover) may already contain edge-adapted species that reduce the influence of a newly created edge (Harper et al. 2005).

Bird nests near forest edges may be more vulnerable to predators, such as raccoons (*Procyon lotor*) and jays. Predators such as coyotes (*Canis latrans*) and foxes commonly use ROWs for hunting because there are more small mammals that prefer open areas there. The cleared ROW segments might also encourage increases in the populations of invasive bird species, such as the house sparrow (*Passer domesticus*) and European starling (*Sturnus vulgaris*), which compete with many native species, or brown-headed cowbirds.

Habitat disturbance could also facilitate the spread and introduction of invasive plant species by altering existing habitat conditions, stressing or removing native plant species, and allowing easier movement by wildlife or human vectors (Trombulak and Frissell 2000). Wildlife habitat could be adversely affected if invasive vegetation became established in the construction-disturbed areas and adjacent off-site habitats. This could adversely affect wildlife occurrence and abundance.

Construction activities could also result in increased erosion and runoff from freshly cleared and graded sites. The amount of soil erosion and the resulting sediment loading of nearby aquatic or wetland habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, and the proximity to the aquatic or wetland habitats. The potential for water quality impacts during construction would be short term, lasting until disturbed soils are stabilized (e.g., from the use of measures to control erosion or the reestablishment of ground cover). Although the runoff would be temporary, erosion could result in impacts on local amphibian populations, particularly if an entire recruitment class was eliminated (e.g., complete recruitment failure could occur in a given year because of the siltation of eggs or mortality of aquatic larvae). The impacts of sedimentation on amphibians could be heightened if the sediments contain toxic materials (Maxell 2000).

Little information is available about the effects of fugitive dust on wildlife; however, if exposure were of sufficient magnitude and duration, the effects could be similar to those on humans (e.g., breathing and respiratory symptoms, including dust pneumonia). A more probable effect would be the dusting of plants, which could make forage less palatable. This localized effect would be short term and would generally coincide with the displacement of and stress to wildlife from human activity. Fugitive dust is not expected to result in any long-term individual or population-level effects. Dusting impacts may be more pervasive along unpaved access roads. Use of calcium or magnesium chloride to control road dust could desiccate salamanders or other amphibians crossing roads, while the use of oils could contaminate aquatic habitats (Maxell 2000).

Overall, the effects of habitat disturbance would be related to the type and abundance of habitats affected and to the wildlife that occur in those habitats. Once construction is complete, most areas not located within the footprint of permanent structures could be restored to native plant cover. However, deep-rooted plants would need to be controlled to avoid compromising buried cables, and tall vegetation would need to be controlled to avoid compromising turbine operations and transmission lines.

Wildlife Disturbance. Wildlife disturbance during construction could be of greater concern than disturbance caused by habitat loss (Arnett et al. 2007). The response of wildlife to disturbance caused by noise and human presence would be highly variable and species-specific. Intraspecific responses could also be affected by the physiological or reproductive condition of individuals; distance from the disturbance; and type, intensity, and duration of the disturbance. Wildlife could respond to disturbance in various ways, including attraction, habituation, or avoidance (Knight and Cole 1991). All three behaviors could be considered adverse impacts. Wildlife might cease foraging, mating, or nesting near areas where construction occurs. For example, construction activities near active sage-grouse leks could lead to lek abandonment, displacement, and reduced reproduction (South Dakota DGFP undated). In contrast, wildlife such as bears, foxes, and squirrels might habituate to construction activities and might even be attracted to human activities, primarily when a food source was accidentally or deliberately made available.

Construction activities could reduce the relative value of the habitat to wildlife such as mule deer or white-tailed deer, especially during periods of heavy snow and cold temperatures. When disturbed, wildlife can experience physiological stress. This increases energy expenditures, which can lead to reduced survival or reproductive outcomes. Furthermore, disturbance could prevent access to the forage needed to sustain individuals. Hobbs (1989) determined that the mortality of mule deer during a severe winter period could double if they were disturbed twice a day and caused to move a minimum of 1,500 ft (457 m) per disturbance. Most heavy construction at a wind energy facility would probably occur during warmer seasons, which would minimize disturbance to big game during winter. In addition, construction would likely not occur during severe winter conditions when impacts on big game would be of greatest concern (WEST, Inc. 2007).

During winter, the average mean flush distance for several raptor species was found to be 387 ft (118 m) from people walking and 246 ft (75 m) from vehicles (Holmes et al. 1993). Disturbance from light traffic (e.g., 1 to 12 vehicles per day) during the breeding season might reduce nest-initiation rates and increase distances moved from leks during nest site selection (Lyon and Anderson 2003). The density of sagebrush obligate passerines was reduced 39 to 60 percent within a 328-ft (100-m) buffer around dirt roads with traffic volumes ranging from 10 to 700 vehicles per day. However, traffic volumes alone may not explain the observed effect. The birds may also have been responding to edge effects, habitat fragmentation, and increases in other passerine species along the road corridors. Thus, declines may persist even after traffic subsides, lasting until the road areas are fully vegetated (Ingelfinger and Anderson 2004).

Bighorn sheep (*Ovis canadensis*) have been reported to respond at a distance of 1,640 ft (500 m) from roads with more than one vehicle per day, while deer and elk (*Cervus canadensis*) respond at a distance of 3,280 ft (1,000 m) or more (Gaines et al. 2003). However, big game species such as mule deer can habituate to and ignore motorized traffic, provided they are not pursued (Yarmoloy et al. 1988). Harassment, an extreme type of disturbance caused by intentional actions to chase or frighten wildlife, generally increases the magnitude and duration of displacement. As a result, there is a greater potential for physical injury from fleeing and higher metabolic rates due to stress. Bears can habituate to human activities, particularly moving vehicles, making them more vulnerable to legal and illegal harvest (McLellan and Shackleton 1989).

The potential effects of noise on wildlife include acute or chronic physiological damage to the auditory system, increased energy expenditures, physical injury incurred during panicked responses, interference with normal activities (e.g., feeding), and impaired communication (AMEC Americas Limited 2005). Principal sources of noise during construction would include workers, vehicle traffic, and machinery operation. The response of wildlife to noise would vary by species; physiological or reproductive condition; distance; and the type, intensity, and duration of the disturbance. Regular or periodic noise could cause adjacent areas to be less attractive to wildlife and result in a long-term reduction in wildlife use of those areas. Responses of birds to disturbance often involve activities that are energetically costly (e.g., flying) or affect their behavior in a way that might reduce food intake (e.g., shift away from a preferred feeding site) (Hockin et al. 1992). Traffic noise could cause an interruption of mate attraction in frogs and toads, although plasticity in vocalizations could allow maintenance of acoustic communications in the presence of traffic noise (Cunnington and Fahrig 2010). Noise can reduce bird nesting success and alter species interactions, resulting in changes in avian communities (Francis et al. 2009).

A variety of adverse effects on raptors have been demonstrated to be caused by noise. For some species, the effects were temporary, as the raptors became habituated to the noise (Brown et al. 1999; Delaney et al. 1999). As reviewed by Hockin et al. (1992), the effects of noise disturbance on bird breeding and breeding success include reduced nest attendance, nest failures, reduced nest building, increased predation on eggs and nestlings, nest abandonment, inhibition of laying, increased absence from nest, reduced feeding and brooding, exposure of eggs and nestlings to heat or cold, retarded chick development, lengthened incubation period, increased physiological stress, increased energy expenditures, habitat avoidance, decreased population or nesting densities, altered species composition, and disruption and disorientation of movements. The most severe impacts associated with noise could occur if critical lifecycle activities were disrupted (e.g., mating and nesting). For instance, disturbance of birds during the nesting season could result in nest or brood abandonment.

Loud, unusual sounds and other noises from construction and human activities can disturb gallinaceous birds (e.g., upland game birds such as grouse, turkey, and pheasants), causing them to avoid traditional use areas or reduce their use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2009). Thus, site construction (and subsequent turbine operation and site maintenance activities) could be a source of auditory and visual disturbance to gallinaceous birds.

Brattstrom and Bondello (1983) reported that peak sound pressure levels reaching 95 dB resulted in a temporary shift in the hearing sensitivity of kangaroo rats (*Dipodomys* spp.) and that at least 3 weeks were required for the recovery of their hearing thresholds. The authors postulated that such hearing shifts could affect the ability of the kangaroo rat to avoid approaching predators. It has been suggested that vehicle noise may affect the ability of amphibians, such as frogs and toads, to hear calls and locate breeding aggregations (Maxell 2000).

***Wildlife Injury or Mortality*.** Clearing, grading, drilling, and trenching activities could result in the direct injury or death of wildlife species that were not mobile enough to avoid construction operations (e.g., reptiles, small mammals), those that used burrows (e.g., ground squirrels and burrowing owls [*Athene cunicularia*]), or those that defend nest sites (e.g., ground-nesting birds). If clearing or other construction activities occurred during the spring and summer, bird nests and eggs or nestlings could be destroyed. Although more mobile wildlife species, such as big game and adult birds, might avoid the initial clearing activity by moving into habitats in adjacent areas, it is conservatively assumed that adjacent habitats would be at carrying capacity for the species that live there and could not support additional individuals from construction areas. As previously mentioned, competition for resources in adjacent habitats may preclude the incorporation of the displaced individuals into the resident populations.

The abundance of the affected species on the site and in the surrounding areas would have a direct influence on population-level effects. Impacts on common and abundant species would probably be less than impacts on individuals from uncommon species. The greater the size of the project site, the greater the potential for more individual wildlife to be injured or killed. In addition, the timing of construction activities could directly affect the number of individual wildlife injured or killed. For example, construction during the reproductive period of ground-nesting birds, such as greater sage-grouse, would have a greater potential to kill or injure birds than would construction occurring at a different time.

Direct mortality from vehicle collisions would be expected to occur along access roads, especially in wildlife concentration areas or travel corridors. When access roads cut across migration corridors, the effects can be dangerous for both animals and humans. Amphibians, being somewhat small and inconspicuous, are vulnerable to road mortality when they migrate between wetland and upland habitats; reptiles are vulnerable because they use roads for thermal cooling and heating. Greater sage-grouse are susceptible to road mortality in spring because they often fly to and from leks near ground level. They are also susceptible to vehicular collision along dirt roads because they sometimes use them to take dust baths (Strittholt et al. 2000). Generally, the species most vulnerable to vehicle collisions are day-active, slow-moving species (Hels and Buchwald 2001). Road kills rarely limit population size. Road avoidance, especially that due to traffic noise, tends to have a greater ecological impact (Forman and Alexander 1998).

Where access is not restricted, power line ROWs and access roads can increase area use by recreationists and others, thus increasing the potential for harassment and legal or illegal taking of wildlife. This might include the collection of live animals, particularly reptiles and amphibians, for pets. Direct mortality of small mammals might increase due to the use of snowmobiles and off-highway vehicles. For example, animals such as mice and voles that occupy subnivean spaces (zones in or under the snow layer) could be crushed or suffocated, and predators could increase when prey moves over compacted vehicular trails (Gaines et al. 2003).

Potential impacts on wildlife from exposure to fuel spills or accidental releases of other hazardous material would vary according to the material spilled, volume of the spill, location of the spill, and the exposed species. A spill could have a population-level adverse impact if the spill was very large or if it contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event is very unlikely. In addition, use of the project area by wildlife during construction would be limited, since there would be construction-related disturbances, thus greatly reducing the potential for exposure to contaminants. Furthermore, a spill prevention and response plan will be required, work crews will be trained in spill response, and materials required for spill cleanup will be kept on hand. Prompt spill response should minimize potential impacts on wildlife.

As described in section 5.6.1, increased human activity could increase the potential for fires. Generally, the effects of fire on wildlife would be related to the impacts on vegetation, which, in turn, would affect habitat quality and quantity, including the availability of forage and shelter (Hedlund and Rickard 1981; Groves and Steenhof 1988; Sharpe and Van Horne 1998; Lyon et al. 2000b). While individuals caught in a fire could incur increased mortality, most wildlife would be expected to escape by either outrunning the fire or seeking underground or aboveground refugia within the area (Ford et al. 1999; Lyon et al. 2000a). However, some mortality of burrowing mammals from asphyxiation in their burrows during a fire has been reported (Erwin and Stasiak 1979).

Operations and Maintenance. Potential impacts on wildlife from ecological stressors associated with the operation and maintenance of wind energy projects are summarized in table 5.6-4. These impacts are discussed in the following subsections. They are broadly categorized as those related to the following: (1) habitat disturbance (i.e., reduction, alteration, and fragmentation of habitat due to the presence and maintenance of wind energy projects and their associated access roads and transmission lines); (2) wildlife disturbance (e.g., from noise and the presence of workers); and (3) and wildlife injury or mortality (e.g., from collisions with wind turbines and transmission lines).

Habitat Disturbance. As discussed previously, the construction of a wind energy project could result in areas with a high probability of being used by wildlife becoming areas of low or no use, while other areas with a low probability of use could become more frequently used. This change might cause a shift of wildlife use to presumably less-suitable habitat (Sawyer et al. 2006). This condition would continue during the operational phase of the project. In addition, periodic habitat disturbance within the transmission line ROWs and along the access roads would occur from maintenance activities. Mowing or other types of vegetation management (e.g., removal of woody vegetation) may also occur periodically within the area of the turbine arrays. Conversely, less sensitive or opportunistic species may expand into the niches that are created by the wind energy development or opened up by species that avoid the area.

Brennan et al. (2009) stated that the primary concern of wind farms (including the associated access roads and transmission lines) on upland game birds is widespread habitat fragmentation. The access road and transmission line could continue to cause habitat fragmentation and provide a means for the spread of invasive species (Kuvlesky et al. 2007; Gelbard and Belnap 2003) throughout the life of a project. A linear array of turbines could also

TABLE 5.6-4 Potential Impacts on Wildlife Associated with Operations and Maintenance of Wind Energy Projects

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

TABLE 5.6-4 (Cont.)

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

increase habitat fragmentation (in addition to increasing the potential for bird and bat collisions) (Larsen and Madsen 2000). If immigration and emigration were prohibited, population and community dynamics would eventually be affected (Andrews and Gibbons 2005).

The types of wind facility components would also influence use of the project area by wildlife. For instance, raptors and ravens commonly nest on older lattice-type turbines, but have not been found to nest on the tubular towers now used at most wind facilities (WEST, Inc. 2007). As summarized by Kunz et al. (2007a), hypotheses as to why bats may be attracted to wind turbines include the following: tree-roosting species perceiving turbines as possible roost trees, availability of insect prey, audible noise of turbines, and fall aggregation and mating behaviors.

Power lines could provide perch sites for raptors and corvids (e.g., ravens, crows, and magpies), thereby increasing predatory levels on other wildlife (e.g., small mammals, gallinaceous birds). The lines and structures would enable birds, such as the golden eagle (*Aquila chrysaetos*), great-horned owl (*Bubo virginianus*), red-tailed hawk, ferruginous hawk (*Buteo regalis*), common raven, prairie falcon (*Falco mexicanus*), American kestrel, and osprey, to nest or perch in otherwise treeless landscapes (BirdLife International 2003; Fernie and Reynolds 2005). Power line support structures could also protect some bird species from mammalian predators, range fires, and heat (Steenhof et al. 1993). However, high winds could cause the nests of birds that use power line support structures to fall apart. Entanglement in tower support structures might be another hazard (Steenhof et al. 1993). A transmission line might also lead to a loss of usable feeding areas for those species that avoid the close proximity of these facilities (BirdLife International 2003). For example, the lesser prairie-chicken (*Tympanuchus pallidicinctus*) seldom nests within 1,300 ft (396 m) of transmission lines (Pitman et al. 2005). Pruett et al. (2009) observed that greater prairie chickens mostly stayed more than 0.6 mi (1.0 km) away from transmission lines and that few leks or nests were located within 1.2 mi (1.9 km) of transmission lines.

Periodic maintenance of transmission line ROWs in forested areas would maintain the corridor segments in an early stage of plant community succession, which could benefit small mammals and their predators. Regrowth of willows and other trees following maintenance could benefit ungulates that use browse. Conversely, habitat maintenance would have localized adverse effects on certain species, such as the red squirrel (*Tamiasciurus hudsonicus*), southern red-backed vole (*Myodes gapperi*), and American marten (*Martes americana*), that prefer late-successional or forested habitats. ROW vegetation maintenance would not be expected to occur more often than approximately once every 3 years. This would lessen impacts on migratory birds and other wildlife species that might use the ROWs.

Wildlife Disturbance. During the operation and maintenance of wind energy projects, turbine operations, vehicles, noise, and the presence of workers could disturb wildlife. The response of wildlife to these disturbances would be highly variable and depend on the species, distance, and the type, intensity, and duration of the disturbance. Although disturbance impacts on wildlife during operation and maintenance would be similar to those discussed for the construction phase, the potential extent of impacts would be less because worker, vehicle, and equipment needs would be fewer during operation. For example, some individual wildlife might temporarily or permanently move from the project area. As mentioned, wildlife moving from the area might incur mortality if the surrounding habitats were at or near carrying capacity, or if the surrounding areas lacked habitat capable of supporting the displaced individuals. Avoidance of an area may or may not imply impacts on population parameters such as population size, but crowding of individuals into remaining suitable habitat or the use of less suitable habitat are thought to depress productivity and/or increase mortality (Erickson et al. 2007). However, there is little information on whether displacement effects have any real impact on population parameters such as population size and reproduction (WEST, Inc. 2007).

Reduced use by and displacement of some birds probably occur in close proximity to turbines. The actual distance would be species-specific and probably ranges from <328 ft to 1.9 mi (<100 m to 3 km) (Strickland 2004). The Service (2012) indicated that possible effects on sensitive species may occur at distances greater than or equal to 1 mi (1.6 km) from the center of a wind farm during periods of peak sound production. A study of the effect of wind turbines on grassland birds conducted in southwestern Minnesota (Leddy et al. 1999) found that the density of male grassland birds was more than 2.4 times greater within control areas and areas that were 591 ft (180 m) away from turbines than in areas that were within 262 ft (80 m) of the turbines. This was considered an indirect impact on the local bird populations due to the decrease in area of grassland habitat available to breeding birds (Leddy et al. 1999). While Leddy et al. (1999) could not determine the precise cause of the observed effect, they suggested that noise, the presence of an access road, and the physical movement of the turbines could have accounted for the effect. At the Stateline Wind Project, located at the border between Oregon and Washington, significantly lower densities of grassland songbirds were noted within 164 ft (50 m) of turbines and associated roads (Erickson et al. 2004). In contrast, Devereux et al. (2008) found no evidence that farmland birds avoided areas close to wind turbines during winter.

Preliminary studies on nest site displacement in Scotland and Northern Ireland indicated that hen harriers (northern harrier, *Circus cyaneus*) will nest 656 to 984 ft (200 to 300 m) from turbines (Whitfield and Madders 2006). If displacement of foraging of hen harriers occurs, it would likely be limited to within 328 ft (100 m) of wind turbines. Wind turbines placed in clusters caused larger avoidance zones for pink-footed geese (*Anser brachyrhynchos*) than turbines along lines, probably due to the three-dimensional visual effect of clusters (Larsen and Madsen 2000). The impact of a wind energy facility to gallinaceous species is more likely due to disturbance or their strong avoidance of tall structures rather than due to collisions (Kingsley and Whittam 2005; Kuvlesky et al. 2007). It is not known whether shadow flicker (the on-and-off flickering effect of a shadow caused when the sun passes behind the rotor of a wind turbine) is tolerated or increases stress level in wildlife, particularly with prey species that may equate the shadow to that of an overhead predator (Illinois DNR 2007).

The presence of a wind energy project could disrupt movements of terrestrial wildlife, particularly during migration. Herd animals, such as elk, deer, and pronghorn (*Antilocapra americana*), could be affected if linear rows of turbines intersect migration paths between winter and summer ranges or in calving areas (NWCC 2002). However, studies conducted at Foote Creek Rim in Wyoming have not demonstrated any displacement effects on pronghorn, and their use of the area has not declined since construction of the wind energy project (Johnson et al. 2000a). The zone of influence on each side of a road for bighorn sheep has been reported to be 1,150 ft (350 m) for roads with 1 vehicle or fewer per day and 1,640 ft (500 m) for roads with more than 1 vehicle per day. For deer and elk, the zone of influence has been reported to be 984 ft (300 m) for motorized trails and closed roads that are open to all-terrain vehicles (ATVs), 2,950 ft (900 m) for roads with up to 1 vehicle per 12 hr, 3,280 ft (1,000 m) for roads with more than 2 to 4 vehicles per 12 hr, and 4,265 ft (1,300 m) for roads with more than 4 vehicles per 12 hr (Gaines et al. 2003). Brown bears (*Ursus arctos*) avoided habitat within 3,000 ft (914 m) of open roads, while American black bears (*U. americanus*) avoided habitat within 900 ft (274 m). Avoidance of high-quality habitat near roads and trails may lessen the opportunity for individuals to obtain food and could increase intraspecific competition by forcing bears into limited remote habitat. The greater tolerance of American black bears could allow them to exploit habitat in relative absence of competition from brown bears (Kasworm and Manley 1990). Ground squirrels have displayed altered behavior near wind turbines, perhaps due to the noise generated by the turbines (Illinois DNR 2007). The noise generated by turbines and increased human activity could disturb roosting bats, but no data exists to support or refute these contentions (Arnett et al. 2007).

Noise associated with wind energy facility operations could be generated by transmission lines (corona), vehicles, maintenance equipment, and the turbines (section 5.5.1). Bird population densities along transmission line ROWs in Oregon that exhibited noise levels of approximately 50 dBA were reported to be reduced by up to 2 percent (Lee and Griffith 1978). Loud, unusual sounds and noise from construction and human activities can disturb gallinaceous birds, causing them to avoid traditional use areas and reduce their use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is attributed to human activity (NatureServe 2009).

Lighting could also disturb wildlife in the wind energy project area. Lights directly attract migratory birds (particularly in inclement weather and during low-visibility conditions), and they can indirectly attract birds and bats by attracting flying insects. The potential for lighting to affect the incidence of bird and bat mortality associated with collisions or barotrauma associated with turbines is discussed below.

***Wildlife Injury or Mortality*.** Exposure to contaminants is a potential source of injury or mortality to wildlife. Wildlife might be exposed to herbicides, fuel, or other hazardous materials (e.g., lubricating oils). Potential exposure to hazardous materials would most likely occur as a result of a spill. A spill could result in direct contamination of individual animals, contamination of habitats, and contamination of food resources. Acute (short-term) effects generally occur from direct contamination; chronic (long-term) effects usually occur as a result of factors such as the accumulation of contaminants from food items and environmental media (Irons et al. 2000).

The impacts on wildlife due to a spill would depend on factors such as the time of year the spill occurred, the volume of the spill, the type and extent of habitat affected, and the home range and density of the wildlife species that could be exposed to the spill. A population-level adverse impact would be expected only if the spill was very large or if it contaminated a crucial habitat area where a large number of individual animals were concentrated. Both events would be unlikely because the amount of hazardous chemicals used or stored at wind energy projects is either dispersed or small. Because the amounts of most fuels and other hazardous materials used in conjunction with a wind energy project are expected to be small, an uncontained spill would affect only a limited area. In addition, the avoidance of contaminated areas by wildlife during spill response activities (due to disturbance from human presence) would reduce the potential for wildlife exposure. Furthermore, a spill prevention and response plan will be required, work crews will be trained in spill response, and materials required for spill cleanup will be kept on hand. Prompt spill response should minimize potential impacts on wildlife.

Most herbicides used within transmission line ROWs would pose little or no risk to wildlife unless the animals were exposed to accidental spills or direct spray or drift, or they consumed herbicide-treated vegetation. Herbicide applications would be conducted following label directions and in accordance with applicable permits and licenses. Therefore, any adverse toxicological threat from herbicides on wildlife would be unlikely. However, accidental spills or releases of these materials could affect exposed wildlife. The most likely effect on wildlife from herbicide use would be primarily attributable to habitat changes resulting from treatment rather than the toxic effects of the applied herbicide.

Impacts on wildlife from colliding with meteorological towers and vehicles and from fires during the operation phase would be similar to those described for the site characterization phase or for the construction phase. Potential annual mortality from meteorological towers during the operation phase could be somewhat less than during the site characterization phase because fewer towers would be maintained during the lifetime of the facility. At the Foote Creek Rim wind energy project in Wyoming, meteorological towers killed an estimated 8.1 birds per year, compared with an estimated average of 1.5 bird fatalities per year for each turbine (Young et al. 2003a). Annual mortality from vehicles would be less during the operation phase compared to the construction phase because the overall amount of traffic would be lower.

Except under unusual circumstances, no electrocution of raptors or other birds would be expected, because the spacing between the conductors or between a conductor and a ground wire or other grounding structure on the transmission facilities would exceed the wrist-to-wrist span (at the outermost bend of the birds' wings) of bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), sandhill cranes (*Grus canadensis*), and whooping cranes (*G. americana*), the largest birds that occur in the UGP Region (USDA RUS 1998). However, the tip-to-tip wingspans of these birds exceed the 60-in. (1.5-m) recommended spacing between conductors, thus, when the feathers of these birds are wet and the tips of their wings come in contact with conducting materials, electrocution may occur. Therefore, additional spacing between conducting materials, or additional insulating of conducting materials, is recommended. Although a rare event, electrocution can occur during current arcing when flocks of small birds cross a transmission line or when several roosting birds take off simultaneously. This is most likely to occur in humid weather conditions (Bevanger 1995; BirdLife International 2003). Arcing can also be caused by the waste streams of large birds roosting on the crossarms above insulators (BirdLife International 2003). The electrocution of other wildlife from contact with electrical transmission lines is even less common, and occurs more often on smaller distribution lines and at substations and switchyards. Non-avian wildlife species that have been electrocuted include snakes, mice, squirrels, raccoons, bobcat (*Lynx rufus*), and American black bear (Edison Electric Institute 1980; Williams 1990). Among the mammals, squirrels are among the most commonly reported species to be electrocuted because of their inclination to chew on electrical wires. Because of the relatively rare nature of electrocutions, they are not expected to adversely affect populations of wildlife species.

The potential effects of electromagnetic field (EMF) exposure on animal behavior, physiology, endocrine systems, reproduction, and immune functions have been found to be negative, very minor, or inconclusive (WHO 2007). Generally, these effects are the results of exposures much higher and longer than those encountered by wildlife under actual field conditions. In addition, there is no evidence that EMF exposure alone causes cancer in animals, and evidence that EMF exposure in combination with known carcinogens can enhance cancer development is inadequate (WHO 2007).

Collisions of birds and bats with transmission lines and turbines would be the most likely cause of mortality and injury to wildlife during the operational phase of a wind energy project. The following discussion provides information regarding avian and bat mortality due to collisions with transmission lines and turbines. It should be noted that, while the review provides an overview of available information, it is based on a limited sample of post-construction monitoring work at a limited number of U.S. wind facilities where monitoring results are available. It is possible that the available data on bird mortalities at wind facilities may not be fully representative of the species that are killed and the level of actual mortality. There are limitations to the fatality studies that are conducted and made available, including the following: studies are not conducted using similar methods; studies are not designed in a statistically rigorous manner; not all birds killed at wind energy facilities are located during such studies; there is variability in habitat types in terms of detectability of bird carcasses; and carcass removal rates (due to scavengers) and searcher efficiency can vary. At present, there is no universally accepted protocol for conducting post-construction mortality studies at wind energy facilities. Therefore, the reader is cautioned that studies that have been conducted do not meet any universal accepted standards, and may not be comparable.

The potential for bird collisions with transmission lines depends on variables such as habitat, relation of the line to migratory flyways and feeding flight patterns, migratory and resident bird species, and structural characteristics of the lines (Beaulaurier et al. 1984; APLIC 2012). Birds that migrate at night, fly in flocks, and/or are large and heavy with limited maneuverability are particularly at risk (BirdLife International 2003; APLIC 2012). Waterfowl, wading birds, shorebirds, and passerines are most vulnerable to colliding with transmission lines near wetlands, while raptors and passerines are most susceptible in habitats away from wetlands (Faanes 1987). Of highest concern with regard to bird collisions are locations where transmission lines span flight paths such as river valleys, wetland areas, lakes, areas between waterfowl feeding and roosting areas, and narrow corridors (e.g., passes that connect two valleys). A disturbance that leads to a panic flight could increase the risk of collision with transmission lines (BirdLife International 2003; APLIC 2012).

Shield wire is often the cause of bird losses associated with higher voltage transmission lines, because birds fly over the more visible conductor bundles, only to collide with the relatively invisible, thin shield wire (Thompson 1978; Faanes 1987). Young, inexperienced birds, as well as migrants in unfamiliar terrain, appear to be more vulnerable to wire strikes than resident breeders (APLIC 2012). In addition, many species appear to be most highly susceptible to collisions when alarmed, pursued, searching for food while flying, engaged in courtship, taking off, and landing, and during the night and inclement weather (Thompson 1978). Sage-grouse and other upland game birds are potentially vulnerable to colliding with transmission lines because they lack good visual acuity and because they are generally poor flyers (Bevanger 1995). However, most upland game birds do not fly high enough to collide with high-voltage transmission lines.

Waterfowl, shorebirds, and raptors appear to be the bird groups most susceptible to colliding with transmission wires (Kingsley and Whittam 2005). Factors that can contribute to the frequency of waterfowl collisions with transmission lines include the number of individuals present, weather conditions and visibility, species composition or the behavior of birds, disturbance, and the familiarity of birds with the area (Anderson 1978; APLIC 2012). During spring migration, inattentiveness by males influences waterfowl collisions with transmission lines. Locating lines between feeding and roosting areas, feeding and drinking areas, or between one migratory stop and the next could increase the potential for collisions by gulls, cranes, and shorebirds (Faanes 1987). In the northern Great Plains, the juxtaposition of power lines and wetlands that support concentrations of waterbirds contributes to avian mortality with the power lines. Lines located within 1,312 ft (400 m) of the water's edge tended to have greater mortality than those located 1,312 ft (400 m) or more from water (Faanes 1987). Winning and Murray (1997) observed the mortality rates for waterbirds that flew across a 330-kV transmission line near a wetland complex to be 0.004 to 0.04 per 1,000 flights.

Meyer and Lee (1981) concluded that although waterfowl (in Oregon and Washington) were especially susceptible to colliding with transmission lines, no adverse population or ecological results occurred, because all species affected were common and because collisions occurred in less than 1 percent of all flights observed. Stout and Cornwell (1976), who suggested that less than 0.1 percent of all non-hunting waterfowl mortality nationwide was due to collisions with transmission lines, reached a similar conclusion. The potential for waterfowl and wading birds to collide with transmission lines could be assumed to be related to the extent preferred habitats are crossed by the lines and the extent of other waterfowl and wading bird habitats within the immediate area (APLIC 2012).

While not immune to collisions, raptors have several attributes that decrease their susceptibility to collisions with transmission lines: (1) they have keen eyesight; (2) they soar or fly by using relatively slow flapping motions; (3) they can generally maneuver while in flight; (4) they learn to use utility poles and structures as hunting perches or nests and become conditioned to the presence of lines; and (5) they do not fly in groups (as waterfowl do), so their position and altitude are not determined by other birds. Therefore, raptors are not as likely to collide with transmission lines except when they are distracted (e.g., while pursuing prey) or when other environmental factors (e.g., weather) increase their susceptibility (Olendorff and Lehman 1986).

Bird and bat collisions with wind turbines have received the major emphasis regarding adverse impacts on wildlife associated with wind energy developments. Local species composition and abundance, geographic area, topography, and turbine type and placement all contribute to the potential for bird and bat fatalities at wind energy facilities (TRC Environmental Corporation 2008). Bird and bat collisions with wind turbines are addressed in more detail below.

The three main factors that contribute to avian mortality at wind energy facilities are density of birds, landscape features, and weather conditions (Ontario Ministry of Natural Resources 2007). Just as with other tall structures, reduced visibility because of fog, clouds, rain, and darkness may contribute to collisions of birds with wind turbines. As many as 51 of the 55 collision fatalities (93 percent) at the Buffalo Ridge Wind Resource Area may have occurred in association with inclement weather such as thunderstorms, fog, and gusty winds (Johnson et al. 2002). Turbine location, design, configuration, and spacing, as well as land use close to the turbines also affect the potential for avian collisions (Edkins 2008). The number of turbines associated with a wind energy project has been identified as the major variable associated with potential avian mortality (EFSEC 2007).

Aviation marker lights installed on turbines have also been considered as a factor affecting the rate of bird fatalities at wind energy projects (NWCC 2002). At communications towers, it has been shown that steady-burning red lights are a primary factor contributing to mass mortality events (Gehring et al. 2009). Particularly during inclement weather when celestial cues are not available, migrating birds are either attracted to such tower lights or fly within their glow and become reluctant to leave it. They will then repeatedly circle the tall structures, becoming vulnerable to collision mortality. Longer wavelengths of red light (and white light, to a lesser extent) also have been shown to contribute to such mortality, because these wavelengths further interfere with birds' magnetic orientation mechanism (Poot et al. 2008). Flashing (as opposed to steady-burning) red lights appear to be less attractive to birds (Gehring et al. 2009), as do quickly flashing white strobes (Ugoretz 2001). The presence of lighting on some turbines might attract birds to the area and increase the potential for collision mortality at both the lit and unlit turbines (Johnson et al. 2002). Substations and ancillary facilities that are lit for security purposes may also contribute to this problem, particularly if they are located in close proximity to turbines (Kerlinger and Kerns 2003; NWCC Wildlife Workgroup 2003). Observed fatality rates of passerines for lit turbines at the Nine Canyon Wind Power Project were higher than for unlit turbines, although differences were not statistically significant (Erickson et al. 2003b). Similar results were reported for the Wild Horse Wind Facility in Washington (Erickson et al. 2008). Lit turbines did not appear to affect the rate of bird or bat fatalities at the Crescent Ridge Wind Power Project in Illinois (Kerlinger et al. 2007).

Overall, results of fatality studies do not support the contention that FAA L-864 red flashing lights attract or disorient birds and lead to collisions at turbines (Jain et al. 2007; Kerlinger 2006). As long as steady-burning red (or other color) lights are not present, the potential for large-scale fatality events or large numbers of bird fatalities due to lighting is very low (Kerlinger 2006). The FAA evaluates proposed wind energy development projects and makes recommendations regarding possible airway marking, lighting, and other safety requirements that would become part of the project. Under current (June 2003) FAA regulations, navigation lights would need to be mounted on the first and last turbine of each string and every 1,000 to 1,400 ft (305 to 427 m) in between (EFSEC 2007).

The composition of species that could collide with turbines would partly depend on habitat type and quality present at and in the vicinity of the wind energy facility. Proper facility siting is an important consideration in order to avoid unnecessary fatalities of birds (Osborn et al. 2000). Table 5.6-5 lists the major bird and raptor species that have been observed as fatalities at various wind energy projects in the United States. Bird fatalities associated with wind turbines are composed of a variety of different groups, including raptors, passerines, gallinaceous birds, waterfowl, and shorebirds. Vulnerability to collisions with turbines is species- and habitat-specific (Erickson et al. 2001). However, the relative abundance of a bird species does not predict the relative frequency of fatalities per species (Thelander and Rugge 2000). Because they tend to fly at relatively high altitudes, birds conducting long-range migrations are not prone to being affected by turbines, except during weather conditions or activities (e.g., landing, taking off) that induce them to fly low (Hanowski and Hawrot 2000). Resident birds may have a higher probability of colliding with turbines than migrants, given that residents tend to fly lower and spend more time in the area (Janss 2000). Many reported bird fatalities involved common, yearlong resident species such as horned lark, house sparrows, starlings, gulls, and rock pigeons (*Columba livia*) (Erickson et al. 2001, 2003a).

WEST, Inc. (2007) reported 39 bird species (plus several unidentified birds) as fatalities at wind energy facilities within the Pacific Northwest (Oregon and Washington). The most prevalent species were horned lark (37.5 percent), ring-necked pheasant (*Phasianus colchicus*) (9.1 percent), golden-crowned kinglet (*Regulus satrapa*) (7.7 percent), western meadowlark (*Sturnella neglecta*) (4.9 percent), and gray partridge (*Perdix perdix*) (4.2 percent). Raptor species observed as fatalities included red-tailed hawk (3.2 percent), American kestrel (2.1 percent), short-eared owl (*Asio flammeus*) (0.7 percent), ferruginous hawk (0.4 percent), Swainson's hawk (*Buteo swainsoni*) (0.4 percent), and rough-legged hawk (*B. lagopus*) (0.4 percent). In a more expanded review, Johnson and Erickson (2008) reported 69 species plus a number of unidentified species. Avian fatalities by species groups were as follows: passerines (69.5 percent); upland gamebirds (14.5 percent); raptors (8.6 percent); doves and pigeons (3.2 percent); waterbirds, waterfowl, and shorebirds (1.7 percent); and woodpeckers, nighthawks, and swifts (2.6 percent).

Fatalities of crane species have not been common, but the collision mortalities of two sandhill cranes (a species often regarded as a surrogate for the endangered whooping crane) have been observed at wind energy facilities in Texas (Stehn 2011). Considering the thousands of cranes that migrate annually through Texas, it is anticipated that the risk of crane mortality due to collisions with turbines is low.

TABLE 5.6-5 Number of Bird Species with Fatalities (and Number of Individual Fatalities) at Wind Energy Facilities in the United States

Wind Resource Area	Observed Fatalities[a]	Timeframe	Species Commonly Found in Carcass Searches (% composition)	Raptor Species Found in Carcass Searches (% composition)
Altamont Pass, CA	45 (1,157)	May 1998 to May 2003	Red-tailed hawk (18.4), rock dove (16.9), western meadowlark (8.3), burrowing owl (6.1), European starling (5.8), American kestrel (5.1), golden eagle (4.7), mallard (3.0), and mourning dove (2.9)	Red-tailed hawk (18.4), burrowing owl (6.1), American kestrel (5.1), golden eagle (4.7), barn owl (4.3), great horned owl (1.6), turkey vulture (0.5), northern harrier (0.3), prairie falcon (0.3), ferruginous hawk (0.2), and white-tailed kite (0.1)
Altamont Pass, CA	50 (1,468)	Oct. 2005 to Sept. 2007	Rock pigeon (20.2), red-tailed hawk (17.6), western meadowlark (13.6), European starling (12.1), burrowing owl (10.8), barn owl (6.7), American kestrel (4.1), and golden eagle (3.3)	Red-tailed hawk (17.6), burrowing owl (10.8), barn owl (6.7), American kestrel (4.1), golden eagle (3.3), great-horned owl (1.7), turkey vulture (0.5), northern harrier (0.2), prairie falcon (0.2), ferruginous hawk (0.1), red-shouldered hawk (0.1), and Swainson's hawk (0.1)[b]
Buffalo Mountain, TN	27 (62)	Oct. 2000 to Sept. 2003	Red-eyed vireo (19.4), bay-breasted warbler (6.5), golden-crowned kinglet (6.5), black-and-white warbler (6.5), and Tennessee warbler (6.5)	None
Buffalo Mountain, TN	8 (11)	Apr. to Dec. 2005	Two each of red-eyed vireo and rose-breasted grosbeak (18.2 each species), one each of six other species (9.1 each species)	None
Buffalo Ridge, MN	31 (55)	1996 to 1999 (mid-March to mid-Nov. each year)	Common yellowthroat (12.7), orange-crowned warbler (7.3), barn swallow (7.3), and black-and-white warbler (5.5)	Red-tailed hawk (1.8)
Buffalo Ridge, MN	11 (12)	Apr. 1994 to Dec. 1995	Two rock doves (16.7) and one each of other 10 species (8.3 each species)	None
Buffalo Ridge, MN	55 (32)	1996 to 1999	Common yellowthroat (12.7), orange-crowned warbler (7.3), barn swallow (7.3), and black-and-white warbler (5.5)	Red-tailed hawk (1.8)

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TABLE 5.6-5 (Cont.)

Wind Resource Area	Observed Fatalities[a]	Timeframe	Species Commonly Found in Carcass Searches (% composition)	Raptor Species Found in Carcass Searches (% composition)
Crescent Ridge, IL	10 (10)	Sept. 2005 to Aug. 2006	One bird each of ten species including six songbirds (60), two waterbirds (20), and one raptor (10)	Red-tailed hawk (10)
Judith Gap, MT	11 (26)	Aug. to Oct. 2006 and Feb. to May 2007	Eared grebe (19.2), American coot (15.4), and horned lark (15.4)	Merlin (3.8) and short-eared owl (3.8)
Klondike, OR	7 (8)	Feb. 2002 to Feb. 2003	Two Canada goose (25) and one each of six other species (12.5 each)	None
Maple Ridge, NY	30 (125)[c]	Mid-June to mid-Nov. 2006	Golden-crowned kinglet (39.2), red-eyed vireo (8.8), black-throated blue warbler (4.8), magnolia warbler (4.8), cedar waxwing (2.4), and wild turkey (2.4)	American kestrel (0.8)
Mountaineer, WV	24 (69)	Apr. to Nov. 2003	Red-eyed vireo (30.4), magnolia warbler (7.2), and yellow-billed cuckoo (5.8)	Turkey vulture (2.9) and red-tailed hawk (1.4)
Oklahoma Wind Energy Center, OK	5 (11)	May to July 2004 and 2005	Northern bobwhite (45.5) and mourning dove (18.2)	Turkey vulture (9.1)
Stateline, OR/WA	35 (232)	July 2001 to Dec. 2003	Horned lark (38.4), golden-crowned kinglet (9.1), ring-necked pheasant (8.2), western meadowlark (5.2), gray partridge (3.9), red-tailed hawk (3.9), and chukar (3.4)	Red-tailed hawk (3.9), American kestrel (2.2), ferruginous hawk (0.4), short-eared owl (0.4), and Swainson's hawk (0.4)
Top of Iowa, IA	5 (7)	Apr. to Dec. 2003 and Mar. to Dec. 2004	One each of yellow-throated vireo, tree swallow, yellow-headed blackbird, red-tailed hawk, and golden-crowned kinglet (14.3 each species), and two unidentifiable birds (28.6)	Red-tailed hawk (14.3)
Vansycle, OR	8 (12)	One year (1999)	White-crowned sparrow (33.3) and gray partridge (15.4)	None

TABLE 5.6-5 (Cont.)

Wind Resource Area	Observed Fatalities[a]	Timeframe	Species Commonly Found in Carcass Searches (% composition)	Raptor Species Found in Carcass Searches (% composition)
Wild Horse, WA	29 (77)	Jan. to Dec. 2007	Horned lark (14.3), dark-eyed junco (9.1), golden-crowned kinglet (9.1), Brewer's sparrow (6.5), and American kestrel (5.2)	American kestrel (5.2), great-horned owl (1.3), and red-tailed hawk (1.3)

[a] The number of species (first number) does not include unidentified birds; the number of birds (in parentheses) includes unidentified species.

[b] List does not include unidentified raptors.

[c] Number of incidents (fatalities or injuries).

Sources: Altamont Pass Avian Monitoring Team (2008); Erickson et al. (2000, 2004, 2008); Fiedler et al. (2007); Jain et al. (2007); Johnson et al. (2000b, 2002, 2003); Kerlinger et al. (2007); Kerns and Kerlinger (2004); Nicholson et al. (2005); Osborn et al. (2000); Piorkowski (2006); Smallwood and Thelander (2008); TRC Environmental Corporation (2008).

Waterfowl, waterbird, and shorebird mortality at wind energy projects is relatively minor (Kerlinger 2006). Wind energy projects with significant sources of open water near turbines (San Gorgonio, California, and Buffalo Ridge, Minnesota) have the highest documented waterfowl mortality, with 10 to 20 percent of all fatalities consisting of waterfowl and shorebirds. Some sites with agricultural landscapes are occasionally observed to have large flocks of Canada geese (*Branta canadensis*) during winter; however, few Canada geese fatalities at these facilities have been documented (Erickson et al. 2002). At locations where turbines were located near important staging areas for many species of shorebirds, the birds readily avoided the turbines and were at low risk of collisions (Kingsley and Whittam 2005). Overall, mortality levels are insignificant in comparison to the use of the project area by waterfowl and waterbirds (Erickson et al. 2002; WEST, Inc. 2007). For example, although 1 million total goose-use days and 120,000 total duck-use days were recorded in the waterfowl management areas surrounding the 89-turbine Top of Iowa wind facility, no waterfowl fatalities were documented at the wind site (Koford et al. 2005).

Among bird fatalities at wind energy projects, primary attention has focused on raptors because of the high numbers of golden eagle, red-tailed hawk, American kestrel, and burrowing owl fatalities observed at the Altamont Pass and Tehachapi wind energy projects (Erickson et al. 2001). Other raptor species that have been observed as fatalities at wind energy projects include ferruginous hawk, northern harrier, prairie falcon, Swainson's hawk, white-tailed kite (*Elanus leucurus*), turkey vulture (*Cathartes aura*), barn owl (*Tyto alba*), flammulated owl (*Otus flammeolus*), short-eared owl, long-eared owl (*Asio otus*), and great-horned owl (Erickson et al. 2001; Thelander et al. 2003; see also table 5.6-5). Few raptor fatalities are generally reported at wind facilities located outside of California (Kerlinger 2006). Five bald eagle mortalities have been reported at wind energy facilities. Observation of raptor fatalities at wind facilities are of particular concern because raptors have a high public profile, some raptor species have relatively small populations or low reproduction rates, and raptors often fly at heights within the blade sweep area (Kingsley and Whittam 2003).

The majority of the golden eagle mortalities at the Altamont Pass Wind Resource Area have been subadults and floaters (adult individuals without breeding territories). A reserve of floaters exists (Hunt et al. 1999; Hunt 2002); therefore, mortalities of golden eagles have not yet demonstrated detectable population-level effects within the region of the Altamont Pass Wind Resource Area (Hunt 2002). Population-level impacts on raptors are likely in some areas because they cannot absorb high losses due to their low reproductive potential (Kuvlesky et al. 2007; Lilley and Firestone 2008).

As discussed in section 4.6.2, bald and golden eagles receive protection under the MBTA, and especially the BGEPA. Any impacts on eagles from a wind energy facility, unless properly permitted, are a violation of the BGEPA (Service 2011a). The Service (2009) finalized permit regulations to authorize limited take of bald and golden eagles under the BGEPA, under which the take to be authorized is associated with otherwise lawful activities (50 CFR 22.26). The regulations also establish permit provisions for intentional take of eagle nests where necessary to alleviate a safety emergency to people or eagles, to ensure public health and safety, where a nest prevents use of a human-engineered structure, and/or to protect an interest in a particular locality where the activity or mitigation for the activity will provide a net benefit to eagles. Only inactive nests are allowed to be taken except in cases of safety emergencies (50 CFR 22.27).

The Service (2011a) issued its draft Eagle Conservation Plan Guidance that describes a process by which wind energy developers can collect and analyze information that could lead to a programmatic permit to authorize unintentional take of eagles at wind energy facilities. The Eagle Conservation Plan Guidance calls on wind energy facility developers to consult with the Service in a five-tiered process that includes the following measures:

1. Conduct an early landscape-level evaluation to identify wind facility locations with manageable risk to eagles;

2. Conduct site-specific surveys (on and within 10 mi [16 km] of the project footprint) to predict eagle fatality rates and disturbance from the facility;

3. Conduct a turbine-based risk assessment to predict annual eagle fatality rates for the project, excluding possible advanced conservation practices;

4. Identify advanced conservation practices that might avoid or minimize fatalities, and when required to do so, identify compensatory mitigation necessary to reduce any remaining fatality effect to a no-net-loss standard; and

5. Conduct fatality monitoring in the project footprint, monitor occupancy and productivity of nests of eagle pairs that are likely using the project footprint, and monitor eagle use of communal roosts in the project area to determine whether the advanced conservation practices are working and/or whether additional advanced conservation practices are required.

The programmatic permit would authorize limited, incidental mortality and disturbance of eagles, provided that effective offsetting conservation measures are implemented. For eagle populations that cannot sustain the additional mortality caused by the wind energy facility, remaining take must be offset through compensatory mitigation so that the net effect to the eagle population is, at a minimum, no change (Service 2011a).

The American kestrel is one of the more common raptor species observed at a number of wind facilities and is among the most commonly observed raptors killed at Altamont Pass (California), Tehachapi Pass (California), San Gorgonio (California), and Foote Rim Creek (Wyoming). Red-tailed hawk fatalities are also commonly observed at the Altamont Wind Resource Area. This hawk's relatively motionless gliding flight within an updraft may increase its risk of turbine-related collisions. Scavenger species such as the turkey vulture are common at many wind energy facilities, but are apparently not susceptible to collisions (Erickson et al. 2001, 2002; Hoover 2002). As indicated in table 5.6-5, few vultures are generally observed as fatalities at wind facilities within the United States.

There is little or no information related to how owl species react to turbines, but they generally fly within turbine height or lower, which puts them at risk of collision. The number of owls killed at wind energy projects varies, ranging from 0 percent up to 10 to 15 percent of the total number of birds killed (Kingsley and Whittam 2005; see also table 5.6-5).

Generally, raptors are able to avoid wind turbines (Young et al. 2003b). However, factors that contribute to a high number of raptor fatalities in California include unusually high raptor densities, topography, and, possibly, older turbine technology (Kingsley and Whittam 2003). Where turbines are located in areas where raptors spend a large portion of their time, the incidence of collision increases (Hoover 2002). Barrios and Rodriguez (2004) suggested that normal behavior endangers raptors approaching wind turbines and that wind turbine casualties increase with bird density. Raptors become susceptible to collisions by looking downward for prey while failing to notice the turbine blades (Illinois DNR 2007).

Topography is perhaps the most important factor that influences raptor collisions (Kingsley and Whittam 2005). Other factors that contribute to the risk potential for migrating raptors include species-specific migration patterns, migration timing, and flight style (Brandes 2005). Some species may become more susceptible to turbine collisions because post-construction conditions at a wind energy facility have increased prey abundance within the vicinity of turbines or ancillary facilities. For example, rock piles that could be produced during construction are used by desert cottontails (*Sylvilagus audubonii*), which are prey for golden eagles. Thus, the eagles are more likely to encounter the turbines while foraging around these rock piles. Thelander et al. (2003) reported a similar relationship between pocket gopher abundance around turbines and red-tailed hawk mortality. The pocket gophers were more abundant on steeper slopes into which laydown areas and access roads were cut. Where wind energy facilities are located in grazing allotments, cattle often cluster around wind turbines, and their wastes can attract insects that are prey items for raptors such as American kestrels and burrowing owls (NWCC Wildlife Workgroup 2003).

Other than the observation of 9.1 percent of mortalities at wind energy facilities in the Pacific Northwest being ring-necked pheasants (WEST, Inc. 2007), gallinaceous birds do not generally comprise a high proportion of birds observed as fatalities at wind energy projects. Gallinaceous birds are not strong flyers and often only fly high enough to clear the height of the existing vegetation. Therefore, they do not tend to fly high enough to collide with turbines.

Passerines (both resident and migratory species) are the most common group of birds killed at many wind energy projects (e.g., Erickson et al. 2004; Johnson et al. 2000b, 2002; Kerns and Kerlinger 2004), often making up more than 80 percent of reported fatalities (Erickson et al. 2001). They are also the most commonly observed group of birds during site surveys (WEST, Inc. 2007). Most studies have indicated that passerines suffer the most collision fatalities regardless of where the wind energy facilities are located. About half of the passerine mortalities involve nocturnal migrants, although no large episodic mortality (such as that documented for bird strikes with communication towers) has been known to occur. The largest single reported incident was 14 migrants found at two turbines (Erickson et al. 2002). Fatalities at wind energy facilities are not thought to impact passerine populations (Kuvlesky et al. 2007).

Grassland birds such as the horned lark, vesper sparrow (*Pooecetes gramineus*), Sprague's pipit (*Anthus spragueii*), and bobolink (*Dolichonyx oryzivorus*) may be particularly at risk for colliding with wind turbines because of aerial courtship displays that occur at the height of turbine blades (Illinois DNR 2007; Kingsley and Whittam 2005). At the Summerview Wind Power Project, the horned lark comprised 34 percent of passerines killed. It is also among the most documented species killed at other wind energy facilities in the United States (Brown and Hamilton 2006).

Table 5.6-6 summarizes avian fatality rates for a number of wind energy projects in the United States. Mortality rates average about 2.2 avian fatalities per turbine per year for all species combined and about 0.03 raptor fatalities per turbine per year (Erickson et al. 2001). These estimates are based on survey methods that may not be equivalent among wind energy facilities and may not accurately reflect actual mortality estimates. Excluding California, these averages are 1.8 total avian fatalities per turbine per year and only 0.006 raptor fatalities per turbine per year. Bird collision fatality rates at various wind energy facilities were found to range from 0.0 to more than 30 birds per turbine per year (Kuvlesky et al. 2007).

The average numbers of avian collision fatalities per turbine and per megawatt in the United States at the end of 2003 were estimated at 2.11 and 3.04, respectively. Some 20,000 to 37,000 birds died from colliding with turbines in 2003. About 9,200 of these deaths occurred outside California (Erickson et al. 2005). Smallwood and Thelander (2008) concluded that reported avian mortality at wind energy facilities is likely lower than actual mortality levels.

Based on studies conducted across the United States, the wind industry estimates that each modern wind turbine kills about two birds per year (Illinois DNR 2007). More recent estimates of raptor mortality for the Altamont Pass Wind Resource Area ranged from 0.16 fatalities per turbine per year to 0.24 fatalities per turbine per year (Smallwood and Thelander 2004). The range of fatality rates among facilities probably reflects differences in the habitats and bird communities among the sites, as well as differences in the designs of the mortality monitoring studies that generated the reported data.

Thelander et al. (2003) evaluated bird fatalities from 1998 through 2000 and provided a yearly mortality estimate of 24 golden eagles, 244 red-tailed hawks, 56 American kestrels, and 93 burrowing owls at the Altamont Pass Wind Resource Area. Smallwood and Thelander (2003) estimated that there were 400 to 800 golden eagle, 2,980 to 5,960 red-tailed hawk, and 2,700 to 5,400 burrowing owl fatalities at the Altamont Pass Wind Resource Area from 1983 to 2003. Altamont Pass is unusual in its intensive use by raptors, relative to most wind energy

TABLE 5.6-6 Avian Mortality Rates Observed at Wind Farms in the United States

Wind Resource Area	State	No. of Turbines	No. Bird Fatalities per Turbine per Year	No. Bird Fatalities per MW Installed Capacity per Year[b]
Altamont	CA	1,526	0.8	7.2
Diablo Winds	CA	31	1.2	1.8
High Winds	CA	90	2.3	1.3
IDWGP	IA	3	0.0	0.0
Top of Iowa	IA	89	0.6	0.7
Crescent Ridge	IL	33	0.9[a]	0.6[a]
Buffalo Ridge I	MN	73	0.9	2.6
Buffalo Ridge II	MN	143	2.3	3.0
Buffalo Ridge III	MN	138	4.4	5.9
Combine Hills	OR	41	2.6	2.6
Klondike	OR	16	1.4	0.9
Leaning Juniper	OR	67	2.1	3.2
Vansycle	OR	38	0.6	1.0
Judith Gap	MT	90	4.5[a]	3.0[a]
Meyersdale	PA	20	0.9	0.6
Buffalo Mountain	TN	3	9.3	14.1
Searsburg	VT	11	0.0	0.0
Big Horn	WA	133	1.7	2.6
Hopkins Ridge	WA	87	0.7	1.2
Nine Canyon	WA	37	3.6	2.8
Wild Horse	WA	127	2.8	1.6
Stateline	WA/OR	454	1.9	2.9
NE Wisconsin	WI	31	1.3	2.0
Mountaineer	WV	44	2.6	1.7
Foote Creek Rim	WY	69	1.5	2.5
National average			2.2	3.0

[a] Spring and fall migration periods.

[b] Estimates are based on survey methods that may not be equivalent among wind energy facilities and may not accurately reflect actual mortality estimates.

Sources: Anderson et al. (2000); Barclay et al. (2007); Erickson et al. (2000, 2001, 2002, 2003a,b, 2004, 2008); Fiedler (2004); Fiedler et al. 2007; Howe et al. (2002); Jain (2005); Johnson et al. (2003, 2004); Kerlinger (2002); Kerlinger et al. (2006, 2007); Kerns and Kerlinger (2004); Strickland et al. (2001); TRC Environmental Corporation (2008); WEST, Inc. (2007); Young et al. (2003a).

facilities. It should be noted that fatalities at wind energy facilities are not due solely to collisions with turbines. During a 7-year study of radio-tagged golden eagles at the Altamont Pass Wind Resource Area, Hunt (2002) recorded deaths from turbine collisions, electrocutions, wire strikes, vehicle strikes, poisoning, and other causes.

At the Altamont Pass Wind Resource Area, turbines kill 40 to 60 golden eagles per year. Nevertheless, all nesting territories are occupied each year by adult pairs. This suggests either a demographic balance in the bird population or buffering by immigrant floaters (Hunt 2002). In the latter case, the wind energy facility could be acting as a population sink.

Smallwood et al. (2007) estimated that the Altamont Pass Wind Resource Area killed more than 100 burrowing owls annually. This is about the same number that likely nest there. This could be a potentially substantial population-level impact in which the site is either an ecological sink for owls or that the turbines are killing owls that are migrating though but not nesting in the area (Smallwood et al. 2007). The Altamont Pass Wind Resource Area may be serving as an ecological sink for burrowing owls in that turbine-related mortality might equal or exceed local production (Smallwood et al. 2007; Smallwood and Thelander 2008).

The number of raptors killed at other wind energy facilities is generally small (see table 5.6-5; NWCC 2002). Depending on the species involved and its population size, the number of fatalities may or may not result in population-level effects to the affected raptors. To date, no studies have shown population-level effects in raptor populations associated with wind energy projects.

On the basis of mortality estimates at existing wind energy projects, the mid-range value expected for passerine mortality would be approximately 1.2 to 1.8 birds per turbine per year. This level of mortality may not have any population-level consequences for individual species, because of the expected low fatality rates for most species and the high population sizes of the common species, such as European starling (*Sturnus vulgaris*), American robin (*Turdus migratorius*), horned lark, and western meadowlark (Young and Erickson 2003). However, population effects may be possible for some species, especially rare species such as those that are threatened or endangered (section 5.6.1.4); however, no studies to date have documented population effects from turbine collision mortality. Researchers estimated that 6,800 birds are killed annually at the San Gorgonio Pass Wind Resource Area (WRA), while 69 million birds pass through the Coachella Valley annually; therefore, the calculated mortality (approximately 1 in 10,000) from the wind energy project was concluded to be not biologically significant (Erickson et al. 2002).

Since the observations of a comparatively large number of bat fatalities at the Mountaineer Wind Energy Center in West Virginia, concerns over bat fatalities at wind facilities have gained increased attention (Johnson and Strickland 2004; Kerns and Kerlinger 2004), and mortality of an an Indiana bat from collision with a wind turbine has been documented (Service 2012a). As other stressors such as white-nosed syndrome become greater concerns for bats, more species may receive federal protections in the future, including species that occur in the UGP Region. However, relatively low numbers of bat fatalities are observed at most wind energy development projects. There are 45 bat species in the United States, 21 of which have been reported from the UGP Region. To date, 12 species (6 species in the UGP Region) have been recorded as fatalities at wind energy facilities (table 5.6-7). Hoary bats (*Lasiurus cinereus*) and eastern red bats (*L. borealis*) comprise most of the bat fatalities in the Midwest and eastern United States, while hoary bats and silver-haired bats (*Lasionycteris noctivagans*) are most commonly observed in the western States.

Bats most affected by wind facilities appear to be tree-roosting species during their fall migration (Arnett et al. 2008). At the Judith Gap Wind Energy Project, 97 percent of bat carcasses were found during fall migration and only 3 percent during spring migration (TRC Environmental Corporation 2008). During the fall, other bat species such as the big brown bat and little brown myotis disperse from summer breeding areas to hibernacula (Johnson et al. 2004). A small peak in mortality of silver-haired bats occurred at the expanded Buffalo Mountain Wind Farm during late spring and early summer, indicating spring migration

TABLE 5.6-7 Bat Species Observed as Fatalities at Wind Facilities in the United States

	Western States					Midwestern and South-Central States					Eastern States			
Species	CA	CO	MT	OR/WA	WY	IA	IL	MN	OK	WI	NY	PA	TN	WV
Molossidae (free-tailed bats)														
Brazilian free-tailed bat (*Tadarida brasiliensis*)	X								X					
Vespertilionidae (vesper bats)														
Big brown bat (*Eptesicus fuscus*)				X	X	X		X	X	X	X	X	X	X
Eastern pipistrelle (*Perimyotis subflavus*)						X		X	X			X	X	X
Eastern red bat (L*asiurus borealis*)						X	X	X	X	X	X	X	X	X
Evening bat (*Nycticeius humeralis*)														
Hoary bat (*Lasiurus cinereus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Little brown myotis (*Myotis lucifugus*)				X	X	X		X			X	X	X	X
Long-eared myotis (*Myotis evotis*)												X		
Northern myotis (*Myotis septentrionalis*)														X
Seminole bat (*Lasiurus seminolus*)													X	
Silver-haired bat (*Lasionycteris noctivagans*)		X	X	X	X	X	X	X	X	X	X	X	X	X
Western red bat (*Lasiurus blossevillii*)	X													

Sources: Arnett et al. (2005; 2008); Fiedler et al. (2007); Jain et al. (2007); Johnson et al. (2004); Kerlinger et al. (2007); Koford et al. (2005); Piorkowski (2006); TRC Environmental Corporation (2008).

may also be a period of increased mortality (Fiedler et al. 2007). Johnson et al. (2004) observed relatively large breeding populations of bats near the wind energy facility when collision mortality was negligible. Summer-resident bats typically experience very low collision rates (Brown and Hamilton 2006). However, Piorkowski (2006) found that relatively high numbers of Brazilian free-tailed bat (*Tadarida brasiliensis*) fatalities, including pregnant females, occurred during May through July at a wind facility in Oklahoma located about 9.3 mi (15 km) from maternity and bachelor colonies for the species.

The hoary bat is the most widespread North American bat (CDFG 2008). It has a dispersed population throughout the United States and is basically solitary except for the mother-young association and during migration when groups of hundreds of individuals may form. In summer, adult males are distributed mainly in the western half of North America, while females predominantly occur in eastern North America (NatureServe 2009). The hoary bat occurs in forests and woodlands, usually roosting in tree foliage 10 to 16 ft (3 to 5 m) above ground with dense foliage above and open flying room below (NatureServe 2009). It feeds chiefly on large moths over clearings and may forage around lights in nonurban situations. The hoary bat may forage more than 1.0 mi (1.6 km) from its diurnal roost site, often along streams or lake edges (NatureServe 2009). It may migrate long distances between summer and winter ranges. Large groups are sometimes encountered during spring and fall migrations. Hoary bats that winter in colder climates hibernate (CDFG 2008). Based on the ecology and life history of the hoary bat, fatalities at wind energy development projects would be minimal during summer and minimal to nonexistent during winter.

The silver-haired bat occurs throughout much of the United States. Maternity colonies are small. The silver-haired bat usually roosts singly, but occasionally in groups of up to six individuals. It generally migrates south for the winter and is usually found over most of its range only during spring and fall migrations (NatureServe 2009). It prefers forested areas adjacent to lakes, ponds, and streams. The silver-haired bat will sometimes occur in xeric areas during migration. Summer roosts and nursery sites include tree foliage, cavities, or under loose bark, although they are sometimes found in buildings (NatureServe 2009). The silver-haired bat forages less than 20 ft (6 m) over forest streams, ponds, and open brushy areas (CDFG 2008). Based on its ecology and life history, fatalities at wind energy development projects would be minimal during summer and winter.

The eastern red bat winters mainly in the southeastern United States. It is generally solitary and may hunt within 0.6 mi (0.9 km) of its roosting site (tree foliage). It generally forages near forest canopy at or above treetop level or along stream or lake margins. In some nonurban areas, it forages often around lights (NatureServe 2009). The western red bat has a life history similar to that of the eastern red bat (NatureServe 2009). Overall, both the eastern red bat and the western red bat would have a minimal susceptibility to wind turbine fatalities during summer and winter.

The little brown myotis occurs throughout most of the United States. Summer colonies range from 50 to 2,500 individuals, averaging about 400; concentrations in winter may include tens of thousands of individuals (NatureServe 2009). In the northeast, the little brown myotis may migrate hundreds of miles between winter and summer habitats, whereas in the West, it is believed to hibernate near its summer range. It uses human-made structures, caves, and hollow trees for resting and maternity sites. The little brown myotis generally forages in woodlands near water and feeds low over water margins of lakes, streams, and ponds, as well as along forest edges. It regularly uses the same feeding areas (NatureServe 2009; CDFG 2008). It hibernates in caves, tunnels, abandoned mines, and similar sites. The availability of suitable maternity sites may limit its abundance and distribution. The little brown myotis often hunts over water or along the margins of lakes and streams (NatureServe 2009). Based on the ecology and life history of the little brown myotis, fatalities at wind energy development projects would be minimal during summer and essentially nonexistent in winter in the UGP Region.

The big brown bat occurs throughout the United States. Nursery colonies rarely number more than a few hundred individuals (mostly 25 to 75 in the eastern States). Males are often solitary in summer, but may roost with females or in all-male colonies. Once young can fly, males may join nursery groups to form large late-summer colonies (NatureServe 2009). The big brown bat is fairly sedentary, rarely moving more than 50 mi (80 km) between summer and winter roosts, although some individuals in the Midwest migrate south for winter (NatureServe 2009). The big brown bat occurs in wooded and semi-open habitats, including cities. Summer roosts and maternity colonies include buildings, hollow trees, rock crevices, tunnels, caves, and cliff swallow nests. Caves, mines, and especially buildings and other human-made structures are used for hibernation (NatureServe 2009). The big brown bat forages over land or water, clearings and lake edges, and around lights in rural areas; and it forages repeatedly over the same route (NatureServe 2009; CDFG 2008). The distance between the day roost and foraging areas is about 0.6 to 1.2 mi (1.0 to 2.0 km) (NatureServe 2009). Based on the ecology and life history of the big brown bat, fatalities at wind energy development projects in the UGP Region would be minimal during summer and essentially nonexistent in winter.

Table 5.6-8 summarizes bat fatality rates at a number of wind energy projects in the United States. Bat mortality rates range from 0.0 bats per turbine at Diablo Winds, in California, to 69.6 bats per turbine at Buffalo Mountain, TN. Yearly bat fatalities are relatively low in the Rocky Mountains and Pacific Northwest, with estimates ranging from 0.8 to 2.5 bats per megawatt, whereas fatalities are relatively high in the eastern States, with estimates ranging from 14.9 to 53.3 bats per megawatt. Bat fatalities are more variable in the upper Midwest, with estimates ranging from 0.2 to 8.7 bats per megawatt (Arnett et al. 2008; Illinois DNR 2007). Actual levels of mortality could vary, depending on regional migratory patterns, patterns of local movements through the area, and the response of bats to different configurations of turbines (Young and Erickson 2003).

The estimated bat collision rate at the Summerview Wind Power Project in Alberta, Canada, was nearly 18.5 bats per turbine per year. This is high compared to other wind energy facilities in western and Midwestern North America. The blades at this wind energy facility are more than 98 ft (30 m) taller than those at other local wind energy facilities and may encroach into the altitude at which hoary and silver-haired bats migrate (Brown and Hamilton 2006). These two species comprised 46 and 51 percent, respectively, of all bat fatalities. Peak bat activity at turbines at Buffalo Ridge, Minnesota, followed the same trend as bat mortality, occurring from mid-July through the end of August. Most bat mortality involves migratory species such as hoary, eastern red, and silver-haired bats. Migrating bats fly lower than migrating birds, and the larger turbines reach the airspace bats fly in (Barclay et al. 2007). Most of the common bat species, such as those in the genus *Myotis*, are not known to travel great distances, compared to *Lasiurus* species, and may be less likely to fly through open areas or at heights where wind turbines blades are located (Keeley 2001). Hoary and eastern red bats

TABLE 5.6-8 Bat Mortality Rates Reported at Wind Farms in the United States

Wind Resource Area	State	No. of Turbines	No. Bat Fatalities per Turbine per Year	No. Bat Fatalities per MW Installed Capacity per Year
Altamont	CA	1,526	<0.1	0.1
Diablo Winds	CA	31	0.0	0.0
High Winds	CA	90	3.4	1.6
Top of Iowa	IA	89	8.0	8.9
Crescent Ridge	IL	33	2.8[a]	1.9[a]
Buffalo Ridge I	MN	73	0.1	0.2
Buffalo Ridge II	MN	143	2.0	2.7
Buffalo Ridge III	MN	138	2.1	2.8
Judith Gap	MT	90	13.4[a]	8.9[a]
Maple Ridge	NY	120	24.5	14.9
Combine Hills	OR	41	1.9	1.9
Klondike	OR	16	1.2	0.8
Leaning Juniper	OR	67	0.6	0.9
Vansycle	OR	38	0.7	1.1
Meyersdale	PA	20	27.0	18.0
Buffalo Mountain	TN	3	21.4	32.4
Buffalo Mountain	TN	15	69.6	38.7
Searsburg	VT	11	0.0	0.0
Big Horn	WA	133	1.3	1.9
Hopkins Ridge	WA	87	0.3	0.6
Nine Canyon	WA	37	3.2	2.5
Wild Horse	WA	127	0.7	0.4
Stateline	WA/OR	454	1.1	1.7
NE Wisconsin	WI	31	4.3	6.5
Mountaineer	WV	44	42.7	28.5
Foote Creek Rim	WY	69	1.3	2.2
National average			3.4	4.6

[a] Spring and fall migration periods.

Sources: Anderson et al. (2000); Barclay et al. (2007); Erickson et al. (2000, 2002, 2003a,b, 2004, 2008); Fiedler (2004); Fiedler et al. 2007; Howe et al. (2002); Jain (2005); Jain et al. (2007); Johnson et al. (2003, 2004); Kerlinger (2002); Kerlinger et al. (2006); Kerns and Kerlinger (2004); Strickland et al. (2001).

generally forage from treetop level to within 3 ft (1 m) of the ground; silver-haired bats usually forage at heights less than 20 ft (6 m); big brown bats forage from 23 to 33 ft (7 to 10 m) above ground; and the little brown myotis forages almost exclusively at heights less than 16 ft (5 m) above ground. The lowest height of most new-generation turbines is above 82 ft (25 m) (Erickson et al. 2002).

An elevated risk for bat fatalities exists at wind energy facilities on forested ridges. Between April 4 and November 11, 2003, a total of 475 bat carcasses representing seven species were detected at the Mountaineer Wind Energy Center in West Virginia. It was estimated that 2,092 bat fatalities actually occurred during this period, representing a fatality rate of about 47.5 bats per turbine. Most carcasses were found between August 18 and September 30 (92.5 percent). Eastern red bats were most numerous, accounting for

42.1 percent of all carcasses, with hoary bats (18.5 percent), eastern pipistrelle (*Perimyotis subflavus*) (18.3 percent), little brown myotis (*Myotis lucifugus*) (12.6 percent), silver-haired bat (5.9 percent), long-eared bat (*Myotis evotis*) (1.3 percent), big brown bat (*Eptesicus fuscus*) (0.4 percent), and unidentified bats (0.8 percent) accounting for the remainder (Kerns and Kerlinger 2004). Between July 13 and September 13, 2004, it was estimated that from 1,364 to 1,980 bats were killed at the facility. During this same period, 400 to 920 bats were killed by the 20 turbines at the Meyersdale facility in Pennsylvania (Arnett et al. 2005).

Bat fatalities at a three-turbine wind energy facility on Buffalo Mountain in Tennessee have been studied over a period of 3 years. During this period, 119 dead bats were documented. Species composition was similar to the Mountaineer site, although no little brown myotis fatalities were found. The fatalities consisted of eastern red bat (61 percent), eastern pipistrelle (24 percent), hoary bat (10 percent), silver-haired bat (2 percent), big brown bat (2 percent), and Seminole bat (*Lasiurus seminolus*) (1 percent) (Johnson and Strickland 2004). The bat mortality rate at the Buffalo Mountain Windfarm in eastern Tennessee was 20.8 bats per turbine per year, or 31.5 bats per megawatt per year, for a total of 62.5 bats fatalities per year. About 70 percent of bat fatalities occurred between August 1 and September 15 (Nicholson et al. 2005). It has been suggested that the bats may be using the long ridgelines in the Alleghenies as migration corridors. Data from the Mountaineer Wind Energy Center support the theory that migrating bats are at most risk of turbine collision and that resident breeding or foraging bats have a low risk of collision mortality (Erickson et al. 2002; Johnson and Strickland 2004).

Generally, bat fatality rates are much lower than observed at the Mountaineer and Buffalo Mountain sites. Johnson and Strickland (2004) summarized bat fatality studies for several other eastern U.S. wind facilities. No bat fatalities were found at a seven-turbine facility near Madison, New York, or at a two-turbine site located near Copenhagen, New York; at an eight-turbine facility in Pennsylvania, only one little brown myotis fatality was found during a 1-year post-construction mortality survey. These three sites were located in farmland habitat. Similarly, no bat fatalities were observed at an eight-turbine facility near Princeton, Massachusetts, or at an 11-turbine facility near Searsburg, Vermont. Both of these facilities were located in forested areas.

From 1996 to 1999, 184 bat fatalities were documented at the Buffalo Ridge wind energy project in Minnesota, where 354 wind turbines were in operation (Johnson et al. 2003). The number of yearly bat fatalities per turbine ranged between 0.26 at the Phase 1 wind plant to 2.04 at the Phase 3 wind plant. For all three wind plants combined, it was estimated that 541 bat collision fatalities occurred each year for an average fatality rate of 1.53 bats per turbine (Johnson et al. 2003).

Biotic factors that may contribute to bat mortality at wind energy facilities include flight behavior, migration patterns, and aggregation of insect prey (Fiedler et al. 2007). Long et al. (2011) observed that common turbine colors (white and light grey) are among the colors that attract significantly more insects, which suggests that turbine color may be a contributing factor in bat and avian collisions. Arnett et al. (2008) identified five key patterns associated with bat fatalities at wind facilities:

1. Fatalities skewed toward migratory species, and were dominated by tree-dwelling vesper bats of the genus *Lasiurus*;

2. Peak fatalities occur in midsummer through fall;

3. Fatalities have not been concentrated at individual turbines and do not show a consistent relationship to habitat;

4. Red strobe lights, suggested by FAA, did not influence bat fatalities; and

5. Fatalities were higher during periods of low wind speed and related to passage of storm fronts.

The prevalence of migratory tree bats observed as fatalities may be related to their behavior of aggregating at tall and highly visible landscape structures, which until recently only consisted of the crowns of trees (Cryan and Brown 2007). Horn et al. (2008) observed bats actively foraging near turbines rather than simply passing through a wind facility. They observed bats approaching both rotating and stationary blades, following or becoming trapped by blade-tip vortices, investigating the various parts of the turbine with repeated flybys, and being struck directly by blades. Blade rotation speed was a significant negative predictor of bat collisions, suggesting that bats may be at more risk on nights with low wind speed (Horn et al. 2008).

Ultrasound emissions do not likely play a significant role in attracting bats (Szewczak and Arnett 2006). Fatalities increased with decreased distance to wetlands (Johnson et al. 2000a), and fatalities increased exponentially with turbine height (Barclay et al. 2007). Cryan (2008) hypothesized that tree bats collided with turbines while engaging in mating behaviors that center on the tallest trees in a landscape (i.e., the bats viewed turbines as tall trees). Bat lekking around turbines would likely include aerial courtship displays. Potential roost attraction, movement or sound attraction, or availability of prey may explain fatalities for species such as the big brown bat and little brown myotis (Kunz et al. 2007b).

Baerwald et al. (2008) found that 90 percent of bat fatalities involved internal hemorrhaging consistent with barotrauma, and that direct contact with turbine blades only accounted for about half of the bat fatalities. Barotrauma is caused by a rapid air pressure reduction near moving turbine blades (Baerwald et al. 2008). It causes tissue damage to air-containing structures due to rapid or excessive pressure change. Pulmonary barotrauma is lung damage due to expansion of air in the lungs that is not accompanied by exhalation. Birds are less susceptible to barotrauma than mammals, so this may account for fewer bird than bat mortalities at some wind energy facilities (e.g., bats have large pliable lungs that expand when exposed to a sudden air pressure drop, whereas birds have compact, rigid lungs that do not expand) (Baerwald et al. 2008). Recently, Rollins (2011) concluded that barotrauma contributes no more than 6 percent of bat mortalities at wind farms, and that collisions are likely the dominant cause of death.

High fatality rates of bats in the eastern States have the potential for population-level effects because bats tend to be long-lived species with generally low reproductive rates (Lilley and Firestone 2008). Because long-term studies on bats have not been conducted, it cannot be assumed that population declines are not occurring at sites where bat collisions routinely occur (Kuvlesky et al. 2007). The effect on migrant bat populations from sustained collision mortality over an extended period of years is not known (Erickson et al. 2002). If the species that were killed were uncommon, impacts could result in population-level effects, while impacts from killing small numbers of common bat species would not be expected to result in population-level effects. Cumulative losses of large numbers of bats due to collisions with turbines may be a serious effect on regional populations of hoary and silver-haired bats if the level of mortality continues (Brown and Hamilton 2006).

Decommissioning. Impacts on wildlife from decommissioning activities would be similar to those from construction, but they could be more limited in scale and shorter in duration. This would depend, in part, on whether decommissioning would involve full removal of facilities, partial removal of key components, or abandonment. For example, leaving buried components in place would reduce the amount of trenching and soil disturbance required and contribute to reduced impacts relative to those that would occur during construction.

Decommissioning activities could affect wildlife by altering existing habitat characteristics and the species supported by those habitats. These activities would vary among locations, depending on the extent of infrastructure that would need to be removed, projected future land use, and the amount of site restoration (e.g., type of revegetation) required. Decommissioning activities that could affect wildlife include (1) dismantling of structures, (2) generation of waste materials, (3) recontouring of project areas, (4) revegetation activities, and (5) accidental releases (spills) of potentially hazardous materials.

During decommissioning activities, localized obstructions of wildlife movement could occur in the areas where the wind energy facilities were being dismantled. There would also be an increase in noise and visual disturbance associated with removal of project facilities and site restoration. Increased traffic levels during decommissioning would result in increased mortality of wildlife from vehicle collisions, but injury and mortality rates of wildlife would probably be lower than they would be during construction.

Most wildlife would avoid areas while decommissioning activities were taking place. Avoidance would be a short-term impact. However, animal feeding and nuisance animal issues might become problematic because of the increased number of workers who might have a shorter-term view of the consequences of their actions. Problematic animals (e.g., bears) might have to be deliberately displaced to protect lives and property, either through harassment or live-trapping and releasing.

Other potential environmental concerns resulting from decommissioning would include the disposal of solid wastes and hazardous materials and the remediation of any contaminated soils. Some fuel and chemical spills could also occur, but these would be generally confined to access roads and project site areas. The probability that wildlife would be exposed to such spills would be small and limited to a few individuals. After decommissioning activities were complete, there would be no fuel or chemical spills associated with the utility-scale wind energy facility.

Removal of aboveground facilities would reduce potential nesting, perching, and resting habitats for several bird species, particularly raptors and common ravens. However, this could benefit species such as small mammals and greater sage-grouse that are preyed upon by those species. Removal of aboveground facilities would also reduce bird and bat collisions. In addition, the removal of aboveground facilities would ensure free passage of wildlife. The revegetation of decommissioned wind energy facilities could increase wildlife habitat diversity, since control of vegetation (including cutting of woody vegetation) would cease, allowing native shrubs and trees to grow and increase in density. As disturbed areas became vegetated, any impacts from fragmentation that existed during the lifetime of the project would diminish. Habitats that had been avoided by wildlife because of the proximity of facilities and humans would become reinhabited. The potential for such increases in habitat diversity would primarily depend upon subsequent use of the project area.

Following decommissioning activities (e.g., removal of aboveground structures), and depending on land ownership, the recreational use of ROWs (e.g., as a travel corridor by OHVs) might increase, which could lead to increased wildlife disturbance and mortality. However, removal of aboveground facilities would reduce the potential for bird collisions.

How soon wildlife resources in the wind energy facility site area could return to pre-project conditions would partly depend on the habitat and vegetation conditions that existed prior to construction. In the extreme, natural recovery to predisturbance plant cover and biomass in desert ecosystems may take 50 to 300 years, with complete ecosystem recovery potentially requiring more than 3,000 years (Lovich and Bainbridge 1999). In the long-term, decommissioning and reclamation would increase species diversity and habitat quality within the project area.

Summary of Impacts on Wildlife. Overall, impacts from site characterization, construction, operation and maintenance, and decommissioning of a wind energy project on wildlife populations would depend on the following:

- The type and amount of wildlife habitat disturbed,
- The nature of the disturbance (e.g., long-term reduction because of project structure and access road placement; complete, long-term alteration due to transmission line placement; or temporary disturbance within construction staging areas),
- The wildlife that occupied the facility site and surrounding areas, and
- The timing of construction activities relative to the crucial life stages of wildlife (e.g., breeding season).

Generally, impacts on most wildlife species would be proportional to the amount of specific habitats directly and indirectly disturbed. Habitat displacement and fragmentation would be of potential significance to a wide array of wildlife. In addition, wildlife habitat could be adversely affected by erosion, sedimentation, water quality degradation, and shadowing (Illinois DNR 2007).

Much public attention has focused on fatalities of birds and bats at wind facilities. Based on estimates provided by the U.S. Department of Energy (NREL 2011a), the installed wind power capacity (as of June 30, 2011) for the States that encompass the UGP Region is as follows:

- Iowa—3,675 MW,
- Minnesota—2,518 MW,
- Montana—386 MW,
- Nebraska—294 MW,
- North Dakota—1,424 MW, and
- South Dakota—784 MW.

Using estimates of 3.04 bird fatalities per megawatt per year in the United States (Erickson et al. 2003b) and 0.2 to 8.7 bat fatalities per megawatt per year in the Midwest (Arnett et al. 2007; Illinois DNR 2007), it is estimated that fatality rates within the six States that include the UGP Region would be approximately 27,606 birds and 1,816 to 79,005 bats per year. Although wind turbines are estimated to account for less than 0.01 percent of anthropogenically caused avian fatalities, it has been suggested that in certain areas wind facilities could be acting as population sinks for some species (Edkins 2008).

It is predicted that the installed wind energy capacity within the United States by 2020 will be 72,000 MW (Kunz et al. 2007a), and possibly as high as 300,000 MW by 2030 (Edkins 2008). Absent any new bird or bat avoidance technologies, this could result in annual nationwide fatalities of nearly 220,000 birds by 2020 and more than 900,000 birds by 2030. Bat fatalities would be nearly three times as high.

5.6.1.3 Aquatic Biota and Habitats

The development of wind energy projects within the UGP Region could impact aquatic biota and their habitats. Potential impacts would be associated with site characterization, facility construction, operations, and decommissioning. The nature and magnitude of impacts would be directly related to the amount of land disturbance, the duration and timing of project-related activities (such as access road construction and use), the types of aquatic biota and habitats in the project area, and the project infrastructure (number and type of facilities). The use of appropriate BMPs and mitigation measures (see section 5.6.2) would minimize potential impacts on aquatic biota and their habitats.

Impacts of wind energy project development to aquatic biota and habitats could result from the following:

- Habitat destruction or degradation from site clearing and grading and associated alteration in topography and hydrology, the placement and construction of project infrastructure within a surface water body, and accidental releases of hazardous materials such as fuels.
- Interference with the movement of aquatic biota in streams to seasonal habitats (e.g., spawning areas, nursery habitats).

- Direct injury or mortality of aquatic biota at stream crossings and in habitats where project infrastructure construction is occurring.

- Disturbance of aquatic biota during construction, operation, and decommissioning activities in areas adjacent to aquatic habitats.

Aquatic biota and habitats may also be affected by human activities that are not directly associated with a wind energy project or its workforce, but that are instead associated with the potential increase in access via project-related access roads and electricity transmission ROWs by the public to aquatic habitats (such as remote stream reaches) that are currently difficult to access.

Site Characterization. The impacts of site characterization activities to aquatic biota and habitats will depend on the location of a proposed wind energy project and especially on the number and location of the meteorological towers that would be erected at the site. Monitoring facilities (e.g., meteorological towers) and most of the associated characterization activities would be located in upland areas and not within aquatic habitats. Characterization activities such as floodplain mapping involve no site disturbance, and are therefore unlikely to affect aquatic biota or habitats. In such cases, direct impacts on aquatic habitats and biota would be negligible.

However, other characterization activities (such as the placement of meteorological towers) may involve site disturbance. If the area of disturbance is located near a surface water body, aquatic biota and habitats within the surface water could be affected. Ground disturbance may increase soil erosion and runoff that could lead to increases in sedimentation and turbidity in downgradient surface water habitats (table 5.6-9). Increased turbidity may affect foraging and predator avoidance, reduce oxygen content of the water, interfere with photosynthesis of algae, and interfere with gill function in some invertebrates and fish. Increased sedimentation may foul eggs and smother larvae of invertebrates and fish and alter sediment characteristics. In the absence of appropriate BMPs and mitigation measures, affected biota and habitats could experience some minor impacts. Because site characterization activities may be expected to be limited in spatial extent and duration, any minor impacts would likely be restricted to relatively small and localized locations and affect relatively few aquatic biota.

Construction. Wind farm construction activities that could affect aquatic biota and habitats include site clearing and grading; constructing laydown areas and an on-site road system; excavating and installing turbine and transmission tower foundations; installing permanent meteorological towers (as necessary); constructing the central control building and other required infrastructure (such as substations and switchyards); and installing power-conducting cables and signal cables (which are typically buried) (section 3.1.2). Many of these activities require the use of heavy equipment and a sizable workforce, and complete project construction could take several years. These construction activities could result in (1) the injury or mortality of aquatic biota; (2) the disturbance or elimination of aquatic habitats; (3) the disruption of important behaviors such as spawning movements; and (4) the accidental exposure of biota to hazardous materials such as fuel (table 5.6-10).

TABLE 5.6-9 Potential Impacts on Aquatic Biota and Habitats from Characterization Activities for Wind Energy Projects

Project Activity	Potential Effect	Potential Extent and Duration of Effects
Vehicle traffic; access road development; meteorological tower placement	Habitat disturbance from soil erosion and runoff, which in turn could increase turbidity and sedimentation; injury or mortality of aquatic biota; interference with downstream movement of fish	Localized; short term
Vehicle and foot traffic crossing streams	Habitat disturbance from soil erosion and runoff, which in turn could increase turbidity and sedimentation; injury or mortality of aquatic biota	Localized, limited to small streams; long term and short term
Water withdrawal from streams during construction	Entrainment/impingement of aquatic species; reduced flow available for aquatics	Localized; short term

During project development, construction equipment activity and worker foot traffic in or through aquatic habitats could injure or kill aquatic organisms or disturb aquatic habitats that may be present within and in the vicinity of infrastructure construction footprints. The draining and filling of aquatic habitats during infrastructure construction would also result in disturbance or loss of aquatic habitats or organisms. For many projects, however, such impacts could be minimized by restricting placement of project infrastructure to upland areas; siting permit requirements (e.g., Clean Water Act permits) would also restrict placement of infrastructure to areas away from aquatic habitats.

Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most populations of aquatic organisms have adapted to short-term changes in these parameters. This is especially true for aquatic biota of the Upper Missouri River Hydrologic Region, where many of the streams exhibit naturally high turbidity and sediment loads. However, if sediment loads are unusually high or last for extended periods of time compared with natural conditions for a given water body, adverse impacts could occur. Increased sediment loads could suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry. In addition, some migratory fishes may avoid streams that contain excessive levels of suspended sediments.

The potential for soil erosion and sediment loading of aquatic habitats is proportional to the amount of surface soil disturbance, the timing and duration during which soils may be exposed to erosional conditions (e.g., heavy rain, high wind), the topography of disturbed areas at any given time, and the proximity of the disturbed soil areas to aquatic habitats. Removal of riparian vegetation would also result in greater levels of sediment entering the aquatic habitat with which the vegetation is associated. It is anticipated that upland areas that are cleared and

TABLE 5.6-10 Potential Effects of Wind Energy Project Construction and Non-Project-Related Activities on Aquatic Biota and Habitats Occurring in the UGP Region

Activity	Potential Effect	Potential Extent and Duration of Effects	Potentially Affected Biota[a]	
			Invertebrates	Fish
Wind Energy Project Construction				
Site clearing and grading, infrastructure construction, and vehicle and foot traffic occurring in aquatic habitats	Injury or mortality of aquatic biota	Localized within construction footprints that include aquatic habitats and along access roads that cross aquatic habitats; short term	+	+
Site clearing and grading, infrastructure construction, and vehicle and foot traffic occurring in aquatic habitats	Disturbance or loss of aquatic habitats	Localized within construction footprints of turbines, support facilities, transmission towers, and access roads that occur within aquatic habitats; long term within infrastructure footprint	+	+
Site clearing, grading, and infrastructure construction	Reduced water quality due to erosion and runoff that result in increased turbidity and sedimentation of downgradient surface waters	Localized to aquatic habitats downgradient of upland construction sites or downstream of aquatic construction sites; short term following revegetation of construction areas	+	+
Site clearing, grading, and infrastructure construction, especially construction and use of stream crossings	Interference with instream movement of fish from increased turbidity and sedimentation, or by the use of stream-crossing structures that physically block fish passage	Localized to stream reaches associated with instream infrastructure construction and access road stream crossings; short term if related to erosion and runoff, or possibly long term if related to stream-crossing structure	–	+
Vegetation removal within construction footprints, access roads, and transmission lines	Increased stream temperatures as a result of the removal of the vegetative canopy over a stream channel	Localized to infrastructure footprints and access road and transmission line ROW crossings of small forested streams; short or long term, depending on riparian restoration plans	+	+

TABLE 5.6-10 (Cont.)

Activity	Potential Effect	Potential Extent and Duration of Effects	Potentially Affected Biota[a]	
			Invertebrates	Fish
Accidental spill during equipment refueling; accidental release of stored fuel or regulated or hazardous materials	Sublethal and lethal toxic effects from exposure to accidental releases of project-related materials (e.g., fuels, lubricating oils, paints)	Localized but may extend downstream; acute short-term or chronic long-term effects, depending on the toxicity of the materials released and the species exposed	+	+
Non-Project-Related Human Activities				
Access to aquatic habitats along access roads and transmission ROWs by unauthorized visitors	Injury or mortality of aquatic biota and/or disturbance or loss of aquatic habitats from increased off-road vehicle and foot-traffic stream crossings	Localized; short or long term, depending on species affected	+	+
Access to aquatic habitats along access roads and transmission ROWs by unauthorized visitors	Legal and illegal take of aquatic biota, especially game fish	Localized; short or long term, depending on species affected	+	+
Access to aquatic habitats along access roads and transmission ROWs by unauthorized visitors, specifically for fishing	Introduction of non-native fish species (used as bait), which may outcompete native fish species or serve as predators of fish and other aquatic biota	Localized or greater, and short-or long term, depending on ability of released species to survive, reproduce, and disperse from the release location	+	+

[a] "+" indicates some biota may be affected; "–" indicates biota not expected to be affected.

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graded during project construction would have a higher erosion potential than undisturbed areas, primarily due to the removal of soil-stabilizing vegetation. Increased soil erosion and subsequent runoff to aquatic habitats could also occur along project-related access roads and transmission lines. Implementation of measures to control erosion and runoff into aquatic habitats (e.g., silt fences, retention ponds, runoff-control structures, and earthen berms) would reduce the potential for impacts from increased turbidity and sedimentation.

The level of effects from increased sediment loads depends on the natural condition of the receiving waters and the timing of sediment inputs. Whereas most aquatic systems might be expected to be affected by large increases in levels of suspended and deposited sediments, aquatic habitats and biota in waters that are normally turbid (such as the main channel of the Missouri River, the Minnesota River, and the Platte River [Galat et al. 2005]) may be less sensitive to small to moderate increases in suspended sediment loads than habitats that normally have clear waters (such as small headwater streams). Similarly, increased sedimentation during periods of the year in which sediment levels might naturally be elevated (e.g., during spring snowmelt or following large rain events) may have smaller impacts compared with sediment impacts that occur during periods in which natural sediment levels would be expected to be lower.

The direction and magnitude of surface water runoff are controlled, in part, by local topography and vegetation cover. As a consequence, construction activities that affect the terrain and vegetation could alter the surface runoff patterns. Impacts on aquatic ecosystems could result if construction activities affect the amount, timing, or flashiness of runoff entering a particular water body. Generally, surface runoff to nearby aquatic habitats may be reduced or controlled through appropriate project design and the use of BMPs and mitigation measures. For example, increased surface runoff may be minimized or avoided by ensuring that the overall grade of a construction site remains as similar to the natural grade of the site as practicable, and by maintaining a relatively unaltered vegetation buffer along the margins of water bodies.

The removal of riparian vegetation (especially taller trees) during site clearing could affect the temperature regime in aquatic systems by altering the amount of solar radiation that reaches the water surface. This thermal effect would be most pronounced in small stream habitats where a substantial portion of the stream channel may be shaded by vegetation. In addition, as water temperature increases, dissolved oxygen levels generally decrease. Changes in temperature and oxygen regimes of aquatic habitats could affect the ability of some species to survive within the affected areas, especially during periods of elevated temperatures. Fish exposed to stressful temperatures (or low oxygen levels) generally move until acceptable conditions are encountered (Coutant 1987; Kramer 1987; Ostrand and Wilde 2001). If thermal refuge is unavailable, fish exposed to excessive temperatures may die (Mundahl 1990). As long as the proportion of a water body's riparian area affected by vegetation clearing is not excessive, fish will likely be able to find temporary refuge in nearby areas. In contrast, less mobile biota such as mollusks would not be able to move to more suitable habitats, and thus could incur reduced survival. The level of thermal impact associated with the clearing of riparian vegetation during project construction would be expected to increase as the amount of affected shoreline increases. The potential for altering the thermal and dissolved oxygen characteristics of aquatic habitats could be minimized or avoided by limiting, to the extent practicable, the clearing of riparian vegetation and by the restoration of areas of disturbed vegetation following completion of construction activities.

During project construction, the accidental release of regulated or hazardous chemicals such as fuel for construction equipment could affect aquatic biota and their habitats in water bodies receiving such a release. The nature and magnitude of possible effects would depend on the type and volume of chemicals released, the location of the release, the nature of the receiving water body (e.g., size, volume, and flow rates), and the types and life stages of aquatic biota present in the receiving waterway. In general, regulated or hazardous chemicals associated with construction equipment (e.g., fuels) would not be expected to enter waterways in appreciable quantities as long as the equipment is not used in or near waterways, the fueling locations for construction equipment are situated away from the waterway, and measures are taken to minimize and control spills that may occur. In addition, the amount of regulated or hazardous materials that may be present at any construction location (such as a turbine or electric transmission tower location) would likely be relatively low, and there would be no long-term storage of fuels or other materials at construction locations. Any short-term storage of such materials would be carried out in accordance with label instructions and in compliance with any applicable hazardous material requirements.

In areas where access roads would cross streams, obstructions to fish movement could occur if culverts or low-water crossings are not properly installed, sized, or maintained to support fish passage. During periods of low water, vehicular traffic could result in rutting and accumulation of cobbles in some crossings that could interfere with fish movements. Restrictions of fish movement would be most significant if they occur in streams that support species whose adults need to move to specific areas to reproduce or where larvae and juveniles need to travel downstream to nursery habitats, or in smaller streams where aquatic organisms may need to move to avoid desiccation or heat stress during low-flow periods (Mundahl 1990). Appropriate design of stream crossings could avoid or minimize the potential for impacts on fish passage.

In addition to the potential construction-related impacts identified above, aquatic resources in the vicinity of wind energy projects could be affected as a result of increased public access (authorized or not) to remote areas via newly constructed access roads and transmission lines ROWs. Fisheries could be affected by increased fishing pressure, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion and sediment-related impacts on water bodies, as discussed above. Such impacts would be smaller in locations where access roads or utility corridors already exist.

Aquatic biota and habitats most likely to be affected during project construction are those associated with smaller water bodies, especially small streams. Such habitats would be most likely to be crossed with some regularity by construction vehicles. In addition, impacts from soil erosion and accidental releases of regulated or hazardous materials may be expected to be greatest in smaller water bodies that exhibit generally low volumes and flow. Impacts on aquatic biota and habitats from the accidental release of regulated or hazardous materials may be moderate in nature. Rapid response to any such release may result in impacts being largely localized to the immediate vicinity of the release, especially if the affected water body is small and has little or no flow.

Operations and Maintenance. During the operation and maintenance of a utility-scale wind energy facility, aquatic habitats and biota could be affected by the following: (1) site maintenance activities that involve mowing or cutting of wetland or riparian vegetation; (2) accidental releases of regulated or hazardous materials (such as fuel, lubricating oils, paints, and pesticides); (3) stream crossings by maintenance and worker transport vehicles; (4) soil erosion and runoff from project facilities and access roads; and (5) increased access to aquatic habitats by non-project personnel (table 5.6-11).

During normal operations, some level of vegetation mowing or cutting (e.g., regularly around turbines and support buildings and every 3 years or more within the transmission line ROW) would be required. For example, selected trees might be removed or trimmed, if they are considered likely to pose a risk to the transmission system. During project construction, the temperature and oxygen regimes of some water bodies could be affected by the removal of riparian vegetation. The temperature and oxygen regimes of the water bodies affected during construction would continue to be affected by the maintenance of riparian vegetation associated with project infrastructure. The use of motorized equipment (e.g., mowers) for the management of riparian vegetation could also result in the erosion and runoff of surface soils from the managed areas. Because complete removal of the vegetative cover would not be expected to be part of normal vegetation management, the level of erosion and runoff may be expected to be small. Potential impacts on aquatic biota from vegetation management activities could be minimized or avoided by limiting the nature and magnitude of maintenance activities occurring in areas of riparian vegetation. For example, vegetation clearing using hand tools rather than motorized vehicles could greatly reduce the potential of soil disturbance, erosion, and runoff.

Vegetation and pest management at turbines and support buildings, and possibly along access roads and transmission line ROWs, could involve the use of herbicides and pesticides. An accidental release of such regulated materials reaching a nearby waterway could affect aquatic biota and habitats. Similarly, accidental spills of fuel or oil could occur during the use of maintenance vehicles (e.g., mowing equipment, trucks). Because the amounts of most fuels and other regulated or hazardous materials on-site are expected to be small, an uncontained spill would probably be relatively small and affect only a limited area. The magnitude of any impacts on aquatic biota and habitats would depend on the size and nature of the accidental release, the exposed biota and habitats, and the sensitivity of the biota to the released materials. In general, lubricants and fuel would not be expected to enter waterways as long as maintenance equipment is not used near waterways, fueling locations for maintenance equipment are situated away from waterways, and measures are taken to control potential spills. Mitigation measures for maintenance of transmission line corridors generally restrict the use of machinery near waterways. Similarly, the application methods, quantities, and types of herbicides that are used in the vicinity of waterways are restricted in order to limit the potential for impacts on aquatic ecosystems. Development and implementation of spill prevention and response plans would further minimize the likelihood and magnitude of an accidental release.

Increased public access (authorized or not) along project access roads and transmission line ROWs could affect aquatic biota in nearby habitats. Potential impacts from increased public access may include the disturbance or loss of aquatic biota and habitats by vehicle and foot traffic, the introduction of non-native fish, and the illegal take of fish or other aquatic biota (table 5.6-11).

The aquatic biota and habitats most likely to be affected during normal operations and maintenance activities are those associated with smaller water bodies (small streams and individual potholes) crossed by access roads and transmission line ROWs. These habitats would have the greatest potential to be regularly crossed by maintenance vehicles and affected by ROW vegetation management activities. As noted earlier for construction impacts, accidental releases of regulated or hazardous materials would likely have the greatest effect on

TABLE 5.6-11 Potential Effects of Wind Energy Operation and Non-Project-Related Human Activities on Aquatic Biota and Habitats Occurring in the UGP Region

			Potentially Affected Biota[a]	
Activity	Potential Effect	Potential Extent and Duration of Effects	Invertebrates	Fish
Wind Energy Operation				
Daily human and vehicle activity	Injury or mortality of aquatic biota and/or disturbance or loss of aquatic habitats from foot and vehicle traffic along access roads	Localized to specific stream crossings; short term	+	+
Accidental fuel spills from maintenance vehicles or during refueling; accidental pesticide spill during pest and vegetation management; accidental release of stored fuel or regulated or hazardous materials (such as herbicides or pesticides)	Sublethal and lethal toxic effects from exposure to accidental releases of project related regulated or hazardous materials	Localized, short or long term, depending on species affected; small to large magnitude, depending on size and duration of the release and the species affected	+	+
Non-Project-Related Human Activities				
Access to surrounding areas along access roads and transmission ROWs by unauthorized visitors	Injury or mortality of aquatic biota and/or disturbance or loss of aquatic habitats from increased off-road vehicle and foot traffic stream crossings	Localized; short or long term, depending on species affected; small to large magnitude, depending on species affected	+	+
Access to aquatic habitats along access roads and transmission ROWs by unauthorized visitors, specifically for fishing	Introduction of non-native species (used as bait or transported on equipment), which may outcompete native fish species or serve as predators of fish and other aquatic biota	Localized or greater, and short or long term, depending on the ability of released species to survive, reproduce, and disperse from the release location	+	+

[a] "+" indicates some biota may be affected.

aquatic biota and habitats in smaller water bodies rather than in large rivers, reservoirs, and lakes.

Decommissioning. Impacts on aquatic biota and habitats during decommissioning should be similar in nature to, and not greater in magnitude than, impacts that may have been incurred during construction. Aquatic habitats and biota that would likely be affected by project decommissioning would be the same as those affected by project construction, operation, and maintenance. Similarly, many of the potential impacts of decommissioning to aquatic habitats and biota would be similar to impacts associated with project construction. The magnitude and extent of potential decommissioning impacts would depend, in part, on whether decommissioning would involve full removal, partial removal, or abandonment of project infrastructure. For example, leaving buried components in place would reduce the amount of trenching and soil disturbance required and would, therefore, result in a lower potential for sediments being introduced into nearby aquatic habitats by erosion and runoff from the decommissioning site.

During decommissioning, aquatic habitats and biota could be affected by (1) erosion and runoff from project locations where excavation activities are occurring, (2) vehicle and foot traffic through aquatic habitats, and (3) accidental releases of regulated or hazardous materials such as fuels. As with project construction, aquatic habitats and biota could be affected during the removal of project infrastructure, especially if the removal activities that involve excavation, trenching, or other soil-disturbing activities that could result in soil erosion and runoff into nearby aquatic habitats. In addition, decommissioning vehicle and foot traffic through aquatic habitats along access roads and transmission line ROWs could disturb aquatic habitats and injure or kill aquatic biota in those habitats. Accidental releases of regulated or hazardous materials such as fuels and hydraulic fluids could affect aquatic habitats and biota in nearby water bodies. As previously discussed, the nature and magnitude of effects would depend on the volume of the accidental release, the size of the receiving water body, and the habitats and biota exposed to the release.

Whether aquatic habitats would recover from impacts following decommissioning and how long such recovery would take would depend on the type and magnitude of potential impacts and on the ability of affected populations of organisms to become reestablished in restored areas. Decommissioning activities would generally impact habitat previously disturbed by initial project construction. Depending on the time since initial construction was completed, the type of construction activities that occurred, and the type of aquatic habitat present, the aquatic communities present at the time of decommissioning may closely resemble nearby undisturbed areas. Some aquatic habitats would again recover from the disturbance associated with decommissioning after a period of time. Recovery time could range from months to many years, depending on the nature of the disturbance and the type of aquatic habitats present. Within some ROWs, permanent differences between aquatic communities in disturbed areas and nearby undisturbed areas may remain.

Recreational use of some portions of the decommissioned project (e.g., OHV use of former access roads and transmission line ROWs) might also increase after aboveground structures were removed, which could lead to increased pressure on adjacent fishery resources. However, it is anticipated that the resulting impacts would be minor. In contrast, the potential introduction of non-native fish (used as live bait) through increased recreational fishing could result in population-level effects in some areas.

Summary of Impacts on Aquatic Biota and Habitats. Overall, in the absence of mitigation, impacts from site characterization, construction, operations and maintenance, and decommissioning activities for a wind energy project on aquatic biota and habitats would depend on the following:

- The water bodies that would be disturbed during each of the project development phases (e.g., large water bodies with large volumes and/or flows; small water bodies with low volumes and limited flows);

- The specific aquatic biota (e.g., mobile or sedentary biota) using the water bodies that would be affected under each phase of project development; and

- The nature of the disturbance (e.g., site clearing and grading; accidental releases of regulated or hazardous materials).

Generally, impacts on most aquatic biota would be proportional to the amount of specific habitats disturbed by each phase of a wind energy project. Short- and long-term habitat loss could occur as a result of site clearing and grading and infrastructure placement. Short- and long-term reductions in habitat quality could occur as a result of vegetation management activities and accidental releases of regulated or hazardous materials. In general, the siting of project infrastructure would be such that water bodies would be avoided to the maximum extent possible, and possible impacts on aquatic biota and habitats would come from construction activities occurring in areas near aquatic habitats rather than directly in them. Overall, impacts on aquatic biota and habitats from project development may be expected to range from largely negligible for site characterization activities to minor or moderate for project construction, operation, and decommissioning. In general, impacts may be expected to be largely localized and not affect the viability of affected resources, especially with the use of BMPs and mitigation measures to address specific types of possible impacts.

5.6.1.4 Threatened, Endangered, and Special Status Species

Impacts on threatened, endangered, and special status species (i.e., State-listed species or species of concern) that could result from wind energy project development within the UGP Region would be associated with site evaluation, facility construction, operations, and decommissioning. The nature of any such impacts would be similar for all of the alternatives (including the no action alternative) evaluated in this EIS. The potential impacts would be directly related to the amount of land disturbance, the duration and timing of the periods of construction and operation, the types of habitats affected by development, the amount and type of infrastructure present, and the occurrence and use of those areas by threatened, endangered, and other special status species. Indirect effects, such as those resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species, are also possible, but their magnitude is considered proportional to the amount of land disturbance.

Impacts on threatened, endangered, and special status species from wind energy development are fundamentally similar to, or the same as, those described for impacts on more common and widespread plant communities and habitats, wildlife, and aquatic resources (see sections 5.6.1.1, 5.6.1.2, and 5.6.1.3). However, because of their low populations, listed species are far more sensitive to impacts than more common and widespread species. Low population size makes these species more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Although listed species often reside in unique and potentially avoidable habitats, the loss of even a single individual of a listed species could result in a much greater impact on the population of the affected species than would the loss of an individual of a more common species.

Specific impacts from wind energy development would depend on the locations of projects relative to species populations, and the details of project development. In the absence of siting considerations (e.g., avoidance of areas where such species are known to be present) and appropriate mitigation, impacts on threatened, endangered, and special status species could result from the following:

- Habitat destruction or degradation resulting from vegetation clearing, construction of wind energy facilities and associated infrastructure, alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, fugitive dust, sedimentation of adjacent habitats, oil or other contaminant spills, and the spread of invasive plant species.

- Habitat and population fragmentation resulting from the development of wind energy projects and supporting electricity transmission infrastructure through intact habitat patches and populations, inhibiting or preventing the free movement of organisms within the entire population area.

- Injury or mortality of individuals from collisions with project infrastructure (e.g., turbines and transmission lines).

- Disturbance of animals resulting from noise and human activities during clearing, construction, operations, and decommissioning. Disturbance during the breeding season generally would have the largest adverse effects and could result in animals abandoning traditional breeding grounds and nest sites.

- Increases in human access (including ATV use) and subsequent disturbance or mortality resulting from project-related access roads and electricity transmission ROWs through otherwise intact and/or difficult-to-reach habitats.

- Localized increases in predator populations (and subsequent increased mortality of vulnerable listed species) resulting from increased access afforded by project-related ROWs and access roads, attraction to project infrastructure for nesting or breeding sites, and attraction to human-occupied sites.

- Aquatic species could be affected by increases in water temperature in areas crossed by project-related transmission lines and access roads resulting from the removal of riparian vegetation that would otherwise shade surface water. The removal of terrestrial vegetation (especially riparian vegetation) is also likely to result in increased soil erosion and runoff, reducing habitat quality for aquatic species.

- Aquatic species could be entrained or impinged at water intakes during water withdrawals from streams for dust abatement or other construction purposes. Available flows for aquatic species could be reduced. If in-stream work is conducted in habitats known to be occupied or potentially occupied by listed aquatic species, take of federally listed species could occur during construction. Long-term impacts on habitat and actions affecting movements (e.g., blocked fish passage through culverts) could also occur.

Nineteen wind energy companies (the Wind Energy Whooping Crane Action Group known as "WEWAG"), convened and coordinated by the American Wind Energy Association, are developing the Great Plains Wind Energy Habitat Conservation Plan (GPWE HCP). WEWAG is collaborating with Region 2 (the Southwest) and Region 6 (Mountain-Prairie) of the Service, as well as each of the nine State wildlife agencies involved, in drafting the plan. The GPWE HCP covers a 200-mi-wide (320-km-wide) corridor across nine States: North Dakota, South Dakota, Montana, Colorado, Nebraska, Kansas, New Mexico, Oklahoma, and Texas. The goal of the GPWE HCP is to comprehensively address potential wind energy development impacts to listed or sensitive species, contributing to more effective conservation efforts and reducing the burden of permit processing on the Service and wind energy developers.

The GPWE HCP is currently analyzing the potential impacts resulting from the development and operation of wind energy facilities on four species: the endangered whooping crane, the endangered interior least tern, the endangered piping plover, and the lesser prairie-chicken (*Tympanuchus pallidicinctus*), a candidate species. The final list of covered species may include all four of these species, a subset of them, or additional species, based on the outcome of the impact assessment and planning process. Three of these species, the whooping crane, the interior least tern, and the piping plover, occur within the UGP Region and are considered in the PEIS. When completed, the GPWE HCP may provide additional information pertaining to potential impacts to populations of these species from development of wind energy projects and may also identify appropriate BMPs and mitigation measures, in addition to those identified in this PEIS. Additional information pertaining to the GPWE HCP is available at http://www.greatplainswindhcp.org/index.cfm.

Site Characterization. The impacts of site characterization to threatened, endangered, and special status species will depend on the location of a proposed wind energy project, and especially on the number and location of the meteorological towers that would be erected at the site. Characterization activities such as floodplain mapping involve no site disturbance, and are therefore unlikely to affect threatened, endangered, and special status species. However, other site characterization activities (such as meteorological tower placement) may involve site disturbance, and thus may affect listed plants and wildlife, if present. Potential effects of site characterization may include (1) habitat disturbance from vehicle traffic, soil sampling, tower placement, and access road development; (2) injury or mortality of biota from vehicle traffic, tower placement, soil sampling, and access road development; (3) the introduction of invasive vegetation by project vehicles; (4) and the disturbance of normal behaviors by vehicle traffic and human activity. Table 5.6-12 summarizes the nature, duration, and extent of these potential effects on threatened, endangered, and special status species.

Threatened, endangered, and special status species that have limited or no ability to leave an area where site characterization activities are occurring would be at greatest risk of being affected. Plants, arthropods, and reptiles, as well as the nests and young of some birds and mammals, could be injured by vehicle traffic, soil sampling, tower placement, and access road development. More mobile biota, such as adult birds and mammals, would likely leave the immediate vicinity of such activities. These biota could, however, experience disruption of normal behaviors. Because characterization activities would likely not be conducted in or immediately adjacent to surface waters such as rivers, few impacts are anticipated for listed mollusks and fish.

Because of the limited area in which site characterization activities would take place, the small amount of surface disturbance that might occur during site characterization, and the short time period during which soil sampling, tower placement, and vehicle traffic would occur, most impacts from site characterization activities would be localized and short term. However, the introduction, establishment, and spread of invasive vegetation could result in long-term impacts on native plant populations and wildlife habitats.

Construction. Wind farm construction would involve a number of major activities, including site clearing and grading; constructing laydown areas and an on-site road system; excavating and installing turbine and transmission tower foundations; erecting towers; installing nacelles and rotors; installing permanent meteorological towers (as necessary); constructing the central control building, electrical power conditioning facilities and substations, and other required infrastructure; and installing power-conducting cables and signal cables (typically buried) (section 3.1.2). Many of these activities require the use of heavy equipment and a sizable workforce. 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 over several years.

Threatened, endangered, and special status species could be affected during construction of project infrastructure (i.e., turbines, control buildings) and associated facilities (i.e., access roads, electricity transmission towers). Construction activities could result in (1) the direct injury or mortality of biota; (2) the modification, fragmentation, and loss of habitat; (3) disruption of normal behaviors, including migratory movements; (4) displacement from nearby habitats; (5) introduction of invasive vegetation; (6) erosion and runoff; (7) exposure to contaminants; and (8) exposure to fugitive dust (table 5.6-13).

The listed or special status species most likely to be affected during project construction would be those present within the project footprint that have little or no capacity to leave the construction area, such as plants and invertebrates. Larger, more mobile animals such as birds and medium-sized or large mammals would be most likely to avoid or leave the project area during site preparation and construction activities. If land clearing and construction activities occurred during the spring and summer, nests and young of more mobile biota in the project area could be destroyed.

TABLE 5.6-12 Potential Effects of Site Characterization Activities on Threatened, Endangered, and Special Status Species Occurring in the UGP Region

			Biota Potentially Affected[a]						
Potential Effect	Project Activity	Potential Extent and Duration of Effects	Plants	Arthropods	Mollusks	Fish	Reptiles	Birds	Mammals
Habitat disturbance	Vehicle traffic; meteorological tower placement; soil sampling; access road development	Localized; short term	+	+	–	–	+	+	+
Injury or mortality of biota	Vehicle traffic; meteorological tower placement; soil sampling; access road development	Localized; long and short term	+	+	-	–	+	+	+
Introduction of invasive plant species	Vehicle traffic; access road development	On- and off-site; long term, if established	+	+	–	–	+	+	+
Behavioral disturbance	Vehicle traffic; meteorological tower placement; soil sampling; access road development	Localized; short term	–	–	–	–	–	+	+

[a] "+" indicates effects expected for at least some biota; "–" indicates no biota expected to be affected.

TABLE 5.6-13 Potential Effects of Construction Activities on Threatened, Endangered, and Special Status Species Occurring in the UGP Region

			Biota Potentially Affected[a]						
Potential Effect	Project Activity	Potential Extent and Duration of Effects	Plants	Arthropods	Mollusks	Fish	Amphibians & Reptiles	Birds	Mammals
Direct injury or mortality of biota	Site clearing and grading; access road construction; vehicle and foot traffic	Localized; long term within construction footprints for turbines, support facilities, transmission towers, and access roads; short term in adjacent areas	+	+	+	+	+	+	+
Habitat disturbance, including loss or fragmentation	Site clearing and grading; access road construction	Localized; long term within construction footprints for turbines, support facilities, transmission towers, and access roads; short term in adjacent areas	+	+	+	+	+	+	+
Behavioral disturbance, including disruption of migratory movements and habitat avoidance	Site clearing and grading; turbine, tower, and access road construction; vehicle and foot traffic	Localized; long or short term	–	–	–	+	+	+	+
Introduction of invasive plant species	Site clearing and grading; access road construction	On- and off-site; long term if established in areas associated with infrastructure and access roads	+	+	+	+	+	+	+

TABLE 5.6-13 (Cont.)

			Biota Potentially Affected[a]						
Potential Effect	Project Activity	Potential Extent and Duration of Effects	Plants	Arthropods	Mollusks	Fish	Amphibians & Reptiles	Birds	Mammals
Erosion and runoff to local surface waters	Site clearing and grading; turbine, tower, and access road construction; vehicle and foot traffic	On- and off-site; short term	–	–	+	+	–	–	–
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or regulated or hazardous materials	Localized; short term	+	+	+	+	+	+	+
Fugitive dust damage to plant surfaces and impairment of photosynthesis; respiratory impairment in wildlife	Site clearing and grading; access road construction; turbine, tower, and access road construction	Localized; short term	+	+	–	–	+	+	+

[a] "+" indicates effects expected for at least some biota; "–" indicates no biota expected to be affected.

The species and populations that could be affected during project construction would depend on the location of the wind energy development, the distribution of the species within the UGP Region, and the specific habitat present at, and in the vicinity of, the project site. For example, the grizzly bear could be affected by wind energy development in 11 counties in Montana and not elsewhere in the six-State UGP Region (figure 4.6-22), while the eastern fringed prairie orchid could be affected by wind energy development in only a single county in Iowa (figure 4.6-11). In contrast, the piping plover occurs throughout portions of five of the six UGP Region States (figure 4.6-18), and thus has the potential to be affected by wind energy projects constructed in these areas.

Site clearing and grading, along with construction of project infrastructure (including turbines, access roads, towers, and support buildings) could result in direct injury to or mortality of biota and reduce, fragment, or dramatically alter existing habitat in the disturbed portions of the UGP Region. In addition, fugitive dust, vehicle emission particulates, and other contaminants (e.g., fuel, oil) may accumulate in areas near the project site, which may be absorbed by plant leaf surfaces and roots. Such processes could reduce photosynthesis and metabolism rates within the plants and subsequently affect plant vigor.

Wildlife in surrounding habitats might also be affected, if the construction activity were to disturb normal behaviors, such as feeding, reproduction, or migration. In addition, the use of project-related access roads by non-project persons (e.g., hunters, hikers, ORV users) may affect local populations of plants and animals through trampling, collection, and/or harassment.

Disturbed areas within or near the project area could be colonized by exotic invasive plant species. Invasive plant species are generally more tolerant of disturbed conditions, and their establishment within and surrounding the project area could be facilitated by the level of disturbance associated with project activities. Further, invasive plant species could develop high population densities that could exclude native species from reestablishing for long periods of time. This may especially impact listed plant species that occur in low population sizes prior to construction activities.

Operations and Maintenance. Threatened, endangered, and special status species may be affected during wind facility operations by (1) collisions with wind turbines, transmission towers, and electricity transmission lines; (2) electrocutions; (3) injury or mortality; (4) facility presence, site activity, noise, and lighting; and (5) exposure to accidental spills of hazardous materials (table 5.6-14). In addition, the presence of a wind energy project and its associated access roads and transmission line ROWs may increase nonfacility-related human use of surrounding areas, which in turn could affect listed and special status species in those areas through (1) the introduction and spread of invasive vegetation, (2) the disturbance of biota, and (3) the increased potential for fire.

Wind turbines, transmission towers, and electric transmission lines represent collision hazards for biota that may be passing through a wind energy facility or crossing transmission line ROWs. Birds and bats would be most vulnerable. Some species, such as the whooping crane, are present in the UGP Region only when they are migrating through the area in spring and fall; these are the seasons when these species would have the greatest potential for collisions. In contrast, the piping plover, the interior least tern, greater sage-grouse, Spraque's pipit, and the Indiana bat are either summer or year-round residents in portions of the UGP

TABLE 5.6-14 Potential Effects of Wind Energy Operations and Nonfacility-Related Human Activity on Threatened, Endangered, and Special Status Species Occurring in the UGP Region

			Biota Potentially Affected[a]						
Potential Effect	Project Activity	Potential Extent and Duration of Effects	Plants	Arthropods	Mollusks	Fish	Amphibians & Reptiles	Birds	Mammals
Wind Energy Operations									
Collisions with turbines, towers, and transmission lines	Presence and operation of turbines, transmission and meteorological towers, and transmission lines	Localized; long term but seasonal	–	–	–	–	–	+	+
Electrocutions	Presence of power lines with less than 60-in. (1.5-m) horizontal separation	Localized; long term but seasonal	–	–	–	–	–	+	–
Injury or mortality	Mowing at turbine locations and support facilities	Localized; short term	+	+	–	–	+	+	+
Behavioral disturbance, including disruption of migratory movements and habitat avoidance	Daily human and vehicle activity; facility presence; turbine noise; facility lighting	Localized; long or short term	–	–	–	+	+	+	+
Exposure to contaminants	Accidental spill of pesticides, fuel, or other regulated or hazardous materials	Localized; short or long term	+	+	+	+	+	+	+

TABLE 5.6-14 (Cont.)

Potential Effect	Project Activity	Potential Extent and Duration of Effects	Biota Potentially Affected[a] Plants	Arthropods	Mollusks	Fish	Amphibians & Reptiles	Birds	Mammals
Nonfacility-Related Human Activities									
Increased foot and vehicle traffic	Access to surrounding areas along access roads and transmission ROWs by unauthorized visitors	Off-site; short or long term, depending on species affected; small to large magnitude, depending on species affected	+	+	–	–	+	+	+
Legal and illegal take of biota	Access to surrounding areas along access roads and transmission ROWs by unauthorized visitors	Off-site; short and long term, depending on species affected; small to large magnitude, depending on species affected	+	+	+	+	+	+	+
Introduction of invasive vegetation	Access to surrounding areas along access roads and transmission ROWs by unauthorized visitors	Off-site; long term, if vegetation becomes established; large	+	+	+	+	+	+	+
Fire	Access to surrounding areas along access roads and transmission ROWs by unauthorized visitors	On- and/or off-site; long term; large	+	+	+	+	+	+	+

[a] "+" indicates effects expected for at least some biota; "–" indicates no biota expected to be affected.

Region (figures 4.6-18, 4.6-20, 4.6-21, and 4.6-22, respectively), and thus could experience collisions in multiple seasons. Listed and special status avifauna contacting project-related transmission lines may also be electrocuted, although this is unlikely given the standard spacing for transmission lines (USDA RUS 1998).

Listed and special status wildlife in the vicinity of an operating wind facility could also be disturbed by daily human and vehicle activity, noise from operating turbines, and infrastructure lighting (table 5.6-14). Daily human and vehicle traffic could temporarily disrupt normal behaviors such as foraging and courtship that may be occurring in nearby areas. Noise from wind turbines could be so long in duration as to result in affected biota permanently leaving surrounding habitats. Nighttime lighting of facility infrastructure could attract some biota (especially birds) to a facility, increasing the potential for collisions, while other biota may avoid nearby habitats.

Decommissioning. In general, the potential effects of wind facility decommissioning on listed and special status species would be short term and similar to but less than those associated with facility construction (table 5.6-13). For the most part, decommissioning activities would only occur in areas previously disturbed by project construction activities and operations, although adjacent areas could be affected. Decommissioning would likely include soil disturbances to remove aboveground and belowground structures. During decommissioning, fugitive dust and other particulates may be spread to adjacent areas and adversely impact protected plant species. Increased human presence, traffic, and noise associated with decommissioning activities may also impact protected animal species through altered behavioral patterns or mortality (e.g., vehicle collisions).

Decommissioning activities would also include reclamation efforts. During this phase, the site would be regraded, if needed, and revegetated with native species in attempts to restore the site to pre-disturbance conditions. Other reclamation activities may include reestablishing natural drainage and hydrological processes and limiting human access to the site. Although reclamation efforts may increase habitat availability and quality from project operation conditions, it may take many years for the project site to be fully restored to pre-disturbance conditions.

5.6.2 BMPs and Mitigation Measures

A variety of BMPs and mitigation measures may be implemented at wind energy projects to reduce potential ecological impacts; these are described in the following sections. Many of the BMPs and mitigation measures for soils (section 5.2.3), water resources (section 5.3.2), air quality (section 5.4.2), and noise (section 5.5.2) would also reduce potential ecological impacts. In addition, monitoring during the various phases of wind energy development can be used to identify potential concerns and direct actions to address those concerns. Monitoring data can be used to track the condition of ecological resources, to identify the onset of impacts, and to direct appropriate site management responses to address those impacts. Results of any required monitoring activities shall be provided to the appropriate State or Federal agencies in a timely manner.

The following subsections identify BMPs and mitigation measures applicable to impacts to ecological resources that could be associated with new wind energy projects.

5.6.2.1 Project Planning and Design

Proper siting of the project area and of specific project components is the best means for minimizing impacts on wildlife from wind energy projects. To reduce the potential for unacceptable impacts on ecological resources, the following measures should be incorporated into the project planning and siting activities for a wind development project:

- Follow the recommendations provided in the *U.S. Fish and Wildlife Service Land-Based Wind Energy Guideline* (Service 2012b) and, as appropriate, the *Draft Eagle Conservation Plan Guidance* (Service 2011a). In addition, follow guidelines or recommendations developed by individual States (e.g., IDNR 2011; Kempema 2009; Nebraska Wind and Wildlife Working Group 2011) to address potential effects of wind energy development on ecological resources.

- Prepare a Bird and Bat Conservation Strategy. The overall goal of such a plan is to reduce or eliminate avian and bat mortality. The wind energy facility developer should work closely with the Service and the appropriate State wildlife agencies to identify protective measures to include in the plan. These would include project design measures, construction phase measures, operational phase measures, and decommissioning phase measures. Post-construction monitoring may be needed to validate the preconstruction risk assessment and allow the facility operators to implement adjustments based on identified problems. Results of monitoring activities shall be reported to the appropriate State or Federal agency in a timely manner. If bat monitoring is appropriate for the site, installation of bat acoustic monitors should be considered at the time meteorological towers are installed to reduce costs and minimize delays by collecting data early in the site review process.

- Review existing information on species and habitats in the project area. Identify important, sensitive, or unique habitat (including large contiguous tracts of grassland cover/habitat) and biota in the project vicinity and site, and design the project to avoid, minimize, or mitigate potential impacts on these resources. Avoidance is the preferred choice for minimizing impacts. The design and siting of the facility should follow appropriate guidance and requirements from the Service, State permitting agencies, and other resource agencies, as available and applicable. In addition, attention should be paid to project placement that may be within or near Important Bird Areas or Important Migratory Shorebird Stopover Sites, or where bird species of conservation concern are known to occur.

- Contact appropriate Federal and State agencies (including State entities responsible for permitting energy development projects) early in the planning process to identify potentially sensitive ecological resources known to be present or likely to be present in the vicinity of the wind energy development.

- If appropriate, conduct surveys for presence of Federal- and State-protected species and other species of concern and the habitats for such species that have a reasonable potential to occur within the project area based on habitat characteristics. Consult with the Service and/or appropriate State agency to identify species likely to be present and appropriate survey techniques, determine permit needs, and identify/apply species-specific avoidance and minimization measures.

- Evaluate potential avian and bat use (including the locations of active nest sites, colonies, roosts, and migration corridors) of the project and use data to plan turbine (and other structure/infrastructure) locations to minimize impacts.

- The transmission lines should be designed and constructed with regard to the recommendations in *Avian Protection Plan Guidelines* (APLIC and Service 2005), in conjunction with *Suggested Practices for Avian Protection on Power Lines* (APLIC 2006) and *Reducing Avian Collisions with Power Lines* (APLIC 2012), to reduce the operational and avian risks that result from avian interactions with electric utility facilities. For example, transmission line support structures and other facility structures should be designed to reduce the likelihood of electrocution with proper spacing of components and by the use of line marking devices, where warranted and appropriate, to reduce the likelihood of collision.

- Evaluate the potential for the wind energy project to adversely affect bald and golden eagles in a manner consistent with the draft *Eagle Conservation Plan Guidance* (Service 2011a). Early in the planning of transmission interconnection and wind farm location, coordination with Service Field Offices with respect to the guidance is highly recommended. Documented occurrence of eagles can be acquired from the local U.S. Fish and Wildlife Ecological Services office, State wildlife agencies, or State natural heritage databases. In accordance with the Service's *Land-Based Wind Energy Guidelines* (Service 2012b), surveys during early project development should identify all important eagle use areas (nesting, foraging, and winter roost areas) within the project's footprint. If eagle use areas occur within a 10-mi (16-km) radius of a project footprint, the project developer should develop an Eagle Conservation Plan (ECP).

The amount and extent of necessary pre-project data would be determined on a project-by-project basis, based in part on the environmental setting of the proposed project location.

5.6.2.2 Characterization

Site characterization activities would generally result in only minimal impacts on ecological resources because of the small areas within which activities would take place and because of the low levels of impacts generally associated with those activities. The following BMPs and mitigation measures are applicable to this phase of development to limit the potential for effects to occur to ecological resources:

- Use existing roads to the maximum extent feasible to access a proposed project area. Install meteorological towers and conduct other characterization activities (e.g., geotechnical testing) as close as practicable to existing access roads.

- Minimize the area disturbed during the installation of meteorological towers (i.e., the footprint needed for meteorological towers and associated laydown areas).

- Do not locate individual meteorological towers in or adjacent to sensitive habitats or in areas where ecological resources known to be sensitive to human activities are present.

- Schedule the installation of meteorological towers and other characterization activities to avoid disruption of wildlife reproductive activities or other important behaviors (e.g., do not install towers during periods of sage-grouse nesting).

- Avoid or minimize the use of guy wires on meteorological towers. Equip any needed guy wires with line marking devices.

5.6.2.3 Construction

A variety of measures may be applicable to minimize the potential for construction activities to affect ecological resources. In addition to BMPs and mitigation measures identified for other resource areas such as soils, water, air quality, and noise, the following measures would be applicable during construction activities for wind energy projects:

- Minimize the size of areas in which soil would be disturbed or vegetation would be removed.

- Reduce habitat disturbance by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.

- Consult with the appropriate natural resource agencies to avoid scheduling construction activities during important periods for wildlife courtship, breeding, nesting, lambing, or calving that are applicable to sensitive species within the project area.

- Instruct employees, contractors, and site visitors to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. Pets should not be allowed on the project area.

- Establish buffer zones around known raptor nests, bat roosts, and biota and habitats of concern if site evaluations show that proposed construction activities would pose a significant risk to avian or bat species of concern.

- If needed during construction, only use explosives within specified times and at specified distances from sensitive wildlife or surface waters as established by the appropriate Federal and State agencies.

- Minimize the use of guy wires on permanent meteorological towers. If guy wires are necessary, they should be equipped with line marking devices.

- Initiate habitat restoration of disturbed soils and vegetation as soon as possible after construction activities are completed. Restore areas of disturbed soil using weed-free native grasses, forbs, and shrubs, in consultation with land managers and appropriate agencies such as State or County extension offices or weed boards.

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

- Establish a controlled inspection and cleaning area for trucks and construction equipment are arriving from locations with known invasive vegetation problems. Visually inspect construction equipment arriving at the project area and remove and contain seeds that may be adhering to tires and other equipment surfaces.

- Regularly monitor access roads and newly established utility and transmission line corridors for the establishment of invasive species. Initiate weed control measures immediately upon evidence of the introduction or establishment of invasive species.

- Place marking devices on any newly constructed or upgraded transmission lines, where appropriate, within suitable habitats for sensitive bird species.

- Do not use fill materials that originate from areas with known invasive vegetation problems.

5.6.2.4 Operations and Maintenance

A variety of measures may be implemented to minimize the potential for impact to ecological resources during the operations phase of a wind energy project, including the following:

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

- Regularly inspect access roads, utility and transmission line corridors, and tower site areas for damage from erosion, washouts, and rutting. Initiate corrective measures immediately upon evidence of damage.

- Turn off unnecessary lighting at night to limit attraction of migratory birds. Follow lighting guidelines, where applicable, from the *Wind Energy Guidelines Handbook* (page 50, items 10 and 11, in Service 2012b). This includes using lights with timed shutoff, downward-directed lighting to minimize horizontal or skyward illumination, and avoidance of steady-burning, high-intensity lights.

- Increasing turbine cut-in speeds (i.e., prevent turbine rotation at lower wind velocity) in areas of bat conservation concern during times when active bats may be at particular risk from turbines (Arnett et al. 2011).

- Instruct employees, contractors, and site visitors to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. Pets should not be allowed on the project area.

- In the absence of long-term mortality studies, monitor regularly for potential wildlife problems including wildlife mortality. Report observations of potential wildlife problems, including wildlife mortality, to the appropriate State or Federal agency in a timely manner, and work with the agencies to utilize this information to avoid/minimize/offset impacts. The Ecological Services Division of the Service shall be contacted. Development of additional mitigation measures may be necessary.

5.6.2.5 Decommissioning

Many BMPs and mitigation measures applicable to construction activities are also applicable to decommissioning activities. One goal of decommissioning should be implementation of appropriate habitat restoration activities to return disturbed areas to pre-project conditions. Additional BMPs and mitigation measures specifically applicable to addressing potential impacts of decommissioning activities on ecological resources include the following:

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

- Salvage and reapply topsoil excavated during decommissioning activities to disturbed areas during final restoration activities.

- Reclaim areas of disturbed soil using weed-free native shrubs, grasses, and forbs. Restore the vegetation cover, composition, and diversity to values commensurate with the ecological setting.

5.6.2.6 Threatened, Endangered, and Special Status Species

The BMPs and mitigation measures presented above for addressing potential effects on ecological resources would also be considered generally protective of many sensitive species and habitats, and specific BMPs and mitigation measures for threatened, endangered, and special status species are not listed here. However, developers may be required to implement additional specific BMPs and mitigation measures to address concerns for species or habitats protected under the ESA or by State regulations or permitting requirements. Typically, BMPs and mitigation measures for protected species are developed on a project-by-project basis once it is known which protected species and habitats could be affected by development of a wind energy project. That approach would continue under the No Action Alternative (section 2.3.1) and for Alternative 3 (section 2.3.4). For Alternative 1 and Alternative 2, compliance with ESA Section 7 would be met, in part, by requiring developers to apply (as appropriate for specific projects) a set of species-specific avoidance criteria, BMPs, and mitigation measures resulting from programmatic ESA Section 7 consultation in order to protect federally listed threatened, endangered, and candidate species, as well as designated critical habitats, from potentially adverse effects (section 2.3.2; table 2.3-2).

5.6.3 No Action Alternative

Under the No Action Alternative, Western would continue to process and evaluate interconnection requests within the UPG Region and the Service would evaluate and make decisions regarding accommodation of wind energy facilities on easements on a case-by-case basis. Separate project-specific NEPA evaluations would be required by both Western and/or the Service and BMPs and mitigation measures for projects would be identified based on those project-specific evaluations. All projects would be required to meet established Federal, State, and local regulatory requirements.

As described at the beginning of this chapter and detailed in appendix B, wind energy projects within the UGP Region between the present and 2030 would encompass 1.1 to 3.8 million ac (0.4 to 1.5 million ha) of land and is expected to occur primarily within areas identified as having high suitability for wind energy development. The areal extent of lands within the UGP Region that would be permanently and temporarily disturbed by the projected levels of wind energy development is also identified at the beginning of the chapter.

5.6.3.1 Vegetation

The types of plant communities that could be affected by wind energy development depend on the ecoregion in which the project is located and the types of plant communities present at the project location within the ecoregion. While the UGP Region includes large areas of agricultural production, croplands are planted and harvested annually and do not form natural communities. Therefore, this discussion focuses on non-cultivated lands having at least some native vegetation. Community types that are associated with the ecoregions occurring in the region are described in section 4.6 and appendix C. The analysis of potential impacts on various plant community types assumes that areas with the highest suitability for wind energy development are most likely to be developed because these areas have suitable wind regimes, do not have land restrictions that would impeded or preclude development, and are within reasonable proximity to existing electric transmission facilities. The ecoregions that overlap these high-suitability areas are primarily the Northwestern Glaciated Plains, Northwestern Great Plains, Northern Glaciated Plains, Lake Agassiz Plain, and Western Corn Belt Plains (figure 5.6-1). The predominant upland plant communities in these ecoregions are short grass prairie, mixed grass prairie, and tallgrass prairie. Wetlands in these ecoregions support wet prairie and marsh communities (palustrine emergent wetlands) and aquatic communities (palustrine and lacustrine aquatic bed and unconsolidated bottom wetlands), with palustrine forested wetlands occurring along rivers, streams, and the margins of some lakes and ponds.

Potential effects on vegetation would primarily result from ground-disturbing activities during construction, but could include any of the common impacts identified in section 5.6.1.1. While areas of high suitability occur throughout the UGP Region, the highest densities are located in the central and eastern portions of the region (figure 5.6-1). The Western Corn Belt Plains, Northwestern Great Plains, Northwestern Glaciated Plains, and Northern Glaciated Plains ecoregions contain the greatest amounts of land categorized as having high suitability for wind energy development, and the Western High Plains, Western Cornbelt Plains, and Nebraska Sand Hills ecoregions have the greatest percentage of overall surface area identified as having high suitability for development (table 5.6-15). In addition, facilities that would connect to Western's transmission system would likely be located within 25 mi (40 km) of Western's transmission lines and substations. The amount of land associated with each ecoregion type within that 25-mi (40-km) buffer area, and in areas of high suitability, is also indicated in table 5.6-15. Development of wind facilities connecting to Western's infrastructure would be expected to be greatest in the Northwestern Great Plains, Northwestern Glaciated Plains, and Northern Glaciated Plains ecoregions. The habitat types associated with these ecoregions are described in section 4.6 and appendix C.

As described in section 5.6.1.1, it is expected that direct placement of structures in wetlands, and the associated impacts, would generally be avoided in the construction of wind energy facilities. Because disturbance of wetland areas complicates construction activities, increases development costs, and requires additional evaluation, permitting, BMPs, and mitigation to limit wetland impacts, developers generally design projects to avoid disturbing these areas unless deemed absolutely necessary (e.g., when long linear drainages act as a barrier between portions of a wind farm site and crossing them with access roads or collector lines is unavoidable). In the development of the suitability analysis (appendix E), NWI wetland areas were considered unsuitable for placement of wind energy facilities in the UGP Region and are therefore excluded from areas categorized as having a high suitability for wind energy development. As an estimate of the potential for indirect impacts on wetlands, as well as any potential direct impacts due to proximity, the ecoregions with the highest percent high suitability land can be compared with the proportion of surface area containing wetlands. Wetland impacts however, would depend on project location and configuration, as well as BMPs and mitigation measures implemented. The Western High Plains (48.6 percent), Western Cornbelt Plains (41.8 percent), and Nebraska Sand Hills (32.1 percent) ecoregions have the greatest overlap with areas designated as high suitability. These ecoregions contain a relatively low percentage of wetland areas (0.25, 2.62, and 4.6 percent, respectively). Ecoregions with a high percentage of wetlands, including Northern Lakes and Forests (26.96 percent) and North Central Hardwood Forests (20.98 percent), have a relatively low overlap with areas designated as high suitability (0 and 15.5 percent, respectively). The Northern Glaciated Plains ecoregion, however, with 25.8 percent of its area designated as high suitability for wind energy development, is nearly 10 percent wetlands, indicating a somewhat greater potential for

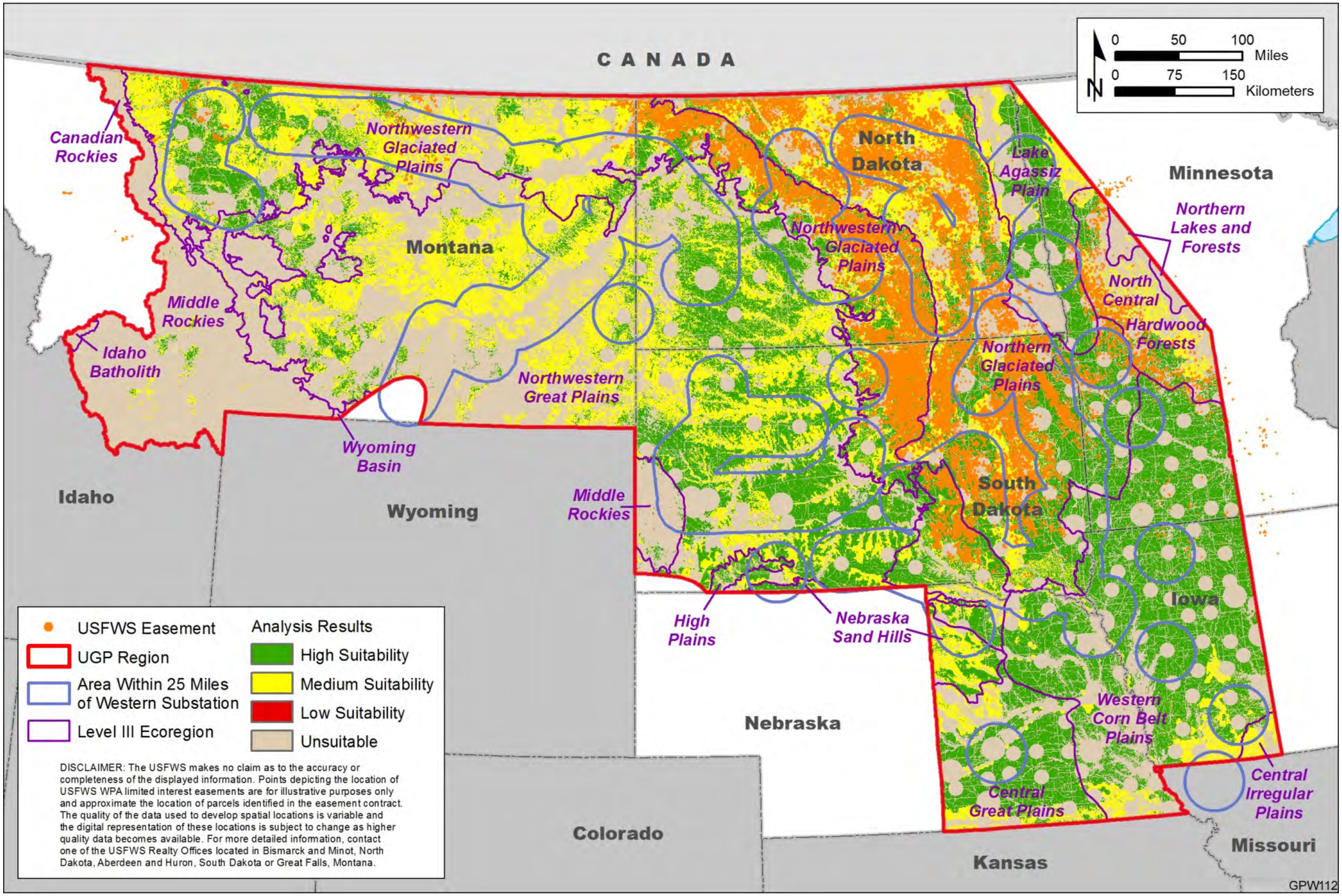

FIGURE 5.6-1 Wind Energy Development Suitability and Ecoregions in the UGP Region, Together with Areas within 25 mi (40 km) of Western's Transmission Substations and General Locations of Service Easements

TABLE 5.6-15 Areal Extent of Ecoregions and Wetlands Associated with Areas Designated as Having High Suitability for Wind Energy Development

Ecoregion	Area of High Suitability (acres [percent of ecoregion])	High Suitability within Western Buffer Area (acres [percent of ecoregion])	Wetlands in Ecoregion (acres [percent of ecoregion])	Wetlands in Western Buffer Area (acres [percent of ecoregion in buffer])
Canadian Rockies	778 (0.05)	0 (0)	30,150 (2.10)	0 (0)
Central Great Plains	2,546,844 (28.9)	465,984 (37.3)	199,027 (2.26)	34,191 (2.7)
Central Irregular Plains	2,224 (0.4)	467 (0.3)	17,734 (2.88)	4,074 (2.4)
Idaho Batholith	0 (0)	0 (0)	0 (0)	0 (0)
Lake Agassiz Plain	1,844,454 (22.2)	1,139,952 (33.3)	279,437 (3.36)	100,982 (3.0)
Middle Rockies	202,357 (1.2)	29,423 (4.1)	120,749 (2.12)	2,494 (0.3)
Nebraska Sand Hills	712,642 (32.1)	241,921 (28.3)	102,003 (4.60)	48,906 (5.7)
North Central Hardwood Forests	910,996 (15.5)	10,030 (28.9)	1,230,810 (20.98)	4,197 (12.1)
Northern Glaciated Plains	9,010,928 (25.8)	6,145,771 (27.4)	3,177,568 (9.10)	2,089,475 (9.3)
Northern Lakes and Forests	0 (0)	0 (0)	199,296 (26.96)	0 (0)
Northwestern Glaciated Plains	10,993,067 (25.5)	6,202,660 (26.5)	2,166,989 (5.17)	1,124,151 (4.8)
Northwestern Great Plains	12,878,642 (17.5)	6,938,564 (21.9)	1,794,035 (4.34)	1,022,980 (3.2)
Western Corn Belt Plains	13,219,284 (41.8)	3,815,473 (45.9)	828,013 (2.62)	180,829 (2.2)
Western High Plains	297,431 (48.6)	111,331 (55.2)	1,555 (0.25)	433 (0.2)
Wyoming Basin	2,024 (2.7)	0 (0)	0 (0)	0 (0)
TOTAL	52,621,694 (23.0)	25,101,575 (27.2)	10,147,366 (4.44)	4,612,712 (5.0)

wetlands impacts. Those areas within 25 mi (40 km) of Western's infrastructure, that are in areas of high suitability, are also summarized for each ecoregion in table 5.6-15. The potential association of wetlands with development of wind facilities connecting to Western's infrastructure would be expected to be greatest in the Northwestern Hardwood Forests and Northern Glaciated Plains ecoregions, each with a somewhat high percentage of area designated as high suitability for wind energy development, and a high proportion of wetlands.

Service easements are located in many of the ecoregions within the UGP Region. The Northwestern Glaciated Plains and Northern Glaciated Plains ecoregions contain the most easements. Easements located in areas of high suitability for wind energy development primarily occur in those ecoregions, and easements that are within 25 mi (40 km) of Western's infrastructure are also primarily located in those ecoregions.

Under the No Action Alternative, direct and indirect impacts on plant communities, including wetlands would be evaluated as part of the separate project-specific NEPA evaluations that would be required for interconnection requests and/or for accommodation of requests to place wind energy facilities on Service easements through easement exchange. BMPs and mitigation measures for wind energy projects would be determined on a project–specific basis by Western and the Service and would be designed to minimize impacts on wetlands and other plant communities. It is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for the No Action Alternative, impacts on plant communities and wetlands from wind energy projects interconnecting to Western's transmission facilities or permitted to place project facilities on easements through easement exchanges would be minor.

5.6.3.2 Wildlife

The types of potential impacts that could occur to wildlife under the alternatives would be similar in nature to those discussed in section 5.6.1.2. However, since many of those impacts can be avoided or reduced through the use of BMPs and mitigation measures, such as those identified in section 5.6.2, the magnitude of impacts under the alternatives differ somewhat according to how the appropriate BMPs and mitigation measures are identified and which BMPs and mitigation measures are required. The following subsections briefly summarize expected impacts on wildlife and their habitats during various phases of wind energy development under the No Action Alternative.

Table 5.6-16 presents the estimated amount of suitable habitat for select wildlife species within the UGP Region, within areas considered to have a high suitability for wind energy development, and within those areas located within 25 mi (40 km) of Western's transmission facilities. The wildlife species presented include bird and bat species that are abundant within the UGP Region and/or that are routinely reported to collide with wind turbines, as well as prominent big game species that occur in the UGP Region.

Site Characterization. Potential impacts on wildlife from site characterization would primarily result from disturbance (e.g., due to equipment and vehicle noise and the presence of workers). Impacts would generally be temporary and at a smaller scale than those during other phases of the project. Some bird mortality would be expected at meteorological towers, especially those with guy wires. Bat fatalities due to collisions with meteorological towers at wind energy facilities appear to be very low to nonexistent (Johnson et al. 2004).

Construction. During construction of a wind energy project and its ancillary facilities, wildlife may be adversely affected as a result of various stressors associated with specific construction activities (table 5.6-3). The impacts associated with construction activities can be broadly categorized as those that result from (1) habitat disturbance (habitat reduction, alteration and fragmentation), (2) wildlife disturbance, and (3) wildlife injury or mortality. Overall, the effects of habitat disturbance would be related to the type and abundance of habitats affected and to the wildlife that occurs in those habitats. Once construction is complete, most areas not located within the footprints of permanent structures could be restored to native plant cover.

During construction, wildlife disturbance could be of greater concern than disturbance caused by habitat loss (Arnett et al. 2007). Wildlife could respond to disturbance in various ways, including attraction, habituation, or avoidance (Knight and Cole 1991). Clearing, grading, and trenching activities could result in the direct injury to or death of wildlife species (or life stages of species) that are not mobile enough to avoid construction operations, those that use burrows, or those that defend nest sites. If clearing or other construction activities occurred during the spring and summer, bird nests and eggs or nestlings could be destroyed. Although more mobile wildlife species, such as big game and adult birds, might avoid the initial clearing

TABLE 5.6-16 Potential for Select Wildlife Species to Occur in Areas Designated as High Suitability for Wind Energy Development

Scientific Name	Common Name	Total Predicted Habitat in the UGP Region (acres)[a]	Predicted Habitat in Area of High Suitability (acres)	Predicted Habitat in Area of High Suitability within Western Buffer Areas (acres)
Waterfowl, Wading Birds, and Shorebirds				
Anas discors	Blue-winged teal	81,861,349	20,682,522	9,226,540
Anas platythynchos	Mallard	103,696,499	29,334,817	11,935,021
Anas strepera	Gadwall	80,965,275	23,919,191	10,679,913
Ardea herodias	Great blue heron	23,241,331	4,779,977	1,185,342
Bartraimia longicauda	Upland sandpiper	79,803,418	20,225,301	10,059,142
Notarus lentiginosus	American bittern	28,965,886	6,639,577	3,026,928
Raptors				
Aquila chrysaetos	Golden eagle	48,628,506	3,838,980	1,625,395
Buteo jamaicensis	Red-tailed hawk	158,214,888	31,701,499	12,933,262
Falco sparverius	American kestrel	158,554,641	33,637,980	13,643,769
Passerines				
Dolichonyx oryzivorus	Bobolink	156,164,652	41,311,425	20,312,124
Eremophila alpestris	Horned lark	154,626,302	46,255,931	22,117,436
Pooecetes gramineus	Vesper sparrow	177,372,538	46,496,606	22,529,356
Big Game				
Antilocapra americana	Pronghorn	85,698,594	11,322,367	6,256,368
Cervus canadensis	Elk	47,455,551	3,602,641	1,396,440
Odocoileus hemionus	Mule deer	140,289,306	29,247,794	15,689,335
Odocoileus virginianus	White-tailed deer	158,654,341	47,306,479	22,633,370
Ovis canadensis	Bighorn sheep	1,493,826	122,073	101,123
Bats				
Lasionycteris noctivagans	Silver-haired bat	40,621,935	7,627,632	2,294,648
Lasiurus borealis	Eastern red bat	39,342,119	9,648,156	3,440,649
Lasiurus cinereus	Hoary bat	52,580,952	8,977,503	2,887,264

[a] Potentially suitable habitat was determined from GAP habitat suitability models.

activity by moving into habitats in adjacent areas, it is conservatively assumed that adjacent habitats would be at carrying capacity for the species that live there and could not readily support additional individuals from construction areas. Direct mortality from vehicle collisions would be expected to occur along access roads, especially in wildlife concentration areas or travel corridors. Some of the habitat impacts that occur during project construction could continue through the operational life of a wind energy facility.

Operations and Maintenance. Potential impacts on wildlife from ecological stressors associated with the operation and maintenance of wind energy projects are summarized in table 5.6-4; they can be broadly categorized as those related to (1) habitat disturbance (i.e., reduction, alteration, and fragmentation of habitat); (2) wildlife disturbance (e.g., from noise and the presence of workers); and (3) and wildlife injury or mortality.

Collisions of birds and bats with transmission lines and turbines would be the most likely cause of mortality and injury to wildlife during the operational phase of a wind energy project. Waterfowl, shorebirds, and raptors appear to be the bird groups most susceptible to colliding with transmission wires (Kingsley and Whittam 2005). Bird and bat collisions with wind turbines have received major emphasis regarding adverse impacts on wildlife associated with wind energy developments. Bird fatalities associated with wind turbines are composed of a variety of different groups, including raptors, passerines, gallinaceous birds, waterfowl, and shorebirds. Many of the reported bird fatalities involve common, yearlong resident species (Erickson et al. 2001, 2003b). Waterfowl, waterbird, and shorebird mortality from wind turbines is relatively minor (Kerlinger 2006). Observation of raptor fatalities at wind facilities are of particular concern because raptors have a high public profile, some raptor species have relatively small populations and/or low reproduction rates, and raptors often fly at heights within the blade sweep area (Kingsley and Whittam 2003). Passerines (both resident and migratory species) are the most common group of birds killed at many wind energy projects (e.g., Erickson et al. 2004; Johnson et al. 2000b, 2002; Kerns and Kerlinger 2004), often making up more than 80 percent of reported fatalities (Erickson et al. 2001). Most studies have indicated that passerines suffer the most collision fatalities regardless of where wind energy facilities are located. Grassland birds such as the horned lark (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*), and bobolink (*Dolichonyx oryzivorus*) may be particularly at risk for colliding with wind turbines because of aerial courtship displays that occur at the height of turbine blades (Illinois DNR 2007; Kingsley and Whittam 2005). Reported bird collision fatality rates range from 0 to more than 30 birds per turbine per year (Kuvlesky et al. 2007). Based on studies conducted across the United States, the wind industry estimates that each modern wind turbine kills about two birds per year (Illinois DNR 2007).

Since the observations of a comparatively large number of bat fatalities at the Mountaineer Wind Energy Center in West Virginia, concerns over bat fatalities at wind facilities have gained increased attention (Johnson and Strickland 2004; Kerns and Kerlinger 2004). However, relatively low numbers of bat fatalities are observed at most wind energy development projects where observations have been made. Hoary bats (*Lasiurus cinereus*) and Eastern red bats (*L. borealis*) comprise most of the bat fatalities in the Midwest and eastern United States, while hoary bats and silver-haired bats (*Lasionycteris noctivagans*) comprise most bat fatalities in the western States. Bats most affected by wind facilities appear to be tree-roosting species during their fall migration (Arnett et al. 2008). Biotic factors that may contribute to bat mortality at wind energy facilities include flight behavior, migration patterns, and aggregation of insect prey (Fiedler et al. 2007). The prevalence of migratory tree bats observed as fatalities may be related to their tendency to aggregate at tall and highly visible landscape structures, which until recently only consisted of the crowns of trees (Cryan and Brown 2007). Horn et al. (2008) observed bats actively foraging near turbines rather than simply passing through a wind facility. Bat fatalities at wind facilities increased with decreased distance to wetlands (Johnson et al. 2000a) and increased exponentially with turbine height (Barclay et al. 2007). Cryan (2008) hypothesized that tree bats collided with turbines while engaging in mating behaviors that center on the tallest trees in a landscape (i.e., the bats viewed turbines as tall trees). Cumulative losses of large numbers of bats due to collisions with turbines may have a serious effect on regional populations of hoary and silver-haired bats if the level of mortality continues (Brown and Hamilton 2006).

Using estimates of 3.04 bird fatalities per megawatt per year in the United States (Erickson et al. 2003b) and 0.2 to 8.7 bat fatalities per megawatt per year in the Midwest (Arnett et al. 2007; Illinois DNR 2007), it is estimated that fatality rates within the six States that are part of the UGP Region would be approximately 18,362 birds and 1,208 to 52,548 bats per year.

Decommissioning. Decommissioning activities that could affect wildlife include (1) dismantling of structures, (2) generation of waste materials, (3) regrading of project areas, (4) revegetation activities, and (5) accidental releases (spills) of potentially hazardous materials. Impacts on wildlife from decommissioning activities would be similar to those from construction, but they could be more limited in scale and shorter in duration. This would depend, in part, on whether decommissioning involved full removal of facilities, partial removal of key components, or abandonment. For example, leaving buried components in place would reduce the amount of trenching and soil disturbance required and contribute to reduced impacts relative to those that would occur during construction.

During decommissioning activities, localized obstructions of wildlife movement could occur in the areas where the wind energy facilities are being dismantled. Most wildlife would avoid areas while decommissioning activities were taking place. Removal of aboveground facilities would reduce potential nesting, perching, and resting habitats for several bird species, particularly raptors and common ravens (*Corvus corax*). However, this could benefit species such as small mammals and greater sage-grouse (*Centrocercus urophasianus*) that are preyed upon by those species. Removal of aboveground facilities would also reduce bird and bat collisions. In addition, the removal of aboveground facilities would ensure free passage of wildlife. The revegetation of decommissioned wind energy facilities could increase wildlife habitat diversity, since control of vegetation (including cutting of woody vegetation) would cease, allowing native shrubs and trees to grow and increase in density. In the long term, decommissioning and reclamation would increase species diversity and habitat quality within the project area.

For the No Action Alternative, the impacts summarized above for site characterization, construction, operations and maintenance, and decommissioning for wind energy developments would be evaluated in detail in project-specific NEPA documents prior to any project-related disturbances.

5.6.3.3 Aquatic Biota and Habitats

Under the No Action Alternative, the types of impacts on aquatic biota and habitats from wind energy projects developed in the UGP Region may be expected to be similar in nature to the common impacts described for project development in section 5.6.13.

During site characterization, impacts in areas of project development could include habitat disturbance, injury or mortality of biota, and interference with fish movement (see table 5.6-9). Because of the nature and extent of activities that would occur under site characterization, potential impacts under the No Action Alternative would be short term and negligible (see introduction to chapter 5 for a definition of impact levels), especially if aquatic habitats are avoided when locating characterization infrastructure and if appropriate BMPs and mitigation measures related to stream crossings and erosion control are implemented where appropriate.

During the construction of a wind energy project in the UGP Region, project-related impacts could include injury or mortality of biota, disturbance or loss of habitat, reduced water quality from soil erosion and accidental releases of regulated hazardous materials, changes in water quality (including temperature, turbidity, and sedimentation), and interference with fish movements (see table 5.6-10). Use of appropriate BMPs and mitigation measures (section 5.6.2) would result in many of the potential impacts being mostly minor in nature. Moderate impacts could be incurred only in the event that the placement and construction of some form of project-related infrastructure must occur within or immediately adjacent to an aquatic habitat feature. However, it is anticipated that such issues would be identified during siting activities and construction of project infrastructure would, to the maximum extent possible, avoid placement within aquatic habitats.

Under the No Action Alternative, potential impacts associated with project operations include injury or mortality of biota from foot and vehicle traffic, and injury or mortality of aquatic biota from the accidental exposure to regulated or hazardous materials used for pest and vegetation management (see table 5.6-11). The use of appropriate BMPs and mitigation measures together with herbicide/pesticide application permit requirements may be expected to reduce potential impacts to largely negligible or minor levels. Potential impacts of decommissioning wind projects developed in UGP Region under the No Action Alternative would be similar to those identified for project construction under this alternative. Similarly, assuming application of appropriate BMPs and mitigation measures, potential impacts of project decommissioning would be expected to be mostly negligible or minor.

Overall, it is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for the No Action Alternative, impacts on wildlife from wind energy projects interconnecting to Western’s transmission facilities or permitted to place project facilities on easements through easement exchanges would be negligible to minor.

5.6.3.4 Threatened, Endangered, and Special Status Species

Under the No Action Alternative, all of the threatened, endangered, and special status species that may occur in the UGP Region have the potential to occur in areas that may be directly or indirectly affected by wind energy development. In addition, designated critical habitat for four species listed under the ESA also occurs in areas that may be affected (see section 4.6.4). However, wind energy developments considered in this PEIS are expected to occur primarily within areas identified as having high wind energy development potential, and that are in close proximity to Western’s electric grid (within 25 mi [40 km]) or on Service easements (see section 2.4). The construction of transmission lines and access roads associated with new wind development, however, would not be limited to areas of high development potential. The amount of suitable habitat for species listed under the ESA as threatened or endangered, or species that are proposed or candidates for listing, which may occur in areas of predicted high wind development suitability, are shown in table 5.6-17.

TABLE 5.6-17 Estimated Amount of Potentially Suitable Habitat and Designated Critical Habitat for Species Federally Listed as Threatened or Endangered or That Are Candidates for Federal Listing within the UGP Region Relative to the Amount in Areas with a High Suitability for Wind Energy Development[a]

Scientific Name	Common Name	Status[b]	Total Potentially Suitable Habitat in the UGP Region[c]	Potentially Suitable Habitat in Area of High Development Potential	Habitat with High Development Potential within Western Buffer Areas	Potential to Occur within Service Easements[d]
Plants						
Asclepias meadii	Mead's milkweed	T	27,400 ac	600 ac	340 ac	N
Lespedeza leptostachya	Prairie bush-clover	T	215,600 ac	85,300 ac	25,700 ac	N
Platanthera leucoaea	Eastern prairie fringed orchid	T	3,500 ac	150 ac	0 ac	N
Platathera praeclara	Western prairie fringed orchid	T	1,323,000 ac	22,000 ac	10,300 ac	Y
Spiranthese diluvialis	Ute ladies-tresses	T	105,700 ac	20 ac	0 ac	N
Mollusks						
Lampsilis higginsii	Higgins eye (pearlymussel)	E	10,500 ac	0 ac	0 ac	N
Leptodea leptodon	Scaleshell mussel	E	29,900 ac	0 ac	0 ac	N
Plethobasus cyphyus	Sheepnose mussel	C	16,500 ac	0 ac	0 ac	N
Arthropods						
Cicindela nevadica lincolniana	Salt Creek tiger beetle	E	7,800 ac	5 ac	0 ac	N
Hesperia dacotae	Dakota skipper	C	557,000 ac	12,500 ac	7,000 ac	Y
Nicrophorus americanus	American burying beetle	E	6,341,000 ac	18,600 ac	14,400 ac	Y
Oanisma poweshiek	Poweshiek skipperling	C	846,165 ac	126,549 ac	8,446 ac	Y
Fishes						
Notropis topeka (=tristis)	Topeka shiner	E	4,850 mi	0 mi	0 mi	Y
	Topeka shiner (critical habitat)[e]		1,100 mi	0 mi	0 mi	Y
Salvelinus confluentus	Bull trout	T	1,825 mi	0 mi	0 mi	N
	Bull trout (critical habitat)[c]		35 mi	0 mi	0 mi	N
Scaphirhynchus albus	Pallid sturgeon	E	6,050 mi	0 mi	0 mi	N

TABLE 5.6-17 (Cont.)

Scientific Name	Common Name	Status[b]	Total Potentially Suitable Habitat in the UGP Region[c]	Potentially Suitable Habitat in Area of High Development Potential	Habitat with High Development Potential within Western Buffer Areas	Potential to Occur within Service Easements[d]
Reptiles						
Sistrurus catenatus catenatus	Massasauga rattlesnake	C	1,147,000 ac	4,150 ac	0 ac	N
Birds						
Anthus spragueii	Sprague's pipit	C	4,228,000 ac	321,600 ac	127,000 ac	Y
Centrocercus urophasianus	Greater sage-grouse	C	1,207,000 ac	20,600 ac	4,500 ac	Y
	Greater sage-grouse (75% breeding density)[f]		9,821,000 ac	300,000 ac	33,000 ac	Y
	Greater sage-grouse (core areas)[g]		8,875,000 ac	215,000 ac	3,500 ac	Y
Charadrius melodus	Piping plover	T	3,971,000 ac	108,000 ac	63,800 ac	Y
	Piping plover (critical habitat)[e]		1,010,000 ac	150 ac	90 ac	N
Grus Americana	Whooping crane[h]	E	2,362,000 ac	496,000 ac	213,000 ac	Y
Sterna antillarum	Least tern (interior population)	E	5,394,000 ac	39,000 ac	31,800 ac	Y
Mammals						
Canis lupis	Gray wolf	E	13,605,000 ac	62,000 ac	14,000 ac	Y
Lynx Canadensis	Canada lynx	T	5,326,000 ac	9,000 ac	1,800 ac	N
	Canada lynx (critical habitat)[e]		1,035,000 ac	0 ac	0 ac	N
Mustela nigripes	Black-footed ferret	E	3,605,000 ac	11,000 ac	7,000 ac	N
Myotis sodalist	Indiana bat	E	401,000 ac	16,000 ac	5,600 ac	N
Ursus arctos horribilis	Grizzly bear	T	617,000 ac	15,000 ac	900 ac	N

Footnotes on next page.

TABLE 5.6-17 (Cont.)

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[a] This table presents potential habitat affected for special status species that are federally listed as threatened or endangered under the ESA or species that are candidates for listing under the ESA. The UGP Region supports hundreds of other special status species (i.e., State-listed species or species that have been placed on some form of watch list). Therefore, future wind energy development in the UGP Region has the potential to affect additional special status species not mentioned in this table.

[b] C = candidate; E = endangered; T = threatened.

[c] Unless otherwise indicated, predicted suitable habitat for plants and invertebrates were determined from landcover models; potentially suitable habitat and designated critical habitat for fish species were determined from Service ECOS and Service Recovery Plans. For reptile, bird, and mammal species, potentially suitable habitat was determined from GAP habitat suitability models (USGS 2011).

[d] Spatial data regarding the areas and boundaries of Service easements were not available. A qualitative evaluation was made to determine whether easements intersected areas of high wind development suitability and whether species potential occurrences intersected those areas.

[e] For species with designated critical habitat, spatial data for critical habitat were obtained from the Service Critical Habitat Portal (Service 2011b). Areas provided represent the areal extent of critical habitat rather than potentially suitable habitat.

[f] Spatial data for greater sage-grouse breeding density areas were obtained from Doherty et al. (2010).

[g] Within the UGP Region, core areas for the greater sage-grouse are only known from the State of Montana. Spatial data for greater sage-grouse core areas were obtained from Montana Fish, Wildlife, and Parks (2011).

[h] Potentially suitable habitat for the whooping crane was estimated using the area of freshwater emergent wetlands within the 95% migration corridor. Spatial data for wetlands were obtained from NWI datasets; spatial data for the 95% migration corridor was obtained from Shelley (2011).

Table 5.6-18 summarizes the potential for impacts to suitable habitat for federally listed species from wind energy projects that could connect to Western's transmission system or that might place wind energy structures on easements managed by the Service on the basis of the potential for species to occur on Service easements, and on the basis of the proportions of suitable habitat for each species that overlaps areas within the UGP Region with a high suitability for wind energy development and within 25 mi (40 km) of Western's transmission facilities. Appropriate siting of project structures to avoid sensitive habitats, and implementation of appropriate BMPs and mitigation measures, would reduce the identified potential impact levels. The UGP Region also supports hundreds of other special status species (i.e., State-listed species or species that have been placed on some form of watch list). Therefore, future wind energy development in the UGP Region has the potential to affect some of these species as well.

The types of impacts that could occur to threatened, endangered, and special status species are fundamentally similar to or the same as impacts on plant communities, aquatic resources, and wildlife described in sections 5.6.1.1, 5.6.1.2, and 5.6.1.3, respectively. The most important difference is the potential consequences of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable to adverse effects than are more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Under the No Action Alternative, specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific NEPA documents and ESA Section 7 consultations prior to any project-related disturbances.

5.6.4 Alternative 1

A description of Alternative 1 is provided in section 2.3.2. It is anticipated that there would be no differences in either the areas considered suitable for development or in the projected amount of development between this alternative and the No Action Alternative. Under Alternative 1, the approach described in section 2.3.2.1 would be applied when reviewing the environmental effects of interconnection requests and requests to accommodate, through easement exchange, wind energy facilities on Service easements. A set of standardized BMPs and mitigation measures would be required for individual projects, as appropriate, to address site-specific conditions and development activities (section 2.3.2). All projects would be required to meet established Federal, State, and local regulatory requirements.

Experience with wind energy facilities in the UGP Region indicates that following established regulatory requirements and implementation of appropriate BMPs and mitigation measures would generally be protective of most ecological resources. However, because the nature and extent of impacts that could occur to ecological resources can vary greatly depending on the size and design of the project and on site-specific factors (e.g., location within the UGP Region, soil types and properties, topography, vegetation cover, climatic differences, and distance to surface water bodies), evaluations of potential impacts from development of wind energy projects and identification of appropriate BMPs and minimization measures necessarily need to be deferred until project-specific information is available.

TABLE 5.6-18 Potential Impacts of Wind Energy Development on Suitable Habitat for Federally Listed Threatened, Endangered, Candidate, and Proposed Species Within the UGP Region

Species	Status[a]	Percentage of Total Suitable Habitat Potentially Affected[b]	Potential to Occur within Service Easements[c]	Magnitude of Potential Impact on Suitable Habitat[d]
Plants				
Asclepias meadii (Mead's milkweed)	T	1.2	N	Minor
Lespedeza leptostachya (Prairie bush-clover)	T	11.9	N	Major
Platanthera leucoaea (Eastern prairie fringed orchid)	T	0	N	Negligible
Platanthera praeclara (Western prairie fringed orchid)	T	0.1	Y	Minor
Spiranthese diluvialis (Ute ladies-tresses)	T	0	N	Negligible
Mollusks				
Lampsilis higginsii (Higgins eye)	E	0	N	Negligible
Leptodea leptodon (Scaleshell mussel)	E	0	N	Negligible
Plethobasus cyphyus (Sheepnose mussel)	C	0	N	Negligible
Arthropods				
Cicindela nevadica lincolniana (Salt Creek tiger beetle)	E	0	N	Negligible
Hesperia dacotae (Dakota skipper)	C	1.2	Y	Minor

TABLE 5.6-18 (Cont.)

Species	Status[a]	Percentage of Total Suitable Habitat Potentially Affected[b]	Potential to Occur within Service Easements[c]	Magnitude of Potential Impact on Suitable Habitat[d]
Arthropods (Cont.)				
Nicrophorus americanus (American burying beetle)	E	0.2	Y	Minor
Oarisma Poweshiek (Poweshiek skippering	C	1.0	Y	Minor
Fishes				
Notropis topeka (=tristis) (Topeka shiner)	E	0	Y	Negligible
Salvelinus confluentus (Bull trout)	T	0	N	Negligible
Scaphirhynchus albus (Pallid sturgeon)	E	0	N	Negligible
Reptiles				
Sistrurus catenatus catenatus (Massasauga rattlesnake)	C	0	N	Negligible
Birds				
Anthus spragueii (Sprague's pipit)	C	3.0	Y	Moderate
Centrocercus urophasianus (Greater sage-grouse)	C	0.4	Y	Minor
Charadrius melodus (Piping plover)	T	1.6	Y	Minor
Grus americana (Whooping crane)	E	1.0	Y	Minor
Sterna antillarum (Least tern)	E	0.6	Y	Minor

TABLE 5.6-18 (Cont.)

Species	Status[a]	Percentage of Total Suitable Habitat Potentially Affected[b]	Potential to Occur within Service Easements[c]	Magnitude of Potential Impact on Suitable Habitat[d]
Mammals				
Canis lupis (Gray wolf)	E	0.1	Y	Minor
Lynx canadensis (Canada lynx)	T	<0.1	N	Minor
Mustela nigripes (Black-footed ferret)	E	0.2	N	Minor
Myotis sodalis (Indiana bat)	E	1.4	N	Minor
Ursus arctos horribilis (Grizzly bear)	T	0.1	N	Minor

[a] C = Candidate; E = Endangered; T= Threatened.

[b] The percentage of potentially suitable habitat affected was determined based on the amount of potentially suitable habitat in areas of high wind development potential within 25 mi (40 km) of a Western substation relative to the amount of potentially suitable habitat in the UGP Region. Refer to table 5.6-18 for calculations of potentially suitable habitat in these areas.

[c] Spatial data for the Service grassland easements were not available at the time of this analysis. A qualitative evaluation was made to determine whether Region 6 grassland easements intersected areas of high wind development suitability and whether species potential occurrences intersected those areas.

[d] Impact magnitude categories were based on professional judgment and are as follows: (2) negligible: 0% of the suitable habitat affected; (1) small: >0 but ≤2% of the suitable habitat affected; (2) moderate: >2 but ≤10% of the suitable habitat affected; (3) large: >10% of the suitable habitat affected. Appropriate siting of project structures to avoid sensitive habitats and facilities and implementation of appropriate BMPs and mitigation measures would reduce the identified impact levels.

Under Alternative 1, project developers shall be required to employ a risk-based evaluation approach, as described in section 2.3.2, to identify project-specific concerns related to vegetation, wildlife, aquatic biota, and special status species. The risk evaluation approach used by developers shall be consistent with the tiered approach identified in the *Land-Based Wind Energy Guidelines* (Service 2012b) developed by the Service. The evaluation process will help identify ecological resources that have a reasonable likelihood to be significantly affected by planned project designs and activities, as well as those ecological resources that are unlikely to be significantly affected. Proper identification of resources that could be significantly affected will help identify modifications to the project design (e.g., siting of specific turbines), BMPs, and mitigation measures that can be implemented to avoid, reduce, or otherwise compensate for potentially significant impacts and will reduce the potential for unexpected impacts to ecological resources and subsequent impediments to project development or operations. Some programmatic BMPs and mitigation measures that would be applied to address potential impacts on ecological resources (as appropriate for specific projects) are identified in section 5.6.2. However, because the types of species and habitats that could be affected may vary greatly from site to site, additional project-specific BMPs and mitigation measures may need to be developed after evaluations of ecological concerns have been completed.

In addition to implementation of the risk evaluation approach identified, Alternative 1 would implement additional procedures to be used for compliance with the BGEPA and ESA Section 7. For compliance with the BGEPA, Alternative 1 would require developers to evaluate the potential for projects to adversely affect bald and golden eagles in a manner consistent with the draft *Eagle Conservation Plan Guidance* (Service 2011a) developed by the Service to assist developers with avoiding, minimizing, and mitigating adverse effects on bald and golden eagles. Under the draft *Eagle Conservation Plan Guidance*, wind turbine developers will consult with the Service in a 5-tiered process that includes the following: (1) early landscape-level site assessments; (2) site-specific surveys; (3) risk assessment; (4) identification of methods for avoiding, minimizing, and mitigating impacts; and (5) post-construction monitoring. Projects are categorized into one of the risk categories based upon the presence of eagles relative to the location of proposed projects. Depending on the risk category for the specific project, project developers would be requested to develop an eagle conservation plan and, potentially, seek issuance of an eagle incidental take permit from the Service and document these in project-specific NEPA evaluations. Project proponents are not required to use the recommended procedures; however, if different approaches are used, the proponent should coordinate with the Service in advance to ensure that proposed approaches will provide comparable data.

Compliance with ESA Section 7 under Alternative 1 would require developers to apply (as appropriate for specific projects) a set of species-specific avoidance criteria, BMPs, and mitigation measures resulting from programmatic ESA Section 7 consultation in order to protect federally listed threatened, endangered, and candidate species from potentially adverse effects (section 2.3.2; table 2.3-2). Project-specific ESA Section 7 consultation would be required for (1) any listed species not considered in the programmatic consultation and (2) for any listed species for which project developers are unwilling or unable to implement the programmatic avoidance measures, BMPs, or mitigation measures applicable to a project.

5.6.4.1 Vegetation

The types and amounts of vegetation communities that could be affected by wind energy development under Alternative 1 are not expected to differ markedly from those described for the No Action Alternative (section 5.6.3.1). The BMPs and mitigation measures that would be applied to specific projects would be determined using the evaluation procedures for ecological resources identified in section 2.3.2 and would include BMPs and mitigation measures identified in section 5.6.2 as appropriate for specific project conditions. In addition, as identified in section 5.6.2, many of the BMPs and mitigation measures that would be applied to address effects on other resources under Alternative 1 would also help avoid or reduce potential effects on ecological resources. Many of these BMPs and mitigation measures would minimize direct and indirect impacts on wetlands and other plant communities. In addition, mitigation requirements associated with Federal and/or State permits required for unavoidable wetland impacts would further minimize impacts. With the implementation of the evaluation procedures, BMPs, and mitigation requirements identified for Alternative 1, it is anticipated that impacts on vegetation from wind energy projects interconnecting to Western’s transmission facilities or allowed to place wind energy structures on Service easements through easement exchange would be minor.

5.6.4.2 Wildlife

The types of impacts that could occur to wildlife and their habitats from wind energy project development in the UGP Region under Alternative 1 would be expected to be similar to those identified for the No Action Alternative (section 5.6.3.2). Implementation of BMPs and mitigation measures that would be identified would be expected to reduce most project impacts on wildlife to negligible or minor levels that are not likely to impact entire populations or species. Some migratory bird mortality will occur from installation of wind development projects in the UGP Region. The Service's Office of Law Enforcement carries out its mission to protect migratory birds through investigations and enforcement, as well as by fostering relationships with agencies, individuals, companies, and industries that have taken effective steps to avoid take of migratory birds, and by encouraging others to implement measures to avoid take of migratory birds. It is not possible to absolve individuals, companies, or agencies from liability even if they implement bird mortality avoidance or other similar protective measures. However, the Office of Law Enforcement focuses its resources on investigating and prosecuting individuals and companies that take migratory birds without identifying and implementing all reasonable, prudent, and effective measures to avoid that take. Companies and agencies are encouraged to work closely with the Service to identify available protective measures when seeking authorization for actions that are expected to take migratory birds.

As under the No Action Alternative, long-term reduction in habitat areas could result from project construction that would continue through the operational life of a wind energy facility; however, the magnitude of such impacts would generally be minor, as long as facilities are sited in appropriate locations, since the land areas affected by facility footprints are typically small. Operation and maintenance of a wind energy facility could also result in long-term impacts on some wildlife. In particular, some wildlife may avoid developed/fragmented areas after construction, birds and bats would be subject to collisions with turbines, bats may be subject to air pressure effects of spinning turbine blades (baratrauma), and birds would also be subject to colliding with transmission lines. Using the risk-based evaluation approach that would be implemented under this alternative to (1) evaluate which wildlife resources would be at risk from wind energy development, (2) identify how to limit potential effects through proper siting of facilities, and (3) identify which BMPs and mitigation measures would be applied would minimize the potential for adverse impacts on wildlife. Alternative 1 would also require developers to evaluate the potential for projects to adversely affect bald and golden eagles in a manner consistent with the draft *Eagle Conservation Plan Guidance* (Service 2011a). If the evaluation process indicated that the potential for adverse effects existed, developers would also be requested to develop an eagle conservation plan and, potentially, seek issuance of an eagle incidental take permit from the Service.

With the implementation of the evaluation procedures, BMPs, and mitigation requirements identified for Alternative 1, it is anticipated that impacts on wildlife from wind energy projects interconnecting to Western's transmission facilities or allowed to place wind energy structures on Service easements through easement exchange could be minor. However, until a comprehensive mitigation package for an individual project is completed, it is not possible to ascertain at the EIS level whether fragmentation impacts caused by wind development at a given site would necessarily qualify for an easement exchange.

5.6.4.3 Aquatic Biota

Under Alternative 1, impacts on aquatic biota and habitats from wind energy project development in the UGP Region may be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.3). The risk-based evaluation approach to be implemented under Alternative 1 (see section 2.3.2) would be used to identify which aquatic biota or habitats could be at risk from the proposed project and to identify which BMPs and mitigation measures would be appropriate to avoid or minimize potential effects. It is anticipated that the identified BMPs and mitigation measures would include appropriate measures identified in section 5.6.2. With the implementation of the evaluation procedures, BMPs, and mitigation requirements identified for Alternative 1, it is anticipated that impacts on aquatic biota and habitats from wind energy projects interconnecting to Western's transmission facilities or allowed to place wind energy structures on Service easements through easement exchange would be negligible or minor.

5.6.4.4 Threatened, Endangered, and Special Status Species

Under Alternative 1, project-specific NEPA evaluations and ESA Section 7 consultations would tier from the analyses in this PEIS as long as the evaluation approach, BMPs, and mitigation measures identified in section 2.3.2.2 would be incorporated into project plans and implemented by developers as part of projects being evaluated.

On the basis of discussions between Western and the Service relative to programmatic measures that could be implemented to limit the potential for adverse effects on federally listed species (i.e., species listed as threatened or endangered and species that are candidates for listing under the ESA) and designated critical habitat for those species, a draft set of measures that would result in determinations that listed species and designated critical habitat would not be affected or are not likely to be adversely affected by wind energy development activities have been identified for each of the federally listed species, candidates for listing, and designated critical habitats that occur within the UGP Region. These measures are summarized in Table 2.3-2. Additional formal ESA Section 7 consultation beyond the programmatic consultation being completed as part of this PEIS would not be required for projects for which the project developers commit to implementing the appropriate and applicable programmatic avoidance measures, BMPs, and mitigation measures that would result in a determination that listed species are not likely to be adversely affected. However, project-specific ESA Section 7 consultation (potentially including formal consultation) would be required for (1) any listed species not considered in the programmatic consultation and (2) for any listed species for which project developers are unwilling or unable to implement the programmatic avoidance measures, BMPs, or mitigation measures applicable to a project.

Impacts on threatened, endangered, and special status species from wind energy project development in the UGP Region under this alternative would be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.2). Even though the ESA Section 7 consultation process would likely be streamlined under Alternative 1 (due to establishment of programmatic avoidance criteria, BMPs, and mitigation measures), it is expected that the consultation process currently followed under the No Action Alternative would also result in identification of project-specific BMPs and mitigation measures that would be just as protective of federally listed species.

As under the No Action Alternative, wind energy developments that would fall under the purview of Western and the Service are expected to occur primarily within areas identified as having high wind development potential and that are in close proximity to Western's transmission facilities (<25 mi [40 km]) or that occur on Service easements. The amount of suitable habitat for species listed under the ESA as threatened or endangered, or species that are proposed or candidates for listing, estimated to occur in areas of high wind development suitability are shown in table 5.6-17. Table 5.6-18 estimates the potential for impacts to suitable habitat for federally listed species from wind energy projects on the basis of the overlap of suitable habitat areas, and lands with a high suitability for wind energy development that are located within 25 mi (40 km) of Western's transmission facilities. With appropriate siting of project structures to avoid sensitive habitats and implementation of appropriate BMPs and mitigation measures, realized magnitudes of impacts would be lower than the identified potential impact levels.

As under the No Action Alternative, impacts on threatened, endangered, and special status species and their habitats (including designated critical habitat for ESA-listed species) would be dependent on project location and placement of project facilities, the amount of land disturbance (i.e., project footprint, number of turbines, access roads, and transmission lines), duration and timing of construction activities and operation periods, and indirect impacts such as habitat fragmentation, soil erosion, and surface runoff.

It is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for Alternative 1, impacts on threatened, endangered, and special status species and designated critical habitats from wind energy projects interconnecting to Western's transmission facilities or allowed to place wind energy structures on Service easements through easement exchange would be minor (i.e., not rise to the level of take).

5.6.5 Alternative 2

Under Alternative 2, Western would follow the same environmental evaluation process and would require developers to apply the same evaluation approaches, BMPs, and mitigation measures for wind energy projects requesting interconnection to Western's transmission system as identified for Alternative 1 (see section 2.3.2). This would include implementation of the same programmatic risk evaluation approach and the same programmatic procedures for compliance with the BGEPA and ESA Section 7 as identified for Alternative 1. All projects would be required to meet established Federal, State, and local regulatory requirements. As with Alternative 1, project-specific NEPA evaluations would be required by Western for interconnection requests, but those NEPA evaluations would tier off of the analyses in this PEIS as long as the project developer is willing to implement the same BMPs and mitigation measures identified for Alternative 1 (see section 2.3.2). If a developer does not wish to implement the evaluation process, BMPs, and mitigation measures identified for this alternative, a separate NEPA evaluation of interconnection requests that does not tier off the analyses in the PEIS would be required. The Service would not allow easement exchanges for wind energy development under Alternative 2.

It is assumed that the level of wind energy development within the UGP Region under Alternative 2, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to those identified for the No Action Alternative. As with the No Action Alternative and Alternative 1, wind energy developments requesting interconnection to Western's transmission system under Alternative 2 would be expected to occur primarily within areas identified as having high suitability for wind development and that are in close proximity to Western's electric grid (within 25 mi [40 km]) (figure 2.4-4). Although direct placement of wind energy facilities on easements managed by the Service within the UGP Region would not be accommodated, it is anticipated that this would result in developers siting those structures on nearby private lands not managed under easements, rather than a noticeable change in the distribution of wind energy facilities within the UGP Region.

5.6.5.1 Vegetation

The types and amounts and locations of vegetation communities that could be affected by wind energy development under Alternative 2 are not expected to differ markedly from those described for the No Action Alternative (section 5.6.3.1). Because no wind energy facilities would be placed on lands managed under Service easements, the direct and indirect impacts on vegetation communities on easements themselves would be smaller. However, because it is anticipated that the number of facilities that would have to be placed elsewhere would be small and because the amount of land area and vegetation likely to be affected by development of those facilities would also be small, the change in impacts to vegetation from a regional perspective would likely be negligible. Because the BMPs and mitigation measures that would be applied to specific projects requesting interconnection to Western's transmission system would be determined using the same evaluation procedures for ecological resources identified for Alternative 1 in section 2.3.2, it is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for Alternative 2, impacts on plant communities and wetlands from those wind energy projects would be minor. Mitigation requirements associated with Federal and/or State permits required for unavoidable wetland impacts would further limit impacts.

5.6.5.2 Wildlife

Under Alternative 2, impacts on wildlife and their habitats from wind energy project development in the UGP Region would be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.2) and Alternative 1 (section 5.6.4.2), although no direct impacts would be expected on wildlife within Service easements. This does not preclude the possibility that individuals of some wildlife species that utilize habitats on easements may travel outside the boundaries of the Service easements, where they could be affected by wind energy project activities occurring on non-easement lands. Implementation of appropriate BMPs and mitigation measures would be expected to reduce most project impacts on wildlife to largely negligible or minor levels. As under Alternative 1, long-term habitat impacts may occur from project construction that would continue through the operational life of a wind energy facility. Operation and maintenance of a wind energy facility would also cause long-term impacts on some wildlife. Most notably, birds and bats would be subject to collisions with turbines; birds, in particular, would also be subject to colliding with transmission lines. It is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for Alternative 2, impacts on wildlife from wind energy projects interconnecting to Western's transmission facilities would be minor.

5.6.5.3 Aquatic Biota

Under Alternative 2, impacts on aquatic biota and habitats from wind energy project development in the UGP Region would be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.3) and Alternative 1 (section 5.6.4.3), although no direct impacts would be expected on aquatic biota or habitats within Service easements. It is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for Alternative 2, impacts on aquatic biota and habitats from wind energy projects interconnecting to Western's transmission facilities would be negligible or minor.

5.6.5.4 Threatened, Endangered, and Special Status Species

Under Alternative 2, impacts on threatened, endangered, and special status species from wind energy project development in the UGP Region would be expected to be similar in nature to those identified for Alternative 1 (section 5.6.4.4). In contrast to the No Action Alternative and Alternative 1, the Service would not consider accommodation of requests for wind energy development on Service easements under Alternative 2; therefore, no direct impacts from characterization or construction activities would be expected on threatened, endangered, and special status species or their habitats within Service easements. This does not preclude the possibility that individuals of some species may travel outside the boundaries of the Service easements, where they could be affected by wind energy project activities occurring on non-easement lands. Under this alternative, Western would evaluate all interconnection requests using the same procedures described in chapter 2 for Alternative 1, and project-specific NEPA evaluations could tier off of the PEIS as long as the BMPs and mitigation measures identified in the PEIS are implemented (as applicable) as part of any project that is approved to interconnect to Western's transmission system.

Under Alternative 2, impacts on threatened, endangered, and special status species from wind energy project development in the UGP Region may be expected to be similar in nature to those identified for the No Action Alternative and Alternative 1 (sections 5.6.3.4 and 5.6.4.4). Under Alternative 2, wind energy developments considered in this PEIS are expected to occur primarily within areas identified as having high suitability for wind development, and that are in close proximity to Western's transmission facilities (<25 mi [40 km]) (see section 2.4). Impacts on threatened, endangered, and special status species and their habitats (including designated critical habitat for ESA-listed species) may occur as a result of wind energy development under Alternative 2, on the basis of project location and the habitats that are affected by the project, the amount of land disturbance (i.e., project footprint, number of turbines, access roads, and transmission lines), duration and timing of construction and operation periods, and indirect impacts such as soil erosion and surface runoff. Programmatic BMPs and mitigation measures for wind energy projects would be implemented to minimize direct and indirect impacts to threatened, endangered, and special status species on the basis of BMPs and mitigation measures identified in section 5.6.2. In addition, programmatic consultation with the Service has been initiated to satisfy ESA Section 7 requirements for those federally listed species that may be affected by project developments. Project developers would be expected to avoid designated critical habitats and other sensitive habitats (e.g., wetlands and specific occupied habitat areas, as appropriate) for special status species. It is expected that with the implementation of the procedures, BMPs, and mitigation requirements identified for Alternative 2, impacts on threatened, endangered, and special status species and designated critical habitats from wind energy projects interconnecting to Western's transmission facilities would be minor.

5.6.6 Alternative 3

Under Alternative 3, as with the other alternatives considered in this PEIS, projects would be required to meet established Federal, State, and local regulatory requirements. However, no additional BMPs and mitigation measures would be requested of project developers by Western or the Service for wind energy projects. Distinctions between regulatory requirements versus non-regultory BMPs and non-regulatory mitigation have not been completed at this time. Those determinations will be made at a later date during review of individual proposals. Project-specific NEPA evaluations would be required and would not tier off the analyses in this PEIS. If an easement exchange was necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers on its merits as to whether or not the proposal meets regulatory requirements. Unlike in current practices (No Action), Western and the Service would not identify additional modifications to reduce the environmental impacts.

As with the other alternatives, wind energy developments submitting interconnection requests to Western under Alternative 3 would be expected to occur primarily within areas identified as having high suitability for wind development and in close proximity to Western's electric grid (within 25 mi [40 km]) (figure 2.4-4), although this is not a requirement of the alternative. As with the No Action Alternative and Alternative 1, direct placement of wind energy facilities on easements managed by the Service within the UGP Region could occur, depending on results of evaluations conducted by the Service of the potential for unacceptable impacts on conservation goals. It is assumed that the overall level of wind energy development within the UGP Region under Alternative 3, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to those identified for the No Action Alternative.

5.6.6.1 Vegetation

Under Alternative 3, separate project-specific NEPA evaluations would be required to assess direct and indirect impacts on plant communities, including wetlands. Projects would be required to meet established Federal, State, and local regulatory requirements. Many of the States in the UGP Region have some form of wetland protection regulation, and mitigation requirements associated with Federal and/or State permits required for regulated wetland impacts would reduce impacts on wetlands. Many wetlands in the UGP Region are isolated wetlands and, therefore, not under the jurisdiction of Section 404 of the Clean Water Act. Such wetlands may be vulnerable to some unmitigated impacts of wind energy development.

Because Western and the Service would not request developers to implement specific evaluation procedures or implement site-specific BMPs and mitigation measures beyond those required by established Federal, State, and local regulatory requirements, localized impacts on wetlands and other plant communities could be larger than those that would occur under the other alternatives, including the No Action Alternative.

5.6.6.2 Wildlife

Under Alternative 3, the types of impacts on wildlife and their habitats from wind energy project development in the UGP Region may be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.2). As under the No Action Alternative, long-term reduction in some habitat features as a result of project construction could continue through the operational life of a wind energy facility. Operation and maintenance of a wind energy facility would also result in long-term impacts on some wildlife. Most notably, birds and bats would be subject to collisions with turbines; birds, in particular, would also be subject to colliding with transmission lines. Because Western and the Service would not request developers to implement specific evaluation procedures or implement site-specific BMPs and mitigation measures beyond those required by established Federal, State, and local regulatory requirements, localized impacts on wildlife from some activities could be greater than those that would occur under the other alternatives, including the No Action Alternative.

5.6.6.3 Aquatic Biota

Under Alternative 3, the types of potential impacts on aquatic biota would be similar in nature to the impacts described for the No Action Alternative (section 5.6.3.3). However, under Alternative 3 the magnitude of impacts on aquatic biota and habitats from wind energy projects considered for interconnection requests by Western or for accommodation of project facilities on easements managed by the Service could be greater than under the other alternatives, including the No Action Alternative, because some BMPs and mitigation measures that would be identified for those alternatives may not be requested of applicants under Alternative 3.

5.6.6.4 Threatened, Endangered, and Special Status Species

The types of impacts on threatened, endangered, and special status species from wind energy project development in the UGP Region under Alternative 3 may be expected to be similar in nature to those identified for the No Action Alternative (section 5.6.3.4). Compared to other alternatives, projects under Alternative 3 may receive somewhat less oversight for the protection of ecological resources in general because some BMPs and mitigation measures that would be applied under the other alternatives may no longer be applied under this alternative. However, because of the Federal and State regulations in place to protect threatened, endangered, and special status species and their habitats, it is anticipated that appropriate BMPs and mitigation requirements to address impacts on such species and habitats would be identified and implemented under Alternative 3. Under such conditions, impacts on threatened, endangered, and special status species and designated critical habitats from wind energy projects interconnecting to Western's transmission system or being allowed to place components on Service easements through easement exchange would be similar to those under the No Action Alternative.

5.7 VISUAL RESOURCES

This section describes potential visual impacts that could occur in the UGP Region from anticipated wind energy development under the proposed action and alternatives analyzed in this PEIS. The common impacts section (5.7.1) describes potential visual impacts that could occur in the UGP Region during major phases of a typical wind energy development project's life cycle. Potential mitigation measures and best practices to reduce or avoid visual impacts from wind energy development are also presented.

The common impacts discussion is followed by a discussion of potential impacts under the four PEIS alternatives (section 5.7.2-5.7.5). The visual impact analysis for potential development under the four PEIS alternatives is general in nature, because the actual development levels that might occur under the alternatives are estimates, and the alternatives do not identify the precise locations of future wind energy projects or the precise size and configurations of future projects. A detailed visual impact assessment is highly site- and project-specific and is not possible without knowing the precise location, size, and configuration of the proposed project, as well as having accurate topographic data and other information that might affect project visibility, such as the presence or absence of screening vegetation and structures. Impacts on particular visually sensitive areas would be assessed as part of the environmental assessment that would be conducted when a specific project is proposed. Depending on the type of analysis necessary for a project, the assessment could include a viewshed analysis that would determine the visibility of the proposed wind energy project from nearby visually sensitive areas, as well as visual impact simulations that would allow stakeholders to get a more precise understanding of the likely appearance of the project from key observation points that would be determined as part of the impact assessment.

The more general visual impact analysis for potential development under the four PEIS alternatives assumes that visual impact levels would be proportional to the number of wind energy projects visible from visually sensitive areas, including scenic resource areas such as National Parks and scenic trails, as well as roadways, housing developments, and other locations where there were large numbers of viewers, long-duration views, or particularly sensitive viewers. In most cases, visually sensitive areas close to wind energy projects would be subject to greater visual impacts than those sensitive areas farther away from the projects; however, local topography, vegetation, and project layout could affect project visibility and perceived visual contrast levels substantially. The analysis identifies areas where wind development may occur under each of the alternatives, shows on maps where selected sensitive visual resource areas (generally areas with high scenic values) are located with respect to the potential wind energy development areas, and discusses the general levels of visual impact that might be expected relative to impacts under the No Action Alternative.

5.7.1 Common Impacts

Visual impacts can be defined as the human response to the creation of visual contrasts that result from the introduction of a new element into the viewed landscape. These visual contrasts interact with the viewer's perception, preferences, attitudes, sensitivity to visual change, and other factors that vary by individual viewer to cause the viewer to react negatively or positively to the changes in the viewed landscape.

Site characterization, construction, operation, and decommissioning of wind energy and associated electric transmission facilities potentially would introduce visual contrasts that would cause a variety of visual impacts. The types of visual contrasts of concern include the potential visibility of wind turbine generators, electric transmission structures and conductors, and associated facilities such as roads; marker lighting on wind turbine generators and transmission structures as well as security and other lighting; modifications to landforms and vegetation; vehicles associated with transport of workers and equipment for construction, operations and maintenance, and facility decommissioning; and the construction, operation, maintenance, and decommissioning activities themselves. A subset of potential visual impacts associated with wind turbine generator structures includes blade movement, blade glinting, and shadow flicker.

While it is possible to describe landscape characteristics, the visual attributes of a proposed project and the degree of visual contrast a proposed project may potentially create, viewer reactions to the proposed project are both subjective and site- and time-specific because of the subjective and experiential nature of human visual perception and cognition in the assessment of the magnitude and importance of perceived visual impacts (Hankinson 1999; University of Newcastle 2002). The perception of visual impacts is highly dependent not only on physical factors that affect what and how the impacts are seen, but also on the number and type of viewers, their sensitivity to the visual environment, their personal preferences and attitudes, and other cultural factors that concern both the viewer and the affected landscape (Benson 2005; BLM 1984; DTI 2005; University of Newcastle 2002; USFS 1995). These factors must be considered in assessing visual impacts.

Factors that influence the perception and evaluation of visual impacts include the following:

- *Impact Characteristics*. The nature and extent of visual contrast associated with the impact depend on the visual characteristics of the impact, including the type of structures; their size and shape; their number and spacing; surface characteristics; visual complexity; the areal extent of the development; the possible presence of visible movement, as from wind turbine generator blades and smoke or dust plumes; and other inherent visual attributes of the impact source.

- *Viewer Distance*. Viewer distance from an affected area is a key factor in determining the level of visual impact, with perceived impact generally diminishing as distance between the viewer and the affected area increases.

- *View Duration*. Duration affects perceived visual impact; impacts that are viewed for a long period of time are generally judged to be more severe than those viewed briefly.

- *Viewer Movement*. Viewer movement affects perceived visual impact because the view of the impacting feature will change as the viewer moves; the viewing experience becomes sequential and dynamic, rather than static.

Depending on the route of the moving viewer, the apparent size and aspect of an impacting feature may change, as well as its spatial relationship with other landscape elements in both the foreground and background. The impacting feature may be partially or wholly screened during a portion of the viewing experience, and the impacting feature may be gradually revealed or concealed as the viewer moves.

- *Visibility Factors*. These are factors that affect the visibility of an impacting feature to viewers. Circumstances or activities that reduce or eliminate views of the impacting feature will reduce or eliminate perceived visual impact. Atmospheric conditions (night, mist, fog, and rain) may also provide temporary screening. Conversely, projects placed at higher elevations relative to viewers may be conspicuously visible over larger areas and thus have greater visual impact. Viewer elevation and aspect with respect to the impact can also affect impact visibility by increasing or decreasing the viewable area and reducing or increasing screening effectiveness. The presence of lighting on or near impacting features will enhance visibility.

- *Seasonal and Lighting Conditions*. Because visual contrast is a key factor in determining the visual impact of a proposed project, seasonal and lighting conditions that affect contrast may affect perceived visual impact. Sun angle that changes by season and time of day affects shadow casting, specular reflection, and color saturation, which affect contrast and perceived impact.

- *Landscape Setting*. Landscape setting plays a key role in determining the level of perceived visual impacts because it provides the context for judging the degree of contrast in form, line, color, and texture between the proposed project and the existing landscape (a key factor in visual impact assessment) as well as the appropriateness of the project to the landscape. Some landscapes are perceived by most viewers to have intrinsically higher scenic value than other landscapes, and physical landscape properties also determine the visual absorption capacity of the landscape; that is, the degree to which the landscape can absorb visual impacts without serious degradation in perceived scenic quality. Scenic integrity describes the degree of “intactness” of a landscape, which is the amount of visual disturbance present; landscapes with high scenic integrity are generally regarded as more sensitive to visual disturbances.

- *Number of Viewers*. Impacts are generally more acceptable in areas that are seldom seen; conversely, impacts are generally less acceptable in areas that are heavily used/viewed.

- *Viewer Activity, Sensitivity, and Cultural Factors*. The type of activity a viewer is engaged in when viewing a visual impact may affect the perception of impact level. Some individuals and groups are inherently more sensitive to visual impacts than others, as a result of educational and social background, life experiences, personal preferences and attitudes, and other cultural factors.

The specific ways in which these factors may influence the perception and evaluation of visual impacts of utility-scale wind facilities are discussed in section 5.7.1.1.

Experience with U.S. and European land-based and European offshore wind facilities has shown that potential visual impacts are often a primary reason for opposition to wind energy developments (Burall 2004; Gipe 2002; Sowers 2006). Primary public concerns include the potential loss of "naturalness" of landscape views and possible effects on land values and tourism.

5.7.1.1 Visual Impacts of Wind Turbine Generators and Ancillary Facilities

Site Characterization. Site characterization of a proposed wind energy facility includes activities that could involve visual impacts. Typical site characterization activities include the placement of one or more meteorological towers in or near the proposed wind energy facility to collect one or more years of meteorological data. Meteorological towers are instrumented towers that vary in height and appearance, but are often 164 ft (50 m) or more in height for wind energy applications, generally approximating the hub height of the proposed wind turbine generators. Multiple meteorological towers would be interconnected with data collection and integration equipment, usually contained in an enclosure centrally located between the towers. A variety of meteorological tower designs are available. Meteorological towers are typically metal (galvanized or painted) lattice-type structures; however, composite materials are also sometimes used, as are smooth-skinned materials. Meteorological towers may be guyed or self-supporting; on guyed meteorological towers, guy wires could be visible depending on distance, and depending on the presence of bird diverters.

Aviation warning lights would be required for meteorological towers more than 200 ft (60.9 m) tall; normally these would be red flashing lights (FAA 2007). Figure 5.7-1 shows a typical lattice-type meteorological tower.

A meteorological tower in a typical landscape would introduce a vertical line that would contrast with the horizon line that dominates many views in the UGP Region, while potentially introducing geometrical man-made elements into a natural or mostly natural landscape. On guyed meteorological towers, guy wires and bird diverters would increase visible contrast for viewers, depending on their distance from the meteorological towers. Some color contrast would also be present, in addition to the FAA-required lighting at night on sufficiently tall towers. Duration of the visual impacts associated with site characterization meteorological towers would be from 1 to 3 years for a typical project, although some meteorological towers might be retained for the life of the project, or replaced elsewhere on the project site with permanent meteorological towers.

Visual impacts from meteorological towers would depend largely on viewer distance from the meteorological tower; the tower could dominate views for viewers sufficiently close. Meteorological towers would likely be visible for several miles under some weather conditions, particularly at night, when aviation warning lights on the towers would be visible. Under daylight conditions, a meteorological tower would be expected to have a much smaller visual impact than an individual wind turbine generator, because the meteorological tower has no turbine or nacelle, has a more slender support structure (often an open latticework), and has no moving

FIGURE 5.7-1 394-ft Lattice-Type Guyed Meteorological Tower

parts that would be visible from longer distances. In some cases, weather conditions might render the open-latticework top of the tower invisible or nearly so from longer distances. Overall, visual impacts of meteorological towers in daylight views would be expected to be negligible to minor except for nearby viewers (Vissering et al. 2006). At night, a flashing light or lights on meteorological towers viewed from several miles away would normally be expected to have a minor impact, which could be a negligible impact if other lights were present, such as cell, radio, and microwave towers that can be found throughout the UGP Region.

Vehicles and workers would be seen during tower construction, and vehicles and workers might occasionally be seen at the tower for maintenance activities, but these activities would be rare and the visual impact would likely be negligible.

Construction. Construction activities for a wind energy facility would involve a range of activities associated with potential visual impacts. Construction activities are site- and project-dependent; however, construction of a typical facility in the UGP Region would normally involve the following major actions with potential visual impacts: building/upgrading roads; grading the site; constructing laydown areas; removing vegetation from construction and laydown areas; transporting towers, turbines, nacelles, and other materials and equipment to the wind energy facility site; assembling and erecting the wind turbine generators; installing permanent meteorological towers (as necessary); constructing ancillary structures (e.g., control building, fences); constructing electrical power conditioning facilities and substations; and installing power-conducting cables and signal cables (typically buried). Additional construction activities may also be necessary at very remote locations or for very large wind energy projects; they may include constructing temporary offices, sanitary facilities, a concrete batching plant, or a transmission line.

Potential visual impacts that could result from construction activities include contrasts in form, line, color, and texture resulting from vegetation clearing and grading (with associated debris); road building/upgrading; construction and use of staging and laydown areas; wind turbine generator, electric transmission, and support facility construction; vehicular, equipment, and worker presence and activity; dust; and emissions. Construction visual impacts would vary in frequency and duration throughout the course of construction; there may be periods of intense activity followed by periods with less activity; and associated visual impacts would to some degree vary in accordance with construction activity levels. Construction schedules are project-dependent. While many projects might be completed within one year, larger projects may take longer and could involve phased development, with construction-related visual impacts therefore lasting longer.

Construction for a wind energy development would require clearing of vegetation, large rocks, and other objects for roads, construction laydown areas, crane staging areas, building pads, and wind turbine tower foundations. The nature and extent of clearing are affected by the requirements of the project, the types of vegetation, and other objects to be cleared. Vegetation clearing and topographic grading may be required for the construction of access roads, maintenance roads, and roads to support facilities (e.g., electric substations). Typically, vegetation-clearing activities would create visual impacts primarily by changing the color and texture of the cleared areas, with additional impacts occurring if refuse materials are not disposed of off-site, mulched, or otherwise concealed. Vegetation clearing could lead to wind-blown dust and to invasive species, if appropriate mitigation measures are not taken.

Depending on the area being developed, a large proportion of the project disturbance may be on cultivated cropland.

Constructing new temporary and permanent access roads and/or upgrading existing roads would be required to support project construction and maintenance activities. Roads would normally be expected to be 10 to 30 ft (3 to 9 m) wide and topped with aggregate. Road development may introduce strong visual contrasts in form, line, color, and texture to the landscape, depending on the elevation compared to the surrounding area, the relationship of the routes to surface contours, and the widths, lengths, and surface treatments of the roads. Construction of access roads would have some associated residual impacts (e.g., vegetation disturbance) that could be evident for some years afterward, with a gradual diminishing of impacts over time. These impacts could be lessened by application of mitigation measures, which are presented elsewhere in this session.

Construction of new wind energy facilities would require construction laydown areas for stockpiling and storing equipment and materials needed during construction, as well as crane staging areas for storing crane components and crane assembly. Construction laydown areas might be 1 to 3 ac (0.01 to 0.03 ha) in size for turbine assembly, and numerous laydown areas and crane staging areas would be required during the construction phase. In addition, there could be a 10- to 30-ac (0.1– to 0.3-ha) construction yard that serves as an assembly point for construction crews and includes offices, storage trailers, fuel tanks, and vehicle parking. The nature and extent of visual impacts associated with construction laydown areas and crane staging areas would depend in part on the size of the area and the nature of required clearing and grading, and on the types and amounts of materials stored at the laydown areas. The presence of materials and equipment in these areas would introduce temporary changes in form, line, color, and texture to the visible landscape, and additional visual contrasts could be introduced by any vegetation clearing or grading required. Most of these areas would be reclaimed immediately after completion of construction.

Because of the very large size of wind turbine towers, blades, and other components, the transport and installation of wind turbines on-site are visually conspicuous activities. Large, and in some cases very unusual, vehicles are required to transport some components, and because the construction of wind energy facilities is still a relatively new phenomenon, in some project areas, the sight of turbine blades and other large components on these vehicles on local roads would be memorable to many members of the public.

The installation of turbines at the project site typically involves excavating the tower foundation, pouring concrete, and performing a variety of other standard construction activities, but because of the height and size of the turbines and the cranes involved, tower erection and placement of the nacelle and rotor on the tower could be visible for long distances. After foundation preparation, each turbine assembly would be completed in three days or less, but erection of the turbine is separated in time from completing the foundation work, because the concrete takes about a month to cure. For a large facility, installation of turbines and associated visual impacts could last for months, but at a given turbine location there would be brief periods of activity between periods of little or no activity. Construction that takes place on private lands might be far from public roads, and thus visible to relatively few viewers.

The various construction activities described above require work crews, vehicles, and equipment that would add to the temporary visual impacts of construction. Small-vehicle traffic for worker access and large-equipment traffic (e.g., trucks, graders, excavators, and cranes) for road and building construction, site preparation, and turbine installation would be expected. Both kinds of traffic would produce visible activity and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions. Temporary parking for vehicles would be needed at or near work locations. Unplanned and unmonitored parking could likely expand these areas, producing visual contrast due to suspended dust and loss of vegetation. Construction activities would proceed in phases, with several crews moving through a given area in succession, giving rise to brief periods of intense construction activity (and associated visual impacts) followed by periods of inactivity. Cranes and other construction equipment would produce emissions while in operation and may thus create visible exhaust plumes.

Ground disturbance would result in visual impacts that produce contrasts of color, form, texture, and line. Any excavating that might be required for building foundations and ancillary structures, trenching to bury cables, grading and surfacing roads, clearing and leveling staging areas, and stockpiling soil and spoils (if not removed) would (1) damage or remove vegetation, (2) expose bare soil, and (3) suspend dust. Soil stockpiles could be visible for the duration of construction. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil could result from excavation, leveling, and equipment/vehicle movement. Invasive species may colonize disturbed and stockpiled soils and compacted areas. These species may be introduced naturally in seeds, plants, or soils introduced for intermediate restoration or by vehicles. In some situations, the presence of invasive species may introduce contrasts with naturally occurring vegetation, primarily in color and texture. The presence of workers and construction activities could also result in litter and debris that could create negative visual impacts within and around work sites. Site monitoring, adherence to standard construction practices, and restoration activities would reduce many of these impacts.

Other construction activities could include bracing and cutting existing fences and constructing new fences and gates or cattle guards to contain livestock; providing temporary walks, passageways, fences, or other structures to prevent interference with traffic. If a concrete batching plant were required, it might create a visible steam plume temporarily under certain atmospheric conditions. New wind energy facilities might require construction of a substation and transmission lines; visual impacts associated with these facilities are discussed in section 5.7.1.3.

Operation. Visual impacts associated with the development of wind energy facilities in the project area include the presence of wind turbine structures; movement of the rotor blades; shadow flicker and blade glinting; turbine marker lights and other lighting on control buildings and other ancillary structures; roads; vehicles; and workers conducting maintenance activities. Potential visual impacts associated with electric transmission facilities are discussed in section 5.7.1.3.

Wind Turbines. The primary visual impacts associated with wind energy developments would result from the introduction of the numerous vertical lines of wind turbines into the generally strongly horizontal landscapes found in most of the project area, or the placement of turbines on ridgelines where they would be “skylined” in an area of greater topographic relief. The visible structures would potentially produce visual contrasts by virtue of their design attributes (form, color, and line) and the reflectivity of their surfaces and resulting glare. In addition, marker lighting could cause large visual impacts at night.

For nearby viewers, the very large sizes and strong geometric lines of both the individual turbines themselves and the array of turbines could dominate views, and the large sweep of the moving rotors would tend to command visual attention. Structural details, such as surface textures, could become apparent, and the control buildings and other structures could be visible as well, as could strong specular reflections from the towers and moving rotor blades (blade glint). Developers will often locate operations and maintenance facilities and substations or switchyards out of sight behind topographic features, which would reduce the potential for visual impacts. For viewers close enough to fall within the cast shadows of the turbines, shadow flicker might be observed. These effects are described in more detail below.

The magnitude of the visual impacts associated with a given wind energy facility would depend on site- and project-specific factors, including:

- Distance of the proposed wind energy facility from viewers;

- Weather and lighting conditions;

- Size of the facility (i.e., number of turbines) and turbine spacing;

- Size (including height and rotor span) of the wind turbines;

- Surface treatment of wind turbines, the control building, and other structures (primarily color);

- The presence and arrangements of lights on the turbines and other structures;

- Viewer characteristics, such as the number and type of viewers (e.g., hosting landowners, residents, tourists, motorists, and workers) and their attitudes toward renewable energy and wind power;

- The visual quality and sensitivity of the landscape, including the presence of sensitive visual and cultural resources including historic properties;

- The existing level of development and activities in the wind energy facility area and nearby areas, and the landscape's capacity to withstand human alteration without loss of landscape character (i.e., scenic integrity and visual absorption capability); and

- The presence of workers and vehicles for maintenance activities.

These factors would typically be evaluated in detail during the course of the site-specific environmental analysis; a general discussion is provided here.

The visibility of a structure depends on the distance between the viewer and the structure; the dimensions of the structure; the elevation of the viewer and structure; the presence of intervening terrain, vegetation, or structures; and the curvature of the earth. The visibility table (table 5.7-1) allows calculation of the maximum viewing distance of a structure for a given distance, structure height, and viewer elevation, and shows that (ignoring elevation differences between the viewer and the wind turbine, and assuming viewer height of 5 ft [1.5 m]) a theoretical maximum viewing distance for a 400-ft (122-m) wind turbine is 26 mi (42 km). If the wind turbine was located on a 300-ft (91-m) hill, the theoretical viewing distance would be 34 mi (54 km). At such a very long distance, the wind turbine would not be noticed by a casual viewer, thus causing negligible visual impact. However, the theoretical visibility distances may exceed what is experienced in a real situation. In real landscapes, atmospheric haze shortens the practical viewing limit, sometimes significantly, and the presence of foreground objects (e.g., topography and vegetation, such as hedgerows and shelterbelts) may also obscure objects very low to the horizon. Furthermore, limits to human visual acuity reduce the ability to discern objects at great distances, suggesting that some turbine components (e.g., blades) would not be discernible at long distances, even though they theoretically would be visible (University of Newcastle 2002). The color, reflectivity, and other visual characteristics of the object and its contrast with the visual background under varying lighting conditions also affect its visibility (Hill et al. 2001; DTI 2005; University of Newcastle 2002).

The relationship of distance to perceived visual impact is important to accurately assessing potential visual impacts for wind energy facilities, but the issue is complex and partially site- and project-specific, so there is currently no agreed-upon standard. Benson et al. (2002) suggest a zone of visual influence (ZVI, the areal extent of turbine visibility) of 21.7 mi (35 km) for wind turbines that are 328 ft (100 m) tall. The NRC (2007) states that 1.5- to 3-MW turbines are visible from 20 mi (32 km) away or more. Based on systematic assessment of eight built wind energy facilities involving turbines between 175 and 215 ft (53 and 66 m) in overall height in the United Kingdom (UK), the University of Newcastle study (2002) suggests that such wind turbines are perceptible at a range of about 9–12 mi (15–20 km) “and up to 15.5 mi (25 km) in special cases and conditions.” The authors suggest that these limits apply for viewers specifically looking for the turbines and that casual observers would notice turbines at about a 6–9 mi (10–15 km) distance. The study recommends a ZVI of about 19 mi (30 km) for turbines 328 ft (100 m) in height (including blades) and, by extrapolation, an approximate value of about 23 mi (37 km) for turbines 410 ft (125 m) in height. However, the University of Newcastle study suggests that beyond 19 mi (30 km), the limits of human visual acuity would begin to limit visibility. The study also states that for turbines between 175 and 215 ft (53 and 66 m) in overall height, turbine detail becomes noticeable at distances of about 3–5 mi (5–8 km), and at distances of about 6–7 mi (10–12 km) turbines begin to be perceived as a group rather than as individual structures. Note that the studies were conducted in the UK, where atmospheric conditions may differ from those in the UGP Region and there are generally more trees, and also that because turbine visibility is determined largely by turbine height, as turbines increase in size, visibility limits would increase.

An extrapolation of the Sinclair-Thomas matrix (Sinclair 2001) in the University of Newcastle study suggests that at distances of 0–2.5 mi (0–4 km), wind farms with turbines 295–328 ft (90–100 m) in overall height would dominate views “due to large scale, movement, proximity, and number” and that at distances of 2.5–5 mi (4–8 km), they would cause major visual impacts and could dominate landscape views. A National Research Council report (NRC 2007) states that the most significant impacts are likely to occur within 3 mi of the facility, and suggests a 10-mi (16-km) radius for impact assessment, or a 15–20 mi (24–32 km) radius in special situations involving sensitive visual resources.

TABLE 5.7-1 Visibility Table (distances at which objects can be seen at sea according to their respective elevations and the elevation of the eye of the observer)

Height (ft)	Distance (geographic or nautical mi)	Height (ft)	Distance (geographic or nautical mi)	Height (ft)	Distance (geographic or nautical mi)	Height (ft)	Distance (geographic or nautical mi)	Height (ft)	Distance (geographic or nautical mi)	Height (ft)	Distance (geographic or nautical mi)
1	1.2	23	5.6	45	7.8	135	13.6	340	21.6	620	29.1
2	1.7	24	5.7	46	7.9	140	13.8	350	21.9	640	29.5
3	2.0	25	5.9	47	8.0	145	14.1	360	22.2	660	30.1
4	2.3	26	6.0	48	8.1	150	14.3	370	22.5	680	30.5
5	2.6	27	6.1	49	8.2	160	14.8	380	22.8	700	31.0
6	2.9	28	6.2	50	8.3	170	15.3	390	23.1	720	31.4
7	3.1	29	6.3	55	8.7	180	15.7	400	23.4	740	31.8
8	3.3	30	6.4	60	9.1	190	16.1	410	23.7	760	32.3
9	3.5	31	6.5	65	9.4	200	16.5	420	24.0	780	32.7
10	3.7	32	6.6	70	9.8	210	17.0	430	24.3	800	33.1
11	3.9	33	6.7	75	10.1	220	17.4	440	24.5	820	33.5
12	4.1	34	6.8	80	10.5	230	17.7	450	24.8	840	33.9
13	4.2	35	6.9	85	10.8	240	18.1	460	25.1	860	34.3
14	4.4	36	7.0	90	11.1	250	18.5	470	25.4	880	34.7
15	4.5	37	7.1	95	11.4	260	18.9	480	25.6	900	35.1
16	4.7	38	7.2	100	11.7	270	19.2	490	25.9	920	35.5
17	4.3	39	7.3	105	12.0	280	19.6	500	26.2	940	35.9
18	5.1	40	7.4	110	12.3	290	19.9	520	26.7	960	36.3
19	5.1	41	7.5	115	12.5	300	20.3	540	27.2	980	36.6
20	5.2	42	7.6	120	12.8	310	20.6	560	27.7	1,000	37.0
21	5.4	43	7.7	125	13.1	320	20.9	580	28.2		
22	5.5	44	7.8	130	13.3	330	21.3	600	28.7		

Continued on next page.

TABLE 5.7-1 (Cont.)

Explanation: The line of sight connecting the observer and a distant object is at maximum length tangent with the spherical surface of the sea. It is from this point of tangency that the tabular distances are calculated. The table must accordingly be entered twice to obtain the actual geographic visibility of the object—first with the height of the object and second with the height of the observer's eye—and the two figures so obtained must be added. Thus, if it is desired to find the maximum distance which a powerful light may be seen from the bridge of a tangent vessel where the height of the eye of the observer is 55 ft above the sea, from the table:

	Nautical mi
55 feet height of observer (visible)	8.7
200 feet of light (visible)	16.5
Distance visible	25.2

Source: Seascape Energy Ltd. (2002).

1

Sullivan et al. (2012) made 377 observations of five wind facilities in Wyoming and Colorado under various lighting and weather conditions to assess wind turbine visibility and visual contrast threshold distances. The facilities were found to be visible to the unaided eye at distances greater than 36 mi (58 km) under optimal viewing conditions. Under favorable viewing conditions, the wind facilities were judged to be major foci of visual attention at distances up to 12 mi (19 km) and likely to be noticed by casual observers at distances greater than 23 mi (37 km). Sullivan suggested that an appropriate radius for visual impact analyses would be 30 mi (48 km), that the facilities would be unlikely to be missed by casual observers at up to 20 mi (32 km), and that the facilities could be major sources of visual contrast at up to 10 mi (16 km). However, visibility in the UGP PEIS study region is generally somewhat poorer than in the Wyoming/Colorado area included in Sullivan's study.

Based on these empirical studies, it is reasonable to expect that within the UGP Region, assuming good visibility, a wind farm with wind turbines approximately 400 ft (122 m) in overall height could be visible from approximately 25 mi (40 km) or farther, and could potentially cause large visual contrasts at distances less than 7–8 mi (11–13 km), and more moderate impacts up to approximately 15 mi (24 km), with smaller visual impacts beyond approximately 15 mi (24 km). These values are approximate, dependent on facility and turbine size, the number of turbines visible, and subject to lighting, atmospheric, and other effects.

Atmospheric haze could reduce turbine visibility (Bishop 2002; URS 2007). Backlighting or frontlighting can either decrease or increase contrast depending on the backdrop. Using photographic simulations, Bishop (2002) found that conditions of high contrast could significantly increase the perceived visual impact of turbines (e.g., when front-lit turbines are viewed against a dark sky or when backlit turbines are viewed against a bright sky). In cases in which turbines are viewed against a landform and vegetation ("backclothing"), the light grey or white color can produce strong visual contrasts with the background, but contrast is reduced when the ground/vegetation is snow-covered (University of Newcastle 2002). Strong visual contrasts can also occur when wind turbines are prominently placed along ridgelines and therefore viewed against an open sky ("skylining"). Because much of the UGP Region is relatively flat or rolling, this situation would be relatively uncommon.

When the rotor blades on turbines are moving, the movement would tend to attract viewers' attention to a greater extent than when the blades were not moving (Gipe 1990, 2002; University of Newcastle 2002). Expert judgment in a field-based study involving wind turbine visibility at eight wind energy facilities in Scotland (University of Newcastle 2002) indicated that blade movement increased visual impact in all cases, was discernible at distances of up to 9.3 mi (15 km) in optimum viewing conditions, and would be noticeable to casual viewers at distances of up to approximately 6.2 mi (10 km). Sullivan et al. (2012) repeatedly observed blade movement at distances of approximately 24 mi (39 km) in favorable viewing conditions in eastern Wyoming; however, within most of the UGP PEIS study region, somewhat lower limits of blade movement visibility would be expected.

Note, however, that while blade movement would tend to increase turbine visibility and the associated visual impact at longer distances, some studies have indicated that the visual impacts of moving turbine blades are positive (NRC 2007; WIMP 1987, cited in Gipe 1990), reportedly in part because idle turbines are perceived by some viewers to be nonproductive (Pasqualetti et al. 2002; Thayer 1988).

As wind turbine blades spin under sunny conditions, they may cast moving shadows on the ground or nearby objects, resulting in alternating light intensity (flickering) as each blade shadow crosses a given point. If the duration and intensity of shadow flicker is sufficient, it can cause a nuisance to viewers, particularly if they are subjected to it frequently, as at their homes or places of work (NRC 2007). Several factors determine the nature and extent of shadow flicker occurrence and the magnitude of potential associated visual impacts at a given wind energy facility (Acciona Energy 2007; Hassel 2005; Nielsen 2003), including the following:

- Distance and orientation of affected location with respect to turbines;
- Rotor size and height of turbines;
- Blade orientation, pitch, and speed (dependent on wind speed and direction);
- Geographic location and sun angle;
- Local topography;
- Presence of screening vegetation;
- Weather/cloud cover;
- Presence of airborne particles/haze; and
- Presence of sensitive viewers.

Shadow flicker effects are more likely to cause visual impacts when the sun is low in the sky, as at sunrise or sunset, and in winter months when cast shadows are longest; however, at greater distances from the turbines, the loss of shadow intensity and sharpness will reduce the visual impacts associated with shadow flicker (NRC 2007). Similarly, cloud cover or haze will reduce shadow intensity and sharpness, thus reducing shadow flicker effects. In general, because shadow flicker effects are dependent on precise geometric relationships between receptors, the turbines, and the sun's direction and height above the horizon, with proper siting, shadow flicker effects are typically very limited in duration and area of effect.

Blade glinting is the reflection of sunlight from moving wind turbine blades when viewed from certain angles under certain lighting conditions. BLM (2005) suggests blade glint may be visible for long distances in some cases; Sullivan et al. (2012) observed blade glinting at a distance of approximately 16 mi (26 km). An International Finance Corporation report (IFC 2007) notes that glinting can also occur from wind turbine tower surfaces. The IFC report suggests that blade and tower glinting is a problem primarily for new turbines, that the problem is reduced as turbines become soiled in normal use, and that it can be mitigated through the use of low-reflectivity coatings, which are commonly specified for wind turbines and other structures to reduce specular reflections on blades and towers.

The visibility and associated visual impacts of a wind energy facility and of individual wind turbines depend in part on the size of the facility, the arrangement of the turbines, and the size, height, surface treatment, and other characteristics of the turbines.

Based on the assumption of unobstructed views, larger numbers of visible wind turbines would have increased visibility, which would be expected to increase perceived visual impact, but the perceived impact is not necessarily directly proportional to the number of wind turbines in view (Pasqualetti et al. 2002; University of Newcastle 2002). Regular spacing (grid layout) versus nonregular spacing (random layout) can strongly affect the appearance of the wind energy facility, with viewers generally finding regular turbine spacing to have less negative visual impact, but the apparent geometry can change significantly as viewer location and distance change (DTI 2005).

Wind turbines are generally painted white or light gray to blend in with sky backgrounds, but other colors are sometimes used in particular settings, such as beige or tan in desert settings (Gipe 1995). When viewed against earth or vegetated backdrops, light-colored wind turbines may create strong color contrasts with these backdrops; however, over much of the relatively flat UGP Region, views against earth or vegetated backdrops would be uncommon. Low-reflectance coatings are commonly specified for wind turbines and other structures to reduce specular reflections; however, leaking fluids could collect dust and grime that soil towers and create negative visual impacts for nearby viewers. These impacts could be avoided by proper maintenance and cleaning (Pasqualetti et al. 2002).

FAA guidelines for marking and lighting wind energy facilities require lights that flash white during the day and at twilight and red at night (FAA 2007). The white daytime lights may be omitted if the turbines are painted white or a light shade of off-white, as is frequently the case. White light strobes could be used optionally. All marker lights within a wind farm are also required to flash simultaneously (approximately 24 times/minute); however, only the perimeter turbines of a wind farm need such markings, provided that there is no unlighted gap greater than 0.5 mi (0.81 km). Terrain, weather, and other location factors allow for adjustments to the manner in which FAA requirements are applied.

The presence of aircraft warning lights would greatly increase visibility of the turbines at night, because the synchronized flashing red warning lights or strobes could be visible for long distances. In the dark nighttime sky conditions typical of the predominantly rural setting within the UGP Region, the warning lights could potentially cause large visual impacts (Gipe 2002; Hecklau 2005), especially if few similar light sources were present in the area. In nighttime observations in a rural setting in eastern Wyoming, Sullivan et al. (2012) observed plainly visible red aircraft warning lights on a wind farm containing 277 wind turbines at distances exceeding 36 mi (58 km). At this distance, the areal extent of visible lighting from the wind turbines was small, but the lights were easily seen because of the synchronized flashing of the red lights against a featureless black background. White lights would likely be less obtrusive in daylight.

Because of their intermittent operation, aircraft warning lights would likely not contribute to sky glow from artificial lighting; however, security and other lighting on support structures (e.g., the control building) could contribute to skyglow. These impacts could be reduced by shielding or other measures and would be expected to be minimal effects in any event because typically only the maintenance facility and possibly the control building in the substation would have lighting capable of producing skyglow.

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

Although describing visual changes that arise from the construction, operation, and decommissioning of wind facilities is relatively straightforward, determining the nature and consequences of the impacts is complicated not only by the site-specific nature of visual impacts but also by the sensitivities of affected viewers and the subjective nature of aesthetic judgments (BLM 1984; NWCC 2002; USFS 1995).

As indicated in section 5.7.1, potential visual impacts are often the primary reason for opposition to wind energy developments, and aesthetic concerns have been a factor in the delay or modification of a number of wind development projects worldwide (Gipe 2002; IEA 2011). Aesthetic concerns include the potential loss of “naturalness” of landscape views and concern about possible effects on land values and tourism. However, a number of research studies on visual impacts of wind energy developments have indicated that wind power enjoys strong support from the public (Gipe 2002; Warren et al. 2005; Yale University 2005), and unlike most large-scale energy facilities, wind turbines are in some cases viewed as having a positive visual impact by significant portions of the public (Minnesota Project 2005; Warren et al. 2005; SEI 2003).

General attitudes toward wind energy may influence public perceptions of wind farms. A study by Johansson and Laike (2007) found that people’s general attitude toward wind power was a significant predictor of their response to a local wind energy project, with wind power supporters being more in favor of the specific project than wind energy opponents. Pedersen and Persson Waye (2008) found synergistic effects between perceived noise, perceived visual impacts, and attitudes toward wind power; their study showed that people with anti-wind energy views perceived wind turbines to be noisier and more visually intrusive than those who supported wind power.

Warren et al. (2005) assessed pre- and post-development attitudes toward visual impacts associated with two wind energy facilities in Ireland. For one location, the survey found that more than 90 percent of survey respondents supported the concept of wind power, but 66 percent of respondents were initially opposed to a local proposed wind energy facility. Contrary to expectations, persons living closest to the wind energy facilities, who had originally opposed it on aesthetic grounds, actually increased their acceptance of the visual impacts after its construction, with 62 percent regarding the visual impact as positive. Similar results were observed for a second wind energy facility. The results in both cases suggested that familiarity with the wind energy facilities decreased aesthetic objections. Stated reasons for changing perceptions of visual impacts varied among respondents; some thought the turbines were attractive, while others thought that the actual impacts were less than had been anticipated. Other studies are in general agreement with these conclusions and suggest that wind power enjoys strong public support in general, that wind power is often opposed at a project-specific level based partly on objections to visual impacts, but that acceptance of visual impacts and support for wind power rise after the facility is built, even for nearby residents (Gipe 2002; Krohn and Damborg 1999; NRC 2007).

The degree of visual impact for a wind energy facility is determined in part by the number of viewers who experience the impact, as well as the type of activities viewers are engaged in when viewing a visual impact, their inherent sensitivity to visual impacts, their educational and social background, their life experiences, and other cultural factors. The perception of visual impacts associated with wind energy development vary among potential viewers, may be positive or negative, and can change over time, and these factors interact in complex ways with landscape characteristics, such as scenic value, visual absorption capacity, and scenic integrity.

The relatively low population density of most of the UGP Region suggests that while wind energy facilities may be visible for long distances, they will generally be viewed by few people, relative to more densely populated areas such as the eastern United States or Europe; however, there may still be significant numbers of viewers in some parts of the UGP Region (Sowers 2006). Impacts on residents are generally greater than those on more transient viewers, such as drivers or workers, in part because residents are likely to view wind energy facilities more frequently and for longer durations. However, a number of studies have shown that residing close to a wind energy facility does not necessarily negatively affect residents' perception of visual impacts (Krohn and Damborg 1999; Warren et al. 2005).

A wind energy facility located in a pristine, high-value scenic landscape typically will be more conspicuous and therefore perceived as having greater visual impact than if that same project were present in an industrialized setting of low scenic value where similar projects were already visible. Some landscapes have special meaning to some viewers because of unique scenic, cultural, or ecological values and are therefore perceived as being more sensitive to visual disturbances. Depending on visibility factors, wind energy facilities located near sensitive landscapes, such as national parks, historic sites, landscapes sacred to native tribes, scenic highways and trails, recreational attractions, and other valued cultural features, may be of particular concern to the public. In the generally visually simple landscapes common to much of the UGP Region (flat to rolling topography, primarily treeless grassland or agricultural land with few structures), visual absorption capacity is relatively low, and wind energy facilities could therefore be more conspicuous, which might result in greater perceived visual impacts.

In one of the few studies addressing public acceptance of wind power and perceptions of visual impact in the UGP Region, Sowers (2006) noted that a large number of project sites in the region had no significant opposition, which was attributed in part to the region's inhabitants regarding wind turbines as a source of income and as being compatible with their perceptions of wind energy facilities providing a "working" agricultural landscape. Most residents he interviewed indicated that they did not view the visual impacts negatively, viewing wind turbines in some cases as "another piece of farm machinery." However, this small, interview-based study involved a little area in northwestern Iowa and may not necessarily be representative of attitudes throughout the UGP Region.

Ancillary Structures. In addition to visual impacts associated with wind turbines, aboveground ancillary structures (including permanent meteorological towers, control buildings, electrical power conditioning facilities, and substations) would potentially produce visual contrasts by virtue of their design attributes (form, color, line, and texture) and by virtue of the reflectivity of their surfaces and resulting glare. Section 5.7.1.2 contains a more detailed discussion of visual impacts associated with substations.

Roads. Roads could also contribute to visual impacts during wind facility operations. In many cases, construction access roads would not be needed during operations and would be reclaimed after construction. Certain roads would remain, such as on-site roads used for inspection and maintenance and the permanent facility access road. Maintenance roads and facility access roads would generally be gravel-surfaced roads. In addition to vegetative clearing, roads may introduce strong visual contrasts to the landscape, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Ground disturbances (e.g., grading and erosion control measures) might introduce lasting visual impacts, while improper management could lead to the growth of invasive species or erosion, both of which could introduce undesirable contrasts in line, color, and texture, primarily for foreground and near-middle-ground views.

Workers, Vehicles, and Equipment. Maintenance activities could potentially cause visual impacts. Vehicles (potentially with associated dust plumes) and technicians would be present at or near wind turbines and other facilities where they would either work directly on the turbine or associated facilities or remove components for repair and subsequent reinstallation. Towers, nacelles, and rotors may need to be upgraded or replaced, thereby repeating initial visual impacts of construction and assembly. Pressures to lessen uniformity among turbines and components (different sizes, styles, and mixes) may be greater than during initial construction, thus potentially increasing visual contrast and visual “clutter.” Additional construction and installation of monitoring equipment may be required to optimize measurements or to replace or upgrade equipment. Repeated visual evidence of disturbance could result. Infrequent outages, disassembly, and repair of equipment may occur. These may produce the appearance of idle or missing rotors, “headless” towers (when nacelles are removed), and lowered towers. Negative visual perceptions of “lost benefits” (e.g., loss of wind power) and “bone yards” (for storage) may result (BLM 2005).

Decommissioning. Decommissioning of a wind energy project would involve the dismantling and removal of infrastructure associated with each wind turbine, the removal of aboveground and some buried ancillary structures, road redevelopment, temporary fencing, and restoration of the decommissioned site to pre-project conditions. In terms of expected visual impacts, decommissioning activities would be similar to construction activities. However, activities would generally proceed in reverse order from construction and would proceed more quickly than during construction; thus, the associated impacts would last for a shorter time.

Restoration activities would include recontouring, grading, scarifying, seeding and planting, and perhaps stabilizing disturbed surfaces. Newly disturbed soils would create a visual contrast that could persist for several seasons before revegetation would begin to disguise past activity. Restoration of vegetation to pre-project conditions may take much longer. Invasive species may colonize newly and recently reclaimed areas. These species may be introduced naturally or in seeds, plants, or soils introduced for intermediate restoration, or by vehicles. Non-native plants that are not locally adapted would likely produce contrasts of color, form, texture, and line.

In a manner similar to construction (see section 6.2.21.3), the various decommissioning activities described above require work crews, vehicles, and equipment that would add to visual impacts during decommissioning.

5.7.1.2 Visual Impacts of Electricity Transmission and Ancillary Facilities

Visual impacts from the construction, operation, and decommissioning of an electricity transmission project are associated with activities that occur during the construction and decommissioning phases of a project and the longer-term impacts that result from the presence and operation of the project facilities themselves. Some impacts are common to transmission lines and wind energy facilities; however, the main structures are fundamentally different in terms of visual impacts.

Site Construction. Potential visual impacts that could result from electricity transmission construction activities include contrasts in form, line, color, and texture resulting from ROW clearing with associated debris; road building/upgrading; construction and use of staging and laydown areas; mainline and support facility construction; vehicular, equipment, and worker presence and activity; and associated vegetation and ground disturbances, dust, and emissions.

ROW Construction. Construction on a ROW requires clearing of vegetation, large rocks, and other objects. The nature and extent of ROW clearing are affected by the ROW requirements of the project, the types of vegetation and other objects to be cleared, and the extent to which a preexisting cleared ROW is being used. Because the construction ROW may be wider than the permanent ROW, the initial cleared area might be much wider than the permanent ROW, thus potentially resulting in a greater visual impact. More complete vegetation clearing and topographic grading would be required for the construction of access roads, maintenance roads, and roads to support facilities (e.g., electric substations). Typically, vegetation-clearing activities would create visual impacts if refuse materials are not either disposed of off-site or mulched, or otherwise concealed. Related activities could include bracing and cutting existing fences and constructing new fences, gates, and cattle guards to contain livestock; providing temporary walks, passageways, fences, or other structures to prevent interference with traffic; and providing lighting in any areas where work might be conducted at night.

Road Building/Upgrading. As noted above, construction of new temporary and permanent access roads and/or upgrading of existing roads to support project construction and maintenance activities would be required in some locations, but would be minimized if transmission was routed along existing roads or trails. Road development may introduce strong visual contrasts to the landscape, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Construction of access roads would have some associated residual impacts (e.g., vegetation disturbance) that could be evident for some years afterward, with a gradual diminishing of impacts over time.

Staging and Laydown Areas. Construction of electricity transmission facilities would require staging areas for temporary stockpiling and storage of equipment and materials needed during construction. For electricity transmission lines, staging areas are generally 1 to 3 ac (0.01 to 0.03 ha) in size and are typically located every 8 to 10 mi (13 to 16 km) along the line. Laydown areas are used for longer term stockpiling and storage of equipment and materials during construction and are normally located adjacent to but not within ROWs. Laydown areas may be located every 8 to 10 mi (13 to 16 km) along the ROW and may be several acres in size. The nature and extent of visual impacts associated with these areas would depend in part on the size of the area and the nature of required clearing and grading, whether the area was an existing or newly constructed site, and the types and amounts of materials stored at the areas. Typically, these areas would be located in cropland or grassland where clearing and grading would not be needed. Some newly constructed staging areas could be converted into permanent facilities for facility maintenance, while laydown areas would be reclaimed immediately after completion of construction.

Construction of Mainline Facilities. Large, cleared, and generally level areas are required for electricity transmission line structure construction and assembly, as well as cable-pulling sites (which may be located on existing laydown areas); these areas would be reclaimed after construction. Smaller areas are generally required for related construction activities. Because electricity transmission facilities are linear, construction activities generally proceed as a “rolling assembly line,” with work crews gradually moving through an area at varying rates depending on circumstances. Transmission line construction activities include clearing, leveling, and excavating at tower sites, as well as assembling and erecting towers followed by cable pulling (see figure 5.7-2). These construction activities would have potentially substantial but temporary visual impacts.

Construction of Support Facilities. Construction of a variety of support facilities would also be required for electricity transmission facilities. Support structures for electricity transmission and distribution systems include substations and switchyards. Construction activities associated with these facilities include clearing, grading, soil compacting, and surfacing with aggregate, in addition to erecting buildings and fences. Substation construction typically requires 6 to 9 months and covers approximately 10 to 15 ac (0.1 to 0.15 ha) for the fenced station plus 3 ac (0.03 ha) for construction support.

Blasting of Rock Faces and Other Cavities. Construction activities associated with ROW clearing, road building, and facilities construction could sometimes involve blasting of rock faces, trenches, and cavities for transmission structure foundations. In all cases, there would potentially be temporary visual impacts from dust, smoke, and debris associated with blasting. Subsurface blasting impacts would not be visible after remediation; however, rock face blasting typically would permanently alter the form of the affected area, although alterations to color may gradually diminish over a long period of time. Because of the generally flat or rolling terrain in much of the UGP Region, rock face blasting would rarely be necessary.

Workers, Vehicles, and Equipment. The various construction activities described above require work crews, vehicles, and equipment that would add to visual impacts during construction. Small-vehicle traffic for worker access and large-equipment traffic (trucks, graders, excavators, and cranes) would be expected for road construction, site preparation, and transmission structure installation. Both kinds of traffic would produce visible activity and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions. Temporary parking for vehicles would be needed at or near

FIGURE 5.7-2 Transmission Structure under Construction

work locations. Unplanned and unmonitored parking could expand these areas, producing visual contrast by suspended dust and loss of vegetation. Construction activities would proceed in phases, with several crews moving through a given area in succession, giving rise to brief periods of intense construction activity (and associated visual impacts), followed by periods of inactivity. There would be the temporary presence of large cranes to erect transmission structures as well as possible helicopter use for particularly remote or rugged terrain. Cranes and other construction equipment would produce emissions while in operation and may thus create visible exhaust plumes.

Construction activities could be conducted at night, resulting in night sky impacts from vehicles and activity lighting. These night sky impacts could potentially be visible for long distances from the construction site, but it would be temporary.

Other Visual Impacts from Construction. Ground disturbance would result in visual impacts that produce contrasts of color, form, texture, and line. Excavating for structure foundations and ancillary structures, grading and surfacing roads, clearing and leveling staging areas, and stockpiling soil and spoils (if not removed) would (1) damage or remove vegetation, (2) expose bare soil, and (3) suspend dust. Soil stockpiles could be visible for the duration of construction. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil could result from excavation, leveling, and equipment/vehicle movement. Invasive species may colonize disturbed and stockpiled soils and compacted areas. These species may be introduced naturally; by seeds, plants, or soils introduced for intermediate restoration; or by vehicles. In some situations, the presence of invasive species may introduce contrasts with naturally occurring vegetation, primarily in color and texture. The presence of workers and construction activities could also result in litter and debris that could create negative visual impacts within and around work sites. Site-monitoring and -restoration activities could reduce many of these impacts.

Site Operation. The operation and maintenance of electricity transmission lines and their associated facilities, roads, and ROWs would have potentially substantial long-term visual effects.

The primary visual impacts associated with electricity transmission facilities would result from the introduction of the generally vertical lines and rectilinear geometry of the transmission structures into the generally strongly horizontal landscapes found in most of the UGP Region, especially if transmission lines were located on ridgelines where they would be “skylined” in areas of greater topographic relief. The visible structures (towers and, to a lesser degree, conductors) would potentially produce visual contrasts by virtue of their design attributes (form, color, and line) and the reflectivity of their surfaces and resulting glare. In forested areas, vegetation clearing for the ROW could also create strong visual contrasts, particularly when view direction is parallel to the ROW; however, in much of the UGP Region vegetation clearing would be unnecessary or would be minimal because of the absence of vegetation tall enough to require clearing.

For nearby viewers, the very large form and strong geometric lines of both the individual transmission structures and the array of structures and conductors in a transmission line could dominate views. Details of transmission structures, such as surface textures and line marking devices, could become apparent, and substations could be visible as well, as could strong specular reflections from the structures, conductors, and other reflective surfaces.

As with wind energy facilities, electricity transmission facilities are associated in many cases with large and unavoidable visual impacts; public opposition to the visual impacts of electricity transmission facilities may be intense and is frequently cited as a major obstacle to building electricity transmission projects (Bishop et al. 1985; Hull and Bishop 1988).

ROW. The width of cleared area for the permanent ROW for a given project would be determined at the project-specific level, but ROW clearing would be unnecessary in much of the UGP Region because of the absence of vegetation tall enough to require clearing. Most vegetation management would be limited to windbreaks or riparian crossings, generally a very small percentage of overall ROW length. Impacts associated with clearing include the potential loss of vegetative screening that would result in the opening of views, especially down the length of the ROW; potentially significant changes in form, line, color, and texture for viewers close to the ROW; and potentially significant changes in line and color for viewers with distant views of the ROW. In general, the impacts would be greater in areas with trees, where vegetation-clearing impacts are more conspicuous, particularly in areas where there are strong color contrasts between understory and overstory vegetation (Hadrian et al. 1988; Driscoll et al. 1976). While the opening of views for viewers close to a cleared ROW might be a positive visual impact in some circumstances, the introduction of strong linear and color contrasts in middle-ground and background views as a result of clearing ROWs can create large negative visual impacts, particularly in forested areas where either the viewer or the ROW is elevated in such a way that long stretches of ROW are visible. The presence of snow cover might greatly accentuate color contrasts in cleared ROWs. In worst-case situations, the impacts could be visible for many miles (Driscoll et al. 1976). Various design and mitigation measures could be used to avoid or reduce impacts in these situations; mitigation measures are presented elsewhere in this section.

Restoration efforts would include reseeding areas where bare soils are exposed. Good mitigation practice would dictate reseeding non-agricultural areas with native plants, which would minimize visual contrasts, but, depending on circumstances, a number of years might pass before contrasts between reseeded and uncleared areas would no longer be noticeable. If non-native plants were used for reseeding or if a lack of proper management led to the growth of invasive species in the reseeded areas, noticeable color and texture contrasts might remain indefinitely. The unsuccessful reclamation of cleared areas may result in soil erosion, ruts, gullies, or blowouts that could cause long-term negative visual impacts unless redial restoration is accomplished.

Other cleared areas would include maintenance roads and facility access roads (e.g., electric substations). Some support facilities would be surrounded by cleared areas. Visual impacts associated with these cleared areas would include the potential loss of vegetative screening that would result in the opening of views and potentially significant changes in form, line, color, and texture for viewers close to the cleared area. Clearing for roads might be subject to some of the linear contrast concerns mentioned above for ROWs. Mainline facility maintenance roads would generally be within the cleared ROW and, in most cases, would not add substantially to the impact., Access roads would generally be shorter but in some cases may create or considerably increase visual impacts (Driscoll et al. 1976). In both cases, the cleared area would be relatively narrow, especially compared to typical electricity transmission line ROW clearings.

Mainline Facilities: Electricity Transmission Structures and Conductors. Electricity transmission structures, where visible, would create potentially large visual impacts. The structures, conductors, insulators, aeronautical safety markings, and lights would all create visual impacts. The visual presence of a transmission line would last from construction throughout the life of the project.

The magnitude of the visual impacts associated with electricity transmission structures and conductors would depend on site- and project-specific factors, including the following:

- Distance of the proposed electricity transmission facility from viewers;

- Viewing angle;

- Weather conditions and lighting conditions;

- The number of structures visible and their spacing;

- Size of the transmission structures;

- Surface treatment of structures and conductors;

- Viewer characteristics, such as the number and type of viewers (e.g., residents, tourists, workers) and their attitudes;

- The visual quality and sensitivity of the landscape, including the presence of sensitive visual and cultural resources;

- The existing level of development and activities in the wind energy facility area and nearby areas, and the landscape's capacity to withstand human alteration without loss of landscape character (i.e., scenic integrity and visual absorption capability); and

- The presence of workers and vehicles for maintenance activities.

These factors would typically be evaluated in detail during the course of the site-specific environmental analysis; a general discussion is provided here.

As noted above, the visibility of a structure depends on the distance between the viewer and the structure, the dimensions of the structure, the elevation of the viewer and structure, and the curvature of the earth. Several studies have addressed the issue of the visibility of transmission lines, particularly the effect of viewer distance on visibility and perceived visual impact (Hull and Bishop 1988; Driscoll et al. 1976). The Driscoll et al. (1976) field-based study recorded visibility of transmission line corridors up to 30 mi (48.3 km) or more in special circumstances, but suggests 25 mi as a conservative estimate of the maximum distance the largest transmission facilities would be visible in most circumstances. However, at these distances, perceived visual impacts would be minimal. The study examined visibility and perceived impact thresholds for a variety of landscapes and structure types, and found distances of 0.8 to 2.3 mi (1.3 to 3.7 km) for high-medium perceived visual impacts, 1.8 to 5.3 mi (2.9 to 8.5 km) for medium-low perceived impacts, and 14.0 to 20 mi (22.5 to 32 km) for low to detection-limit impacts. Variability was explained primarily by structure type and size and landscape type, although there were a number of variables not considered in the study that might have reduced or increased the perceived impact levels in certain situations. In the open landscapes present in much of the UGP Region and under favorable viewing conditions, the structures and conductors might be visible for many miles, especially if skylined. A variety of mitigation measures could be used to reduce impacts from these structures (see section 5.7.1.3), but, because of their size, it is difficult to avoid at least some level of visual impact in many circumstances, except at very long distances.

Hull and Bishop (1988) found that the perceived visual impact of transmission lines dropped off quickly with distance, with visual impacts greatly diminished beyond 1 km; however, the study examined a much more limited range of variables and structure types, and the study relied on the use of 35-mm slides as surrogates for field-based observations.

Viewing angle could be an important factor in determining the perceived visual impact of electricity transmission facilities (Driscoll et al. 1976). Transmission structures present narrower profiles when viewed from the side, which presumably would result in lower perceived visual impacts than structures seen face on. A series of structures viewed parallel to the ROW would normally create far larger visual impacts than structures viewed more perpendicularly to the ROW, not only because of the strong lines of the ROW edges but also because multiple structures of different apparent size would be visible in the same view when viewed down the

ROW, particularly when the viewer is elevated with respect to the transmission line. The eye would also follow transmission lines, and this could direct attention to parts of the landscape or additional transmission structures and ROWs that might otherwise escape close scrutiny.

As for wind turbines, atmospheric haze could reduce electricity transmission facility visibility (Driscoll et al. 1976). Backlighting or frontlighting could either decrease or increase contrast, depending on the backdrop. Transmission lines would be significantly less visible against vegetated backgrounds than against the sky, especially when backlit. Because much of the UGP Region is relatively flat or rolling, viewing transmission lines against vegetated backgrounds would be relatively uncommon.

Transmission lines that connect wind facilities to the electrical grid (“gen-tie lines”) would typically use single pole steel, or perhaps single pole wood or wood pole H-frame structures. Main transmission grid line additions might be lattice steel, but could also be monopole structures. Transmission structures could be as tall as 150 ft (45.7 m) with cross arms as much as 100 ft (30.5 m) wide. A transmission line with structures of such dimensions might be constructed to serve areas where there is a reasonable expectation, based on the availability and accessibility of the wind resource, that numerous wind farms may be developed over time in a relatively limited geographic area. Structures for transmission line segments providing interconnections to the existing high-voltage grid for individual wind energy facilities typically would be far smaller.

The height of single-pole single-circuit structures would range from approximately 55 to 150 ft (16.8 to 45.7 m), depending on voltage, but most gen-tie lines for wind facilities would use structures less than 100 ft (30.5 m) tall. Either single- or multiple-pole structures might be utilized as angle structures, which are generally more massive and somewhat different in appearance than regular transmission structures, because of the need to withstand greater tension. Monopole transmission structures are shown in figure 5.7-2 and figure 5.7-3.

H-frame structures for typical gen-tie lines vary in size and configuration details, and might be of wooden or steel construction. Single-circuit H-frame structures typically would be approximately 60 to 90 ft (18.3 to 27.4 m) high (Minnesota Electric Transmission Planning 2011). Double-circuit H-frame structures would range in height between approximately 90 and 125 ft (27.4 and 38.1 m). An H-frame transmission structure is shown in figure 5.7-4.

For all transmission structure types, structures could be considerably taller in special situations (e.g., valley crossings). Driscoll et al. (1976) found that larger structures were associated with larger perceived visual impacts. Available studies do not address the relationship between the number of visible transmission structures and perceived visual impact. It would normally be expected that having more impacting elements in view would increase visual impacts; however, it cannot be assumed that the relationship would be linear in nature.

For all transmission structure types, if steel structures are used, the finish could be galvanized steel, which would provide a shiny appearance, or Cor-ten, sometimes referred to as self-weathering, which would use an outer coating to retard normal weathering and have a brown, rusty appearance, somewhat similar to wooden poles. From a visual impact mitigation perspective, in some situations (for example, when viewed from against mountains or vegetation), Cor-ten or wooden structures may be preferable because they may blend in better

FIGURE 5.7-3 Transmission Structures: Lattice (left) and Monopole (right)

FIGURE 5.7-4 H-Frame Transmission Structure, Substation, and Guyed Meteorological Tower at Wind Facility

with the background, and are less reflective than galvanized steel; however, in the UGP Region, most transmission structures would be viewed against a sky backdrop.

Lattice structures have an open framework of thin members (compared to monopoles) but overall are much wider than monopoles. Monopoles present a single but more massive upright member, but the overall width is much smaller than that of a lattice structure (see figure 5.7-3). Special steel lattice turning structures may be employed to bear the extra weight and tension of conductors where a turn occurs in the line. Turning structures use stronger, thicker steel members than are used for typical steel lattice structures and appear more massive than typical structures when viewed from the same viewpoint.

Under certain conditions, lattice structures tend to blend better into the background when viewed from a distance against mountains or vegetation. With their slender members and open structure, they allow the forms, lines, colors, and textures of the background landscape to show through. The simpler, narrower monopoles may create less contrast with the natural environment in foreground views when viewed against the sky (i.e., skylined) compared to the "industrial" structural look of lattice structures, which could be visually dominating at short distances (DOE 2003).

Transmission structures, conductors, and insulators are subject to specular reflection, that is, the direct reflection of light off smooth reflective surfaces. These reflections could cause very bright spots (or brief flashes of light to moving observers) to appear under certain lighting conditions in which the sun directly illuminates the reflective surface, which could extend the visibility of the surfaces for several miles (BPA 2002). Specular reflections are relatively uncommon, and tend to occur early in the morning or in early evening when sun angles are relatively low; furthermore, they tend to decrease as structures age because the structure surface finishes become dull due to weathering (Hadrian et al. 1988). Nonreflective coatings or processes to eliminate or diminish specular reflection are commercially available and are often used to mitigate these impacts. However, non-specular conductors and ground wires may result in more bird collisions compared to untreated types during the first few years of service. However, after natural weathering reduces the specular reflectance of untreated conductors and ground wires the risk of bird collisions should be very similar.

Other visual impacts associated with electricity transmission lines include airway marker balls and bird diverters. These devices are designed to enhance the visibility of the structures to aircraft and birds. As such, they increase visual impacts associated with the structures and/or conductors on which they are placed. Aviation marker balls are round colored balls (usually aviation orange) that are attached to the conductors or overhead ground wires for daytime marking. They are available in various sizes, and may be 9 in. in diameter or larger, with 24-in. (61-cm) balls being in common use. Their spherical shape and the colors of the markings contrast with natural surroundings when visible (during daylight hours). Aviation marker balls would only be used on certain lines in close proximity to airports, and so would rarely be observed. Bird diverters could be required as a result of Section 7 consultation with the Service.

Little information is available that specifically addresses the influence of viewer characteristics on the perceived visual impacts of electricity transmission facilities. Driscoll et al. (1976) and Hull and Bishop (1988) recognize viewer characteristics as an important factor in determining perceived visual impact, but do not discuss specific effects.

The degree of visual impact for an electricity transmission facility would be determined in part by the number of viewers that experience the impacts, as well as the type of activity viewers are engaged in when viewing a visual impact, their inherent sensitivity to visual impacts, their educational and social background, life experiences, and other cultural factors. The perception of visual impacts associated with electricity transmission facilities would likely vary among potential viewers and could change over time. These factors could interact in complex ways with landscape characteristics, such as scenic value, visual absorption capacity, and scenic integrity. Note that, in contrast to wind energy facilities, there is no evidence to suggest that a significant portion of the public has a favorable perception of electricity transmission facilities that might influence their perception of associated visual impacts.

The relatively low population density of most of the UGP Region suggests that, while electricity transmission facilities may be visible for long distances, they would generally be viewed by few people; however, there may still be significant numbers of viewers in some parts of the region (Sowers 2006). As with wind turbines, perceived impacts on residents would generally be expected to be greater than those experienced by more transient viewers, such as drivers or workers.

Driscoll et al. (1976) and Bishop et al. (1985) found that environmental setting had important effects on the perceived visual impact of an electricity transmission facility. Visual impacts associated with an electricity transmission facility in a pristine, high-value scenic landscape would typically be more conspicuous. Therefore, it would be perceived as having a greater visual impact than if the same facility were located in an industrialized setting of low scenic value where similar projects were already visible. Regardless of scenic quality, some landscapes have special meaning to some viewers because of unique scenic, cultural, or ecological values, and are therefore perceived as being more sensitive to visual disturbances. Depending on visibility factors, electricity transmission facilities located near sensitive landscapes, such as national parks, historic sites, landscapes sacred to Native American tribes, scenic highways and trails, recreational attractions, and other valued cultural features, may be of particular concern to the public.

Driscoll et al. (1976), Bishop et al. (1985), and Hadrian et al. (1988) found that visual absorption capability strongly influenced perceived visual impact. Driscoll et al. (1976) found that visually complex backgrounds tended to reduce the visibility of transmission lines in certain landscapes. Hadrian et al. (1988) cite an earlier Driscoll et al. report suggesting that visual absorption factors increased preference ratings for scenes containing transmission structures. Bishop et al. (1985) found that negative ratings of scenes with transmission structures decreased as the visible surrounding landscape became more complex. These findings suggest that in the generally visually simple landscapes common to much of the UGP Region (flat to rolling topography, primarily treeless grassland, or agricultural land with few structures), visual absorption capacity is relatively low, and electricity transmission facilities would therefore be more conspicuous and may result in greater perceived visual impacts.

Roads. In some cases, construction access roads would not be needed during operations and would be reclaimed after construction, but more often would be retained as permanent maintenance roads used for transmission line inspection and maintenance and the permanent facility access roads. Maintenance roads (where needed) would generally be unimproved two-track roads, although there might be improvements such as drainage crossings in some locations. In addition to vegetative clearing, roads may introduce strong visual contrasts to the landscape, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Ground disturbances (e.g., grading and erosion control measures) might introduce lasting visual impacts, while improper management could lead to the growth of invasive species or erosion, both of which could introduce undesirable contrasts in line, color, and texture, primarily for foreground and near-middle-ground views.

Substations. Each transmission line would start from an existing substation, switchyard, or tap and end at a similar facility. Substations vary in size and configuration but may occupy several acres; they are cleared of vegetation and typically surfaced with gravel, are normally fenced, may include security lighting, and are reached by an all-weather permanent access road. In general, substations include a variety of visually complex equipment, structures, conductors, fencing, lighting, and other features that result in an “industrial” appearance. The industrial look of a typical substation, together with the substantial height of its structures (up to 40 ft or more) and its large areal extent, may result in large, negatively perceived visual impacts for nearby viewers, if the facility cannot be screened from view (see figure 5.7-4).

Workers, Vehicles, and Equipment. Visual impacts from workers, vehicles, and equipment should generally be much smaller at most locations during operation of an electricity transmission/distribution line than impacts that occur during construction. Maintenance would consist primarily of regular ROW inspections (likely on an annual basis), maintenance activities (e.g., vegetation management on the ROW), and occasional repairs. Some inspections and other activities might be conducted by helicopter or small aircraft. Ground-based activities require work crews (generally small crews except for major repairs), vehicles, and equipment that would create small, temporary visual impacts while under way. Some small-vehicle traffic for workers and large-equipment traffic for ROW management and repairs would be expected. Both would produce visible activity and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions.

Decommissioning. Electricity transmission facility decommissioning would involve removal of all aboveground facilities and gravel workpads and roads; subsurface facilities would be removed to a depth of 3 ft (0.9 m). Removal of these facilities would greatly reduce the visual impacts of the transmission facilities.

Either the original construction laydown areas or new laydown areas, each several acres in size, would support decommissioning; however, such laydown areas would be used only for interim storage, and salvaged equipment and materials would be promptly removed from laydown areas to staging areas. Other decommissioning activities would include road redevelopment, recontouring, grading, and scarifying; seeding, planting, maintaining, managing, and monitoring of the revegetation until self-sustainable; and perhaps stabilizing of disturbed surfaces within the ROW.

Visual impacts during decommissioning would be similar in nature to those encountered in the construction phase, but typically of shorter duration and smaller magnitude. Along with the decommissioning activities themselves, impacts would include the presence of workers, vehicles, and equipment with intermittent or phased activity persisting over extended periods of time, as well as the presence of idle or dismantled equipment for as long as such equipment remained on-site. Decommissioning activities could generate dust, emissions, litter, and other effects associated with the presence of workers, vehicles, and equipment.

Newly disturbed soils would create a visual contrast that generally would persist for at least several seasons before revegetation would begin to disguise past activity. Invasive species may colonize newly and recently reclaimed areas. These species may be introduced naturally; by seeds, plants, or soils introduced for intermediate restoration; or by vehicles. Non-native plants that are not locally adapted could produce persisting contrasts of color, form, and texture. In forested areas and in areas with dry soils or other challenging environments, regrowth to pre-project conditions could take a number of years and might not be realized without active management.

5.7.1.3 Mitigation Measures

The preceding section identified potential visual impacts that could be incurred during the construction, operation, and decommissioning of wind energy facilities and associated electricity transmission facilities. The nature, extent, and magnitude of these potential impacts would vary on a site-specific basis and depend on the specific phase of the project (e.g., construction or operation). Similarly, visual impact mitigation measures appropriate for wind energy and transmission facilities would vary on a site-specific basis and would depend on the specific phase of the project.

Several Federal agencies (e.g., BLM, U.S. Department of the Interior [DOI], and USFS), State agencies, other organizations, and individuals have established mitigation measures pertaining to visual impacts of energy production, electric transmission, roads, and associated facilities. Several of their publications (BLM 1984, 1985, 1986a,b, 1992, 2006; DOI and USDA 2006; USFS 1975, 1977, 2001; Gipe 1998, 2002; NRC 2007; NY DEC 2000; Western 2008) were the sources for mitigation measures listed in this section. These publications describe additional mitigation measures and provide related information.

Mitigation Measures Related to Project Siting. The greatest potential for visual impacts associated with wind energy facilities and associated electricity transmission systems would occur as a result of decisions made during the siting and design of the projects. In many cases, visual impacts associated with these facilities could be avoided or substantially reduced by careful project siting.

Assessment of visual resources needs to be part of the project's early pre-planning phases and must continue throughout the life of the project. A professional landscape architect should be a part of the planning team evaluating visual resource issues as project siting options are considered. The professional landscape architect and the planning team as a whole should use procedures for conducting detailed visual resource analyses that identify and map landscape characteristics, key observation points (KOPs), and key viewsheds; prominent scenic and cultural landmarks; and other visually sensitive areas near the project location.

The appropriate land management agencies, planning entities, and local public should be consulted to provide input on the identification of important visual resources in the project area and on the siting and design process. The public should be involved and informed about the visual site design elements of the proposed wind energy projects. Possible approaches include conducting public forums for disseminating information regarding facets of wind energy development, such as design, operations, and productivity; offering organized tours of operating wind energy development projects; using computer simulation and visualization techniques in public presentations; and conducting surveys regarding public perceptions and attitudes about wind energy development.

Geographical information system (GIS) tools and visual impact simulations are valuable for conducting visual analyses (including mapping), analyzing the visual characteristics of landscapes, visualizing the potential impacts of project siting and design, and fostering the type of communication among stakeholders that informs decision making. The visual analyses provide data that would be critical for identifying constraints and opportunities for siting projects to minimize visual impacts. All the above are typical components of both developer project planning and agency environmental documentation.

The following specific project-siting measures could help reduce visual impacts of wind energy development, and should be employed where appropriate and feasible:

- Because the landscape setting observed from national historic sites, national trails, and tribal cultural resources may be a part of the historic context contributing to the historic significance of the site or trail, project siting should avoid locating facilities that would alter the visual setting such as would reduce the historic significance or function.

- Where possible, projects should be sited outside the viewsheds of KOPs, highly sensitive viewing locations, and/or areas with limited visual absorption capability and/or high scenic integrity. When wind energy developments and associated facilities must be sited within view of KOPs, they should be sited as far away as possible, since visual impacts generally diminish as viewing distance increases.

- Where possible, developments should be sited in already industrialized and developed landscapes, with due consideration for visual absorption capacity and possible cumulative effects.

- Siting should take advantage of both topography and vegetation (where possible) as screening devices to restrict views of projects from visually sensitive areas.

- The eye is naturally drawn to prominent landscape features (e.g., knobs and waterfalls); thus, projects and their elements should not be sited next to such features, where possible.

- The eye naturally follows strong natural lines in the landscape, and these lines and associated landforms can “focus” views on particular landscape features. For this reason, linear facilities associated with a wind energy project, such as transmission lines and roads, generally should not be sited so that they bisect ridge tops or run down the center of valley bottoms.

- Although wind turbines may sometimes be located on ridgelines, skylining of substations, transmission structures, communication towers, and other structures associated with wind energy developments should be avoided; that is, they should not be placed on ridgelines, summits, or other locations where they will be silhouetted against the sky from important viewing locations. Siting should avoid skylining by taking advantage of opportunities to use topography as a backdrop for views of facilities and structures. The presence of these structures should be concealed or made less conspicuous by siting and designing them to harmonize with desirable or acceptable characteristics of the surrounding environment.

- Wind turbines should be sited properly to eliminate shadow flicker effects on nearby residences or other highly sensitive viewing locations, or reduce them to the lowest achievable levels, as calculated using appropriate siting software and procedures. Accurately determined shadow flicker estimates should be made available to stakeholders in advance of project approval. If turbine locations are changed during the siting process, shadow flicker effects should be recalculated and made available to potentially affected stakeholders.

- Spatially accurate and realistic photo simulations of wind turbines in the proposed location should be prepared as part of the siting process. Simulations should show views from sensitive visual resource areas; highly sensitive viewing locations, such as residences; and more representative typical viewing locations. Stakeholders should be involved in selecting KOPs for simulations. Where feasible, simulations should portray a range of lighting conditions and sun angles. Simulations should be based on accurate spatial information, particularly elevation data, and must account for screening vegetation and structures. Simulations should show enough of the surrounding landscape to show the project in the appropriate spatial context and should be reproduced at a large enough size to be comfortably viewed from the appropriate specified distance to accurately depict the apparent size of the facility in a real setting.

- As feasible, siting of linear features (ROWs and roads) associated with wind energy developments should follow natural land contours rather than straight lines, particularly up slopes. Fall-line cuts should be avoided. Where it can be accomplished without introducing unacceptable impacts on other resources, following natural contours echoes the lines found in the landscape and often reduces cut-and-fill requirements; straight lines can introduce conspicuous linear contrasts that appear unnatural.

- Siting of facilities, especially linear facilities, should take advantage of natural topographic breaks (i.e., pronounced changes in slope), and siting of facilities on steep side slopes should be avoided. Facilities sited on steep slopes are often more visible (particularly if either the project or viewer is elevated); in addition, they may be more susceptible to soil erosion, which could contribute to negative visual impacts.

- In forested areas or shrublands, where possible, linear facilities should follow the edges of clearings (where they would be less conspicuous) rather than pass through their center.

- Because visual impacts are usually lessened when vegetation and ground disturbances are minimized, where possible, in forested areas or shrublands, siting should take advantage of existing clearings to reduce vegetation clearing and ground disturbance.

- Locations for transmission line and ROW road crossings of other roads, streams, and other linear features within a corridor should be chosen to avoid KOP viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landforms. The ROWs should cross linear features (e.g., trails, roads, and rivers) at right angles whenever possible to minimize the viewing area and duration.

- To the extent possible, transmission lines and roads associated with wind energy facilities should be collocated within a corridor to use existing/shared ROWs, existing/shared access and maintenance roads, and other infrastructure in order to reduce visual impacts associated with new construction.

Mitigation Measures Related to Project Design. Most visual impact mitigation measures that apply to siting wind energy facilities as a whole would also apply to the siting and design of individual facilities, structures, roads, and other components of the projects. A number of additional mitigation measures are directed at minimizing vegetation and ground disturbance to lessen associated visual impacts:

- Wind turbine siting should be sensitive to and respond to the surrounding landscape in a visually pleasing way. For example, in rolling landscapes, a less rectilinear and rigid configuration of turbines that follows local topography may be appropriate. In flatter agricultural landscapes with rectilinear patterns of road and fields, a more geometric or linear wind turbine configuration may be preferred.

- To the extent possible, given the terrain of a site, wind turbines should be clustered or grouped when placed in large numbers, but a cluttering effect should be avoided by separating otherwise overly long lines of turbines or large arrays, and breaks or open zones should be inserted to create distinct visual units or groups of turbines.

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

- Wind turbines should exhibit visual uniformity in the shape, color, and size of rotor blades, nacelles, and towers.

- Power collection cables or lines on the site should be buried in a manner that minimizes additional surface disturbance (e.g., collocating them with access roads).

- For ancillary buildings and other structures, low-profile structures should be chosen whenever possible to reduce their visibility.

- Where screening topography and vegetation are absent, natural-looking earthwork berms and vegetative or architectural screening should be used to minimize visual impacts associated with ancillary facilities. Vegetative screening can be particularly effective along roadways.

- The siting and design of facilities, structures, roads, and other project elements should match and repeat the form, line, color, and texture of the existing landscape.

- In forested areas and shrublands, openings in vegetation for facilities, structures, roads, etc., should mimic the size, shape, and characteristics of naturally occurring openings to the extent possible.

- Through site design, the number of structures required should be minimized. Activities should be combined and carried out in one structure, or structures should be collocated to share pads, fences, access roads, lighting, etc.

- Structures and roads should be designed and located to minimize and balance cuts and fills. Reducing cut and fill has numerous visual benefits, including fewer fill piles, landforms and vegetation that appear more natural, fewer or reduced color contrasts with disturbed soils, and reduced visual disturbance from erosion and the establishment of invasive species.

- Facilities, structures, and roads should be located in stable fertile soils to reduce visual contrasts from erosion and to better support rapid and complete regrowth of affected vegetation. Site hydrology should also be carefully considered in siting operations to avoid visual contrasts from erosion. Strip, stockpile, and stabilize topsoil from the site before excavating earth for facility construction.

- The vegetation-clearing design in forested areas should include the feathering of cleared area edges (i.e., the progressive and selective thinning of trees from the edge of the clearing inward) combined with the mixing of tree heights from the edge to create an irregular vegetation outline. These actions would result in a more natural-appearing edge, thereby avoiding the very high linear contrasts associated with straight-edged, clear-cut areas.

- Structures, roads, and other project elements should be set as far back from road, trail, and river crossings as possible, and vegetation should be used to screen views from crossings, where feasible.

Mitigation Measures Related to Building and Structural Materials. Visual impacts associated with wind energy facilities and associated electricity transmission could be partially mitigated by choosing appropriate building and structural materials and surface treatments (i.e., paints or coatings designed to reduce contrast and reflectivity). A careful study of the site should be performed to identify appropriate colors and textures for materials; both summer and winter appearance should be considered, as well as seasons of peak visitor use. The choice of colors should be based on the appearance at typical viewing distances and consider the entire landscape around the proposed development. Appropriate colors for smooth surfaces often need to be two to three shades darker than the background color to compensate for shadows that darken most textured natural surfaces.

Specific mitigation measures that could be found appropriate and feasible include the following:

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

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

- Grouped structures should all be painted the same color to reduce visual complexity and color contrast.

- For ancillary structures, materials and surface treatments should repeat and/or blend with the existing form, line, color, and texture of the landscape. If the project will be viewed against an earthen or other non-sky background, appropriately colored materials should be selected for structures, or appropriate stains/coatings should be applied to blend with the project’s backdrop.

- The operator should use nonreflective paints and coatings on wind turbines, visible ancillary structures, and other equipment to reduce reflection and glare.

- Turbines, visible ancillary structures, and other equipment should be painted before or immediately after installation.

- For ancillary facilities, multiple-color camouflage technology applications should be considered for projects within sensitive viewsheds and with a visibility distance between 0.25 to 2 mi (0.4 to 3.2 km).

- Electricity transmission projects associated with wind energy facilities should utilize nonspecular conductors and nonreflective coatings on insulators.

- For transmission structures, monopoles may reduce visual impacts more effectively than lattice structures in foreground and middle-ground views, while lattice structures may be more appropriate for more distant views, where the latticework would “disappear,” allowing background textures to show through.

- Lighting for facilities should not exceed the minimum required for safety and security, and full-cutoff designs that minimize upward light scattering (light pollution) should be selected. If possible, site design should be accomplished to make security lights nonessential. Such lights increase the contrast between a wind energy project and the night sky, especially in rural/remote environments common to UGP Region. Where they are necessary, security lights should be extinguished except when activated by motion detectors (e.g., only around the substation).

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

Mitigation Measures Related to Construction. Visual impacts associated with construction activities can be partially mitigated by implementing the following measures, where appropriate and feasible:

- Where possible, staging and laydown areas should be sited outside the viewsheds of KOPs and not in visually sensitive areas; they should be sited in swales, around bends, and behind ridges and vegetative screens, where these screening opportunities exist.

- A site restoration plan should be in place prior to construction. Restoration of the construction areas should begin immediately after construction to reduce the likelihood of visual contrasts associated with erosion and invasive weed infestation and to reduce the visibility of affected areas as quickly as possible.

- Disturbed surfaces should be restored to their original contours as closely as possible and revegetated immediately after, or contemporaneously with, construction. Prompt action should be taken to limit erosion and to accelerate restoring the preconstruction color and texture of the landscape.

- Visual impact mitigation objectives and activities should be discussed with equipment operators before construction activities begin.

- Penalty clauses should be used to protect trees and other sensitive visual resources.

- Existing rocks, vegetation, and drainage patterns should be preserved to the maximum extent possible.

- Valuable trees and other scenic elements can be protected by clearing only to the edge of the designed grade manipulation and not beyond through the use of retaining walls, and by protecting tree roots and stems from construction activities. Brush-beating or mowing rather than vegetation removal should be done, where feasible.

- Slash from vegetation removal should be mulched and spread to cover fresh soil disturbances (preferred) or should be buried. Slash piles should not be left in sensitive viewing areas.

- Installation of gravel and pavement should be avoided where possible to reduce color and texture contrasts with the existing landscape.

- For road construction, excess fill should be used to fill uphill-side swales to reduce slope interruption that would appear unnatural and to reduce fill piles.

- The geometry of road ditch design should consider visual objectives; rounded slopes are preferred to V-shaped and U-shaped ditches.

- Road-cut slopes should be rounded, and the cut/fill pitch should be varied to reduce contrasts in form and line; the slope should be varied to preserve specimen trees and nonhazardous rock outcroppings.

- Planting pockets should be left on slopes, where feasible.

- Benches should be provided in rock cuts to accent natural strata.

- Topsoil from cut/fill activities should be segregated and spread on freshly disturbed areas to reduce color contrast and aid rapid revegetation. Topsoil piles should not be left in sensitive viewing areas.

- Excess fill material should not be disposed of downslope in order to avoid creating color contrast with existing vegetation/soils.

- Excess cut/fill materials should be hauled in or out to minimize ground disturbance and impacts from fill piles.

- Soil disturbance should be minimized in areas with highly contrasting subsoil color.

- Natural or previously excavated bedrock landforms should be sculpted and shaped when excavation of these landforms is required. A percentage of backslope, benches, and vertical variations should be integrated into a final landform that repeats the natural shapes, forms, textures, and lines of the surrounding landscape. The earthen landform should be integrated and transitioned into the excavated bedrock landform. Sculpted rock face angles, bench formations, and backslope need to adhere to the natural bedding planes of the natural bedrock geology. Half-case drill traces from pre-split blasting should not remain evident in the final rock face. Where feasible, the color contrast should be removed from the excavated rock faces by color-treating with a rock stain.

- Where feasible, construction on wet soils should be avoided to reduce erosion.

- Communication and other local utility cables should be buried, where feasible.

- Culvert ends should be painted or coated to reduce color contrasts with existing landscape.

- Signage should be minimized; reverse sides of signs and mounts should be painted or coated to reduce color contrasts with the existing landscape.

- The burning of trash should be prohibited during construction; trash should be stored in containers and/or hauled off-site.

- Litter must be controlled and removed regularly during construction.

- Dust abatement measures should be implemented in arid environments to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils.

Mitigation Measures Related to Operations and Maintenance. Visual impacts associated with operations and maintenance activities could be partially mitigated by implementing the following measures, where appropriate and feasible:

- Wind facilities and sites should be actively and carefully maintained during operation. Wind energy projects should evidence environmental care, which would also reinforce the expectation and impression of good management for benign or clean power.

- Inoperative or incomplete turbines cause the misperception in viewers that “wind power does not work” or that it is unreliable. Inoperative turbines should be repaired, replaced, or removed quickly. Nacelle covers and rotor nose cones should always be in place and undamaged.

- Nacelles and towers should be cleaned regularly (yearly, at minimum) to remove spilled or leaking fluids and the dirt and dust that accumulates, especially in seeping lubricants.

- Facilities and off-site surrounding areas should be kept clean of debris, “fugitive” trash or waste, and graffiti. Scrap heaps and materials dumps should be prohibited and prevented. Materials storage yards, even if thought to be orderly, should be kept to an absolute minimum. Surplus, broken, disused materials and equipment of any size should not be allowed to accumulate.

- Maintenance activities should include dust abatement (in arid environments), litter cleanup, and noxious weed control.

- Road maintenance activities should avoid blading of existing forbs and grasses in ditches and adjacent to roads; however, any invasive or noxious weeds should be controlled as needed.

- Interim restoration should be undertaken during the operating life of the project as soon as possible after disturbances.

Mitigation Measures Related to Decommissioning. As noted above, a reclamation plan that includes visual impact mitigation measures should be in place prior to construction, and reclamation activities should be undertaken as soon as possible after disturbances occur and be maintained throughout the life of the project. The following reclamation activities/practices can partially mitigate visual impacts associated with electricity transmission/distribution lines and pipelines, where appropriate and feasible:

- All aboveground and near-ground structures should be removed.

- Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas should be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes. Contouring to rough texture would trap seed and discourage off-road travel, thereby reducing associated visual impacts.

- Cut slopes should be randomly scarified and roughened to reduce texture contrasts with existing landscapes and to aid in revegetation.

- Combining seeding, planting of nursery stock, transplanting of local vegetation within the proposed disturbance areas, and staging of construction should be considered, enabling direct transplanting. Generally, native vegetation should be used for revegetation, establishing a composition consistent with the form, line, color, and texture of the surrounding undisturbed landscape. Seed mixes should be coordinated with local authorities, such as country extension services, weed boards, or land management agencies.

- Gravel and other surface treatments should be removed or buried.

- Rocks, brush, and forest debris should be restored, whenever possible, to approximate preexisting visual conditions.

Other Mitigation Methods. In addition to mitigation measures that directly reduce the visual resource impacts of wind energy and associated facilities, aesthetic offsets present a mitigation option in some situations. Aesthetic offsets should be considered in situations where visual impacts are unavoidable or where alternative mitigation options are only partially effective or uneconomical. An aesthetic offset is a correction or remediation of an existing condition located in the same viewshed of the proposed development that has been determined to have a negative visual or aesthetic impact. For example, aesthetic offsets could include reclamation of unnecessary roads in the area, removal of abandoned buildings, cleanup of illegal dumps or trash, or the rehabilitation of existing erosion or disturbed areas.

5.7.2 No Action Alternative

Under the No Action Alternative, Western would continue to process and evaluate interconnection requests on a case-by-case basis. The Service would also continue to consider proposals to place wind energy facilities on wetland and grassland easements managed by the Service as they have in the past (section 2.1.2). This means that, in some cases, placement of facilities on Service easements will be accommodated by executing an exchange of easement interests. Separate project-specific NEPA evaluations would be required, and both agencies would identify needed BMPs and mitigation measures, on a case-by-case basis. Development could occur anywhere on unrestricted lands in the UGP Region, but would be more likely to occur on the lands with the highest suitability for wind energy development. It is assumed that there would be a greater likelihood of requests to interconnect to Western's transmission facilities where lands with high wind energy suitability are located within 25 mi (40 km) of Western's facilities. The locations of selected sensitive visual resource areas and the areas with high suitability for wind energy development within the UGP Region are shown on a State-by-State basis in figures 5.7-5 through 5.7-10. The locations of selected sensitive visual resource areas, Service easements, and the areas within 25-mi (40 km) of Western's existing substations are shown on a State-by-State basis in figures 5.7-11 through 5.7-16.

Future wind energy projects would be more likely to be sited in areas with the highest wind development suitability within the region, as shown in figures 5.7-5 through 5.7-10. As a result, it is anticipated that relatively higher impacts would be expected for sensitive visual resource areas within or near areas with higher suitability for wind energy development. Because areas with higher suitability for wind energy development are more concentrated in the eastern portions of the UGP Region, those areas would be expected to have generally higher levels of impacts than the other portions of the UGP Region.

In addition to potential visual impacts from individual projects, the addition of multiple wind energy projects to these areas, which already contain wind energy projects, would likely contribute to cumulative impacts, because there would be increased likelihood of seeing multiple wind farms from one location, or multiple wind farms in succession when traveling on area trails or roads. This would be especially likely in the open and relatively flat landscapes of much of the UGP Region, which have few screening features and generally good air quality that favors long-distance views.

Figures 5.7-11 through 5.7-16 show that a number of sensitive visual resource areas are located within 25 mi (40 km) of Western substations. Table 5.7-2 lists the selected sensitive visual resource areas that fall wholly or partially within these 25-mi (40-km) substation buffer

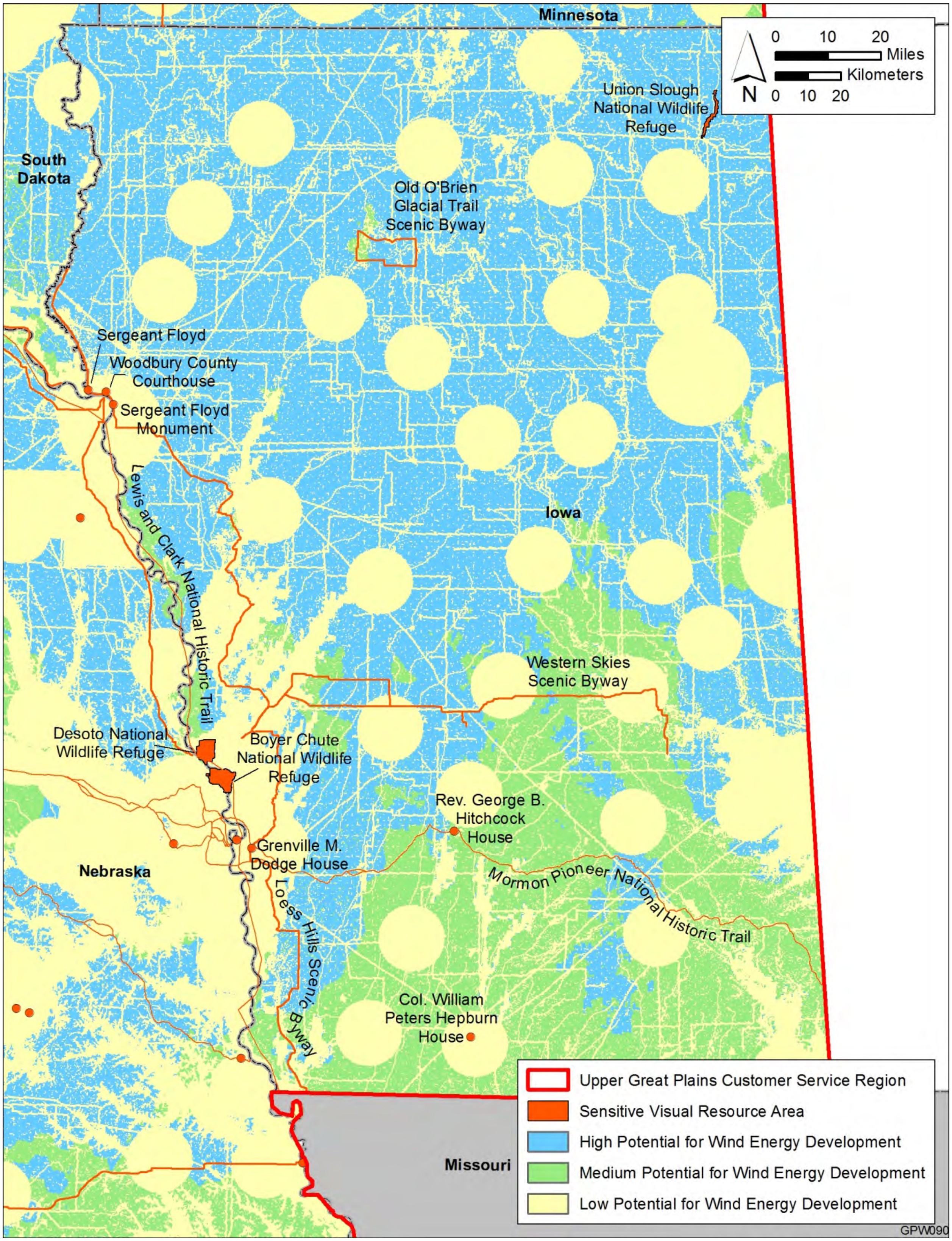
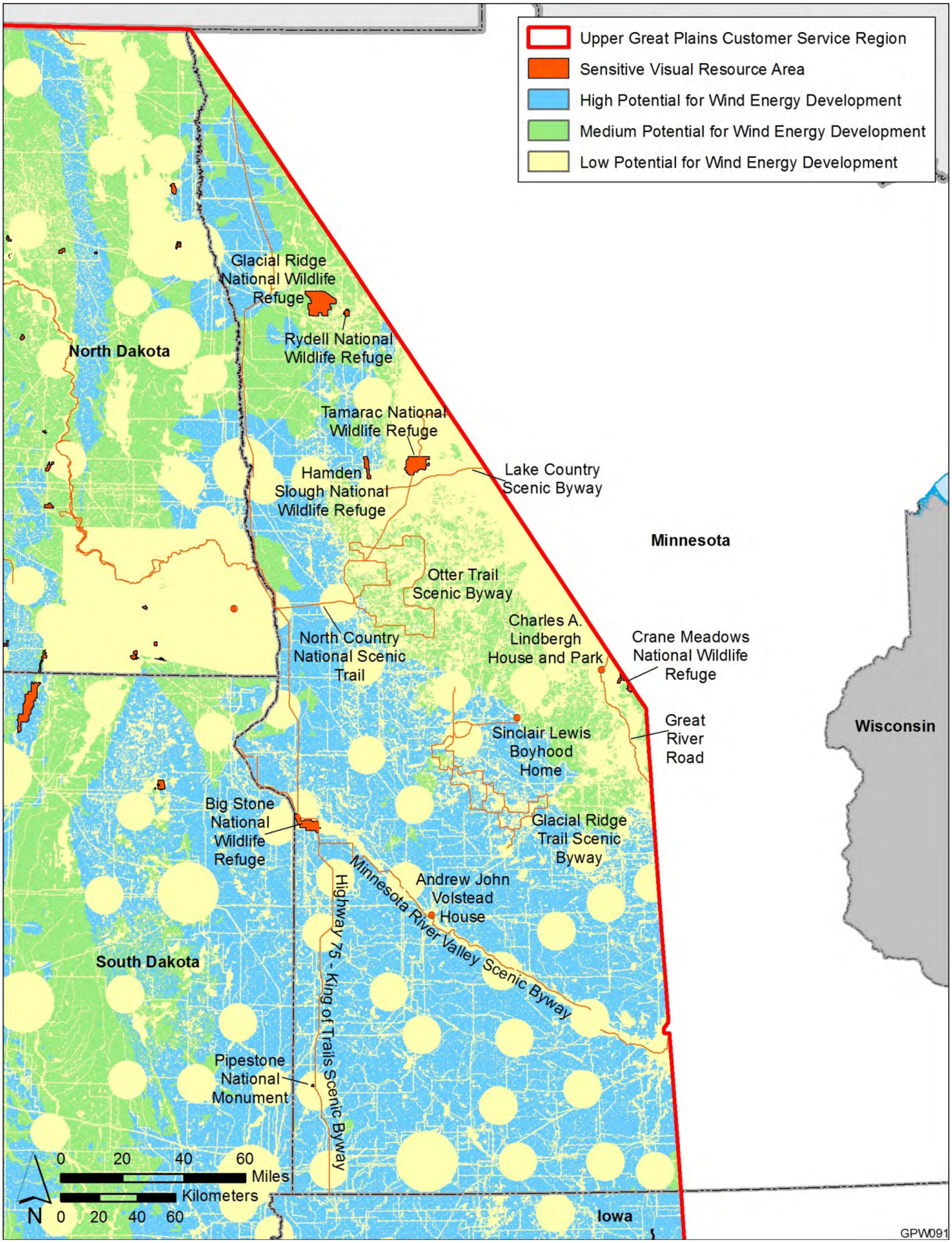


FIGURE 5.7-5 Selected Sensitive Visual Resource Areas and Wind Energy Development Suitability within the UGP Region in Iowa

1 

2 **FIGURE 5.7-6 Selected Sensitive Visual Resource Areas and Wind Energy Development**
3 **Suitability within the UGP Region in Minnesota**

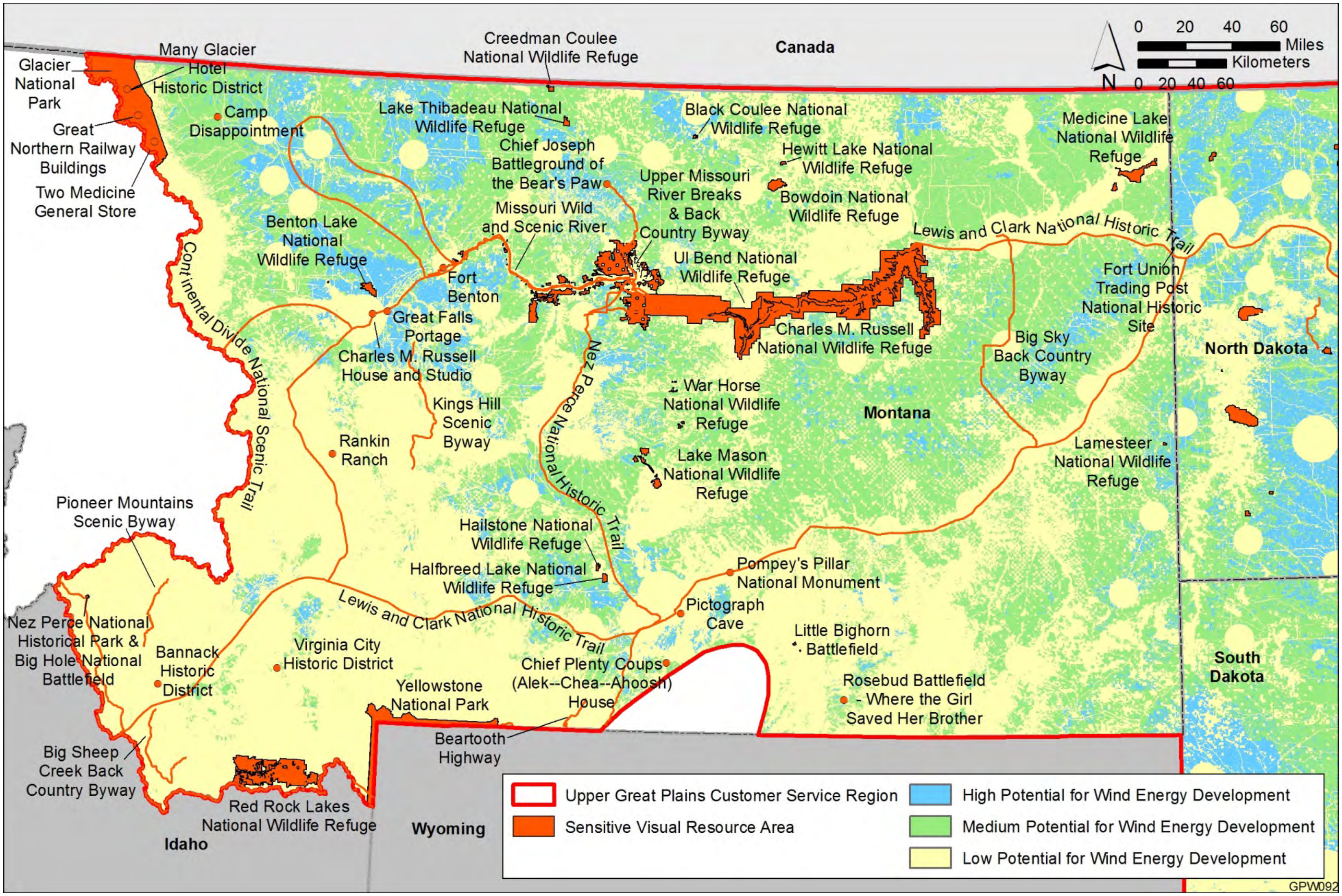
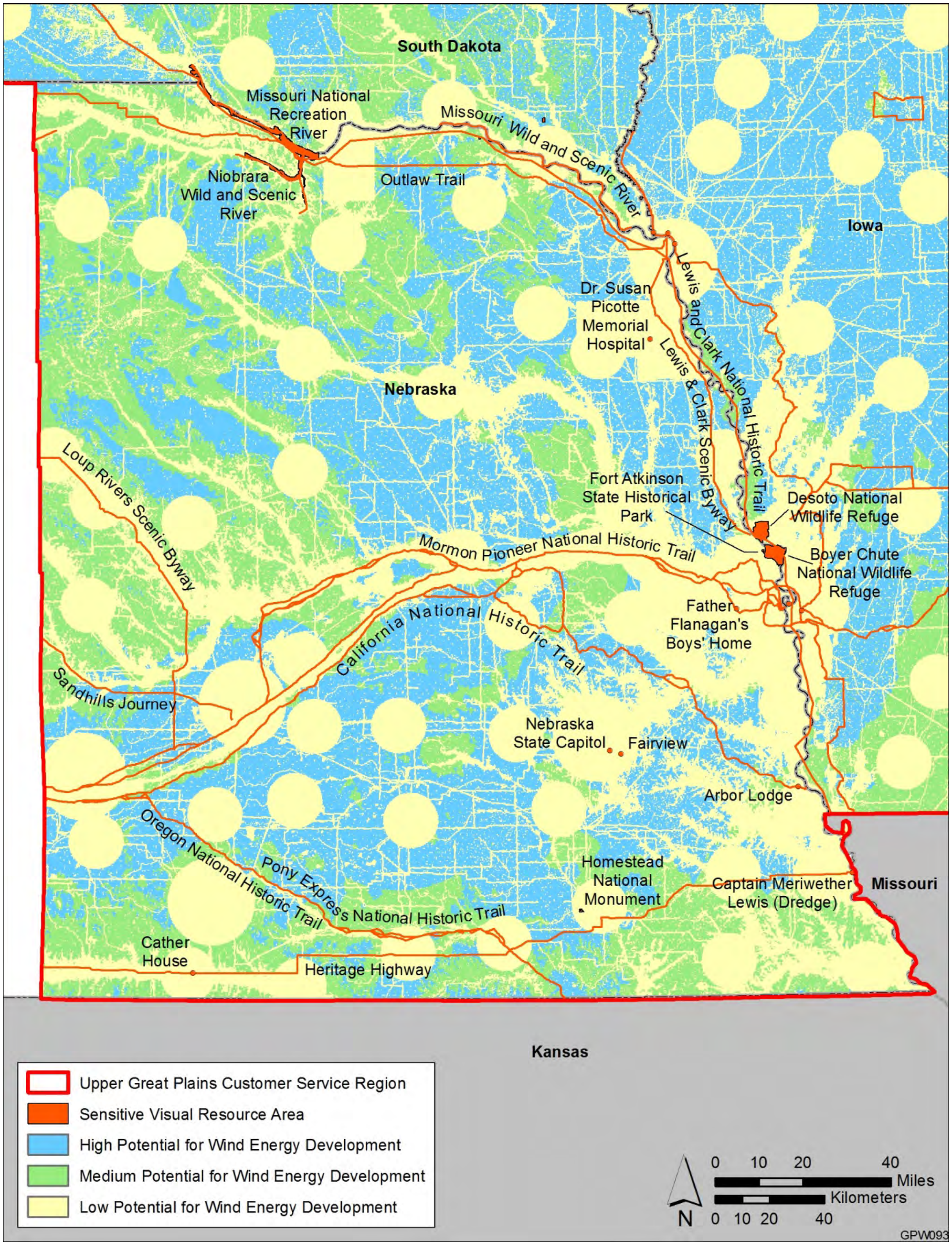


FIGURE 5.7-7 Selected Sensitive Visual Resource Areas and Wind Energy Development Suitability within the UGP Region in Montana

1 

2 **FIGURE 5.7-8 Selected Sensitive Visual Resource Areas and Wind Energy Development**
3 **Suitability within the UGP Region in Nebraska**

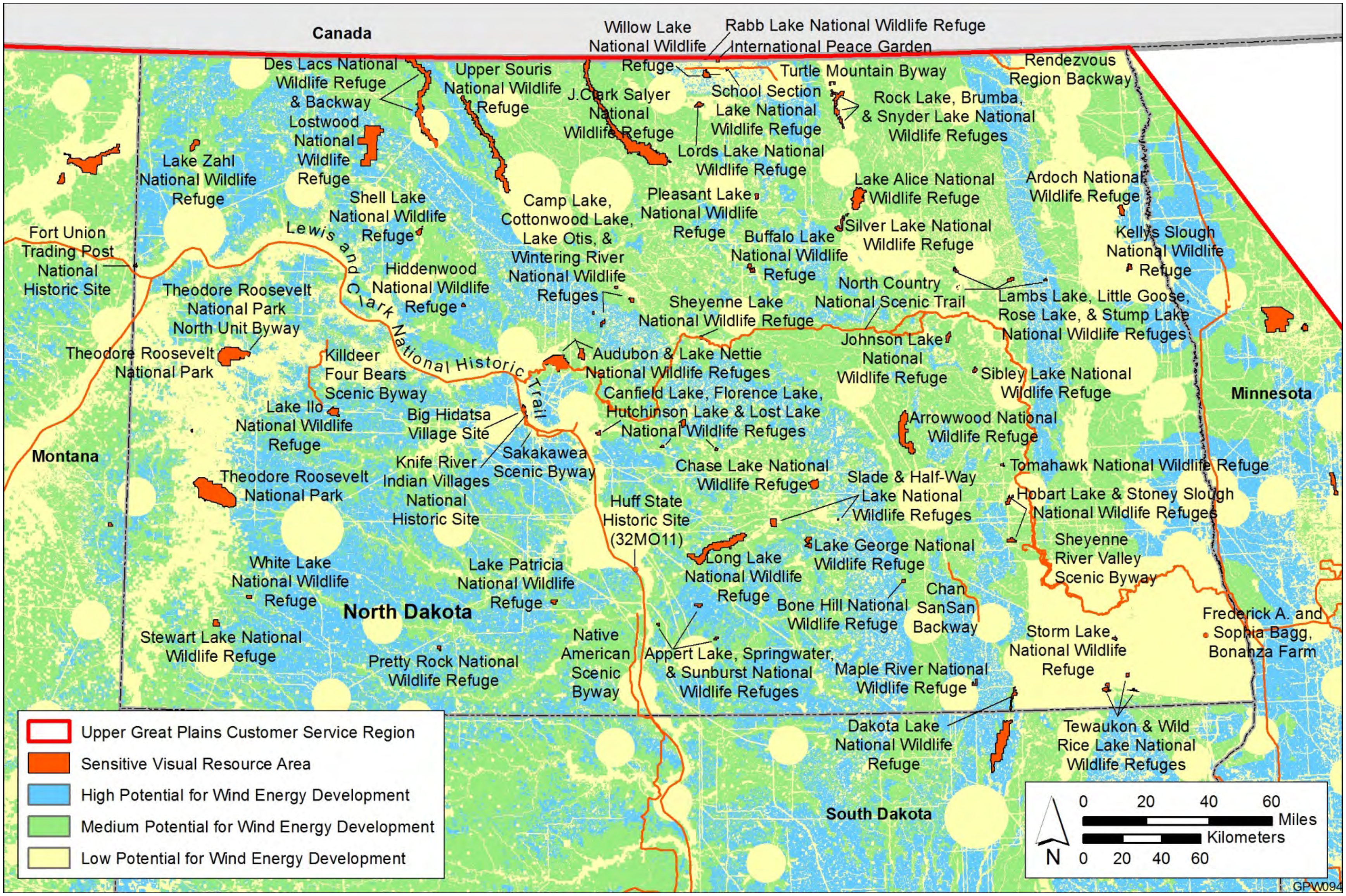


FIGURE 5.7-9 Selected Sensitive Visual Resource Areas and Wind Energy Development Suitability within the UGP Region in North Dakota

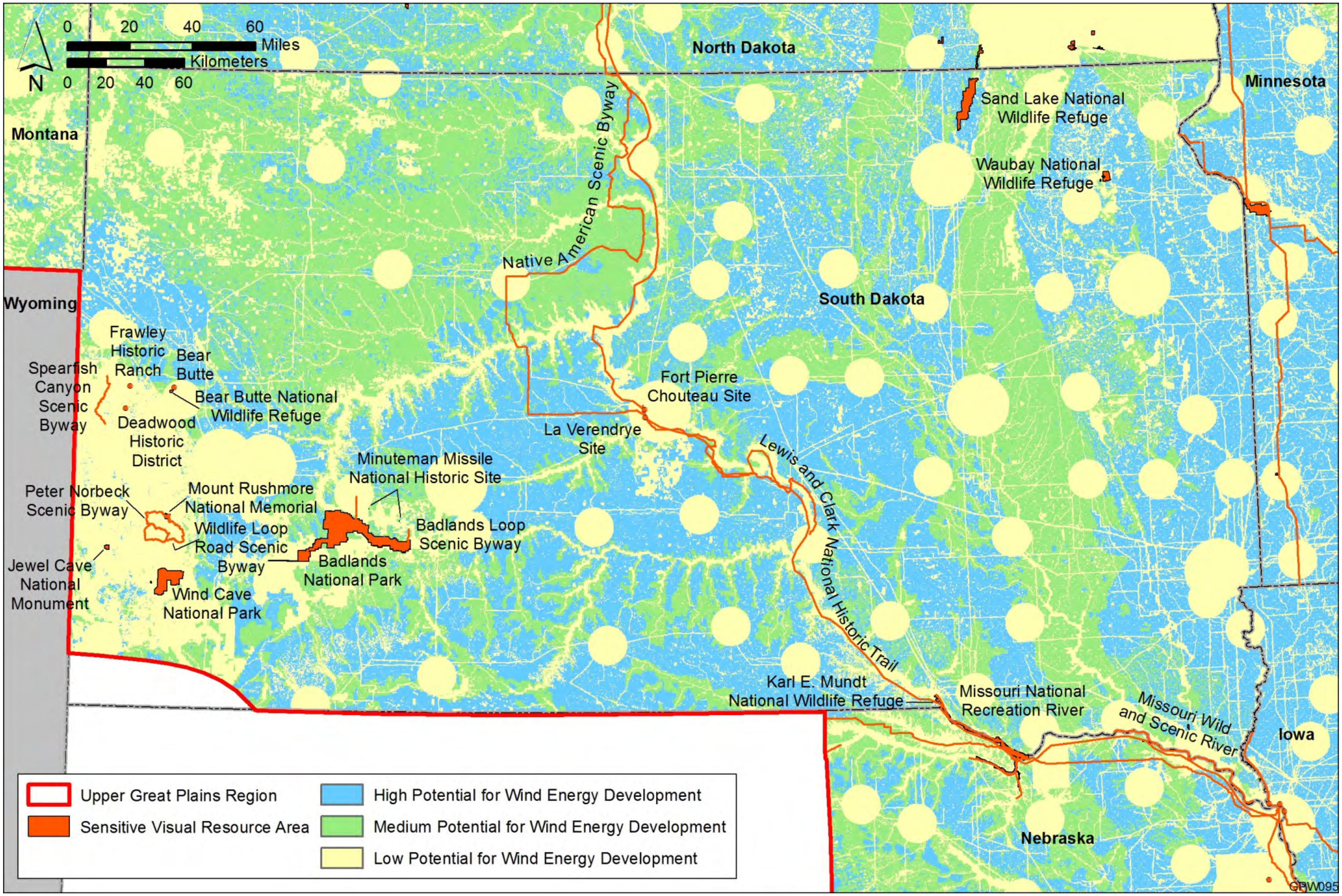


FIGURE 5.7-10 Selected Sensitive Visual Resource Areas and Wind Energy Development Suitability within the UGP Region in South Dakota

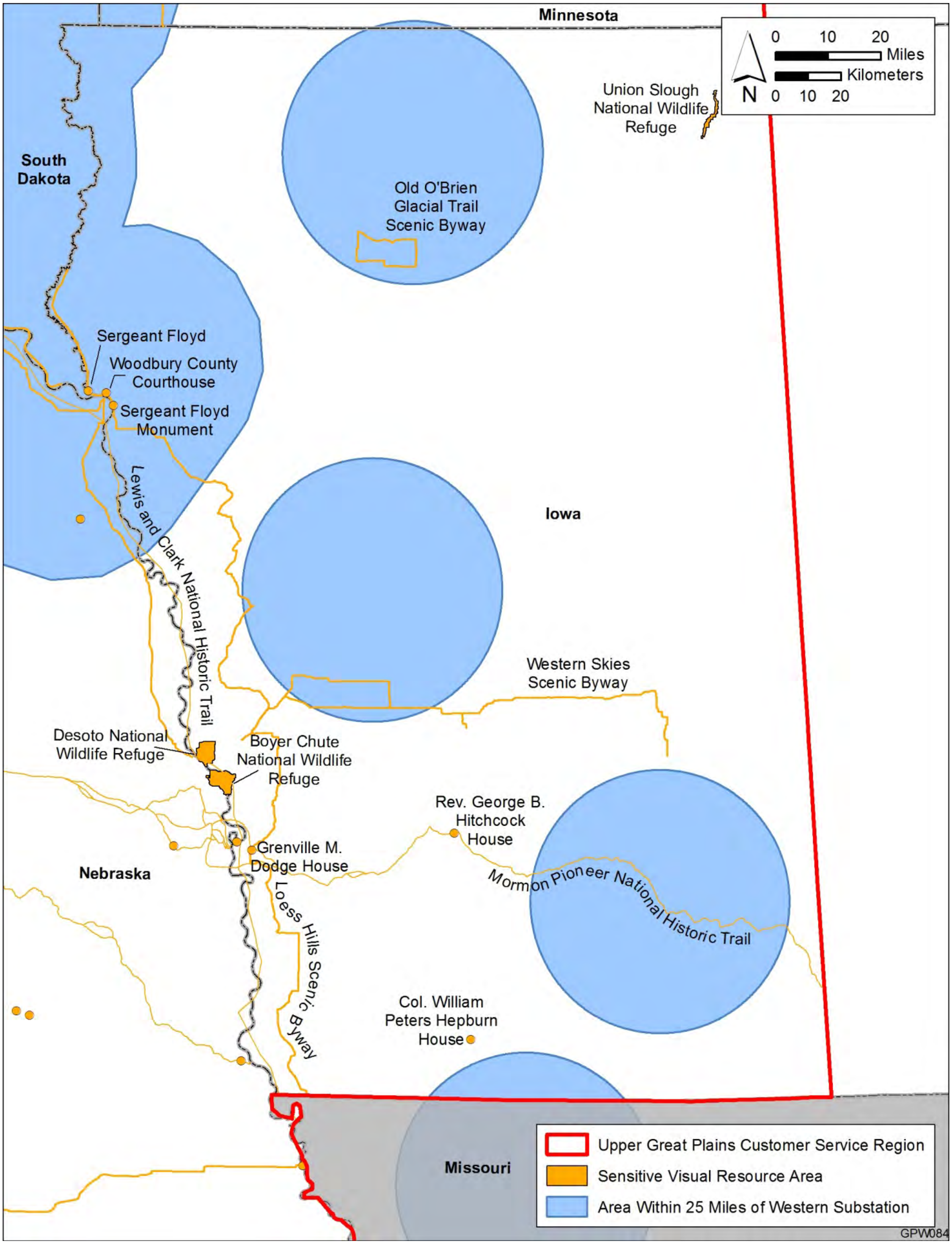
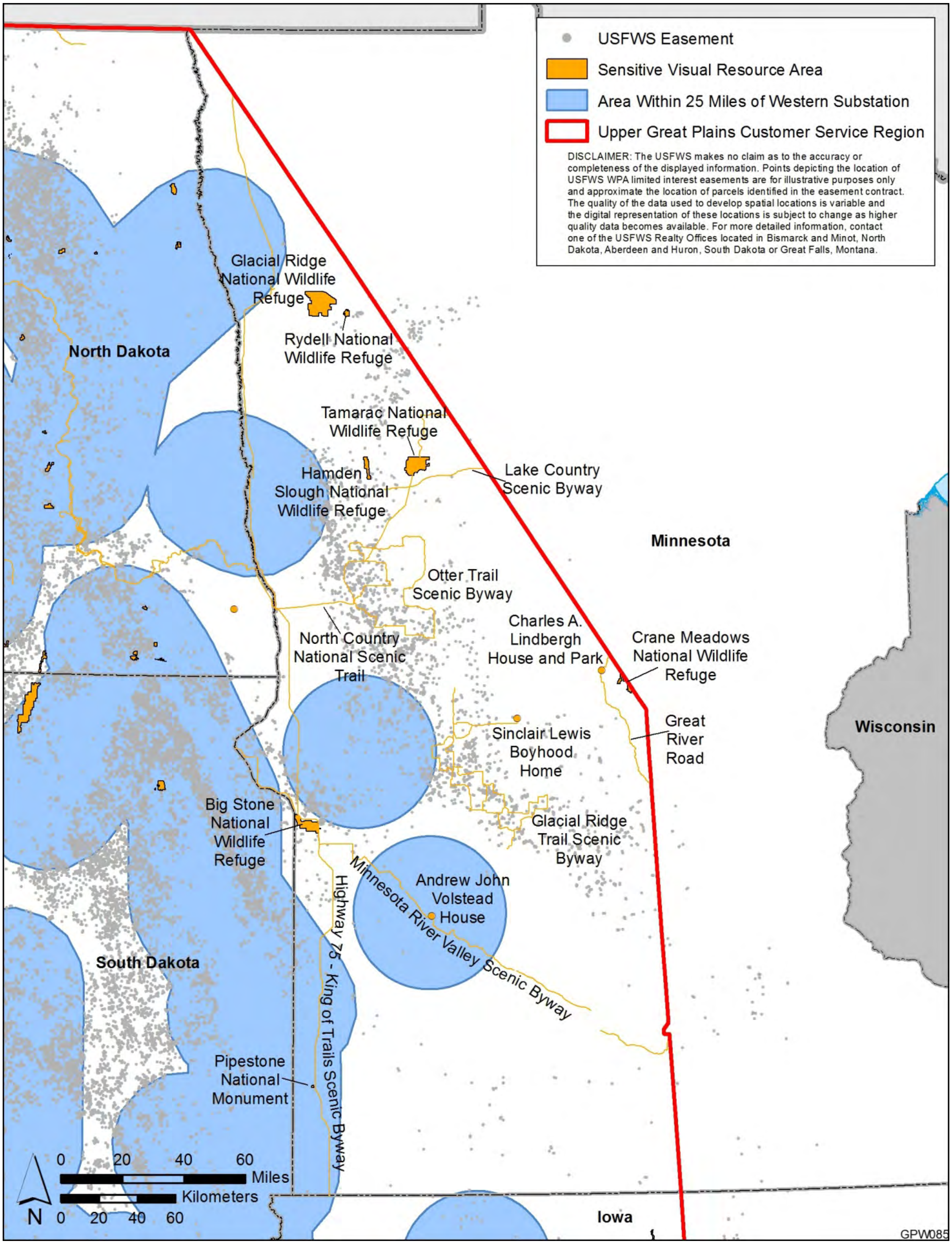


FIGURE 5.7-11 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within 25 mi (40 km) of Western's Substations within the UGP Region in Iowa

1 

2 **FIGURE 5.7-12 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within**
3 **25 mi (40 km) of Western's Substations within the UGP Region in Minnesota**

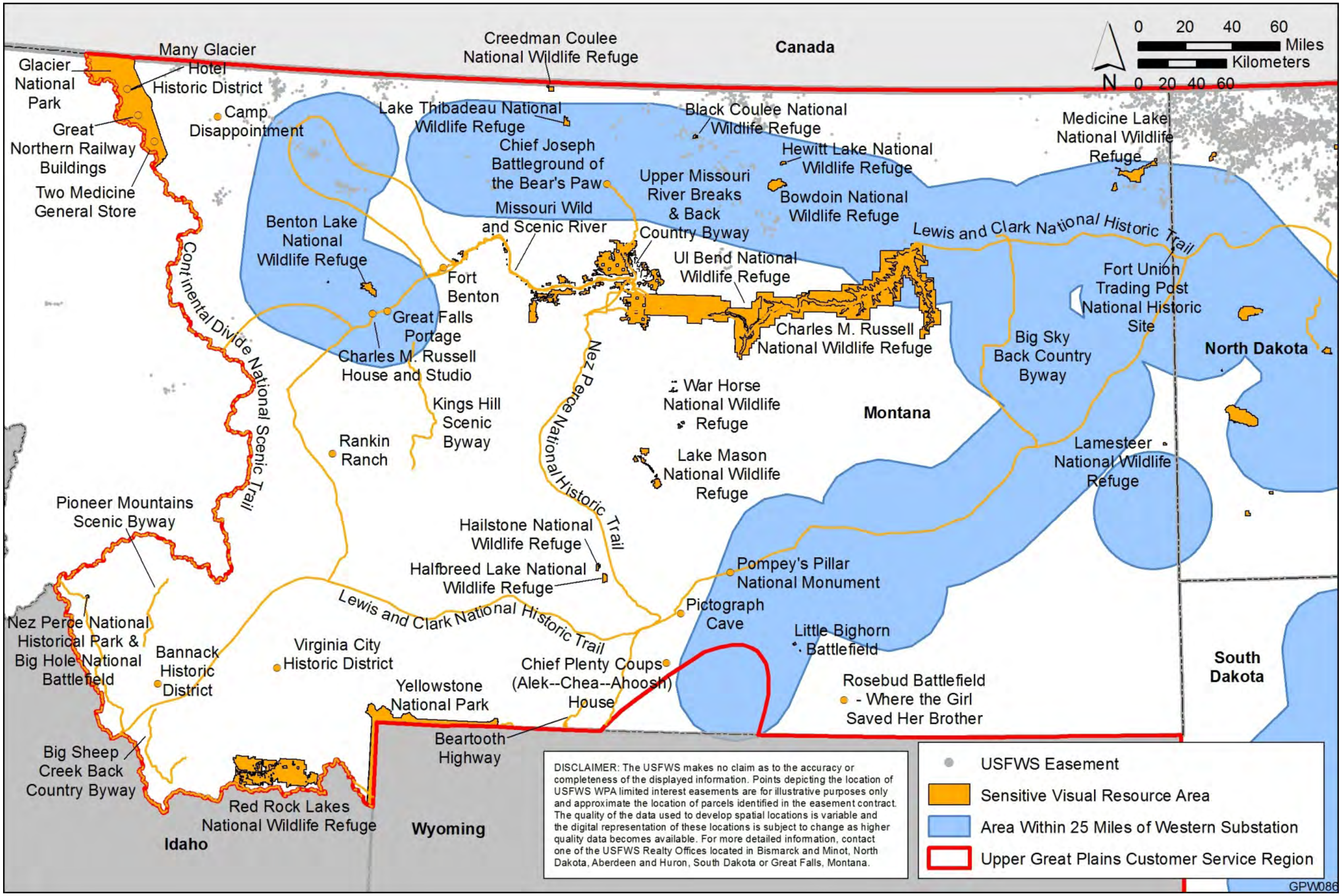


FIGURE 5.7-13 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within 25 mi (40 km) of Western's Substations within the UGP Region in Montana

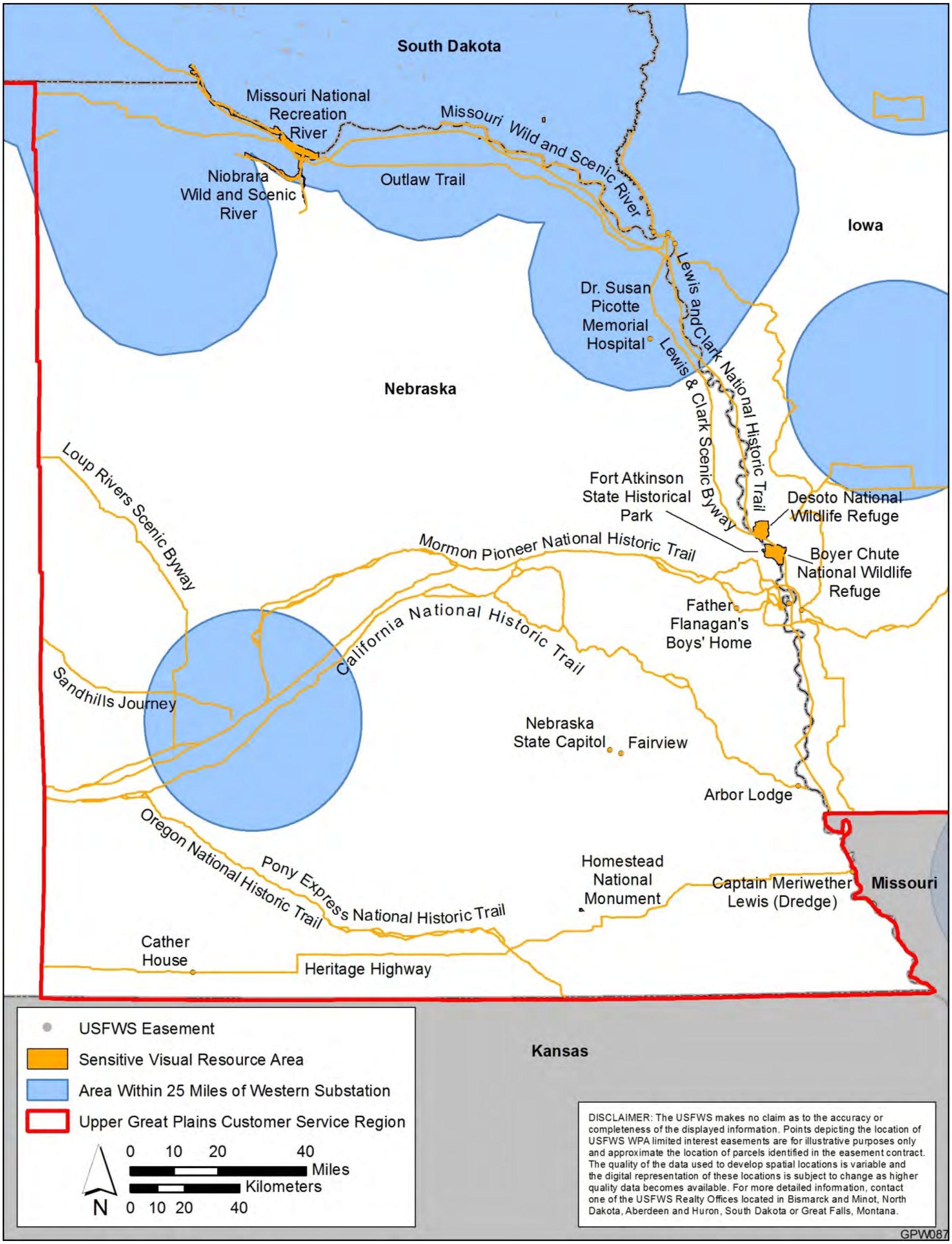


FIGURE 5.7-14 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within 25 mi (40 km) of Western's Substations within the UGP Region in Nebraska

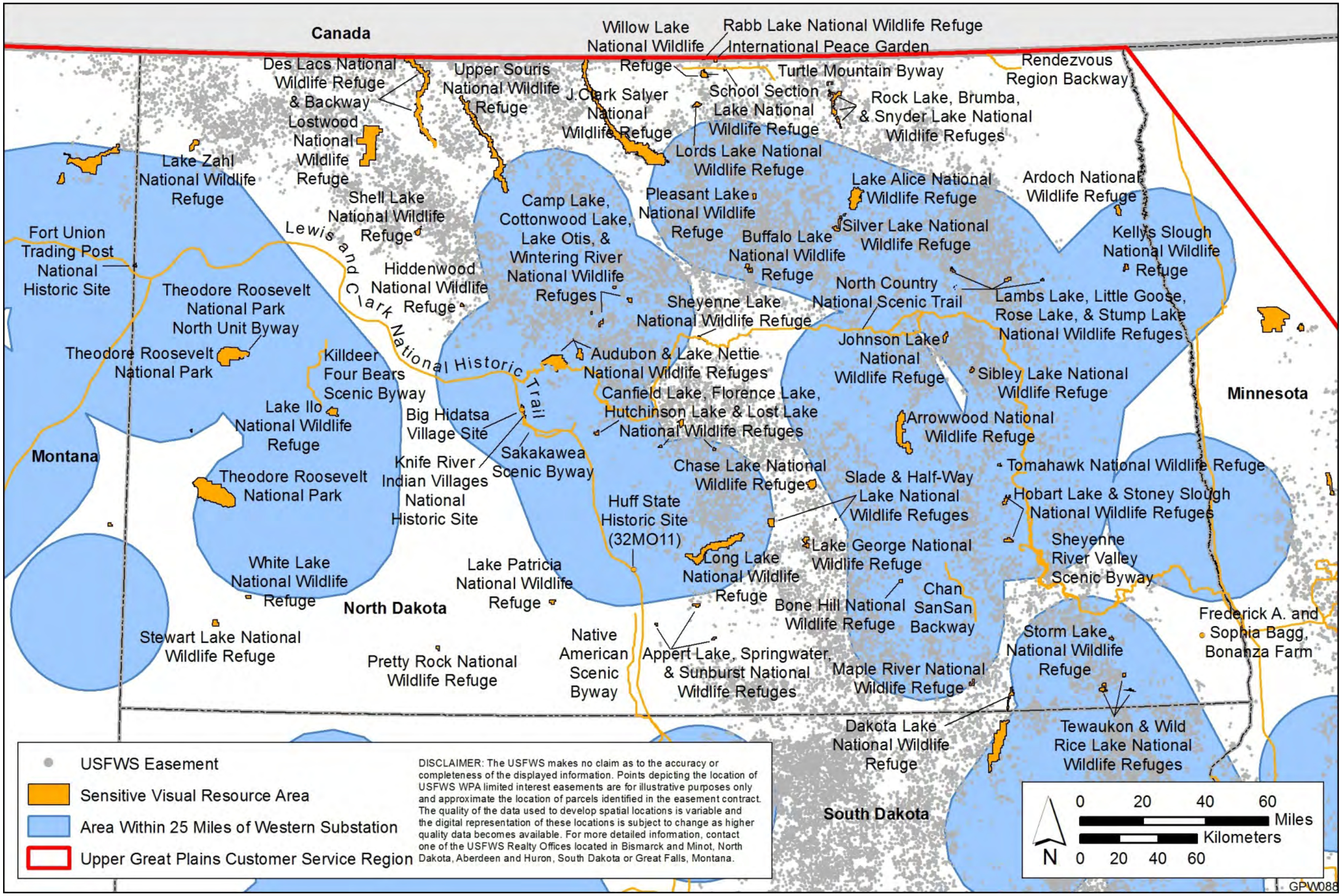


FIGURE 5.7-15 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within 25 mi (40 km) of Western's Substations within the UGP Region in North Dakota

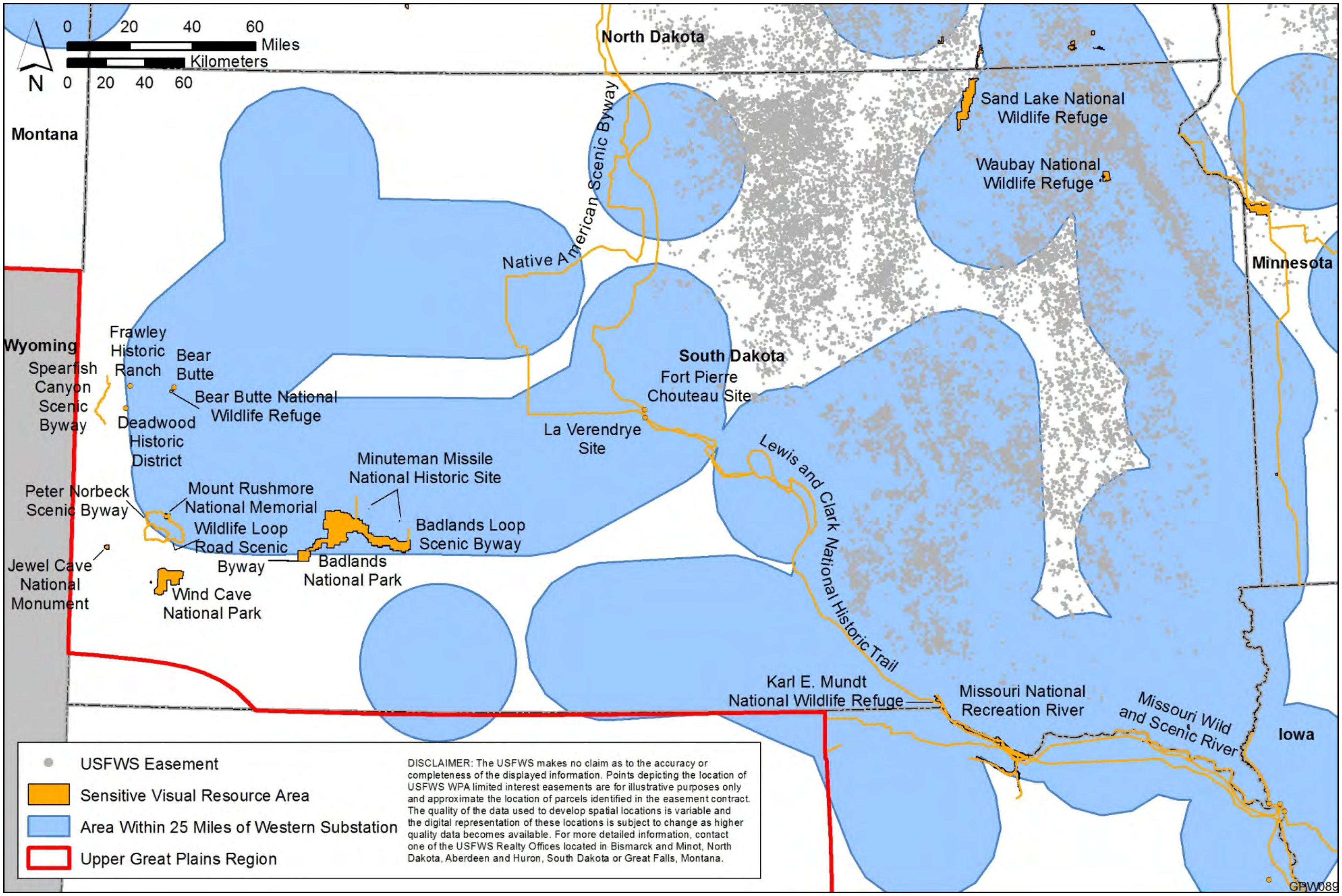


FIGURE 5.7-16 Selected Sensitive Visual Resource Areas, Service Easements, and Areas within 25 mi (40 km) of Western's Substations within the UGP Region in South Dakota

1 **TABLE 5.7-2 Selected Sensitive Visual Resource Areas (with Acreages) within 25 mi (40 km)**
2 **of Western's Substations within the UGP Region**

Sensitive Visual Resource Area	State	Area (acres)	Length (miles)
Ardoch National Wildlife Refuge	North Dakota	2,988	
Arrowwood National Wildlife Refuge	North Dakota	19,522	
Audubon National Wildlife Refuge	North Dakota	14,778	
Badlands Loop Scenic Byway	South Dakota		32
Badlands National Park	South Dakota	96,787	
Bear Butte	South Dakota	NA	
Bear Butte National Wildlife Refuge	South Dakota	402	
Benton Lake National Wildlife Refuge	Montana	12,342	
Big Hidatsa Village Site	North Dakota	15	
Big Sky Back Country Byway	Montana		107
Black Coulee National Wildlife Refuge	Montana	1,356	
Bone Hill National Wildlife Refuge	North Dakota	638	
Bowdoin National Wildlife Refuge	Montana	15,699	
Buffalo Lake National Wildlife Refuge	North Dakota	1,471	
California National Historic Trail	Nebraska		133
Camp Lake National Wildlife Refuge	North Dakota	1,216	
Canfield Lake National Wildlife Refuge	North Dakota	377	
Chan SanSan Scenic Backway	North Dakota		24
Charles M. Russell National Wildlife Refuge	Montana	305,673	
Chief Joseph Battleground of the Bear's Paw	Montana	360	
Cottonwood Lake National Wildlife Refuge	North Dakota	1,026	
Dakota Lake National Wildlife Refuge	North Dakota	513	
Fort Pierre Chouteau Site	South Dakota	34	
Fort Union Trading Post National Historic Site	Montana, North Dakota	442	
Frawley Historic Ranch	South Dakota	NA	
Glacial Ridge Trail Scenic Byway	Minnesota		6
Great Falls Portage	Montana	7,700	
Hewitt Lake National Wildlife Refuge	Montana	1,678	
Highway 75 – King of Trails Scenic Byway	Minnesota		207
Hobart Lake National Wildlife Refuge	North Dakota	2,007	
Huff State Historic Site (32MO11)	North Dakota	14	
Hutchinson Lake National Wildlife Refuge	North Dakota	445	
J. Clark Salyer National Wildlife Refuge	North Dakota	5,948	
Johnson Lake National Wildlife Refuge	North Dakota	902	
Karl E. Mundt National Wildlife Refuge	South Dakota	1,366	
Kellys Slough National Wildlife Refuge	North Dakota	1,632	
Killdeer Four Bears Scenic Byway	North Dakota		28
Kings Hill Scenic Byway	Montana		8
Knife River Indian Villages National Historic Site	North Dakota	1,783	
La Verendrye Site	South Dakota	5	
Lake Alice National Wildlife Refuge	North Dakota	12,646	
Lake Ilo National Wildlife Refuge	North Dakota	4,471	
Lake Nettie National Wildlife Refuge	North Dakota	3,313	
Lake Otis National Wildlife Refuge	North Dakota	323	
Lake Thibadeau National Wildlife Refuge	Montana	4,672	
Lambs Lake National Wildlife Refuge	North Dakota	1,327	
Lewis and Clark Scenic Byway	Nebraska		36
Lewis and Clark National Historic Trail	Iowa, Montana, Nebraska, North Dakota, South Dakota		1,238

3

TABLE 5.7-2 (Cont.)

Sensitive Visual Resource Area	State	Area (acres)	Length (miles)
Little Bighorn Battlefield National Monument	Montana	780	
Little Goose National Wildlife Refuge	North Dakota	361	
Loess Hills National Scenic Byway	Iowa		61
Long Lake National Wildlife Refuge	North Dakota	27,087	
Lost Lake National Wildlife Refuge	North Dakota	961	
Loup Rivers Scenic Byway	Nebraska		28
Maple River National Wildlife Refuge	North Dakota	1,031	
Medicine Lake National Wildlife Refuge	Montana	28,723	
Minnesota River Valley National Scenic Byway	Minnesota		81
Minuteman Missile National Historic Site	South Dakota	7	
Missouri National Recreation River	Nebraska, South Dakota	27,358	
Missouri Wild and Scenic River	Nebraska, South Dakota		94
Mormon Pioneer National Historic Trail	Iowa, Nebraska		115
Mount Rushmore National Memorial	South Dakota	1,293	
Native American National Scenic Byway	South Dakota		260
Nez Perce National Historic Trail	Montana		19
Nez Perce National Historical Park	Montana	194	
Niobrara Wild and Scenic River	Nebraska, South Dakota		26
North Country National Scenic Trail	North Dakota		425
Old O'Brien Glacial Trail Scenic Byway	Iowa		35
Outlaw Trail	Nebraska		163
Peter Norbeck National Scenic Byway	Nebraska		51
Picotte, Dr. Susan, Memorial Hospital	Nebraska	1	
Pipestone National Monument	Minnesota	284	
Pleasant Lake National Wildlife Refuge	North Dakota	1,025	
Pompey's Pillar	Montana	6	
Pompey's Pillar National Monument	Montana	51	
Rose Lake National Wildlife Refuge	North Dakota	844	
Russell, Charles M., House and Studio	Montana	2	
Sakakawea Scenic Byway	North Dakota		22
Sand Lake National Wildlife Refuge	South Dakota	2,871	
Sandhills Journey Scenic Byway	Nebraska		22
Sergeant Floyd	Iowa	1	
Sergeant Floyd Monument	Iowa	1	
Sheyenne River Valley National Scenic Byway	North Dakota		57
Sibley Lake National Wildlife Refuge	North Dakota	726	
Silver Lake National Wildlife Refuge	North Dakota	3,336	
Slade National Wildlife Refuge	North Dakota	2,646	
Stoney Slough National Wildlife Refuge	North Dakota	1,998	
Storm Lake National Wildlife Refuge	North Dakota	688	
Stump Lake National Wildlife Refuge	North Dakota	27	
Tewaukon National Wildlife Refuge	North Dakota	2,864	
Theodore Roosevelt National Park	North Dakota	65,594	
Theodore Roosevelt National Park North Unit Byway	North Dakota		8
Tomahawk National Wildlife Refuge	North Dakota	438	
Upper Souris National Wildlife Refuge	North Dakota	9,920	
Volstead, Andrew John, House	Minnesota	1	
Waubay National Wildlife Refuge	South Dakota	3,952	
Western Skies Scenic Byway	Iowa		49
Wild Rice Lake National Wildlife Refuge	North Dakota	776	

TABLE 5.7-2 (Cont.)

Sensitive Visual Resource Area	State	Area (acres)	Length (miles)
Wildlife Loop Road Scenic Byway	South Dakota		7
Wintering River National Wildlife Refuge	North Dakota	402	
Woodbury County Courthouse	Iowa	1	
Totals		712,119	3,346

areas. Projects within these areas would be more likely to seek interconnection through Western. While in many cases wind energy developments could not be located on or within the boundaries of the sensitive visual resource areas identified, where wind developments were in proximity to and visible from these visually sensitive areas, day- and night-sky visual impacts on the sensitive areas might occur. Impacts could range from negligible to major, depending on visibility, distance, and a variety of other site- and project-specific factors. Day- and night-sky impacts from particular projects could extend 25 mi (40 km) or more from projects, depending on topography, screening, air quality and other site- and project-specific factors. However, proximity to a wind energy development does not necessarily indicate there would be visual impacts on a given visually sensitive area, because screening topography and/or vegetation might partially or completely hide the project from view from within the visually sensitive area.

With the predicted increases in wind energy development in the UGP Region over the 20-year period analyzed in the PEIS, the number of wind turbines per State would roughly double or triple depending on the State. This does not mean necessarily that the number of wind farms would double or triple; however, the projected increase in turbines installed does suggest that there could be a substantial increase in visual impacts from wind energy projects in some parts of the region. Projects would be likely to concentrate in areas with higher suitability for wind energy development within the region, and therefore there would likely be a proportionally greater increase in impacts in these areas.

The actual level of impact perceived by residents would depend on their attitudes toward wind power and renewable energy in general, their perceptions of potential personal and/or community benefits and costs associated with local wind power, the prevalence of existing wind energy projects in the area, and site- and project-specific factors affecting the potential visibility and contrast levels from the proposed projects. Because these factors are both complex and highly variable, because little reliable information about them specific to the UGP Region exists, and because the programmatic nature of the PEIS precludes having specific locations and project specifications for wind projects in the region, no quantitative statements can be made about the ultimate level of visual resource impacts that will result from wind development in the UGP Region through 2030.

Visual impact mitigation and best practices would continue to be designated on a case-by-case basis, and thus might vary from project to project. While the major visual impacts from wind projects cannot easily be mitigated except by siting the project in different locations, visual impact mitigation and best practices would likely reduce the impacts associated with new wind energy developments to some degree, especially for roads, and other ancillary structures.

Effectiveness would vary depending on site- and project-specific factors, as well as the stringency of the specified mitigation and best practices.

5.7.3 Alternative 1

Under Alternative 1, the same levels of wind energy development are forecast to occur in the same areas as under the No Action Alternative. Expected levels of visual impact would be similar, but projects seeking interconnection to Western's transmission system or seeking accommodation of wind energy structures on Service easements would have project-specific NEPA evaluations tiering off the analyses in the PEIS as long as the developers agreed to implement the identified BMPs and mitigation measures from the PEIS for their projects. These projects would have mitigation and BMPs that could be more or less effective than the case-by-case mitigation and best practices implemented under the No Action Alternative.

5.7.4 Alternative 2

Under Alternative 2, the same levels of wind energy development are forecast to occur as under the No Action Alternative. As under Alternative 1, projects seeking to interconnect to Western's transmission system would have project-specific NEPA evaluations tiering off the analyses in the PEIS as long as the developers agreed to implement the identified BMPs and mitigation measures from the PEIS for their projects. However, the Service would not accommodate placement of wind energy facilities on easements under this alternative.

Although wind energy development would not occur on wetland and grassland easements managed by the Service, it is anticipated that similar levels of development in the vicinity of easements would be attained by developing projects on non-easement private lands. Thus under this alternative, because easements would be excluded, a slightly higher density of development would occur on non-easement lands. Because of the possible higher density of projects in these areas, expected levels of impacts in these areas on average could be slightly higher compared to the No Action Alternative, while the overall impact would be similar. The higher density of projects in some areas could result in higher levels of cumulative impacts in these areas, because there would be a greater likelihood of seeing multiple wind projects from a given location or seeing multiple projects in succession when traveling on local roads or trails.

In a manner similar to that for Alternative 1, projects seeking interconnects through Western would have project-specific NEPA evaluations tiering off the analyses in the PEIS as long as the developers agreed to implement the identified applicable BMPs and mitigation measures from the PEIS for their projects. These projects would have mitigation and BMPs that could be more or less effective than the case-by-case mitigation measures and BMPs implemented under the No Action Alternative.

5.7.5 Alternative 3

Under Alternative 3, the same levels of wind energy development are forecast to occur in the same areas as under the No Action Alternative. Projects seeking interconnection through Western would have project-specific NEPA evaluations tiering off the analyses in the PEIS, but the projects would not be subject to BMPs and mitigation measures beyond those required to meet established Federal, State, and local regulatory requirements, such as requirements to disclose visual impacts on scenic areas and private lands; to conduct a shadow flicker analysis (Minnesota Department of Commerce 2010); or to conform to a community aesthetics standard (State of Vermont 2010). These projects would be subject to fewer mitigations and BMPs and thus would be expected to result in somewhat higher levels of impact to visual resources, because of fewer restrictions for project siting and increased levels of visual contrast resulting from fewer requirements for impact mitigation.

5.8 PALEONTOLOGICAL RESOURCES

5.8.1 Common Impacts

There is a possibility of encountering significant paleontological remains in the UGP Region. The identification of paleontological resources is generally done on a project-specific basis. Fossils only appear in sedimentary rock formations; therefore, this is an efficient initial screen as to the potential for the presence of fossils in a project area. Soil unit descriptions can also be used to help identify the potential for fossils to be present. Many States maintain a database or repository of information on past paleontological finds either through the State Historical Preservation Office (SHPO) or through a designated repository, such as a university. Additional information regarding the presence of paleontological resources may be provided by amateur fossil hunters. If there is a strong potential for fossil remains to be present in a project area, a survey would be required. The following describes the potential impacts on paleontological resources, should they be present in a project area, and measures that could be taken to eliminate, reduce, or mitigate potential impacts.

5.8.1.1 Site Characterization

The potential exists for impacts on paleontological resources during site characterization. Often, characterization takes place in cultivated agricultural fields. Characterization in these settings generally occurs when the ground is frozen to minimize damage to crops. No impacts on paleontological resources would result from site characterization under these circumstances. In more unusual cases, access roads may need to be established in order to characterize the potential of a location for possible development for wind energy. While these roads would not be elaborate, they would still require grading and earthmoving activities that could potentially affect paleontological resources. The creation of access roads could modify drainage patterns and encourage erosion, which could result in impacts on paleontological resources. The creation of access roads could also open previously inaccessible areas to vehicle traffic, thereby increasing the potential for the unlawful removal of fossils. The use of vehicles by workers could also cause compaction of the soils under the road that could affect certain more delicate fossils. The introduction of workers into the area could also increase the possibility for the removal of fossils.

Actual site characterization is done with temporary meteorological towers, sometimes mounted on trailers. An average site generally only requires about 10 towers during the characterization phase, but larger sites or sites with complex terrain could require more. Placement of towers could require the removal of some vegetation in the area. Paleontological resources could be affected during vegetation removal activities or by increases in erosion due to vegetation removal. In general, only small areas would be affected by vegetation removal during characterization activities, and these areas would typically be located close to existing roads used for access. Although excavation is not typically needed, guyed towers would require borings to secure guy wires for support. Borings would impact only localized areas and would not present a significant risk to resources. Borings would also be required during geotechnical surveys to assess the soil characteristics and strength of the surrounding rock strata. Borings would extend to roughly 35 to 40 ft (11 to 12 m). Borings could impact fossils if they were encountered, but the likelihood of major impacts is small. Construction of a control building may also be required during characterization. Again, the small area needed for a control building would result in the disturbance of a relatively small area, and it is unlikely that construction would represent a major threat to the resource.

If a site is selected for further development, some of the meteorological towers may be installed permanently. This would require excavations for the foundations, which could result in minor impacts, if fossils where encountered by earthmoving equipment.

Most impacts associated with site characterization could be minimized by a paleontological survey prior to accessing the area. If the area contains a high potential for paleontological resources, monitoring by a trained professional could alleviate many of the impacts; educating the workers regarding the need to watch for signs of paleontological resources could also limit impacts. In fossil-rich areas, site characterization activities could expose fossils that add to paleontological knowledge. Determinations would require a case-by-case review.

5.8.1.2 Construction

Construction of the infrastructure needed for wind energy development has the greatest potential to impact paleontological resources. This is because most ground-disturbing activities, which represent the greatest impacting factor to paleontological resources, take place during construction.

The development of an area for wind energy requires site access, site modification, construction of the towers and associated electrical substations and support structures, and collection of raw materials for construction. Impacts can occur both locally and remotely. Potential impacts on paleontological resources during construction are detailed below.

The development of an area for wind energy requires the construction of access roads capable of supporting the large trucks necessary to transport the towers. Such roads would require removing vegetation, grading, potentially blasting, the laying of gravel collected either locally to the development site or remotely from an appropriate source, and possibly paving. Grading and blasting have a potential to impact fossils, but this potential could be minimized by conducting a paleontological survey prior to initiating activities. If aggregate for a road is obtained from a remote source, this location should be examined for its potential to contain fossils. Borrow sites are typically included within the project area for these purposes. The construction of wind turbines may also require the widening of existing roads and reinforcement of bridges. These activities are unlikely to impact paleontological resources, since they occur in areas that were previously disturbed. Development of access roads may also alter drainage patterns on a site, which could lead to erosion. Erosion has the potential to alter fossils, separate collections of fossils, or uncover fossils so that they are more easily discovered.

In addition to access roads, it may be necessary to establish laydown areas, staging areas for cranes, turnaround areas, and, if concrete is used, a batching plant. All of these activities require the prepping of an area, potentially including grading and soil removal. In rare instances, ground preparation could require grading, which has the potential to impact paleontological resources. The use of heavy machinery could impact fossils through compaction of the soils. Again, evaluating the potential for fossils being present prior to construction activities is crucial for avoiding impacts; in areas where paleontological resources are absent, there would be no impact. In fossil-rich areas, there is the potential for new paleontological discoveries to result from construction activities.

Actual construction of the turbines requires a temporary disturbance area of up to about 3 ac (1.2 ha) per turbine, and generally about 5 percent or less of the ground surface for a wind project site experiences soil disturbance. Turbine foundations can extend 35 to 40 ft (11 to 12 m) below the surface, depending on the type of tower foundation used. In most cases, the foundation for the tower would be made of poured concrete and reinforcing steel. The immediate area around the tower would be compacted by the trucks hauling the tower. A crane, which requires a level working area, may be used to construct the turbine tower. After excavation of the tower foundation location, it may be necessary to pump water out of the excavation while the foundation is poured. The pumped-out water could potentially cause erosion in the vicinity of the tower, exposing or moving fossils. The towers would likely have lightning protection, which would require drilling down to the closest aquifer. Given the small size of this excavation, it is unlikely that large numbers of fossils or other paleontological resources would be affected. Depending on the area, cables connecting each tower could either be buried in 4 ft (1.2 m) deep trenches or hung between the towers, if the ground is comprised of hard rock or reduced. If the lines are elevated, the vegetation between each tower may be removed or reduced. In addition to the towers, the support buildings, storage buildings, and pads for transformers would also require leveling and grading. For security reasons, fencing may be erected around the transformer for each turbine or around the base of each turbine. The amount of excavation needed for the fencing would be minimal.

Construction activities are often the means by which significant fossil discoveries are made, thereby allowing specimens to be made available for scientific study. One of the greatest threats to paleontological resources comes from people removing fossils rather than reporting them after discovery. Development of a wind energy area would bring numerous workers into the region. The creation of access roads also provides people with easier access to areas. This poses a risk to a resource that only training and monitoring of the area by a paleontologist can minimize.

5.8.1.3 Operations and Maintenance

Very few impacts on paleontological resources would be expected during operation. Most activities associated with operation of a wind energy development would not result in earthmoving activities or increases in erosion. Rehabilitation of a site for technology upgrades has some potential to cause ground disturbance, but is not expected to extend beyond that employed for initial construction. The increased access provided to the public by the new roads would present the greatest threat to the resource; however, the impact level is still expected to be small.

5.8.1.4 Decommissioning

Decommissioning of a wind energy development has a limited potential for affecting paleontological resources. Most of the cables and foundations would be left in place. Some foundations would be crushed and removed, which represents a slight opportunity for additional disturbance, but this work would likely stay within the area disturbed during construction. The vegetation would be allowed to reestablish on reclaimed access roads and cleared areas; however, it is possible that improved access to the area would remain after the removal of the development. This could allow the removal of fossils by unauthorized collectors, since the area would no longer be periodically monitored. Because most wind energy development within the UGP Region would occur on private land, changes in public access would likely be minor for most projects. Fossils found on private land belong to the landowner, while significant fossils (i.e., vertebrate) found on public lands are protected.

5.8.1.5 Transmission Lines

The adding of transmission lines to connect a wind energy development project to the regional energy grid has the potential to impact paleontological resources. Impacts on paleontological resources would largely result from ground-disturbing activities associated with establishing the ROW and initial placement of transmission structures and conductors. Construction of access roads during ROW siting has the potential to impact certain more fragile paleontological resources through compaction. Construction would involve ground-disturbing activities, such as site clearing, excavating for foundations and footings, stockpiling excavated material for backfilling, and grading for access roads and staging and laydown areas. The greatest potential for impacts on paleontological resources during construction would result from those uncommon situations when drilling rock to set foundations and footings for transmission structures would be needed. Increased erosion could also result from these activities, which could affect or expose some paleontological resources. To minimize these impacts, a paleontological survey should be completed for the transmission line ROW, if it is in an area with a high potential for paleontological resources. Transmission lines can often be routed and individual structures can be sited to avoid areas of fossil concentrations. Overall, only a small portion of a ground surface in a designated transmission line ROW is disturbed to place structures.

Operating and maintaining transmission lines are not expected to impact paleontological resources. Periodic monitoring of the line would not affect the resources and could identify any erosion issues that may arise. Revegetation of the transmission line ROW after construction would minimize the likelihood of erosion-related impacts. Decommissioning has the potential to impact the resources; however, ground-disturbing activities would be expected to remain within the area disturbed during construction. The use of mitigation measures could greatly minimize the potential for impacts associated with decommissioning.

5.8.1.6 BMPs and Mitigation Measures

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

- Whether paleontological resources exist in a project area should be determined on the basis of the sedimentary context and soil surveys of the area, a records search of Federal, State, and local inventories for past paleontological finds in the area, review of past paleontological surveys, and/or a paleontological survey.

- Placement of wind energy structures in fossil-rich areas, such as outcrops, should be avoided.

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

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

5.8.2 No Action Alternative

Under the No Action Alternative, current practices would be followed for consideration of paleontological resources. Both Western and the Service would conduct project-by-project NEPA reviews, and paleontological resources are generally considered through the NEPA review process. Both Western and the Service would apply BMPs and mitigation measures (see section 5.8.1.6) to development projects if determined appropriate on the basis of project-specific information. Because fossils discovered on private lands belong to the landowner, development of wind projects on private lands without a Federal nexus would be expected to result in less protection of the fossil resource than would a federalized project. However, many landowners remain willing to make important specimens available for study by appropriate museums or other institutions.

There is potential for significant paleontological finds throughout the UGP Region, and projects conducted under the No Action Alternative could affect paleontological resources. Potential impacts could only be determined on a site-specific basis. Areas being considered for wind energy development would likely be identified well in advance of construction activities and paleontological resources would be considered appropriately. Projects conducted under the No Action Alternative also have the potential to discover fossils that add to the paleontological understanding for the region.

5.8.3 Alternative 1

Under Alternative 1, both Western and the Service would establish standardized procedures for considering the environmental effects of wind energy projects. Project-specific NEPA evaluations could tier off of the PEIS provided that the BMPs and mitigation measures identified in the PEIS are implemented as requirements. The use of standardized procedures would assist in streamlining the process required for a development project.

Application of the BMPs and mitigation measures identified in the PEIS (see section 5.8.1.6) would reduce the potential for impacts on paleontological resources from wind energy development projects. All projects would include a review of surface geology maps and soil type information for the project area to determine whether fossils are likely to be present. Review of State or local fossil inventories would indicate whether significant fossils had been found within the project area. In areas with high potential for significant finds, paleontological surveys would be conducted in an attempt to identify and remove significant fossils prior to initiating any project activities. In areas likely to contain significant resources, on-site monitors would be employed to oversee development and construction activities that could expose paleontological resources. The monitor would be a trained professional knowledgeable in the types of fossils that could be encountered and in the process for removing significant fossils. Additional BMPs and mitigation measures could be employed if determined necessary.

Projects conducted under Alternative 1 have the potential to affect significant paleontological resources; however, the potential for impacts would be reduced by application of BMPs. Significant fossil beds or resources would be identified prior to or during project activities, greatly reducing the potential for unintended impacts. Development projects could avoid concentrations of sensitive resources if they are identified early in the process. Projects conducted under Alternative 1 also have the potential to discover fossils that add to the paleontological understanding for the region. Overall, the potential effects under Alternative 1 would be similar to those that could occur under the No Action Alternative.

5.8.4 Alternative 2

Under Alternative 2, Western would establish standardized procedures for considering development projects as identified for Alternative 1, but the Service would not accommodate placement of wind energy facilities on easements. Project-specific NEPA evaluations could tier off of the PEIS, provided that the BMPs and mitigation measures identified in the PEIS are implemented by developers. The use of standardized procedures by Western would assist in streamlining the process required for evaluating environmental effects of a proposed wind energy development project requesting an interconnection to Western's transmission system.

Application of the BMPs and mitigation measures identified in the PEIS by Western would help reduce the potential for impacts on paleontological resources from wind development projects. All projects would include a detailed review of surface geology maps and soil type information for the project area to determine whether fossils could be present. Review of State or local fossil inventories would indicate whether significant fossils had been found within the project area. In areas with high potential for significant finds, paleontological surveys would be conducted in an attempt to identify and remove significant fossils prior to initiating any project activities. In areas likely to contain significant resources, on-site monitors would be employed to oversee development and construction activities that could expose paleontological resources. The monitor would be a trained professional knowledgeable in the types of fossils that could be encountered and in the process for removing significant fossils. Additional BMPs and mitigation measures could be employed if determined necessary.

It is assumed that the level of wind energy development within the UGP Region under Alternative 2, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to that identified for the No Action Alternative. As with the No Action Alternative and Alternative 1, wind energy developments requesting interconnection to Western's transmission system under Alternative 2 would be expected to occur primarily within areas identified as having high suitability for wind development and that are in close proximity to Western's electric grid (within 25 mi [40 km]).

Although direct placement of wind energy facilities on easements managed by the Service within the UGP Region would not be accommodated, it is anticipated that this would result in developers siting those structures on nearby private lands not managed under easements, rather than a noticeable change in the distribution of wind energy facilities within the UGP Region. Because fossils discovered on private lands belong to the landowner, development of wind projects on private lands without a Federal nexus would be expected to result in less protection of the fossil resource than would a federalized project. However, the number of wind energy facilities that have been accommodated on easements in the past is relatively small and the overall change in effects on paleontological resources resulting from a decision to forego wind energy development on easement lands would be small.

Potential effects on paleontological resources under Alternative 2 could be slightly greater than under the No Action Alternative and Alternative 1 because there would be no consideration of accommodating development activities on easements managed by the Service. Although projects requesting interconnection to Western's transmission system still have the potential to affect significant paleontological resources, the potential for impacts would be greatly reduced by application of the identified BMPs and mitigation measures. Significant fossil beds or resources would be identified prior to initiating project activities, greatly reducing the potential for unintended impacts. Development projects could avoid concentrations of sensitive resources because they would likely be identified early in the process. Projects conducted using the process identified for Alternative 2 also have the potential to discover fossils that add to the paleontological understanding for the region.

5.8.5 Alternative 3

Under Alternative 3, as with the other alternatives considered in this PEIS, projects would be required to meet established Federal, State, and local regulatory requirements. However, no additional BMPs and mitigation measures would be requested of project developers by Western or the Service for wind energy projects. Project-specific NEPA evaluations would be required, but would not tier off the analyses in this PEIS. If an easement exchange was necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers, without requiring additional modifications to reduce the environmental impacts.

As with the other alternatives, wind energy developments submitting interconnection requests to Western under Alternative 3 would be expected to occur primarily within areas identified as having high suitability for wind development and that are in close proximity to Western's electric grid (within 25 mi [40 km]) (figure 2.4-4). As with the No Action Alternative and Alternative 1, direct placement of wind energy facilities on easements managed by the Service within the UGP Region could occur (after easement exchange), depending upon results of evaluations conducted by the Service of the potential for unacceptable impacts on conservation goals. It is assumed that the overall level of wind energy development within the UGP Region under Alternative 3, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to those identified for the No Action Alternative.

Federal land managers such as the BLM or USFS consider the effects projects on land under their jurisdiction could have on paleontological resources. Some States have laws concerning the collecting of significant paleontological resources, which apply on State lands only. Section 4.1 describes the amount of public and State-administered lands in the region. It is less likely that a project conducted under Alternative 3 would receive a systematic survey for paleontological resources. Projects implemented under Alternative 3 have the greatest potential to affect significant paleontological resources due to the lack of predevelopment review being required. The lack of pre-development survey requirements or on-site monitoring during construction activities would increase the potential for unintended destruction of significant paleontological resources, except for those located on public and State lands. Projects conducted under Alternative 3 also have the potential to discover fossils that add to the paleontological understanding for the region.

5.9 CULTURAL RESOURCES

5.9.1 Common Impacts

Although the specific nature of impacts on cultural resources must be determined on a site-specific basis, certain activities associated with wind energy development are known to have the potential to affect cultural resources. Earthmoving activities (e.g., grading and, excavating) have the highest potential to disturb significant cultural resources; however, pedestrian and vehicular traffic and indirect impacts of earthmoving activities, such as erosion, may also have an effect. Important cultural resources, such as sacred landscapes or historic trails, may also be impacted visually. This section describes the activities with a potential to affect cultural resources for each of the stages of wind energy development and identifies measures that could be taken to reduce or mitigate potential impacts.

5.9.1.1 Site Characterization

Site characterization activities have the potential to impact cultural resources in a number of ways. During the site characterization phase, a minimum-specification access road would be required. Typically, this would be an existing road that would not be improved during the characterization phase, and characterization activities (e.g., installation of meteorological towers or soil sampling) would occur adjacent to it; small areas might need to be cleared of vegetation or graded in order to install monitoring equipment or access a site. Although the effects of these activities would be localized (occurring primarily in areas adjacent to existing access roads), removal of vegetation has the potential to impact sacred items and areas (e.g., a particular medicinal plant that has significance to a Native American tribe) and erosion resulting from ground disturbance could impact an archaeological site. Construction of new access roads, which would be required for only the most remote sites, would result in ground clearing that could also affect cultural resources; there is the potential for compaction of the soil by trucks and equipment that could crush some types of artifacts. Bringing workers and creating new access roads into the project area could also increase the potential for looting of cultural artifacts.

5.9.1.2 Construction

Construction has the greatest potential to impact cultural resources due to ground-disturbing activities, vegetation removal, and increased access to remote locations. Due to the weight and length of wind turbines, the grade of access routes must be kept to a minimum. Maintaining minimal grades can require extensive grading, thus increasing the potential for impacts on cultural resources due to ground disturbance. Effects on cultural resources would generally be avoided by conducting cultural resource surveys and consulting with Native Americans with ancestral ties to the project area in order to identify cultural resources. Surveys should also include an assessment of potential visual impacts on cultural resources. All significant cultural resources should be considered prior to creating access roads and beginning construction activities, and project elements should be sited to avoid and minimize potential impacts.

Most impacts on cultural resources would result from ground-disturbing activities. Wind energy developments often require road improvement and/or the creation of new access roads, excavation for placement of turbine towers, grading for construction of support buildings and electrical substations, and potentially the creation of batching areas for making concrete. The trucks needed to transport the towers are very large and require well maintained roads and large cleared areas for turning and staging. In some cases, bridges may need to be reinforced. Some bridges are considered historically significant for their engineering, and the historical attributes may be impacted by modification associated with strengthening.

While the footprint of permanent structures would be expected to occupy less than 1 percent of the project area, the area temporarily disturbed by construction activities may be two to three times that (Denholm et al. 2009). As described at the beginning of this chapter and in greater detail in appendix B, the average amount of land that would be permanently affected (i.e., within footprints of turbine towers, access roads, substations, and transmission facilities) was estimated as 0.7 ac (0.3 ha) per MW of generation. The amount of land that would be temporarily affected (i.e., disturbed, but not covered by structure footprints) was estimated to be

1.7 ac (0.7 ha) per MW of generation. Assuming a typical turbine size of 1.5 MW, this would translate into approximately 1 ac (0.4 ha) of permanently disturbed land and 2.6 ac (1.1 ha) of temporarily disturbed land per turbine. Thus, for an average-sized project composed of about 75 turbines, the total area of land disturbed by a project would be approximately 270 ac (109.3 ha). In the UGP Region, much of the disturbed land is likely to be on agricultural land that has been previously disturbed.

The creation of access roads also provides people with easier access to areas. Since one of the greatest threats to archaeological sites is from looting, increased access often leads to greater opportunities for looting to take place. However, since nearly all of the wind energy development in the UGP Region would occur on private lands, where it is anticipated that access levels by the general public would not change following development, the overall effect of increased access on archeological sites within the Region would be small. Although archaeological material is protected on public or State lands, archaeological sites and associated artifacts on private land are the property of the landowner.

5.9.1.3 Operations and Maintenance

Very few impacts would be likely to affect cultural resources from operation and maintenance of a wind energy project, because the majority of impacts would occur during construction. Impacts associated with operation would primarily come from the looting of sites by workers or the public, although erosion of disturbed areas, if not properly controlled, could also result in ongoing effects on some cultural resources. The visual impact resulting from the towers may also affect certain types of cultural resources (see section 5.7.1); in such cases, the impacts would continue for the duration of the project. In the event that the development site needs to be expanded or reconfigured, the impacts would be similar to those associated with construction.

5.9.1.4 Decommissioning

Very few impacts on cultural resources would be expected from decommissioning. Again, the majority of impacts would be associated with new ground disturbance during construction. Ground disturbance during decommissioning would be confined primarily to areas that were originally disturbed during construction. If new work areas were needed in areas that had not previously been disturbed, there would be a potential for impacts on additional cultural resources. Removal of structures would be necessary but would not be expected to affect any previously undisturbed areas.

5.9.1.5 Transmission Lines

Transmission lines may be needed to connect a wind energy project to the regional transmission system. Impacts on cultural resources from the construction and operation of a transmission line would primarily result from ground-disturbing activities associated with establishing the ROW and initial construction. Once a prospective ROW has been selected, cultural resource surveys and consultation with Native American tribes with ancestral ties to the project area would be necessary to identify cultural resources. Surveys should also include an assessment of potential visual impacts on cultural resources. All significant cultural resources should be considered prior to finalizing the ROW location, creating access roads, and preparing the site. Construction would involve ground-disturbing activities, such as site clearing, excavating for foundations and footings, drilling rock to set the foundations and footings, stockpiling excavated material for backfilling, and grading for access roads and staging and laydown areas. Increased erosion could also result from these activities, which could affect cultural resources. Standard practice is to reroute transmission lines to avoid significant cultural resources. Overall, only a small portion of the ground surface in a designated transmission line ROW would be disturbed in placing structures.

Operation and maintenance of transmission lines are not expected to impact cultural resources. Periodic monitoring of the lines would not affect the resources. However, there is the potential for cultural resource impacts from erosion during operation. Erosion can destroy archaeological sites. Revegetation of the line after construction would minimize the likelihood of erosion-related impacts in subsequent years.

Decommissioning of transmission facilities also has the potential to impact cultural resources; however, ground-disturbing activities would likely remain within the area that was originally disturbed during construction. Cultural resource surveys would be needed for any new areas that could be affected by decommissioning activities. The use of mitigation measures would minimize the potential for impacts associated with decommissioning.

5.9.1.6 Mitigation Measures

The following mitigation measures could be implemented to address potential impacts on cultural resources:

- The appropriate Federal agency should consult with federally recognized Native American governments early in the planning process for a wind energy development to identify issues and areas of concern. Consultation is required under the NHPA. Consultation is necessary to establish whether the project is likely to disturb traditional cultural properties, affect access rights to particular locations, disrupt traditional cultural practices, and/or visually impact areas important to the tribe(s).

- The presence of archaeological sites and historic properties in the area of potential effect should be determined on the basis of a records search of recorded sites and properties in the area and/or an archaeological survey. The SHPO is the primary repository for cultural resource information. The *National Register of Historic Places* could also be consulted at http://www.nps.gov/nr/research/index.htm.

- Archaeological sites and historic properties present in locations that would be affected by project activities should be reviewed to determine whether they meet the criteria of eligibility for listing on the NRHP. Cultural resources listed on or eligible for listing on the NRHP are considered “significant” resources.

- If a development is within the viewshed of a national historic trail eligible for listing on the NRHP, the developer should evaluate the potential visual impacts on the trail associated with the proposed project. If impacts were to occur, mitigation measures such as vegetation or landscape screening could be employed. Other mitigation options are identified in section 5.7.1.3.

- If cultural resources are known to be present at the site, or if areas with a high potential to contain cultural material have been identified, consultation with the SHPO should be undertaken by the appropriate Federal agency (e.g., Western, the Service, USFS, or BLM). In instances where Federal oversight is not appropriate, developers can interact directly with the SHPO. Avoidance of these resources is always the preferred mitigation option. Other mitigation options include archaeological survey, excavation, data recovery, and monitoring (as warranted). If an area exhibits a high potential but no artifacts are observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report should be prepared documenting these activities. Other steps include the identification and implementation of measures to prevent potential looting/vandalism or erosion impacts, as well as educating workers and the public to make them aware of the consequences of unauthorized collection of artifacts.

- Periodic monitoring of significant cultural resources in the vicinity of development projects may help curtail potential looting/vandalism and erosion impacts. If impacts are recognized early, additional actions can be taken before the resource is destroyed. Monitoring activities do not require Federal involvement.

- Cultural resources discovered during construction should immediately be brought to the attention of the responsible Federal agency. Work should be immediately halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation plans are being developed.

- If human remains are found on a development site, work should cease immediately in the vicinity of the find. The appropriate law enforcement officials and the appropriate Federal agency should be contacted. No material should be removed from the find location. Once it is determined that the remains belong to an archaeological site, the appropriate SHPO should be contacted to determine how the remains should be addressed.

- Significant cultural resources can be affected by soil erosion. See the mitigation measures discussed in section 5.2.1.7 for methods that could control soil erosion during a development project. Minimization of soil erosion would protect important resources from damage.

5.9.2 No Action Alternative

Under the No Action Alternative, wind energy facilities would be built independently across private and public lands, following the existing procedures and policies of Western and the Service (as applicable) to avoid, minimize, or mitigate impacts on cultural resources on a project-by-project basis. Western would continue to process and evaluate environmental effects of interconnection requests within the UGP Region, and the Service would evaluate accommodation of wind energy facilities on Service easements, on a case-by-case basis. Completely separate project-specific NEPA evaluations would be required by both Western and the Service, and BMPs and mitigation measures for projects would be identified on the basis of those project-specific evaluations. Potential effects on cultural resources would primarily result from ground-disturbing activities such as excavations and movement of heavy equipment during construction, but could also result from the unauthorized collection of artifacts by workers. Impacts could include any of the common impacts identified in section 5.9.1.

The main elements used in assessing direct impacts on cultural resources within the UGP Region are the location and the spatial extent of all ground-disturbing activities needed for both temporary and permanent use areas during each project phase and whether cultural resources are present (section 5.9.1). The presence of cultural resources is generally only discovered through cultural resource surveys. During characterization, construction, operation, and decommissioning phases for wind energy projects, the nature and extent of potential impacts on cultural resources would primarily depend on the size of the land areas where ground-disturbing activities would occur and whether cultural resources surveys were completed prior to the commencement of activities. During operation, the primary factors determining potential impacts on cultural resources include the density of cultural resources within the project area, the proximity of known archaeological sites to the individual turbines and access roads, and how evident the resources are to workers (e.g., resources vulnerable to unauthorized collecting). Because the information on locations and footprints of wind energy projects to be developed by 2030 are not currently known, the cultural resources that could be affected cannot be identified and the magnitude of potential impacts cannot be quantified in this PEIS. For project activities occurring on previously cultivated cropland, the impacts of ground disturbance on cultural resources would likely be negligible. Past experiences related to development of wind energy projects indicate that the potential impacts of individual wind energy projects on cultural resources during the characterization, construction, operation, and decommissioning phases would likely be minor because most effects on identified cultural resources can be avoided or mitigated.

Under the No Action Alternative, potential impacts on cultural resources associated with wind energy project development would be addressed on a project-by-project basis. This approach does not mean that resources would be more or less likely to be affected, only that there would be somewhat less clarity in the process to be followed for identifying and addressing potential impacts to cultural resources and potentially longer time frames for completing environmental reviews. Typically, if significant cultural resources are present the agencies would be required to consult with the appropriate State Historic Preservation Office (SHPO), federally recognized Native American tribes, and other interested parties to determine the appropriate actions needed to address the resource. In addition to the Federal requirements, most, if not all, State siting and permitting agencies would require cultural resource surveys for proposed wind energy projects. Most cultural resources are expected to be avoided during site characterization and construction phases of development due to the flexibility available for locating specific project activities and facilities.

5.9.3 Alternative 1

Under Alternative 1, both Western and the Service would establish standardized procedures for considering the environmental effects of wind energy projects. Project-specific NEPA evaluations could tier off of the PEIS, provided that the BMPs and mitigation measures identified in the PEIS are implemented as requirements. The use of standardized procedures would assist in streamlining the process required for a wind energy development project.

During construction and operation, the nature and extent of potential impacts would depend on the same factors described in section 5.9.2. It is assumed that the level of wind energy development within the UGP Region under Alternative 1, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to those identified for the No Action Alternative. The BMPs and mitigation measures identified in section 5.9.1.6 would be implemented, as appropriate, for projects, and additional BMPs and mitigation measures could be employed if determined necessary on the basis of project-specific review. Project-specific NEPA analyses would tier off the analyses in this PEIS.

Consultation requirements for cultural resources would be the same as previously identified for the No Action Alternative (i.e., SHPOs, tribes, and other interested parties). Because the information on locations and footprints of wind energy projects to be developed by 2030 are not currently known, the cultural resources that could be affected cannot be identified and the magnitude of potential impacts cannot be quantified in this PEIS. For project activities occurring on previously cultivated cropland, the impacts of ground disturbance on cultural resources would likely be negligible. Past experiences related to development of wind energy projects interconnecting to Western's transmission system indicate that the potential impacts of individual wind energy projects on cultural resources during the characterization, construction, operation, and decommissioning phases would likely be minor because most effects on identified cultural resources can be avoided or mitigated.

Under Alternative 1, the process for considering the effects of a wind development project would be more explicit compared to the No Action Alternative due to the implementation of standardized procedures including the mitigation measures identified in section 5.9.1.6 by both Western and the Service. The use of standardized procedures would help to ensure that significant cultural resources, if present on a project site, would be identified and appropriately protected during project development activities.

Standard BMPs and mitigation measures require consultation with the appropriate SHPO and tribes concerning the identification of significant cultural resources. If an area has not been previously investigated for the presence of cultural resources, a survey would be required. Based on the survey and consultation, significant resources within the project area would be identified and the effect of the project on these resources would be assessed. In most cases, it is expected that significant resources could be avoided. In the event that a significant resource cannot be avoided, mitigation would be developed in consultation with the SHPO, tribes, and other interested parties. Sites that are avoided may require monitoring throughout the project. Cultural resources such as archaeological sites are nonrenewable and very sensitive to disturbance. Monitors are trained professionals that would physically inspect significant resources within the project area throughout the duration of the project to ensure the resources are not disturbed by project personnel or activities. The actual effect of a project on significant cultural resources could only be determined on a case-by-case basis. Overall, the level of impacts on cultural resources under Alternative 1 would be similar to those that would occur under the No Action Alternative.

5.9.4 Alternative 2

Under Alternative 2, Western would establish standardized procedures for considering development projects as identified for Alternative 1, but the Service would not accommodate placement of wind energy facilities on easements. Project-specific NEPA evaluations could tier off of the PEIS, provided that the BMPs and mitigation measures identified in the PEIS are implemented by developers requesting interconnection to Western's transmission system. The use of standardized procedures by Western would assist in streamlining the process required for evaluating the environmental effects of a proposed wind energy development project requesting an interconnection to Western's transmission system.

During construction and operation, the nature and extent of potential impacts would depend on the same factors described in section 5.9.2. It is assumed that the level of wind energy development within the UGP Region under Alternative 2, including the amount of land disturbance and the areas developed for wind energy projects, would be similar to those identified for the No Action Alternative and Alternative 1. Although direct placement of wind energy facilities on easements managed by the Service within the UGP Region would not be accommodated under Alternative 2, it is anticipated that this would result in developers siting those structures on nearby private lands not managed under easements, rather than a noticeable change in the distribution of wind energy facilities within the UGP Region. Regardless, the number of wind energy facilities that have been accommodated on easements through easement exchanges in the past is relatively small, and the overall change in effects on cultural resources resulting from a decision to forego wind energy development on easement lands would be small.

The BMPs and mitigation measures identified in section 5.9.1.6 would be implemented, as appropriate, for projects requesting interconnection; additional BMPs and mitigation measures could be employed if determined necessary on the basis of project-specific review. Project-specific NEPA analyses would tier off the analyses in this PEIS. Consultation requirements for cultural resources would be the same as previously identified for Alternative 1 (i.e., SHPOs, tribes, and other interested parties) for all projects requesting interconnection to Western's transmission system.

Because the information on locations and footprints of wind energy projects to be developed by 2030 is not currently known, the cultural resources that could be affected cannot be identified and the magnitude of potential impacts cannot be quantified in this PEIS. For project activities occurring on previously cultivated cropland, the impacts of ground disturbance on cultural resources would likely be negligible. Past experiences related to development of wind energy projects interconnecting to Western's transmission system indicate that the potential impacts of individual wind energy projects on cultural resources during the characterization, construction, operation, and decommissioning phases would likely be minor because most effects on identified cultural resources can be avoided or mitigated. Overall, the level of impacts on cultural resources under Alternative 2 would be similar to those that would occur under the No Action Alternative or Alternative 1.

5.9.5 Alternative 3

Under Alternative 3, as with the other alternatives considered in this PEIS, projects would be required to meet established Federal, State, and local regulatory requirements. However, no additional BMPs and mitigation measures would be requested of project developers by Western or the Service for wind energy projects. Project-specific NEPA evaluations would be required, but would not tier off the analyses in this PEIS. If an easement exchange was necessary for a project to proceed, the Service would evaluate the proposed project as presented by the developers, without requiring additional modifications to reduce the environmental impacts.

As with the other alternatives, wind energy developments submitting interconnection requests to Western under Alternative 3 would be expected to occur primarily within areas identified as having high suitability for wind development and that are in proximity to Western's electric grid (within 25 mi [40 km]) (figure 2.4-4). As with the No Action Alternative and Alternative 1, direct placement of wind energy facilities on easements managed by the Service within the UGP Region could occur, depending upon results of evaluations conducted by the Service of the potential for unacceptable impacts on conservation goals. It is assumed that the overall level of wind energy development within the UGP Region under Alternative 3, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to that identified for the No Action Alternative.

Alternative 3 could result in greater impacts on significant cultural resources compared to the other alternatives considered because no avoidance measures, minimization measures, mitigation measures, or monitoring requirements would be requested of projects by either Western or the Service beyond those required by existing Federal, State, and local regulations. Existing cultural resource laws require the consideration of effects on significant cultural resources on Federal and State lands. Much of the development that could take place in the UGP Region could be on private lands that are not necessarily subject to the requirements of Federal and State law, including the consideration of project effects on cultural resources. However, most, if not all, State siting and permitting agencies would require cultural resource surveys. In those States that do not have siting and permitting requirements, cultural resources on private lands being developed for wind energy could be more susceptible to impacts. Cultural resources are fragile and non-renewable. Once a cultural resource, such as an archaeological site, has been altered, the information is permanently lost.

5.10 SOCIOECONOMICS

5.10.1 Common Impacts

5.10.1.1 Socioeconomic Impacts

Construction and operation of wind energy facilities and transmission lines in the six States would produce direct and indirect economic impacts. Direct impacts occur as a result of expenditures on wages and salaries, procurement of goods and services required for project construction and operation, and the collection of State sales and income taxes. To calculate direct impacts, data were taken from the National Renewable Energy Laboratory's Jobs and Economic Development Impact (JEDI) model (NREL 2011b), which provides relevant construction and operating cost data for labor and materials, in various general cost categories for each of the six States. These data were then used to calculate the direct fiscal impacts of wind facilities. Indirect impacts occur as project wages and salaries; procurement expenditures subsequently circulate through the economy of each State creating additional employment, income, and tax revenues. Indirect impacts were estimated using IMPLAN® data for each State (MIG, Inc. 2009), an input-output modeling framework designed to capture spending flows among all economic sectors and households in each State economy. Facility construction and operation would also require in-migration of workers and their families into each State, which would affect rental housing, public services, and local government employment. Direct in-migration was calculated using estimates of the local share of labor in various construction categories provided by the labor market in each State taken from the JEDI model. The number of direct workers bringing additional family members was estimated using data from the economic development literature and Census data on national average family size. Impacts on housing assumed that 50 percent of in-migrants would use temporary accommodation (motels or trailer homes), with the remaining 50 percent using rental housing. Estimation of impacts on public services was based on the expenditures and employment that would be required to maintain existing levels of service.

For the purposes of the analysis, a low and high wind development scenario was used. The low scenario represents the projection of likely wind development based on existing trends in the six States, while the high development scenario corresponds to recent DOE projections, showing wind capacity that would be needed to allow wind energy to generate 20 percent of U.S. electricity supply by 2030 (DOE 2008). This approach allows the analysis to capture a range of possible impacts of the construction and operation of wind generation facilities. For the analysis, cumulative impacts of all wind generation facilities built in each State during the period 2012–2030 were estimated.

Construction. Total employment impacts (including direct and indirect impacts) of wind power generation facilities built during the period 2012–2030 would be largest in Iowa, where development would create 44,681 jobs under the low scenario and 92,696 jobs under the high scenario (table 5.10-1). Smaller impacts would occur in Minnesota, where between 27,460 and 49,854 jobs would be created, and in South Dakota (between 6,095 and 38,561 jobs) and Nebraska (between 2,447 and 37,508 jobs). Wind power construction activities would constitute less than 1 percent of total State employment for both the low and high development scenarios in each of the six States in each year over the period 2012–2030. Facility construction would produce larger income impacts in Iowa (between $1.9 billion and $4.0 billion), Minnesota (between $1.4 billion and $2.6 billion), and in South Dakota ($235 million to $1.5 billion). Fiscal impacts of facility construction include State sales and income taxes. Sales taxes would be highest in Iowa (between $179.2 million and $371.7 million generated), with smaller impacts in Minnesota (between $101.5 million and $184.4 million), and South Dakota (between $23.8 million and $150.5 million). Income taxes would also be largest in Iowa (between $45.7 million and $94.9 million), with smaller impacts in Minnesota (between $31.7 million and $57.5 million).

TABLE 5.10-1 Socioeconomic Impacts of Wind Generation Facilities[a]

	Iowa		Minnesota		Montana		Nebraska		North Dakota		South Dakota	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Construction												
Employment (number)												
Direct	19,284	40,006	10,894	19,779	2,259	10,656	1,024	15,704	6,921	4,532	2,569	16,251
Total	44,681	92,696	27,460	49,854	5,218	24,617	2,447	37,508	16,718	10,949	6,095	38,561
Income ($m 2010)												
Total	1,912,	3,966	1,439	2,613	188	886	103	1,578	709	464	235	1,486
State Direct Taxes ($m 2010)												
Sales	179.2	371.7	101.5	184.4	NA[b]	NA	9.6	146.4	64.2	42.0	23.8	150.5
Income	45.7	94.9	31.7	57.5	4.4	20.7	2.3	35.1	16.7	10.9	NA	NA
Direct In-migrants (number)	13,022	27,015	7,268	13,195	1,541	7,271	687	10,538	4,654	3,048	1,753	11,093
Vacant rental housing (number)	6,511	13,508	3,634	6,597	771	3,636	344	5,269	2,327	1,524	877	5,546
Local Government												
Expenditures ($m 2010)	113.5	235.4	71.7	130.2	13.3	62.6	7.1	109.0	41.2	27.0	13.3	83.9
Employment (number)	562	1,166	171	311	206	974	48	740	979	641	299	1,894
Easement and Lease Fees ($m 2010)	33.6	69.7	19.2	34.8	3.9	18.4	1.8	27.6	12.1	7.9	4.5	28.2

TABLE 5.10-1 (Cont.)

	Iowa		Minnesota		Montana		Nebraska		North Dakota		South Dakota	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Operations												
Employment (number)												
Direct	896	1,858	511	928	104	491	48	735	322	211	119	752
Total	1,681	3,488	985	1,789	189	889	92	1,410	575	377	223	1,413
Income ($m 2010)												
Total	75.1	155.7	53.1	96.3	7.3	34.6	4.0	60.6	26.0	17.0	8.8	55.5
State Direct Taxes ($m 2010)												
Sales	7.3	15.2	3.9	7.2	NA	NA	0.4	5.8	2.6	1.7	1.0	1.7
Income	2.4	5.0	1.7	3.0	0.2	1.1	0.1	1.8	0.9	0.6	NA	NA

[a] Impacts are assessed for all facilities built during the period 2012–2030.

[b] NA = not applicable. There is currently no sales tax in Montana and no income tax in South Dakota.

The likelihood of local worker availability in the required occupational categories during construction of wind development projects would mean that some in-migration of workers and their families from outside each State would be required. Between 13,022 and 27,015 persons would in-migrate into Iowa during the construction period 2012–2030, between 7,268 and 13,195 in Minnesota, and between 1,753 and 11,093 in South Dakota. Although in-migration may potentially impact local housing markets, the relatively small number of in-migrants and the availability of temporary accommodation (hotels, motels, and mobile home parks) would mean that the impact of wind facility construction on the number of vacant rental housing units is not expected to be large over the period 2012 to 2030. Between 6,511 and 13,508 rental units are expected to be occupied in Iowa, between 3,634 and 6,597 in Minnesota, and between 877 and 5,546 in South Dakota. These occupancy rates would represent less than 5 percent of the vacant rental units expected to be available in each of the States in each year over the period 2012–2030.

In addition to the potential impact on housing markets, in-migration would also affect State and local government expenditures and employment. Facility construction in Iowa would require between $113.5 million and $234.5 million in expenditures to meet the existing levels of service in the provision of State and local government services. Smaller impacts would occur in Minnesota, where between $71.7 million and $130.2 million in local government expenditures would be required. These increases would represent an increase of less than 5 percent over expenditures expected in each of these States in each year over the period 2012–2030. Increases in employment would also be expected with wind facility construction in South Dakota (where between 299 and 1,894 new employees would be required) an Iowa (562 to 1,166) to maintain existing levels of service.

Although the specific locations that would be chosen by developers for building wind generation facilities are not known, new capacity would be located on private land in each of the States, with public land also used for development in Montana, North Dakota, and South Dakota. There would be no wind development on public lands with conservation easements in Iowa, Minnesota, and Nebraska. Private landowners and agencies managing public land would receive compensation in the form of lease and easement fees from wind developers in exchange for using land for wind development. Based on a survey of lease and easement fees paid by wind developers (Windustry 2009), fees for projects built or approved since 2005 averaged $3,500 per megawatt per year. Assuming this fee amount would be paid on wind projected installed capacity in 2030, fees for wind development would vary between $33.6 million and $69.7 million in Iowa, between $19.2 million and $34.8 million in Minnesota, and between $4.5 million and $28.2 in South Dakota.

Operations and Maintenance. Total employment impacts (including direct and indirect impacts) of wind power generation facilities built during the period 2012–2030 would be largest in Iowa, where development would create 1,681 jobs under the low scenario and 3,488 jobs under the high scenario (table 5.10-1). Smaller impacts would occur in Minnesota, where between 985 and 1,789 jobs would be created, and South Dakota (between 223 and 1,413 jobs). Facility construction would produce larger income impacts in Iowa (between $75.1 million and $155.7 million), Minnesota (between $53.1 million and $96.3 million), and South Dakota (between $8.8 million to $55.5 million). Fiscal impacts of facility construction include State sales and income taxes. Sales taxes would be highest in Iowa, with between $7.3 million and $15.2 million generated, with smaller impacts in Minnesota (between

$3.9 million and $7.2 million). Income taxes would also be largest in Iowa, between $2.4 million and $5.0 million, with smaller impacts in Minnesota (between $1.7 million and $3.0 million).

With a relatively small local labor force required to maintain and operate wind facilities, no in-migrants are expected under either the low or high development scenario, with no impacts likely in the rental housing market or to local government expenditures or employment.

5.10.1.2 Recreation Impacts

Estimating the impact of wind facilities on recreation is problematic, as it is not clear how wind developments in each State would impact recreational visitation and nonmarket values (the value of recreational resources for potential or future visits; see section 3.10). While some land in each State may be no longer accessible for recreation following development of a wind energy project on such land, the majority of popular recreational locations would be precluded from wind development. Overall, the majority of wind energy development in the UGP Region occurs on private property, where recreational use (including hunting) would be by landowners, their families, and invited guests; such use would be unlikely to change substantially as the result of wind energy development. It is also possible that wind developments in each State would be visible from popular recreation locations, reducing visitation and consequently impacting the economy of each State.

Because the impacts of wind energy facilities on visitation and nonmarket values are not known, this section presents two simple scenarios to indicate the magnitude of the economic impact of wind development on recreation: the impact of a 0.5 percent and 1 percent reduction in recreation activity in each State. Impacts include the direct loss of recreation employment in the recreation sectors, indirect effects (which represent the impact on the remainder of the economy in each State as a result of declining recreation employee wage and salary spending), and expenditures by the recreation sector on materials, equipment, and services. Indirect impacts were estimated using IMPLAN data for each State (MIG, Inc. 2009), an input-output modeling framework designed to capture spending flows among all economic sectors and households in each State economy.

Construction and operation of wind developments could produce the socioeconomic impacts shown in table 5.10-2 resulting from a 0.5 percent and a 1 percent decline in recreational activity. In Minnesota, the total (direct plus indirect) impacts of a 0.5 percent reduction in recreational activity would be the loss of 1,819 jobs Statewide; 3,637 jobs would be lost if recreation employment were to decline 1 percent. Income lost as a result of the 0.5 percent contraction in recreational activity would be $43.5 million, with $87.1 million lost for the 1 percent loss in recreation. A 0.5 percent reduction in recreational activity would mean the loss of 989 jobs and $19.7 million in income in Iowa, 601 jobs and $12.2 million in income in Nebraska, and 438 jobs and $8.4 million in income in Montana, with proportional increases in impacts with a 1 percent reduction in recreational activity. Again, because wind development in the UGP Region would typically not result in changes in access or other land uses, and because most development would be on private lands, the realized impact could be considerably smaller than either of these simple scenarios would indicate.

TABLE 5.10-2 State Economic Impacts of Reductions in Recreation Sector[a] Activity

	0.5 Percent Reduction		1 Percent Reduction	
State	Employment	Income ($million)	Employment	Income ($million)
Iowa	989	19.7	1,978	39.4
Minnesota	1,819	43.5	3,637	87.1
Montana	438	8.5	876	17.0
Nebraska	601	12.2	1,201	24.4
North Dakota	232	4.3	464	8.5
South Dakota	315	6.2	630	12.3

[a] The recreation sector includes amusement and recreation services, automotive rental, eating and drinking places, hotels and lodging places, museums and historic sites, RV parks and campsites, scenic tours, and sporting goods retailers.

5.10.1.3 Property Value Impacts

A number of studies have assessed the potential impacts of wind projects on property values due to deterioration in aesthetic quality, increases in noise, real or perceived health effects, and traffic congestion. ECONorthwest (2002) interviewed county tax assessors in 13 locations with recent, multiple-turbine wind developments. While not all the locations chosen had wind turbines that were visible from residential areas, and some had been constructed too recently for their full impact to be properly assessed, the study found no evidence that wind turbines decreased property values. Indeed in one area examined, it was found that designation of land parcels for wind development actually increased property values. Sterzinger et al. (2003) analyzed the effect of 10 wind projects built during the period 1998 to 2001 on housing sale prices. The study used a hedonic statistical framework that attempts to account for all influences on change in property value and used evidence of 25,000 property sales, both within view of recent wind developments and in a comparable region with no wind projects, before and after project construction. The results of the study indicate that were no negative impacts on property values. Indeed, for the majority of the wind projects considered, property values actually increased within the viewshed of each project, with property values also tending to increase faster within areas with a view of wind turbines than in areas with no wind projects.

Electricity transmission lines associated with wind developments can also potentially affect property values through the visibility of electricity transmission structures, with other factors such as health and safety and noise associated with each of the three transmission systems likely being less important. In a review of the evidence from sales data and interviews with real estate professionals (Kroll and Priestley 1992; Grover, Elliot, and Company 2005), it was found that price differentials for residential properties based on sales data in appraisal studies tended to be small, usually 5 percent or less, with slightly larger price impacts for agricultural, commercial, and industrial land. Studies attempting to establish how individual property owners and real estate professionals perceive the impact of energy transmission developments using questionnaires and personal interviews found that the majority of respondents felt that transmission lines had little or no effect on residential property values, with small increases noted only in some studies (Rhodeside and Harwell, Inc. 1988; Kroll and Priestley 1992; International Electric Transmission Perception Project 1996; Grover, Elliot, and Company 2005) Interviews with agricultural land owners found a high level of indifference with respect to property value losses.

In general, potentially hazardous facilities can directly affect property values in two ways (Clark et al. 1997; Clark and Allison 1999). First, negative imagery associated with these facilities could reduce property values if potential buyers believed that any given facility might produce an adverse environmental impact. Negative imagery could be based on individual perceptions of risk associated with proximity to these facilities or on perceptions at the community level that the presence of such a facility might adversely affect local economic development prospects. Even though a potential buyer might not personally fear a potentially hazardous facility, the buyer might still offer less for a property in the vicinity of a facility if there was fear that the facility would reduce the rate of appreciation of housing in the area. Second, there could be a positive influence on property values associated with accessibility to the workplace for workers at the facility, with workers offering more for property close to the facility to minimize commuting times. Workers directly associated with a solar facility would probably also have much less fear of the technology and operations at the facility than would the population as a whole. The importance of this influence on property values would likely vary with the size of the workforce involved.

There is some evidence of the impact of large-scale energy development on property values. In western Colorado communities adjacent to oil and gas drilling activities, property values declined with the announcement of drilling, and during the first stages of extraction, the values rebounded, at least partly, once production was fully under way (BBC Research and Consulting 2006). Other studies have assessed the impact of other potentially hazardous facilities — such as nuclear power plants and waste facilities (Clark and Nieves 1994; Clark et al. 1997; Clark and Allison 1999) and hazardous material and municipal waste incinerators and landfills (Kohlhase 1991; Kiel and McClain 1995) — on, for example, local property markets. Many of these studies used a hedonic modeling approach to take into account the wide range of spatial influences, including noxious facilities, crime (Thaler 1978), fiscal factors (Stull and Stull 1991), and noise and air quality (Nelson 1979), on property values.

Under conditions of moderate population growth and housing demand, it appears that property values could increase with the expansion in local employment opportunities resulting from wind development. Given the modular, phased nature of wind development, it is unlikely that significant in-migration would occur; rather, construction crews would likely move between individual wind towers, meaning an absence of the need for a large workforce for specific phases of construction as would be required for other energy projects, meaning that impacts on property values as a result of congestion and excess housing demand would likely be small. However, with larger-scale construction occurring over relatively short periods of time in each State, increases in population and the associated congestion — in the absence of adequate private sector real estate investment and appropriate local community planning — might have adverse impacts on property values. Various energy development studies have suggested that once the annual growth in population is between 5 and 15 percent in smaller rural communities, a breakdown in social structures could start to occur, with a consequent increase in alcoholism, depression, suicide, social conflict, divorce, and delinquency, and a deterioration in levels of community satisfaction (BLM 1980, 1983, 1996), and the resulting deterioration in local quality of life could adversely affect property values.

The general conclusion from many of these studies is that, while there may be a small negative effect on property values in the immediate vicinity of large-scale facilities such as wind farms (i.e., less than 1 mi [1.6 km]), this effect is often temporary and often associated with announcements related to specific project phases, such as site selection, the start of construction, or the start of operations. At larger distances, over longer project durations, no significant enduring negative property value effects have been found. Depending on the importance of the employment effect associated with the development of the various activities analyzed in these studies, a positive impact on property values was found to be associated with increases in demand for local housing.

5.10.1.4 Transmission Line Impacts

Construction and operation of transmission lines in the six States would produce direct and indirect economic impacts. Direct impacts occur as a result of expenditures on wages and salaries, procurement of goods and services required for project construction and operation, and the collection of State sales and income taxes. Expenditure data associated with the construction and operation of transmission lines was derived from Buchanan et al. (2005), which provided the relevant construction and operating cost data for labor and materials in various general cost categories. Indirect impacts occur as project wages, salaries, and procurement expenditures subsequently circulate through the economy of each State, creating additional employment, income, and tax revenues. Facility construction and operation would also require in-migration of workers and their families into each State, affecting rental housing, public services, and local government employment. Indirect impacts were estimated using IMPLAN data for each State (MIG, Inc. 2009), an input-output modeling framework designed to capture spending flows among all economic sectors and households in each State economy.

To capture the range of possible impacts of the construction and operation of transmission lines, two line sizes, 230 kV and 500 kV, were assessed. As the location of individual wind projects and the length of transmission line required to connect to the transmission network are not known, impacts were estimated for a single, 25-mi (40.2-km) length of line, built in 2030 The actual projected socioeconomic impacts of transmission line construction and operation would depend on the number of wind projects developed between 2012 and 2030 in each State and their location relative to the transmission network.

Construction. Total employment impacts (including direct and indirect impacts) of a transmission line in 2020 would be largest in South Dakota, where a 230-kV line would create 50 jobs, and a 500-kV line, where 114 jobs would be produced (table 5.10-3). Smaller impacts would occur in Nebraska, where 49 jobs would be created for a 230-kV line and 113 jobs would be created for a 500-kV line; in Iowa, Minnesota, and Montana, 47 and 109 jobs, respectively, would be created in each State. Transmission line construction activities would constitute less than 1 percent of total State employment for a 25-mi (40.2-km) 230-kV and 500-kV line in each year in each of the six States over the period 2012 to 2030. Transmission line construction would produce larger income impacts in South Dakota (between $2.9 million and $6.8 million), Nebraska ($2.2 million to $5.2 million), and Iowa ($2.2 million to $5.1 million). Fiscal impacts of transmission line construction include State sales and income taxes. Direct sales taxes and direct income taxes would be less than $0.1 million for both line sizes in each of the States.

TABLE 5.10-3 Socioeconomic Impacts of 25-mi (40-km) Transmission Lines[a]

	Iowa		Minnesota		Montana		Nebraska		North Dakota		South Dakota	
	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV
Construction												
Employment (number)												
Direct	22	50	22	50	22	50	22	50	22	50	22	50
Total	47	109	47	109	47	109	49	113	46	105	50	114
Income ($m 2010)												
Total	2.2	5.1	2.0	4.8	2.1	4.7	2.2	5.2	2.1	5.0	2.9	6.8
State Direct Taxes ($m 2008)												
Sales	0.1	0.1	0.1	0.1	NA[b]	NA	0.1	0.1	0.1	0.1	0.1	0.1
Income	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	NA[b]	NA
Direct In-migrants (number)	3	6	3	6	3	6	3	6	3	6	3	6
Vacant Rental Housing (number)	2	5	2	5	2	5	2	5	2	5	2	5
Local Government												
Expenditures ($m 2010)	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Employment (number)	0	0	0	0	0	0	0	1	0	1	0	0

TABLE 5.10-3 (Cont.)

	Iowa		Minnesota		Montana		Nebraska		North Dakota		South Dakota	
	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV	230 kV	500 kV
Operations												
Employment (number)												
Direct	0	1	0	1	0	1	0	1	0	1	0	1
Total	1	3	1	3	1	3	1	3	1	3	1	3
Income ($m 2010)												
Total	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
State Direct Taxes ($m 2010)												
Sales	<0.1	<0.1	<0.1	<0.1	NA	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Income	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	NA

[a] Impacts are assessed for a single 25-mile line built in each State in the year 2020.

[b] NA = not applicable. There is currently no sales tax in Montana and no income tax in South Dakota.

The likelihood of local worker availability in the required occupational categories during construction of a transmission line would mean that some in-migration of workers and their families from outside each State would be required, with between 3 and 6 persons in-migrating into each of the six States during construction. Although in-migration may potentially impact local housing markets, the relatively small number of in-migrants and the availability of temporary accommodations (hotels, motels, and mobile home parks) would mean that the impact of transmission line construction on the number of vacant rental housing units is not expected to be large, with between 2 and 5 rental units expected to be occupied in each of the States. These occupancy rates would represent less than 0.1 percent of the vacant rental units expected to be available in each year in each of the States over the period 2012 to 2030.

In addition to the potential impact on housing markets, in-migration would also affect State and local government expenditures and employment. Transmission line construction would require less than $0.1 million in expenditures for a 230-kV line and $1.0 million for a 500-kV line in each of the States to meet the existing levels of service in the provision of State and local government services. These increases would represent an increase of less than 0.1 percent over expenditures expected in each of these States in 2021. Slight increases in employment would also be expected with transmission line construction in Nebraska and North Dakota to maintain levels of service.

Operations and Maintenance. Total employment impacts (including direct and indirect impacts) in the first year of operation (2020) of a transmission line would be similar in each of the six States. Income impacts would also be similar in each of the six States, with small State sales and income tax revenues produced during operation of a 25-mi (40.2-km) line.

With a relatively small local labor force required to maintain and operate a transmission line, no in-migrants are expected with either facility size, with no impacts likely in the rental housing market or on local government expenditures or employment.

Transmission lines associated with wind developments would also have impacts on recreation, although it is not clear how transmission lines in each State would impact recreational visitation and nonmarket values (the value of recreational resources for potential or future visits). While some land in each State would no longer be accessible for recreation, the majority of popular wilderness locations would be precluded from transmission line development. It is also possible that of transmission lines associated with wind developments in each State would be visible from popular recreation locations, reducing visitation and consequently impacting the economy of each State.

Energy transmission lines could also affect property values in communities located on land adjacent to wind developments, primarily as a result of the visibility of electricity transmission structures; the health and safety issues (in particular, EMF), noise, and traffic congestion associated with transmission lines would likely be less important. Although various studies have attempted to measure the impact of transmission lines on property values, significant data and methodological problems are associated with many of the studies, and the results are often inconclusive (Kroll and Priestley 1992; Grover, Elliot, and Company 2005).

5.10.2 No Action Alternative

Under the No Action Alternative, it is anticipated wind energy developments could be sited on private or public land in each of the States. The socioeconomic impacts of the No Action Alternative would be the same as those described in section 5.10.1, where it was assumed that easement fees would be collected from a certain percentage of wind capacity constructed in Montana, North Dakota, and South Dakota, and that no fees would be collected in Iowa, Minnesota, and Nebraska.

5.10.3 Alternative 1

The projected levels of wind energy development and the locations affected by wind energy development are expected to be similar under Alternative 1 to those that would occur under the No Action Alternative. Because the procedures, BMPs, and mitigation measures identified for Alternative 1 would not significantly alter economic inputs regionally compared to the No Action Alternative, the socioeconomic impacts of Alternative 1 would be similar to those described in section 5.10.1.

5.10.4 Alternative 2

The projected levels of wind energy development and the locations affected by wind energy development are expected to be similar under Alternative 2 to those that would occur under the No Action Alternative and Alternative 1. Because the procedures, BMPs, and mitigation measures identified for Alternative 2 would not significantly alter economic inputs regionally compared to the No Action Alternative, the socioeconomic impacts of Alternative 2 would be similar to those described in section 5.10.1.

Alternative 2 would differ from Alternative 1 and the No Action Alternative in that accommodation of wind energy facilities on Service easements would not be considered. Despite restrictions placed on wind energy development on Service easements, with the exception of revenues from easement fees, the socioeconomic impacts of Alternative 2 would be the same as those described in section 5.10.1, where it was assumed that easement fees would be collected from a certain percentage of wind capacity constructed in Montana, North Dakota, and South Dakota. Under Alternative 2, no easement fees would be collected. However, given the small number of facilities that would be accommodated on easements on an annual basis, impacts on socioeconomic values compared to the No Action Alternative or Alternative 1 would be minor.

5.10.5 Alternative 3

The projected levels of wind energy development and the locations that would be affected by wind energy development under Alternative 3 are expected to be similar to those that would occur under the No Action Alternative, Alternative 1, and Alternative 2. Because the procedures, BMPs, and mitigation measures identified for Alternative 3 would not significantly alter the estimated economic inputs regionally compared to the No Action Alternative, the socioeconomic impacts of Alternative 3 would be similar to those described in section 5.10.1.

5.11 ENVIRONMENTAL JUSTICE

5.11.1 Common Impacts

The analysis considered noise and dust during the construction of utility-scale wind energy facilities and the associated access roads; the visual impacts of wind energy generation and auxiliary facilities, including electric transmission lines; noise and EMF effects associated with wind project operations; access to land having economic, cultural, or religious significance; and property values as areas of concern that might potentially impact minority and low-income populations.

Noise and dust impacts during construction of wind energy generation and other facilities would be minor and temporary, even given the amount of land typically disturbed, and the relative remoteness of locations used for wind energy facilities would mitigate some of the impacts. Another issue may be impacts from access roads required during construction for the delivery of equipment and materials to energy project sites. There may environmental justice issues associated with wind energy project construction, depending on the terrain across which these roads would be constructed, access road length, the length of time they would be needed for construction traffic, and the proximity to minority and low-income populations. In many cases, the landowners who agreed to allow wind energy development on their lands would be the people in closest proximity.

A major potential environmental justice impact of wind energy facility operation might be the visual impact of wind energy generation and auxiliary facilities. Although preliminary screening excludes development on public lands that are designated as being of scenic quality or interest, wind energy developments may potentially alter scenic quality in areas of traditional or cultural significance to minority and low-income populations. Although likely to be minor, noise and EMF impacts from project operation could also create an environmental justice issue. The extent to which noise and EMF effects are issues would depend on the facility size of any specific energy project and related transmission lines and their proximity to minority and low-income populations.

Access to certain animals or types of vegetation that may be of cultural or religious significance to certain population groups or that form the basis for subsistence agriculture may be restricted with the development of wind energy facilities, which may affect low-income and minority populations. The curtailment of various economic uses of Federal lands with wind energy facility development, such as leasing for mineral, energy, and forestry-resource development, may also affect minority and low-income populations if minority and low-income individuals involved in specific resource developments are concentrated in impacted local communities.

Property value impacts on private land in the vicinity of wind energy developments may affect minority and low-income populations, depending on the extent to which these population groups are concentrated in impacted local communities. The precise nature of the impact of designation on property values would depend on the range of alternate uses of specific land parcels available to landowners, current property values, and the perceived value of costs (visual impacts, traffic congestion, noise and dust pollution, EMF effects) and benefits (infrastructure upgrades, utility hookups, cheap and reliable energy supplies, local tax revenues) from proximity to wind energy facilities to potential purchasers of properties owned by minority and low-income individuals in local communities.

Potential impacts on low-income and minority populations could be incurred as a result of the construction and operation of wind energy developments; however, because impacts are likely to be small, and because there are no low-income or minority populations defined by Council on Environmental Quality (CEQ) guidelines (see section 4.11.1) in the six States, impacts of wind energy projects would not disproportionately affect low-income or minority populations. There is also a possibility that wind energy development could create economic opportunities for some groups in the form of jobs and contracts for goods, services, and raw materials such as gravel or aggregate.

Mitigation of environmental justice impacts may be required, specifically those associated with visual impacts of wind generation facilities. Mitigation of visual impacts would include the siting of facilities to minimize contrast with scenic views, the appropriate use of construction materials that minimize scenic contrast, and avoidance of traditional and cultural sites important to low-income and minority populations.

Noise and dust impacts during construction of wind facilities and noise and EMF effects during project operation would likely not produce impacts that are high and adverse to the general population. Similar impacts on minority and low-income populations would also be expected, with no additional mitigation required. Noise and dust impacts during construction, particularly those associated with the construction of access roads, would be reduced using standard mitigation methods, while noise and EMF effects during project operation would be minimal due to the remote locations of the majority of wind energy facilities in each of the six States.

5.11.2 No Action Alternative

Under the No Action Alternative, individual wind energy projects and associated transmission lines would be subject to NEPA reviews, based on the location of specific projects. Because individual project reviews would be based on the analysis of populations within a 50-mi (80-km) area around proposed project locations, these reviews would analyze the distribution of low-income and minority populations at the local level, and would describe environmental justice populations that could be significantly different from those described at the six-State level in the PEIS. A more thorough evaluation of the populations that could be adversely affected by specific projects would then allow identification of site-specific BMPs and mitigation measures that could be implemented to address those effects.

5.11.3 Alternative 1

From a regional, six-State perspective, the projected levels of wind energy development and the locations affected by wind energy development are expected to be similar under all of the programmatic alternatives. Because evaluation of environmental justice impacts relies on site-specific information, it is not possible to fully evaluate those impacts in a programmatic fashion. Under Alternative 1, evaluation of environmental justice would be conducted for individual wind energy projects and associated transmission lines during site-specific NEPA reviews. Because individual project reviews would be based on the analysis of populations within a 50-mi (80-km) area around proposed project locations, these reviews would analyze the distribution of low-income and minority populations at the local level, and would describe environmental justice populations that could be significantly different from those described at the six-State level in the PEIS. A more thorough evaluation of the populations that could be adversely affected by specific projects would then allow identification of site-specific BMPs and mitigation measures that would be implemented to address those effects.

5.11.4 Alternative 2

From a regional, six-State perspective, the projected levels of wind energy development and the locations affected by wind energy development are expected to be similar under all of the programmatic alternatives. Because evaluation of environmental justice impacts relies on site-specific information, it is not possible to fully evaluate those impacts in a programmatic fashion. Under Alternative 2, evaluation of environmental justice would be conducted for individual wind energy projects and associated transmission lines during site-specific NEPA reviews. Because individual project reviews would be based on the analysis of populations within a 50-mi (80-km) area around proposed project locations, these reviews would analyze the distribution of low-income and minority populations at the local level, and would describe environmental justice populations that could be significantly different from those described at the six-State level in the PEIS. A more thorough evaluation of the populations that could be adversely affected by specific projects would then allow identification of site-specific BMPs and mitigation measures that would need to be implemented to address those effects.

5.11.5 Alternative 3

From a regional, six-State perspective, the projected levels of wind energy development and the locations affected by wind energy development are expected to be similar under all of the programmatic alternatives. Because evaluation of environmental justice impacts relies on site-specific information, it is not possible to fully evaluate those impacts in a programmatic fashion. Under Alternative 3, evaluation of environmental justice would be conducted for individual wind energy projects and associated transmission lines during site-specific NEPA reviews. Because individual project reviews would be based on the analysis of populations within a 50-mi (80-km) area around proposed project locations, these reviews would analyze the distribution of low-income and minority populations at the local level, and would describe environmental justice populations that could be significantly different from those described at the six-State level in the PEIS. However, because Western and the Service would not require implementation of any BMPs or mitigation measures beyond those required under Federal, State, or local regulations, impacts on environmental justice could potentially be greater in some areas.

5.12 HAZARDOUS MATERIALS AND WASTE

Section 3.9 provides a discussion of the amounts and types of hazardous materials that would be present at a wind farm during its construction, operation, and decommissioning phases. Wastes expected to be generated during those phases and the likely management and disposal strategies that would be employed are also discussed. The following sections discuss the possible adverse impacts resulting from the presence and use of hazardous materials and the generation, management, and disposal of wastes. Appropriate mitigation strategies are also presented.

5.12.1 Common Impacts

5.12.1.1 Construction

The array of hazardous materials used in facility construction is quite similar to hazardous materials used in the construction of any industrial facility. The acquisition, transport, storage, use, and disposal of these materials are all regulated by Federal and State agencies. In addition, the wastes expected to be generated are common to many other construction projects, and various BMPs and mitigation measures exist for their safe management and disposal. Impacts from the hazardous materials present during construction could include increased risks of fires and contamination of environmental media from improper storage and handling, leading to spills or leaks. However, there is considerable experience in the use of such hazardous materials to support industrial construction, and the construction industry has established appropriate BMPs, worker training, personal protective equipment (PPE), and contingency planning to address such potentially adverse impacts. Section 5.12.14 provides a list of appropriate mitigation measures for hazardous materials used during construction.

Construction-related wastes include various fluids from the on-site maintenance of construction vehicles and equipment (used lubricating oils, hydraulic fluids, glycol-based coolants, and spent lead-acid storage batteries); incidental chemical wastes from the maintenance of equipment and the application of corrosion-control protective coatings (solvents, paints, and coatings); construction-related debris (e.g., dimension lumber, stone, and brick); and dunnage and packaging materials (primarily wood and paper). All such materials are expected to be initially accumulated on-site and ultimately disposed of or recycled through off-site facilities. Some construction-related waste (e.g., spent solvents and corrosion control coatings that are applied in the field) may qualify as characteristic hazardous waste or State- or Federal-listed hazardous waste. Short-term accumulation and storage of hazardous waste on-site would be subject to the generator regulations in 40 CFR Part 261 promulgated under the authority of the Resource Conservation and Recovery Act (RCRA). However, any hazardous waste is likely to be transported to off-site RCRA-permitted treatment, storage and disposal facilities (TSDF) prior to the time when the RCRA regulations would require a permit for their on-site management.

Potential impacts from the generation of such wastes include potential contamination of environmental media from improper collection, containerization, storage, and disposal. As with hazardous materials, appropriate waste management strategies, supported by the availability of appropriate waste containers and properly designed storage areas and implemented by worker training and adherence to established and disseminated waste management policies and appropriate in-house spill response capabilities,[9] can be expected to successfully avert adverse

[9] Because of the expected remoteness of some facilities, responses by external resources may not be immediate and in-house spill/emergency response capabilities sufficient to stabilize the upset condition are considered essential.

impacts while the wastes are being accumulated on-site and during delivery to off-site disposal or recycling facilities. A comprehensive list of appropriate mitigation measures for on-site management and off-site transport of construction-related wastes is provided in section 5.12.3.

5.12.1.2 Operations and Maintenance

Wind energy facilities can be expected to have substantial quantities (500 gal [1,893 L] or more) of dielectric fluids contained in various electrical devices such as switches, transformers, and capacitors. Several types of common industrial cleaning agents may also be present at wind energy facilities during operations, although the quantities would generally be small (<55 gal [208 L]) (section 3.9; table 3.9.1). Many wind energy facilities also can be expected to engage in some degree of noxious weed and vegetation management that would result in approved and registered herbicides being applied on the site and some wastes generated as a result of such activities. Beyond these factors, wind energy facilities can be expected to have a relatively small complement of hazardous materials present to support equipment cleaning, repair, and maintenance. Section 5.12.1.4 presents mitigation measures to limit adverse impacts.

Wastes resulting from operation of wind energy facilities would include (1) domestic solid wastes and sanitary wastewaters from workforce support and (2) industrial solid and liquid wastes resulting from routine cleaning and equipment maintenance and repair. During the operational phase, a maintenance crew of six individuals or fewer is likely to be present on the site daily during business hours and the generated volumes of solid wastes and sanitary wastewaters would be limited. Solid wastes can be expected to be accumulated on-site for short periods until they are delivered to permitted off-site disposal facilities, typically by commercial waste disposal services. Sanitary wastewater generated by work crews at wind energy facilities would be collected in portable facilities and periodically removed by a licensed hauler and introduced into existing municipal sewage treatment facilities. All such treatment or disposal options, properly implemented, would preclude adverse environmental impacts. Some industrial wastes (e.g., spent cleaning solvents) may exhibit hazardous character, but well-established procedures for the management, disposal, and/or recycling of all industrial wastes should be readily available and would keep adverse impacts to a minimum. Wastes from herbicide applications would likely include empty containers and possibly some herbicide rinsates.[10]

Unless major malfunctions occur, dielectric fluids can be expected to remain in their devices throughout the active life of the facility, and no dielectric wastes are expected except as a result of unplanned spills or leaks. Adverse impacts would include potential worker exposure to hazardous materials and wastes and contamination of environmental media resulting from spills or leaks of hazardous materials or from improper waste management techniques. Well-developed management programs involving proper facility design, worker training, PPE, well-developed and well-understood management strategies, and appropriate spill contingency plans

[10] Pesticide and herbicide application is likely to be a contracted service. Typically, contractors will be responsible for removing any wastes from the operation to off-site treatment or disposal facilities. Use of proper techniques in developing field-strength solutions from pesticide concentrates typically results in a triple-rinsed container that can be disposed of as solid waste and rinsates that will have been incorporated into the solution to be applied. Application equipment is typically cleaned at the contractor's off-site location.

can be expected to largely preempt adverse impacts. Section 5.12.1.4 identifies possible mitigation measures.

5.12.1.3 Decommissioning

The hazardous materials that would be present during decommissioning of wind energy facilities would be virtually identical to those that would be present to support vehicles and equipment during facility construction.

Wastes generated during decommissioning would largely be derived from the maintenance of vehicles and equipment and can expected to be managed in the same manner as during construction, with the same potential for adverse impacts. However, in addition to wastes generated in support of vehicles and equipment, other wastes, such as spent dielectric fluids, would be generated as a result of draining and purging of facility systems. Impacts could occur during facility dismantlement and draining as a result of spills and leaks and releases to the environment from improper temporary on-site storage of recovered fluids.

Substantial quantities of solid materials would also be produced during facility dismantlement. Some would need to be managed as solid waste (e.g., broken concrete and masonry from on-site buildings and foundations); however, some of the material produced (e.g., tower segments, power cables) is likely to be recyclable after short-term on-site storage.[11]

5.12.1.4 Mitigation Measures

Means to eliminate or reduce adverse impacts from hazardous materials and wastes include compliance with applicable laws, ordinances, and regulations and conformance with relevant industry standards (including those issued by nonregulatory bodies such as the National Fire Protection Association). Wind energy facility projects issued ROWs by Federal agencies, including the Service, and interconnection access to transmission facilities operated by Western or other transmission system operators will be required to incorporate elements of relevant construction standards and interconnection requirements as well as the reliability requirements of FERC orders.[12]

Developers of wind energy facilities should prepare several plans addressing various aspects of hazardous materials and waste, including a hazardous materials and waste management plan, a construction and operation waste management plan, a fire management and protection plan, an integrated pest and vegetation management plan (if the facility will use pesticides/herbicides), and a spill prevention and emergency response plan. Such plans should include the following items:

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[11] Given the volumes of materials produced during facility dismantlement, it is possible that laydown areas used during initial construction would be re-established as temporary storage areas for materials awaiting delivery to recycling areas. Waste materials would ideally be stored in areas used for hazardous materials and waste storage during facility operation before being transported to off-site treatment, storage, or disposal facilities.

[12] See, for example, the construction standards issued by Western (2008).

- Prepare a hazardous materials and waste management plan that addresses the selection, transport, storage, and use of all hazardous materials needed for construction, operation, and decommissioning of the facility for local emergency response and public safety authorities and for the regulating agency, and that addresses the characterization, on-site storage, recycling, and disposal of all resulting wastes. The plan should include a comprehensive hazardous materials inventory; Material Safety Data Sheets (MSDSs) for each type of hazardous material; emergency contacts and mutual aid agreements, if any; site map showing all hazardous materials and waste storage and use locations; copies of spill and emergency response plans (see below), and hazardous materials-related elements of a decommissioning/closure plan. The waste management plan should identify the waste streams that are expected to be generated at the site during construction and operation and address hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements (e.g., selecting appropriate waste storage containers, appropriate off-site treatment, storage, and disposal facilities), inspection procedures, and waste minimization procedures. The plan should address solid and liquid wastes that may be generated at the site in compliance with CWA requirements if a NPDES permit is needed.

- Develop a fire management and protection plan to implement measures to minimize the potential for fires associated with substances used and stored at the site. The flammability of the specific chemicals used at the facility should be considered.

- If pesticides/herbicides are to be used on the site, develop an integrated pest and vegetation management plan to ensure that applications will be conducted within the framework of managing agencies and will entail the use of only EPA-registered pesticides/herbicides that are (1) nonpersistent and immobile and (2) applied by licensed applicators in accordance with label and application permit directions, following stipulations regarding suitability for terrestrial and aquatic applications.

Potentially applicable mitigation measures for hazardous materials and wastes at wind energy facilities include the following:

- All site characterization, construction, operation, and decommissioning activities should be conducted in compliance with applicable Federal and State laws and regulations, including the Toxic Substances Control Act of 1976, as amended (15 USC 2601, et seq.). In addition, any release of toxic substances (leaks, spills, and the like) in excess of the reportable quantity established by 40 CFR Part 117 should be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Section 102b. A copy of any report required or requested by any Federal agency or State government as a result of a reportable release or spill of any toxic substances should be furnished to the authorized officer concurrent with the filing of the reports to the involved Federal agency or State government.

- Pollution prevention opportunities should be identified and implemented, including material substitution of less hazardous alternatives, recycling, and waste minimization.

- Systems containing hazardous materials should be designed and operated in a manner that limits the potential for their release, and constructed of compatible materials in good condition (as verified by periodic inspections), including provision of secondary containment features (to the extent practical); installation of sensors or other devices to monitor system integrity; installation of strategically placed valves to isolate damaged portions and limit the amount of hazardous materials in jeopardy of release; and robust inspection and use of repair procedures.

- Dedicated areas with secondary containment should be established for off-loading hazardous materials transport vehicles.

- To the greatest extent practicable, “just-in-time” ordering procedures should be employed that would limit the amounts of hazardous materials present on the site to quantities minimally necessary to support continued operations. Excess hazardous materials should receive prompt disposition.

- Written procedures for the storage, use, and transportation of each type of hazardous material present should be provided, including all vehicle and equipment fuels.

- Authorized users for each type of hazardous material should be identified.

- Procedures should be established for fuel storage and dispensing, including shutting off vehicle (equipment) engines; using only authorized hoses, pumps, and other equipment in good working order; maintaining appropriate fire and spill response materials at equipment-fueling stations; providing emergency shutoffs for fuel pumps; ensuring that fueling stations are paved; ensuring that both aboveground fuel tanks and fueling areas have adequate secondary containment; prohibiting smoking, welding, or open flames in fuel storage and dispensing areas; equipping the area with fire suppression devices, as appropriate; conducting routine inspections of fuel storage and dispensing areas; requiring prompt recovery and remediation of all spills, and providing for the prompt removal of all fuel and fuel tanks used to support construction vehicles and equipment at the completion of facility construction and decommissioning phases.

- Refueling areas should be located away from surface water locations and drainages and on paved surfaces; features should be added to direct spilled materials to sumps or safe storage areas where they can be subsequently recovered.

- Drip pans should be used under the fuel pump and valve mechanisms of any bulk fueling vehicles and during on-site refueling to contain accidental releases.

- Spills should be immediately addressed per the appropriate spill management plan, and cleanup and removal initiated, if needed. Operations and maintenance personnel should be trained in spill prevention and containment, and spill containment supplies should be located on site and be readily available.

- All vehicles and equipment should be in proper working condition to ensure that there is no potential for leaks of motor oil, antifreeze, hydraulic fluid, grease, or other hazardous materials.

- Hazardous materials and waste storage areas or facilities should be formally designated and access to them restricted to authorized personnel. Construction debris, especially treated wood, should not be disposed of or stored in areas where it could come in contact with aquatic habitats.

- Design requirements should be established for hazardous materials and waste storage areas that are consistent with accepted industry practices as well as applicable Federal, State, and local regulations and that include, at a minimum, containers constructed of compatible materials, properly labeled, and in good condition; secondary containment features for liquid hazardous materials and wastes; physical separation of incompatible chemicals; and fire-fighting capabilities when warranted.

- Written procedures should be established for inspecting hazardous materials and waste storage areas and for plant systems containing hazardous materials; identified deficiencies and their resolution should be documented.

- Schedules should be established for the regular removal of wastes (including sanitary wastewater generated in temporary, portable sanitary facilities) for delivery by licensed haulers to appropriate off-site treatment or disposal facilities.

- During facility decommissioning, the following should occur: emergency response capabilities should be maintained throughout the decommissioning period as long as hazardous materials and wastes remain on-site, and emergency response planning should be extended to any temporary material and equipment storage areas that may have been established; temporary waste storage areas should be properly designated, designed, and equipped; hazardous materials removed from systems should be properly containerized and characterized, and recycling options should be identified and pursued; off-site transportation of recovered hazardous materials and wastes resulting from decommissioning activities should be conducted by authorized carriers; hazardous materials and waste should be removed from on-site storage and management areas, and the areas should be surveyed for contamination and remediated as necessary.

5.12.2 No Action Alternative

Under the No Action Alternative, the types of impacts associated with hazardous materials and wastes from wind energy development in the UGP Region would be expected to be similar in nature to the common impacts identified above for the various phases of project development. Western would continue to process and evaluate interconnection requests on a case-by-case basis and would require the appropriate level of NEPA analysis on a project specific-basis. Applicable BMPs and mitigation measures would continue to be identified on a project-by-project basis. Similarly, the Service would process and evaluate requests to accommodate placement of wind energy structures on easements (through easement exchanges) on a case-by-case basis, and would require project-specific NEPA evaluations and the implementation of appropriate BMPs and mitigation measures. Implementation of established Federal, State, and local regulations, together with other BMPs typically requested of project developers by Western and the Service, would minimize the potential for improper handling or accidental releases of regulated hazardous materials and wastes. Because of the plans and controls that will be in place, the low potential for releases, and the relatively small quantities of hazardous materials and wastes that would be expected to be present during wind energy development, impacts on natural resources or worker or public health and safety would be minor.

5.12.3 Alternative 1

The level of wind energy development within the UGP Region under Alternative 1, including the amount of hazardous materials and wastes used, stored, or generated, would be similar to that identified for the No Action Alternative. Under this alternative, Western and the Service would use a set of standardized procedures for processing and evaluating environmental effects of interconnection requests and to process and evaluate requests for easement exchanges in order to accommodate the placement of wind energy structures on easements. Western and the Service would prepare project-specific NEPA evaluations for wind energy projects that tier off of this PEIS, as long as applicable Federal, State, and local regulations, together with applicable BMPs and mitigation measures identified for Alternative 1, would be implemented by project developers. The types of impacts associated with hazardous materials and wastes from wind energy development in the UGP Region would be expected to be similar in nature under this alternative to the common impacts identified above for the various phases of project development. Under Alternative 1, as appropriate for project-specific conditions, implementation of the BMPs and mitigation measures identified in section 5.12.1.4 would be expected to limit the magnitude of impacts on natural resources or worker or public health and safety as a result of hazardous materials and wastes to negligible or minor levels.

5.12.4 Alternative 2

The level of wind energy development within the UGP Region under Alternative 2, including the amount of hazardous materials and wastes used, stored, or generated, would be similar to that identified for the No Action Alternative and Alternative 1. Under this alternative, wind energy development on Service easements would not be accommodated, thereby removing any potential for direct impacts on easements from releases of hazardous materials and wastes from wind energy projects. Western would implement the same standardized procedures for processing and evaluating interconnection requests for wind energy projects as under Alternative 1 and would develop project-specific NEPA evaluations that tier off of this PEIS as long as applicable Federal, State, and local regulations, together with BMPs and mitigation measures identified for Alternative 2, are implemented by developers. The types of impacts associated with hazardous materials and wastes from wind energy development in the UGP Region would be expected to be similar in nature under this alternative to the common impacts identified above for the various phases of project development. For projects interconnecting to Western's transmission system under Alternative 2, as appropriate for project-specific conditions, implementation of the BMPs and mitigation measures identified in section 5.12.1.4 would be expected to limit the magnitude of impacts on natural resources or worker or public health and safety from hazardous materials and wastes to negligible or minor levels.

5.12.5 Alternative 3

The level of wind energy development within the UGP Region under Alternative 3, as well as the amount of hazardous materials and wastes used, stored, or generated, would be similar to that identified for the No Action Alternative and Alternatives 1 and 2. Under Alternative 3, Western and Service Region 6 would use the standardized procedures identified in chapter 2 for considering interconnection requests and accommodation of wind energy facilities on easements, respectively. However, unlike the other alternatives, the agencies would not require developers to implement any BMPs or mitigation measures beyond those required by established Federal, State, and local regulations.

The types of impacts associated with hazardous materials and wastes from wind energy development in the UGP Region would be expected to be similar in nature under this alternative to the common impacts identified above for the various phases of project development. Although the potential for improper use or accidental releases of regulated hazardous materials and wastes could be somewhat greater under this alternative than under the No Action Alternative and Alternatives 1 and 2 because some BMPs may not be required of developers, implementation controls and procedures in established Federal, State, and local regulations would still limit the potential for releases. Relatively small quantities of hazardous materials and wastes would still be expected to be present during wind energy facility construction, operation, maintenance, and decommissioning phases under this alternative, and the impacts on natural resources or worker or public health and safety would be minor.

5.13 HEALTH AND SAFETY

Wind energy development could produce occupational health impacts on workers and environmental health concerns in the area around the facilities. Such impacts and concerns would result from the construction and operation of wind energy projects, including transmission lines. The following subsections discuss the technology-specific health and safety concerns that could occur from wind energy development and potentially applicable mitigation measures and evaluate the degree to which potential human health and safety issues related to construction and operation of typical wind energy projects would be affected by the alternatives.

5.13.1 Occupational Hazards

Common occupational hazards associated with the various phases of wind energy development are provided in section 3.8.1. Overall, many of the occupational hazards associated with wind energy projects are similar to those of the heavy construction and electric power industries (i.e., working at heights, exposure to weather extremes including temperature extremes and high winds, exposure to dangerous animals and plants, working around energized systems, working around lifting equipment and large moving vehicles, and working in proximity to rotating/spinning equipment). Table 3.8-1 summarizes information on numbers and rates of occupational fatalities, injuries, and illnesses associated with relevant activity categories.

Because it is anticipated that the alternatives evaluated in the PEIS would not significantly affect the level of wind energy development in the UGP Region, the types of occupational hazards that would be present during development, operation, or decommissioning phases, or the controls on those occupational hazards, there would be no substantial differences in occupational health and safety among the alternatives.

5.13.2 Public Safety, Health, and Welfare

Public safety and health hazards resulting from physical hazards, electric and magnetic fields, electromagnetic interference to communications, radar interference, low-frequency sound, shadow flicker and blade glint, voltage flicker, and aviation safety are described in section 3.8.2. Because it is anticipated that the alternatives evaluated in the PEIS would not significantly affect the level of wind energy development in the UGP Region or the locations of wind energy facilities aside from decisions regarding placement of wind facilities on easements managed by the Service, there would be no substantial differences in public safety and health hazards among the alternatives.

5.13.3 Potential Impacts of Accidents, Sabotage, and Terrorism

Owners and operators of critical infrastructure (which includes wind energy facilities and transmission systems) are responsible for ensuring the operability and reliability of their systems. To do so, they must evaluate the impacts on their system from all credible events, including natural disasters (landslides, earthquakes, storms, and so on) as well as mechanical failure, human error, sabotage, cyber attack, or deliberate destructive acts of both domestic and international origin, recognizing intrinsic system vulnerabilities, the realistic potential for each event/threat, and the consequences. This section discusses both the regulatory requirements for these assessments and the types of events that could occur at wind energy facilities and associated transmission lines.

Because it is anticipated that the alternatives evaluated in the PEIS would not significantly affect the level of wind energy development in the UGP Region or the locations of wind energy facilities aside from decisions regarding accommodation of wind facilities on easements managed by the Service, there would be no substantial differences in types and magnitudes of impacts from accidents or incidences of sabotage or terrorism among the alternatives.

5.13.3.1 Regulatory Background

Regulations promulgated by various Federal and State oversight agencies confirm project developers' responsibilities for protecting critical infrastructure through a variety of prescribed actions and system performance requirements designed to protect the public and/or the environment from adverse consequences of disruptions or failures, and to provide for system reliability and resiliency. Regulations and directives promulgated by the FERC are an example of such a regulatory program. Special system designs, construction techniques, advanced communication and system-monitoring capabilities, and other preemptive protective measures have been developed to meet the requirements of those regulations. BMPs have also been developed to further ensure system reliability and minimize interruptions in service (e.g., security measures, fencing, personnel policies). Developers of wind energy facilities will be expected to conform to all applicable regulations and best industry practices.

Homeland Security Presidential Directive 7 (HSPD-7), signed by President Bush on December 17, 2003, establishes a National policy that affirms the responsibility of Federal departments and agencies to identify and prioritize U.S. critical infrastructure and key resources and to protect them from terrorist attacks (DHS 2003). Under that Directive, "Federal departments and agencies will identify, prioritize, and coordinate the protection of critical infrastructure and key resources in order to prevent, deter, and mitigate the effects of deliberate efforts to destroy, incapacitate, or exploit them. Federal departments and agencies will work with State and local governments and the private sector to accomplish this objective."

HSPD-7 resulted in the June 2006 publication of the *National Infrastructure Protection Plan* (DHS 2006), the development of which was coordinated by the U.S. Department of Homeland Security (DHS). The current *National Infrastructure Protection Plan* (DHS 2009) comprises 18 sector-specific plans, each addressing a category of critical infrastructure and key resources. Two sector-specific plans are especially relevant to protection of critical infrastructure of wind energy facilities and transmission lines: the plan for energy (DHS and DOE 2007) and the plan for transportation systems (DHS 2007), both of which were published in May 2007. The DOE Office of Energy Efficiency and Electricity Reliability serves as the sector-specific agency for energy and is primarily responsible for the development and implementation of the energy plan. The Transportation Security Administration (TSA) of DHS serves a similar function for the transportation plan.

The energy sector-specific plan addresses the production, refining, storage, and distribution of oil and gas and electricity. The transportation sector-specific plan addresses the movement of people and the transport of goods by all modes of transportation, and especially addresses the transport of hazardous materials (including crude oil, natural gas, and refined petroleum products) by all modes of transport, including pipelines. Pipelines are addressed in the transportation sector-specific plan as a mode of transportation; however, pipelines are also an integral part of the energy sector. As a result, unique partnerships have been struck between private-sector representatives and representatives of both sector-specific agencies to ensure coordinated implementation of both plans. The energy and transportation plans establish appropriate risk management frameworks to meet their respective goals and objectives. Although the DOE and the TSA are the agencies explicitly directed to develop and implement the plans that most directly address critical infrastructure and key resources for wind energy facilities, HSPD-7 obligates all Federal agencies to cooperate with those efforts. Wind energy project developers would also be full participants in the implementation of applicable plan objectives and programs.

Although it is important for the public to be informed as to the commitment and basic structural approach of the National integrated effort to address terrorism, the specific strategies and tactics that emerge cannot be shared. Thus, while some protective measures and activities are obvious (e.g., fencing around electric substations and switchyards, routine surveillance and inspections), other measures must remain covert to maintain their effectiveness.

5.13.3.2 Credible Events

Natural Events. There is a potential for natural events to affect human health and the environment during all phases of development of wind energy facilities. Such events include tornadoes, earthquakes, severe storms, and fires. Depending on the severity of the event, fixed components of a wind energy facility could be damaged or destroyed, resulting in economic, safety, and environmental consequences. The probability of a natural event occurring is location-specific and differs among the locations considered in this PEIS. Such differences should be taken into account during project-specific studies and reviews.

The consequences of natural events could include injuries, loss of life, and the release of hazardous materials to the environment. The likelihood of injuries and loss of life may be decreased by emergency planning (e.g., tornado drills) and on-site first-aid capabilities. For hazardous material releases, the potential types and quantities of materials that would be present at a wind energy facility and that potentially could be released to the environment during a natural event are discussed in section 3.9. Substances stored in the highest quantities on-site include dielectric fluids and lubricants. These substances have generally low volatility, and thus accidental or intentional releases from components or storage containers would not be likely to pose significant on-site inhalation hazards. Various fuels for equipment and vehicles could be stored at the site during construction and decommissioning and propane could be present at some sites to provide heat for control buildings. Although such fuels are flammable and present a fire and explosion hazard, quantities would generally be limited to 1,000 gal (3,785 L) or less.

As described in section 3.8.2.1, dry vegetation and high winds may combine to cause a potential fire hazard around wind facilities. Under these conditions, fires have started due to a variety of causes, including electrical shorts, insufficient equipment maintenance, contact with power lines, vehicle operation, and lightning. The IEC requires that the design of a WTGS electrical system comply with relevant IEC standards (IEC 1999). Conformance with IEC standard requirements, including lightning protection for the towers and for switchyards and substations provides adequate control of any potential fire hazards.

In general, wind energy facilities would have fairly low numbers of employees on-site during operations. In addition, these facilities are typically located in remote areas with low numbers of nearby residents. These factors would help limit the potential casualties during adverse natural events. Neighboring residences and businesses should be informed of potential hazards and emergency plans for wind energy facilities.

Sabotage or Terrorism. In addition to the natural events described above, there is a potential for intentional destructive acts to affect human health and the environment. In contrast to natural events, for which it is possible to estimate event probabilities based on historical statistical data and information, it is not possible to accurately estimate the probability of sabotage or terrorism. Consequently, discussion of the risks from sabotage or terrorist events generally focuses on the consequences of such events.

The consequences of a sabotage or terrorist attack on a wind energy facility would be expected to be similar to those discussed above for natural events. Depending on the severity of the event, fixed components of a wind energy facility could be damaged or destroyed, resulting in economic, safety, and environmental consequences. The potential consequences of such events need to be evaluated on a project- and site-specific basis. However, the dispersed nature of wind facilities and the relative lack of potential for acts of terrorism or sabotage on these facilities to cause extensive damage, make such facilities unlikely targets for these acts. Wind generation facilities (particularly the switchyards or substations) are much more likely to be the targets of metal thieves, or random isolated acts of vandalism.

5.13.4 Potentially Applicable Mitigation Measures

5.13.4.1 Occupational Health and Safety

The following mitigation measures to protect wind energy facility and transmission line workers are applicable during all phases associated with a project.

- All site characterization, construction, operation, and decommissioning activities must be conducted in compliance with applicable Federal and State occupational safety and health standards (e.g., the Occupational Health and Safety Administrations [OSHA's] Occupational Health and Safety Standards, 29 CFR Parts 1910 and 1926, respectively).

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

- Develop a health and safety program to protect workers during site characterization, construction, operation, and decommissioning of a wind energy project. The program should identify all applicable Federal and State occupational safety standards and establish safe work practices addressing all hazards, including requirements for developing the following plans: general injury prevention; PPE requirements and training; respiratory protection; hearing conservation; electrical safety; hazardous materials safety and communication; housekeeping and material handling; confined space entry; hand and portable power tool use; gas-filled equipment use; and rescue response and emergency medical support, including on-site first-aid capability.

- As needed, the health and safety program must address OSHA standard practices for the safe use of explosives and blasting agents (if needed for site development); measures for reducing occupational EMF exposures; the establishment of fire safety evacuation procedures; and required safety performance standards (e.g., electrical system standards and lighting protection standards). The program should include training requirements for applicable tasks for workers and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies should be established.

- Design all electrical systems to meet all applicable safety standards (e.g., the National Electrical Safety Code) and comply with the interconnection requirements of the transmission system operator.

- In the event of an accidental release of hazardous substances to the environment, document the event, including a root cause analysis, a description of appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event should be provided to permitting agencies and other appropriate Federal and State agencies within 30 days, as required.

5.13.4.2 Public Health and Safety

The following mitigation measures for the protection of public health and safety are applicable during all phases associated with a wind energy project:

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

- Develop a traffic management plan for the site access roads to control hazards that could result from increased truck traffic (most likely during construction or decommissioning), ensuring that traffic flow would not be adversely affected and that specific issues of concern (e.g., the locations of school bus routes and stops) are identified and addressed. This plan should incorporate measures such as informational signs, flaggers (when equipment may result in blocked throughways), and traffic cones to identify any necessary changes in temporary lane configurations. The plan should be developed in coordination with local planning authorities.

- Site and design wind energy facilities to eliminate glint and glare effects on roadway users, nearby residences, commercial areas, or other highly sensitive viewing locations, or reduce it to the lowest achievable levels.

- Use proper signage and/or engineered barriers (e.g., fencing) to limit access to electrically energized equipment and conductors in order to prevent access to electrical hazards by unauthorized individuals or wildlife.

- If operation of the wind energy facility and associated transmission lines and substations could cause potential adverse impacts on nearby residences and occupied buildings as a result of noise, sun reflection, or EMF, incorporate recommendations for addressing these concerns into the project design (e.g., establishing a sufficient setback from transmission lines).

- Site and design the project to comply with FAA regulations, including lighting requirements, and to avoid potential safety issues associated with proximity to airports, military bases or training areas, or landing strips.

- Develop a fire management and protection plan to implement measures to minimize the potential for a human-caused fire and to respond to human-caused or natural-caused fires.

- Project developers shall work with appropriate agencies (e.g., DOE and TSA) to address critical infrastructure and key resource vulnerabilities at wind energy facilities, and to minimize and plan for potential risks from natural events, sabotage, and terrorism.

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6 CUMULATIVE IMPACTS

6.1 METHODOLOGY

A cumulative impact, as defined by the Council on Environmental Quality (CEQ), "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The analysis presented in this chapter places the impacts associated with the preferred alternative (Alternative 1) into a broader context that takes into account the full range of impacts of actions taking place in the UGP Region in the foreseeable future. When viewed collectively over space and time, individual minor impacts could produce significant impacts. The goal of the cumulative impacts analysis, therefore, is to identify potentially significant impacts early in the planning process to improve decisions and move toward more sustainable development (CEQ 1997; EPA 1999). While the analysis here considers the preferred alternative and other programmatic-scale actions, it defers the analysis of individual wind energy projects and other local actions to cumulative impact assessments to be conducted as part of future project-specific NEPA reviews.

The analysis of cumulative impacts considers the resources that could be affected by the incremental impacts from the proposed action. For this analysis, the proposed action is Alternative 1, the preferred alternative. These analyses also take into account the issues raised by the public and focus on the environmental effects associated with wind energy projects under the preferred alternative, as described in chapter 5. The general approach incorporates the following basic guidelines for the cumulative impact analysis:

- Individual receptors (or receptor groups) described in the affected environment sections in chapter 4 are the end points or units of analysis;

- Direct and indirect impacts described in chapter 5 form the basis for the impacting factors;

- Impacting factors (e.g., soil disturbance) are derived from a set of past, present, and reasonably foreseeable future actions or activities (or types of actions); and

- The temporal and spatial boundaries are defined around the individual receptors and the set of past, present, and reasonably foreseeable future actions or activities that could impact them.

Based on the guidance provided in CEQ (1997), the cumulative impacts analysis presented here considers the following:

1. *The geographic scope (i.e., regions of influence or ROIs).* The ROIs encompass the areas of affected resources and the distances at which impacts associated with the preferred alternative may occur. For many resources (e.g., soils and vegetation), they occur within or adjacent to the locations of the preferred alternative, but for other resources (e.g., air quality), they also take into account the distances that impacts may travel and the

regional characteristics of the affected resources. Because the PEIS addresses wind energy development at a programmatic level, the ROIs for many resources evaluated are spatially extensive, encompassing all the States in the UGP Region in which wind projects would be constructed. The ROIs for the cumulative impacts analysis are summarized in table 6.1-1.

2. *The time frame.* The temporal aspect of the cumulative impacts analysis generally extends from the past history of impacts on each receptor through the anticipated life of the project (and beyond, for resource areas having more long-term impacts). The time frame incorporates the sum of the effects

TABLE 6.1-1 Regions of Influence for the Cumulative Impacts Analysis by Resource

Resource	Regions of Influence
Land Use	Project site and transmission line ROWs (including Service easements); adjacent lands
Soil Resources	Project site and transmission line ROWs (including Service easements); adjacent lands
Water Resources	Nearby surface water bodies; shallow aquifers (recharge areas)
Air Quality	Local airsheds
Acoustic Environment (Noise)	Project site and transmission line ROWs (including Service easements); adjacent lands (residential areas and sensitive wildlife areas)
Ecological Resources	
Vegetation	Project site and transmission line ROWs (including Service easements), and adjacent lands (native habitats)
Wildlife	Project site and transmissions line ROWs, and adjacent lands (habitats, ecosystems)
Aquatic biota and habitats	Nearby surface water bodies (habitats, ecosystems)
Threatened and endangered species	Project site and transmissions line ROWs (including Service easements), and adjacent lands (habitats, ecosystems)
Visual Resources	Project site and transmission line ROWs (including Service easements), and adjacent lands (local viewsheds)
Paleontological Resources	Project site and transmission line ROWs (including Service easements), and adjacent lands
Cultural Resources	Project site and transmission line ROWs (including Service easements), and adjacent lands (historic districts and landscapes)
Socioeconomic Conditions	Adjacent properties; local communities, counties, States
Environmental Justice	Adjacent properties; local communities, counties, States

of the preferred alternative (Alternative 1) in combination with past, present, and reasonably foreseeable future actions, since impacts may accumulate or develop over time. The reasonably foreseeable time frame for the cumulative impacts analysis is generally considered to be 20 yr from the time the respective wind energy development programs under Alternative 1 are established by Western and the Service. While it is difficult to assess impacts beyond this time frame, it is acknowledged that the effects identified in the cumulative impacts analysis could continue beyond the 20-yr horizon.

3. *Past, present, and reasonably foreseeable future actions or activities (or types of actions).* These include projects, activities, or trends that could affect human and environmental receptors within the defined ROIs and within the defined time frame. Past and present actions are generally accounted for in the analysis of direct and indirect impacts under each resource area (chapter 5) and carried forward to the cumulative impacts analysis. The future actions described in this analysis are those that are "reasonably foreseeable"; that is, they are ongoing (and will continue into the future), are funded for future implementation, or are included in firm near-term plans. The types of foreseeable future actions (including programmatic-level Federal actions) are described in section 6.2.

4. *The baseline conditions of resources and receptors (i.e., ecosystems and human communities) identified during scoping.* These are described in the affected environment sections for each resource area in chapter 4. The cumulative impacts analysis also considers actions and issues raised during the scoping process.

5. *Direct and indirect impacts to resources and receptors.* Direct impacts are those caused by wind energy projects under the preferred alternative (Alternative 1) and that occur at the same time and place in which the alternative is implemented. Indirect impacts are also caused by the preferred alternative, but occur later in time or farther in distance from the wind energy projects and are still reasonably foreseeable. These impacts are discussed in the environmental consequences sections of chapter 5 for each resource area.

6. *The potential impacting factors of each type of past, present, or reasonably foreseeable future action or activity.* Impacting factors are the mechanisms by which an action affects a given resource or receptor. These individual contributions are summarized in table 6.3-1 and aggregated to form the basis of the cumulative impacts analysis.

7. *Cumulative impacts analysis.* Cumulative impacts on receptors are evaluated by considering the impacting factors for each of the various resource areas and the incremental contributions of the preferred alternative (Alternative 1) to the cumulative impact. The cumulative impacts for each resource area are presented in section 6.3 and summarized in table 6.3-2. Cumulative impacts under the preferred alternative are compared to those under the other

alternatives (Alternatives 2 and 3 and the No Action Alternative) in section 6.3.3.

Cumulative impacts can be additive, less than additive, or more than additive (synergistic). Because the contributions of individual actions, including those related to wind energy development under the preferred alternative, to an impacting factor were uncertain or not well known at the time of this report (because specific projects are not yet planned and locations have not been identified), only a qualitative evaluation of cumulative impacts is possible. A qualitative evaluation covers the locations of impacts, the times they would occur, the level of impact expected, and the potential for long-term and/or synergistic effects.

6.2 REASONABLY FORESEEABLE FUTURE ACTIONS

Reasonably foreseeable future actions include projects, activities, or trends that could impact human and environmental receptors within the defined ROIs and within the defined time frame. The types of future actions identified as reasonably foreseeable in the UGP Region are described in section 6.2.1 and summarized in table 6.2-1. General trends, programmatic-level Federal actions, and relevant legislative actions and regional initiatives are discussed in sections 6.2.2, 6.2.3, and 6.2.4.

6.2.1 Types of Actions

6.2.1.1 Renewable Energy Development

In 2008, renewable energy sources accounted for about 7.5 percent of the total U.S. electricity supply, up from about 6.2 percent in 2004 (EIA 2010a). The net electricity generation from renewable energy sources in the States of the UGP Region was about 6.9 percent of the total U.S. electricity generation from renewable energy sources. Table 6.2-2 presents a breakdown of the net electricity generated from renewable energy sources by States in the UGP Region. As of 2007, renewable sources of energy have included wind, biomass, and hydroelectric power. Electricity generation from renewable sources is expected to grow by about 72 percent between 2009 and 2035, and is projected to constitute a 14 percent share of the total U.S. electricity generation by 2035 (EIA 2011a).

Wind Energy. Wind energy accounted for about 7.4 percent of renewable electricity generation and 0.55 percent of the total U.S. electrical supply in 2008 (EIA 2010a). Most of the wind energy potential in the United States is in the western States, but wind capacity is high in the Great Plains States of North and South Dakota, Nebraska, Minnesota, and Iowa. In 2007, Iowa and Minnesota had the highest net generation from wind energy resources in the UGP Region (EIA 2010a). Future expansion of wind energy production in the Midwest is highly likely because the resource is abundant and provides substantial environmental and public health benefits relative to other energy sources (e.g., fossil fuels) (Synapse Energy Economics 2001). The DOE projects that wind energy development in the United States will nearly double between 2009 and 2035 (EIA 2011a).

TABLE 6.2-1 Reasonably Foreseeable Future Actions in the UGP Region

Types of Actions	Associated Activities and Facilities
Renewable Energy Development	*Wind Energy:* ▪ Vegetation clearing and excavation ▪ Construction of meteorological towers ▪ Construction of turbine towers ▪ Access roads ▪ Electrical collector substations and transformer pads ▪ Ancillary facilities (including generation tie lines) *Biomass Resources:* ▪ Agriculture residue collection ▪ Energy crop production ▪ Power plants (and/or co-fire with coal plants) ▪ Ash disposal *Hydroelectric:* ▪ Generating stations ▪ Dams *Solar Energy:* ▪ PV systems (the solar technology most likely to be implemented in the Midwest; see section 6.2.1.1.4) *Geothermal Energy:* ▪ Well installation ▪ Power plants ▪ Solid waste ▪ Hydrogen sulfide recovery and recycling
Transmission and Distribution Systems	▪ Transmission lines ▪ Substations and switchyards ▪ Access roads ▪ Carrier pipelines ▪ Oil and natural gas pipelines ▪ Compressor/pumping stations ▪ Fuel transfer stations ▪ Spills/releases
Coal Production (Mining)	▪ Surface and underground mines ▪ Access roads ▪ Processing plants ▪ Transportation (railroads) ▪ Solid waste (overburden, waste rock, and tailings) ▪ Site reclamation and rehabilitation
Power Generation	▪ Coal-fired plants ▪ Natural gas–fired plants ▪ Nuclear plants ▪ Cooling systems ▪ Surface impoundments ▪ Transmission

TABLE 6.2-1 (Cont.)

Types of Actions	Associated Activities and Facilities
Oil and Natural Gas Exploration, Development, and Production	*Exploration and Development:* ▪ Exploratory drilling ▪ Construction of well pads ▪ Well Installation ▪ Spills/releases ▪ Gathering pipelines ▪ Pipeline and utility corridors ▪ Access roads and helipads ▪ Compressor stations ▪ Storage facilities ▪ Site reclamation and rehabilitation *Production:* ▪ Production and processing plants ▪ Refineries ▪ Carrier pipelines ▪ Spills/releases ▪ Power plants ▪ Access roads
Transportation	▪ Highways, roads, and parkways ▪ Vehicle miles traveled ▪ Fuel economy standards ▪ Railroads (coal transport) ▪ Hazardous material releases
Recreation and Leisure	▪ Viewing natural features and wildlife ▪ General relaxation ▪ Hiking ▪ Skiing ▪ Driving for pleasure ▪ Off-road vehicles ▪ Hunting and fishing ▪ Camping, hiking, and picnicking ▪ Visiting scenic and historic places
Agriculture	▪ Grassland conversion ▪ Cropland production ▪ Irrigation ▪ Local improvements (fences and reservoirs) ▪ Grazing
Urbanization	▪ Population growth (see section 6.2.2.1) ▪ Resource demand/use (see sections 6.2.2.2 and 6.2.2.3) ▪ Land use modification (see Section 6.2.2.4) ▪ Land development ▪ Residential and commercial expansion of existing towns/ cities ▪ Roads and traffic ▪ Employment (jobs, income, and revenue) ▪ Light and air pollution

TABLE 6.2-2 Net Electricity Generation (in thousand kilowatt-hours) by Renewable Energy Source and State in the UGP Region, 2007

State	Hydroelectric	Biomass	Geothermal	Solar (Thermal/PV)	Wind	Total
Iowa	962,346	122,715	–	–	2,756,676	3,841,737
Minnesota	558,269	797,676	–	–	2,638,812	3,994,757
Montana	9,364,336	–	–	–	495,776	9,860,112
Nebraska	347,444	49,021	–	–	216,765	613,230
North Dakota	1,305,393	–	–	–	620,772	1,926,165
South Dakota	2,917,283	–	–	–	150,018	3,067,301
Total (UGP)	15,455,071	969,412	–	–	6,878,819	23,303,302
U.S. Total	253,095,539	26,016,380	14,951,348	864,235	55,363,100	350,290,602

Source: table 1.15, EIA (2010a).

The agencies' projections of wind energy development in the UGP Region from 2010 to 2030 are described in detail in chapter 2 and summarized here. Case 1 predicts wind energy development based on the levels of development within the UGP Region States from 2000 to 2010; Case 2 predictions are based on modeling conducted by NREL to examine how wind energy could provide 20 percent of the electrical generation in the United States by 2030. Depending on the method used (Case 1 or Case 2), it is estimated that an additional 8,600 to 30,000 wind turbines and associated infrastructure would be built in the UGP Region by 2030, with the greatest number in Iowa (5,900 to 16,200), followed by Minnesota, Nebraska, and the Dakotas. This level of development would permanently affect about 9,500 to 33,000 ac (3,845 to 13,355 ha) of land, with an additional 22,000 to 77,000 ac (8,903 to 31,160 ha) temporarily affected by new development activities (e.g., during construction).

Biomass Resources. In 2008, biomass resources, including landfill gas, municipal solid waste, agriculture byproducts/crops, biomass solids, liquids, and gases, and wood and derived fuels, accounted for about 52 percent of renewable electricity generation and about 3.9 percent of the total U.S. electricity supply (up from 3.0 percent in 2004). The DOE projects that biofuels used to generate electricity in the United States will triple between 2009 and 2035 (EIA 2011a). Of the three States in the UGP Region that generated electricity from biomass resources in 2007, Minnesota had the highest net generation at 797,676 thousand kWh, followed by Iowa at 122,715 thousand kWh, and Nebraska at 49,021 thousand kWh (EIA 2010a). Future expansion of biomass energy production in the Midwest is highly likely because feedstocks (agricultural residues) are abundant and energy crops (switchgrass) could be grown. Co-firing with biomass in existing coal plants reduces coal use and its associated emissions and has been practiced at a number of Midwestern coal plants (Synapse Energy Economics 2001). Currently, the EIA excludes CO_2 emissions from the combustion of biomass to produce energy from its energy-related CO_2 emissions totals because it is assumed to be balanced by the uptake of carbon when the feedstock is grown (EIA 2010a).

Hydroelectric Power. Hydroelectric power generation accounted for about 34 percent of renewable electricity generation and about 2.5 percent of the total U.S. electricity supply in 2008 (EIA 2010a). Montana depends heavily on this resource, which contributes about 94 percent of the State's total electricity generated by renewable sources. Since areas best suited for this technology have already been developed and current laws and regulations protect many of the rivers in the region from further development, the future expansion of this technology will likely be relatively low. In a recent feasibility study of potential low power and small hydropower projects in the United States, the DOE found that the feasible potential hydropower in States of the UGP Region was relatively low in terms of power generated (except for Montana); however, in Iowa, Minnesota, Montana, and Nebraska much of that power had yet to be developed (Hall et al. 2006; table 6.2-3).

Solar Energy. Solar energy accounted for about 1.3 percent of renewable electricity generation and about 0.098 percent of the total U.S. electricity supply in 2008 (EIA 2010a). In 2007, no electricity was generated by utility-scale solar energy sources in the UGP Region. The potential for solar energy development in the UGP Region is greatest in Nebraska and the western Dakotas. Fixed, flat-plate photovoltaic (PV) systems would be the most likely technology to be implemented in the future because most of the Midwest does not have sufficient direct solar radiation to support solar thermal power plants that operate year round (Synapse Energy Economics 2001).

Geothermal Energy. Geothermal resources accounted for about 4.9 percent of the renewable electricity generation and 0.36 percent of the total U.S. electricity supply in 2008 (EIA 2010a). In 2007, no electricity was generated by utility-scale geothermal energy sources in the UGP Region. The Midwest has low-temperature geothermal resources suitable for efficient heating and cooling of buildings (using ground-source heat pumps); however, with the exception of Montana, it lacks the high-temperature geothermal resources needed for utility-scale power production. The potential for developing geothermal energy sources in Montana is still being assessed, but the DOE's Geothermal Technologies Program indicates that there may be

TABLE 6.2-3 Hydropower Potential of Feasible Potential Hydropower Projects by State in the UGP Region

State	Developed Hydropower (MW)	Feasible Potential Hydropower (MW)	Potential Hydropower Increase (percent)
Iowa	95	329	346
Minnesota	128	40	109
Montana	1,192	1,669	140
Nebraska	152	354	233
North Dakota	270	40	15
South Dakota	622	119	19

Source: Hall et al. (2006).

up to 25,000 mi^2 (65,000 km^2) of high-potential geothermal sites across the State (MDEQ 2011; DOE 2011e).

6.2.1.2 Transmission and Distribution Systems

The States of the UGP Region have a total of 59,364 linear mi (95,537 km) of energy transport projects, most of which occur on non-Federal land (table 6.2-4). Natural gas pipeline projects are most prevalent, with about one and a half times as many miles as high-voltage electricity transmission lines and almost five times as many miles of oil pipelines greater than 8 in. (20 cm) in diameter. Oil pipelines greater than 8 in. (20 cm) in diameter occur in all States but Nebraska and South Dakota. Only about 2,011 linear mi (3,236 km) of energy transport infrastructure cross Federal land in the States of the UGP Region.

Electricity Transmission. Most of the UGP Region occurs within the Midwest Reliability Organization (MRO) in the Eastern Interconnection (Krummel et al. 2011). The MRO is one of eight regional entities operating under authority from U.S. and Canadian regulators through a delegation agreement with the North American Electric Reliability Corporation (NERC). It ensures reliability and security of the bulk power system in the north central region of North America (including both the United States and Canada) (MRO 2011).

The current electric infrastructure was designed to move power from centralized supply sources to fixed predictable loads; however, significant upgrades to the system will be needed in the future to accommodate contributions from new production sources, such as solar and wind generation, which are highly distributed and intermittent. Future improvements to existing infrastructure are planned to improve overall transmission system reliability, transfer capabilities,

TABLE 6.2-4 Total Linear Miles of Energy Transport Infrastructure in the States of the UGP Region

	Energy Transport Type[a]					
	≥230-kV Electricity Transmission Line (mi)		Natural Gas Pipeline (mi)		≥8-in. Diameter Oil Pipeline (mi)	
State	Non-Federal Land	Federal Land	Non-Federal Land	Federal Land	Non-Federal Land	Federal Land
Iowa	1,873	1	8,759	44	223	0
Minnesota	4,433	32	5,772	46	2,208	28
Montana	2,875	659	5,058	424	1,962	77
Nebraska	2,638	3	6,424	15	672	0
North Dakota	3,880	61	4,460	514	1,277	45
South Dakota	2,696	41	1,916	16	221	0
Total	18,395	796	32,388	1,061	6,573	151

[a] To convert mi to km, multiply by 1.609; to convert in. to cm, multiply by 2.540.

Source: Platts (2011).

and local voltage support. In the MRO, there are 618 circuit mile additions greater than 100 kV currently under construction, and construction of an additional 682 circuit miles is planned for 2009 to 2013. By 2018, plans for the MRO could add as much as 11 percent to the circuit miles of the existing electric transmission line system (Krummel et al. 2011).

Natural Gas Pipelines. The demand for natural gas is projected to increase in the coming years as natural gas consumption in the U.S. grows from 26.8 trillion cubic feet (Tcf) in 2008 to 31.8 Tcf by 2030 (a market growth of about 18 percent). Electricity production in the industrial sector will account for most of this increased demand. To accommodate the demand, both infrastructure and operational changes to the natural gas industry will be needed. Expansion and upgrades to infrastructure will account for about 80 percent of the improvement expenditures in the industry between 2009 and 2030. Expenditures will also go toward increasing natural gas processing capacity, developing liquefied natural gas (LNG) infrastructure, and expanding geologic storage capacity (Krummel et al. 2011).

The primary gas resources supplying the interstate gas pipeline network are in the Gulf of Mexico (including LNG imports), the midcontinent, western Canada, and the Rockies. Substantial amounts of gas flow from these areas to load centers in the Midwest, East and West Coasts, and Florida. By 2030, new interregional flow patterns will occur, connecting gas from unconventional fields (especially shale gas) in the Mid-Continent and Northern Rockies with the existing interstate system and expanding the pipeline network to accommodate increases in flows from Wyoming to the northeast; the midcontinent and east Texas to the northern Louisiana corridor; western Canada to the Chicago corridor; and along the Gulf Coast into Florida. Proposed expansions would add about 3,000 mi (4,828 km) of pipeline each year. While the demand for natural gas in the southwest and central regions of the country represents only 23 percent of the projected growth in consumption, about 45 percent of the changes to the pipeline infrastructure are anticipated in these regions (Krummel et al. 2011).

Oil Pipelines. Oil pipeline infrastructure includes pipelines that carry crude oil from source areas to refineries and those that deliver petroleum fuels and products. Five of the UGP Region States are in the Petroleum Administration for Defense District (PADD) 2, which includes other midwestern States; Montana is in PADD 4. On average, PADD 2 receives 38,480 thousand barrels of crude oil and 36,187 thousand barrels of petroleum imports, mainly from PADD 3 (Gulf Coast), but also from PADD 1 (East Coast) and PADD 4 (Rockies). It exports a total of 3,441 thousand barrels of crude oil and 11,667 thousand barrels of petroleum products to PADDs 1 (East Coast), 3 (Gulf Coast), and 4 (Rockies).

Oil production in the continental United States is expected to increase from 4.28 million barrels per day in 2008 to 5.83 million barrels per day by 2035. The growth in crude oil imports is expected to be reduced by the increased use of domestically-produced biofuels. Future capacity additions to the oil transportation system will support increasing oil production and crude imports in the Gulf of Mexico as well as imports from Canada. A recent project in the UGP Region involved a 51,000 barrel per day expansion of the Enbridge North Dakota system (in January 2010) to deliver crude oil from Montana and North Dakota to a metering station in Minnesota where it is transferred to refineries in the Minneapolis–St. Paul area (Krummel et al. 2011).

The TransCanada Keystone Pipeline, LP, filed an application for a Presidential Permit with the State Department in 2008 to build and operate the Keystone XL Project. The proposed project consists of a 1,700-mi (2,736-km) crude oil pipeline and related infrastructure to transport up to 830,000 bbl of crude oil per day from an oil supply hub in Alberta, Canada (as well as U.S. crude oil) to delivery points in Oklahoma and Texas. The pipeline would cross the eastern portion of three UGP Region States: North Dakota, South Dakota, and Nebraska.

A final EIS for the project, dated August 26, 2011, was prepared and is available at the U.S. Department of State's Keystone XL Pipeline Project Web site (see http://www.keystonepipeline-xl.state.gov/clientsite/keystonexl.nsf?Open). The State Department has delayed its final decision due to public concern regarding impacts of the current proposed route through the Sand Hills region of Nebraska, an area with a high concentration of wetlands of special concern, a sensitive ecosystem, and extensive areas of shallow groundwater. It is currently preparing a supplement to the final EIS to review alternate routes that would avoid the Sand Hills region (U.S. Department of State 2011).

6.2.1.3 Coal Production

Coal production (mining) in the United States declined in 2009 and is predicted to continue its decline through 2014 as a consequence of low natural gas prices and increased generation from renewables and nuclear capacity. Between 2014 and 2035, the Nation's coal production is expected to grow at an annual rate of 1.1 percent, with increases in coal used for electricity generation and in the production of synthetic liquids. Most of the coal used to supply coal-fired power plants in the Midwest (east of the Mississippi River) will come from the West. Coal production in the Midwest region is expected to rebound slightly through 2035 (with an annual growth of 0.7 percent projected between 2009 and 2035), and would be mined from the substantial reserves of mid- and high-sulfur bituminous coal in Illinois, Indiana, and western Kentucky (EIA 2011a). In the UGP Region, only Montana (one underground and five surface mines) and North Dakota (five surface mines) had coal mining operations in 2009 (EIA 2009a).

6.2.1.4 Power Generation

Coal-Fired Power Plants. Coal is the primary energy source for all States in the UGP Region except South Dakota, the only State in the UGP Region for which coal-fired plants generated less than a 50 percent share of its energy supply in 2009 (hydroelectric generated a 54.1 percent share) (EIA 2009b). Coal for coal-fired plants in the region is shipped by rail from Wyoming and Montana (North Dakota uses its own coal) (EIA 2009b). While coal-fired electric power generation increased in all States in the UGP Region between 1990 and 2009, its share of electricity generation (taking into account both electric utilities and independent power producers) has generally declined (table 6.2-5).

The DOE projects that coal-fired electricity generation will remain substantial in the coming decades, accounting for about 25 percent of the growth in total U.S. electricity generation from 2009 through 2035 (generation from renewable sources will grow by about 72 percent during this same period and account for about 14 percent of the total U.S. electricity generation by 2035) (EIA 2011a).

Natural Gas–Fired Plants. Natural gas is an energy source for all States in the UGP Region. Although its overall contribution to the energy supply in the region is small, natural gas electric power generation increased in all States except North Dakota between 1990 and 2009 (table 6.2-5).

The DOE projects that natural gas–fired plants will account for as much as 60 percent of capacity additions in the United States between 2010 and 2035 (EIA 2011a).

Nuclear Power Plants. There are currently five operating nuclear power plants in the UGP Region: Iowa (Duane Arnold), Minnesota (Monticello and Prairie Island), and Nebraska (Cooper and Fort Calhoun). Two plants in the region are undergoing decommissioning: South Dakota (Pathfinder) and Nebraska (Veterans Administration Research and Test Reactor Facility) (U.S. Nuclear Regulatory Commission 2011; EIA 2010c).

The DOE projects that power generation from U.S. nuclear plants will increase by 9 percent between 2009 and 2035; however, it will provide a smaller share of total generation (from 20 percent in 2009 to 17 percent in 2035), assuming all existing nuclear power plants continue to operate (EIA 2011a).

6.2.1.5 Oil and Natural Gas Production

Domestic and imported oil and gas provided 63 percent of the energy supply in the United States and almost all of its transportation fuels in 2009 (EIA 2011a). About 5.6 percent of domestic oil and 0.73 percent of domestic natural gas were produced in four of the six UGP Region States (Montana, Nebraska, North Dakota, and South Dakota; Iowa and Minnesota are non-producing) (EIA 2009b, 2010b). The largest producer of oil in the UGP Region is North Dakota. In 2010, its share of production from the four producing States was 79.5 percent (EIA 2011c). The largest producer of natural gas in the UGP Region States is Montana. In 2009, its share of production from the four producing States was 49.3 percent (EIA 2009c).

Between 2000 and 2010, overall annual oil production from UGP Region States almost tripled (from 52,270 to 142,154 thousand bbl[1]). The largest increases were in North Dakota (up 345 percent from 32,718 to 113,033 thousand bbl). Production was up 64.1 percent in Montana (from 15,427 to 25,308 thousand bbl) and 37.3 percent in South Dakota (from 1,170 to 1,606 thousand bbl). Only Nebraska had a decrease in oil production (down 25.3 percent from 2,955 to 2,207 thousand bbl) (EIA 2001a, 2011c).

Annual natural gas production from UGP Region States (from gas, oil, coalbed, and shale gas wells) increased by about 71 percent between 2000 and 2009, from 125,232 to 213,583 million ft^3 (3,546 to 6,047 million m^3). The largest increases in production were in South Dakota (up 783 percent from 1,652 to 12,927 million ft^3 [46.8 to 366 million m^3]) and Nebraska (up 239 percent from 1,218 to 2,916 million ft^3 [34.5 to 82.6 million m^3]). Production was up 76.4 percent in North Dakota (from 52,426 to 92,489 million ft^3

[1] This section uses the units "thousand bbl" as reported by the EIA. The quantities 52,270 and 111,325 thousand bbl are equivalent to 52 and 111 million bbl.

TABLE 6.2-5 Coal-Fired and Natural Gas–Fired Electric Power Generation (Electric Utilities and Independent Power Producers) by State in the UGP Region, 1990 to 2009

	Electric Power Generation (Megawatt-hours)				
	Coal-Fired		Natural Gas		
State	1990 (percent share)	2009 (percent share)	1990 (percent share)	2009 (percent share)	Notes
Iowa	25,751,941 (85.4)	37,351,436 (72.0)	333,390 (1.3)	1,184,217 (2.3)	Six of the 10 largest electric plants are coal-fired (two are natural gas); Walter Scott Energy Center is the largest coal-fired plant in the State (net summer capacity of 1,623 MW in 2009)
Minnesota	28,176,280 (62.2)	29,327,226 (55.9)	539,839 (2.9)	2,846,483 (5.4)	Four of the 10 largest electric plants are coal-fired (four are natural gas); Sherburne County is the largest coal-fired plant in the State (net summer capacity of 2,278 MW in 2009)
Montana	15,119,619 (54.1)	15,611,279 (58.4)	55,255 (0.1)	77,762 (0.3)	Three of the 10 largest electric plants are coal-fired (six are hydroelectric); Colstrip is the largest coal-fired plant in the State (net summer capacity of 2,094 MW in 2009)
Nebraska	12,661,150 (59.3)	23,349,780 (68.7)	308,065 (1.2)	311,581 (0.9)	Four of 10 largest electric plants are coal-fired (four are natural gas); Gerald Gentleman is the largest coal-fired plant in the State (net summer capacity of 1,365 MW in 2009)
North Dakota	25,189,003 (91.3)	29,606,966 (86.6)	51,563 (*)[a]	16,606 (*)	Six of the 10 largest electric plants are coal-fired (two are wind); Coal Creek is the largest coal-fired plant in the State (net summer capacity of 1,143 MW in 2009)
South Dakota	2,472,514 (34.8)	3,217,353 (39.3)	12,408 (1.7)	80,334 (1.0)	Two of the 10 largest electric plants are coal-fired (three are hydroelectric and three are natural gas); Big Stone is the largest coal-fired plant in the State (net summer capacity of 476 MW in 2009)

[a] A (*) indicates that the value is less than half of the smallest unit of measure (e.g., for values with no decimals, the smallest unit is 1 and values under 0.5 are indicated by an asterisk).

Source: EIA (2009b).

[1,485 to 2,619 million m^3]) and 50.4 percent in Montana (from 69,936 to 105,251 million ft^3 [1,980 to 2,980 million m^3]) (EIA 2001b, 2009c).

The DOE projects that fossil fuels (oil, gas, and coal) will provide a 79 percent share of the total U.S. energy supply by 2035 (EIA 2011a). Future actions will focus on the development of new recovery techniques to enhance oil and gas recovery in the field.

6.2.1.6 Transportation

There is an extensive network of railroads and interstate, State, county, and local roads (paved and unpaved) within the UGP Region (section 4.1.3.4; figures 4.1-10 and 4.1-11). National Scenic Byways and All-American Roads are shown in figure 4.1-12.

Travel on interstate highways (as measured in vehicle miles traveled or VMT) was reported to be 694 billion VMT in 2002. From 1995 to 2004, the growth rate in interstate VMT was about 2.8 percent per year (the fastest growing portion of VMT). The VMT on all U.S. public roads, including interstate highways, is expected to continue to increase (USDOT 2006). Conditions on interstates and other higher order systems have improved over the past few decades; however, in lower-order road systems, conditions have either stayed the same or declined. In 2008, about 11.8 percent of the Nation's bridges were found to be structurally deficient; 13.3 percent were functionally obsolete (USDOT 2008).

The DOE projects that energy consumption in the transportation sector between 2009 and 2035 will grow at an average rate of 0.6 percent, much slower than the rate of 1.2 percent between 1975 and 2009 (EIA 2011a). The reduction in consumption is attributed to changing demographics, increased fuel economy, and saturation of personal travel demand. Energy demand for air travel is expected to increase by 16 percent during the same period. Energy use for rail travel is also expected to increase as industrial output rises and demand for coal transport grows.

6.2.1.7 Recreation and Leisure

Popular recreation and leisure activities on Federal lands include viewing natural features, general relaxation, hiking, hunting, viewing wildlife, skiing, and driving for pleasure (section 4.1.3.1). State recreational areas are used for hiking, off-highway vehicle, snowmobile, and canoe trails. There are also wildlife management areas, hatcheries, parks, and zoos. All the UGP Region States have free-flowing river segments with "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance (most of these are in Montana).

It is estimated that more than 5.2 million U.S. residents (age 16 and older) participated in wildlife-related recreational activities (fishing, hunting, and wildlife watching) in the UGP Region States in 2006 (section 4.1.3.1).

6.2.1.8 Agriculture

Agriculture Land and Commodities. According to the 2007 agriculture census (NASS 2009), about 247,875,000 ac (or about 75.4 percent) of land in the States of the UGP Region are considered farmland,[2] with a total of about 314,223 farms (table 6.2-6). Most farmland (about 54.3 percent) is dedicated cropland, of which about 4.6 percent is used only for grazing. Pastureland makes up the remainder. Iowa and Minnesota had the highest number of farms in the region, 92,856 and 80,992 (with average farm sizes of 331 and 332 ac), respectively; however, Montana, Nebraska, North Dakota, and South Dakota all had more total land in farms. In these States, farms on average are larger, ranging in size from 953 ac (in Nebraska) to 2,079 ac (in Montana). About 4.8 percent of farmland in the region is irrigated. All UGP Region States have irrigated cropland, but most irrigation (about 89.0 percent) occurs in Montana and Nebraska.

Iowa has the greatest portion of farmland as cropland (85.6 percent), followed by Minnesota (81.5 percent) and North Dakota (69.4 percent). Montana has the greatest portion of farm land as pastureland (70.8 percent), followed by South Dakota (56.0 percent) and Nebraska (52.2 percent). Only about 10 percent of farm land in Iowa and Minnesota is pastureland.

The top agriculture commodities and commodities exports for States in the UGP Region are shown in table 6.2-7. Top commodities include corn, soybeans, wheat, and cattle. In 2010, Iowa ranked highest in the United States among States exporting soybeans, feed grains, and live animals/meat. Nebraska ranked highest in the United States among States exporting hides and skins. North Dakota provided 90.3 percent of the nation’s value of canola.

Conversion of Grassland to Cropland. A recent study by the U.S. Department of Agriculture (USDA) evaluated the conversion of grassland to crop production in States of the Northern Plains (ERS 2011). Native grasslands, especially those of the Prairie Pothole Region, are important breeding habitat for migratory birds (e.g., they account for about 50 percent of North American duck production); and conversion of these grasslands to croplands could be damaging this habitat. The study focused on the rate at which various types of grasslands[3] are being converted to cropland as well as the role USDA programs may have played in this process.

The study found that, between 1997 and 2007, producers in the Northern Plains region “were more likely to convert grassland to cropland or retain land in crops rather than returning it to grass.” During this period about 1.1 percent (about 770,000 ac) of rangeland was converted to crop production (mainly for hay), while only 100,000 ac were converted from cropland to rangeland. The conversion in the region accounted for 57 percent of grassland-cropland conversion in the United States during this period. The study also concluded that the benefits of

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[2] A farm is defined by NASS (2009) as any place from which $1,000 or more of agricultural products were produced or sold during the census year.

[3] Grasslands encompass a wide variety of grassland types, including those that are native and those that are managed for forage production; they are typically defined by land cover and land use. The dominant land cover of grasslands is grass, but may also include legumes, forbs (an herb or non-woody flowering plant) and, depending of climate, may be dotted by trees. Grasslands are also defined by grazing, haying, and other forms of forage harvest (ERS 2011).

TABLE 6.2-6 Agricultural Lands by UGP Region (in Acres)

State	No. of Farms (Average Size)	Land in Farms	Total Cropland	Harvested Cropland	Irrigated Land	Cropland Used for Pasture and Grazing Only	Pasture Land—All Types
Iowa	92,856 (331)	30,747,550	26,316,332	23,799,380	189,518	829,784	3,144,321
Minnesota	80,992 (332)	26,917,962	21,948,603	19,267,018	506,357	725,403	2,722,452
Montana	29,524 (2,079)	61,388,462	18,241,710	9,163,867	2,013,167	1,677,851	43,459,429
Nebraska	47,712 (953)	45,480,358	21,486,205	18,169,876	8,558,559	891,810	23,741,780
North Dakota	31,970 (1,241)	39,674,586	27,527,180	22,035,717	236,138	812,553	11,344,160
South Dakota	31,169 (1,401)	43,666,403	19,094,311	15,278,709	373,842	1,257,737	24,448,108
Total	314,223	247,875,321	134,614,161	107,714,567	11,877,581	6,195,138	108,860,250

Source: NASS (2009).

TABLE 6.2-7 Top Agriculture Commodities and Exports by UGP Region State, 2010

	Top Five Agriculture Commodities		Top Five Agriculture Exports	
State	Commodity	Percentage of U.S. Value	Commodity	Rank among States
Iowa	1. Corn	17.9	1. Soybeans and products	1
	2. Hogs	29.7	2. Feed grains and products	1
	3. Soybeans	14.5	3. Live animals and meat	1
	4. Cattle and calves	5.7	4. Feeds and fodder	7
	5. Chicken eggs	12.7	5. Poultry and products	19
Minnesota	1. Corn	9.0	1. Soybeans and products	3
	2. Soybeans	8.9	2. Feed grains and products	4
	3. Hogs	12.8	3. Live animals and meat	5
	4. Dairy products	4.6	4. Wheat and products	6
	5. Cattle and calves	2.3	5. Feeds and fodder	8
Montana	1. Cattle and calves	2.1	1. Wheat and products	3
	2. Wheat	9.5	2. Feeds and fodder	5
	3. Hay	5.0	3. Vegetables and preparations	10
	4. Barley	21.2	4. Feed grains and products	24
	5. Lentils	37.0	5. Seeds	19
Nebraska	1. Cattle and calves	14.0	1. Soybeans and products	4
	2. Corn	11.9	2. Feed grains and products	3
	3. Soybeans	8.0	3. Live animals and meat	2
	4. Hogs	4.6	4. Hides and skins	1
	5. Wheat	3.0	5. Feeds and fodders	6
North Dakota	1. Wheat	17.5	1. Wheat and products	2
	2. Soybeans	3.8	2. Soybeans and products	9
	3. Cattle and calves	1.4	3. Feeds and fodders	4
	4. Corn	1.5	4. Vegetables and preparations	4
	5. Canola	90.3	5. Feed grains and products	12
South Dakota	1. Corn	4.6	1. Soybeans and products	8
	2. Cattle and calves	3.9	2. Feed grains and products	7
	3. Soybeans	4.8	3. Wheat and products	9
	4. Wheat	6.0	4. Live animals and meat	16
	5. Hogs	2.5	5. Seeds	3

Source: ERS (2011).

farm programs (such as crop insurance and disaster assistance) had a modest but measurable effect (about 2.9 percent) on the amount of grassland-cropland conversion. In the absence of such programs, it estimates that 181,000 ac would have remained (or been returned to) grassland. Although commodity prices likely did not play a role in grassland-cropland conversion between 1997 and 2007, higher crop prices in recent years will likely encourage farmers to convert grassland to cropland (or retain land in crop production) to further expand their cropland acreage.

6.2.1.9 Urbanization

Urbanization in the Midwest is a historically recent phenomenon, with most major cities having taken root in the mid-1800s (c. 1830 to 1870). Midwestern cities were an important part of the nation’s industrial growth between 1870 and 1920, and rapid expansion of rail transportation during this time facilitated growth in urban centers. Many of these new urban centers were based on the availability and commercialization of agricultural land resources. The present geographic pattern of urbanization was well established by 1920; changes taking place in the urban system since then have typically occurred within this pattern. While deindustrialization in the 1970s and early 1980s caused a marked decline in the manufacturing sector, the pattern of urbanization remained virtually unchanged as urban centers adapted to the requirements of a new economic climate (focusing mainly on business and professional services). The Midwest continues to be a significant part of the nation’s economy, but growth in its urban centers has been generally slow (Sisson et al. 2007).

According to the 2010 census, less than about 2 percent of the land area in the UGP Region States is classified as urban (the remainder is rural); the percentage of the population living in urban areas ranged from about 56 percent (Montana) to about 73 percent (Minnesota) (U.S. Census Bureau 2012a). The trend in urban area growth (in both population and land area) over the past few years is shown in table 6.2-8. All urban areas in the UGP Region States experienced increases in population between 2000 and 2010, with several cities increasing in population by more than 20 percent: Sioux Falls (26 percent), Iowa City (25 percent), Fargo (24 percent), Rapid City (22 percent), St. Cloud (21 percent), and Des Moines (21 percent). Several urban areas also had significant growth in land area: Fargo (53 percent), Ames (47 percent), Grand Forks (46 percent), Des Moines (43 percent), Cedar Rapids (41 percent), and Sioux Falls (41 percent). Although the rate of future growth is uncertain, it is likely that urban areas in the UGP Region will continue to grow into the foreseeable future (see also section 6.2.2.1).

6.2.2 General Trends

6.2.2.1 Population Growth

The 2010 census reported 308.7 million people in the United States, a 9.7 percent increase from the population reported in the 2000 census. Most of the growth was in the South and West regions, with only a 3.9 percent increase recorded for the Midwest region (Mackun and Wilson 2011). Based on the 2000 census (the 2010 statistics are not yet available), the U.S. population is projected to grow by about 29 percent between 2010 and

TABLE 6.2-8 Urban Areas in UGP Region States, 2000 and 2010[a,b]

	Population		Land Area (mi^2)	
State/Urban Area	2000	2010	2000	2010
Minnesota				
Duluth (MN and WI)	118,265	120,378 (2)	66.27	70.48 (6)
Fargo (ND and MN)	142,477	176,676 (2)	45.81	70.27 (6)
Grand Forks (ND and MN)	56,573	61,270 (8)	16.76	24.44 (46)
La Cross (WI and MN)	89,966	100,868 (12)	40.39	50.99 (26)
Minneapolis-St. Paul	2,388,593	2,650,890 (11)	894.22	1,021.80 (14)
Rochester	91,271	107,677 (18)	40.26	50.58 (26)
St. Cloud	91,305	110,621 (21)	39.48	50.25 (27)
Montana				
Billings	100,317	114,773 (14)	45.77	52.96 (16)
Great Falls	64,387	65,207 (1)	31.11	28.70 (8)
Missoula	69,491	82,157 (18)	36.38	45.20 (24)
Iowa				
Ames	50,726	60,438 (19)	15.79	23.23 (47)
Cedar Rapids	155,334	177,844 (14)	59.33	83.45 (41)
Davenport (IA and IL)	270,626	280,051 (3)	123.87	138.23 (12)
Des Moines	370,505	450,070 (21)	140.32	200.59 (43)
Dubuque (IA and IL)	65,251	67,818 (4)	30.23	33.79 (12)
Iowa City	85,247	106,621 (25)	35.75	45.58 (27)
Omaha (NE and IA)	626,623	725,008 (16)	226.36	271.21 (20)
Sioux City (IA, NE and SD)	106,494	106,119 (<1)	52.77	54.37 (3)
Waterloo	108,298	113,418 (5)	52.75	62.23 (18)
Nebraska				
Lincoln	226,582	258,719 (14)	78.12	88.47 (13)
Omaha (NE and IA)	626,623	725,008 (16)	226.36	271.21 (20)
Sioux City (IA, NE, and SD)	106,494	106,119 (<1)	52.77	54.37 (3)
North Dakota				
Bismarck	74,991	81,955 (9)	33.92	38.76 (14)
Fargo (ND and MN)	142,477	176,676 (24)	45.81	70.27 (53)
Grand Forks (ND and MN)	56,573	61,270 (8)	16.76	24.44 (46)
South Dakota				
Rapid City	66,780	81,251 (22)	30.39	42.25 (39)
Sioux City (IA, NE, and SD)	106,494	106,119 (<1)	52.77	54.37 (3)
Sioux Falls	124,269	156,777 (26)	45.65	64.17 (41)

[a] Urban areas are defined by the U.S. Census Bureau as core census blocks or block groups having a population density of at least 1,000 people per square mile, with surrounding census blocks having an overall density of at least 500 people per square mile.

[b] Numbers in parentheses represent the percent change (increase) between 2000 and 2010.

Source: U.S. Census Bureau (2012b).

2030, with most of the growth continuing in the South and West. In the UGP Region States, the largest increases in population are expected to occur in Minnesota (with an expected increase of about 21 percent), followed by Iowa (13 percent), Nebraska (8.3 percent), Montana (5.9 percent), South Dakota (2.6 percent), and North Dakota (1.7 percent) (U.S. Census Bureau 2005).

6.2.2.2 Energy Demand

Energy consumption in the United States is on the rise and projected to increase by about 20 percent between 2009 and 2035. Growth in energy demand is directly related to population growth through increases in housing, commercial floorspace, transportation, and goods and services. Fossil fuels, including liquid fuels, natural gas, and coal would comprise about 82 percent of energy consumption in 2035, down from 85 percent in 2008. The decline in fossil fuel use is attributed to the greater use of nonhydroelectric renewable energy resources, which is projected to increase to 7.9 percent in 2035, up from 5.7 percent in 2008 (EIA 2011a).

In 2009, the States in the UGP Region collectively consumed about 46 percent more energy than they produced (EIA 2011b). Only Montana and North Dakota produced more energy than they consumed (more than twice as much in each case) – mainly derived from coal and crude oil (EIA 2011b). This trend is likely to continue well into the next several decades, although use of renewable energy sources is expected to offset some of the decline in fossil fuel use.

6.2.2.3 Water Demand

In 2005 (the latest year for which annual statistics are available at publication), freshwater and saline water withdrawals in the United States were estimated to be 410,000 million gallons per day (460,000 thousand-acre-ft per year), with 80 percent of the total withdrawals coming from surface water. In the UGP Region States, freshwater and saline water withdrawals were estimated to be 31,950 million gallons per day (35,761 thousand acre-ft per year), with the highest usage occurring in Nebraska and Montana. Surface water accounted for 69 percent of total water withdrawals in the UGP Region States, although 61 percent of the water withdrawals in Nebraska were from groundwater sources (Kenny et al. 2009).

The U.S. Geological Survey defines eight categories of water use in the United States: public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power. In 2005, the greatest water consumption in Nebraska and Montana (the UGP Region States with the highest water usage) was in the category of irrigation (8,460 million gallons per day from groundwater in Nebraska; and 9,670 million gallons per day from surface water in Montana) and thermoelectric power (3,550 million gallons per day from surface water in Nebraska). Consumption of water via the public supply was generally proportional to the State population (highest in Minnesota; lowest in North Dakota). The highest per capita usage in 2005 occurred in Nebraska (188 gallons per day) and Montana (152 gallons per day).

Water consumption in the UGP Region States between 2000 and 2005 increased for Montana (up 21.8 percent), North Dakota (up 17.5 percent), Minnesota (up 4.4 percent), and Nebraska (up 2.4 percent). Consumption declined in South Dakota (down 5.6 percent) and

Iowa (down less than 1 percent) (based on data from Kenny et al. [2009] and Hutson et al. [2004]). These trends will likely continue over the next few decades.

6.2.2.4 Land Use Trends

Of the 328,525,000 ac (133,000,000 ha) that comprised the UGP Region States in 2007, about 284,995,000 ac (115,333 ha) (86.7 percent) were non-Federal land and water areas, most of which was rural (table 6.2-9). The remainder consisted of Federal land. Over the 25-yr period from 1982 to 2007, the greatest change in land use designation occurred in the "developed" land category, with a 22 percent increase in the region overall and significant increases in Minnesota (up 40 percent), Montana (up 28 percent), South Dakota (up 19 percent), and Iowa (up 16 percent). The size of water areas and Federal lands also increased for some States over this period, most markedly in Iowa (up 8.5 and 14 percent, respectively), Nebraska (up 4.5 and 12 percent, respectively), and North Dakota (up 12 and 3.3 percent, respectively). Most of the "developed" land category was converted from rural lands (based on data from NRCS 2009).

Non-Federal rural land categories in the States of the UGP Region (as of 2007) are shown in table 6.2-10. Most of the non-Federal rural land in the region is used as cropland (43.5 percent) and rangeland (33.7 percent). Iowa had the highest proportion of land used as cropland (76.0 percent), followed by North Dakota (57.8 percent) and Minnesota (45.9 percent). Montana and Nebraska had the highest proportion of land used as rangeland (56.9 and 48.9 percent, respectively). Minnesota had the greatest area of land designated as forestland (16,541 ac [6,694 ha]), accounting for about 36.6 percent of its non-Federal rural land (NRCS 2009).

TABLE 6.2-9 Surface Area of Federal and Non-Federal Land and Water Areas, 2007[a]

				Non-Federal Land		
State	Surface Area	Federal Land	Water	Developed	Rural	Total
Iowa	36,016.5	172.4 (+14)	485.9 (+8.5)	1,892.3 (+16)	33,645.9 (0)	35,358.2 (0)
Minnesota	54,009.9	3,336.1 (0)	3,144.9 (0)	2,395.2 (+40)	45,133.7 (–1.5)	47,528.9 (0)
Montana	94,110.0	27,092.0 (0)	1,039.4 (–1.3)	1,047.0 (+28)	64,931.6 (0)	65,978.6 (0)
Nebraska	49,509.6	647.6 (+12)	476.2(+4.5)	1,156.5 (+12)	47,229.3 (0)	48,385.8 (0)
North Dakota	45,250.7	1,784.8 (+3.3)	1,087.3 (+12)	967.5 (+7.2)	41,404.1 (0)	42,377.3 (0)
South Dakota	49,358.0	3,112.2 (+2.7)	879.4 (+1.6)	962.8 (+19)	44,403.6 (0)	45,366.4 (0)
Total	328,524.7	36,145.1(0)	7,113.1 (+2.8)	8,421.3 (+22)	276,568.2 (0)	284,995.2 (0)

[a] Area in thousands of acres; numbers in parentheses represent the change between 1982 and 2007 (a zero value indicates change of less than 1 percent).

Source: NRCS (2009).

TABLE 6.2-10 Land Use Categories for Non-Federal Rural Lands in the UGP Region, 2007[a]

State	Cropland	CRP Land[b]	Pasture Land	Rangeland	Forest Land	Other	Total
Iowa	25,446.2	1,427.5	3,304.8	0	2,354.7	932.7	33,465.9
Minnesota	20,693.9	1,453.8	3,759.8	0	16,541.2	2,685.0	45,133.7
Montana	13,930.5	3,315.7	3,960.1	36,953.4	5,488.1	1,283.8	64,931.6
Nebraska	19,526.2	1,198.3	1,773.5	23,107.0	823.7	800.6	47,229.3
North Dakota	23,951.6	3,211.3	1,194.9	11,018.8	466.3	1,561.2	41,404.1
South Dakota	16,764.4	1,342.3	2,089.5	22,189.7	524.2	1,493.5	44,403.6
Total	120,312.8	11,948.9	16,082.6	93,268.9	26,198.2	8,756.8	276,568.2

[a] Area in thousands of acres.

[b] CRP land is land enrolled in the U.S. Department of Agriculture Conservation Reserve Program.

Source: NRCS (2009).

6.2.2.5 Climate

There is a growing consensus in the scientific community that human activity is contributing substantially to the increase in the Earth's surface temperature. The phenomenon, referred to as global warming, is likely due to human-generated increases in greenhouse gas concentrations. Greenhouse gases include water vapor, carbon dioxide, methane, ozone, nitrous oxide, and several fluorine- and chlorine-containing gases. Of these gases, carbon dioxide is believed to be contributing the most to recent warming, with average atmospheric concentrations increasing from an estimated 280 ppm in the 18th century to 383 ppm in 2007. In the atmosphere, greenhouse gases trap heat that would otherwise escape into space, creating a "greenhouse effect." The greenhouse effect moderates atmospheric temperatures, keeping the Earth warm enough to support life; however, since the inception of the industrial era, the burning of fossil fuels and clearing of forests have greatly intensified the natural greenhouse effect, causing global average temperatures to rise at a fast rate; for example, in the United States, average temperatures have risen at a rate of nearly 0.6°F per decade in the past few decades (National Science and Technology Council 2008).

Because the warming phenomenon is not distributed evenly across the Earth's surface, it is increasingly referred to as "global climate change." Climate change is a more appropriate term, reflecting the fact that changes in the climate due to warming are not universal across the globe. Some of the critical climate changes already observed in the United States include:

- *Temperature.* An increase in the number of heat waves since 1950 and fewer unusually cold days during the last few decades.

- *Precipitation and drought.* An overall increase in annual precipitation, with significant regional variability; an increase in the proportion of heavy precipitation events, especially in the eastern half of the country; and an increase in the fraction of annual precipitation falling as rain rather than snow.

- *Snow and ice.* Large decreases in Arctic summer sea ice and an increase in the snow-covered areas of North America in the November to January season, although there has been a general decrease in spring snow cover in mountainous regions in the West, lowering spring snowmelt runoff and resulting in less water available in late summer.

- *Sea level rise.* Global rise in sea level; along the U.S. Atlantic and Gulf Coasts, sea level is rising at a rate of 0.08 to 0.12 in. (0.2 to 0.3 cm) per year.

- *Atlantic hurricanes.* The annual number of tropical storms, hurricanes, and major hurricanes have increased over the past 100 years (National Science and Technology Council 2008).

In the Great Plains region (stretching from Montana and North Dakota to Texas), significant trends in regional climate have been observed over the past few decades (U.S. Global Change Research Program 2009). Average temperatures have increased throughout the region, with the greatest increases occurring in the northern States during winter months. Accompanying such increases in temperature are faster evaporation rates and more sustained droughts; these in turn affect the natural rates of recharge to the High Plains aquifer (also known as the Ogallala aquifer), a resource that is already stressed by widespread irrigation, particularly in the south. Extreme weather events such as heat waves, droughts, and strong storms are projected to occur more frequently.

Precipitation has also increased over most of the region and conditions are expected to become wetter in the northern areas of the Great Plains. However, such increases may not be enough to offset decreasing soil moisture and water availability due to rising temperatures and aquifer depletion, especially in the heavily irrigated southern areas of the Great Plains. The long-term effects of climate-driven changes in the UGP Region include the following:

- *Key native plant and animal habitats:* increases in the vulnerability of natural ecosystems to pests, invasive species, and loss of native species; changes in the composition and diversity of native plants and animals caused by alterations in their breeding patterns, water and food supply, and habitat availability; increases in adaptive species; decreases in species sensitive to habitat fragmentation; and decreases in migratory waterfowl and shorebirds that depend on wetlands.

- *Agriculture:* shifts in the optimal zones for growing particular crops; decreases in yields and withered crops from heat and water stress caused by droughts, heat waves, and decreased soil moisture and water availability; greater number and earlier emergence of insects with milder winters and earlier springs; and the northward spread of pests.

- *Socioeconomics:* economic stressors to traditional communities (Native American and small, rural communities) due to shifts in crop production, and the increased risk of drought, pests, and extreme weather events.

Many of these changes are projected to occur over the next century; it is less certain to what degree such changes will be experienced in the near term. Over the 20-yr time frame of the cumulative analysis, it is likely that climate conditions would fall within the natural fluctuations of the recent past.

6.2.3 Programmatic-Level Federal Actions

6.2.3.1 Renewable Energy Development on DOE Legacy Management Lands

Only two of the UGP Region States, South Dakota and Nebraska, have DOE legacy management lands that could be developed for renewable energy (in particular, solar and wind energy). These include a 5.1 ac (2.1 ha) site in Hallam, Nebraska (a decommissioned reactor) and a 360 ac (146 ha) site in Edgemont, South Dakota (a former disposal site). Both were cited as having high to medium potential for solar (photovoltaic) and wind energy development (wind class 3 and 4, respectively) (DOE 2008).

6.2.3.2 Wind Energy Development Program

In 2005, the BLM published a record of decision (ROD) to record its decision to implement a comprehensive Wind Energy Development Program on BLM-administered public lands in 11 western States (including Montana) and to amend 52 BLM land use plans (in nine of the States) to adopt the new program policies and BMPs (BLM 2005a). Potential direct impacts of the program were identified: use of geologic and water resources, creation or increase of geologic hazards or soil erosion, water quality degradation, localized generation of airborne dust, generation of noise, alteration or degradation of wildlife habitat or sensitive or unique habitat, interference with resident or migratory fish or wildlife species (including protected species), alteration or degradation of plant communities (including the occurrence of invasive vegetation), land use changes, alteration of visual resources, release of hazardous materials or wastes, increased traffic, increased human health and safety hazards, and destruction or loss of paleontological or cultural resources.

Mitigation measures to address many of these impacts were identified in the programmatic environmental impact statement (PEIS) (BLM 2005b), which is available on the program's Web site (see http://windeis.anl.gov/documents/fpeis/index.cfm).

6.2.3.3 West-Wide Energy Corridors Program

In 2009, the BLM published a ROD to record its decision to designate Section 368 energy transport corridors on BLM-administered public lands in 11 western States (including Montana) for future project development and to amend its associated resource management plans (BLM 2009). The FS also published a ROD at that time to record its decision to designate Section 368 energy transport corridors on National Forest System land (USFS 2009). The designated corridors included a total of 236 mi (380 km) of proposed corridors on BLM and USFS land in Montana, located in the western half of the State near Missoula and Helena. The PEIS discloses no environmental impacts as a result of the corridor designation; however, it acknowledged that future development would likely be directed to these areas. The agencies developed interagency operating procedures, or IOPs (also adopted with the ROD), to facilitate systematic planning for energy transport development in the West, and to provide the industry with a coordinated and consistent interagency permitting process and measures to avoid or minimize environmental impacts. The PEIS is available on the program's Web site (see http://corridoreis.anl.gov/documents/fpeis/index.cfm).

6.2.4 Legislative Actions and Regional Initiatives

6.2.4.1 Mandatory State Renewable Portfolio Standards

Three of the six UGP Region States have set mandatory standards, known as Renewable Portfolio Standards (RPSs), which require electric utilities to generate a specified amount of electricity from renewable sources by a given date. Two States, North Dakota and South Dakota, have passed laws that establish voluntary objectives (table 6.2-11). Some States (e.g., Minnesota) allow utilities to comply with the RPS through tradable renewable energy credits. Nebraska is the only UGP Region State that has not set mandatory standards.

Definitions of qualified renewable energy vary, but generally include the following:

- Wind power
- Solar power
- Geothermal
- Small-scale and run-of-the-river hydropower
- Landfill or farm-based methane gas
- Municipal solid waste
- Hydrogen generated from renewable sources (e.g., fuel cells)
- Recycled energy systems (unused waste heat)

States cite various reasons for mandating the increased use of renewable energy. These generally include greenhouse gas reduction, as well as the benefits of new job creation, increasing self-sufficiency and independence, energy security (through diversification), and cleaner air (Pew Center on Global Climate Change 2011a).

6.2.4.2 Midwest Greenhouse Gas Reduction Accord

In November, 2007, six Midwestern States (including Iowa and Minnesota) and one Canadian province established the Midwest Greenhouse Gas Reduction Accord (MGGRA). The MGGRA is the third regional agreement among U.S. States to collectively reduce GHG

TABLE 6.2-11 Mandatory State Renewable Portfolio Standards[a]

State	Citation	Effective Date	Requirement
Iowa	Iowa Alternative Energy Production Law (Iowa Code § 476.41 et seq.; IAC 199-15.11(1); and IUB Order, Docket No. AEP-07-1)	February 9, 1997 (enacted 1983, amended 1991, 2003); IUB Order issued November 21, 2007	Requires that the State's two utilities (MidAmerica Energy and Alliant Energy Interstate Power and Light) contract for a combined total of 105 MW of their generation from renewable sources; and establishes a voluntary goal of 2,015 MW by 2015. In 2001, a secondary voluntary goal of 1,000 MW of wind generating capacity was established.
Minnesota	MS § 216B.1691; PUC Order, Docket E-999/CI-04-1616	February 22, 2007 (SB 4; subsequently amended)	Mandates that 25 percent of the State's power generated by producers other than Xcel Energy come from renewable sources by 2025. Xcel Energy (producing about half of the State's electricity) will be required to produce 30 percent of its power from renewable sources by 2020 (25 percent by wind). Requires utilities to study and develop plans for transmission network enhancements to optimize delivery of renewable energy.
Montana	The Montana Renewable Power Production and Rural Economic Development Act (MCA 69-3-2001 et seq.; MAR 38.5.8301)	April 28, 2005	Mandates that 15 percent of the State's energy come from renewable sources by 2015, and for each year thereafter. Public utilities must purchase at least 75 MW from community renewable projects.
North Dakota	NDCC § 49-02-24 et seq.; NDAC 69-09-08; NDPSC Order PU-07-318	March 23, 2007 (HB 1506)	Establishes a voluntary renewable portfolio objective that 10 percent of the State's energy would come from renewable sources by 2015.
South Dakota	SDCL § 49-34A-101 et seq.; SDCL § 49-34A-94 et seq.	February 21, 2008 (HB 1123; subsequently amended)	Establishes a voluntary renewable portfolio objective that 10 percent of the State's energy would come from renewable sources by 2015.

[a] IAC=Iowa Administrative Code; IUB=Iowa Utility Board; MS=Minnesota Statute; PUC=Public Utilities Commission; SB=Senate Bill; MCA=Montana Code Annotated; MAR=Montana Administrative Rules; NDCC=North Dakota Century Code; NDAC=North Dakota Administrative Code; NDPSC=North Dakota Public Service Commission; HB=House Bill; SDCL=South Dakota Codified Laws

Sources: Pew Center on Global Climate Change (2011a); DOE (2010, 2011a–d).

emissions. Members of the Accord agree to establish region GHG target with a long-term target of a 60 to 80 percent reduction in current emissions levels and to develop a multi-sector cap-and-trade system to help meet these targets. Members will also develop a GHG emissions reductions tracking system and implement other policies to reduce emissions (e.g., low-carbon fuel standards). South Dakota has joined the Accord as an observer (Pew Center on Global Climate Change 2011b).

6.2.4.3 Western Climate Initiative

The Western Climate Initiative was established in 2007 by the governors of several western States as a joint effort to reduce regional GHG emissions to 15 percent below 2005 levels by 2020. The region currently includes Arizona, California, New Mexico, Oregon, Utah, and Montana, as well as British Columbia, Manitoba, Ontario, and Quebec (several other U.S. States and Canadian provinces have signed on as observers). The emissions covered by the initiative include CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. A cap-and-trade program, beginning in 2012, will cover emissions from electricity and large industrial and commercial sources (emissions from transportation and other fuel use will begin in 2015) (Center for Climate and Energy Solutions 2011).

6.2.4.4 Energy Security and Climate Stewardship Platform for the Midwest

In 2007, the governors of 11 Midwestern States (including all the UGP States except Montana) and the premier of one Canadian province adopted all or portions of an Energy Security and Climate Stewardship Platform. The platform lists goals for energy efficiency improvements, low-carbon transportation fuel availability, renewable electricity production, and the development of carbon capture and storage; and defines objectives for carbon capture and storage (CCS). Member States agree to have a regional regulatory framework for CCS by 2010; to have sited and permitted a CO_2 transport pipeline by 2012; and to have all new coal plants in the region capture and store CO_2 emission by 2020 (Center for Climate and Energy Solutions 2011).

6.3 CUMULATIVE IMPACTS ANALYSIS

6.3.1 Cumulative Impacts on Resources

The construction and operation of future wind energy projects in the UGP Region could contribute to cumulative impacts affecting both private and public lands. The level of contributions from projects under the preferred alternative (Alternative 1) would vary depending on the size and number of individual projects within a given area, as well as their location and timing relative to other local actions. It is important to note that even though 115 to 400 new wind energy projects are projected to be built in the UGP Region by 2030, most of these projects would not seek interconnection to Western’s transmission system, but rather, to other transmission facilities that provide an extensive network throughout the UGP Region. It is also anticipated that only a small number of projects (an estimated eight wind energy projects) would be accommodated on service easements by 2030 (see section 7.2.2).

The cumulative impacts analysis presented in the following sections encompasses the direct and indirect impacts associated with both the period of project construction and the post-construction period of operation (covered in chapter 5) for wind energy projects, and the potential impacting factors for activities associated with other reasonably foreseeable future actions (table 6.3-1). Impact levels (negligible, minor, moderate, and major) used for the cumulative impacts analysis are the same as those used in chapter 5 for the analysis of direct and indirect impacts.

For this analysis, it is assumed that the requirements of the BMPs and mitigation measures identified in chapters 2 and 5 would be met. Some mitigation measures would require environmental monitoring to evaluate environmental conditions and adjust impact mitigation objectives, as necessary, and would reduce the contribution of wind energy development to cumulative impacts for most resource areas.

6.3.1.1 Land Use

The cumulative impacts of past, present, and future land cover and land use trends in the UGP Region States result from the continued development of non-Federal land and the increase of commercial, industrial, and recreational use of Federal lands. Oil and gas development and conversion from grassland to cultivated agriculture is ongoing at a rapid pace and, from a cumulative impact standpoint, may substantially affect the ability of grassland to maintain some ecological functions. For example Johnson (2012) estimated that approximately 16 percent of the prairie grassland present in the portion of the Prairie Pothole Region in the eastern Dakotas in 2001 had been converted to cropland by 2010. Under the preferred alternative (Alternative 1), future wind energy projects could affect land cover and land use on those lands classified as being highly suitable for utility scale wind energy development, especially those lands located within 25 mi (40 km) of Western’s transmission and substation facilities, where development would most likely occur. The total area of lands potentially affected in the UGP Region ranges from 1.1 to 2.5 million ac (0.4 to 1.0 million ha) – enough land to accommodate the 115 to 400 new wind energy projects projected to be built between the present and 2030 (see section 2.4). Wind energy development is generally compatible with many land uses, including agriculture and livestock grazing. However, impacts could result in areas where productive existing or future use (e.g., farming, mining, or military operations) would be precluded.

Under Alternative 1, a standardized structured process for evaluating wind energy interconnection requests and easement exchange requests would be adopted, and programmatic BMPs and mitigation measures would be implemented as part of proposed wind energy projects to minimize or avoid impacts and to ensure the integrity and conservation objectives of Service easements are maintained. As a result, developers would use the process to design and site their projects in more suitable and less sensitive areas, thus avoiding or minimizing potential impacts on land cover and land uses. The incremental contributions of wind energy projects to cumulative land-related impacts, therefore, are expected to be reduced compared to other alternatives.

TABLE 6.3-1 Potential Impacting Factors of Activities Associated with the Preferred Alternative and Other Reasonably Foreseeable Future Actions in the UGP Region

Resource Area and Potentially Impacting Activities	Impacting Factor	Type of Action[a]
Land Cover and Land Use:		
Construction/operations	Land use conflicts	A, B, C, D, E, F, G, H
Soil Resources:		
Earthmoving/blasting	Soil disturbance/erosion (by wind and water) Soil horizon mixing	A, B, C, E
Vegetation clearing/roads	Soil disturbance/erosion (by wind and water)	A, B, C, E, H
Construction	Soil compaction Resource use	A, B, C, E, F
Spills/releases	Soil contamination	A, B, C, D, E, F, H
Water Resources:		
Groundwater –		
▪ Construction/operations	Resource use	A, D, E
▪ Spills/releases	Resource contamination	A, B, C, D, E, F, H
Surface Water –		
▪ Construction/operations	Resource Use	A, D, E
▪ Earthmoving/blasting	Sedimentation (from increased runoff and soil erosion)	A, B, C, D, E, F
▪ Spills/releases	Resource contamination	A, B, C, D, E, F, H
Air Quality:		
Earthmoving/blasting Vegetation clearing/roads Equipment/vehicles Facility operations Spills/releases	Dust emissions Dust emissions Exhaust emissions Fuel combustion emissions Evaporative emissions	A, B, C, D, E, F
Noise:		
Earthmoving/blasting Construction/operations Traffic Corona effects Aircraft surveillance	Increased ambient noise levels Increased ambient noise levels Increased ambient noise levels Increased ambient noise levels Increased ambient noise levels	A, B, C, D, E, F
Ecological Resources:		
Vegetation clearing/roads	Injury/mortality Interference with behavioral activities Habitat disturbance/loss Increased noise Dust emissions	A, B, C, D, E, F, H

TABLE 6.3-1 (Cont.)

Resource Area and Potentially Impacting Activities	Impacting Factor	Type of Action[a]
Construction/operations	Injury/mortality Interference with behavioral activities Habitat disturbance/loss Increased noise Dust emissions	A, B, C, D, E, F, H
Spills/releases	Injury/mortality (increased exposure risk) Habitat disturbance	A, B, C, D, E, F, H
Visual Resources:		
Urbanization	Decreased visibility (light and air pollution)	A, B, C, D, E
Vegetation clearing/roads	Increased contrast with surrounding landscape Degradation of visual quality	A, B, C, D, E
Tower/facility construction	Increased contrast with surrounding landscape Degradation of visual quality	A, B, C, D, E
Tower/facility operations	Decreased visibility (due to emissions) Degradation of visual quality	A, B, C, D, E
Paleontological Resources:		
Earthmoving/blasting	Soil disturbance/erosion (by wind and water) Resource damage/destruction	A, B, C, D, E, F
Vegetation clearing/roads	Increased accessibility Vandalism/theft	A, B, C, D, E, F
Cultural Resources:		
Earthmoving/blasting	Soil disturbance/erosion (by wind and water) Resource damage/destruction	A, B, C, D, E, F
Vegetation clearing/roads	Increased accessibility Vandalism/theft	A, B, C, D, E, F
Socioeconomics:		
Construction/operations	Housing Expenditures in the local economy Employment Taxes/revenues Recreation/tourism Change in private property values	A, B, C, D, E, F, G, H
Environmental Justice:		
Construction/operations	Noise Dust emissions EMF effects Degradation of visual quality Change in private property values	A, B, C, D, E, F, H

[a] Key to types of actions: A = renewable energy development (including the preferred alternative), B = transmission and distribution systems, C = coal production, D = power generation, E = oil and natural gas exploration, development, and production, F = transportation, G = recreation and leisure, and H = agriculture (see table 6.2-1 for activities and facilities associated with these actions).

6.3.1.2 Soil Resources

The cumulative impacts of past, present, and future actions on soil resources within projects sites and transmission line ROWs (and adjacent lands) in the UGP Region (the defined ROI for soils) would result mainly from ground-disturbing activities associated with wind energy projects, such as the construction of wind towers and related infrastructure (e.g., on-site roads, access roads, buildings, and transmission lines). These impacts are short in duration and generally can be controlled through mitigation measures; for this reason, cumulative impacts on soils are expected to be minor. Depending on the location, other activities such as farming or grazing would also contribute to cumulative impacts in project areas (if collocated), but their contribution to cumulative impacts would be small. Adverse impacts on soils relate to the increased potential for erosion, compaction, surface runoff, sedimentation, and soil contamination. These impacts, in turn, could contribute to adverse impacts on other resources such as air, water, vegetation, and wildlife. After construction, soils would stabilize with time and adverse impacts would not be expected.

Because adverse soil impacts from wind energy projects under the preferred alternative (Alternative 1) are associated mainly with construction and would be localized and short in duration, they are considered to be small in terms of their contribution to cumulative impacts. Implementing mitigation measures and BMPs, such as those proposed in this PEIS, would further minimize these contributions.

6.3.1.3 Water Resources

The cumulative impacts of past, present, and future actions on nearby surface water bodies and shallow aquifers (recharge areas) result from water use, water quality degradation, and changes in natural flow systems in the vicinity of wind energy projects. Depending on the location, other activities (e.g., municipal, industrial, or agricultural) would also contribute to cumulative impacts in project areas (although the magnitude of these impacts is location-dependent and currently undetermined). During the construction phase, water would be needed for various construction activities (e.g., as drinking water and for concrete mixing). Water quality could be degraded by accidental spills (through infiltration or runoff) and by ground-disturbing activities that increase soil erosion and sedimentation in nearby surface water bodies. Temporary alteration of the natural flow system may also occur (e.g., as a result of dewatering around tower foundations during excavation). After construction, however, water use would be negligible, since it would only be used for cleaning wind turbine blades (and only in dry areas). Accidental spills could still occur but are expected to be rare. Such events would be addressed in accordance with the requirements of the project spill prevention and emergency response plan required under the preferred alternative.

Because adverse impacts on surface water and groundwater from wind energy projects under the preferred alternative would occur mainly during construction and would be localized and short in duration, they would be small in terms of their contributions to cumulative impacts. Implementing mitigation measures and BMPs, such as those proposed in this PEIS, would further minimize these contributions.

6.3.1.4 Air Quality

The cumulative impacts of past, present, and future actions on airsheds in the UGP Region States relate to increases in pollutant loads associated with industrial activity (e.g., oil and gas development and production, mining, and increased traffic), which is on the rise in the UGP Region. Impacts would be highest in nonattainment areas where air quality standards are exceeded. The increased development of renewable energy sources (section 6.2.1.1) over the next 20 yr, including wind energy, would offset some of these impacts.

The contributions of wind energy projects under the preferred alternative to cumulative ambient air quality impacts would be small because mitigation measures and BMPs, such as those proposed in this PEIS, would be implemented. Most emissions associated with wind energy projects would be attributed to construction activities that could release small amounts of criteria pollutants, VOCs, GHGs, and small amounts of HAPs from fugitive dust, engine exhaust, and vehicular traffic. Operating wind turbines and transmission lines would generate no direct emissions, but maintenance activities would release small amounts of engine exhaust and generate fugitive dust. These emissions would be insignificant.

If wind energy projects result in avoiding construction and operation of other types of new or existing power generation facilities (e.g., fossil fuel power plants) that produce criteria pollutant, VOC, GHG, and HAP emissions, they would have a major overall beneficial impact on the local and regional ambient air quality by offsetting potential visibility impairment, acid rain, ozone, heavy metals, and PM concentration impacts. In chapter 2, it is estimated that new wind energy generation capacity could range from 12,828 to 44,711 MW by 2030 (table 2.4-1). Assuming a new capacity of 28,770 MW by 2030 (the average of the two projections in table 2.4-1), it is estimated that 700,000 tons less SO_x and 343,000 tons less NO_x (two criteria pollutants) would be emitted each year if that power were generated by wind energy projects rather than the current mix of power plants (coal, nuclear, and gas).[4] Using the same capacity, it is estimated that GHG emissions (estimated as CO_2 equivalent [CO_2e]) would be 243 million metric tons less if generated by wind energy projects rather than coal, and 103 million metric tons less if generated by wind energy projects rather than natural gas.[5]

6.3.1.5 Acoustic Environment (Noise)

The cumulative impacts of past, present, and future actions on residential areas and sensitive wildlife near project sites and transmission line ROWs (the defined ROI) due to noise would result mainly from construction and operation activities associated with wind energy projects (if such receptors are present). Depending on the location, other activities (e.g., commercial, agricultural, industrial, or recreational) would also contribute to cumulative impacts in project areas. During the construction phase, the contributions of wind energy projects to these impacts would be high (though localized and short in duration) as a result of using heavy earthmoving equipment, diesel generators, and construction cranes (or helicopters) to install

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[4] Estimates were calculated using the SO_x and NO_x emission factors (6.04 lb/MWh and 2.96 lb/MWh, respectively) for the current mix of power generators in the United States reported in table 1 of Jaramillo et al. (2007).

[5] Estimates were calculated using the CO_2 equivalents for lifecycle coal and gas generation (1,050 and 443 g CO_2e/KWh, respectively) reported in table 8 of Sovacool (2008).

turbine towers and transmission tower structures as well as increased vehicular traffic to and from the construction site.

Over the long term, contributions to adverse cumulative impacts resulting from noise would be associated with the project operations phase. Noise during this phase results from (1) mechanical and aerodynamic noise from wind turbines, (2) transformer and switchgear from substations, (3) corona discharges from transmission lines, and (4) operations and maintenance facilities. These effects would be localized; some would be intermittent or infrequent.

Adverse impacts due to noise would be minimized under the preferred alternative (Alternative 1) by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include positioning noise sources to take advantage of topography and the distance to sensitive receptors, and selecting equipment with the lowest noise levels. As a result, the contributions of wind energy development to cumulative impacts due to noise would be small.

6.3.1.6 Ecological Resources

Vegetation. The cumulative impacts of past, present, and future actions on upland and wetland plant communities within the project site and transmission line ROWs (and adjacent lands) result mainly from construction and operation activities associated with wind energy projects (although other activities, such as grazing and grassland conversion, could also affect vegetation if they occur at the project site). Adverse impacts would include direct injury or mortality of vegetation (by clearing, grading, and trampling); habitat reduction or degradation; damage to plants that increases water loss and decreases CO_2 uptake (from fugitive dust); and exposure to contaminants that affect plant survival, reproduction, development, or growth. Habitat reduction or degradation could result in fragmentation of remaining native habitat. Increased site accessibility increases the risk of invasive species growth and fires (which could be damaging to habitats not adapted to fires). Although wind turbines are not likely to be located in wetland areas, they could be affected by project-related access roads and ancillary structures.

The contribution of future wind energy projects to adverse cumulative impacts on vegetation within future project sites would depend in part on the level of prior land disturbance (i.e., impacts would be lower in cropland, previously disturbed, or fragmented habitat than in undisturbed habitats of high quality). Increased site accessibility in previously undisturbed areas increases the risk of invasive species growth and fires (which could be damaging to habitats not adapted to fires).

Adverse impacts on vegetation would be minimized under the preferred alternative (Alternative 1) by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include initiating habitat restoration activities as soon as possible after construction activities and prohibiting foot and vehicle traffic through undisturbed areas (to reduce habitat disturbance). As a result, the contributions of wind energy development to cumulative impacts on vegetation would be small.

Wildlife. The cumulative impacts of past, present, and future actions on wildlife within the project site and transmission line ROWs (and adjacent lands) result mainly from the activities associated with increased commercial, agricultural (especially grassland conversion), industrial, and residential development across the UGP Region States. Adverse impacts include direct injury and mortality, habitat disturbance or loss, fragmentation (breaking contiguous parcels of habitat [e.g., native grasslands] into smaller parcels where the impact on wildlife is greater than the amount of habitat lost), interference with behavioral activities (e.g., restricted mobility or reduced reproductive success, avoidance of an area), increased risk of toxic release (a minor risk) or fugitive dust exposures, and increased risk of invasive species and fires. With BMPs and other mitigation measures in place, the contribution of wind energy facilities to cumulative impacts will often be minor. Impacting factors associated with wind energy projects with the potential to contribute more substantially to cumulative impacts within the UGP Region include collisions of birds and bats with turbines, and collisions of birds with transmission lines (section 5.6.2.1). Habitat loss, habitat fragmentation, and avoidance of areas are also potential impacts, depending on where the turbines are located.

Adverse impacts on wildlife would be minimized or avoided under the preferred alternative (Alternative 1) by following mitigation measures and BMPs such as those proposed in this PEIS. These would include following the evaluation process consistent with the *Land-based Wind Energy Guidelines* (Service 2012) during wind energy development to identify affected resources and modify project design accordingly, and conducting agency consultation to address federally listed species and designated critical habitat (see section 2.3.2). As a result, the contributions of wind energy development to cumulative impacts on wildlife would be reduced compared to the other alternatives.

Aquatic Biota and Habitats. The cumulative impacts of past, present, and future actions on aquatic biota and habitats result from the activities associated with increased commercial, agricultural, industrial, and residential development across the UGP Region States. Adverse impacts would include direct injury and mortality (and disturbance), habitat destruction or degradation, interference with movement to seasonal habitats (e.g., spawning areas), and increased risk of toxic release exposure. Increased site accessibility (via roads and transmission line ROWs) increases the risk of disturbance or loss of aquatic biota, non-native fish introduction, and legal and illegal take of aquatic biota, especially game fish. Increases in water temperature (resulting from vegetation removal) and degradation of water quality from increased turbidity and sedimentation would also contribute to adverse impacts over the long term. Such impacts could affect all life stages of aquatic biota, including eggs, larvae, and adults.

The contribution of future wind energy projects to adverse cumulative impacts on aquatic biota and habitats within and around future project sites would depend in part on the location of the project relative to water bodies (streams and potholes), the number and types of water bodies disturbed (in terms of size, volume and flow rates), the nature of the disturbance (e.g., stream crossing or hazardous spill), and the species present. Some wind energy project-related impacts (e.g., from vehicle and foot traffic crossing streams) would be localized and short in duration and would not be expected to contribute to adverse cumulative impacts on aquatic biota, especially if mitigation measures and BMPs, such as those proposed in this PEIS, were followed.

Adverse impacts on aquatic biota and habitats would be minimized or avoided under the preferred alternative (Alternative 1) by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include following the evaluation process consistent with the *Land-based Wind Energy Guidelines* (Service 2012) during wind energy development to identify affected resources and modify project design accordingly, and conducting agency consultation to address federally listed species and designated critical habitat (see section 2.3.2). As a result, the contributions of wind energy development to cumulative impacts on aquatic biota and habitats would be small.

Threatened, Endangered, and Special Status Species. The cumulative impacts of past, present, and future actions on threatened, endangered, and special status species (i.e., State-listed or of concern) result from the activities associated with increased commercial, agricultural, industrial, and residential development across the UGP Region States. Adverse impacts would be the same as those described for plant communities and habitats (section 6.3.1.6.1), wildlife (section 6.3.1.6.2), and aquatic biota and habitats (section 6.3.1.6.4). However, their low populations make these species more vulnerable to the effects of habitat fragmentation and alteration, human disturbance and harassment, individual mortality, and the loss of genetic diversity.

The contribution of future wind energy projects to adverse cumulative impacts on threatened, endangered, and special status species within and around future project sites would depend in part on the details of project development (e.g., number and heights of turbines), their location relative to species populations and habitats, and the species present. Some impacts related to wind energy projects (e.g., from construction noise, workforce presence, and dust or hazardous release spills) would be localized and short in duration and would not be expected to contribute to adverse cumulative impacts on these species, especially if mitigation measures and BMPs, such as those proposed in this PEIS, were followed.

Adverse impacts on threatened, endangered, and special status species would be minimized or avoided under the preferred alternative (Alternative 1) by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include following the evaluation process consistent with the *Land-based Wind Energy Guidelines* (Service 2012) during wind energy development to identify affected resources and modify project design accordingly, and conducting agency consultation to address federally listed species and designated critical habitat (see section 2.3.2). As a result, the contributions of wind energy development associated with implementation of the proposed action to cumulative impacts on threatened, endangered, and special status species are expected to be manageable.

As identified in section 5.6.1.4, the GPWE HCP that is currently under development will consider potential impacts resulting from the development and operation of wind energy facilities on four species that are federally listed or that are candidates for Federal listing (whooping crane, interior least tern, piping plover, and lesser prairie-chicken). The GPWE HCP covers a 200-mi-wide (322-km-wide) corridor across nine States (North Dakota, South Dakota, Montana, Colorado, Nebraska, Kansas, New Mexico, Oklahoma, and Texas), and includes portions of the UGP Region considered in this PEIS. The goal of the GPWE HCP is to comprehensively address potential wind energy development impacts on listed or sensitive species, contributing to more effective conservation efforts and reducing the burden of permit processing on the Service and wind energy developers. When completed, the GPWE HCP may identify appropriate BMPs and mitigation measures, in addition to those identified in this PEIS that could avoid or reduce impacts from wind energy development on listed species. As an adaptive management measure, it is the intent of this PEIS to adopt most or all of the BMPs and mitigation measures from the GPWE HCP when it is finalized for any subsequent wind development occurring under this PEIS. This will serve the dual purpose of having one consistent set of guidelines for the four species of concern (three of which are in the UGP Region) and will also incorporate the most recent and studied measures into future activities conducted under this PEIS.

6.3.1.7 Visual Resources

The cumulative impacts of past, present, and future actions on viewsheds within the UGP Region result from activities associated with urbanization, industrial activity (e.g., oil and gas development and production, and mining), recreational activity (e.g., ATV use), and traffic. Long-term impacts include decreased visibility (e.g., light pollution), increased contrast with the surrounding landscape, and degradation of the visual quality of the landscape. The contribution of the construction and operation of wind energy projects under the preferred alternative to these impacts could be high, especially in areas without existing energy facilities or transmission line ROWs. Adverse impacts would be greatest in landscapes with low visual absorption capability (the degree to which the landscape can absorb visual impacts without serious degradation in perceived scenic quality) such as in areas with low vegetative diversity and a lack of screening vegetation and structures. Such impacts would be project- and region-specific and would depend on the precise location, size, and configuration of future projects, as well as their proximity to scenic resource areas (e.g., National Parks) and the sensitivity of local stakeholders to their appearance.

Under the preferred alternative, adverse impacts would be avoided as a result of decisions made during the siting and design of wind energy projects, on the basis of an assessment of visual resources (among other considerations) and consultation with appropriate land management agencies, planning entities, and the local public. As a result, the contributions of wind energy development to cumulative impacts on visual resources would be small.

6.3.1.8 Paleontological Resources

The cumulative impacts of past, present, and future actions on paleontological resources within projects sites and transmission line ROWs (and adjacent lands) in the UGP Region (the defined ROI for paleontological resources) would result from the increased accessibility that may accelerate erosional processes over time and expose fossils, leaving them vulnerable to theft and vandalism. Conversely, a beneficial effect is that fossil discovery could increase knowledge about historical geology and enhance protection of paleontological resources in the region. Ground-disturbing activities associated with site clearing, construction of the wind turbines, transmission systems, and related infrastructure, and increased accessibility to project sites could damage or destroy fossil remains and disrupt the contexts in which they are found. The contribution of future wind energy projects to adverse cumulative impacts on paleontological resources within future project sites would depend in part on the level of prior land disturbance (i.e., impacts would be lower for project activities in cultivated cropland, and higher in previously undisturbed areas).

Adverse impacts on paleontological resources under the preferred alternative (Alternative 1) would be minimized by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include paleontological surveys in areas with high potential for significant fossil finds so that significant fossils (if present) could be identified and removed prior to initiating project activities. As a result, the contributions of wind energy development to cumulative impacts on paleontological resources within and adjacent to project sites would be small.

6.3.1.9 Cultural Resources

The cumulative impacts of past, present, and future actions on cultural resources within projects sites and transmission line ROWs (and adjacent lands) in the UGP Region (the defined ROI for cultural resources) would result from the potential for damage or destruction of artifacts and their context and increased pedestrian and vehicular traffic, which may increase accessibility to artifacts and areas of significance to Native Americans (e.g., sacred landscapes) and accelerate erosional processes over time. The contribution of future wind energy projects to adverse cumulative impacts on cultural resources within future project sites would depend in part on the level of prior land disturbance (i.e., impacts would be lower for project activities in cultivated cropland, and higher in previously undisturbed areas).

Adverse impacts on cultural resources under the preferred alternative (Alternative 1) would be minimized by following mitigation measures and BMPs, such as those proposed in this PEIS. These would include consultation with federally recognized Native American governments and the SHPO, as well as records searches of recorded sites and properties in the project area, and/or an archaeological survey. As a result, the contributions of wind energy development to cumulative impacts on cultural resources within and adjacent to project sites would be small.

6.3.1.10 Socioeconomics

Cumulative socioeconomics impacts of past, present, and future actions result from changes in employment opportunities and income, expenditures for goods and services, and tax revenues associated with various types of commercial, industrial, and recreational activities that are taking place in the UGP Region. These impacts are generally considered beneficial to local communities, counties, and States. Wind energy development under the preferred alternative would contribute to these beneficial impacts, with the exception of its possible adverse impact on adjacent property values. While most studies to date have found that values of adjacent properties increase as a result of wind energy development designations (section 5.10.1.3), it is likely too early in the development history to declare with certainty what the actual impacts on property values would be. In addition, such impacts could result from project- and region-specific factors that are currently undetermined (e.g., local perceptions of wind turbines). Impacts on property values may also accompany the construction of related infrastructure (e.g., transmission lines); these impacts could be adverse or beneficial, depending on the project.

6.3.1.11 Environmental Justice

The cumulative environmental justice impacts of past, present, and future actions would encompass any (and all) impacts that could be disproportionately high and adverse on minority or low-income populations, but most often result from construction noise and dust generation, noise (corona discharge) and EMF effects (typically from transmission lines), degradation of scenic quality, restriction of subsistence activities, land use conflicts, and loss of property value. Because such impacts are location-dependent, they can only be addressed qualitatively in this analysis; therefore, a more detailed analysis should be part of the project-level environmental assessment.

Wind energy development would not cause significant impacts as a result of construction noise and dust generation because these effects are localized and short in duration and are, therefore, considered small. However, impacts associated with noise and EMF effects, degradation of scenic quality, restriction of subsistence activities, land use conflicts, and loss of property value could occur, depending on project- and region-specific factors that are currently undetermined (e.g., the magnitude of project impacts, if any, and the project's proximity to minority or low-income populations, if any). Under the preferred alternative, impacts would be avoided during the siting and design phase based on an assessment of minority and low-income populations to be conducted as part of the project-level NEPA review. It should be noted that because the development of wind energy does not depend on permitting facilities on easement land (and could therefore occur on private land) disproportionate impacts to minority and low-income populations could still occur, but would be lessened, under the preferred alternative.

6.3.2 Summary of Cumulative Impacts under the Preferred Alternative (Alternative 1)

The greatest contributions to cumulative impacts to resources in the UGP Region States are expected to stem from increasing population growth and land development (commercial, industrial, agricultural, and residential). Population growth and land development increase the demand for energy and water, and would create environmental stressors that affect ecological resources on private, State, and Federal lands. Development also affects the visual landscape, with decreased visibility (due to light and air pollution) and degradation of visual quality, among the most important impacting factors.

While the programs described in this PEIS are administrative actions that would not contribute directly to cumulative impacts, wind energy development within highly suitable areas in combination with past, present, and reasonably foreseeable future actions could affect all resources in the UGP Region to some degree. Over the long term, the most significant potential impacts would be to ecological and visual resources. Adverse incremental impacts on soil resources and air quality, and those resulting from noise due to project construction activities would be localized and short in duration (for the construction period) and, therefore, would not be likely to contribute significantly to cumulative impacts in the region. Impacts on cultural and paleontological resources and on minority or low-income populations are dependent on location and, therefore, are undetermined at this time; these resources would be evaluated as part of a project-specific environmental review. Incremental impacts considered beneficial to the region include those associated with socioeconomic resources (jobs, incomes, and tax revenues), water resources (negligible water use relative to other power producing technologies), and air quality (negligible emissions relative to other power-producing technologies).

A summary of cumulative impacts for each resource area under the preferred alternative (Alternative 1) is provided in table 6.3-2, based on an analysis of the incremental contribution of wind energy projects to cumulative impacts, described in section 6.3, in combination with the past, present, and future actions and trends, described in section 6.2. The incremental impacts of wind energy projects under the preferred alternative (Alternative 1) are reduced to “small” for most resources because the wind energy development program under Alternative 1 would use a standardized structured process to evaluate environmental impacts associated with interconnection and easement exchange requests, and would require implementation of programmatic mitigation measures, BMPs, and monitoring (including programmatic ESA Section 7 consultations) to minimize or avoid impacts to resources and ensure that the conservation objectives of Service easements are maintained.

6.3.3 Comparison of Cumulative Impacts under the Preferred Alternative (Alternative 1) and Other Alternatives

It is assumed that the level of wind energy development within the UGP Region under all of the alternatives, including the amount of land disturbance and the areas that would be developed for wind energy projects, would be similar to those identified for the No Action Alternative. Because it employs a standardized structured process to evaluate environmental impacts associated with wind energy projects interconnecting to Western’s transmission facilities or building on Service easements (on wetlands and grasslands), the preferred alternative (Alternative 1) would likely be the most protective of resources in the UGP Region. This would be especially true for ecological resources, where it is anticipated that implementation of the risk-based evaluation method (see section 2.3.2) would improve the identification of ecological resources that could be affected and would improve the ability to identify and implement appropriate BMPs and mitigation measures to protect those resources. Under Alternative 2, Western would employ the same approach as Alternative 1, but the Service would not allow easement exchanges to accommodate wind energy development. While this means that potential impacts on the various resources within Service easements would be reduced, it is likely that the small number of wind energy projects that would otherwise have chosen to build on easements would instead be located on private lands. Therefore, under Alternative 2, there would be less environmental evaluation and fewer requirements to implement mitigation measures, BMPs, and resource monitoring for such projects. Given the small number of wind energy projects affected, however, the difference in the incremental contribution of wind energy development under Alternatives 1 and 2 to cumulative impacts in the UGP Region is anticipated to be small.

Under Alternative 3, Western would require separate project-specific NEPA evaluations for each interconnection request and the Service would process and evaluate requests for easement exchanges on a case-by-case basis. However, no additional mitigation measures, BMPs, or monitoring would be required by either Western or the Service other than those mandated under applicable Federal, State, and local regulations. For this reason, wind energy development under Alternative 3 could result in a larger incremental contribution to cumulative impacts on some resources (e.g., birds and bats) as compared to the No Action Alternative and Alternatives 1 and 2, especially for projects located in less regulated jurisdictions.

TABLE 6.3-2 Summary of Anticipated Cumulative Impacts in the UGP Region and Contributions from the Preferred Alternative (Alternative 1) by Resource Area

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Preferred Alternative (Alternative 1)
Land Cover and Land Use	6.3.1.1	Cumulative impacts in the UGP Region States result from the continued development of non-Federal land and the increase of commercial, industrial, and recreational use of Federal lands. Such impacts in the UGP Region are currently considered to be minor.	Future wind energy projects could affect land use on lands classified as being highly suitable for utility scale wind energy development, especially those lands located within 25 mi (40 km) of Western's transmission and substation facilities. Wind energy development is generally compatible with many land uses, including agriculture and livestock grazing. Under Alternative 1, developers would use a standardized structured process to design and site their projects in more suitable and less sensitive areas, thus avoiding or minimizing potential impacts on land cover and land uses. The contributions of wind energy projects on cumulative land-related impacts, therefore, are expected to be small.
Soil Resources	6.3.1.2	Cumulative impacts result mainly from ground-disturbing activities associated with the construction of wind towers and related infrastructure on project sites and transmission line ROWs (and adjacent lands). Adverse impacts relate to the increased potential for erosion, compaction, surface runoff, sedimentation, and soil contamination. These impacts, in turn, could contribute to adverse impacts on other resources such as air, water, vegetation, and wildlife. Depending on the location, other activities such as farming or grazing may also contribute to cumulative impacts in project areas (if collocated), but overall, cumulative impacts to soil resources in the ROI are expected to be minor.	Because adverse soil impacts are associated mainly with project construction and would be localized and short in duration, their contribution to cumulative impacts is considered to be small. Implementing the mitigation measures and BMPs required under Alternative 1 would further minimize these contributions.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Water Resources	6.3.1.3	Cumulative impacts on nearby surface water bodies and shallow groundwater aquifers result from water use, water quality degradation, and changes in natural flow systems in the vicinity of the proposed action. Depending on the location, other activities (e.g., municipal, industrial, or agricultural) may also contribute to cumulative impacts in project areas. The magnitude of these impacts is location-dependent and currently undetermined.	Because adverse impacts on surface water and groundwater are associated mainly with project construction and would be localized and short in duration, their contribution to cumulative impacts is considered to be small. Implementing the mitigation measures and BMPs required under Alternative 1 would further minimize these contributions. An important beneficial effect of wind energy development in general is its negligible operational water usage relative to other power-generating technologies.
Air Quality	6.3.1.4	The cumulative impacts on airsheds within the UGP Region relate to increases in pollutant loads associated with industrial activity (e.g., oil and gas development and production, mining, and increased traffic). The increased development of renewable energy (including wind energy) in the region over the next 20 yr is expected to offset these impacts. Most emissions associated with the proposed action are attributed to construction activities that could release small amounts of criteria pollutants, VOCs, GHGs, and HAPs from fugitive dust, engine exhaust, and vehicular traffic. Operating wind turbines and transmission lines would generate no direct emissions, but maintenance activities would release small amounts of engine exhaust and generate fugitive dust.	The contribution of the wind energy projects to ambient air quality impacts could vary from project to project, but is expected to be small. If wind energy projects displace other types of facilities (e.g., fossil fuel power plants) that generate criteria pollutant, GHG, and HAP emissions, they could have a major overall beneficial impact on the local and regional ambient air quality. To the extent that increased wind development would reduce the need to develop additional fossil fuel plants, it contributes to maintaining present air quality. If wind and other renewable energy sources (and/or conservation) are increased to the point that it allows fossil fuel sources to be taken offline, it will help to improve air quality.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Acoustic Environment	6.3.1.5	Cumulative impacts on residential areas and sensitive wildlife near project sites and transmission line ROWs due to noise would result mainly from activities associated with wind energy projects, although depending on the location other commercial, agricultural, industrial, or recreational activities may also contribute. Noise impacts during construction could be high but would be localized and short in duration. Over the long term, contributions to adverse cumulative impacts resulting from noise would be associated with the project operations phase (e.g., mechanical and aerodynamic noise from wind turbines).	Most long-term effects associated with the project operations phase would be localized; some would be intermittent or infrequent. Adverse impacts due to noise would be minimized by following mitigation measures and BMPs required under Alternative 1, including positioning noise sources to take advantage of topography and the distance to sensitive receptors, and selecting equipment with the lowest noise levels. The contribution of wind energy development to cumulative impacts, therefore, would be small.
Ecological Resources			
Vegetation	6.3.1.6	The cumulative impacts on upland and wetland plant communities within the project site and transmission line ROWs (and adjacent lands) would result mainly from construction and operation activities associated with wind energy projects. Adverse impacts include direct injury or mortality of vegetation; habitat reduction or degradation (and native habitat fragmentation); damage to plants that increases water loss and decreases CO_2 uptake; exposure to contaminants that affect plant survival, reproduction, development, or growth; and establishment of invasive species.	The contribution of wind energy projects to adverse cumulative impacts would depend in part on the level of prior land disturbance (i.e., impacts would be lower in previously disturbed or fragmented habitats than in undisturbed habitats of high quality). Increased site accessibility would increase the risk of invasive species growth and fires. Adverse impacts on vegetation would be minimized by following mitigation measures and BMPs required under Alternative 1. These would include avoiding contiguous grassland to the extent possible, and initiating habitat restoration activities as soon as possible after construction activities and prohibiting foot and vehicle traffic through undisturbed areas (to reduce habitat disturbance). For long-term disturbance such as access roads and turbine pads, habitat may not be easily restorable. The full impacts will depend on how much important habitat (e.g., native grasslands, prairies) is disturbed or fragmented and to what extent such loss is mitigated.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Ecological Resources (Cont.)			
Wildlife	6.3.1.6	Cumulative impacts would result mainly from the activities associated with increased commercial, industrial, agricultural (especially grassland conversion), and residential development across the UGP Region States. Adverse impacts include direct injury and mortality, habitat disturbance or loss (fragmentation), interference with behavioral activities, and increased risk of toxic release or fugitive dust exposures. Increased site accessibility increases the risk of invasive species growth, fire, and legal and illegal take of wildlife.	The contribution of wind energy projects to adverse cumulative impacts on wildlife would depend in part on the location, size, and configuration of the project (e.g., number and heights of turbines), and the affected species present. Adverse impacts on wildlife would be minimized by following mitigation measures and BMPs required under Alternative 1. These would include following the evaluation process consistent with the *Land-based Wind Energy Guidelines* during wind energy development to identify affected resources and modify project design accordingly, and conducting agency consultation to address federally listed species and designated critical habitat. As a result, the contributions of wind energy development to cumulative impacts on wildlife would be small.
Aquatic Biota and Habitats	6.3.1.6	The cumulative impacts would result from the activities associated with increased commercial, agricultural, industrial, and residential development across the UGP Region States. Adverse impacts include direct injury and mortality (and disturbance), habitat destruction or degradation, interference with movement to seasonal habitats, and increased risk of toxic release exposure. Increased site accessibility increases the risk of disturbance or loss of aquatic biota, non-native fish introduction, and legal and illegal take of aquatic biota, especially game fish. Increases in water temperature and degradation of water quality from increased turbidity and sedimentation would also contribute to adverse impacts over the long term.	The contribution of wind energy projects to adverse cumulative impacts would depend in part on the location of the project relative to water, the number and types of water bodies disturbed, the nature of the disturbance, and the species present. Adverse impacts on aquatic biota and habitats would be minimized by following mitigation measures and BMPs required under Alternative 1. These would include following the evaluation process consistent with the *Land-based Wind Energy Guidelines* during wind energy development to identify affected resources and modify project design accordingly, and conducting agency consultation to address federally listed species and designated critical habitat. As a result, the contributions of wind energy development to cumulative impacts on aquatic biota and habitats would be small.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Ecological Resources (Cont.)			
Threatened, Endangered, and Special Status Species	6.3.1.6	The cumulative impacts would result from the activities associated with increased commercial, agricultural, industrial, and residential development across the UGP Region States. Adverse impacts are the same as those described for plant communities and habitats, wildlife, and aquatic biota and habitats. However, their low populations make these species more vulnerable to the effects of habitat fragmentation and alteration, human disturbance and harassment, individual mortality, and the loss of genetic diversity.	The contribution of wind energy projects to adverse cumulative impacts would depend in part on the details of project development, their location relative to species populations, and the species present. Adverse impacts on threatened, endangered, and special status species would be minimized by following mitigation measures and BMPs required under Alternative 1. Project proponents are advised to contact the local Service Field Office very early in the siting process to identify potential listed species in the area and what avoidance and minimization measures might be necessary. As a result, the incremental contributions of wind energy development to cumulative impacts on threatened, endangered, and special status species would be manageable. Cumulative impacts on listed species will be less for Alternative 1 than for the other alternatives.
Visual Resources	6.3.1.7	Cumulative impacts on viewsheds within the UGP Region result from activities associated with urbanization, industrial activity, recreational activity, and traffic. Long-term impacts include decreased visibility (e.g., light pollution), increased contrast with the surrounding landscape, and degradation of the visual quality of the landscape. Adverse impacts would be greatest in landscapes with low visual absorption capability (the degree to which the landscape can absorb visual impacts without serious degradation in perceived scenic quality) such as areas with low vegetative diversity and a lack of screening vegetation and structures.	The contribution of projects to adverse cumulative impacts could be high, especially in areas without existing energy facilities or transmission line ROWs. Such impacts are project- and region-specific and would depend on the precise location, size, and configuration of future projects, as well as their proximity to scenic resource areas (e.g., National Parks) and the sensitivity of local stakeholders to their appearance. Under Alternative 1, impacts would be avoided during the siting and design phase based on an assessment of visual resources and consultation with appropriate land managers, planning entities, and the local public. The contributions of wind energy projects to cumulative impacts, therefore, would be small.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Paleontological Resources	6.3.1.8	Cumulative impacts result from the increased accessibility to project sites and transmission line ROWs (and adjacent lands) that may accelerate erosional processes over time and expose fossils, leaving them vulnerable to theft and vandalism. Ground-disturbing activities could damage or destroy fossil remains and disrupt the contexts in which they are found. A beneficial effect is that fossil discovery could increase knowledge about historical geology and enhance protection of paleontological resources in the region.	The magnitude of impacts would depend in part on the level of prior land disturbance (i.e., impacts would be higher in previously undisturbed areas). Adverse impacts on paleontological resources would be minimized by following mitigation measures and BMPs required under Alternative 1, including paleontological surveys in areas with high potential for significant fossil finds. The contributions of wind energy projects to cumulative impacts, therefore, would be small.
Cultural Resources	6.3.1.9	Cumulative impacts result from the potential for damage or destruction of artifacts and their context and increased pedestrian and vehicular traffic on project sites and transmission line ROWs (and adjacent lands), which may increase accessibility to artifacts and areas of significance to Native Americans (e.g., sacred landscapes) and accelerate erosional processes over time.	The magnitude of impacts would depend in part on the level of prior land disturbance (i.e., impacts would be higher in previously undisturbed areas). Adverse impacts on cultural resources would be minimized by following mitigation measures and BMPs required under Alternative 1, including consultation with Native American governments and SHPOs and conducting archaeological surveys, as appropriate. The contributions of wind energy projects to cumulative impacts, therefore, would be small.
Socioeconomics	6.3.1.10	Increased employment opportunities and income, expenditures for goods and services, and tax revenues associated with various types of commercial, industrial, and recreational activities that are on the rise in the UGP Region. Generally considered beneficial to local communities, counties, and States.	Wind energy projects under Alternative 1 would contribute to beneficial impacts on employment, income, and tax revenues in the region. Impacts on property values could be adverse or beneficial, and would likely be project-specific.

TABLE 6.3-2 (Cont.)

Resource Area	Section in PEIS	Anticipated Trends and Cumulative Impacts	Contributions from Proposed Action
Environmental Justice	6.3.1.11	Cumulative environmental justice impacts encompass any (and all) impacts that could be disproportionately adverse to minority or low-income populations, but most often relate to construction noise and dust generation, noise (corona discharge) and EMF effects, degradation of scenic quality, restriction of subsistence activities, land use conflicts, and loss of property value (resulting from development on public or private land). Because such impacts are location dependent, a more detailed analysis should be part of the project-level environmental assessment.	Wind energy projects would not cause significant impacts as a result of construction noise and dust generation because these effects are localized and short in duration. However, other impacts (such as those associated with restriction of subsistence activities or land use conflicts) could occur, depending on project- and region-specific factors that are currently undetermined (e.g., the magnitude of project impacts, if any, and the project's proximity to minority or low-income populations, if any). Under Alternative 1, impacts would be avoided during the siting and design phase based on an assessment of minority and low-income populations conducted as part of the project-level NEPA review. The contributions of wind energy projects to cumulative impacts, therefore, would be small.

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7 ANALYSIS OF THE PROPOSED ACTION AND ITS ALTERNATIVES

Through this PEIS, Western and the Service are evaluating the proposed action to implement a standardized process for evaluating environmental impacts of wind energy development projects in the UGP Region seeking interconnection of wind energy facilities to Western's transmission systems or requesting easement exchanges in order to accommodate placement of wind energy facilities on Service easements. Under the No Action Alternative (section 2.3.1), Western and the Service would not implement a programmatic approach for conducting environmental evaluations of wind energy projects and would, instead, continue to evaluate requests for interconnections (Western) and requests for accommodating placement of facilities on Service easements through exchanges on a separate project-by-project basis, following existing procedures. BMPs and mitigation measures would be identified on a project-by-project basis during project-specific environmental reviews under the No Action Alternative.

Alternative 1, identified by Western and the Service as the preferred alternative, is described in section 2.3.2. Under this alternative, the agencies would establish standardized procedures for evaluating the potential environmental effects of wind energy projects that request interconnection to Western's transmission facilities or seek accommodation of wind energy facilities on Service easements. Alternative 1 would also identify standardized BMPs and mitigation measures to be applied by developers where specific resource conditions occur. If a developer does not wish to implement the evaluation process, BMPs, or mitigation measures identified for this alternative, a separate NEPA evaluation of the interconnection request that does not tier off the analyses in the PEIS would be required and project-specific BMPs and mitigation measures would be developed on the basis of the environmental evaluation.

Alternative 2 is described in section 2.3.3. Under Alternative 2, Western would proceed with establishment of programmatic wind energy environmental evaluation process relative to interconnection of wind energy facilities to Western's transmission systems in the UGP Region, while the Service would discontinue the current policy of considering placement of wind energy facilities on easements through easement exchange. Western would establish the same standardized procedures for evaluating the potential environmental effects of wind energy projects and the same standardized BMPs and mitigation measures for interconnection requests as identified for Alternative 1. Project-specific NEPA evaluations would be required by Western for interconnection requests, but those NEPA evaluations would tier off of the analyses in this PEIS as long as the project developer was willing to implement the BMPs and mitigation measures identified for the alternative. If a developer does not wish to implement the evaluation process, BMPs, or mitigation measures identified for this alternative, a separate NEPA evaluation of the interconnection request that does not tier off the analyses in the PEIS would be required, and project-specific BMPs and mitigation measures would be developed on the basis of the environmental evaluation.

Under Alternative 3, Western would continue to require individual NEPA analyses for interconnection of wind energy facilities to Western's transmission systems in the UGP Region and the Service would continue to evaluate and consider easement exchanges for wind energy development. However, rather than applying the standardized BMPs and mitigation measures identified in Alternative 1, the agencies would impose no BMPs or mitigation measures beyond those that would be required by existing Federal, State, and local policies and regulations.

Chapter 5 presents an evaluation of the potential environmental impacts of wind energy development within the UGP Region under the potential development scenario for each of the alternatives, and discusses BMPs and mitigation measures to avoid, minimize, and mitigate those environmental impacts. Chapter 6 identifies the potential cumulative environmental impacts of wind energy development under the potential development scenario. In this chapter, the different alternatives for implementing the proposed action are evaluated for their effectiveness at limiting potential impacts, and for how well each alternative would support or facilitate wind energy development within the UGP Region. Thus, this chapter evaluates whether the preferred alternative presents the best management approach for Western and the Service to adopt relative to the decisions the two agencies must make concerning wind energy development.

Sections 7.1 through 7.4 discuss the potential impacts of each of the management alternatives being evaluated. Section 7.5 discusses other NEPA considerations related to the proposed action, including unavoidable adverse impacts, short-term uses of the environment and long-term productivity, irreversible and irretrievable commitment of resources, and mitigation of adverse impacts.

7.1 IMPACTS OF THE NO ACTION ALTERNATIVE

As described in section 2.3, Western and the Service would not establish programmatic environmental evaluation procedures for wind energy development projects under the No Action Alternative. Instead, the agencies would evaluate environmental effects of wind energy projects requesting interconnections (Western) and requests for easement exchanges (the Service) on a project-by-project basis, following existing procedures. Programmatic BMPs and mitigation measures would not be established under the No Action Alternative. Thus, future wind energy projects would continue to be evaluated solely on an individual, case-by-case basis, and there would be no programmatic process for environmental reviews.

The potential wind energy development scenarios described in section 2.4 are assumed to represent the bounds of development scenarios that would occur under the No Action Alternative and to define the extent and distribution of lands within the UGP Region that would potentially be subject to wind energy development by 2030. An assessment of the potential effects of the No Action Alternative on the pace of development, the environment, and the economy is described in the following sections.

7.1.1 Pace of Wind Energy Development in the UGP Region

The absence of a standardized environmental process for wind energy projects would likely cause interconnection of wind energy developments to Western's transmission system and evaluations and approvals for easement exchanges to accommodate wind energy facilities on Service easements to occur at a slower pace than under the proposed action. The anticipated benefits of the proposed programmatic wind energy evaluation procedures (section 2.3), in terms of tiered NEPA analyses and the identification of programmatic BMPs and mitigation measures to be implemented, would not be realized under the No Action Alternative. Without these elements, the length of time needed to review, process, and approve requests for interconnection of wind energy projects and to make decisions regarding accommodation of wind energy facilities on easement lands would be expected to be greater.

Extended timelines for application and approval processes usually translate into increased costs for developers, and the cost per unit of wind energy developed would likely be greater under the No Action Alternative than under the various alternatives for implementing the proposed action. This could result in delays in establishing necessary project financing and power market contracts. Furthermore, developers could elect to avoid delay and uncertainty by shifting interconnection requests for their projects to privately owned transmission systems or to State, tribal, and private land with potentially less Federal environmental oversight. If this resulted in less development of wind energy, this alternative would be less suitable for meeting the intent of the Energy Policy Act of 2005 (EPAct) and other policies and initiatives that encourage Federal departments and agencies to consider and to facilitate the development of renewable energy and electric power transmission. Such an outcome would also be less effective at meeting the requirements of Executive Order 13212, which ordered that executive departments and agencies take appropriate actions to expedite projects that will increase the production, transmission, or conservation of energy.

7.1.2 Environmental Impacts

The potential adverse impacts on natural and cultural resources associated with the No Action Alternative could be greater than those described in chapter 5 for Alternatives 1 and 2 if effective BMPs and mitigation measures are not applied to individual projects. In all likelihood, however, effective measures would be developed for individual wind energy projects by virtue of the environmental analyses required by Western and the Service. In that event, potential adverse impacts on natural and cultural resources under the No Action Alternative would be similar to those for Alternatives 1 and 2. The absence of a standardized programmatic process for environmental reviews of wind energy projects, however, could result in inconsistencies in the types of BMPs and mitigation measures required for individual projects.

Under the No Action Alternative, current policies and procedures used by the Service regarding easement exchanges to accommodate wind energy facilities on easement lands would continue (section 2.1.2). Overall, it is anticipated that the potential benefits of considering requests for easement exchanges would provide the same overall benefits to conservation efforts under the No Action Alternative as under Alternative 1 (see section 7.2.2).

Although it is beyond the scope of the jurisdiction or responsibility of Western or the Service, it is important to note that potential adverse impacts on natural and cultural resources on non-Federal lands could be greater under the No Action Alternative than under Alternatives 1 or 2. If the absence of standardized wind energy evaluation procedures delayed the processing of interconnection requests for wind energy projects by Western or easement exchanges on Service-administered easements or resulted in increases in the cost of developing wind power, developers could respond by focusing their wind energy development efforts on privately owned transmission systems or on State-owned, tribal, and private lands. While wind energy development not requiring interconnection to federally owned transmission systems or on non-Federal lands is subject to a wide array of environmental reviews and approvals by virtue of State and local permitting processes, such development may not be subject to NEPA requirements for environmental evaluations if Federal actions or funding are not required for the project to proceed.

7.1.3 Economic Impacts

Because it is difficult to estimate the degree to which the absence of the proposed programmatic environmental review process for wind energy development would affect the pace and amount of development, it is difficult to estimate the extent to which economic impacts under the No Action Alternative would vary from those estimated for the proposed action alternatives (section 5.10). While the economic impact of specific projects would likely be similar regardless of whether a programmatic review process is in place or not, uncertainties surrounding the time required for approvals and the consequent impact on project cost could delay the development of any given project. The consequent postponement of the various economic (employment, income, and output) and fiscal (taxes and ROW rental receipts) benefits of specific projects could affect economic development of the region.

Although it can be assumed that there would be an increased demand for wind energy as wind generation technology becomes more economically viable, it is difficult to predict where this development would occur. There is the potential for wind energy development to shift to non-Federal lands, as discussed in section 7.1.1, but it is also possible that economic factors would stifle development elsewhere. For example, sites on non-Federal land within the UGP Region may not necessarily be chosen for development if wind availability at these sites is inferior to that of sites on Federal land, and if higher land costs undermine the economic viability of wind energy development. Whether the focus for wind energy development would shift to potential locations outside the UGP Region is unknown, although the suitability of the wind resource and availability of lands with high development potential suggest that the UGP Region will remain important for wind energy development. Given the remote location of much of the federally administered land and the rural nature of surrounding communities, it is likely that the economic development prospects of communities located near potential wind development projects would be poorer than elsewhere in the UGP Region. The absence or reduction of wind energy development could represent a lost economic development opportunity for rural communities.

7.2 IMPACTS OF ALTERNATIVE 1

As discussed in section 2.3.2, under Alternative 1 Western would adopt a standardized, structured process for collecting information and evaluating and reviewing the environmental impacts, and would establish programmatic BMPs and mitigation measures to minimize the environmental impacts from projects requesting interconnection with Western's transmission facilities in the UGP Region. Under this alternative, the Service would adopt a similar process for evaluating and addressing the impacts associated with projects requesting easement exchanges in order to accommodate placement of wind energy facilities on Service easements. The extent of wind energy development expected within the UGP Region is defined by the potential development scenarios (section 2.4) and is expected to be the same under all the alternatives (including the No Action Alternative).

Chapter 5 presents an analysis of the potential environmental impacts associated with wind energy development under Alternative 1. It also presents relevant BMPs and mitigation measures to avoid and reduce those impacts. Western and the Service reviewed the impact analysis and mitigation measures to identify appropriate programmatic evaluation procedures, BMPs, and mitigation measures to be applied to wind energy development projects requesting interconnections to Western's transmission systems or easement exchanges to accommodate placement of facilities on easements managed by the Service within the UGP Region. The identified programmatic BMPs and mitigation measures would be applied to all projects, as appropriate, to address site-specific conditions and concerns for each of the resources evaluated in chapter 5. The programmatic evaluation review process identified for Alternative 1 in section 2.3.2 would be used to identify the project-specific environmental issues that would need to be addressed and to identify which of the programmatic BMPs and mitigation measures would be required. In addition, the evaluation would be used to identify significant environmental impacts that would not be adequately addressed by the programmatic BMPs and mitigation measures and would guide identification of additional measures that would be needed. Thus, site-specific and species-specific issues would be addressed at the project level to ensure that potential impacts of a wind developer's project would be minimized. Project-specific mitigation measures would be incorporated into plans of development and would be identified in site-specific NEPA documents that tier from the PEIS.

Impacts on the pace of wind energy development, the environment, and the economy are discussed below for the case in which Alternative 1 would be used to implement the proposed action.

7.2.1 Pace of Wind Energy Development in the UGP Region

Implementation of the proposed wind energy development process, including the establishment of programmatic procedures, BMPs, and mitigation measures, would be expected to minimize some of the delays that currently occur for wind energy development projects and reduce costs by reducing the amount of time needed to complete environmental reviews. Some other factors that can affect the pace and cost of wind energy development within the region are largely beyond the influence or control of Western or the Service and would not be affected by implementation of the proposed programmatic approach; these include (1) the presence, absence, or structure of national production tax credits and national and State renewable portfolio standards; (2) access to and the cost of electricity transmission; (3) the cost of other fuels for electricity supply, including natural gas and coal; and (4) public support or opposition to wind power development. Implementation of Alternative 1 would promote efficiency and consistency in the environmental evaluation of wind project interconnection requests by Western and in the way environmental evaluations of easement exchanges for accommodation of wind energy facilities on easements managed by the Service are reviewed and resolved.

The programmatic evaluations alone would not eliminate the need for detailed analyses at the project level; they would, however, bring focus to the efforts. Decisions regarding what actions must be undertaken at the project level to address concerns for some resources cannot be resolved until specific information regarding the location and design of a proposed project is known. Identification of the appropriate BMPs and mitigation measures would be guided by the programmatic risk-based evaluation process identified for Alternative 1; those measures would then be incorporated into project-specific development plans. To the extent practicable, the environmental issues that must be evaluated in detail at the project level would be reduced to site-specific and species-specific issues and concerns that cannot be effectively dealt with in a standardized manner. The PEIS provides a general guide for developers regarding the impacts proposed projects might have on environmental resources and the BMPs and mitigation measures expected to be implemented to avoid and minimize those impacts. This would be helpful to developers in their planning and designing of projects to avoid or minimize environmental impacts up front, thus greatly reducing the need for mitigation.

Under Alternative 1, the time necessary to obtain approval of interconnection requests and easement exchanges could be reduced compared to the No Action Alternative, along with the associated costs to both the Agencies and industry, without compromising the level of protection to natural and cultural resources. To the extent that decisions about future wind energy projects could be tiered off of the analyses in this PEIS or decisions in the resultant record of decision, there could be additional time and cost savings. Compared to the No Action Alternative, Alternative 1 would facilitate wind energy development in the UGP Region and reduce the agencies' workloads for processing requests from developers and completing NEPA evaluations, while ensuring that the adverse environmental, sociocultural, and economic impacts would be minimized.

7.2.2 Environmental Impacts

Alternative 1 would establish programmatic evaluation procedures, BMPs, and mitigation measures for projects. The proposed process includes requirements for public involvement, consultation with Federal, State, and local agencies, and government-to-government consultation with tribes; defines the need for project-level environmental review; and establishes requirements for the scope and content of project development plans. The proposed BMPs and mitigation measures would establish environmentally sound and economically feasible mechanisms for avoiding and protecting natural and cultural resources. Processes are identified for establishing the issues and concerns that must be addressed by project-specific plans during each phase of development. Specifically, the proposed BMPs and mitigation measures would address issues associated with land use, project location, sensitive or critical habitats, habitat fragmentation, threatened and endangered and other protected species, avian and bat impacts, habitat restoration, visual resources, road construction and maintenance, transportation planning and traffic management, air emissions, noise, noxious weeds, pesticide use, cultural and paleontological resources, hazardous materials and waste management, erosion control, and human health and safety.

The Service considers the easement program to be a crucial tool in conserving native grassland habitat in the UGP Region, where conversion of grasslands to agriculture and other uses continues at a rapid rate. Although existing easement properties could be protected from impacts by not allowing wind energy development to occur on easements, there is a possibility that achievement of habitat conservation goals could be hampered by outright exclusion of wind energy development on easements if such a policy diminishes the ability to continue to secure easements from landowners in the future. The proposed action would keep the potential for limited wind energy development on Service easements the same as under the No Action Alternative, while implementing requirements to steer wind energy development away from sensitive habitats; would require implementation of BMPs and mitigation measures to reduce impacts on remaining areas to negligible or minor levels; and would secure compensatory easement areas to offset habitat losses from facility placement. The amount of easement land that would require exchange to accommodate facilities under Alternative 1 would probably be small. If it is assumed that the level of accommodation of wind energy facilities on Service easements would be similar to the average level that occurred from 2002 to 2012, it is estimated that between 2012 and 2030 accommodation would be made for eight wind energy projects, which would occur on parts of 31 different easement tracts, and the total area of direct impacts from placement of facilities that would require easement exchanges would be approximately 83 ac (33.6 ha) (Azure 2012). Overall, it is anticipated that implementing the proposed action in the manner described for Alternative 1 would provide a minor benefit to overall conservation efforts by helping to encourage landowners to enter into easement agreements while still allowing for wind energy development.

Implementation of the proposed programmatic environmental review procedures, BMPs, and mitigation measures would help ensure that potential adverse impacts on most of the natural and cultural resources present at wind energy development sites would be negligible to minor (potential exceptions include some species of wildlife and visual resources). This would include potential impacts on soils and geologic resources, paleontological resources, water resources, air quality, noise, land use, and cultural resources not having a visual component. The proposed environmental review procedures, BMPs, and mitigation measures would encourage designing and locating projects to avoid environmental impacts to the extent practicable, and would require incorporation of BMPs and mitigation measures for resources that would be affected into project plans. This would include the incorporation of programmatic BMPs and mitigation measures, measures contained in other existing and relevant guidance, and additional measures developed to address site-specific or species-specific concerns. Programmatic BMPs and mitigation measures summarized in section 2.3.2.2 would be required as appropriate for project-specific conditions.

Implementation of the proposed programmatic environmental evaluation process and the programmatic BMPs and mitigation measures would reduce potential impacts on wildlife by requiring that wildlife issues be addressed comprehensively, using a risk-based evaluation approach. For example, under Alternative 1, operators would be required to collect and review information regarding federally listed threatened and endangered species and designated critical habitats with a potential to occur in the vicinity of the project site and to design the project to avoid, minimize, and mitigate impacts on these resources. The specific measures needed to address many site-specific and species-specific issues, however, would be addressed at the project level. While it is possible that adverse impacts on wildlife could occur at some of the future wind energy development sites, the magnitude of potential impacts and the degree to which they could be successfully avoided or mitigated would vary from site to site.

The processes, BMPs, and mitigation measures that would be applied under Alternative 1 would also reduce potential impacts on visual resources, although the degree to which this could be achieved would be site-specific. This would include impacts on cultural resources that have a visual component (e.g., sacred landscapes). The proposed program would require that the public be involved in and informed about potential visual impacts of a specific project during the project review process. Minimum requirements regarding project design (e.g., measures such as setback distances from residences and roads, and color and lighting of turbines) would be incorporated into individual project plans. Ultimately, determinations regarding the magnitude of potential visual impacts would consider input from local stakeholders.

Under Alternative 1, Western and the Service would periodically review and revise the programmatic procedures, BMPs, and mitigation measures on the basis of new information and experiences regarding the environmental impacts of wind energy projects.

7.2.3 Economic Impacts

Implementation of the proposed action, as described for Alternative 1, would generally be expected to benefit local and regional economies, as described in Section 5.10. The projected development under the potential development scenarios described in section 2.5.1 would result in new jobs and increased income, sales tax, and income tax in each of the UGP Region States during both construction and operation. These economic benefits would be realized and increase to varying degrees in each State by the year 2030. Because the potential development scenarios are similar for all alternatives in terms of the level of development and the areas in which wind energy development is likely to occur, the impacts on the economy of the UGP Region States under all the alternatives would be similar to those under the No Action Alternative. However, as described in section 7.1.3, resolving uncertainties surrounding the amount of time required for approving interconnection requests and exchanges for placement of wind energy facilities on easement lands, and the consequent impact on project cost and development time, could affect the relative timing and magnitude of economic benefits among alternatives.

7.3 IMPACTS OF ALTERNATIVE 2

As discussed in section 2.3.3, under Alternative 2 Western would analyze typical impacts of wind energy development and would develop and identify standardized BMPs and mitigation measures for projects seeking interconnection to Western's transmission system as described for Alternative 1. However, the Service would not allow easement exchanges to accommodate placement of wind energy facilities on Service easements under Alternative 2.

7.3.1 Pace of Wind Energy Development in the UGP Region

Implementation of Alternative 2 would be expected to facilitate wind energy development in the UGP Region at a pace similar to that described in section 7.2.1 for Alternative 1.

Although cessation of the consideration of easement exchanges for accommodating wind energy facilities on Service easements could inconvenience some developers, it is anticipated that placement of wind energy facilities would shift to non-easement private lands in the same general vicinity. Because the Service would not need to consider requests for placement of wind energy facilities on easement properties, there would be reduced demand for the Service's time to evaluate such requests. Given the relatively small number of turbines and other wind energy facilities that have been placed on easement properties in the past, the impacts of such a decision on the overall pace of wind energy development within the UGP Region would be negligible.

7.3.2 Environmental Impacts

Because Western would implement the same environmental review processes, BMPs, and mitigation measures for wind energy projects requesting interconnection to Western's transmission system as for Alternative 1, the overall environmental impacts from implementation of Alternative 2 would be expected to be similar to those described in section 7.2.1.

Although existing easement properties would be protected from direct impacts of wind energy projects under Alternative 2 by not allowing wind energy development to occur on easements, it is possible that the achievement of habitat conservation goals could be hampered if such a policy diminishes the Service's ability to continue to secure easements from landowners in the future. Overall, however, it is anticipated that implementing such a policy under Alternative 2 would have a minor effect on conservation efforts by the Service in the UGP Region.

7.3.3 Economic Impacts

The potential economic impacts of Alternative 2 would be similar to those described for Alternative 1. As described in section 5.10 wind energy development in the UGP Region under the potential development scenarios would be generally beneficial to local and regional economies, resulting in new jobs and increased income, sales tax, and income tax in each of the UGP Region States during both construction and operation. These economic benefits would be realized and increase to varying degrees in each State through the year 2030.

Compared to the No Action Alternative and Alternative 1, some landowners who have entered into easement agreements with the Service could be affected by potential loss of income from an inability to alternately lease portions of those easement lands for wind energy development. However, at a regional or State scale, the number of affected leases would be small. It is estimated that portions of 31 additional easement tracts would be exchanged for accommodation of wind energy facilities by 2030 if the annual average levels were similar to those experienced from 2002 to 2012 (Azure 2012). Further, it is anticipated that the necessary wind energy development leases would be negotiated for other nearby non-easement lands. Consequently, the regional or State-level economic impacts of such foregone revenue would probably be negligible.

7.4 IMPACTS OF ALTERNATIVE 3

Under Alternative 3, Western would evaluate environmental effects of wind energy projects requesting interconnections and the Service would evaluate requests for easement exchanges in order to accommodate placement of wind energy facilities on Service easements on a project-by-project basis following existing procedures. However, unlike the No Action Alternative, no additional BMPs or mitigation measures would be requested by Western or the Service beyond those mandated under applicable Federal, State, and local regulations. In addition, easement exchanges by the Service would occur for wind energy projects as presented by developers, without consideration of additional measures to reduce impacts. Chapter 5 presents an analysis of the potential environmental impacts associated with wind energy development under Alternative 3, assuming the levels of development identified in the potential development scenario. The following sections discuss the impacts of Alternative 3 on the pace of wind energy development, the environment, and the economy.

7.4.1 Pace of Wind Energy Development in the UGP Region

The proposed approach under Alternative 3 would promote efficiency and consistency in the environmental evaluation of wind project interconnection requests by Western and in the way requests for easement exchanges to accommodate placement of wind energy facilities on easements managed by Service would be reviewed and resolved.

While not changing the need for detailed NEPA environmental analyses at the project level, decisions and debate regarding which BMPs and mitigation measures would need to be undertaken at the project level might be resolved more quickly, because BMPs and mitigation measures to be addressed in project-specific plans of development would be determined solely on the basis of existing Federal, State, and local requirements and would not require consideration of additional measures by Western or the Service. As a result, the time necessary to obtain approval of interconnection requests and requests for easement exchanges under Alternative 3 could be reduced compared to other alternatives, along with the associated costs to both the Agencies and industry.

7.4.2 Environmental Impacts

Under Alternative 3, implementation of environmental review procedures, BMPs, and mitigation measures for wind energy projects beyond those required to meet existing Federal, State, and local regulations would not be requested by Western or the Service. Easement exchanges to accommodate wind energy facilities on Service easements would continue to be considered and, if allowed, would not require consideration of additional measures to reduce potential environmental impacts.

The types of potential impacts on various environmental attributes under Alternative 3 would be similar in nature to those described for various resource areas under the No Action Alternative in chapter 5. However, the magnitude of impacts on some of those resources from wind energy projects considered for interconnection requests by Western or for accommodation of project facilities on easements by the Service could be greater under Alternative 3 than under the other alternatives. This is because some BMPs and mitigation measures are not mandated under existing regulations and would no longer be requested of developers. Although the Service’s ability to acquire additional conservation easements would probably not change under Alternative 3, its ability to protect conservation values on those easements could be reduced if fewer BMPs and mitigation measures are implemented by developers. Overall, it is anticipated that Alternative 3 would result in less environmental protection than the other alternatives considered in the PEIS.

7.4.3 Economic Impacts

As described in Section 5.10 wind energy development in the UGP Region under the potential development scenarios generally would be beneficial to local and regional economies, resulting in new jobs and increased income, sales tax, and income tax in each of the UGP Region States during both construction and operation. These economic benefits would be realized and increase to varying degrees in each State through the year 2030. Because the overall regional level of development and the areas where development would be likely to occur are not expected to differ noticeably among the alternatives, the impacts on the economy of the UGP Region States under Alternative 3 would be similar to those under the No Action Alternative. However, as described in section 7.1.3, resolution of uncertainties surrounding the amount of time required for approving interconnection requests and permits for placement of wind energy facilities on easement lands and the consequent impact on project cost and development time could result in positive economic benefits for developers. Therefore, it is anticipated that the economic benefits of Alternative 3 would be somewhat greater compared to the No Action Alternative.

7.5 OTHER NEPA CONSIDERATIONS

7.5.1 Unavoidable Adverse Impacts

The impacts of the various alternatives on environmental resources are discussed in chapter 5. In general, with the exception of potential impacts on some wildlife species and habitats and on visual resources, the impacts on environmental resources from the alternatives would be minor as long as appropriate BMPs and mitigation measures were applied. Unavoidable adverse impacts on wildlife and visual resources would likely occur at some of the future wind energy development sites; however, the magnitude of these impacts and the degree to which they can be successfully avoided, minimized, or mitigated would vary from site to site. These site-specific and species-specific issues would be addressed at the project level in order to maximize opportunities to address impacts.

7.5.2 Relationship between Local Short-Term Uses of the Environment and Long-Term Productivity

Activities associated with wind energy development that could be considered to be short-term uses of the environment would include those limited activities that would occur during the site monitoring and testing phase and the short-term disturbance associated with construction and decommissioning activities (e.g., for lay-down areas). The impacts associated with short-term use of the environment during the site monitoring and testing phase would be negligible, provided new access roads are not constructed and surface-disturbing activities are kept to a minimum. Most environmental impacts during construction of projects would be relatively short term (about 1 to 2 years) and would be largely addressed by programmatic BMPs and mitigation measures, including requirements for habitat restoration. The impacts on the environment during operations would constitute a long-term use of the environment; however, it would not conflict with most other land uses expected to exist in the areas developed for wind energy. Should a proposed location have substantive land use conflicts, it is likely the landowner would not consider a lease for a wind project. The impacts of short-term use during decommissioning also would be mitigated by required habitat restoration activities, thereby rendering the land suitable for other uses.

The proposed action would result in favorable short-term and long-term effects for the local and regional economies where wind energy projects are located (section 5.10). These benefits include the creation of new jobs and increased regional income, GDP, and sales and income tax revenues.

7.5.3 Irreversible and Irretrievable Commitment of Resources

The development of wind energy projects would result in the consumption of sands, gravels, and other geologic resources, as well as fuel, structural steel, and other materials. Upon decommissioning, some of these materials could be available for reuse. Water resources also would be consumed during the construction and, to a lesser extent, decommissioning phases. These would be temporary uses and would be largely limited to on-site mixing of concrete and dust abatement activities, if needed.

In general, the impact on biological resources would not constitute an irreversible and irretrievable commitment of resources. During construction, operation, and decommissioning, individual animals would be affected. For most species, population-level effects would be unlikely; however, population-level effects are possible for some species. Site-specific and species-specific analyses conducted at the project level for all project phases would help ensure that the potential for such impacts would be avoided or minimized to the extent possible. While habitat would be affected during construction and decommissioning, the restoration of habitat required by the programmatic BMPs and mitigation measures would reduce these impacts over time.

Cultural and paleontological resources are nonrenewable. Impacts to these resources would constitute an irreversible and irretrievable commitment of resources; however, the programmatic BMPs and mitigation measures identified under Alternatives 1 and 2 are designed to minimize the potential for impacts on these resources to the extent possible. Impacts to visual resources in specific locations could constitute an irreversible and irretrievable commitment of resources. Efforts to mitigate these impacts would be undertaken at the project level with consideration of stakeholder input.

7.5.4 Mitigation of Adverse Effects

The proposed programmatic approach, as identified under Alternatives 1 and 2, would establish programmatic environmental evaluation procedures, BMPs, and mitigation measures to ensure that potential adverse effects from wind energy development associated with interconnection requests and placement of facilities on Service-managed easements would be mitigated to the fullest extent possible. Potential adverse impacts that cannot be addressed at the programmatic level would be addressed at the project level, where resolution of site-specific and species-specific concerns is more readily achievable.

Under the preferred alternative (Alternative 1), Western and the Service would periodically review and revise the BMPs and mitigation measures as new data and experience regarding the environmental impacts of wind power projects and the success of specific BMPs and mitigation measures become available.

7.6 REFERENCES

Azure, D., 2012, personal communication from Azure (Easement Coordinator, U.S. Fish and Wildlife Service, Mountain-Prairie Region) to J. Hayse (Argonne National Laboratory, Argonne, IL), Mar. 27.

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8 CONSULTATION AND COORDINATION UNDERTAKEN TO SUPPORT PREPARATION OF THE PEIS

8.1 PUBLIC SCOPING

Western and the Service published a Notice of Intent (NOI) to prepare a PEIS to evaluate wind energy development in the portions of six States located within Western's UGP Region in the *Federal Register* (Volume 73, page 52855) on September 11, 2008. The NOI invited interested members of the public to provide comments on the scope and objectives of the PEIS, including identification of issues and alternatives that should be considered in the PEIS analyses. Western and the Service conducted scoping for the PEIS from September 11, 2008, through November 10, 2008.

The public was provided with three methods for submitting scoping comments for the UGP Wind Energy PEIS: (1) via the online comment form on the project Web site, (2) by mail, and (3) in person at public scoping meetings. Public scoping meetings were held at three locations in September and October 2008:

- Sioux Falls, South Dakota (September 30, 2008);
- Bismarck, North Dakota (October 1, 2008); and
- Billings, Montana (October 2, 2008).

At each meeting, Western and the Service presented background information about the UGP Wind Energy PEIS, and a representative from the U.S. Department of Energy's National Renewable Energy Laboratory presented information about wind energy resources and technologies. The presentation materials from these meetings, including electronic versions of slides and posters, were made available on a project Web site (see http://plainswindeis.anl.gov). Following the presentations, attendees were invited to ask questions and to provide scoping comments for the PEIS. The verbal proceedings at each of the public scoping meetings, including presentations, questions, and comments, were recorded. Transcripts prepared from those recordings were also made available on the project Web site (see http://plainswindeis.anl.gov).

Ninety-four people registered at the public scoping meetings held during October and November 2008. The Sioux Falls, South Dakota, meeting drew the most people (42), followed by the Bismarck, North Dakota (39), and Billings, Montana (13), meetings. Approximately 17 individuals provided verbal comments at one or more of the public meetings, and seven people submitted written comments at the public scoping meetings that were not read into the public record.

Twenty-five sets of comments were submitted via the comment form on the project Web site or by e-mail, and two additional comment letters (that had not also been submitted via the comment form on the Web site) were received by postal mail. Written comments were made available for viewing on the public Web site (see http://plainswindeis.anl.gov). Nearly all of the comments submitted originated from States within the study area.

Federal agencies that provided comments included:

- U.S. Environmental Protection Agency

State agencies that provided comments included:

- Minnesota Department of Natural Resources
- North Dakota Department of Agriculture
- South Dakota Energy Policy Office

Local government agencies and organizations that provided comments included:

- City of Minot, North Dakota
- City of Velva, North Dakota
- McHenry County Jobs Development Authority
- Minot Area Chamber of Commerce
- Minot Area Development Corporation
- South Prairie School District #70, Minot, North Dakota
- Velva Community Development Corporation

Industry organizations and businesses that provided comments included:

- American Wind Energy Association
- Basin Electric Power Cooperative
- Central Electric Cooperative
- East River Electric Power Cooperative
- Farm Credit Services of North Dakota
- Irrigation and Electrical Districts Association of Arizona
- Mid-West Electric Consumers Association
- National Wind, LLC
- South Dakota Public Utilities Commission
- Verendrye Electric Cooperative

Native American organizations that submitted comments included:

- Intertribal Council on Utility Policy

Environmental organizations that provided comments are:

- Defenders of Wildlife
- Montana Audubon
- National Wildlife Federation
- The Nature Conservancy

In addition, some elected officials (including a South Dakota State Representative, and the mayors of Velva, South Dakota, and Minot, South Dakota) provided verbal or written comments at the public scoping meetings.

Comments received during the initial scoping period largely fell into several key categories: (1) policies of the agencies relative to wind energy; (2) alternatives that should be considered in the PEIS; (3) interagency cooperation and government-to-government consultation; (4) siting and technology concerns; (5) environmental and socioeconomic concerns; (6) cumulative impacts; and (7) mitigation of impacts. The agencies prepared an internal report that summarized and categorized all comments received during this initial scoping period and used the report and the individual comments as part of the process to determine the scope of analyses in the PEIS.

8.2 GOVERNMENT-TO-GOVERNMENT CONSULTATION

The Federal Government works on a government-to-government basis with federally recognized Native American tribes. The government-to-government relationship was formally recognized on November 6, 2000, with Executive Order 13175 (*Federal Register*, Volume 65, page 67249). As a matter of practice, Western and the Service coordinate with all tribal governments, associated Native communities and Native organizations, and tribal individuals whose interests might be directly and substantially affected by their actions. In addition, Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies to consult with Indian tribes for undertakings on tribal lands and to identify and address historic properties of significance to the tribes that may be affected by an undertaking (Title 36, Part 800.2 (c)(2) of the *Code of Federal Regulations*). The agencies have given substantial consideration to the proper conduct of government-to-government consultations for this project in order to provide opportunities for tribal consultation.

Executive Order 13175 stipulates that tribes identified as “directly and substantially affected” be consulted by Federal agencies during the NEPA process. In addition to the public scoping meetings described above, Western and the Service coordinated with tribes within the UGP Region by making presentations to individual tribes regarding the development of the PEIS and soliciting scoping input. In September 2008, letters originating from the Western’s Regional Office in Billings and the Service’s Office in Lakewood, CO were sent to 25 tribes, chapters, and bands identified by the State offices, inviting those tribes to be cooperating parties and offering government-to-government consultation (table 8.2-1). The Agencies followed up with additional letters, phone calls, e-mails, and meetings for tribes whose traditional use areas are within the UGP Region; the tribes to be contacted were identified using internal agency documents, data from States within the UGP Region, and information from specific tribes. These communications were sent to a broad range of tribes to determine levels of interest in further discussions regarding the UGP Wind Energy PEIS.

As of October 21, 2011, two tribes had responded by letter, e-mail, or telephone or had met with personnel from Western or the Service, and the Spirit Lake Sioux Tribe requested further information on the PEIS.

The Agencies will continue to consult with interested tribes and will continue to keep all tribal entities informed about the NEPA process for the PEIS. In addition, the Agencies will continue to implement government-to-government consultation on a case-by-case basis for site-specific wind energy development projects that will involve interconnection to Western’s transmission system or that will involve easement exchanges to accommodate placement of wind energy facilities on Service-administered easements.

TABLE 8.2-1 Tribal Organizations Contacted Regarding Government-to-Government Consultation

Assiniboine and Sioux Tribes of Ft. Peck	Lower Brule Sioux	Spirit Lake Sioux Tribe
– Blackfeet Nation Tribe	– Northern Cheyenne Tribe	– Standing Rock Sioux Tribe
– Cheyenne River Sioux Tribe	– Oglala Sioux Tribe	– Three Affiliated Tribes (Mandan, Arikara, and Hidatsa Tribes)
– Chippewa-Cree of Rocky Boys	– Omaha Tribe	– Turtle Mountain Chippewa Band
– Crow Tribe	– Ponca Tribe of Nebraska	– Winnebago Tribe of Nebraska
– Crow Creek Sioux	– Rosebud Sioux Tribe	– Yankton Sioux Tribe
Flandreau Santee Sioux	– Confederated Salish and Kootenai Tribes	Upper Sioux Indian Community
Gros Ventre and Assiniboine Tribes of Ft. Belknap	– Santee Sioux Tribe	Lower Sioux Indian Community
	Sisseton-Wahpeton Oyate	

8.3 AGENCY COOPERATION, CONSULTATION, AND COORDINATION

Western and the Service invited Federal, tribal, State, and local government agencies to participate in preparation of the Plains Wind PEIS as cooperating agencies. Letters were sent to State and Federal agencies to alert those agencies that the PEIS was being prepared and to solicit input from those agencies regarding the availability of information that could be used to evaluate environmental impacts and information about specific concerns or issues that should be considered. A total of three agencies, including Bureau of Indian Affairs (U.S. Department of the Interior), Bureau of Reclamation (U.S. Department of the Interior), and the Rural Utilities Service (U.S. Department of Agriculture), are working with Western and the Service as cooperating agencies. Interactions with the cooperating agencies have included periodic briefings and reviews of preliminary, internal draft sections of text. Western and the Service will continue to engage these cooperating agencies throughout the preparation of the PEIS.

In accordance with the requirements of Section 106 of the NHPA, the Agencies are coordinating with and soliciting input from the State Historic Preservation Offices (SHPOs) in each of the six States in the study area and from the Advisory Council on Historic Preservation. In addition, the National Council of SHPOs, the National Trust for Historic Preservation, and tribal governments have been invited to consult on the PEIS.

In accordance with the requirements of Section 7 of the Endangered Species Act, the Agencies are consulting with the Service to ensure that the proposed action will not jeopardize the continued existence of any federally listed threatened or endangered species. These consultations are ongoing and are anticipated to result in a programmatic biological assessment and, perhaps, a programmatic biological opinion for wind energy projects requesting interconnection to Western's transmission systems or that will involve easement exchanges to accommodate placement of wind energy facilities on Service-administered easements. Coordination regarding the consultation approach for the programmatic component of the PEIS continues to occur and the final disposition of the consultation will be presented in the final PEIS.

9 LIST OF PREPARERS

Table 9-1 lists the Western Area Power Administration and U.S. Fish and Wildlife Service management team members for the UGP Wind Energy PEIS. Table 9-2 lists the names, education, and expertise of the UGP Wind Energy PEIS preparers.

TABLE 9-1 Agency Management Team

Name	Office – Title
Western Area Power Administration	
Nick Stas	Western Area Power Administration, Upper Great Plains Region – Regional Environmental Manager
Mark Wieringa	Western Area Power Administration, Corporate Services Office – Environmental Specialist
Lou Hanebury	Western Area Power Administration, Upper Great Plains Region – Environmental Specialist
Matt Marsh	Western Area Power Administration, Upper Great Plains Region – Environmental Protection Specialist
U.S. Fish and Wildlife Service	
Lloyd Jones	U.S. Fish and Wildlife Service, Audubon National Wildlife Refuge Complex – Project Leader
Dave Azure	U.S. Fish and Wildlife Service, Region 6 – Easement Coordinator
Kelly Hogan	U.S. Fish and Wildlife Service, Souris River Basin NWR Complex – Project Leader

TABLE 9-2 UGP Wind Energy PEIS Preparers

Name	Education/Expertise	Contribution
Argonne National Laboratory		
Timothy Allison	M.S., Mineral and Energy Resource Economics; M.A., Geography; 20 years of experience in regional analysis and economic impact analysis.	Technical lead for socioeconomic analysis and environmental justice
Georgia Anast	B.A., Mathematics/Biology; 16 years of experience in environmental assessment.	Comment/response manager
Youngsoo Chang	Ph.D., Chemical Engineering; 20 years of experience in air quality and noise impact analysis.	Technical lead for air quality and emissions, noise
Victor Comello	M.S., Physics; 34 years of experience in technical writing and editing.	Editor
Linda Graf	Desktop publishing specialist; 40 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
John Hayse	Ph.D., Zoology; 23 years of experience in ecological research and environmental assessment.	Project Manager, programmatic analyses, ecological resources analysis (aquatic); preparation of Programmatic Biological Assessment
Ihor Hlohowskyj	Ph.D., Zoology; 31 years of experience in ecological research and environmental assessment.	Ecological resources analysis (aquatic and special status species)
Patricia Hollopeter	B.A., Religion; M.A., Philosophy; 26 years of experience in technical editing and environmental assessment document production.	Editor
James A. Kuiper	M.S. Biometrics; 24 years of experience in GIS analysis, spatial modeling, and GIS programming.	GIS mapping and analysis; wind development suitability analysis
Ronald Kolpa	M.S., Inorganic Chemistry; B.S., Chemistry; 36 years of experience in environmental regulation, auditing, and planning.	Technical lead for hazardous materials and waste management and technology overview; health and safety assessment analysis
Thomas J. Kotek	M.S., Computer Science; 35 years of experience in data management and database-driven Web applications.	Webmaster and data management for PEIS online comment submissions
Kirk E. LaGory	Ph.D., Zoology, M.En., Environmental Science; 33 years of experience in ecological research and environmental assessment.	Program Manager

TABLE 9-2 (Cont.)

Name	Education/Expertise	Contribution
James E. May	M.S., Water Resources Management; B.A., Zoology; 32 years of experience in natural resources management; 4 years of consulting experience in land use planning and NEPA compliance.	Technical lead for land cover and land use
Mary Moniger	B.A., English; 35 years of experience in technical editing and writing.	Editor
Michele Nelson	Graphic designer; 32 years of experience in graphical design and technical illustration.	Graphics
Lee Northcutt	A.A., General Studies/English; 22 years of experience in program/editorial assistance, and environmental impact statements.	Glossary; acronyms
Terri Patton	M.S., Geology; 22 years of experience in environmental research and assessment.	Technical lead for geological resources, water resources, and cumulative impacts analysis
Edwin D. Pentecost	Ph.D., Zoology, Ecology; M.S., Biology; 32 years of experience in ecological research and environmental assessment.	Ecological resources analysis (special status species); preparation of Programmatic Biological Assessment
Pamela Richmond	M.S., Computer Information Systems; 15 years of experience in Web site development and related technology.	Public Web site development
Lorenza Salinas	Desktop publishing specialist; 29 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
Kerri Schroeder	Desktop publishing specialist; 30 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
Karen P. Smith	M.S., B.A., Geology; B.S., Anthropology; more than 21 years of experience in energy and environmental regulatory and policy analysis.	Program Manager
Carolyn M. Steele	B.A., English; B.A., Rhetoric; 5 years of experience in technical writing and editing.	Editor
Robert Sullivan	M.L.A., Landscape Architecture; 21 years of experience in visual impact analysis and simulation; 13 years in Web site development.	Technical lead for visual impact analysis; public Web site development
Robert A. Van Lonkhuyzen	B.A., Biology; 20 years of experience in ecological research and environmental assessment.	Ecological resources analysis (plant communities/habitats; wetlands)

TABLE 9-2 (Cont.)

Name	Education/Expertise	Contribution
Daniel O'Rourke	20 years of experience in archaeological analysis; 16 years in environmental assessment and records management.	Technical lead for cultural and paleontological resources analysis; Native American concerns
William S. Vinikour	M.S., Biology with environmental emphasis; 34 years of experience in ecological research and environmental assessment.	Technical lead for ecological resources analysis; ecological resources analysis (wildlife)
Leroy J. Walston, Jr.	M.S., Biology; 5 years of experience in ecological research and environmental assessment.	Ecological resources analysis (special status species); preparation of Programmatic Biological Assessment
Suzanne Williams	B.S. Communication Studies; 27 years of experience in technical writing and editing.	Editor
Emily A. Zvolanek	B.A., Environmental Science; 2 years of experience in GIS mapping.	GIS mapping and analysis; wind development suitability analysis

10 GLOSSARY

Abiotic: Non-living or non-biological; includes chemical and physical environments and processes.

Absorption: The passing of a substance or force into the body of another substance.

Absorption (sound): The properties of a material composition convert sound energy into heat, thereby reducing the amount of energy that can be reflected.

Acceleration: *See* Peak horizontal acceleration.

Access roads: Gravel or dirt roads (rarely paved) that provide overland access to transmission line and pipeline rights-of-way (ROWs) and facilities for construction, inspection, maintenance, and decommissioning.

ACEC: *See* Areas of Critical Environmental Concern.

Acoustics: The science of sound: how it is produced and transmitted, and its effects on people.

Acute: Resulting in immediate impacts; short term.

Adaptive management: A management system that is designed to make changes (i.e., to adapt) in response to new information and changing circumstances.

Aerodynamic diameter: The diameter of a spherical particle having a density of 1 gram per cubic meter (g/m^3) that has the same inertial properties (i.e., settling velocity) in the gas as the particle of interest.

Aerodynamic noise: Aerodynamic noise is produced by the movement of an object through the air. For wind turbines, it is the noise caused by the rotor blades passing through the air, often described as a “swishing” sound. In general, the higher the rotational speed, the louder the sound.

Aerodynamics: The study of the forces exerted on solid objects by the flow of gases moving gas around them, especially the gases in the atmosphere.

Aerodynamic stall: A condition in which the wind’s aerodynamic lifting force is approximately equal to its aerodynamic drag, resulting in the lowest wind power capture by the blade.

Aesthetic offsets: A correction or remediation of an existing condition located in the same viewshed of the proposed development that has been determined to have a negative visual or aesthetic impact. For example, aesthetic offsets could include reclamation of unnecessary roads in the area, removal of abandoned buildings, cleanup of illegal dumps or trash, or the rehabilitation of existing erosion or disturbed areas.

Aggregate: Mineral materials such as sand, gravel, crushed stone, or quarried rock used for construction purposes.

Air quality: Measure of the health-related and visual characteristics of the air to which the general public and the environment are exposed.

Algorithm: A step-by-step procedure for solving a mathematical problem.

All-American Roads: A National Scenic Byway is a road recognized by the U.S. Department of Transportation for its archeological, cultural, historic, natural, recreational, and/or scenic qualities. The most scenic of the roads are called All-American Roads. The designation means they have features that do not exist elsewhere in the United States and are scenic enough to be tourist destinations unto themselves. As of September 2005, there were 99 National Scenic Byways and 27 All-American Roads located in 44 States.

Alluvial: Formed by the action of running water; of or related to river and stream deposits.

Alluvial fan: A gently sloping mass of unconsolidated material (e.g., clay, silt, sand, or gravel) deposited where a stream leaves a narrow canyon and enters a plain or valley floor. Viewed from above, it has the shape of an open fan. An alluvial fan can be thought of as the land counterpart of a delta.

Alluvial valley: An alluvium-filled basin, usually occurring between mountain ranges.

Alpine tundra: Vegetation in montane habitats above the tree line. Vegetation consists of perennial forbs, grasses, sedges, and short woody shrubs. Alpine tundra is distinguished from Arctic tundra because alpine tundra typically does not have permafrost, and alpine soils are generally better drained than arctic soils.

Alternating current (AC): A flow of electrical current that increases to a maximum in one direction, decreases to zero, and then reverses direction and reaches maximum in the other direction. This cycle is repeated continuously. The number of such cycles per second is equal to the frequency, measured in Hertz (Hz). U.S. commercial power is 60 Hz.

Ambient noise: The total of all noise in a given environment, other than the noise emanating from the source of interest. *See also* Background noise.

Ambient noise level: The level of acoustic noise existing at a given location, such as in a room or somewhere outdoors.

American Antiquities Act of 1906: This act prohibits excavating, injuring, or destroying any historic or prehistoric ruin or monument or object of antiquity on Federal land without the prior approval of the agency with jurisdiction over the land.

American Indian Religious Freedom Act of 1978: This act requires Federal agencies to consult with tribal officials to ensure protection of religious cultural rights and practices.

American Recovery and Reinvestment Act of 2009 (ARRA): An economic stimulus bill created to help the U.S. economy recover from an economic downturn that began in late 2007. Congress enacted ARRA on February 17, 2009.

Amphibian: A cold-blooded, smooth-skinned vertebrate of the class Amphibia, such as a frog, toad, or salamander, that characteristically hatches as an aquatic larva with gills. The larva then transforms into an adult with air-breathing lungs.

Anoxic: Absence of oxygen. Usually used in reference to an aquatic habitat.

Anthropogenic: Human made; produced as a result of human activities.

Anticyclone: A large body of air in which the atmospheric pressure is higher than the pressure in the surrounding air. The winds blow clockwise around an anticyclone in the Northern Hemisphere.

Aquatic biota: Collective term describing the organisms living in or depending on the aquatic environment.

Aquifer: A permeable underground formation that yields usable amounts of water to a well or spring. The formation could be sand, gravel, limestone, and/or sandstone.

Aquifer system: A body of permeable and poorly permeable material that functions regionally as a water-yielding unit; it comprises two or more permeable beds separated at least locally by confining beds that impede groundwater movement but do not greatly affect the regional hydraulic continuity of the system; includes both saturated and unsaturated parts of permeable material.

Archeological Resources Protection Act of 1979: This act requires a permit for excavation or removal of archeological resources from public or Native American lands.

Archaeological site: Any location where humans have altered the terrain or discarded artifacts during prehistoric or historic times.

Areas of Critical Environmental Concern (ACECs): These areas are managed by the Bureau of Land Management (BLM) and are defined by the Federal Land Policy and Management Act of 1976 as having significant historical, cultural, and scenic values, habitat for fish and wildlife, and other public land resources, as identified through the BLM's land use planning process.

Array (turbine): The positioning and spatial arrangement of wind turbines relative to each other.

Artifact: An object produced or shaped by human beings and of archaeological or historical interest.

Atmospheric refraction: The change in direction of a ray of light as it passes from space into the atmosphere. This change causes celestial objects to appear to be in a location different from their true positions. *See also* Refraction.

Attainment area: An area considered to have air quality as good as or better than the National Ambient Air Quality Standards for a given pollutant. An area may be in attainment for one pollutant and in nonattainment for others.

Attenuation: The reduction in level of sound. *See also* Radar attenuation.

Avian: The scientific classification for all bird species.

Avoidance (areas): Areas within Candidate Study Areas and/or Renewable Energy Zones where development of renewable energy resources should not occur because of purpose, policy, or other restrictions related to environmental, land use, or other issues.

A-weighted scale: *See* Decibel, A-weighted [dB(A)].

Background-level noise: Noise in the environment (other than noise emanating from the source of interest). *See also* Ambient noise.

Bald and Golden Eagle Protection Act of 1940 (BGEPA): This act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs. Permits must be obtained from the U.S. Department of the Interior in order to relocate nests that interfere with resource development or recovery.

Barotrauma: Injury following pressure changes caused by a rapid air pressure reduction near moving turbine blades.

Basin: (1) A depression in the earth's surface that collects sediment. (2) The area of land that drains to a particular river.

Bedrock: General term referring to the solid rock or ledge underlying other unconsolidated material (soil, loose gravel, etc.).

Bench: A relatively level step, excavated into a slope on which fill is to be placed. Its purpose is to provide a firm, stable contact between the existing material and the new fill to be placed.

Best management practices (BMPs): A practice (or combination of practices) that are determined to provide the most effective, environmentally sound, and economically feasible means of managing an activity and mitigating its impacts.

Big game: Those species of large mammals normally managed as a sport-hunting resource.

Biological Assessment (BA): A document prepared for the Endangered Species Act of 1973 Section 7 process to determine whether a proposed activity under the authority of a Federal action agency is likely to adversely affect listed species, proposed species, or designated critical habitat.

Biological Opinion (BO): A document resulting from formal consultation with the U.S. Fish and Wildlife Service. The document presents the opinion of the U.S. Fish and Wildlife Service as to whether or not a Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

Biomass: Anything that is or was once alive.

Biomass energy (bioenergy): The production, conversion, and use of material directly or indirectly produced by photosynthesis (including organic waste) to manufacture fuels and substitutes for petrochemical and other energy-intensive products.

Biota: The living organisms in a given region.

Blade glint: A phenomenon that occurs when the sun's light is reflected from the surface of rotating wind turbine blades. Blade glint can have a disruptive effect on some observers. *See also* Glint; Glare.

Blades: The aerodynamic surface on a turbine that catches the wind. Most commercial turbines have three blades.

Borrow: Material such as soil or sand that is removed from one location and used as fill material in another location.

BLM: The Bureau of Land Management.

BLM lands: Land administered by the Bureau of Land Management.

Borrow area: A pit or excavation area used for gathering earth materials (borrow) such as sand or gravel.

Broadband noise: Noise that has a continuous spectrum (i.e., energy is present at all frequencies in a given range). This type of noise lacks a discernible pitch and is described as having a "swishing" or "whooshing" sound.

Browse: Twigs, leaves, and young shoots of trees and shrubs that animals eat.

Build-out: The estimated extent of residential, commercial, and industrial development in a given geographic area; usually related to the upper limit of the population to be served by water resource development.

Bureau of Land Management (BLM): An agency of the U.S. Department of the Interior that is responsible for managing public lands.

Cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation and some chemicals.

Candidate species: Candidate species are plant and animals for which the U.S. Fish and Wildlife Service has sufficient information about their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a listing regulation is precluded by other higher priority listing activities.

Canopy: The upper forest layer of leaves consisting of tops of individual trees whose branches sometimes cross each other.

Capacity: The amount of electric power delivered or required for which a generator, turbine, transformer, transmission circuit, station, or system is rated by the manufacturer. The rate of delivery of electricity is measured in kilowatts or megawatts.

Capacity factor: The practically available power (usually expressed as a percentage) from a wind turbine. It is defined as the ratio of the annual energy output of a wind turbine to the turbine's rated power times the total number of hours in a year (8,760).

Carbonate rock: Rocks (such as limestone or dolostone) that are composed primarily of minerals (such as calcite and dolomite) containing the carbonate ion.

Carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentrations over an extended period. Carbon monoxide is listed as a criteria air pollutant under Title I of the Clear Air Act.

Carcinogen: Potential cancer-causing agents in the environment. Among others, they include industrial chemical compounds found in food additives, pesticides and fertilizers, drugs, household cleaners, and paints. Naturally occurring ultraviolet solar radiation is also a carcinogen.

Carrion: The dead, decomposing flesh of an animal.

Categorical Exclusion (CX): Under the National Environmental Policy Act, these are classes of actions that the U.S. Department of the Interior has determined do not individually or cumulatively have a significant effect on the human environment.

Cell: *See* Radar cell.

CERCLA: *See* Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Chaparral: A plant community of shrubs and low trees adapted to annual drought and often extreme summer heat and also highly adapted to fires recurring every 5 to 20 years.

Chinook: A strong downslope wind that causes the air to warm rapidly as a result of compressive heating; called a foehn wind in Europe.

Chronic effects: Effects resulting from exposure to low levels of a stressing factor (e.g., contaminant, disease, electromagnetic field, noise, and radionuclides) over long periods.

Class I Area: As defined in the Clean Air Act, the following areas that were in existence as of August 7, 1977: national parks over 6,000 acres, national wilderness areas and national memorial parks over 5,000 acres, and international parks. *See* Clean Air Act.

Class II Area: Areas of the country protected under the Clean Air Act, but identified for somewhat less stringent protection from air pollution damage than a Class I area, except in specified cases. *See* Clean Air Act.

Clean Air Act: This act establishes national ambient air quality standards and requires facilities to comply with emission limits or reduction limits stipulated in State Implementation Plans (SIPs). Under this act, construction and operating permits, as well as reviews of new stationary sources and major modifications to existing sources, are required. The act also prohibits the Federal government from approving actions that do not conform to SIPs.

Clean Water Act (CWA): This act requires National Pollutant Discharge Elimination System permits for discharges of effluents to surface waters, permits for stormwater discharges related to industrial activity, and notification of oil discharges to navigable waters of the United States.

Climate change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer).

Clutter: *See* Ground clutter; Radar clutter; Visual clutter.

Code of Federal Regulations* (CFR)*: A compilation of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the United States. It is divided into 50 titles that represent broad areas subject to Federal regulation. Each volume of the CFR is updated once each calendar year and is issued on a quarterly basis.

Color: The property of reflecting light of a particular intensity and wavelength (or mixture of wavelengths) to which the eye is sensitive. It is the major visual property of surfaces.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): An act providing the regulatory framework for the remediation of past contamination from hazardous waste. If a site meets the act's requirements for designation, it is ranked along with other Superfund sites on the National Priorities List. This ranking is the U.S. Environmental Protection Agency's way of determining the priority of sites for cleanup.

Conductor: A substance or body that allows an electrical current to pass continuously along it. Electrical equipment receives power through electrical conductors.

Cone of depression: A depression in the water table that develops around a pumped well.

Conifers: Cone-bearing trees, mostly evergreens, that have needle-shaped or scale-like leaves.

Conservation easement: A non-possessory interest in real property owned by another imposing limitations or affirmative obligations with the purpose of returning or protecting the property's conservation values. *See also* Easement; Grassland easement; Prairie and Grassland easements; Wetlands easement; and Wetlands Reserve Program easement.

Conterminous United States: The 48 mainland States; all States excluding Alaska and Hawaii.

Corona discharge: Electrical discharge accompanied by ionization of surrounding atmosphere around high-voltage transmission lines, occurring mostly under wet conditions.

Corona/corona noise: The electrical breakdown of air into charged particles. The phenomenon appears as a bluish-purple glow on the surface of and adjacent to a conductor when the voltage gradient exceeds a certain critical value, thereby producing light, audible noise (described as crackling or hissing), and ozone.

Corridor: A strip of land through which one or more existing or potential facilities may be located. *See also* Transmission corridor.

Coteau: *See* Missouri Coteau; Prairie coteau.

Council on Environmental Quality (CEQ): Established by the National Environmental Policy Act. Council on Environmental Quality regulations (40 CFR Parts 1500–1508) describe the process for implementing the National Environmental Policy Act, including preparation of environmental assessments and environmental impact statements, and the timing and extent of public participation.

Cover: Vegetation, rocks, or other materials used by wildlife for protection from predators or weather.

Cretaceous: The final period of the Mesozoic era, spanning the time between 145 and 65 million years ago.

Criteria air pollutants: Six common air pollutants for which National Ambient Air Quality Standards (NAAQS) have been established by the U.S. Environmental Protection Agency under Title I of the Clean Air Act. They are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter ($PM_{2.5}$ and PM_{10}), and lead. Standards were developed for these pollutants on the basis of scientific knowledge about their health effects.

Critical habitat: The specific area within the geographical area occupied by the species at the time it is listed as an endangered or threatened species. The area in which physical or biological features essential to the conservation of the species are found. These areas may require special management or protection.

Cultural resources: Archaeological sites, architectural structures or features, traditional-use areas, and Native American sacred sites or special-use areas that provide evidence of the prehistory and history of a community.

Culvert: A pipe or covered channel that directs surface water through a raised embankment or under a roadway from one side to the other.

Cumulative impacts: The impacts assessed in an environmental impact statement that could potentially result from incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal), private industry, or individual undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Cut-and-fill: The process of earth grading by excavating part of a higher area and using the excavated material for fill to raise the surface of an adjacent lower area.

Cut-in speed: The wind speed below which a wind turbine cannot economically produce electricity. It is unique for each turbine. (Conversely, cut-out speed is the wind speed above which a wind turbine cannot economically produce electricity without also potentially suffering damage to its blades or other components.)

Day-night average sound level (L_{dn}): *See* L_{dn}.

Debris flows: A mixture of water-saturated rock debris that flows downslope under the force of gravity (also called lahar or mudflow).

Decibel (dB): A standard unit for measuring the loudness or intensity of sound. In general, a sound doubles in loudness with every increase of 10 dB.

Decibel, A-weighted [dB(A)]: A measurement of sound approximating the sensitivity of the human ear and used to characterize the intensity or loudness of a sound.

Deciduous: Plants that shed their leaves annually. Not evergreen.

Decommissioning: All activities necessary to take out of service and dispose of a facility after its useful life.

Degradation: *See* Habitat degradation.

De minimis: Lacking significance; of minor importance.

Demographics: Specific population characteristics such as age, gender, education, and income level.

Desert scrub: The desert scrub community is characterized by plants adapted to a seasonally dry climate.

Dewater: To remove or drain water from an area.

Dielectric fluids: Fluids that do not conduct electricity.

Diffraction: The bending and spreading of a wave, such as a light wave, around the edge of an object.

Direct current: Electric current that flows in one direction only.

Direct impact: An effect that results solely from the construction or operation of a proposed action without intermediate steps or processes. Examples include habitat destruction, soil disturbance, and water use.

Directional drilling: The practice of drilling non-vertical wells (also called slant drilling).

Distribution: The act or process of distributing electric energy from convenient points on the transmission or bulk power system to consumers.

Dolomite: A magnesium-rich carbonate sedimentary rock; a magnesium-rich carbonate mineral ($CaMgCO_3$).

Doppler Effect: The observed change in the frequency of sound or electromagnetic waves due to the relative motion of the source and observer.

Doppler radar: A type of weather radar that determines whether atmospheric motion is toward or away from the radar. It determines the intensity of rainfall and uses the Doppler effect to measure the velocity of droplets in the atmosphere.

Downwind turbine: A turbine whose rotor and blades are oriented to the downwind side of the turbine's support structure. Downwind is the direction toward which the wind is blowing; with the wind.

Dunnage: Package waste; loose packing material.

Earthquake: Ground shaking caused by the sudden release of energy stored in rock beneath the earth's surface.

Easement: A non-possessory interest in real property owned by another, imposing limitations or affirmative obligations for the purpose of returning or protecting the property's conservation values; an agreement by which landowners give up or sell one of the rights on their property. *See also* Conservation easement; Grassland easement; Prairie and Grassland easements; Wetlands easement; and Wetlands Reserve Program easement.

Echo: Energy backscattered from a target (precipitation, clouds, etc.) and received by and displayed on a radar screen.

Ecological resources: Fish, wildlife, plants, biota and their habitats, which may include land, air, and/or water.

Ecoregion: A geographically distinct area of land that is characterized by a distinctive climate, ecological features, and plant and animal communities.

Ecosystem: A group of organisms and their physical environment interacting as an ecological unit.

Edge habitat: The transitional zone where one cover type ends and another begins.

Effects: Environmental consequences (the scientific and analytical basis for comparison of alternatives) as a result of a proposed action. Effects may be either direct, caused by the action and occur at the same time and place; or indirect, caused by the action and later in time or farther removed in distance, but still reasonably foreseeable; or cumulative.

Electromagnetic fields (EMFs): Electromagnetic fields are generated when charged particles (e.g., electrons) are accelerated. Electromagnetic fields are typically generated by alternating current in electrical conductors. They are also referred to as EM fields.

Electromagnetic interference: Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment. It is caused by the presence of electromagnetic radiation.

Emissions: Substances that are discharged into the air from industrial processes, vehicles, and living organisms. *See also* Point source emissions; Nonpoint-source pollution.

Empirical: Based on experimental data rather than theory.

Endangered species: Any species (plant or animal) that is in danger of extinction throughout all or a significant part of its range. Requirements for declaring a species endangered are found in the Endangered Species Act.

Endangered Species Act of 1973 (ESA): This act requires consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service to determine whether endangered or threatened species or their habitats will be impacted by a proposed activity and what, if any, mitigation measures are needed to address the impacts.

Energy Policy Act of 2005 (EPAct): Act passed to address growing energy concerns. Officially known as Public Law 109-58, EPAct 2005 provides tax incentives and loan guarantees, new equipment efficiency standards, and other measures.

Enhanced Fujita scale: *See* Fujita scale.

Environmental Assessment (EA): A concise public document that a Federal agency prepares under the National Environmental Policy Act to provide sufficient evidence and analysis to determine whether a proposed action requires preparation of an environmental impact statement or whether a Finding of No Significant Impact can be issued. An environmental assessment must include brief discussions on the need for the proposal, the alternatives, and the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted.

Environmental Impact Statement (EIS): A document required of Federal agencies by the National Environmental Policy Act for major proposals or legislation that will or could significantly affect the environment.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Eolian: Refers to the processes of wind erosion, transport, and deposition.

EPAct: *See* Energy Policy Act of 2005.

Equivalent continuous sound level (L_{eq}): *See* L_{eq}.

Erosion: The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

Escarpment: A cliff or the steep slopes of a plateau edge.

Eutrophication: The uncontrolled growth of aquatic plants in response to excessive nutrient inputs to surface waters; the process of enrichment of water bodies by nutrients.

Evapotranspiration: Plants absorb water through their roots and emit it through their leaves. This movement of water is called "transpiration." Evaporation, the conversion of water from a liquid to a gas, also occurs from the soil around vegetation and from trees and vegetation as they intercept rainfall on leaves and other surfaces. Together, these processes are referred to as evapotranspiration, which lowers temperatures by using heat from the air to evaporate water.

Executive Order (E.O.): A president's or governor's declaration that has the force of law, usually based on existing statutory powers, and requiring no action by the Congress or State legislature.

Exotic species: A plant or animal that is not native to the region where it is found.

Exposure: Contact of an organism with a chemical, radiological, or physical agent.

Extant: Currently existing.

Extinction: The death of an entire species.

Extirpation: The elimination of a species or subspecies from a particular area, but not from its entire range.

Extremely low frequency (ELF): Refers to a band of frequencies from 30 to 300 Hz. Sometimes the band from 0 to 3,000 Hz is considered to be extremely low frequency. The 60 Hz power frequency is in this range.

Fault: A fracture on either side of which blocks of the earth's crust have moved relative to one another.

Fauna: The community of animals in a specific region or habitat.

Federal Cave Resources Protection Act of 1988: This act allows the collection and removal of resources from federal caves only when a permit has been authorized by the Secretary of Agriculture or the Secretary of the Interior.

Federal land: Land owned by the United States, without reference to how the land was acquired or which Federal agency administers the land, including mineral and coal estates underlying private surface.

Federal Land Policy and Management Act of 1976: This act requires the Secretary of the Interior to issue regulations to manage public lands and the property located on those lands for the long term.

Floaters: Nonbreeding adult and subadult birds that move and live within a breeding population.

Floodplain: Mostly level land along rivers and streams that may be submerged by floodwater.

Flora: Plants, especially, those of a specific region, considered as a group.

Fluvial: Pertaining to a river. Fluvial sediments are deposited by rivers.

Flyway: A concentrated, predictable flight path of migratory bird species from their breeding ground to their wintering area.

Footprint: The land or water area covered by a project. This includes direct physical coverage (i.e., the area on which the project physically stands) and direct effects (i.e., the disturbances that may directly emanate from the project, such as noise).

Forage: Forms of vegetation available for animal consumption. Food for animals, especially when taken by browsing or grazing. Vegetation used for food by wildlife, particularly big-game wildlife and domestic livestock.

Forbs: Nonwoody plants that are not grasses or grasslike.

Form: The mass or shape of an object or objects that appears unified, such as a vegetative opening in a forest, a cliff formation, or a water tank.

Fossil: Remains of ancient life forms, their imprints or behavioral traces (e.g., tracks, burrows, or residues), and the rocks in which they are preserved.

Fossil fuels: Natural gas, petroleum, coal, and any form of solid, liquid, or gaseous fuel derived from such materials for the purpose of creating useful heat.

Fragmentation: The process by which habitats are increasingly subdivided into smaller units, resulting in their increased insularity as well as losses of total habitat area.

Frequency: The number of oscillations or cycles per unit of time. Acoustical frequency is usually expressed in units of Hertz (Hz) where 1 Hz is equal to 1 cycle per second. *See also* Low-frequency sound.

Fugitive dust: The dust released from activities associated with construction, manufacturing, or transportation.

Fujita scale: The official classification system for tornado damage. The scale ranges from F0 (gale tornado, minor damage, winds up to 72 mph) to F5 (devastating tornado, winds 261 to 318 mph). In the United States and in some other countries, the Fujita scale was decommissioned in favor of a more accurate Enhanced Fujita Scale, which replaces it. The new Enhanced Fujita (EF) scale, based on a 3-second wind gust, was implemented on February 1, 2007. Since that date, all tornadoes in the United States have been rated by using EF categories. Similar to the original Fujita scale, it has ratings from EF0 to EF5. However, historical tornadoes recorded on or before January 31, 2007, are still categorized with the original Fujita scale.

Furbearer: An animal that is hunted or farmed for its fur.

Gallinaceous birds: A term used for birds of the order Galliformes. They are heavy-bodied, largely ground-feeding domestic or game birds, including chickens, pheasants, turkeys, grouse, partridges, and quail.

Generator: In power systems, a generator is the machine that converts mechanical energy to electrical energy.

Geologic resources: Material of value to humans that is extracted (or is extractable) from solid earth, including minerals, rocks, and metals; energy resources; soil; and water.

Geology: The science that deals with the study of the materials, processes, environments, and history of the earth, including rocks and their formation and structure.

Geotechnical: Refers to the use of scientific methods and engineering principles to acquire, interpret, and apply knowledge of earth materials for solving engineering problems.

Geothermal energy: Energy that is generated by the heat of the earth's own internal temperature. Sources of geothermal energy include molten rock, hot springs, geysers, steam, and volcanoes.

GHGs: *See* Greenhouse gases (GHGs).

Glacial till: An unsorted, unstratified mixture of fine and coarse rock debris deposited by a glacier.

Glare: The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility. *See also* Glint.

Glint: A momentary flash of light resulting from a spatially localized reflection of sunlight. *See also* Blade glint; Glare.

Global warming potential (GWP): An index used to compare the relative heat-trapping ability of different greenhouse gases to that of carbon dioxide (because it is the most common greenhouse gas).

Grasslands: Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees.

Grassland easement: A grassland easement is a legal agreement signed with the United States of America, through the U.S. Fish and Wildlife Service that pays landowners to permanently keep their land in grass. Many landowners never plan on putting their land into crop production and can benefit from the added cash incentive of a grassland easement. Property must lie within an approved county and have potential value to wildlife. Highest priority lands are large tracts of grassland with high wetland densities and native prairie or soils most likely to be converted to cropland. Subsurface rights, such as oil, gas, and mineral, are not affected. Landowners must consult their local U.S. Fish and Wildlife Service representative to avoid potential easement violations situations. A grassland easement is a permanent (perpetual) agreement between the U.S. Fish and Wildlife Service and all present and future landowners. *See also* Easement; Conservation easement; Prairie and grassland easements; Wetlands easement, and Wetlands Reserve Program easement.

Grazing: Consumption of native forage from rangelands or pastures by livestock or wildlife.

Greenhouse effect: A natural phenomenon occurring when certain gases in the air absorb much of the long-wave thermal radiation emitted by the land and ocean and reradiate it back to earth, making the atmosphere warmer than it otherwise would be without greenhouse gases (GHGs).

Greenhouse gases (GHGs): Heat-trapping gases that cause global warming. Natural and human-made greenhouse gases include water vapor, carbon dioxide, methane, nitrogen oxides, ozone, and chlorofluorcarbons.

Grid: A term used to describe an electrical utility distribution network.

Ground clutter: A pattern of radar echoes from fixed ground targets (buildings, hills, etc.) near the radar. Ground clutter may hide or confuse precipitation echoes near the radar antenna. It is usually more noticeable at night when the radar beam encounters superrefractive conditions. *See also* Radar clutter.

Ground motion (shaking): The movement of the earth's surface from earthquakes. Ground motion is produced by seismic waves that are generated by a sudden slip on a fault and travel through the earth and along its surface.

Groundwater: The supply of water found beneath the earth's surface, usually in porous rock formations (aquifers), which may supply wells and springs. Generally, it refers to all water contained in the ground. Groundwater in the UGP Region occurs primarily in basin-filled sediments, sandstone, and carbonate bedrock.

Grubbing: Removal of stumps, roots, and vegetable matter from the ground surface after clearing and prior to excavation.

Guy wire: Wire or cable used to secure and stabilize wind turbines, meteorological towers, and other vertical objects in wind resource areas.

Habitat: The place, including physical and biotic conditions, where a plant or animal lives.

Habitat degradation: Decline in habitat quality that accompanies non-natural forms of disturbance.

Habitat fragmentation: *See* Fragmentation of habitat.

Harassment: Intentional or unintentional disturbance of individual animals causing them to flee a site or avoid use of an area.

Hazardous air pollutants (HAPs): Substances that have adverse impacts on human health when present in ambient air.

Hazardous material: Any material that poses a threat to human health and/or the environment. Hazardous materials are typically toxic, corrosive, ignitable, explosive, or chemically reactive.

Hazardous material transportation law: The hazardous material transportation law (Title 49, Sections 5101–5127 of the *United States Code*) is the major transportation-related statute affecting transportation of hazardous cargoes. Regulations include The Hazardous Materials Table (49 CFR 172.101), which designates specific materials as hazardous for the purpose of transportation, and Hazardous Materials Transportation Regulations (49 CFR Parts 171–180), which establish packaging, labeling, placarding, documentation, operational, training, and emergency response requirements for the management of shipments of hazardous cargos by aircraft, vessel, vehicle, or rail.

Hedonic statistical framework: A method of assessing the impact of various structural (number of bedrooms, bathrooms, square footage, age, etc.) and locational (local amenities, fiscal conditions, distance to workplace, etc.) attributes on residential housing prices.

Herbaceous plants: Nonwoody plants.

Herbicides: Chemicals used to kill undesirable vegetation.

Herd Management Area (HMA): An area that has been designated for management of wild horses and/or burros.

Hertz (Hz): The unit of measurement of frequency, equivalent to one cycle per second.

Historic properties: Any prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the *National Register of Historic Places* maintained by the Secretary of the Interior. They include artifacts, records, and remains that are related to and located within such properties.

Historic site: The site of a significant event, prehistoric or historic activity, or structure or landscape (existing or vanished), where the site itself possesses historical, cultural, or archeological value apart from the value of any existing structure or landscape.

Hub: The central portion of the rotor to which the blades of a turbine are attached.

Hydroelectric power: The use of flowing water to produce electricity.

Hydrology: The study of water; covers the occurrence, properties, distribution, circulation, and transport of water, including groundwater, surface water, and rainfall.

Igneous rock: A crystalline rock formed by the cooling and solidification of molten or partly molten material (magma). Igneous rock includes volcanic rock (rock solidified above the earth's surface) and plutonic rock (rock solidified at considerable depth).

IMPLAN: Input-output economic model based on economic accounts showing the flow of commodities to industries from producers and institutional consumers. The accounts also show consumption activities by workers, owners of capital, and imports from outside the region.

Impulsive noise: Noise from impacts or explosions (e.g., from a pile driver, forging hammer, punch press, or gunshot) that is brief and abrupt; its startling effects cause great annoyance.

Incidental take: Take that results from, but is not the purpose of, carrying out an otherwise lawful activity. *See also* Take.

Indigenous: Native to an area.

Indirect impact: An effect that is related to but removed from a proposed action by an intermediate step or process. An example would be changes in surface-water quality resulting from soil erosion at construction sites.

Infiltration: The movement of water (usually precipitation) from the ground surface into the subsurface.

Infrasound: Sound waves below the frequency range that can be heard by humans (about 1 to <20 Hz). Infrasound can often be felt, or sensed as a vibration, and can cause motion sickness and other disturbances.

Infrastructure: The basic facilities, services, and utilities needed for the functions of an industrial facility or site. Examples of infrastructure for wind farms are access roads, transmission lines, and meteorological towers.

In-migration: People moving into an area.

Installed capacity: The total of the capacities as shown by the nameplates of similar kinds of apparatus such as generating units, turbines, synchronous condensers, transformers, or other equipment in a station or system.

Interconnection: A connection or link permitting a flow of electricity between the facilities of two electric systems.

Interconnection Agreement (IA): A legally binding document defining the technical and contractual terms under which a generator can interconnect and deliver energy.

Intermittent stream: A stream that flows for a portion of the year but occasionally is dry or reduced to a pool stage when losses from evaporation or seepage exceed the available streamflow.

Intermontane: An alluvium-filled valley between mountain ranges, often formed over a graben (an elongated crustal block that is relatively depressed between two parallel normal faults).

Invasive species: Any species, including noxious and exotic species, that is an aggressive colonizer and can outcompete indigenous species.

Invertebrates: An animal, such as an insect or mollusk, that lacks a backbone or spinal column.

Isochronal: Recurring at regular intervals; of equal time.

Just-in-time ordering: A strategy for managing materials used at a project that ensures materials become available as needed to support activities, but are not stockpiled at the project location in excess of what is needed at any point in time. The just-in-time approach controls costs by avoiding the accumulation of inflated inventories, reducing the potential for stockpiled materials to go out-of-date or otherwise become obsolete, and minimizing product storage and management requirements. When applied to hazardous chemicals, this approach reduces waste generation, the potential for mismanagement of materials, and the overall risk of adverse impacts resulting from emergency or off-normal events involving those materials.

Lacustrine wetland: Wetlands that are generally larger than 20 ac and have less than 30% cover of vegetation such as trees, shrubs, or persistent emergent plants. Lacustrine sediments are generally made up of fine-grained particles deposited in lakes.

Land cover: The physical coverage of land, usually expressed in terms of vegetation cover or lack thereof. Land covers within the UGP Region include agricultural fields, rangeland, forests, wetlands and water bodies, barren land, and developed land (e.g., urban areas).

Landscape: The traits, patterns, and structure of a specific geographic area including its biological composition, its physical environment, and its anthropogenic or social patterns.

Landslide: A movement of surface material down a slope.

Land use: A characterization of land surface in terms of its potential utility for various activities.

Land Use Plan: A set of decisions that establish management direction for land within an administrative area, as prescribed under the planning provisions of FLPMA; an assimilation of land-use-plan-level decisions developed through the planning process outlined in 43 CFR 1600, regardless of the scale at which the decisions were developed.

Lattice tower: A transmission tower constructed of strips of steel.

Lay-down area: An area that has been cleared for the temporary storage of equipment and supplies. To ensure accessibility and safe maneuverability for transport and off-loading of vehicles, lay-down areas are usually covered with rock and/or gravel.

L_{dn}: The day-night average sound level. It is the average A-weighted sound level over a 24-hour period that gives additional weight to noise that occurs during the night (10:00 p.m. to 7:00 a.m.) to account for the greater sensitivity of most people to nighttime noise.

Lead: A gray-white metal that is listed as a criteria air pollutant. Health effects from exposure to lead include brain and kidney damage and learning disabilities. Sources include leaded gasoline and metal refineries.

Lease: A contract in legal form that provides for the right to develop and produce reserves within a specific area for a specific period of time under certain agreed-upon terms and conditions.

Lek: A traditional site that is used year after year by males of certain bird species for communal display as they compete for female mates.

L_{eq} : For sounds that vary with time, L_{eq} is the steady sound level that would contain the same total sound energy as the time-varying sound over a given time.

Light pollution: Any adverse effect of human-made lighting, such as excessive illumination of night skies by artificial light. Light pollution is an undesirable consequence of outdoor lighting that includes such effects as sky glow, light trespass, and glare.

Light spillage: An undesirable condition in which light is cast where it is not wanted. Also referred to as light trespass. *See also* Spill light.

Light trespass: *See* Light spillage.

Limestone: A sedimentary rock made mostly of the mineral calcite (calcium carbonate) and usually formed from shells of once-living organisms or other organic processes in a marine environment, but that may also form by inorganic precipitation.

Line: The path, real or imagined, the eye follows when perceiving abrupt differences in form, color, or texture. Within landscapes, lines may be formed by ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

Liquefaction: Refers to a sudden loss of strength and stiffness in loose, saturated soils. It causes a loss of soil stability and can result in large, permanent displacements of the ground.

Listed species: Any species of fish, wildlife, or plant that has been determined, through the full, formal ESA listing process, to be either threatened or endangered.

Loess: A group of windblown soils, largely composed of silt, weakly cemented by calcite.

Low-frequency sound: Sound waves with a frequency in the range of 20 to 80 Hz. The range of human hearing is approximately 20 to 20,000 Hz.

Low-income population: Persons whose average family income is below the poverty line. The poverty line takes into account family size and age of individuals in the family. For any family below the poverty line, all family members are considered to be below the poverty line. In 1999, for example, the poverty line for a family of five with three children below the age of 18 was $19,882.

Mammals: A group of air-breathing animals whose skin is more or less covered with hair or fur and who have mammary glands. Young are born alive (except for the platypus and echidna) and are nourished with milk. Mammals include man, dogs, cats, deer, mice, squirrels, raccoons, bats, opossums, whales, seals, and others.

Mantle: The layer of the earth below the crust and above the core. The uppermost part of the mantle is rigid and, along with the crust, forms the “plates” of plate tectonics. The mantle is made up of dense iron- and magnesium-rich rock.

Marsh: A wetland where the dominant vegetation is nonwoody plants, such as grasses, as compared with a swamp where the dominant vegetation is woody plants, such as trees and shrubs.

Masking: The process by which the threshold of hearing of one sound is raised due to the presence of another sound.

Mechanical noise: Noise caused by the vibration or rubbing of mechanical parts. Sources of mechanical noise from wind turbines include the gearbox, the generator, yaw drives, and cooling fans.

Mesozoic: An era of geologic time between the Paleozoic and the Cenozoic, spanning the time between 251 and 65 million years ago. The word Mesozoic is from Greek and means “middle life.”

Metamorphic rock: A sedimentary or igneous rock that has been changed by pressure, heat, or chemical action. For example, marble is the metamorphosed version of limestone, a sedimentary rock.

Meteorological tower: A wind monitoring system that measures meteorological information such as wind speed, wind direction, and temperature at various heights above the ground. These data are used to evaluate the wind resource at a specific location.

Migration corridor: A route followed by animals such as big game, birds, or fish when traveling between winter and summer habitats.

Migratory Bird Treaty Act of 1918 (MBTA): This act requires that the U.S. Fish and Wildlife Service be consulted to determine the effects of a proposed activity on migratory birds and requires that opportunities to minimize the effects be considered.

Mineral: A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal morphology, and physical properties such as density and hardness. Minerals are the fundamental units from which most rocks are made.

Minority population: Includes Hispanic; American Indian, or Alaskan Native; Asian; Native Hawaiian or Other Pacific Islander; Black (not of Hispanic origin) or African American. “Other” races and multi-racial individuals may be considered as separate minorities.

Missouri Coteau: The Missouri Coteau extends from South Dakota through central North Dakota and into northeastern Montana. It is characterized by a rolling hummocky surface with numerous closed depressions, most of them filled by lakes (also referred to as prairie potholes). The landscape of the coteau represents a “dead ice” moraine, formed from the last glacial advances. The Missouri Coteau and the plains in northern Montana make up the glaciated portion of the Missouri Plateau. *See also* Prairie coteau.

Mitigation: Actions taken to avoid, minimize, rectify, or compensate for any adverse environmental impact.

Montane: The highland area located below the subalpine zone. Montane regions generally have cooler temperatures, and often have higher rainfall than the adjacent lowland regions, and they are frequently home to distinct communities of plants and animals.

Moraine: An accumulation of boulders, stones, or other debris carried and deposited by a glacier.

Multiple use: A combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife, and fish, along with natural scenic, scientific, and historical values.

Multiple use management: Coordinated management of the various surface and subsurface resources, without permanent impairment of the productivity of the land, that will best meet the present and future needs of the people.

NAAQS: *See* National Ambient Air Quality Standards (NAAQS).

Nacelle: The housing that protects the major components (e.g., generator and gear box) of a wind turbine.

Nameplate rating: The maximum amount of power that can be produced by a wind turbine under ideal conditions. It is usually expressed in watts or megawatts of electrical power.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the Clean Air Act, as amended. The primary NAAQS specify maximum outdoor air concentrations of criteria pollutants that would protect the public health within an adequate margin of safety. The secondary NAAQS specify maximum concentrations that would protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Conservation Areas: Areas designated by Congress to provide for the conservation, use, enjoyment, and enhancement of certain natural, recreational, paleontological, and other resources, including fish and wildlife habitat.

National Environmental Policy Act of 1969 (NEPA): This act requires Federal agencies to prepare a detailed statement on the environmental impacts of their proposed major actions significantly affecting the quality of the human environment.

National Historic Preservation Act of 1996, as Amended (NHPA): This act requires Federal agencies to take into account the effects of their actions on historical and archaeological resources and consider opportunities to minimize their impacts.

National Historic Trails: These trails are designated by Congress under the National Trails System Act of 1968 and follow, as closely as possible, on Federal land, the original trails or routes of travel with national historical significance.

National Landscape Conservation System (NLCS): The NLCS was created by the BLM in June 2000 to increase public awareness of BLM lands with scientific, cultural, educational, ecological, and other values. It consists of National Conservation Areas, National Monuments, Wilderness Areas, Wilderness Study Areas, Wild and Scenic Rivers, and National Historic and Scenic Trails.

National Monument: An area owned by the Federal Government and administered by the National Park Service, the BLM, and/or U.S. Forest Service for the purpose of preserving and making available to the public a resource of archaeological, scientific, or aesthetic interest. National monuments are designated by the President, under the authority of the American Antiquities Act of 1906, or by Congress through legislation.

National Parks: National Parks are public lands set aside by an act of Congress because of their unique physical and/or cultural value to the nation as a whole. They are administered by the National Park Service.

National Pollutant Discharge Elimination System (NPDES): A Federal permitting system controlling the discharge of effluents to surface water and regulated through the Clean Water Act, as amended.

National Recreation Area: An area designated by Congress to conserve and enhance certain natural, scenic, historic, and recreational values.

National Recreation Trails: Trails designated by the Secretary of the Interior or the Secretary of Agriculture that are reasonably accessible to urban areas and meet criteria established in the National Trails System Act.

National Register of Historic Places (NRHP): A comprehensive list of districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The NRHP is administered by the National Park Service, which is part of the Department of the Interior.

National Scenic Byway: *See* All-American Roads.

National Scenic Trails: These trails are designated by Congress and offer maximum outdoor recreation potential and provide enjoyment of the various qualities – scenic, historical, natural, and cultural – of the areas through which these trails pass.

National Wild and Scenic River: A river or river section designated by Congress or the Secretary of the Interior, under the authority of the Wild and Scenic Rivers Act of 1968, to protect outstanding scenic, recreational, and other values and to preserve the river or river section in its free-flowing condition.

National Wildlife Refuge: A designation for certain protected areas in the United States managed by the U.S. Fish and Wildlife Service. The National Wildlife Refuge System includes all lands, waters, and interests therein administered by the U.S. Fish and Wildlife Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish, wildlife, and plant resources.

National Weather Service (NWS): The Federal agency responsible for issuing weather, hydrological, and climate forecasts and warnings for the United States to protect the life and property of its citizens and to enhance the national economy.

Native American Graves Protection and Repatriation Act (NAGPRA): This act established the priority for ownership or control of Native American cultural items excavated or discovered on Federal or tribal land after 1990 and the procedures for repatriation of items in Federal possession. The act allows the intentional removal from or excavation of Native American cultural items from Federal or tribal lands only with a permit or upon consultation with the appropriate tribe.

Neotropical migrants: Birds (especially songbirds) that summer in North America but migrate to the tropics for the winter.

NEXRAD: Next Generation Radar. A National Weather Service network of about 140 Doppler radars operating nationwide.

Nitrogen dioxide (NO_2): A toxic reddish brown gas that is a strong oxidizing agent, produced by combustion (as of fossil fuels). It is the most abundant of the oxides of nitrogen in the atmosphere and plays a major role in the formation of ozone.

Nitrogen oxides (NO_x): Nitrogen oxides include various nitrogen compounds, primarily nitrogen dioxide and nitric oxide. They form when fossil fuels are burned at high temperatures and react with volatile organic compounds to form ozone, the main component of urban smog. They are also a precursor pollutant that contributes to the formation of acid rain. Nitrogen oxides are one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Noise: Any unwanted sound that interferes with speech and hearing, causes damage to hearing, or annoys a person.

Noise Control Act of 1972: This act requires that noise levels of facilities or operations not jeopardize public health and safety. States are authorized to establish their own noise levels.

Nominal (measurement): A design value, based on experience and generally reflecting accepted industry practice. A nominal value (e.g., depth of a tower foundation) may change depending on the conditions at a specific location.

Nonattainment area: The U.S. Environmental Protection Agency's designation for an air quality control region (or portion thereof) in which ambient air concentrations of one or more criteria pollutants exceed National Ambient Air Quality Standards.

Nongame species: Those species not commonly harvested either for sport or profit.

Nonpoint-source pollution: Pollution whose source is not specific in location; the sources of the pollutant discharge are dispersed, not well defined or constant. Examples include sediments from logging activities and runoff from agricultural chemicals.

Notice of Intent (NOI): A public notice that an environmental impact statement will be prepared and considered in the decision making for a proposed action.

Noxious plants/noxious weeds: Those plants regulated by law or those that are so difficult to control that early detection is important.

NPDES: *See* National Pollutant Discharge Elimination System (NPDES).

Occupational Safety and Health Administration (OSHA): Congress created the Occupational Safety and Health Administration under the Occupational Safety and Health Act on December 29, 1970. Its mission is to prevent work-related injuries, illnesses, and deaths.

Off-Highway vehicles (OHV) or off-road vehicles: Any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain, except that such term excludes (a) any registered motorboat, (b) any military, fire, emergency, or law enforcement vehicle when used for emergency purposes, and (c) any vehicle whose use is expressly authorized by the respective agency head under a permit, lease, license, or contract.

Oligocene: A geological epoch in the Tertiary period lasting from about 38 to 25 million years ago.

Operator: The party holding the right-of-way grant allowing either monitoring and testing of wind energy resources at a site or commercial development of a wind energy project.

Outwash: Stratified and sorted sediments (chiefly sand and gravel) removed or "washed out" from a glacier by melt-water streams and deposited in front of or beyond the end moraine or the margin of a glacier.

Outwash plain: A smooth plain covered by deposits from water flowing from glaciers.

Overburden: Layers of earth and rock overlying an area or point of interest in the subsurface.

Ozone (O_3): A strong-smelling, reactive toxic chemical gas consisting of three oxygen atoms chemically attached to each other. It is formed in the atmosphere by chemical reactions involving nitrogen oxide and volatile organic compounds. The reactions are energized by sunlight. Ozone is a criteria air pollutant under the Clean Air Act and is a major constituent of smog.

Paleocene: Earliest epoch of the Tertiary period around 65 to 55 million years ago.

Paleontological resources: Any remains, trace, or imprint of a plant or animal that has been preserved in the earth's crust from some past geologic period.

Paleontology: The study of plant and animal life that existed in former geologic periods, particularly through the study of fossils.

Paleozoic: An era of geologic time, from the end of the Precambrian to the beginning of the Mesozoic, spanning the time between 542 and 251 million years ago.

Palustrine wetland: Shallow freshwater wetlands that often support plant communities of trees, shrubs, emergent plants, mosses, or lichens. Palustrine wetlands without such plant communities are small (less than 20 ac) and lack an active wave-formed or bedrock shoreline.

Particulate matter (PM): Fine solid or liquid particles, such as dust, smoke, mist, fumes, or smog, found in air or emissions. The size of the particulates is measured in micrometers (μm). One micrometer is 1 millionth of a meter or 0.000039 in. Particle size is important because the U.S. Environmental Protection Agency has set standards for $PM_{2.5}$ and PM_{10} particulates.

Passeriformes: *See* Passerines.

Passerines: Birds of the order Passeriformes, which include perching birds and songbirds such as the jays, blackbirds, finches, warblers, and sparrows.

Peak horizontal acceleration: A measure of earthquake acceleration (i.e., shaking) on the ground surface expressed in g, the acceleration due to the earth's gravity.

Perennial streams: Streams that flow continuously, because they lie at or below the groundwater table that constantly replenishes them.

Permissible exposure limit (PEL): The maximum amount or concentration of a chemical that a worker may be exposed to under Occupational Safety and Health Administration regulations.

Personal protective equipment (PPE): Clothing and equipment worn to reduce exposure to potentially hazardous chemicals and other pollutants.

Photovoltaic (PV) system: A system that converts light into electric current.

Physiography: The physical geography of an area or the description of its physical features.

Pitch: The orientation of a turbine blade relative to the direction of the wind.

Pitch control: Continuous adjustment of the orientation of a turbine blade's airfoil in order to achieve maximum efficiency or maintain the rotation speed within design limits.

Plains: An extensive area that ranges from level to gently sloping or undulating.

Plateau: A large, flat area of land that is higher than the surrounding land.

Playa/playa lake: Playas form in arid basins where rivers merge but do not drain. They are flat areas that contain seasonal or year-to-year shallow lakes that often evaporate leaving minerals behind.

Plutonic: Pertaining to a class of igneous rocks that have solidified far below the earth's surface.

PM: *See* Particulate matter.

PM_{10}: Particulate matter with a mean aerodynamic diameter of 10 μm (0.0004 in.) or less. Particles less than this diameter are small enough to be deposited in the lungs. PM_{10} is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

$PM_{2.5}$: Particulate matter with a mean aerodynamic diameter of 2.5 μm (0.0001 in.) or less.

Point source emissions: A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; examples include power plants, refineries, ore pits, factory smokestacks.

Policy: A plan of action adopted by an organization. Policies adopted as part of the proposed Wind Energy Development Program would establish a system for the administration and management of wind energy development on BLM-administered lands.

Pollutant: Any material entering the environment that has undesired effects.

Pollutant load/loading: The total amount of pollutants entering a water body from one or multiple sources (measured as a rate, as in weight per unit time or per unit area).

Polychlorinated biphenyls (PCBs): A group of manufactured organic compounds made up of carbon, hydrogen, and chlorine. They were used in the manufacture of plastics and as insulating fluids for electrical equipment. Because they are very stable and fat-soluble, they accumulate in ever-higher concentrations as they move up the food chain. Their use was banned in the United States in 1979.

Population: A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.

Potable water: Water that can be used for human consumption.

Pothole: A type of small pit or closed depression commonly containing an intermittent or seasonal pond or marsh. *See also* Prairie pothole.

Prairie and grassland easements: Prairie and grassland easements were designed by the U.S. Fish and Wildlife Service as complimentary programs to help protect native prairie and grassland resources. Through these easements, the U.S. Fish and Wildlife Service purchases certain property rights, including the right to plow or destroy the grassland. Grazing, haying, mowing, and grass-seed harvest are restricted. Some of these agricultural practices, depending upon the condition of the land and the desire of the landowners, are still allowed with certain easements. If a landowner's land is covered by native prairie that has never been plowed, the landowner is eligible for a prairie easement. If the land contains wetlands and the landowner wants to maintain or restore grassland cover, the landowner is eligible for a grassland easement. *See also* Conservation easement; Easement; Grasslands easement; Wetlands easement; and Wetlands Reserve Program easement.

Prairie coteau: A plateau approximately 200 mi long and 100 mi wide, rising from the prairie flatlands in eastern South Dakota, southwestern Minnesota, and northwestern Iowa in the United States. *See also* Missouri Coteau.

Prairie potholes: Shallow depressional wetlands found most often in the Upper Midwest: the Upper Great Plains Region of Minnesota, the Dakotas, Montana, and north into Canada. This formerly glaciated landscaped is pockmarked with an immense number of potholes, which fill with snowmelt and rain in the spring. The Prairie Pothole Region includes all or portions of the Northwestern Glaciated Plains, Northwestern Great Plains, Northern Glaciated Plains, Lake Agassiz Plain, Northcentral Hardwood Forests, and Western Cornbelt Plains ecoregions. *See also* Pothole.

Precambrian: The oldest and largest division of geologic time, between the consolidation of the earth's crust and the beginning of the Cambrian period. It includes all time from the origins of the earth to about 542 million years ago; about 3.3 billion years in duration.

Prevention of Significant Deterioration (PSD) Program: An air pollution-permitting program intended to ensure that air quality does not diminish in attainment areas.

Production Tax Credit (PTC): The Production Tax Credit was a Federal policy that promoted the development of renewable energy (including wind energy). It provided qualifying facilities with an annual tax credit based on the amount of electricity that was generated. The Production Tax Credit expired December 31, 2003.

Public land: Any land and interest in land (outside of Alaska) owned by the United States and administered by the Secretary of the Interior through the BLM.

Pulse: A single short duration transmission of electromagnetic energy.

Putrescible waste: Solid waste that contains organic matter that can rot or decompose.

Quaternary: The most recent period of the Cenozoic era, spanning the time between 2.6 million years ago and the present. It contains two epochs: the Pleistocene and the Holocene.

Radar: An acronym for Radio Detection And Ranging; a method of detecting the distance, size, and movement of objects by their reflection of radio waves.

Radar attenuation: The absorption or reflection of radar signals by a weather cell, preventing that radar from detecting any additional cells that might lie behind the first cell.

Radar cell: Describes the radar echo returned by an individual shower or thunderstorm.

Radar clutter: Unwanted signals, echoes, objects, or images on the face of a radar display caused by unwanted reflections in a radar return. As an example, heavy rain or snow can obscure areas on a radarscope. *See also* Ground clutter.

Radar interference: Unwanted or confusing signals or patterns produced on the radarscope by another radar or transmitter on the same frequency.

Rain shadow: A region on the leeward (downwind) side of a mountain range where rainfall is noticeably less than the windy (windward) side of a mountain.

Rangeland: Land on which the native vegetation, climax, or natural potential consists predominately of grasses, grasslike plants, forbs, or shrubs. Rangeland includes lands that are revegetated naturally or artificially to provide a plant cover that is managed similar to native vegetation. Rangelands may consist of natural grasslands, savannas, shrub lands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows.

Raptor: Bird of prey.

Raster: A spatial data model that defines space as an array of equally sized cells arranged in rows and columns, and composed of single or multiple bands. Each cell contains an attribute value and location coordinates. Unlike a vector structure, which stores coordinates explicitly, raster coordinates are contained in the ordering of the matrix. Groups of cells that share the same value represent the same type of geographic feature.

RCRA: *See* Resource Conservation and Recovery Act of 1976.

Receptor: The individual or resource being affected by the impact.

Recharge: The addition of water to an aquifer by natural infiltration (e.g., rainfall that seeps in to the ground) or by artificial injection through wells.

Reflection: The process whereby radiation (or other waves) incident upon a surface is directed back into the medium through which it traveled.

Refraction: Changes in the direction of energy propagation as the result of density changes within the propagating medium. In weather terms, this is important in determining how a radar beam reacts in the atmosphere. *See also* Atmospheric refraction.

Refugium: An area where special environmental circumstances have enabled a species or a community of species to survive after extinction in surrounding areas.

Region of influence (ROI): Area occupied by affected resources and the distances at which impacts associated with license renewal may occur.

Renewable energy: Energy derived from resources that are regenerative or that cannot be depleted. Types of renewable energy resources include wind, solar, biomass, geothermal, and moving water.

Renewable Energy Portfolio Standard (RPS): A policy set by Federal or State governments that a percentage of the electricity supplied by electricity generators be derived from a renewable source.

Renewable energy zone: Areas with high concentrations of developable renewable energy resources that can meet regional energy demand.

Reptile: Cold-blooded vertebrate of the class Reptilia whose skin is usually covered in scales or scutes. Reptiles include snakes, lizards, turtles, crocodiles, and alligators.

Resource Conservation and Recovery Act (RCRA): This act regulates the storage, treatment, and disposal of hazardous and nonhazardous wastes.

Richter Magnitude Scale: Developed in 1935 by Charles Richter to measure and compare the size of earthquakes. The magnitude is determined from the logarithm of the amplitude of waves recorded by seismographs.

Right-of-way (ROW): Public land authorized to be used or occupied pursuant to a ROW grant. A ROW authorizes the use of a ROW over, upon, under, or through public lands for construction, operation, maintenance, and termination of a project.

Riparian: Relating to, living in, or located on the bank of a river, lake, or tidewater.

Riverine wetland: Wetlands within river and stream channels, generally characterized by flowing water. Ocean-derived salinity is less than 0.5 parts per thousand.

Rotational speed: The rate (in revolutions per minute) at which a turbine blade makes a complete revolution around its axis. Wind turbine speeds can be fixed or variable.

Rotor: The portion of a modern wind turbine that interacts with the wind. It is composed of the blades and the central hub to which the blades are attached.

Sacred landscapes: Natural places recognized by a cultural group as having spiritual or religious significance.

Sacred sites: Any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriate authoritative representative of an Indian religion has informed the agency of the existence of such a site.

Safe Drinking Water Act (SDWA): This act authorizes development of maximum contaminant levels for drinking water applicable to public water systems (i.e., systems that serve at least 25 people or have at least 15 connections).

Sag: The distance the conductor droops below a straight line between adjacent points of support.

Sanitary wastewater: Wastewater (includes toilet, sink, shower, and kitchen flows) generated by normal housekeeping activities.

Savannah: A flat grassland of tropical and subtropical regions usually having distinct periods of dry and wet weather.

Scenic integrity: The degree of "intactness" of a landscape, which is related to the existing amount of visual disturbance present. Landscapes with higher scenic integrity are generally regarded as more sensitive to visual disturbances.

Scenic quality: A measure of the intrinsic beauty of landform, water form, or vegetation in the landscape, as well as any visible human additions or alterations to the landscape.

Scenic resources: The visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features). Also referred to as visual resources. *See* Visual resources.

Scenic value: The importance of a landscape based on human perception of the intrinsic beauty of landform, water form, and vegetation in the landscape, as well as any visible human additions or alterations to the landscape.

Scoping: The scoping process is used to solicit public input on potential issues and whether there is a potential for significant adverse effects on the human environment from a proposed energy project, and identify the scope of the Environmental Assessment or Environmental Impact Statement to be prepared.

Section 7 of the ESA: The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the U.S. Fish and Wildlife Service, ensure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat.

Sedges: Perennial nonwoody plants that resemble grasses in that they have relatively narrow leaves. They are common to most freshwater wetlands.

Sediment: Materials that sink to the bottom of a body of water, or materials that are deposited by wind, water, or glaciers.

Sedimentary rock: Rock formed at or near the earth's surface from the consolidation of loose sediment that has accumulated in layers through deposition by water, wind, or ice, or deposited by organisms. Examples are sandstone and limestone.

Sedimentation: The removal, transport, and deposition of sediment particles by wind or water.

Seepage: The act or process involving the slow movement of water or other fluid through a porous material such as soil or rock.

Seeps: Wet areas, normally not flowing, arising from an underground water source. Any place where liquid has oozed from the ground to the surface.

Seismic: Pertaining to any earth vibration, especially that of an earthquake.

Seismic zone: An area within which the seismic-design requirements are constant.

Sensitive species: A plant or animal species listed by the State or Federal government as threatened, endangered, or as a species of special concern.

Shadow flicker: Refers to the flickering effect that occurs when a wind turbine casts shadows over structures and observers at times of day when the sun is directly behind the turbine rotor from an observer's position. Shadow flicker can have a disorienting effect on a small segment of the general population.

Shadow zone: The region where direct sound does not penetrate because of upward diffraction due to vertical temperature and/or wind gradients.

Shake-down tests: Tests conducted to demonstrate that equipment is operational and meets performance requirements.

Shale: A fine-grained sedimentary rock characterized by parallel layering.

Shrub steppe: Habitat composed of various shrubs and grasses.

Silt: Sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

Siltation: The deposition or accumulation of silt.

Sinkhole: A closed, circular or elliptical depression, commonly funnel-shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock or by collapse of underlying caves within bedrock.

Sky glow: Brightening of the sky caused by outdoor lighting and natural atmospheric and celestial factors.

Skylining: Siting of a structure on or near a ridge line so that it is silhouetted against the sky.

Slash: Any tree-tops, limbs, bark, abandoned forest products, windfalls, or other debris left on the land after timber or other forest products have been cut.

Slip: Motion occurring along a fault plane.

Slope failure: The downward and outward movement of a mass of rock or unconsolidated materials as a unit. Landslides and slumps are examples.

Slope stability: The resistance of an inclined surface to failure by sliding or collapsing.

Small game: Mid-size mammal species that include carnivores, rabbits, and squirrels.

Socioeconomics: The social and economic conditions in the study area.

Soil compaction: Compression of the soil that results in reduced soil pore space (the spaces between soil particles), decreased movement of water and air into and within the soil, decreased soil water storage, and increased surface runoff and erosion.

Soil deposition: A general term for the accumulation of sediments by either physical or chemical sedimentation.

Soil horizon: A layer of soil developed in response to localized chemical and physical processes resulting from the activities of soil organisms, the addition of organic matter, precipitation, and water percolation through the layer.

Soil horizon mixing: Soil horizon mixing occurs when soil is disturbed by activities such as excavation.

Soil mantle: All the loose or weathered material, residual or transported, overlying the parent rock.

Solar energy: Electromagnetic energy emitted from the sun (solar radiation). The amount that reaches the earth is equal to one billionth of total solar energy generated, or the equivalent of about 420 trillion kilowatt-hours.

Sole source aquifer: An aquifer that supplies 50% or more of the drinking water of an area.

Solid waste: All unwanted, abandoned, or discarded solid or semisolid material, whether subject to decomposition or not, originating from any source.

Solid Waste Disposal Act: An act that regulates the treatment, storage, or disposal of solid hazardous and nonhazardous waste.

Sound pressure level: The level, in decibels, of acoustic pressure waves. Very loud sounds have high sound pressure levels; soft sounds have low sound pressure levels. A 3-dB increase in sound doubles the sound pressure level. Zero decibels is the threshold of human hearing. The maximum level of human hearing is around a 120-dB sound pressure level, which is the level where people begin to experience pain because of the high sound pressure levels.

Source: Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources and sources that move are mobile sources.

Special areas: Areas of high public interest and containing outstanding natural features or values. Special areas include National Wild and Scenic Rivers, National Wildernesses, National Conservation Areas, National Scenic Areas, National Recreation Areas, locations registered in the National Monuments, National Outstanding Natural Areas, locations registered in the *National Register of Historic Places*, National Historic Landmarks, National Natural Landmarks, National Recreational Trails, National Scenic Trails, National Historic Trails, National Backcountry Byways, Areas of Critical Environmental Concern, Research Natural Areas, Important Bird Areas, United Nations Biosphere Reserves, and World Heritage Sites.

Special status species: Special status species include both plant and animal species that are proposed for listing, officially listed as threatened or endangered, or are candidates for listing as threatened or endangered under the provisions of the Endangered Species Act; those listed by a State in a category such as threatened or endangered, implying potential endangerment or extinction; and those designated by each BLM State Director as sensitive.

Species of special concern: A species that may have a declining population, limited occurrence, or low numbers for any of a variety of reasons.

Specular reflection: The mirror-like reflection of light (or other forms of radiation) from a surface, in which light from a single incoming direction is reflected into a single outgoing direction.

Spill light: Light that falls outside the area to be lighted. *See* Light spillage.

Staging area: A designated area where construction equipment is temporarily stored (usually only during the construction phase).

State Historic Preservation Officer (SHPO): The State officer charged with the identification and protection of prehistoric and historic resources in accordance with the National Historic Preservation Act.

Stratigraphy, subsurface: The arrangement (in layers) of different types of geologic materials located below the surface of an area.

Subalpine: The growing or living conditions in mountainous regions just below the timberline.

Subsidence: Sinking or settlement of the land surface, due to any of several processes. As commonly used, this term relates to the vertical downward movement of natural surfaces although small-scale horizontal components may be present. The term does not include landslides, which have large-scale horizontal displacements, or settlements of artificial fills.

Subsistence: The practices by which a group or individual acquires food, such as through hunting and gathering, fishing, and agriculture.

Substation: A substation consists of one or more transformers and their associated switchgear. It is used to switch generators, equipment, and circuits or lines in and out of a system. It is also used to change AC voltages from one level to another.

Sulfur dioxide (SO_2): A gas formed from burning fossil fuels. Sulfur dioxide is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Surface runoff: Precipitation runoff over the landscape.

Surface rupture: The breakage of ground along the surface trace of a fault caused by the intersection of the fault surface area ruptured in an earthquake with the earth's surface.

Surface water: Water on the earth's surface that is directly exposed to the atmosphere, as distinguished from water in the ground (groundwater).

Surficial: Of, relating to, or occurring on or near the earth's surface.

Switchgear: A group of switches, relays, circuit breakers, etc. Used to control distribution of power to other distribution equipment and large loads.

Synergism: The added effect produced by two processes working in combination, resulting in a value greater than the simple sum of each process.

Tailings: Leftovers from a refining process; refuse material separated as residue.

Take: From Section 3(18) of the Federal Endangered Species Act: "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." *See also* Incidental take.

Tariff: A compilation of all effective rate schedules of a particular company or utility. Tariffs include General Terms and Conditions along with a copy of each form of service agreement.

Taxon: One or more organisms that belong to the same taxonomic unit. Taxonomy is the field of science that classifies life.

Terrace: A step-like surface, bordering a valley floor or shoreline, that represents the former position of a floodplain, lake, or sea shore.

Terrain: Topographic layout and features of a tract of land or ground.

Terrestrial: Pertaining to plants or animals living on land rather than in the water.

Tertiary volcanics: Volcanic rocks deposited during the Tertiary period (between 2.8 and 65 million years ago). The Tertiary period was a time of extensive volcanism in what is now the western United States.

Texture: The visual manifestations of light and shadow created by the variations in the surface of an object or landscape.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act.

Tiering: Tiering refers to the coverage of general matters in broader Environmental Impact Statements (such as national program or policy statements); subsequent narrower statements or environmental analyses (such as regional or ultimately site-specific statements) are "tiered" to the broader, general statements and incorporate them by reference. The narrower statements concentrate solely on the issues specific to the site.

Tip speed or rotor tip speed: The speed of the tip of a rotor blade as it travels along the circumference of the rotor-swept area.

Tip speed ratio: The ratio of the speed of the tip of a rotating blade to the speed of the wind.

Tonal noise: Discrete frequency noise characterized as annoying and repetitive.

Topography: The shape of the earth's surface; the relative position and elevations of natural and human-made features of an area.

Tornado Alley: A geographic corridor in the Midwest United States that stretches north from Texas to Nebraska and Iowa. In terms of sheer numbers, this section of the United States receives more (often very destructive) tornadoes than any other.

Tower: The base structure that supports and elevates a wind turbine rotor and nacelle.

Toxicity: Harmful effects to an organism through exposure to a hazardous substance. Environmental exposures primarily take place through inhalation, ingestion, or the skin.

Toxic Substances Control Act (TSCA): An act authorizing the U.S. Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment.

Traditional cultural property: A property that is eligible for inclusion in the National Register of Historic Places because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community. An example would be a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.

Transformer: A device for transferring AC electric power from one circuit to another in a system. Transformers are also used to change voltage from one level to another.

Transmission: An interconnected group of lines and associated equipment for the movement or transfer of electric energy between points of supply and points at which it is transformed for delivery to customers or is delivered to other electric systems.

Transmission corridor: A route approved on public lands, in a BLM or other Federal agency land use plan, as a location that may be suitable for the siting of electric or pipeline transmission systems. *See also* Corridor.

Transmission line: A system of structures, wires, insulators and associated hardware that carry electric energy from one point to another in an electric power system. Lines are operated at relatively high voltages, from 69 kV up to 765 kV, and are capable of transmitting large quantities of electricity over long distances.

Transmission system: An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems.

Tundra: *See* Alpine tundra.

Turbidity: A measure of the cloudiness or opaqueness of water. Typically, the higher the concentration of suspended material, the greater the turbidity.

Turbine: A device in which a stream of water or gas turns a bladed wheel, converting the kinetic energy of the fluid flow into mechanical energy available from the turbine shaft. Turbines are considered the most economical means of turning large electrical generators. They are typically driven by steam, fuel vapor, water, or wind. *See also* Wind turbine.

Turbine spacing: The distance between wind turbines in a string. This distance is generally proportional to the rotor diameter.

Upper Great Plains (UGP) Region: The UGP includes Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota. Part or all of these States are within Western's UPG region and include grassland and wetland easements managed by Regions 3 and 6 of the U.S. Forest Service.

Upwind turbine: A turbine whose rotor and blades are oriented to the upwind (the direction from which the wind is blowing) side of the turbine's support structure.

U.S. Environmental Protection Agency (EPA): The independent Federal agency, established in 1970, that regulates Federal environmental matters and oversees the implementation of Federal environmental laws.

U.S. Fish and Wildlife Service (Service): The U.S. Fish and Wildlife Service, a bureau within the Department of the Interior. Its mission is to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service manages the 93-million-ac (37.6-million-ha) National Wildlife Refuge System, which consists of more than 520 National Wildlife Refuges and thousands of small wetlands and other special management areas. The Service also operates 66 National Fish Hatcheries, 64 fishery resource offices, and 78 ecological services field stations. Among its key functions, the Service enforces Federal wildlife laws, protects threatened and endangered species, manages migratory birds, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their international conservation efforts.

Utility-scale energy generation: Facilities that generate large amounts of electricity that is delivered to many users through transmission and distribution systems.

Vertebrate: Any species having a backbone or spinal column, including fish, amphibians, reptiles, birds, and mammals.

Vibroacoustic disease (VAD): A whole-body, systemic pathology, characterized by the abnormal proliferation of extra-cellular matrices, and caused by excessive exposure to low frequency noise (LFN). VAD has been observed in LFN-exposed professionals, and has also been observed in several populations exposed to environmental LFN.

Viewshed: The total landscape seen or potentially seen from all or a logical part of a travel route, use area, or water body.

Visibility factors: Conditions or other phenomena that affect the visibility or appearance of an object or a landscape. Examples of visibility factors include distance, lighting conditions, air quality, atmospheric conditions, and viewing angle.

Visual absorption: The physical capacity of a landscape to accept human alterations without loss of its inherent visual character or scenic quality.

Visual attention: Noticing and focusing of vision on a particular object or landscape element.

Visual clutter: The complex visual interplay of numerous disharmonious landscape characteristics and features resulting in a displeasing view.

Visual contrast: Opposition or unlikeness of different forms, lines, colors, or textures in a landscape.

Visual impact: Any modification in landforms, water bodies, or vegetation, or any introduction of structures, which negatively or positively affect the visual character or quality of a landscape through the introduction of visual contrasts in the basic elements of form, line, color, and texture.

Visual intrusion: Any human-caused change in the landform, water form, vegetation, or the addition of a structure that creates a visual contrast in the basic elements (form, line, color, texture) of the naturalistic character of a landscape.

Visual quality: *See* Scenic quality.

Visual resource management (VRM): The planning, design, and implementation of management objectives for maintaining scenic values and visual quality.

Visual resources: The composite of basic terrain, geologic features, hydrologic features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal that the unit may have. *See also* Scenic resources.

Volatile organic compounds (VOCs): A broad range of organic compounds that readily evaporate at normal temperatures and pressures. Sources include certain solvents, degreasers (benzene), and fuels. VOCs react with other substances (primarily nitrogen oxides) to form ozone. They contribute significantly to photochemical smog production and certain health problems.

Voltage flicker: A noticeable dimming of a light source for a fraction of a second (flicker) caused by a sudden dip in voltage. Some people can detect dips as low as a third of a volt.

Waste management: Procedures, physical attributes, and support services that collectively provide for the identification, containerization, storage, transport, treatment (as necessary), and disposal of wastes generated in association with an activity.

Watershed: An area from which water drains to a particular body of water. Watersheds range in size from a few acres to large areas of the country.

Western Area Power Administration (Western): A Federal power marketing authority that owns or operates generation and transmission facilities primarily in the interior western United States.

Wetlands: Areas that are soaked or flooded by surface or groundwater frequently enough or long enough to support plants, birds, animals, and aquatic life. Wetlands generally include swamps, marshes, bogs, estuaries, and other inland and coastal areas and are federally protected.

Wetlands easement: A legal agreement signed with the United States, through the U.S. Fish and Wildlife Service, that pays the landowner to permanently protect wetlands. Wetlands covered by an easement cannot be drained, filled, leveled, or burned. When these wetlands dry up naturally, they can be farmed, grazed, or hayed. *See also* Easement; Conservation easement; Grassland easement; Prairie and Grassland easements; and Wetlands Reserve Program easement.

Wetlands Reserve Program (WRP) easement: The WRP is a U.S. Department of Agriculture program offering payments to landowners for restoring and protecting wetlands on their property. By signing a Wetlands Reserve Program easement, a landowner transfers most land-use rights to the U.S. Department of Agriculture. However, some uses, such as haying or grazing, can be granted back to the landowner at U.S. Department of Agriculture's discretion. The Farm Security and Rural Investment Act of 2002 set the national aggregate cap for the WRP at 2,275,000 ac nationwide. *See also* Easement; Conservation easement; Grassland easement; Prairie and Grassland easements; and Wetlands easement.

Wilderness Areas: Areas designated by Congress and defined by the Wilderness Act of 1964 as places "where the earth and its community are untrammeled by man, where man himself is a visitor who does not remain." Designation is aimed at ensuring that these lands are preserved and protected in their natural condition.

Wilderness Study Areas (WSAs): Areas designated by a federal land management agency as having wilderness characteristics, thus making them worthy of consideration by Congress for wilderness designation.

Wild horses and burros: Unbranded and unclaimed horses or burros roaming free on public lands in the western United States and protected by the Wild Free-roaming Horse and Burro Act of 1971. They are descendants of animals turned loose by, or escaped from, ranchers, prospectors, Indian tribes, and the U.S. cavalry form the late 1800s through the 1930s.

Wind energy: The kinetic energy of wind converted into mechanical energy by wind turbines (i.e., blades rotating from a hub) that drive generators to produce electricity for distribution. *See also* Wind power.

Wind farm: One or more wind turbines operating within a contiguous area for the purpose of generating electricity.

Wind power: Power generated using a wind turbine to convert the mechanical power of the wind into electrical power. *See also* Wind energy.

Wind power class: A way of quantifying on a scale level the strength of the wind at a project site. The National Renewable Energy Laboratory defines the wind class on a scale from 1 to 7 based on average wind speed and power density to offer guidance to potential developers as to where wind projects might be feasible. Class 7 has the highest potential wind power generation and Class 1 has the lowest.

Wind resource areas (WRAs): Areas where wind energy is available for use based on historical wind data, topographic features, and other parameters.

Wind rose: A circular diagram, for a given locality or area, showing the frequency and strength of the wind from various directions over a specified period of record.

Wind shadow: The area behind an obstacle in which air movement is not capable of moving material.

Wind shear: The change, sometimes severe, in wind direction caused primarily by geographic features and obstructions near the land surface.

Wind tower: The base structure supporting and elevating the nacelle and the rotor of a wind turbine.

Wind turbine: A term used for a device that converts wind energy to electricity.

Xeric: Low in moisture.

Yaw: Side-to-side movement. For wind turbines, it refers to the angle between the axis of the rotor shaft and the wind direction. As this angle increases, the turbine’s ability to capture the wind’s energy decreases.

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APPENDIX A

SCOPING SUMMARY REPORT

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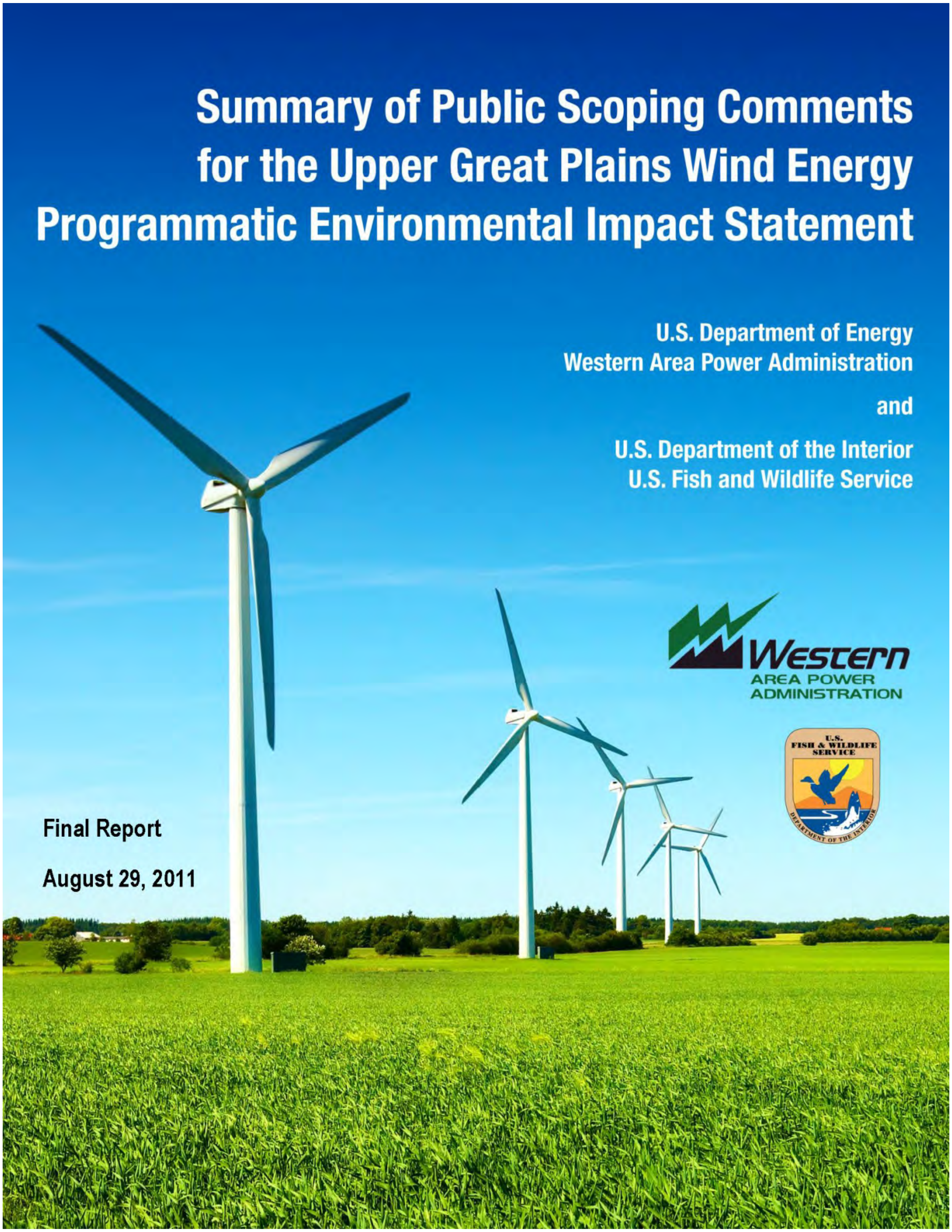
APPENDIX A

SCOPING SUMMARY REPORT



SUMMARY OF PUBLIC SCOPING COMMENTS FOR THE UPPER GREAT PLAINS WIND ENERGY PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Prepared by

Environmental Science Division
Argonne National Laboratory

for

U.S. Department of Energy
Western Area Power Administration

and

U.S. Department of the Interior
Fish and Wildlife Service

Final Report

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CONTENTS

NOTATION

AWEA	American Wind Energy Association
BIA	Bureau of Indian Affairs
BMPs	best management practices
EIS	environmental impact statement
ESA	Endangered Species Act
GIS	Geographic Information System
LGI	Large Generator Interconnection
MISO	Midwest Independent Transmission System Operator
NEPA	National Environmental Policy Act
NOI	Notice of Intent
PEIS	programmatic environmental impact statement
SGI	Small Generator Interconnection
UGP	Upper Great Plains
USEPA	U.S. Environmental Protection Agency
Service	U.S. Fish and Wildlife Service
Western	Western Area Power Administration

SUMMARY OF PUBLIC SCOPING COMMENTS FOR THE UPPER GREAT PLAINS WIND ENERGY PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

John W. Hayse and Kirk E. LaGory
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1 INTRODUCTION

In Executive Order 13212 (*Actions to Expedite Energy-Related Projects*, 2001), the President ordered that executive departments and agencies take appropriate actions "to expedite projects that will increase the production, transmission, or conservation of energy." The U.S. Department of Energy's Western Area Power Administration (Western) and the U.S. Department of the Interior, Fish and Wildlife Service (the Service), have identified wind energy development as a potentially critical component in meeting this mandate. To help accomplish this national goal, Western and the Service are considering the implementation of agency-specific programs that would establish environmental policies and mitigation strategies for wind energy development within Western's Upper Great Plains Customer Service Region (UGP Region), which encompasses all or parts of the states of Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota, and upon the Service's landscape-level grassland and wetland easements in North Dakota, South Dakota, and eastern Montana. The upper Great Plains of the United States has been identified as having a high potential for wind energy development due to the availability of a suitable wind resource regime.

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate, and disclose to the public, the environmental impacts of any major action they are planning. Western and the Service have decided that establishing agency-specific programs for wind energy development in the aforementioned areas would constitute a major federal action, and they have elected to prepare an environmental impact statement (EIS) that will describe alternative ways the proposed programs could be structured and implemented and the environmental impacts associated with those alternatives.

Western and the Service both have interests in establishing programs that would guide and streamline their processes for evaluating wind energy applications and for developing guidelines and mitigation measures to minimize the environmental impacts associated with wind energy projects in the upper Great Plains area. There is also a potential that the decision of one agency regarding wind energy projects could affect interests of the other agency due to the general overlap in the areas where such developments could occur and the potential for wind energy facilities that affect Service easements to connect to Western's transmission system. Consequently, Western and the Service have agreed to co-lead the development of a programmatic EIS (PEIS) to evaluate the environmental impacts associated with their proposed programs.

Public involvement is an important requirement of NEPA, especially for determining the appropriate scope of the analyses to be conducted. The scope includes the range of alternatives that will be considered and potentially significant impacts that should be evaluated. This public involvement process (which also includes other state and federal agencies and Indian tribes) is referred to as scoping. As part of the public involvement process, a Notice of Intent (NOI) to prepare the Upper Great Plains Wind Energy Programmatic Environmental Impact Statement (PEIS) was published in the *Federal Register* on September 11, 2008 (73 FR 52855-52858). This NOI invited interested members of the public to provide comments on the scope and objectives of the PEIS, including identification of issues and alternatives that should be considered in the PEIS analyses. Western and the Service conducted scoping for the PEIS from September 11, 2008, through November 10, 2008. This report presents a summary of the comments that were received during the scoping period.

2 SCOPING PROCESS

2.1 APPROACH

The public was provided with three methods for submitting scoping comments for the UGP Wind Energy PEIS: (1) via the online comment form on the project Web site, (2) by mail, and (3) in person at public scoping meetings. Public scoping meetings were held at three locations in September and October 2008:

- Sioux Falls, South Dakota (September 30, 2008);
- Bismarck, North Dakota (October 1, 2008); and
- Billings, Montana (October 2, 2008).

At each meeting, Western and the Service presented background information about the UGP Wind Energy PEIS, and a representative from the U.S. Department of Energy's National Renewable Energy Laboratory presented information about wind energy resources and technologies. The presentation materials from these meetings, including electronic versions of slides and posters, are available on the project Web site (http://plainswindeis.anl.gov). Following the presentations, attendees were invited to ask questions and to provide scoping comments for the PEIS. The verbal proceedings at each of the public scoping meetings, including presentations, questions, and comments, were recorded. Transcripts prepared from those recordings are available on the project Web site (http://plainswindeis.anl.gov).

2.2 SCOPING PARTICIPATION

Ninety-four people registered at the public scoping meetings held during October and November 2008. The Sioux Falls, South Dakota, meeting drew the most people (42), followed by the Bismarck, North Dakota (39), and Billings, Montana (13), meetings. Approximately

17 individuals provided verbal comments at one or more of the public meetings, and seven people submitted written comments at the public scoping meetings that were not read into the public record.

Twenty-five sets of comments were submitted via the comment form on the project Web site or by e-mail, and two additional comment letters (that had not also been submitted via the comment form on the Web site) were received by postal mail. Written comments are available for viewing on the public Web site (http://plainswindeis.anl.gov). Nearly all of the comments submitted originated from states within the study area.

Federal agencies that provided comments included:

- U.S. Environmental Protection Agency (USEPA)

State agencies that provided comments included:

- Minnesota Department of Natural Resources
- North Dakota Department of Agriculture
- South Dakota Energy Policy Office

Local government agencies and organizations that provided comments included:

- City of Minot, North Dakota
- City of Velva, North Dakota
- McHenry County Jobs Development Authority
- Minot Area Chamber of Commerce
- Minot Area Development Corporation
- South Prairie School District #70, Minot, North Dakota
- Velva Community Development Corporation

Industry organizations and businesses that provided comments included:

- American Wind Energy Association
- Basin Electric Power Cooperative
- Central Electric Cooperative
- East River Electric Power Cooperative
- Farm Credit Services of North Dakota
- Irrigation and Electrical Districts Association of Arizona
- Mid-West Electric Consumers Association
- National Wind, LLC
- South Dakota Public Utilities Commission
- Verendrye Electric Cooperative

Native American organizations that submitted comments included:

- Intertribal Council on Utility Policy

Environmental organizations that provided comments are:

- Defenders of Wildlife
- Montana Audubon
- National Wildlife Federation
- The Nature Conservancy

In addition, some elected officials (including South Dakota State Representative Mike Vehle, and the mayors of Velva, South Dakota, and Minot, South Dakota) provided verbal or written comments at the public scoping meetings.

3 SUMMARY OF SCOPING COMMENTS

The comments received during the public scoping period for the UGP Wind Energy PEIS are summarized in this section. Specific comments and their context are not fully presented in this report, only the relevant issues raised in those comments as they apply to the preparation of the PEIS. Copies of all written scoping comments submitted by mail, via an online comment form, or in person at public meetings are available for viewing on the PEIS project Web site (http://plainswindeis.anl.gov). Transcripts of verbal comments received at the public meetings are also available on the Web site.

Issues raised in comments were categorized as those pertaining to the (1) policies of the agencies relative to wind energy; (2) alternatives that should be considered in the PEIS; (3) interagency cooperation and government-to-government consultation; (4) siting and technology concerns; (5) environmental and socioeconomic concerns; (6) cumulative impacts; and (7) mitigation of impacts.

3.1 AGENCY POLICIES

Commenters identified a number of policy issues related to wind energy, including:

Need for the PEIS and Overall Project Scope. A number of commenters specifically indicated support for the proposed action by the agencies to develop a regionwide management program for evaluating wind energy projects. They recognized the excellent wind resource potential of the project area, which, if developed, could reduce some of the adverse environmental impacts associated with the use of conventional sources of energy. For example, commenters pointed out that wind energy projects do not emit carbon dioxide during their operation and that use of this power source could potentially alleviate global climate change. Further, some commenters stated that utilizing wind in place of conventional fossil fuels could also reduce water consumption by the electrical generation sector. Some commenters stated that wind energy should be seen as a necessary component of the energy mix from a national energy policy perspective, including one means of reducing dependence on foreign sources of energy. In a number of cases, commenters identified support for specific wind energy projects that are proposed or under development rather than providing comments on the programmatic-level action being proposed by Western and the Service.

Most commenters agreed with the programmatic approach identified in the NOI. However, a few commenters questioned the need for the PEIS. One commenter suggested that a PEIS may not provide sufficient detail to be meaningful and that the PEIS is trying to cover too much ground. It was also suggested in one comment that some of the work envisioned by the PEIS appears to already have been done, although specific examples were not provided.

One comment suggested that calling for the development of a "guide for wind energy development in the Upper Great Plains" goes far beyond an assessment of the impacts of wind energy and beyond the scope and jurisdiction of the Endangered Species Act (ESA). While one comment stated that the PEIS should concern itself with environmental stewardship alone and the issues of environmental impacts and development of wind energy should be kept separate, this appears to be contrary to the designated purpose of an EIS.

Best Management Practices (BMPs) or Environmental Guidelines. Many comments related to the establishment and use of BMPs, mitigation measures, or specific environmental guidelines. Several commenters representing the wind and power industry supported the identification and establishment of BMPs to facilitate future development but stated a preference for flexible BMPs applied on a project- and site-specific basis. One comment from an industry representative offered assistance to the agencies with development of BMPs for the PEIS if desired. Concerns were also expressed regarding imposing mitigation measures that would be considered severely restrictive or that would greatly affect the economic viability of individual wind energy projects. Most of the specific BMPs/mitigation measures/guidelines mentioned by the commenters were related to the protection of natural resources (see Section 3.5). One commenter recommended that full consideration be given to recommendations from the Department of the Interior's Wind Turbine Guidelines Advisory Committee when they become available.

Receipt and Processing of Applications during the PEIS. A number of comments, especially from industry, stated that processing of applications and ongoing wind energy developments should be allowed to proceed while the PEIS is being prepared. At the public scoping meetings, representatives for Western and the Service stated that the agencies would continue to accept and process wind energy development applications and interconnection requests on a case-by-case basis, following existing procedures, while the PEIS is being prepared. In one comment, a request was made that the agencies not make the application process similar to the process used by the Midwest Independent Transmission System Operator (MISO) but did not elaborate further. There were some comments, mostly from industry organizations, that expressed a desire for clarity, transparency, and flexibility in the agencies' programs with regard to the approval process and decision-making on wind energy development applications.

Relationship of the PEIS to Individual Projects. There were several comments that identified the need for NEPA evaluations (including EISs in some cases) to still be conducted for individual projects regardless of whether the PEIS was in place or not. Some commenters stated that they would like the PEIS to result in a simpler, more streamlined NEPA evaluation process for specific projects. Defenders of Wildlife urged the agencies to recognize the importance of early coordination on wildlife and habitat issues in the PEIS, and Montana Audubon stated that the PEIS should set standards that would be followed for individual projects regarding consultation with various local agencies and science-based conservation organizations. One commenter stated that the PEIS should not provide for establishment of categorical exclusions for individual or grouped wind energy development projects regardless of whether they are sited on federally owned lands. It was also stated that the PEIS should not diminish the rigor or commitment of interagency consultation and that each proposed wind energy project should be examined for ESA Section 7 and Migratory Bird Treaty Act compliance. Comments from the American Wind Energy Association (AWEA) stated that they did not believe that the net generation capacity for a project should automatically be used to determine whether NEPA compliance could be accomplished using an environmental assessment or EIS; rather, they stated that a simpler environmental assessment tiered off the PEIS would likely be sufficient for most wind energy projects.

Monitoring and Data Collection. A few of the commenters requested that the PEIS identify additional research needs in the area of natural resources impacts of wind energy development, including surveys to obtain baseline information, and that monitoring during the construction and operation phases of the projects should occur to ensure that the impacts are within the anticipated ranges. Some commenters also requested that the baseline survey data be used in the design of the facilities and that projects be implemented in a phased approach, so that additional appropriate mitigation measures can be adopted in subsequent phases of the project based on the monitoring results. The types of monitoring information requested to be collected included various ecological indicators (e.g., bird strikes). Several commenters requested that such surveys and monitoring be mandatory. Some commenters suggested developing an adaptive management framework that would allow identification of impacts associated with specific actions under the program and would allow the flexibility to adjust the program as needed to minimize and mitigate impacts.

Land Use Planning. There were some requests to identify areas where wind energy development could occur and where development would not be permitted. However, the AWEA expressed concerns about the agencies attempting to map areas within the study area boundaries that may or may not be appropriate for wind energy development based on wildlife and habitat criteria. They mentioned that the Western Governors Association is undertaking a similar analysis with the use of geographic information system (GIS) datasets and suggested that Western and the Service not duplicate those efforts but focus instead on identifying BMPs and mitigation measures. The AWEA also identified concerns about the quality of the habitat information that would be available to complete such determinations.

3.2 ALTERNATIVES

The NOI for this project stated that at least three alternatives would be considered in the PEIS:

- The proposed action;
- A no action alternative (the existing situation wherein new proposals undergo fully separate NEPA analyses); and
- An alternative that consists of Western's proposed action for approving wind projects but that would not allow further wind development on any of the Service's easements.

The NOI also identified that additional alternatives might be identified through the public scoping process.

Scoping comments received from the USEPA stated that the PEIS should include a range of reasonable alternatives that meet the stated purpose and need for the project and that are responsive to input received through the scoping process. They encouraged the selection of feasible alternatives that will minimize environmental impacts.

One commenter suggested including an alternative that avoids placing wind energy facilities on federal public lands where possible. Another commenter encouraged the Service to develop policies that would continue to allow wind energy development on Service easements, stating that restricting this potential use could cause land owners to be less willing to enter into easement agreements. The Nature Conservancy stated that any wind energy development on wetland or grassland easements managed by the Service as part of the National Wildlife Refuge System should be considered separately and with sufficient detail to identify the implications under NEPA and that release of those lands should not be considered as part of the PEIS. One comment encouraged the Service to adopt a multiple-use adaptive management approach that would continue to allow reasonable and environmentally responsible development of wind energy on easements.

3.3 INTERAGENCY COOPERATION AND GOVERNMENT-TO-GOVERNMENT CONSULTATION

There were requests by Tribal representatives and others commenters to coordinate with Tribal governments. At the public scoping meeting in Bismarck, North Dakota, a representative from the Bureau of Indian Affairs (BIA) indicated on the registration form that the BIA would be interested in being a cooperating agency on the PEIS. The AWEA stated that it had heard that Tribal consultations for individual wind energy projects are complex and time-consuming. For this reason, they recommended that the agencies consult with the BIA on a programmatic level so that future consultations within the region could be more streamlined. The AWEA also recommended proactive outreach to individual tribes in order to determine their concerns.

There were also requests to get the local county, city, or township governments involved when projects are within their jurisdictional boundaries. In addition, some environmental and industry groups asked to be consulted in various phases of project development. One commenter suggested that the agencies form a technical advisory committee to review postconstruction wildlife impact surveys and make recommendations if project-level or program-level changes are needed to address impacts.

3.4 SITING AND TECHNOLOGY CONCERNS

Siting. There were many comments and suggestions on where or how to site wind energy facilities and associated transmission lines within the six-state study area. The National Wildlife Federation included a copy of one of their resolutions entitled, "Support for Sound Siting Guidelines for Wind Generators," as part of their comments. Defenders of Wildlife recommended that a tiered, risk assessment approach that considers wildlife concerns be used when siting wind energy projects; specifically mentioned were risk assessment approaches being developed by the National Wind Coordinating Committee ("Studying Wind Energy/Bird Interactions") and the Wind-Wildlife Federal Advisory Committee. In general, many of these comments suggested that improperly sited and constructed wind energy facilities (including associated transmission lines) have the potential to cause significant damage to the environment and wildlife habitat. Suggestions for siting preferences included:

- Use of lands that are already degraded, disturbed, or impaired;
- Use of lands that are close to existing transmission infrastructure to reduce the amount of land affected by construction of new transmission lines; and
- Use of lands that are located away from water bodies such as wetlands and streams.

Some commenters identified areas where wind energy projects should not be built. Suggested areas to avoid included:

- National Parks;
- National Wildlife Refuges;
- National Monuments;
- National Forests;
- National Grasslands;
- National Conservation Areas;

- National Historic and National Scenic Trails;
- National Wild, Scenic, and Recreational Rivers, as well as rivers and river segments under study or considered eligible for such designations;
- State Wildlife Management Areas;
- Roadless areas or other large tracts of intact habitat where roads and transmission lines are generally absent;
- Areas with extensive hardwood draws;
- Designated Wilderness Areas and Wilderness Study Areas;
- Audubon-designated Important Bird Areas;
- Threatened, endangered, and sensitive species habitats, as well as other important wildlife habitats and migration linkages on both public and private lands;
- Riparian areas, including prairie pothole habitats;
- Known migration flyways for the whooping crane;
- Significant migration corridors for birds and bats;
- Important flyways and raptor concentration areas;
- Breeding, nesting, or winter concentration areas for sage grouse and other prairie nesting species;
- Prairie dog towns;
- Lands owned by private conservation organizations and managed for conservation purposes; and
- Montana's Rocky Mountain front from the Canadian border south to Helena.

The AWEA expressed concerns about the agencies attempting to map areas within the study area boundaries that may or may not be appropriate for wind energy development based on wildlife and habitat criteria. They stated that the Western Governors Association is undertaking a similar analysis with the use of GIS-based information and suggested that Western and the Service not duplicate those efforts but focus instead on identifying BMPs and mitigation measures. The AWEA also identified concerns about the quality of the habitat information that would be available to complete such determinations.

Technology. A few comments called for research into technologies that could reduce barotrauma[1] impacts on bats. One commenter stated that newer technology less likely to cause wildlife mortality, such as vertical spiral vane generators, must be considered an acceptable alternative to more traditional turbines in locations where mortality to birds or impacts on habitat are expected to be significant.

Transmission and Integration. A number of comments concerned the relationship between the development of wind energy projects and electrical transmission. For example, several commenters suggested that transmission system capacity and enhancements be considered as part of the proposed action and that impacts of transmission facilities be considered along with the impacts of wind power generation. Some commenters stated that siting decisions for wind energy facilities should not be made without considering how the electricity generated would be transmitted to the users. As identified previously in this section, there were also a number of comments regarding the siting of transmission lines. There were requests to use existing transmission lines and corridors as much as possible and requests that any new transmission lines be planned and constructed through coordination among the various federal, state, and local government agencies. One comment called for new transmission line planning to follow a landscape-level habitat analysis in order to avoid fragmenting and disturbing sensitive and important habitats.

One comment requested that the PEIS address how the integration of wind energy would affect the possibility of integration of power from existing or new solar and hydropower facilities. Another comment requested that the PEIS address how the costs of additions to Western's transmission system to accommodate electricity generated by wind energy projects might affect the rates charged to all transmission users.

3.5 ENVIRONMENTAL AND SOCIOECONOMIC CONCERNS

This section summarizes the predominant environmental and socioeconomic concerns identified by commenters, organized by major technical areas. There were some comments that suggested that the PEIS and Record of Decision prepared in 2005 by the U.S. Bureau of Land Management could serve as a model for evaluating impacts of wind energy programs being considered by Western and the Service.

Air Quality and Climate Change. The positive impacts of wind energy development in regards to decreased emissions of criteria air pollutants and greenhouse gases and the positive effect on climate change, as compared with the emissions from fossil fuel–based power plants, were mentioned in many of the comments received. The USEPA commented that the PEIS should evaluate the potential for the project to affect criteria pollutants under the National

[1] Barotrauma refers to injuries sustained due to the pressure wave associated with moving turbine blades rather than direct strikes from the blades.

Ambient Air Quality Standards, airborne dust particulates, and visibility associated with emissions from construction equipment or from increased traffic during operations.

The USEPA recommended that the PEIS estimate annual greenhouse gas emissions that would result from the proposed action and describe those in terms of the carbon dioxide equivalent per megawatt-hour produced. The PEIS should then compare these values to estimated greenhouse emissions at regional, national, and global scales for different inventory categories.

Noise. One commenter identified the noise produced by wind turbines as an issue of concern.

Water Resources. There were relatively few comments regarding potential impacts on water resources. The USEPA stated that the PEIS should clearly describe water bodies and groundwater resources within the area that could be affected by project alternatives, with special attention to work that would occur in identified sole-source aquifer areas. Comments from the USEPA also stated that appropriate BMPs for reducing non-point sources of pollution from projects, and how the agencies would coordinate program activities with existing protection efforts for impaired waters (under Section 303(d) of the Clean Water Act), should be identified in the PEIS. The USEPA also commented that the potential for spills of hazardous or toxic materials and stormwater management associated with construction of projects should be considered.

Ecology. Many comments touched on the potential effects of wind energy projects on ecological resources. Not surprisingly, most of these comments mentioned the potential mortality of birds and bats due to collisions with wind turbines or transmission lines; barotrauma injuries to bats during wind turbine operation; or impacts of construction, operation, and maintenance activities on threatened, endangered, or rare species. There were some comments that indicated that bird and bat mortality from existing wind projects in the region may be small, including one comment from an electric cooperative that stated that they were unaware of any bird problems with existing wind turbines or transmission lines in their service area. The USEPA recommended that the locations of important migration corridors for birds and potential collision areas be identified on maps and that these areas be avoided. The National Wildlife Federation commented that the PEIS should provide for a thorough evaluation of impacts on avian species, especially migratory birds, raptors, and bats.

Another ecological concern identified was the potential for the loss of wetland or grassland habitat that is used by waterfowl and other birds in the region. One commenter stated that he was more concerned with the general survival of ducks and geese affected by drainage of wetlands in the prairie pothole region than with the "rare" incidence of whooping cranes colliding with a tower or transmission line. The USEPA commented that Section 404 of the Clean Water Act regarding protection of wetlands should be considered when developing the

PEIS and when considering alternatives, and suggested that the resulting programs should include a commitment to avoid indirect draining or direct disturbance of wetland areas.

Commenters requested that the PEIS consider the impacts to federal and state-listed threatened and endangered species. One commenter requested that the PEIS define the process or procedures that will be used for Section 7 consultations within the UGP region. Some commenters recommended that surveys for listed species be conducted as part of the Section 7 consultation for projects. Comments from the USEPA stated that the PEIS should describe critical habitat for listed species in the region, identify the potential impacts of the proposed project on critical habitat, and describe how the proposed project will meet the requirements of the ESA. It was also commented that the PEIS should be cognizant of other wildlife laws, such as the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and other state, local, and tribal wildlife laws and regulations.

The USEPA provided comments about issues related to wildlife habitat and vegetation that should be considered and evaluated in the PEIS, including loss of habitat due to clearing for construction. In addition, it was requested that the PEIS consider the fragmentation impacts on individual prairie species related to the placement of turbines, support structures, rights-of-way, and new roads that would result from wind energy projects. The USEPA also commented that toxic hazards that could be associated with the use of pesticides and herbicides used for vegetation treatment during project operations should be addressed in the PEIS, and that appropriate mitigation measures to control those hazards should be identified.

Several commenters pointed out the potential harm that wind energy projects could inflict on ecosystems. Many comments cautioned against adversely affecting sensitive biological resources. Habitat fragmentation and destruction were most often mentioned as likely causes of ecological damage. Some commenters wanted the PEIS to address these issues in a holistic manner, with consideration of both the direct and indirect effects, and the potential connected actions that occur not only in the immediate vicinity of the proposed wind energy facilities and associated transmission corridors, but beyond such projects. One commenter specifically stated that the PEIS needs to address how impacts from habitat fragmentation would be identified and minimized. The Nature Conservancy suggested that the analyses of impacts on habitats and ecosystems should examine all areas within the project area that feature wind resources of Class 3 or higher since developing technology is making electricity generation within such areas economically feasible. The issues that were specifically mentioned by the Nature Conservancy included destruction of wildlife habitat; habitat fragmentation; potential interruption of wildlife migration corridors; increased edge effects such as the proliferation of non-native or invasive species; and changes in water flow patterns.

Biota that were specifically identified in comments as needing to be considered in the PEIS because they were rare, migratory, or potentially sensitive to impacts from wind energy development included the whooping crane, greater sage-grouse, greater prairie-chicken, piping plover, least tern, ducks and other waterfowl, raptors, migratory birds, grizzly bear, Canada lynx, black-footed ferret, Indiana bat, massasauga rattlesnake, Dakota skipper, Karner blue butterfly, Salt Creek tiger beetle, blowout penstemon, Ute ladies'-tresses, and eastern prairie fringed orchid. There were also mentions of some specific areas that belonged to the categories of lands that commenters urged the agencies to avoid (see Section 3.4). The AWEA commented that the agencies should take advantage of efficiencies that may be afforded by considering efforts underway to develop a region-wide habitat conservation plan for the whooping crane and, potentially, other protected species in the migration corridor of the Wood Buffalo-Aransas whooping crane flock.

Visual Impacts. One commenter expressed concerns that wind energy development facilities may result in adverse visual impacts. "Strobe-like lighting" was specifically mentioned as one problem with wind towers. Another commenter suggested that visual impacts not be considered because there was no objective, quantitative way to measure them.

Waste Generation and Disposal. The USEPA identified concerns about potential hazardous chemical spills during construction or operations of wind energy production and transmission facilities. Identified substances of concern included engine fluids from construction and maintenance vehicles and herbicides used for vegetation control.

Cultural Resources. Some commenters recommended that the requirements of the National Historic Preservation Act be achieved through the PEIS process, potentially through programmatic consultation.

Socioeconomics. A number of specific comments addressed the potential socioeconomic impacts of wind energy development in the project area. Many of these comments stated that the job opportunities, tax revenue, and income generated from the development of wind energy projects were important to area schools, businesses, communities, and farmers. A number of commenters stated that wind energy leases with area farmers may reduce the incentive for conversion of grasslands to cropland. One commenter stated that wind energy projects negatively affect property values.

Environmental Justice. The USEPA commented that the PEIS must consider environmental justice issues in a manner consistent with Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. Another commenter suggested that environmental justice impacts not be considered because there was no objective, quantitative way to measure such impacts.

3.6 CUMULATIVE IMPACTS

A number of commenters requested that the PEIS consider the cumulative impacts on the environment resulting from the incremental impacts of future wind energy development projects, including their associated transmission lines and infrastructure improvements (such as roads), when added to impacts from other past, present, and reasonably foreseeable future actions. The

USEPA commented that the analyses of cumulative impacts should be based on airsheds or watersheds rather than political boundaries. The Nature Conservancy commented that the known and suspected impacts of wind energy development could not be fully considered, avoided, or mitigated without an inclusive assessment of cumulative impacts across the PEIS area and across the range of species with large-landscape habitat requirements. The Nature Conservancy suggested that the PEIS address only cumulative impacts of wind energy development and leave the project-specific, detailed evaluation of impacts from large commercial wind facilities for separate NEPA evaluations.

There was one question regarding how thresholds for significant direct, indirect, and cumulative environmental impacts from wind energy development and associated transmission systems would be defined.

3.7 MITIGATION

Many commenters requested that the PEIS address mitigation measures for minimizing the impacts on environmental resources. There were also requests for the agencies to identify BMPs that could be applied to wind energy developments and associated transmission lines. A number of commenters requested that such measures and practices be reasonable and consistent with changing laws and regulations, incorporate monitoring, and utilize adaptive management. Avoidance of impacts was sometimes mentioned as the preferred method of mitigation, followed by efforts to minimize effects, and the repair or restoration of affected areas when efforts to avoid and minimize impacts are not successful.

For example, some commenters expressed a desire for wind energy projects to avoid certain areas and periods during development. They requested that developers avoid areas of high ecological sensitivity and societal value (see Section 3.4), avoid disturbance and harassment of wildlife, minimize the ecological footprint of the facilities, and avoid vegetation removal during the nesting/breeding season for migratory birds. They suggested that the developers instead use areas that are already disturbed (such as existing roads and rights of way) as much as possible (see Section 3.4). Some commenters wanted the agencies to develop a set of mandatory BMPs that apply to all future projects, while others requested that BMPs be standard, flexible, and not too prescriptive. One commenter expressed a willingness to provide additional input on the development of BMPs for the PEIS. Specific measures suggested by commenters included:

- Implement dust-control measures (such as the application of a nonchlorine-based dust-abatement chemical) during construction.
- Use native plants in postconstruction restoration work.
- Incorporate buffers or setback distances along surface waters and riparian zones.
- Base mitigation of wetlands and streams on quantified impacts on federal and state species of concern.

- Follow guidelines for the construction and operation of proposed transmission lines to reduce the potential for avian electrocution hazards (e.g., Avian Power Line Protection Plan standards).

- Incorporate project siting and design features that avoid creating perching opportunities for birds, including putting all electrical lines between turbines underground.

- Use appropriate lighting that will not attract night migrants (bird and bats) to the substation.

- Experiment with ways to deter bats from approaching wind turbines in order to avoid barotrauma.

- Avoid placement of turbines on escarpment edges.

- Ensure that the sweep point of the turbine blades is higher than the apex of nuptial flights for birds in project areas.

- Adopt limits on the amount of disturbed acreage permitted within certain habitat types.

One comment stated that it was not appropriate for Western to become a "police force" on mitigation practices of another entity's construction practices and that identification of specific mitigation measures was appropriate only when Western is the constructing agency or when activities on Western's side of a substation are being considered.

Some comments requested that costs associated with mitigation and other environmental requirements be addressed in the PEIS.

4 CONCLUSIONS

Western and the Service will use this report and the individual comments as part of a process to determine the scope of analyses in the PEIS. All comments, regardless of how they were submitted, will receive equal consideration in the development of the PEIS. As stated previously, copies of all scoping comments, whether submitted by mail, via an online comment form, or in person at public meetings are available for viewing on the UGP Wind Energy PEIS project Web site (http://plainswindeis.anl.gov).

Scoping is the first phase of public involvement under the NEPA process. The public will have additional opportunities to be involved in the preparation of the UGP Wind Energy PEIS. The next phase of public involvement will be public review and comment on the Draft PEIS. Western and the Service anticipate releasing the Draft PEIS in Fall 2011.

Information about all opportunities for public involvement in the UGP Wind Energy PEIS, including announcements of public meetings and releases of documents for review, will be maintained on the project Web site (http://plainswindeis.anl.gov). Individuals seeking e-mail notification of such opportunities can sign up for e-mail announcements via the Web site.

APPENDIX B

PROJECTED WIND ENERGY DEVELOPMENT IN THE UGP REGION THROUGH 2030

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APPENDIX B

PROJECTED WIND ENERGY DEVELOPMENT IN THE UGP REGION THROUGH 2030

The projected level of wind energy development that would occur in the Upper Great Plains (UGP) between 2010 and 2030 was estimated in order to be consistent with a scenario under which 20 percent of the Nation's electricity would be generated from wind energy by 2030 (DOE 2008). Two estimates for wind energy development within the UPG region were used to bound analyses of potential natural resource impacts:

1. Projected wind energy development based upon levels of development within the UGP Region States from 2000 through 2010; and

2. Projected wind energy development based upon modeling conducted by the National Renewable Energy Laboratory (NREL) to see how a goal for 20 percent of the Nation's electrical generation to be from wind energy by the year 2030 could be accomplished.

B.1 CASE 1: PROJECTED DEVELOPMENT BASED UPON DEVELOPMENT IN THE UGP REGION STATES FROM 2000 THROUGH 2010

For this case, it was assumed that the trajectory for the increase in installed wind energy capacity during the next 20 years would remain similar to the annual rate of increase during the past 10 years. Overall, the installed capacity within each of the UGP States has increased substantially during the previous 10-year period (figure B-1, table B-1). The rate of increase has slowed in some States in recent years (e.g., Iowa) and has increased in others (e.g., South Dakota).

The estimated level of wind energy development within the UGP Region in 2030 was calculated by developing a best-fit linear relationship using reported values of installed wind energy capacity for each of the UGP States from 2000 through 2010 and using those relationships to predict the amount of installed capacity that would be present by 2030. To estimate the number of turbines that would be needed to meet the projected capacity, it was assumed that each turbine would be capable of generating 1.5 MW of electricity. Typical wind turbines currently being installed in the UGP Region generate between 1.5 and 2 MW per turbine. The predicted level of generation and the estimated number of turbines to meet the generation capacity estimates under Case 1 are presented in table B-2.

B.2 CASE 2: PROJECTED DEVELOPMENT BASED UPON NREL MODELING

For this case, the estimate of future installed wind energy capacity between 2010 and 2030 was based on an analysis conducted by NREL using its Wind Deployment System (WinDS) model. The model used a variety of inputs and assumptions, as described in Appendix B of the DOE (2008) report, to modify a base case version of the model (Denholm and Short 2006). The revised model indicated that the wind turbines required to

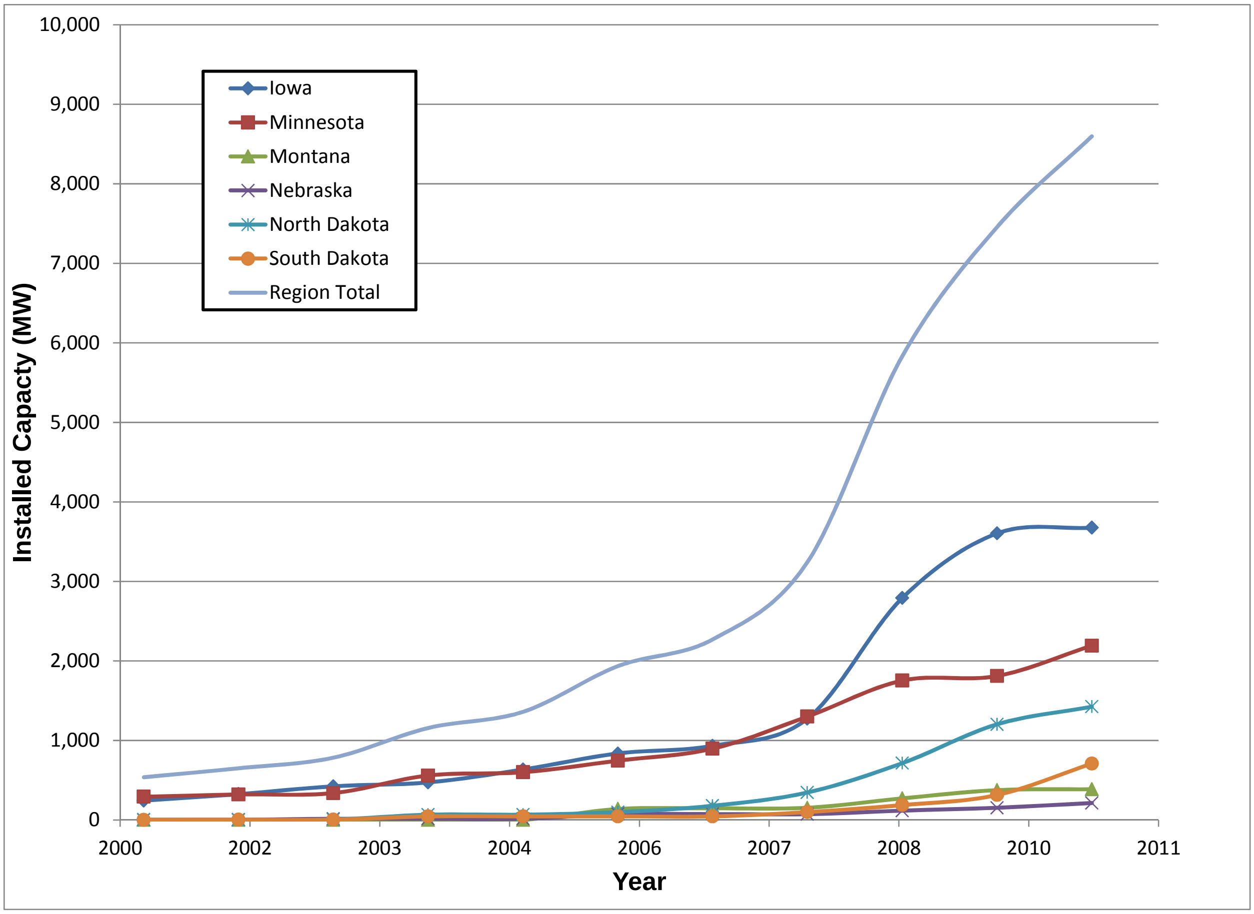

FIGURE B-1 Installed Capacity (MW) for States within the UGP Region, 2000–2010 (Source: DOE 2011)

supply 20 percent of the Nation's electricity (more than 300 GW) would be broadly distributed across the United States, and that at least 100 MW would be installed in 43 of the 48 contiguous States. The revised model presented one way of providing 20 percent of the nation's electricity through wind energy.

The specific assumptions used in the model significantly affect each State's projected wind capacity, and the DOE (2008) report stated that the projected levels would vary significantly as electricity markets evolve and State policies promote or restrict wind energy production. The modeled levels of wind energy capacity that would be developed in each of the States within the UGP Region to meet a goal for 20 percent of the Nation's electrical generation to be from wind energy by 2030 (as presented by Kiesecker et al. 2011) is shown in table B-3. As for Case 1, the number of turbines needed to meet the projected capacity (table B-3) was estimated by assuming that each turbine would be capable of generating 1.5 MW of electricity.

TABLE B-1 Installed Capacity (MW) for States within the UGP Region, 2000–2010

	Year										
State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Iowa	242.4	324.2	422.7	471.8	634.0	836.3	932.2	1,272.9	2,791.2	3,603.9	3,675.0
Minnesota	291.2	319.8	337.7	558.3	600.1	745.4	895.9	1,299.8	1,752.8	1,810.0	2,192.0
Montana	0.1	0.1	0.4	1.1	1.1	136.9	145.9	152.9	271.5	375.0	386.0
Nebraska	2.8	2.8	14.0	14.0	14.0	73.4	73.4	71.9	116.9	152.9	213.0
North Dakota	0.4	0.4	4.8	66.3	66.3	97.8	178.3	344.8	714.5	1,202.6	1,424.0
South Dakota	0.0	2.6	3.0	44.3	44.3	44.3	44.3	98.3	186.8	313.2	709.0
Region Total	536.9	649.9	782.5	1,155.7	1,359.8	1,934.0	2,269.9	3,240.6	5,833.7	7,457.6	8,599.0

Source: DOE (2011).

TABLE B-2 Current and Predicted Development of Wind Energy Capacity and Estimated Number of Wind Turbines under the Case 1 Projection for the UGP Region

	Capacity (MW)			Number of Turbines[a]		
State	2010[b]	2030[c]	Increase	2010	2030	Increase
Iowa	3,675	9,597	5,922	2,450	6,398	3,948
Minnesota	2,192	5,475	3,283	1,461	3,650	2,189
Montana	386	1,115	729	257	743	486
Nebraska	213	514	301	142	343	201
North Dakota	1,424	3,451	2,027	949	2,301	1,352
South Dakota	709	1,274	565	473	850	377
UGP Region	8,599	21,427	12,828	5,733	14,285	8,522

[a] Number of turbines estimated by assuming each turbine would generate 1.5 MW.

[b] Source: DOE (2011).

[c] Capacity for 2030 was estimated by assuming that the rate of increase would be similar to the annual rate of increase in wind energy capacity from 2000 through 2010.

TABLE B-3 Current and Predicted Development of Wind Energy Capacity and Estimated Number of Wind Turbines under the Case 2 Projection for the UGP Region

	Capacity (MW)			Number of Turbines[a]		
State	2010[b]	2030[c]	Increase	2010	2030	Increase
Iowa	3,675	19,910	16,235	2,450	13,273	10,823
Minnesota	2,192	9,940	7,748	1,461	6,627	5,165
Montana	386	5,260	4,874	257	3,507	3,249
Nebraska	213	7,880	7,667	142	5,253	5,111
North Dakota	1,424	2,260	836	949	1,507	557
South Dakota	709	8,060	7,351	473	5,373	4,901
UGP Region	8,599	53,310	44,711	5,733	14,285	29,807

[a] Number of turbines estimated by assuming each turbine would generate 1.5 MW.

[b] Source: DOE (2011).

[c] Sources: DOE (2008) and Kiesecker et al. (2011).

B.3 DIFFERENCE BETWEEN THE ESTIMATED LEVELS OF DEVELOPMENT

The projected overall wind energy capacity and numbers of turbines for the UGP States by 2030 under Case 1 and Case 2 differ considerably (table B-4). Table B-5 presents the new generation capacity and number of additional turbines that would be needed to reach the levels of wind energy development projected under Case 1 and Case 2. With the exception of North Dakota, the levels of development projected based upon past development are lower than the levels projected based upon modeling conducted by NREL (DOE 2008). This indicates that the rate of wind energy development in most of the UGP States and region-wide would likely need to increase dramatically to meet a goal of 20 percent of the Nation's electrical generation being supplied by wind energy by 2030. In effect, the estimates under Case 1 and Case 2 bound the anticipated levels of wind energy development within the UGP Region through 2030.

TABLE B-4 Comparison of Overall Projected Capacity and Number of Turbines for Wind Energy Development in the UGP Region States by 2030

	Projected Capacity (MW)			Number of Turbines		
State	Case 1	Case 2	Difference	Case 1	Case 2	Difference
Iowa	9,597	19,910	10,313	6,398	13,273	6,875
Minnesota	5,475	9,940	4,465	3,650	6,627	2,976
Montana	1,115	5,260	4,145	743	3,507	2,764
Nebraska	514	7,880	7,366	343	5,253	4,910
North Dakota	3,451	2,260	–1,191	2,301	1,507	–794
South Dakota	1,274	8,060	6,786	850	5,373	4,524
UGP Region	21,427	53,310	31,883	14,285	35,540	21,255

TABLE B-5 Comparison of Estimated New Generation Capacity and Additional Number of Turbines Needed to Meet Projected Wind Energy Development in the UGP Region States by 2030

	Projected Capacity (MW)			Number of Turbines		
State	Case 1	Case 2	Difference	Case 1	Case 2	Difference
Iowa	5,922	16,235	10,313	3,948	10,823	6,875
Minnesota	3,283	7,748	4,465	2,189	5,165	2,976
Montana	729	4,874	4,145	486	3,249	2,763
Nebraska	301	7,667	7,366	201	5,111	4,910
North Dakota	2,027	836	–1,191	1,352	557	–795
South Dakota	565	7,351	6,786	377	4,901	4,524
UGP Region	12,828	44,711	31,883	8,552	29,807	21,255

B.4 DEVELOPMENT RELEVANT TO THE PROPOSED ACTION

Depending upon the method (Case 1 or Case 2) used to estimate future wind energy development, it is estimated that approximately an additional 8,600 to 30,000 wind turbines and associated infrastructure would be installed in the UGP Region by 2030. On the basis of information for wind energy projects that have connected to transmission facilities managed by Western Area Power Administration (Western) within the UGP Region (table B-6), it is assumed that a typical project would be composed of 75 turbines and would have a generation capacity of approximately 112 MW. Using information from Denholm et al. (2009), which estimates a wind energy project will encompass 84 ac (34 ha) of land per MW of capacity, it is estimated that the area encompassed by a typical project would be approximately 9,500 ac (3,845 ha) (including permanently disturbed, temporarily disturbed, and undisturbed lands). Combining these estimates, it is anticipated that about 115 to 400 new wind energy projects, encompassing a total area of about 1.1 to 3.8 million ac (0.4 million to 1.5 million ha) could be developed within the UGP Region States by 2030; most of this land area would not be directly disturbed by project activities.

On the basis of information provided by Denholm et al. (2009) for 172 individual wind energy projects totaling 26,462 MW of capacity, the average amount of land that would be permanently affected, temporarily affected, and the average overall project area was estimated using values of 0.7, 1.7, and 84 ac (0.3, 0.7, and 34 ha) per MW of generation, respectively. Using these values, which are based on information for modern wind power plants in the United States and incorporate disturbance for areas affected by turbine towers, access roads, substations, and transmission facilities associated with development of wind farms, between 15,000 and 40,000 ac (6,070 and 16,187 ha) of land within the UGP Region could be permanently affected by existing and new wind energy development by 2030; an additional 37,000 to 92,000 ac (14,973 to 37,231 ha) of land could be affected by temporary disturbance from development activities, resulting in a total of about 52,000 to 132,000 ac (21,043 to 53,419 ha) of land that could be disturbed by existing and new wind energy development (table B-7).

It is estimated that 8,600 to 30,000 additional turbines would need to be installed in the UGP Region by 2030 to generate the increased capacity (table B-5) and that approximately 9,500 to 33,000 ac (3,845 to 13,355 ha) of land would be permanently affected by the footprints of turbine towers and other infrastructure associated with this level of development (table B-8). An additional 22,000 to 77,000 ac (8,903 to 31,160 ha) would be temporarily affected by new development activities, resulting in a total of about 32,000 to 110,000 ac (12,950 to 44,515 ha) of new land that could be disturbed by wind energy development by 2030 (table B-8).

Predicting where future wind energy development is likely to occur within the UGP Region is difficult. Not all of the lands within the UGP Region are suitable for development of wind energy projects because of factors such as lack of suitable wind regimes, unsuitable land cover types, steep slopes, open water and wetland areas, urban development, and Federal and State land use restrictions.

NREL has modeled and mapped the wind resources in each of the UGP States and has assigned class designations to indicate the potential for wind power generation (figure B-2). Wind power classes range from 1 to 7; Class 7 has the highest potential wind power generation

TABLE B-6 Installed Capacity and Number of Turbines for Wind Energy Projects within the UGP Region from 2000 through 2010

State	Project Name	Capacity (MW)	Number of Turbines
IA	Endeavor	100	40
IA	Endeavor II	50	20
IA	Intrepid	160	107
IA	Pomeroy Wind Phase I	123	87
MN	Chanarambie	85	57
MN	Elm Creek Wind Farm	99	66[a]
MN	Elm Creek II	150	62
MN	Trimont Area Wind Farm	100	67
MN	Fenton Wind Farm	205	137
MN	Jeffers Wind Farm	50	20
MN	Moraine Wind	51	34
MN	Moraine Wind II	48	23
MN	Stoneray Wind Power	105	70
NE	Elkhorn Ridge Wind Energy	80	27
SD	Buffalo Ridge	306	204
SD	White Wind Farm	200	103
SD	Wessington Springs	99	66
SD	South Dakota Wind	41	27
SD	MinnDakota Wind II	54	36
ND	Ashtabula Wind Phase II	200	133
ND	Wilton Wind	50	33
ND	Tatanka Wind	180	120
ND	North Dakota Wind 1 & 2	62	41
ND	Langdon Wind	159	106
MT	Glacier McCormick Ranch Phase I	120	60
MT	Judith Gap	135	90
MT	Valley County Wind	170	114
Total within UGP Region		3,182	1,950

[a] Value not reported, but the number of turbines was calculated based on capacity, using an assumption of 1.5 MW per turbine.

Source: Stas (2011).

and Class 1 has the lowest. On the basis of projected wind technology development, NREL has determined that wind resources in Class 3 and higher could be economically developable by 2030 (i.e., during the time frame under consideration). Therefore, for the purposes of evaluating which resources would be at the most risk from wind energy development to be considered as part of the proposed program, the focus is on those areas where the wind resource potential is Level 3 or greater (figure B-2). Overall, most areas within the UGP Region are predicted to have a suitable wind resource for wind energy development. It should be noted that development of transmission lines to connect proposed wind energy projects to existing transmission services would not be limited to areas with suitable wind potential.

Because of the expense of acquiring rights-of way and building transmission lines, the cost of a wind energy project would increase significantly with increasing distance from existing

TABLE B-7 Comparison of Overall Land Area Disturbance[a] for Wind Energy Development in the UGP Region States by 2030 under Case 1 and Case 2 Development Projections

	Permanent Disturbance (ac)[b]		Temporary Disturbance (ac)[c]		Total Disturbance (ac)		Project Area (ac)[d]	
State	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Iowa	7,111	14,753	16,593	34,424	23,705	49,178	805,964	1,672,042
Minnesota	4,057	7,366	9,467	17,186	13,524	24,552	459,824	834,761
Montana	826	3,898	1,927	9,095	2,753	12,992	93,597	441,735
Nebraska	381	5,839	890	13,625	1,271	19,464	43,207	661,762
North Dakota	2,558	1,675	5,968	3,908	8,525	5,582	289,856	189,795
South Dakota	944	5,972	2,203	13,936	3,147	19,908	107,013	676,879
UGP Region Total	15,878	39,503	37,048	92,173	52,925	131,676	1,799,462	4,476,974

[a] Values were calculated based upon information in Denholm et al. (2009) and include estimated land disturbance for existing wind energy projects.

[b] Permanent disturbance area estimated using a value of 0.7 ac (0.3 ha) per MW of capacity.

[c] Temporary disturbance area estimated using a value of 1.7 ac (0.7 ha) per MW of capacity.

[d] Project area estimated using a value of 84 ac (34 ha) per MW of capacity.

TABLE B-8 Comparison of Additional Land Area Disturbance[a] Needed to Meet Wind Energy Development in the UGP Region States by 2030 under Case 1 and Case 2 Development Projections

	Permanent Disturbance (ac)[b]		Temporary Disturbance (ac)[c]		Total Disturbance (ac)		Project Area (ac)[d]	
State	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Iowa	4,388	12,030	10,239	28,070	14,628	40,100	497,338	1,363,415
Minnesota	2,433	5,741	5,677	13,396	8,110	19,138	275,740	650,677
Montana	540	3,612	1,260	8,427	1,799	12,039	61,180	409,319
Nebraska	223	5,681	521	13,256	745	18,937	25,319	643,875
North Dakota	1,502	619	3,506	1,445	5,008	2,065	170,269	70,207
South Dakota	419	5,447	977	12,710	1,396	18,157	47,471	617,337
UGP Region Total	9,506	33,131	22,180	77,305	31,686	110,436	1,077,318	3,754,830

[a] Values were calculated based upon information in Denholm et al. (2009).

[b] Permanent disturbance area estimated using a value of 0.7 ac (0.3 ha) per MW of capacity.

[c] Temporary disturbance area estimated using a value of 1.7 ac (0.7 ha) per MW of capacity.

[d] Project area estimated using a value of 84 ac (34 ha) per MW of capacity.

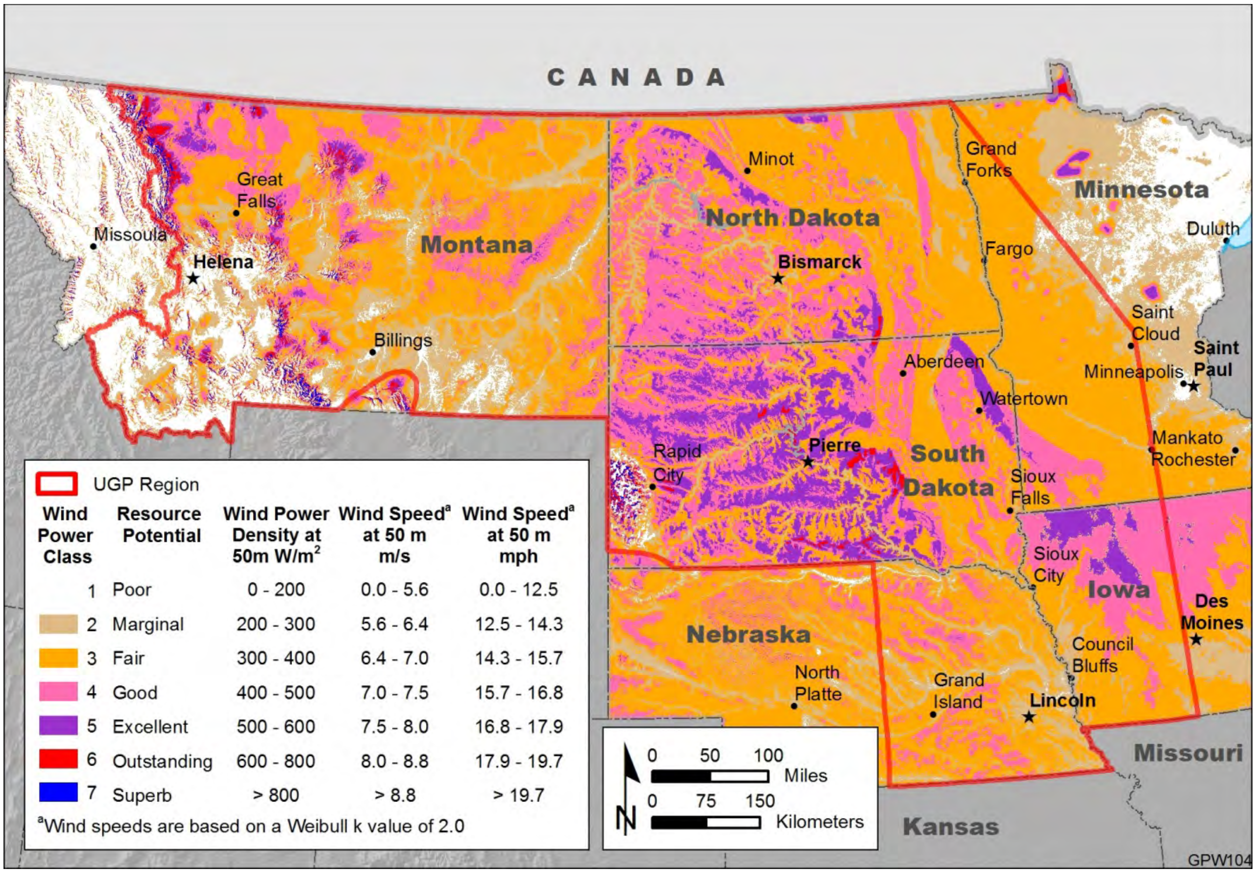

FIGURE B-2 Distribution of Wind Energy Resources in the UGP Region

transmission services to which it could connect. Therefore, to further delineate the areas within the UGP Region where wind energy projects are likely to request interconnection to Western's transmission facilities, areas within 25 mi (40 km) of existing substations on the transmission infrastructure operated by Western were identified (figure B-3). Natural resources that overlap these areas are considered to be more likely to be affected by projects that would be evaluated under the proposed wind energy program. Overall, the areas within 25 mi (40 km) of these substations encompass more than 97 million ac (39 million ha) within the UGP Region. From 2000 through 2010, 27 wind energy projects, with a total capacity of 3,182 MW, interconnected to Western's transmission system within the UGP Region (table B-6). To date, four wind energy projects have been allowed to place turbines on U.S. Fish and Wildlife Service (the Service) easements within the UGP Region through easement exchange. In total, 33 turbines have been placed on easements lands.

In addition to the wind resource alone, a number of assumptions were used regarding factors that affect the appropriateness of particular locations for wind energy development in order to identify which areas within the UGP Region would be most suitable for wind energy development. A similar analysis was conducted by the Western Governors' Association to evaluate the suitability of lands in the western United States for development of renewable energy facilities (Western Governors' Association and DOE 2009). Information and assumptions regarding suitability criteria for utility-scale wind energy development for that analysis were incorporated into our analysis. In general, the suitability analysis assigned

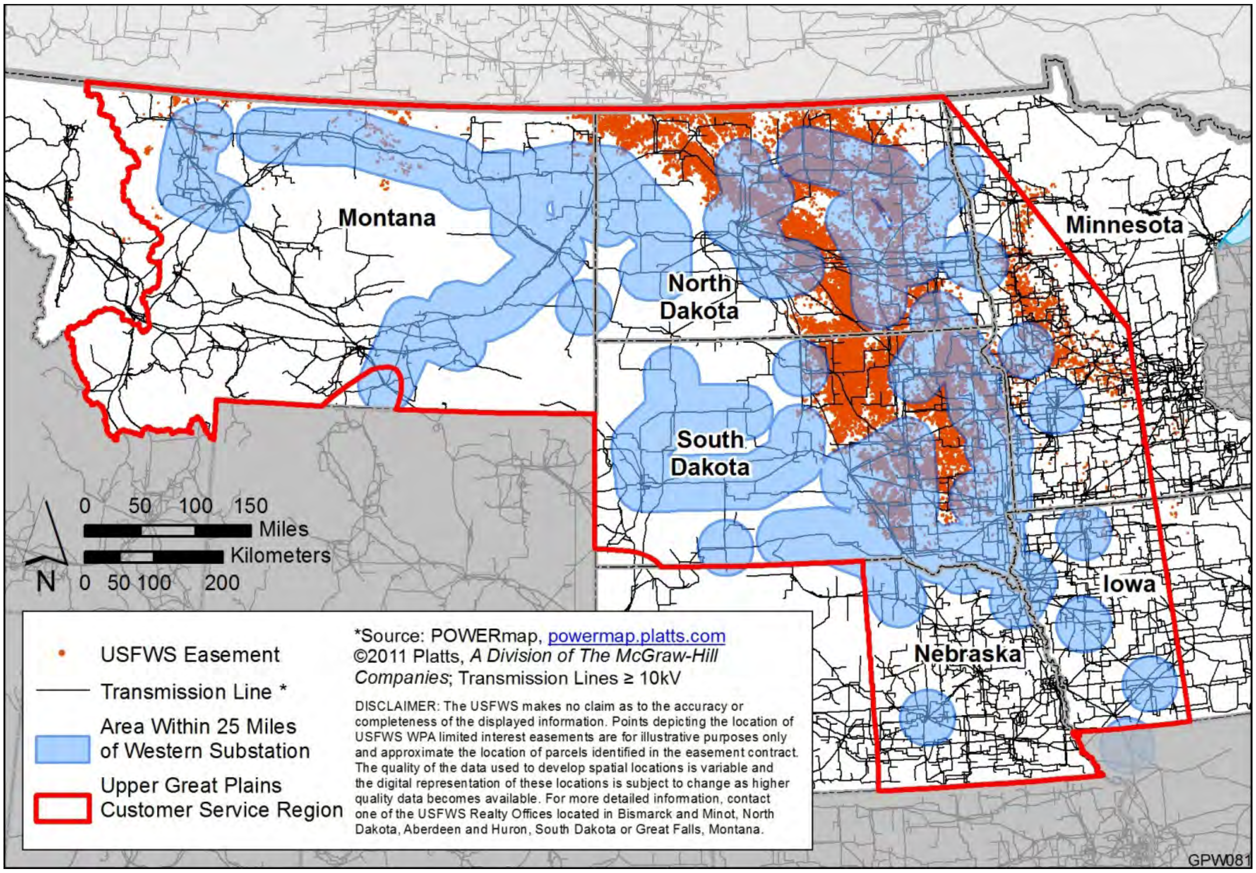

FIGURE B-3 Areas within 25 mi (40 km) of Western's Transmission Substations within the UGP Region, Together with General Locations of Service Easements

weights to spatial information for land cover, slope, wind power class, protected lands, and proximity to existing energy infrastructure to develop an overall index of wind development suitability for locations within the UGP Region. These index values were than categorized as low, medium, and high suitability. The methods for calculating the suitability index values are described in Appendix E of this programmatic environmental impact statement, and the results of the analysis are presented in figure B-4 and table B-9.

On the basis of analyses conducted, the land area needed to accommodate new projects (1.1 million to 3.8 million ac [0.4 million to 1.5 million ha] for 115 to 400 projects) to build out wind energy to the projected levels would encompass about 2.1 to 7.2 percent of the lands identified as having high suitability for wind energy development within the UGP Region. It is also estimated that all permanently and temporarily disturbed lands would require between 0.1 and 0.2 percent of the lands identified as having high suitability for wind energy development within the UGP Region.

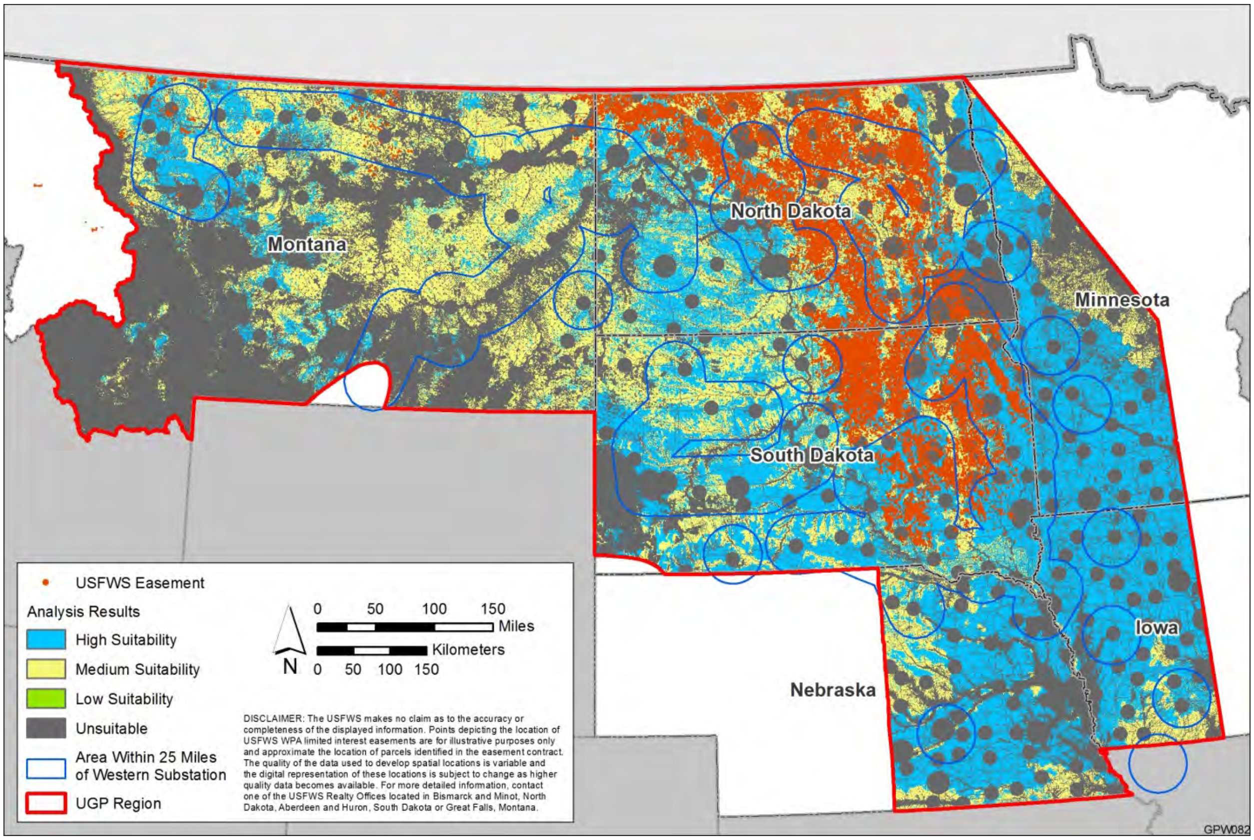

FIGURE B-4 Wind Energy Development Suitability for Lands within the UGP Region, Together with Areas within 25 mi (40 km) of Western's Transmission Substations and General Locations of Service Easements

TABLE B-9 Estimated Acreages of Lands within Wind Development Suitability Categories for the UGP Region

Potential for Wind Energy Development	UGP Region	Within 25 mi of Western Transmission	Portions of States within Region (ac)					
			Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota
Low[a]	110,868,000	39,847,845	6,796,498	9,973,053	47,537,348	10,380,614	18,756,672	17,394,058
Medium	65,093,977	27,476,285	2,486,997	2,488,954	23,952,728	4,770,103	16,032,379	15,338,596
High	52,621,694	25,101,575	6,546,237	8,429,032	5,288,550	5,765,765	10,457,785	16,126,897
Total	228,583,671	92,425,705	15,829,733	20,891,040	76,778,625	20,916,482	45,246,836	48,859,552

[a] Includes lands classified as unsuitable for wind energy development.

B.5 REFERENCES

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APPENDIX C

ECOREGIONS OF THE UPPER GREAT PLAINS REGION

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APPENDIX C

ECOREGIONS OF THE UPPER GREAT PLAINS REGION

An ecoregion is defined as an area that has a general similarity of ecosystems and is characterized by the spatial pattern and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography, climate, soils, land use, and hydrology (EPA 2007). Ecoregions of the United States as mapped and described by the U.S. Environmental Protection Agency (EPA) are presented here as the basis for describing visual resources and ecosystems at a general level. The Level III ecoregion classification includes 15 ecoregions covering the Western Area Power Administration's Upper Great Plains Customer Service Region (UGP Region; Figure C-1). The ecoregion descriptions presented here are derived primarily from EPA (2002), except where noted. In some cases, Level IV ecoregion information was used to supplement the Level III ecoregion descriptions. Level IV ecoregion supplemental data presented here are derived from Bryce et al. (1996), Chapman et al. (2001, 2002), and Woods et al. (2002).

In the ecoregion descriptions presented here, "major urban areas" are defined as urban areas with populations exceeding 50,000, except where noted. "Major roads" are defined as U.S. highways and Interstate highways.

IDAHO BATHOLITH. Within the UGP Region, this ecoregion is found in western Montana at elevations ranging from 6,142 to 9,692 ft (1,872 to 2,954 m), and covering 282.74 mi^2 (732.28 km^2). This ecoregion is a dissected, partially glaciated, mountainous plateau. Many perennial streams originate here and water quality can be high if basins are undisturbed. Deeply weathered, acidic, intrusive igneous rock is common. Soils are sensitive to disturbance, especially when stabilizing vegetation is removed. Grand fir, Douglas fir, and—at higher elevations—Engelmann spruce and subalpine fir occur; ponderosa pine, shrubs, and grasses grow in very deep canyons. The highest elevations are above tree line, and are characterized by tundra, alpine grassland, subirrigated meadows, and wetlands. Logging, grazing, mining, and recreation are common land uses. There are no major populated areas, and few roads.

MIDDLE ROCKIES. Within the UGP Region, this ecoregion is found in western Montana and western South Dakota (Black Hills region), at elevations ranging from 2,999 to 12,402 ft (914 to 3,780 m), and covering 25,912.90 mi^2 (67,114.09 km^2). The climate of the Middle Rockies lacks a strong maritime influence. Mountains have Douglas fir, subalpine fir, and Engelmann spruce forests and alpine areas; Pacific tree species are never dominant. Forests can be open. Foothills are partly wooded or shrub and grass covered. Intermontane valleys are grass and/or shrub covered and contain a mosaic of terrestrial and aquatic fauna that is distinct from the nearby mountains. Many mountain-fed, perennial streams occur and differentiate the intermontane valleys from the Northwestern Great Plains. Granitics and associated management problems are less extensive than in the Idaho Batholith. Recreation, logging, mining, and summer livestock grazing are common land uses. Within the Montana portion of the UGP Region, this ecoregion includes scenic resources of national importance, including the Lewis and Clark Trail and the BLM's Judith Mountain Scenic ACEC. The Black

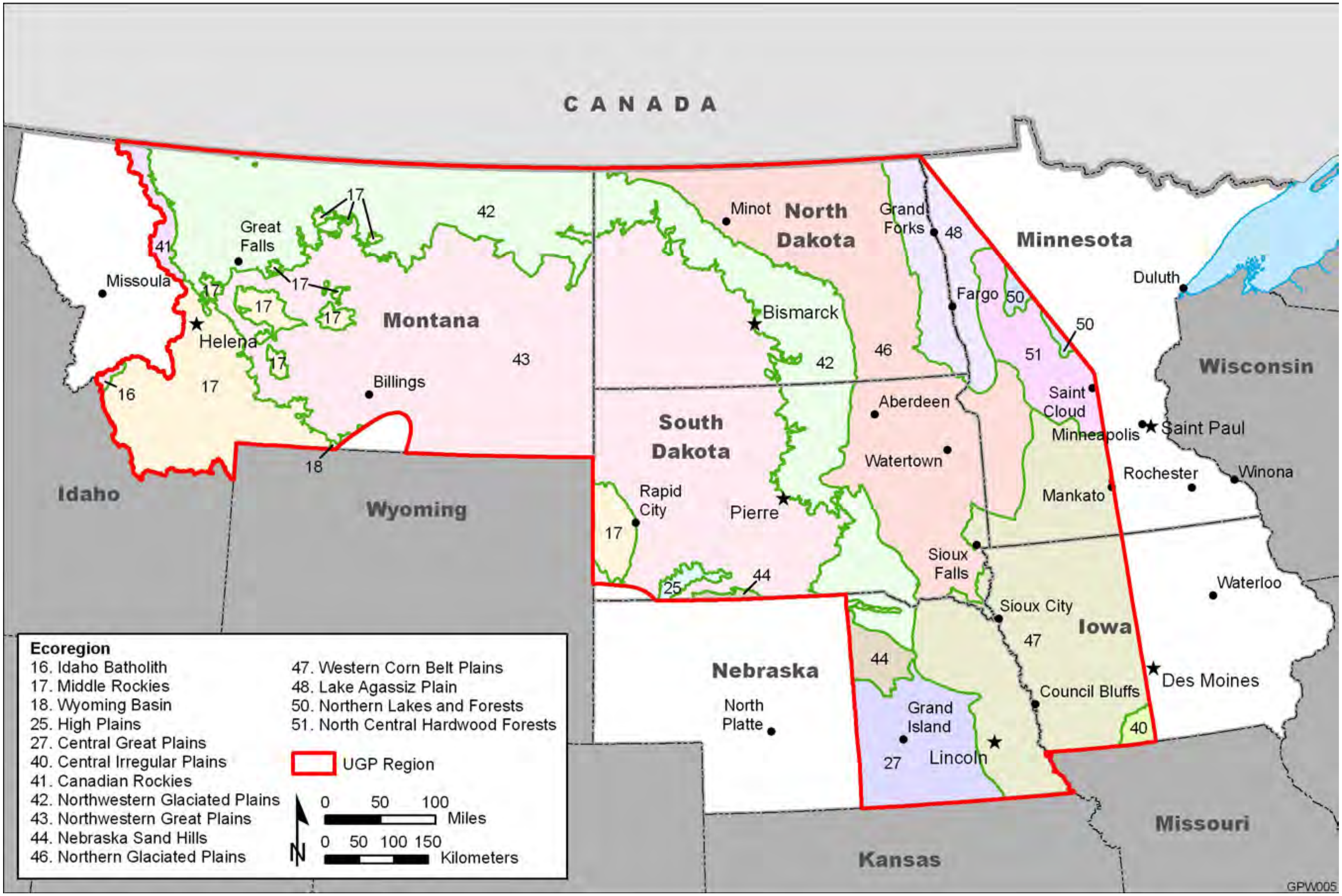

FIGURE C-1 Level III Ecoregions within the UGP Region (Source: EPA 2011)

Hills region of South Dakota is an area of high scenic value and an important recreational and tourist area. Sensitive visual resources of national importance in this area include Jewel Cave, Wind Cave, and Mount Rushmore. Significant urban areas include Helena, Montana, and Rapid City, South Dakota, and there are several major roads, including sections of I-90 and I-15.

WYOMING BASIN. Within the UGP Region, this ecoregion is found in south central Montana, at elevations ranging from 3,760 to 7,156 ft (1,146 to 2,181 m), and covering 122.28 mi^2 (316.71 km^2). The portion of the ecoregion in Montana is within the Bighorn Basin Level IV ecoregion. The Bighorn Basin lies in the rain shadow of the Beartooth Plateau. It includes some of the driest places in Montana, and parts receive an average of only 6 in. (15 cm) of precipitation per year. Unleached, nearly white soils commonly occur and are often alkaline and/or gypsiferous. The potential natural vegetation is mostly sagebrush steppe and is distinct from that of the surrounding ecoregions. Most land is used for grazing, but some irrigated agriculture occurs, especially near the Yellowstone River. There are no major populated areas, and few major roads.

WESTERN HIGH PLAINS. Within the UGP Region, this ecoregion is found in southwestern South Dakota, at elevations ranging from 2,782 to 3,698 ft (848 to 1,127 m), and covering 964.92 mi^2 (2,499.14 km^2). The Western High Plains ecoregion is a landscape of rolling plains and tablelands formed by the erosion of the Rocky Mountains. The portion of the ecoregion in South Dakota is within the Pine Ridge Escarpment Level IV ecoregion, and lies entirely within the Pine Ridge Indian Reservation. The Pine Ridge Escarpment forms the boundary between the Missouri Plateau to the north and the High Plains to the south. Ponderosa pines are present on the northern face and the ridgecrest outcrops of sandstone. Cattle graze the rolling grasslands of the Pine Ridge Indian Reservation, and there is limited agriculture and logging as well. Mixed-grass prairie vegetation dominates this northern extremity of the Western High Plains. Sensitive visual resource areas of national importance within this region include Badlands National Park, which overlaps the northern edge of the northernmost portion of the Pine Ridge Escarpment. There are no major populated areas, and few major roads.

CENTRAL GREAT PLAINS. Within the UGP Region, this ecoregion is found in southeastern Nebraska, at elevations ranging from 1,191 to 2,510 ft (363 to 765 m), and covering 13,809.44 mi^2 (35,766.28 km^2). The Central Great Plains are slightly lower, receive more precipitation, and are somewhat more irregular than the Western High Plains to the west. Once a grassland with scattered low trees and shrubs in the south, much of this ecological region is now cropland, the eastern boundary of the region marking the eastern limits of the major winter wheat growing area of the United States. A number of small towns are located in the region, but there are no major urban areas. Sensitive visual resources of national importance include several National Historic Trails: Oregon Trail, California Trail, Mormon Pioneer Trail, and Pony Express Trail. Within the ecoregion, these trails generally follow the courses of the Platte, Loup, and Little Blue Rivers. There are several major roads, including a section of I-80.

CENTRAL IRREGULAR PLAINS. Within the UGP Region, this ecoregion is found in south-central Iowa, at elevations ranging from 883 to 1,348 ft (269 to 411 m), and covering 960.37 mi^2 (2,487.35 km^2). Within Iowa, this portion of the ecoregion is within the Loess Flats and Till Plains Level IV ecoregion. Deep to moderate loess deposits over glacial till and dark shallow soils are characteristic of the Loess Flats and Till Plains ecoregion. Loess deposits generally increase to the south, especially near the Missouri River. Several streams have headwaters in this region, and the topography varies from flat to moderately hilly. Valley sides are not steep, with slopes generally less than 10 percent. The Chariton River area is a more dissected and hilly area within this region. It lacks glacial till in many places and has a greater drainage density and more woody vegetation in stream reaches than in other parts of the ecoregion. Natural wetlands occur along the Grand River and several other rivers in the region. Soils are inherently fertile, but use can be limited due to severe erosion. Land use includes areas of cropland, pasture in the valleys and on upland slopes, and bands of woodland. Corn and soybeans are the major crops. Sensitive visual resources of national importance within the ecoregion include the Mormon Pioneer National Historic Trail. There are no major populated areas, and few major roads.

CANADIAN ROCKIES. Within the UGP Region, this ecoregion is found in western Montana, at elevations ranging from 4,190 to 10,000 ft (1,277 to 3,048 m), and covering 2,254.79 mi^2 (5,839.88 km^2). It straddles the border between Alberta and British Columbia in Canada and extends southeastward into northwestern Montana. Vegetation is mostly Douglas fir, spruce, and lodgepole pine at lower elevations and alpine fir at middle elevations. The higher elevations are treeless alpine. A large part of the region is in national parks (primarily Glacier National Park), where tourism is the major land use and where scenic values are generally very high. Forestry and mining occur on the non-park lands. There are no major populated areas, and few major roads.

NORTHWESTERN GLACIATED PLAINS. Within the UGP Region, this ecoregion is found in Northern Montana, Northern Nebraska, and North and South Dakota, at elevations ranging from 1,207 to 6,401 ft (368 to 1,951 m), and covering 67,504.98 mi^2 (174,837.09 km^2). The Northwestern Glaciated Plains ecoregion is a transitional region between the generally moister, more level, and more agricultural Northern Glaciated Plains to the east and the generally more irregular, dryer Northwestern Great Plains to the west and southwest. The western and southwestern boundary roughly coincides with the limits of continental glaciation. Pocking this ecoregion is a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as “prairie potholes.” Land uses are primarily agriculture and grazing (especially on steeper slopes), with numerous wetlands, and some forested areas and native prairie. Oil production occurs in some places. Sensitive visual resource areas within the ecoregion include the Lewis and Clark National Historic Trail, the North Country National Scenic Trail, portions of the Missouri and Niobrara Rivers designated as National Wild and Scenic Rivers, and Nez Perce National Historical Park. Bismarck, North Dakota, and Great Falls, Montana, are the only major urban area within the ecoregion. There are a number of major roads in this region, including sections of I-15, I-94 and I-90.

NORTHWESTERN GREAT PLAINS. Within the UGP Region, this ecoregion is found in Montana, Nebraska, and North and South Dakota, at elevations ranging from 1,355 to 9,419 ft

(413 to 2,871 m), and covering 114,911.61 mi^2 (297,619.70 km^2). The Northwestern Great Plains ecoregion encompasses the Missouri Plateau section of the Great Plains. It is a semiarid rolling plain of shale and sandstone punctuated by occasional buttes. Native grasslands, largely replaced on level ground by spring wheat and alfalfa, persist in rangeland areas on broken topography. Agriculture is restricted by the erratic precipitation and limited opportunities for irrigation. Land uses include grazing, crop production, scattered coal production, and recreation, with logging in wooded areas. Sensitive visual resource areas within the ecoregion include Badlands National Park, Theodore Roosevelt National Park, Bighorn Canyon National Recreation Area, Little Bighorn Battlefield National Monument, Lewis and Clark National Historic Trail, the North Country National Scenic Trail, portions of the Missouri and Niobrara Rivers designated as National Wild and Scenic Rivers, Fort Union Trading Post, and Knife River Indian Villages and Minuteman Missile National Historic Sites. Within the portion of the ecoregion in Western's service area, Billing, Montana, and Pierre, South Dakota are the only major urban areas, and Pierre's population is less than 15,000. There are a number of major roads in this vast ecoregion, including sections of I-94 and I-90.

NEBRASKA SANDHILLS. Within the UGP Region, this ecoregion is found in north-central Nebraska and southern South Dakota, at elevations ranging from 1,342 to 3,642 ft (409 to 1,110 m), and covering 3,512.35 mi^2 (9,096.93 km^2). The Nebraska Sandhills comprise one of the most distinct and homogenous ecoregions in North America. One of the largest areas of grass-stabilized sand dunes in the world, this region is generally devoid of cropland agriculture and, except for some riparian areas in the north and east, the region is treeless. Large portions of this ecoregion contain numerous lakes and wetlands and have a lack of streams. Cattle grazing is common. Only the easternmost and extreme northernmost portions of the ecoregion are contained within the UGP Region. Very small portions of these areas contain lakes. Most of the South Dakota portion of the ecoregion within the service area is sandhill landscape (generally low east-west grassy ridges), while the Nebraska portion of the ecoregion within the UGP Region is about evenly split between sandhill landscape and the flat, sandy plains of the Wet Meadow and Marsh Plain Level IV ecoregion. Unlike the strictly rangeland characteristics of other Sand Hills regions, land use in the Wet Meadow and Marsh Plain Level IV ecoregion is a mix of rangeland, hayed meadows, and more extensive irrigated cropland. The region is very sparsely populated, with few major roads.

NORTHERN GLACIATED PLAINS. Within the UGP Region, this ecoregion is found in Minnesota and North and South Dakota, at elevations ranging from 915 to 2,507 ft (279 to 764 m), and covering 54,549.59 mi^2 (141,282.79 km^2). The Northern Glaciated Plains ecoregion is characterized by a flat to gently rolling landscape composed of glacial till; however, there is some wooded and hilly terrain within the far northern portions of the ecoregion. The subhumid conditions foster transitional grassland containing tall-grass and short-grass prairie. High concentrations of temporary and seasonal wetlands create favorable conditions for waterfowl nesting and migration. Though the till soils are very fertile, agricultural success is subject to annual climatic fluctuations. Much of the ecoregion is devoted to crop production. Sensitive visual resource areas of national significance include the North Country Scenic Trail and the Lewis and Clark Trail, which borders the extreme southern end of the ecoregion on the Missouri River. There are many small towns within this ecoregion, but no major urban areas. Several Interstate highways pass through the ecoregion (I-94, I-90, I-29).

WESTERN CORN BELT PLAINS. Within the UGP Region, this ecoregion is found in Iowa, Minnesota, Nebraska, and South Dakota, at elevations ranging from 761 to 2,067 ft (232 to 630 m), and covering 49,387.10 mi^2 (127,912.00 km^2). Once covered with tall-grass prairie, over 75 percent of the Western Corn Belt Plains is now used for cropland agriculture and much of the remainder is in forage for livestock. A combination of nearly level to gently rolling glaciated till plains and hilly loess plains, an average annual precipitation of 25–35 in. (63–89 cm) that occurs mainly in the growing season, and fertile, warm, moist soils make this one of the most productive areas of corn and soybeans in the world. The northeastern portion of the ecoregion within the UGP Region consists primarily of rolling plains dominated by row crops and pasture, while portions of the ecoregion in far western Iowa and eastern Nebraska are hilly, and more likely to have wooded areas. Because the ecoregion within the UGP Region includes portions of the Platte and Missouri Rivers, several National Historic Trails pass through the ecoregion and constitute sensitive visual resources of national significance, including the Oregon Trail, California Trail, Mormon Pioneer Trail, Pony Express Trail, and the Lewis and Clark Trail. In addition, a portion of the Missouri River within the ecoregion is designated as a National Scenic River. The ecoregion within Western's service area includes several major urban areas, specifically Council Bluffs and Sioux City, Iowa, and Lincoln, Nebraska. There are numerous major roads, including several Interstate highways (I-80, I-680, I-90, and I-29).

LAKE AGASSIZ PLAIN. Within the UGP Region, this ecoregion is found in Minnesota and North and South Dakota, at elevations ranging from 787 to 1,404 ft (240 to 428 m), and covering 12,992.78 mi^2 (33,651.14 km^2). Glacial Lake Agassiz was the last in a series of proglacial lakes to fill the Red River valley in the three million years since the beginning of the Pleistocene. Thick beds of lake sediments on top of glacial till create the extremely flat floor of the Lake Agassiz Plain. The historic tall-grass prairie has been replaced by intensive row crop agriculture. The preferred crops in the northern half of the region are potatoes, beans, sugar beets, and wheat; soybeans, sugar beets, and corn predominate in the south. The landscape is predominantly flat, but with low ridges of gravel and sand in the easternmost portion of the ecoregion. Sensitive visual resources of national significance within this ecoregion and within the UGP Region include the North Country National Scenic Trail. Fargo, North Dakota, is the single large urban area in the ecoregion. There are several major roads within the ecoregion, including sections of I-94 and I-29.

NORTHERN LAKES AND FORESTS. Within the UGP Region, this ecoregion is found in Minnesota, at elevations ranging from 1,181 to 2,001 ft (360 to 610 m), and covering 1,154.94 mi^2 (2,991.29 km^2). The portion of the ecoregion within the Western service region is within the Itasca and St. Louis Moraines Level IV ecoregion and the Wadena/Todd Drumlins and Osakis Till Plain Level IV ecoregion. The Northern Lakes and Forests is a region of nutrient-poor glacial soils, coniferous and northern hardwood forests, undulating till plains, moraine hills, broad lacustrine basins, and extensive sandy outwash plains. Soils in this ecoregion are thicker than in those to the north and generally lack the arability of soils in adjacent ecoregions to the south. The numerous lakes that dot the landscape are clearer and less productive than those in ecoregions to the south. The Itasca and St. Louis Moraines Level IV ecoregion consists primarily of forested rolling landscape with some lakes, crops, and pasture. Sensitive visual resources of national significance within this ecoregion and within the UGP Region include the North Country National Scenic Trail. The Wadena/Todd Drumlins and Osakis Till Plain Level IV ecoregion contains primarily drumlins and rolling plains with row crops, pasture, and woodland. There are a few small towns within these areas, but no large urban areas and few major roads.

NORTH CENTRAL HARDWOOD FORESTS. Within the UGP Region, this ecoregion is found in Minnesota, at elevations ranging from 771 to 1,739 ft (235 to 530 m), and covering 9,165.24 mi^2 (23,737.85 km^2). The North Central Hardwood Forests is transitional between the predominantly forested Northern Lakes and Forests to the north and the agricultural ecoregions to the south. The portion of the ecoregion within the Western service region consist primarily of rolling plains, with elevated knob and kettle landscapes and many lakes in the westernmost portion of the ecoregion. Land use/land cover in this ecoregion consists of a mosaic of forests, wetlands and lakes, cropland agriculture, pasture, and dairy operations. Sensitive visual resources of national significance within this ecoregion and within the UGP Region include the North Country National Scenic Trail, which passes through the northern portion of the ecoregion. Major urban areas include St. Cloud, Minnesota. There are few major roads, although the portion of the ecoregion within the UGP Region includes a section of I-94.

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APPENDIX D

PROGRAMMATIC BIOLOGICAL ASSESSMENT FOR WIND ENERGY DEVELOPMENT IN THE UGP REGION

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APPENDIX D

PROGRAMMATIC BIOLOGICAL ASSESSMENT FOR WIND ENERGY DEVELOPMENT IN THE UGP REGION

The programmatic biological assessment is being developed as part of the Endangered Species Act Section 7 consultation with the U.S. Fish and Wildlife Service and will be included in the final PEIS.

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APPENDIX E

THE UPPER GREAT PLAINS WIND ENERGY POTENTIAL DEVELOPMENT SUITABILITY MODEL

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APPENDIX E

THE UPPER GREAT PLAINS WIND ENERGY POTENTIAL DEVELOPMENT SUITABILITY MODEL

E.1 INTRODUCTION

The number of proposed, planned, and developed wind energy projects in the Western Area Power Administration's (Western) Upper Great Plains (UGP) Region is rapidly increasing. To facilitate a more informed assessment of the potential impacts related to wind energy development in the UGP Region, a location-specific model was created. The purpose of the UGP Wind Energy Potential Development Model (UGP Model) is to broadly quantify the suitability of the region for wind energy development in a spatial context, identify the approximate areas for likely development in the future, and determine the associated potential impacts of development to sensitive resources. While the UGP Model provides an estimate of suitability for locations throughout the study area, it was not used to identify wind energy zones.

Many recent studies have been conducted to help inform and improve decision making related to future energy development, which provided a basis for designing the UGP Model. One such study, the *Western Renewable Energy Zone — Phase I Report* (WGA and DOE 2009) commissioned by the Western Governors' Association (WGA), employed GIS analysis and stakeholder engagement to identify hubs most appropriate for future renewable energy projects in the western States. While the study included multiple types of renewable energy, the *Phase 1 Report* described several criteria specific to wind energy analyses that are applicable for the UGP Model.

The WGA is not the only organization to establish renewable energy zones in recent years. In 2008 the Colorado Governor's Energy Office published a revision to its 2007 study on the potential of various renewable energy technologies within the State (Colorado Governor's Energy Office 2008). The report, submitted in response to Colorado Senate Bill 07-091, briefly explains the potential of wind, solar, hydroelectric, and geothermal power, as well as biomass, ethanol, and biodiesel energy development within the State. The Colorado study used wind power class data from the National Renewable Energy Laboratory (NREL), to determine specific wind power generation development areas, mostly along the eastern edge of the State.

The Electric Reliability Council of Texas (ERCOT) contracted AWS Truewind (now AWS Truepower) to conduct a study in order to designate competitive renewable energy zones in Texas (ERCOT System Planning 2006). AWS Truewind used its proprietary meteorological model and stakeholder input to identify 25 potential zones. In addition, the Wind Energy Resource Zone Board of Michigan used GIS analysis for a wind siting study that resulted in the identification of four regions with the highest wind energy harvest potential in the State (PSC and MSU 2009). The Michigan Board ran 18 different scenarios varying setbacks from roads and open water, wind resource data, and included land types to determine the four optimal regions.

Two regional studies, prepared by Midwest ISO and ISO New England, did not seek to designate specific wind energy zones, but instead, to determine which areas are better suited for wind energy development. One of the overall goals of the *Regional Generation Outlet Study*

(MISO 2010) was to identify potential sites from eastern Montana to Ohio that had a combined rated capacity of at least 3,000 gigawatts. This was accomplished using the AWS Truewind meteorological model and included other limiting factors, such as slope and land use. ISO New England sought to determine the total onshore and offshore installed capacity within the region, given several transmission scenarios (Levitan & Associates, Inc. 2008). This analysis also used AWS Truewind data, as well as wind power class, population, water depth, and other restrictive factors (ISO-NE 2010).

These studies, along with several others, provided the basis for the UGP Model. Some factors included in the UGP Model were not present in all or any of the previously developed models. These factors, incorporated into the UGP Model based on expert input, produce a balanced model for studying the wind energy development potential of lands within Western's UGP Region.

E.2 METHODOLOGY

E.2.1 Model Design

The UGP Model included six major siting factors: wind resource potential, slope, land use, proximity to existing transmission infrastructure, protected areas, and potentially suitable habitat for threatened and endangered species. All model input rasters were clipped to the study area, had a cell size of 300 meters, and were in the USA Contiguous Albers Equal Area Conic USGS Version projected coordinate system with the North American 1983 datum. Suitability scores, which were assigned to the model input rasters and calculated in the model results, ranged from zero to one, with zero representing excluded lands and one representing the highest suitability. Table E.2-1 lists the data and sources used to develop the UGP Model.

E.2.2 Wind Resource Model Input Layer

Following the procedure cited in the *Western Renewable Energy Zone — Phase 1 Report*, only land with a NREL wind power class value of three or greater at 50 meters above ground was considered to be suitable for development in the UGP Model (WGA and DOE 2009). The exclusion of lands rated one or two for wind power class was prevalent throughout the various wind siting studies. The *Final Report of the Michigan Wind Energy Resource Zone Board* (PSC and MSU 2009) and the ISO New England *Phase II Wind Study* (Levitan & Associates, Inc. 2008) also only included lands rated three or better for analysis. The Wind Resource model input layer is comprised solely of this NREL wind power class data. For the UGP Model, individual State wind power class rasters were stitched together and then clipped to the study area. Wind power classes three to seven were assigned suitability values ranging from 0.2–1.0, while wind power classes one and two were assigned the exclusionary value of zero. Table E.2-2 displays the analysis values attributed to the NREL wind power classes in the UGP Model. Figure E.2-1 shows the wind resource model input layer.

1 **TABLE E.2-1 Data Sources Used to Develop Model Inputs**

Data	Source
25-mi buffer around Western substations	Western Area Power Administration (Western) (Weisbender 2009a)
Airports	National Transportation Atlas Database 2010 (Research and Innovative Technology Administration's Bureau of Transportation Statistics) (FAA 2010)
Areas of Critical Environmental Concern	Argonne National Laboratory, Bureau of Land Management (BLM) (Argonne 2008a)
Battlefields and Military Park Sites	National Park Service (NPS) (NPS 2010a)
Defined critical habitat	U.S. Fish and Wildlife Service (Service) (Service 2010)
Electric substations	Platts (2010a)
GAP potentially suitable habitat models	U.S. Geological Survey (USGS) GAP Analysis Program (USGS 2011)
Military installations, ranges, training areas	The Defense Installation Spatial Data Infrastructure (DISDI) Program (The DISDI Program 2010)
National Elevation Dataset 30-m digital elevation models	U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS) (USDA 2010)
National Historic and Scenic Trails	NPS (2003)
National Land Cover dataset	USDA NRCS (USDA 2001)
National Monuments	Argonne National Laboratory, from various sources (Argonne 2009)
National Park Service property	NPS (2010b)
National Scenic and Back Country Byways	National Scenic Byways Program (NSBP) (NSBP 2010)
National Wetland Inventory	Service, Division of Habitat and Resource Conservation (Service 2004)
Protected Areas Database of the United States, Version 1.1 for State lands, national conservation areas, and other protected areas	USGS National Gap Analysis Program (USGS 2010)
Surface management agency (Federal land ownership) for military lands, National Parks, National Wildlife Refuges	BLM (Reitsma 2010)
Surface water stream centerlines	National Atlas of the United States (ESRI 2004a)
Surface water body areas	National Atlas of the United States (ESRI 2004b)
Transmission lines	Platts (2010b)

TABLE E.2-1 (Cont.)

Data	Source
USFS roadless areas	U.S. Forest Service (USFS) (USFS 2008)
USFS specially designated areas	USFS (2000)
Western service boundary	Western (Weisbender 2009b)
Weather radar sites	National Oceanic and Atmospheric Administration (NOAA) (Crum 2009)
Wild and Scenic Rivers	USFS (2009)
Wilderness Areas	National Atlas of the United States (National Atlas 2005)
Wilderness Study Areas	Argonne National Laboratory, from BLM and USFS sources (Argonne 2008b)
Wind resource potential at 50 meters for Iowa	Iowa Energy Center (Slaats 2009)
Wind resource potential at 50 meters for Minnesota, Montana, Nebraska, North Dakota, South Dakota	National Renewable Energy Laboratory (NREL) (NREL 2000, 2002, 2005; Heimiller 2009)

TABLE E.2-2 Assigned Values in the Wind Power Class Model Input Layer

Wind Power Class	Analysis Value
1	0.0
2	0.0
3	0.2
4	0.4
5	0.6
6	0.8
7	1.0

E.2.3 Slope Model Input Layer

Another factor affecting the placement of wind turbines, especially for utility-scale wind projects, is the gradient of the land. Wind turbines cannot be readily placed on land that is too steep. The UGP Model excluded from analysis any land where the terrain slope was greater than 20 percent, or 11.31 degrees. Both the *Western Renewable Energy Zone – Phase 1 Report* (WGA and DOE 2009) and the Midwest ISO *Regional Generation Outlet Study* (MISO 2010) used this 20 percent threshold as well. For the UGP Model, the slope model input layer was first created by stitching together a number of 30-meter Digital Elevation Models and then running a percent rise slope analysis on the final output. The percent rise analysis resulted in values ranging from 0 to 527. For percent rise, the range is 0 to near infinity. A flat surface is

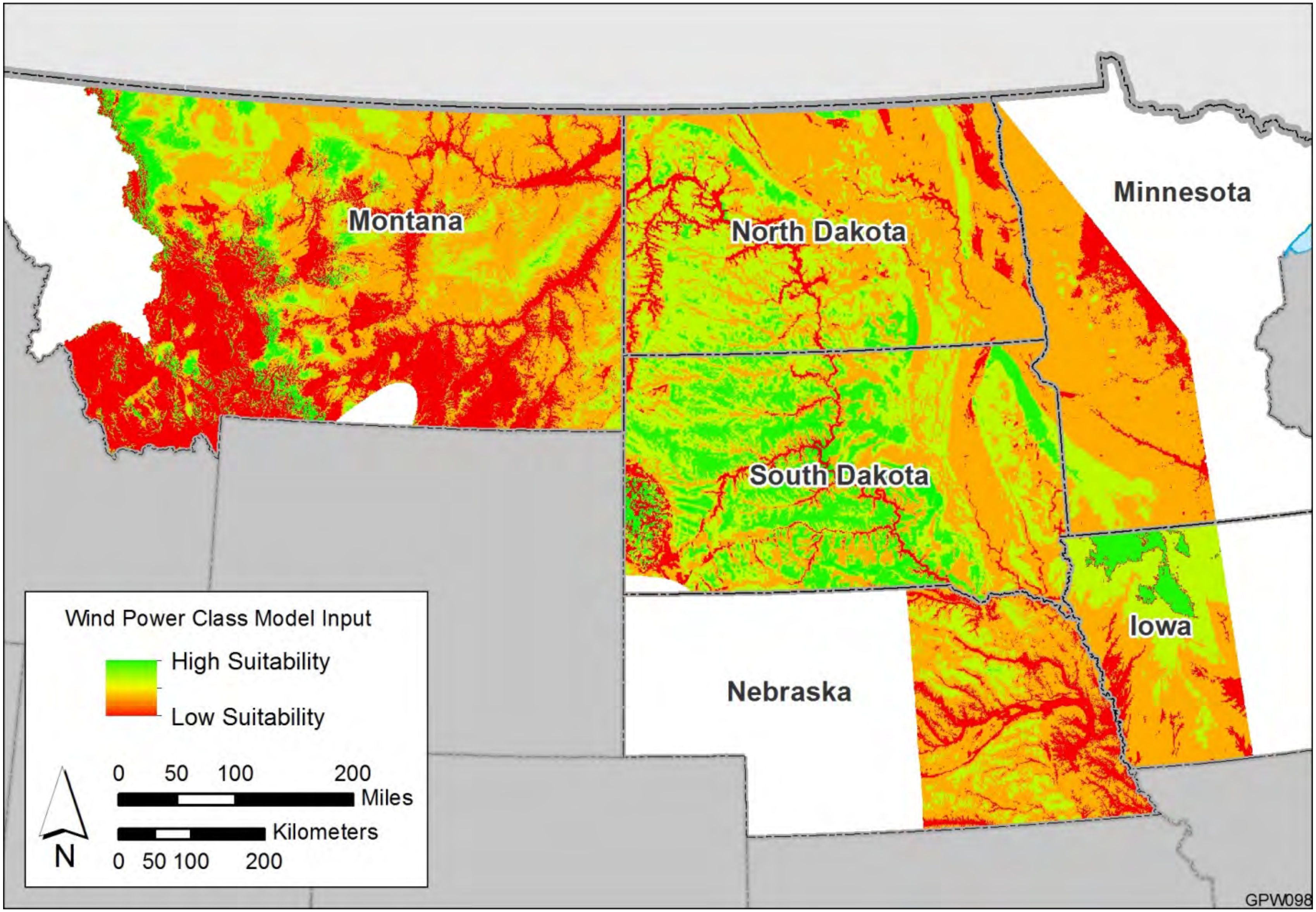


FIGURE E.2-1 Model Input Layer for Wind Resources

0 percent, a 45-degree surface is 100 percent, and as the surface becomes more vertical, the percent rise becomes increasingly larger. The highest percent rise value in the slope model input layer was 527 percent, which means the steepest area (cell in the GIS layer) within the UGP Region had a gradient of 79.25 degrees. All cells with a slope of less than 20 percent were given a suitability value of one and all cells with a slope of 20 percent or greater were assigned a suitability value of zero. The slope model input layer can be seen in figure E.2-2.

E.2.4 Land Use Model Input Layer

The UGP Model also factored land use into the analysis as a land constraint, in addition to wind power class and slope. The UGP Land Cover model input layer included land use information from the USGS National Land Cover Database (NLCD), stream centerlines and water bodies from the National Atlas, and wetland data from the National Wetland Inventory. The NLCD data contained a number of land types, some that were suitable for utility-scale wind projects and others that were not. Developed areas, for example, were one classification of NLCD lands excluded in both the UGP Model and the Midwest ISO *Regional Generation Outlet Study* (MISO 2010). Open water and wetlands, aside from uplands, were also deemed unsuitable for wind projects for the purpose of this analysis. Table E.2-3 indicates the values assigned to the attributes in the Land Cover model input layer. The compilation of all the land use factors is shown in figure E.2-3, the land use model input layer.

E.2.5 Transmission Infrastructure Model Input Layer

Access to electrical transmission infrastructure is an important requirement and cost factor for siting utility-scale wind energy projects. For this UGP Model input, existing electrical transmission line and substation data (Platts 2010) were used. Distance to the nearest substation was calculated for each cell to a limit of 25 mi (40 km), and the same computation was performed for transmission lines. The resulting layers were converted to inverse distances, scaled to a range of 1.0 (adjacent to a substation or transmission line) to 0.2 (25 mi [40 km] from the nearest substation or transmission line). Cells over 25 mi (40 km) from the nearest transmission infrastructure component were assigned scores of 0.2 since longer distances are not completely prohibitive to project siting.

Next the total capacity of substations and transmission lines within 25 mi (40 km) of the aforementioned infrastructure components was computed. In these computations, substations lacking a voltage value were assigned a voltage of 34 kV, and transmission lines lacking a voltage value were assigned a voltage of 10 kV. The 34 kV and 10 kV assigned voltages were based on the expert input of a systems engineer who is very knowledgeable on electricity infrastructure. These results were also scaled to ranges from 0.2 to 1.0, with 1.0 corresponding to the highest summed substation and transmission line capacities.

The four resulting layers were multiplied together to combine the distance and capacity scores. Finally, areas within 300 meters of infrastructure were assigned a score of 0.0 to allow for minimum setbacks of towers from the infrastructure. The resultant model input layer for proximity to existing electrical infrastructure is shown in figure E.2-4.

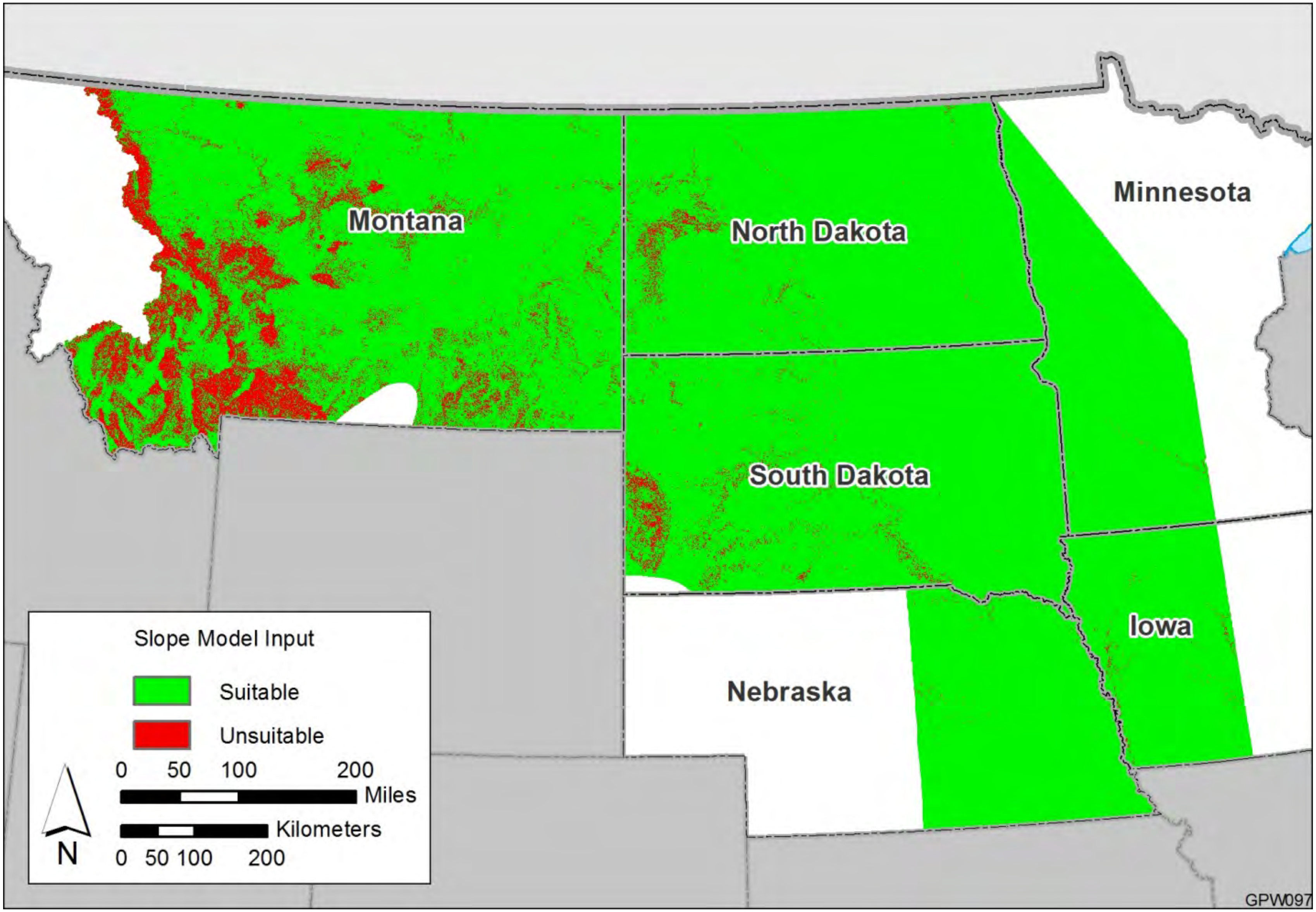


FIGURE E.2-2 Model Input Layer for Slope

TABLE E.2-3 Data Layers and Assigned Values in Land Use Model Input Layer

Land Type	Value
Open water and wetlands	0.0
Developed areas	0.0
Barren land	1.0
Deciduous, coniferous, and mixed forests	0.0
Shrub/scrub	1.0
Grassland/herbaceous	1.0
Pasture/hay	1.0
Cultivated crops	1.0

E.2.6 Protected Areas Model Input Layer

Protected areas, such as Specially Designated Areas and Wilderness Areas, were included in the UGP Model in order to exclude them from potentially suitable land. Most data layers were acquired from the Renewable Energy Atlas produced by the Environmental Science Division of Argonne National Laboratory (Argonne) as part of the *Section 368B Report to Congress*, which was created in response to the Programmatic Environmental Impact Statement (PEIS), *Designation of Energy Corridors on Federal Land in the 11 Western States* (DOE and DOI 2008). Data for airports, Department of Defense (DOD) properties, radar, and critical habitat came from other sources. Land in the immediate vicinity of airports was also deemed unsuitable, as cited in the *Final Report of the Michigan Wind Energy Resource Zone Board* (PSC and MSU 2009). Airport data obtained from the National Transportation Atlas Database were buffered 10 mi (16 km) for commercial, military and airports with control towers and 6.32 mi (10.2 km) for local airports. The resultant area was then added to the protected areas model input layer. Areas that the US Fish and Wildlife Service (Service) has designated as critical habitat also were included in the protected areas model input layer, as were DOD lands and 10-mi (16-km) buffers around weather radar points.

In order to account for State parks, national forests, and other protected areas, the USGS National Biological Information Infrastructure (NBII) Gap Analysis Program (GAP) Protected Areas Database of the United States (PAD-US) was added to the protected areas model input layer. The data were queried based on GAP Status Code and International Union for the Conservation of Nature (IUCN) Category. Lands with GAP Status Code 1, 2, or 3 or assigned IUCN Category Ia, Ib, II, III, IV, V, or VI were excluded from potential suitable land. Data layers included in the protected areas model input layer are listed in table E.2-4. All protected areas were considered unsuitable for wind energy development and were therefore assigned a suitability value of zero. Figure E.2-5 displays the protected areas model input layer.

E.2.7 Potentially Suitable Habitat Model Input Layer

Threatened and endangered species habitats are similar to protected areas in that they also need to be considered for a land development suitability analysis. Twelve candidate, threatened, or endangered species in the Upper Great Plains study area that could be affected

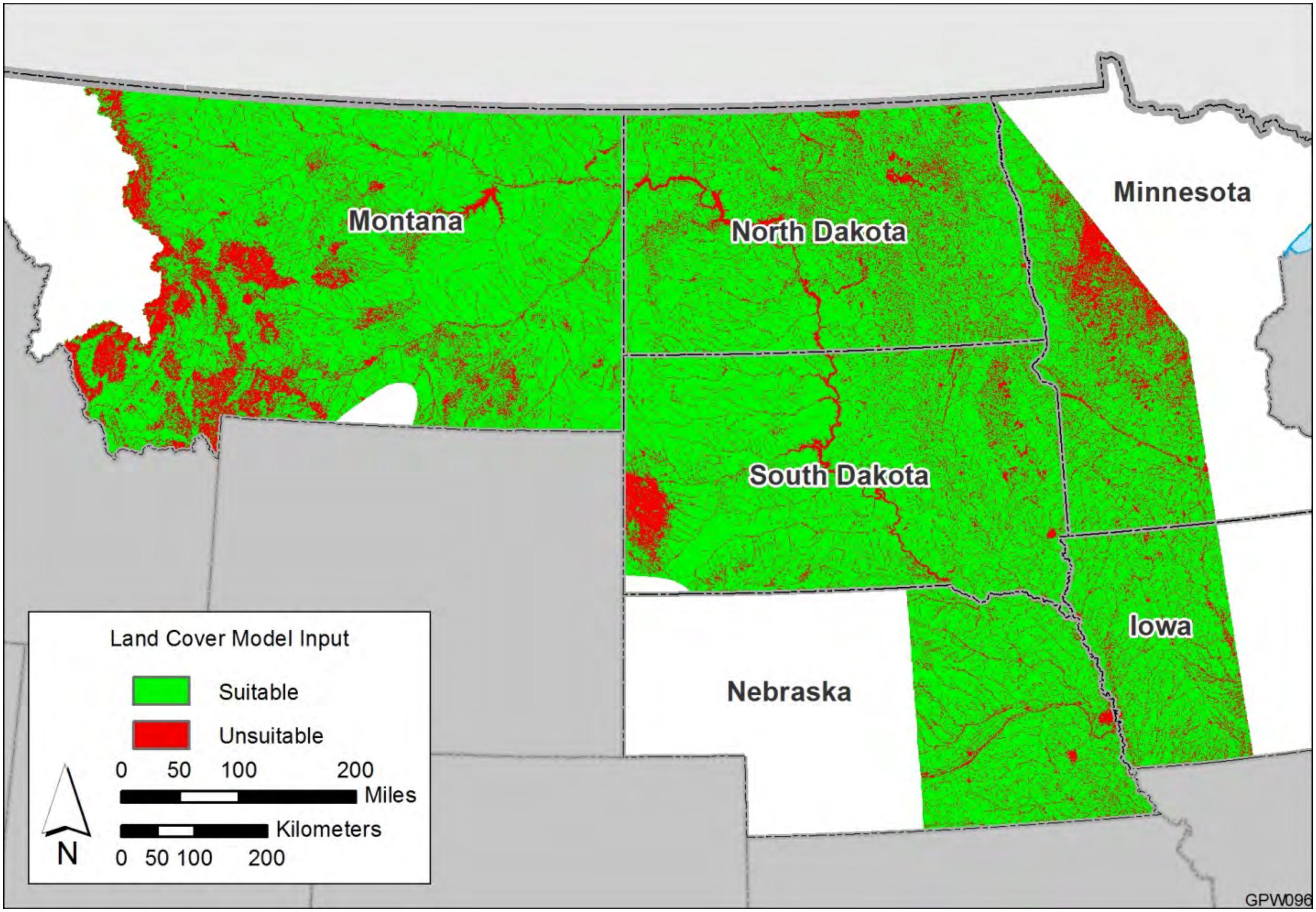
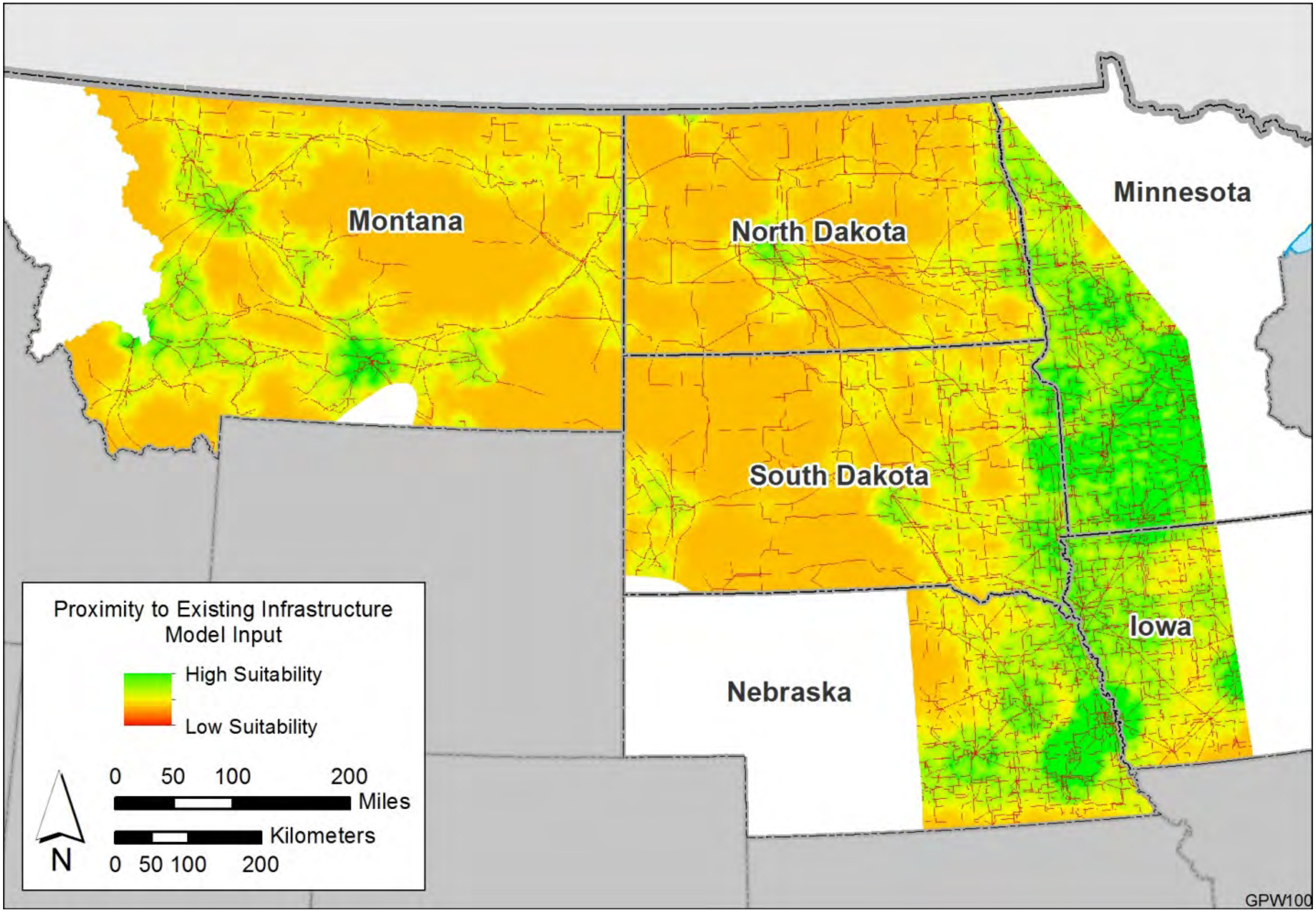


FIGURE E.2-3 Model Input Layer for Land Use



1

2 **FIGURE E.2-4 Model Input Layer for Proximity to Existing Infrastructure**

TABLE E.2-4 Data Layers in the Protected Areas Model Input Layer

Protected Area
Wild and Scenic Rivers
National Park Service (NPS) National Trails
National Scenic and Back Country Byways
National Parks
NPS Battlefields and Military Park Sites
Areas of Critical Environmental Concern
National Monuments
National Wildlife Refuges
NPS Property
Wilderness Study Areas
Wilderness Areas
U.S. Forest Service (USFS) roadless areas
USFS specially designated areas
National Conservation Areas
U.S. Fish and Wildlife Service critical habitat
U.S. Department of Defense military lands
Airport buffers
National Oceanic and Atmospheric Administration (NOAA) weather radar points (10-mi buffer)
U.S. Geological Survey (USGS) NBII GAP Protected Areas Database of the United States

by the development or operation of utility-scale wind projects were identified. Aquatic species were not included, as open water areas were already deemed unsuitable land for analysis in the UGP Model. USGS Gap Analysis Program (GAP) data were used to determine the extent of potentially suitable habitat in the study area. Two factors were considered in the potentially suitable habitat analysis: the Service status assigned to each species and the impact of multiple species occupying the same area. The GAP Suitability Models, which indicate the presence or absence of potentially suitable habitat for a particular species, were assigned an endangerment score based on the Service status. The second factor, impact of multiple species in the same area, was determined by multiplying all the species rasters in a State together. The resultant compounded values were used to represent potentially suitable habitat in the final analysis. The list of candidate, threatened, and endangered species, as well as the States in which they are present and the assigned suitability score can be seen in table E.2-5. Figure E.2-6 shows the result of all the raster multiplication: the model input layer for potentially suitable habitat for threatened and endangered species.

E.3 MODEL EXECUTION

Once the six model input layers were compiled, the UGP Model itself was relatively straightforward. The model input layers were weighted equally with a value of 1.0 and put into the following equation to calculate the geometric mean for each cell:

$$\bar{x} = \left(\prod_{i=1}^{n} {x_i}^{w_i} \right)^{1/\sum_{i=1}^{n} w_i}$$

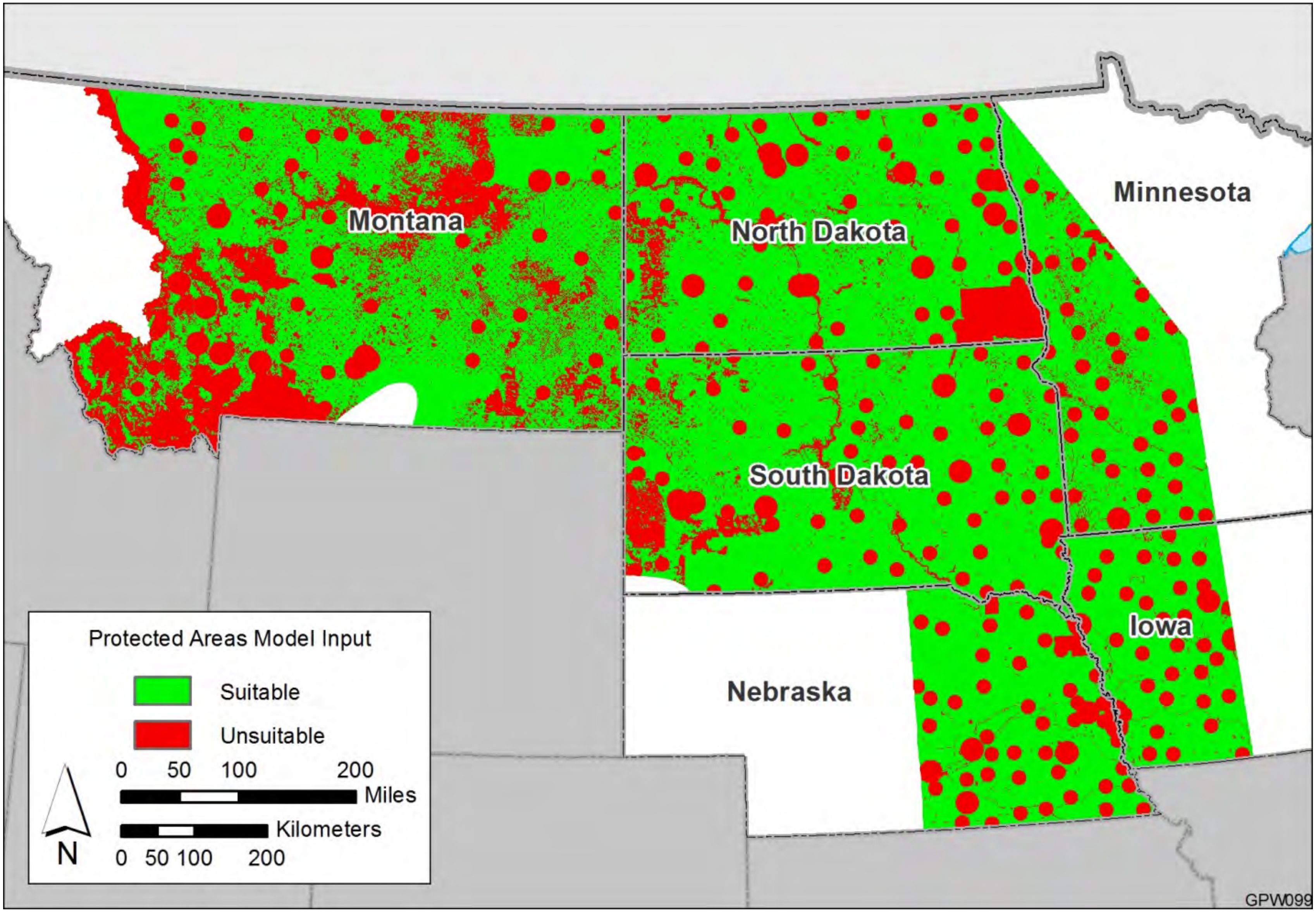


FIGURE E.2-5 Model Input Layer for Protected Areas

TABLE E.2-5 Threatened and Endangered Species GAP Suitability Models Included in the Suitability Analysis and Assigned Endangerment Score

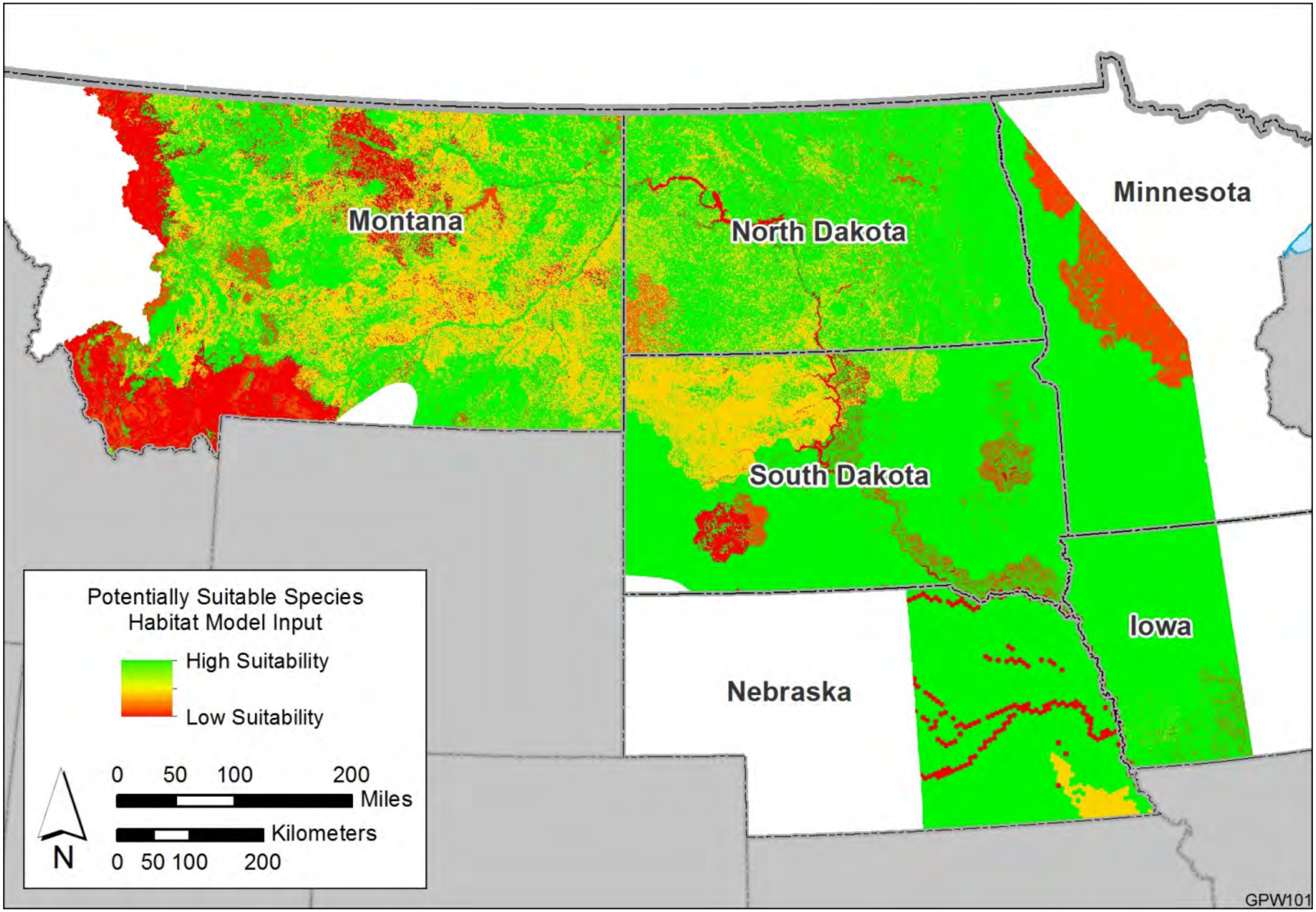
	State						Status
Species	Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota	(Endangerment Score)
Black-footed ferret			X			X	Endangered (0.2)
Canada lynx		X	X				Threatened (0.2)
Gray wolf		X	X				Endangered (0.2)
Greater sage-grouse			X		X	X	Candidate (0.5)
Grizzly bear			X				Threatened (0.2)
Indiana bat	X						Endangered (0.2)
Least tern	X		X	X	X	X	Endangered (0.2)
Massasauga	X			X			Candidate (0.5)
Mountain plover			X				Proposed (0.2)
Piping plover	X		X	X	X	X	Threatened (0.2)
Sprague's pipit			X		X	X	Candidate (0.5)
Whooping crane			X				Endangered (0.2)

where x_i = the suitability index score for variable *i*, and w_i = weight given to variable *i*. The model expression, as entered into the ESRI ArcGIS Spatial Analyst Extension Raster Calculator, was:

Power("protected_areas"*"wpc_final"*"infrastructure"*"land_cover"*"slope"* "potentially_suitable_habitat",0.1667)

The designated raster names of the model input layers are displayed in table E.3-1.

1



2 **FIGURE E.2-6 Model Input Layer for Potentially Suitable Habitat for Threatened and Endangered Species**

TABLE E.3-1 Suitability Analysis Model Input Layers with Weights Used in Model Runs

Model Input Layer	Raster Name	Model 1 Weight
Potentially suitable species habitat	potentially_suitable_habitat	1
Existing infrastructure	infrastructure	1
Land cover	land_cover	1
Protected areas	protected_areas	1
Slope	slope	1
Wind power class	wpc_final	1

E.4 RESULTS

For analysis, the results from Model 1 were classified into three ranges: low, medium, and high suitability, based on standard deviation. The low-suitability category is comprised of values less than one standard deviation below the mean, including zero. Zero was included in this category because the value of one standard deviation below the mean was so small, it was almost zero itself. The medium-suitability category consists of values within one standard deviation above and below the mean. The high-suitability category contains values that are greater than one standard deviation above the mean. None of the cells has a suitability value of one, meaning no land in the study area is 100 percent suitable based on the UGP Model. These categories equate to 110,868,000 acres of low-suitability land, including excluded unsuitable land, 65,093,977 acres of medium-suitability land, and 52,621,694 acres of high-suitability land in the Upper Great Plains Wind Energy PEIS study region (the Western Area Power Administration service area).

Results from the initial UGP Model run are displayed in tables E.4-1 and E.4-2 and figure E.4-1. All six States within the study region have land that falls into the three suitability categories; no State has been completely excluded from potential wind energy development based on this model. No State is lacking in low-suitability land, either. Based on the results from this analysis, nearly 50 percent of the UGP study region consists of low/unsuitable land, with at least 35 percent of each State's acreage classified as low-suitability land. See table E.4-1 for the percentage of low, medium, and high potentially suitable land for wind energy development within each State. These percentages demonstrate the suitability categorization based on each State's individual total acreage. See table E.4-2 for the breakdown of low, medium, and high potentially suitable land as a percentage of the total acreage of the UGP study region. The results are classified by State, but each number represents a percentage of the region as a whole.

In general, most of the land with high potential for wind energy development lies in the Minnesota–Iowa–South Dakota region. Reasons for this include good proximity to pre-existing electrical transmission infrastructure and a general lack of potentially suitable habitat for

TABLE E.4-1 Percentage of Potentially Low-, Medium-, and High-Suitability Land for Wind Energy Development within Each State, on the Basis of Each Location's Acreage

	Percentage in Each Location						
Potential for Wind Energy Development	Region	Iowa	Minnesota	Montana	Nebraska	North Dakota	South Dakota
Low	48.5	42.9	47.7	61.9	49.6	41.5	35.6
Medium	28.5	15.7	11.9	31.2	22.8	35.4	31.4
High	23.0	41.4	40.3	6.9	27.6	23.1	33.0

TABLE E.4-2 Percentage of Potentially Low-, Medium-, and High-Suitability Land within the Study Region, on the Basis of the Total Region's Acreage

	Percentage in Total Region			
Area	Low	Medium	High	Total
Region	48.5	28.5	23.0	100.0
Iowa	3.0	1.1	2.9	6.9
Minnesota	4.4	1.1	3.7	9.1
Montana	20.8	10.5	2.3	33.6
Nebraska	4.5	2.1	2.5	9.2
North Dakota	8.2	7.0	4.6	19.8
South Dakota	7.6	6.7	7.1	21.4

threatened and endangered species. The area also has favorable slope and land cover for wind energy development.

Montana has the most low/unsuitable land and the least highly suitable land, with respect to classification within each State and the region as a whole. Nearly 21 percent of the entire study region is low-suitability land in Montana, while 2.3 percent of the entire region's acreage is highly suitable land in Montana (see table E.4-2). Looking at the suitability categorization within the State, 61.9 percent of Montana's total acreage falls into the low-suitability category, while 6.9 percent of the State's acreage is considered highly suitable. Viewing the model input layer figures gives an indication of Montana's suitability results. Figure E.2-1 indicates that a large portion of southern Montana is designated with poor wind power class. Figure E.2-5 shows a number of excluded protected areas in the State. Figure E.2-6 denotes large areas that could be potentially suitable habitat to threatened and endangered species.

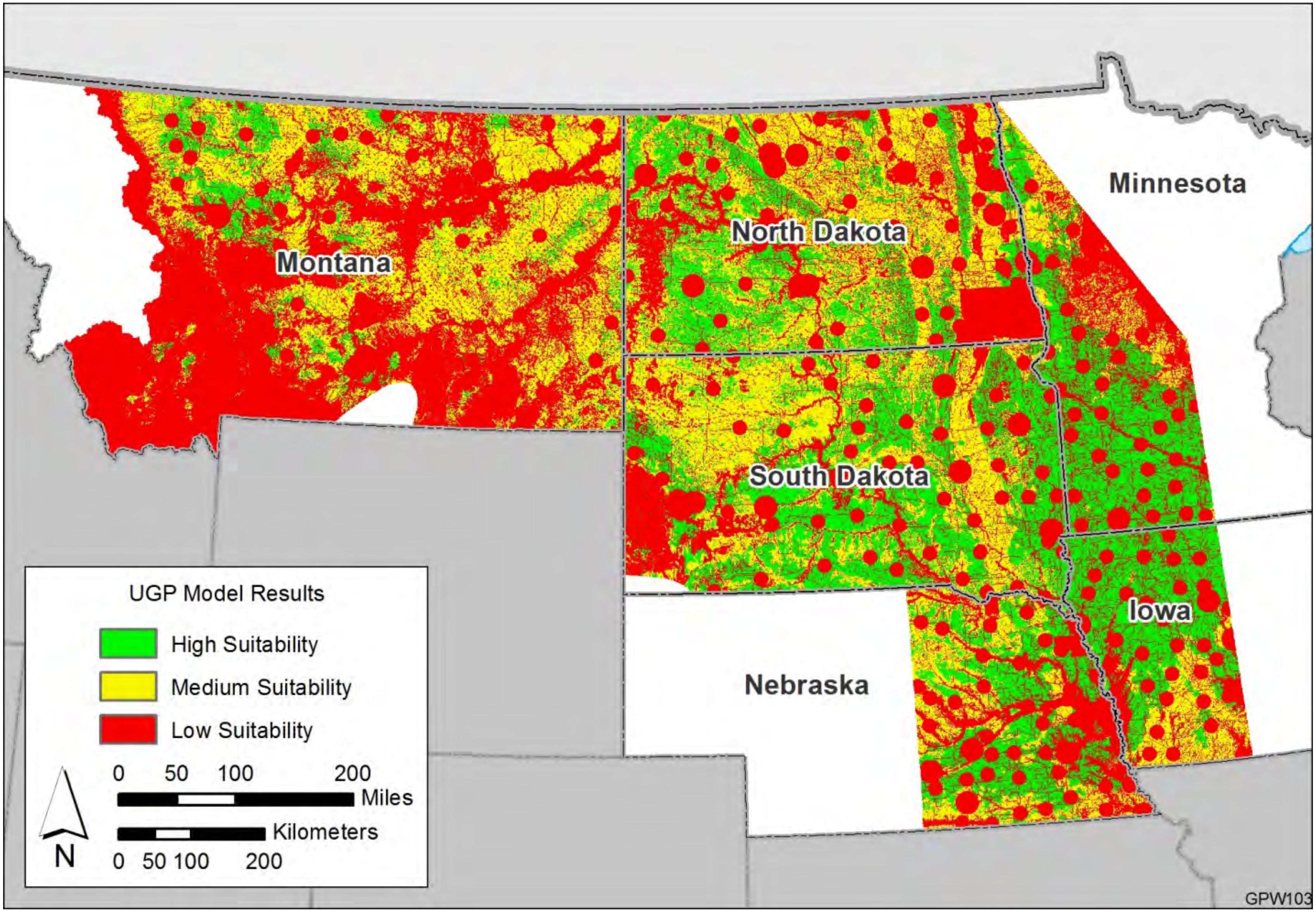


FIGURE E.4-1 UGP Model Results

Turning to the other end of the scale, in comparison to the entire UGP Region, South Dakota contains the most land with a high potential for wind energy development, at 7.1 percent (see table E.4-2). Iowa has the most highly suitable land on an individual State level, however, with 41.4 percent of its total acreage deemed highly suitable (see table E.4-1).

E.5 CONCLUSION

While a considerable number of input data sources and siting variables were considered in the UGP Model, some were determined to be out of scope for the analysis or not included because they would not affect the suitability of a location for wind development. Several of the significant issues are listed below.

- Local zoning designations and building codes;
- Locations of military aircraft training routes and special airspace areas;
- Distance zones around sensitive resources, such as national parks and scenic areas;
- Specific right-of-way routes necessary to connect a particular location to transmission infrastructure;
- Barriers (such as major rivers, protected lands, etc.) between particular locations and transmission infrastructure; and
- Newer data being published by NREL that focuses on 80-meter turbine heights or higher.

Consideration of many of these factors is necessary for siting projects, and some would be useful in a more detailed modeling effort.

The UGP Model found almost 50 percent of the total acreage of the UGP Region to have a low potential for future wind energy development. However, changes in the assumptions used in the UGP Model would affect this outcome. By altering weights assigned to the various model input layers the importance of different siting restrictions or considerations could be explored. Similarly, refinements to the various input layers used in the model based upon guidance from field experts could result in changes to the suitability values. Based upon the input values and assumptions identified above, the highest potential for wind energy development in the Western Area Power Administration’s service region is in concentrated areas in Minnesota and Iowa and spread more generally throughout North Dakota, South Dakota, and Nebraska.

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APPENDIX F

SPECIES DESIGNATED AS THREATENED OR ENDANGERED UNDER STATE STATUTES IN THE UGP REGION

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TABLE F-1 Species Listed as Threatened or Endangered under State of Iowa Statutes

Scientific Name	Common Name	State Status[a]
Mammals		
Clethrionomys gapperi	Red-backed vole	Endangered
Myotis soladis	Indiana bat	Endangered
Perognathus flavescens	Plains pocket mouse	Endangered
Spilogale putorius	Spotted skunk	Endangered
Cryptotis parva	Least shrew	Threatened
Synaptomys cooperi	Southern bog lemming	Threatened
Birds		
Asio flammeus	Short-eared owl	Endangered
Buteo lineatus	Red-shouldered hawk	Endangered
Charadrius melodus	Piping plover	Endangered
Circus cyaneus	Northern harrier	Endangered
Falco peregrinus	Peregrine falcon	Endangered
Haliaeetus leucocephalus	Bald eagle	Endangered
Rallus elegans	King rail	Endangered
Sterna antillarum	Least tern	Endangered
Tyto alba	Barn owl	Endangered
Ammodramus henslowii	Henslow's sparrow	Threatened
Asio otus	Long-eared owl	Threatened
Fish		
Acipenser fulvescens	Lake sturgeon	Endangered
Etheostoma chlorosomum	Bluntnose darter	Endangered
Etheostoma microperca	Least darter	Endangered
Notropis anogenus	Pugnose shiner	Endangered
Notropis texanus	Weed shiner	Endangered
Noturus nocturus	Freckled madtom	Endangered
Scaphirhynchus albus	Pallid sturgeon	Endangered
Semotilus margarita	Pearl dace	Endangered
Ammocrypta clara	Western sand darter	Threatened
Esox americanus	Grass pickerel	Threatened
Etheostoma spectabile	Orangethroat darter	Threatened
Ichthyomyzon castaneus	Chestnut lamprey	Threatened
Lamptera appendix	American brook lamprey	Threatened
Lota lota	Burbot	Threatened
Moxostoma duquesnei	Black redhorse	Threatened
Notropis heterolepis	Blacknose shiner	Threatened
Notropis topeka	Topeka shiner	Threatened
Reptiles		
Agkistrodon contortrix	Copperhead	Endangered
Clemmys insculpta	Wood turtle	Endangered
Crotalus viridis	Prairie rattlesnake	Endangered
Eumeces obsoletus	Great Plains skink	Endangered
Heterodon nasicus	Western hognose snake	Endangered
Kinosternon flavescens	Yellow mud turtle	Endangered
Nerodia erythrogaster neglecta	Copperbelly water snake	Endangered
Sistrurus catenatus	Massasauga rattlesnake	Endangered
Carphophis amoenus vermis	Western worm snake	Threatened
Emydoidea blandingii	Blanding's turtle	Threatened
Lampropeltis getulus	Speckled kingsnake	Threatened

TABLE F-1 (Cont.)

Scientific Name	Common Name	State Status[a]
Reptiles (Cont.)		
Nerodia rhombifera	Diamondback water snake	Threatened
Ophisaurus attenuatus	Slender glass lizard	Threatened
Sternotherus odoratus	Common musk turtle	Threatened
Terrapene ornatua	Ornate box turtle	Threatened
Amphibians		
Ambystoma laterale	Blue-spotted salamander	Endangered
Rana areolata	Crawfish frog	Endangered
Necturus maculosus	Mudpuppy	Threatened
Notophthalamus viridescens	Central newt	Threatened
Insects		
Coenonympha tullia	Ringlet	Endangered
Hesperia dacotae	Dakota skipper	Endangered
Euphydryas phaeton	Baltimore	Threatened
Glaucopsyche lygdamus	Silvery blue	Threatened
Oarisma powesheik	Powesheik skipperling	Threatened
Poanes massasoit	Mulberry wing	Threatened
Problema byssus	Byssus skipper	Threatened
Molluscs		
Alasmidonta viridis	Slippershell	Endangered
Catinella gelida	Frigid ambersnail	Endangered
Cumberlandia monodonta	Spectacle case	Endangered
Discus macclintocki	Iowa Pleistocene snail	Endangered
Fusconaia ozarkensis	Ozark pigtoe	Endangered
Lampsilis teres anodontoides	Yellow sandshell	Endangered
Lampsilis teres teres	Slough sandshell	Endangered
Lampsilis higginsi	Higgen's-eye pearly mussel	Endangered
Novisuccinea new species A	Minnesota Pleistocene ambersnail	Endangered
Novisuccinea new species B	Iowa Pleistocene ambersnail	Endangered
Plethobasus cyphyus	Bullhead	Endangered
Pleurobema sintoxia	Ohio River pigtoe	Endangered
Tritogonia verrucosa	Buckthorn	Endangered
Vertigo briarensis	Briarton Pleistocene vertigo	Endangered
Vertigo meramecensis	Bluff vertigo	Endangered
Vertigo new species	Iowa Pleistocene vertigo	Endangered
Anodontoides ferussacianus	Cylinder	Threatened
Cyclonaias tuberculata	Purple pimpleback	Threatened
Ellipsaria lineolata	Butterfly	Threatened
Lasmigona compressa	Creek heelsplitter	Threatened
Strophitus undulates	Strange floater	Threatened
Venustaconcha ellipsiformis	Ellipse	Threatened
Vertigo hubrichti	Midwest Pleistocene vertigo	Threatened
Vertigo occulta	Occult vertigo	Threatened
Plants		
Agalinus skinneriana	Pale false foxglove	Endangered
Agastache foeniculum	Blue giant-hyssop	Endangered
Arctostaphylos uva-ursi	Bearberry	Endangered
Aronia melanocarpa	Black chokeberry	Endangered
Asclepias engelmanniana	Eared milkweed	Endangered

TABLE F-1 (Cont.)

Scientific Name	Common Name	State Status[a]
Plants (Cont.)		
Asclepias meadii	Mead's milkweed	Endangered
Asclepias stenophylla	Narrow-leaved milkweed	Endangered
Aster dumosus	Ricebutton aster	Endangered
Aster macrophyllus	Large-leaved aster	Endangered
Aster schreberi	Schreber's aster	Endangered
Aureolaria pedicularia	Fern-leaved false foxglove	Endangered
Botrychium matricariifolium	Matricary grape fern	Endangered
Callirhoe triangulata	Poppy mallow	Endangered
Carex chordorrhiza	Cordroot sedge	Endangered
Corydalis curvisiliqua	Large-bracted corydalis	Endangered
Dalea villosa	Silky prairie-clover	Endangered
Decodon verticillatus	Swamp-loosestrife	Endangered
Dichanthelium boreale	Northern panic-grass	Endangered
Drosera rotundifolia	Roundleaved sundew	Endangered
Floerkea proserpinacoides	False mermaid	Endangered
Galium labradoricum	Bog bedstraw	Endangered
Hudsonia tomentosa	Povertygrass	Endangered
Hypericum boreale	Northern St. Johnswort	Endangered
Hypericum gentianoides	Pineweed	Endangered
Ilex verticillata	Winterberry	Endangered
Isoetes melanopoda	Black-based quillwort	Endangered
Justicia americana	Water-willow	Endangered
Krigia virginica	Dwarf dandelion	Endangered
Leucospora multifida	Cleft conobea	Endangered
Lomatium foeniculaceum	Whiskbroom parsley	Endangered
Lycopodium clavatum	Running clubmoss	Endangered
Lycopodium inundatum	Bog clubmoss	Endangered
Lygodesmia rostrata	Annual skeletonweed	Endangered
Megalodonta beckii	Water marigold	Endangered
Mertensia paniculata	Northern lungwort	Endangered
Opuntia macrorhiza	Bigroot pricklypear	Endangered
Orobanche fasciculata	Clustered broomrape	Endangered
Oryzopsis pungens	Ricegrass	Endangered
Osmunda cinnamomea	Cinnamon fern	Endangered
Pellaea atropurpurea	Purple cliffbrake	Endangered
Peltandra virginica	Arrow arum	Endangered
Platanthera flava	Pale green orchid	Endangered
Platanthera leucophaea	Eastern prairie fringed orchid	Endangered
Polansia jamesii	Clammyweed	Endangered
Polygala cruciata	Crossleaf milkwort	Endangered
Polygala polygama	Purple milkwort	Endangered
Polygonella articulata	Jointweed	Endangered
Polygonum douglasii	Douglas' knotweed	Endangered
Potentilla tridentata	Three-toothed cinquefoil	Endangered
Prunus nigra	Canada plum	Endangered
Psoralea onobrychis	Frenchgrass	Endangered
Pyrola asarifolia	Pink shinleaf	Endangered
Rosa acicularis	Prickly rose	Endangered
Selaginella eclipes	Meadow spikemoss	Endangered
Solidago patula	Rough-leaved goldenrod	Endangered
Solidago uliginosa	Bog goldenrod	Endangered
Spiranthes lucida	Yellow-lipped ladies-tresses	Endangered

TABLE F-1 (Cont.)

Scientific Name	Common Name	State Status[a]
Plants (Cont.)		
Stylisma pickeringii	Pickering morning-glory	Endangered
Talinum rugospermum	Rough-seeded fameflower	Endangered
Thalictrum revolutum	Waxy meadowrue	Endangered
Thelypteris phegopteris	Long beechfern	Endangered
Viola incognita	Large-leaved violet	Endangered
Woodsia ilvensis	Rusty woodsia	Endangered
Xyris torta	Yellow-eyed grass	Endangered
Aconitum noveboracense	Northern wild monkshood	Threatened
Agalinus gattingerii	Round-stemmed false foxglove	Threatened
Allium cernuum	Nodding wild onion	Threatened
Amorpha nana	Fragrant false indigo	Threatened
Aristolochia serpentaria	Virginia snakeroot	Threatened
Asclepias lanuginosa	Woolly milkweed	Threatened
Asclepias speciosa	Showy milkweed	Threatened
Aster furcatus	Forked aster	Threatened
Aster junciformis	Rush aster	Threatened
Aster linariifolius	Flax-leaved aster	Threatened
Berula erecta	Water parsnip	Threatened
Besseya bullii	Kittentails	Threatened
Betula pumila	Bog birch	Threatened
Blephilia ciliata	Pagoda plant	Threatened
Botrychium multifidum	Leathery grapefern	Threatened
Botrychium simplex	Little grapefern	Threatened
Cacalia suaveolens	Sweet Indian-plantain	Threatened
Callirhoe alcaeoides	Poppy mallow	Threatened
Chimaphila umbellata	Pipsissewa	Threatened
Chrysosplenium iowense	Golden saxifrage	Threatened
Commelina erecta	Dayflower	Threatened
Corallorhiza maculata	Spotted coralroot	Threatened
Cornus canadensis	Bunchberry	Threatened
Corydalis aurea	Golden corydalis	Threatened
Corydalis sempervirens	Pink corydalis	Threatened
Cypripedium reginae	Showy lady's-slipper	Threatened
Dichanthelium linearifolium	Slim-leaved panic-grass	Threatened
Dodecatheon amethystinum	Jeweled shooting star	Threatened
Dryopteris intermedia	Glandular wood fern	Threatened
Dryopteris marginalis	Marginal shield fern	Threatened
Equisetum sylvaticum	Woodland horsetail	Threatened
Eriophorum gracile	Slender cottongrass	Threatened
Erythronium americanum	Yellow trout lily	Threatened
Filipendula rubra	Queen of the prairie	Threatened
Fraxinus quadrangulata	Blue ash	Threatened
Gaylussacia baccata	Black huckleberry	Threatened
Gymnocarpium dryopteris	Oak fern	Threatened
Hybanthus concolor	Green violet	Threatened
Jeffersonia diphylla	Twinleaf	Threatened
Juniperus horizontalis	Creeping juniper	Threatened
Lechea intermedia	Intermediate pinweed	Threatened
Lechea villosa	Hairy pinweed	Threatened
Lespedeza leptostachya	Prairie bush clover	Threatened
Linnaea borealis	Twinflower	Threatened
Lomatium orientale	Western parsley	Threatened

TABLE F-1 (Cont.)

Scientific Name	Common Name	State Status[a]
Plants (Cont.)		
Lupinus perennis	Wild lupine	Threatened
Lycopodium dendroideum	Tree clubmoss	Threatened
Lycopodium porophilum	Rock clubmoss	Threatened
Marsilea vestita	Hairy waterclover	Threatened
Menyanthes trifoliata	Bog buckbean	Threatened
Mimulus alatus	Winged monkeyflower	Threatened
Mimulus glabratus	Yellow monkeyflower	Threatened
Mitchella repens	Partridge berry	Threatened
Monotropa hypopithys	Pinesap	Threatened
Oenothera perennis	Small sundrops	Threatened
Opuntia fragilis	Little pricklypear	Threatened
Osmunda regalis	Royal fern	Threatened
Panicum philadelphicum	Philadelphia panic-grass	Threatened
Penstemon gracilis	Slender beardtongue	Threatened
Platanthera hookeri	Hooker's orchid	Threatened
Platanthera hyperborea	Northern bog orchid	Threatened
Platanthera praeclara	Western prairie fringed orchid	Threatened
Platanthera psycodes	Purple fringed orchid	Threatened
Polygala incarnata	Pink milkwort	Threatened
Potentilla anserina	Silverweed	Threatened
Potentilla fruticosa	Shrubby cinquefoil	Threatened
Potentilla pensylvanica	Pennsylvania cinquefoil	Threatened
Pyrola secunda	One-sided shinleaf	Threatened
Rhexia virginica	Meadow beauty	Threatened
Rhynchospora capillacea	Beaked rush	Threatened
Ribes hudsonianum	Northern currant	Threatened
Salix lucida	Shining willow	Threatened
Salix pedicellaris	Bog willow	Threatened
Scleria verticillata	Low nutrush	Threatened
Sheperdia argentea	Buffaloberry	Threatened
Sphaeralcea coccinea	Scarlet globemallow	Threatened
Spiranthes lacera	Slender ladies-tresses	Threatened
Spiranthes ovalis	Oval ladies-tresses	Threatened
Spiranthes romanzoffiana	Hooded ladies-tresses	Threatened
Spiranthes vernalis	Spring ladies-tresses	Threatened
Streptopus roseus	Rosy twisted-stalk	Threatened
Talinum parviflorum	Fameflower	Threatened
Triglochin maritimum	Large arrowgrass	Threatened
Triglochin palustre	Small arrowgrass	Threatened
Vaccinium angustifolium	Low sweet blueberry	Threatened
Vaccinium myrtilloides	Velvetleaf blueberry	Threatened
Veratrum woodii	False hellebore	Threatened
Viola renifolia	Kidney-leaved violet	Threatened
Woodsia oregana	Oregon woodsia	Threatened

[a] Endangered = the species is in danger of extinction through all or a significant part of its range. Threatened = the species is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Source: Iowa Department of Natural Resources (2009).

1 **TABLE F-2 Species Listed as Threatened or Endangered under State of Minnesota Statutes**

Scientific Name	Common Name	State Status[a]
Mammals		
Spilogale putorius	Eastern spotted skunk	Threatened
Birds		
Ammodramus bairdii	Baird's sparrow	Endangered
Ammodramus henslowii	Henslow's sparrow	Endangered
Anthus spragueii	Sprague's pipit	Endangered
Calcarius ornatus	Chestnut-collared longspur	Endangered
Charadrius melodus	Piping plover	Endangered
Rallus elegans	King rail	Endangered
Speotyto cunicularia	Burrowing owl	Endangered
Cygnus buccinator	Trumpeter swan	Threatened
Falco peregrinus	Peregrine falcon	Threatened
Lanius ludovicianus	Loggerhead shrike	Threatened
Phalaropus tricolor	Wilson's phalarope	Threatened
Podiceps auritus	Horned grebe	Threatened
Sterna hirundo	Common tern	Threatened
Reptiles		
Sistrurus catenatus	Massasauga	Endangered
Clemmys insculpta	Wood turtle	Threatened
Crotalus horridus	Timber rattlesnake	Threatened
Emydoidea blandingii	Blanding's turtle	Threatened
Amphibians		
Acris crepitans	Northern cricket frog	Endangered
Fish		
Polyodon spathula	Paddlefish	Threatened
Molluscs		
Arcidens confragosus	Rock pocketbook	Endangered
Elliptio crassidens	Elephant-ear	Endangered
Fusconaia ebena	Ebonyshell	Endangered
Lampsilis higginsi	Higgins eye	Endangered
Lampsilis teres	Yellow sandshell	Endangered
Novasuccinea n. sp. Minnesota B	Iowa Pleistocene ambersnail	Endangered
Plethobasus cyphyus	Sheepnose	Endangered
Quadrula fragosa	Winged mapleleaf	Endangered
Quadrula nodulata	Wartyback	Endangered
Vertigo hubrichti hubrichti	Midwest Pleistocene vertigo	Endangered
Actinonaias ligamentina	Mucket	Threatened
Alasmidonta marginata	Elktoe	Threatened
Cumberlandia monodonta	Spectaclecase	Threatened
Cyclonaias tuberculata	Purple wartyback	Threatened
Ellipsaria lineolata	Butterfly	Threatened
Epioblasma triquetra	Snuffbox	Threatened
Megalonaias nervosa	Washboard	Threatened
Novasuccinea n. sp. Minnesota A	Minnesota Pleistocene ambersnail	Threatened
Pleurobema coccineum	Round pigtoe	Threatened
Quadrula metanevra	Monkeyface	Threatened
Simpsonaias ambigua	Salamander mussel	Threatened

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TABLE F-2 (Cont.)

Scientific Name	Common Name	State Status[a]
Molluscs (Cont.)		
Tritogonia verrucosa	Pistolgrip	Threatened
Venustaconcha ellipsiformis	Ellipse	Threatened
Vertigo hubrichti variabilis	Variable Pleistocene vertigo	Threatened
Vertigo meramecensis	Bluff vertigo	Threatened
Butterflies and Moths		
Erynnis persius	Persius dusky wing	Endangered
Hesperia comma assiniboia	Assiniboia skipper	Endangered
Hesperia uncas	Uncas skipper	Endangered
Lycaeides melissa samuelis	Karner blue	Endangered
Oeneis uhleri varuna	Uhler's arctic	Endangered
Hesperia dacotae	Dakota skipper	Threatened
Hesperia ottoe	Ottoe skipper	Threatened
Oarisma garita	Garita skipper	Threatened
Caddisflies		
Chilostigma itascae	Headwaters chilostigman	Endangered
Tiger Beetles		
Cicindela fulgida fulgida	Subspecies of crimson saltflat tiger beetle	Endangered
Cicindela limbata nympha	Sandy tiger beetle	Endangered
Cicindela denikei	Laurentian tiger beetle	Threatened
Cicindela fulgida westbournei	Subspecies of crimson saltflat tiger beetle	Threatened
Cicindela lepida	Little white tiger beetle	Threatened
Vascular Plants		
Agalinis auriculata	Eared false foxglove	Endangered
Agalinis gattingeri	Round-stemmed false foxglove	Endangered
Asclepias stenophylla	Narrow-leaved milkweed	Endangered
Astragalus alpinus	Alpine milk-vetch	Endangered
Bartonia virginica	Virginia bartonia	Endangered
Botrychium gallicomontanum	Frenchman's Bluff moonwort	Endangered
Botrychium oneidense	Blunt-lobed grapefern	Endangered
Botrychium pallidum	Pale moonwort	Endangered
Cacalia suaveolens	Sweet-smelling Indian-plantain	Endangered
Caltha natans	Floating marsh-marigold	Endangered
Carex formosa	Handsome sedge	Endangered
Carex pallescens	Pale sedge	Endangered
Carex plantaginea	Plantain-leaved sedge	Endangered
Castilleja septentrionalis	Northern paintbrush	Endangered
Cheilanthes lanosa	Hairy lip-fern	Endangered
Chrysosplenium iowense	Iowa golden saxifrage	Endangered
Cristatella jamesii	James' polanisia	Endangered
Dodecatheon meadia	Prairie shooting star	Endangered
Draba norvegica	Norwegian whitlow-grass	Endangered
Eleocharis wolfii	Wolf's spike-rush	Endangered
Empetrum eamesii	Purple crowberry	Endangered
Empetrum nigrum	Black crowberry	Endangered
Erythronium propullans	Dwarf trout lily	Endangered
Escobaria vivipara	Ball cactus	Endangered
Fimbristylis puberula var. *interior*	Hairy fimbristylis	Endangered
Glaux maritima	Sea milkwort	Endangered

TABLE F-2 (Cont.)

Scientific Name	Common Name	State Status[a]
Vascular Plants (Cont.)		
Hydrastis canadensis	Golden-seal	Endangered
Iodanthus pinnatifidus	Purple rocket	Endangered
Isoetes melanopoda	Blackfoot quillwort	Endangered
Lechea tenuifolia	Narrow-leaved pinweed	Endangered
Lesquerella ludoviciana	Bladder pod	Endangered
Listera auriculata	Auricled twayblade	Endangered
Malaxis paludosa	Bog adder's-mouth	Endangered
Marsilea vestita	Hairy water clover	Endangered
Montia chamissoi	Montia	Endangered
Oryzopsis hymenoides	Indian ricegrass	Endangered
Osmorhiza berteroi	Chilean sweet cicely	Endangered
Oxytropis viscida	Sticky locoweed	Endangered
Paronychia fastigiata	Forked chickweed	Endangered
Parthenium integrifolium	Wild quinine	Endangered
Platanthera flava	Tubercled rein-orchid	Endangered
Platanthera praeclara	Western prairie fringed orchid	Endangered
Polemonium occidentale ssp. *lacustre*	Western Jacob's-ladder	Endangered
Polygala cruciata	Cross-leaved milkwort	Endangered
Polystichum braunii	Braun's holly fern	Endangered
Potamogeton bicupulatus	Snailseed pondweed	Endangered
Potamogeton diversifolius	Diverse-leaved pondweed	Endangered
Psoralidium tenuiflora	Slender-leaved scurf pea	Endangered
Sagina nodosa ssp. *borealis*	Knotty pearlwort	Endangered
Saxifraga cernua	Nodding saxifrage	Endangered
Scleria triglomerata	Tall nut-rush	Endangered
Sedum integrifolium ssp. *leedyi*	Leedy's roseroot	Endangered
Selaginella selaginoides	Northern spikemoss	Endangered
Senecio canus	Gray ragwort	Endangered
Talinum rugospermum	Rough-seeded fameflower	Endangered
Tofieldia pusilla	Small false asphodel	Endangered
Xyris torta	Twisted yellow-eyed grass	Endangered
Achillea sibirica	Siberian yarrow	Threatened
Allium cernuum	Nodding wild onion	Threatened
Allium schoenoprasum var. *sibiricum*	Wild chives	Threatened
Ammophila breviligulata	Beachgrass	Threatened
Arabis holboellii var. *retrofracta*	Holboell's rockcress	Threatened
Arnica lonchophylla	Long-leaved arnica	Threatened
Arnoglossum plantagineum	Tuberous Indian-plantain	Threatened
Asclepias hirtella	Prairie milkweed	Threatened
Asclepias sullivantii	Sullivant's milkweed	Threatened
Asplenium trichomanes	Maidenhair spleenwort	Threatened
Aster shortii	Short's aster	Threatened
Aureolaria pedicularia	Fernleaf false foxglove	Threatened
Besseya bullii	Kitten-tails	Threatened
Botrychium lanceolatum	Triangle moonwort	Threatened
Botrychium lunaria	Common moonwort	Threatened
Botrychium rugulosum	St. Lawrence grapefern	Threatened
Carex careyana	Carey's sedge	Threatened
Carex conjuncta	Jointed sedge	Threatened
Carex davisii	Davis' sedge	Threatened
Carex festucacea	Fescue sedge	Threatened
Carex garberi	Garber's sedge	Threatened

TABLE F-2 (Cont.)

Scientific Name	Common Name	State Status[a]
Vascular Plants (Cont.)		
Carex jamesii	James' sedge	Threatened
Carex katahdinensis	Katahdin sedge	Threatened
Carex laevivaginata	Smooth-sheathed sedge	Threatened
Carex laxiculmis	Spreading sedge	Threatened
Carex sterilis	Sterile sedge	Threatened
Crassula aquatica	Pigmyweed	Threatened
Crataegus douglasii	Black hawthorn	Threatened
Cyperus acuminatus	Short-pointed umbrella-sedge	Threatened
Cypripedium arietinum	Ram's-head lady's-slipper	Threatened
Diplazium pycnocarpon	Narrow-leaved spleenwort	Threatened
Dryopteris marginalis	Marginal shield-fern	Threatened
Eleocharis nitida	Neat spike-rush	Threatened
Eleocharis olivacea	Olivaceous spike-rush	Threatened
Eleocharis rostellata	Beaked spike-rush	Threatened
Eupatorium sessilifolium	Upland boneset	Threatened
Floerkea proserpinacoides	False mermaid	Threatened
Heteranthera limosa	Mud plantain	Threatened
Huperzia porophila	Rock clubmoss	Threatened
Lespedeza leptostachya	Prairie bush clover	Threatened
Melica nitens	Three-flowered melic	Threatened
Moehringia macrophylla	Large-leaved sandwort	Threatened
Napaea dioica	Glade mallow	Threatened
Nymphaea leibergii	Small white waterlily	Threatened
Paronychia canadensis	Canadian forked chickweed	Threatened
Phegopteris hexagonoptera	Broad beech-fern	Threatened
Plantago elongata	Slender plantain	Threatened
Poa paludigena	Bog bluegrass	Threatened
Polystichum acrostichoides	Christmas fern	Threatened
Rhynchospora capillacea	Hair-like beak-rush	Threatened
Rotala ramosior	Tooth-cup	Threatened
Rubus chamaemorus	Cloudberry	Threatened
Salicornia rubra	Red saltwort	Threatened
Saxifraga paniculata	Encrusted saxifrage	Threatened
Scleria verticillata	Whorled nut-rush	Threatened
Scutellaria ovata	Ovate-leaved skullcap	Threatened
Shinnersoseris rostrata	Annual skeletonweed	Threatened
Silene nivea	Snowy campion	Threatened
Subularia aquatica	Awlwort	Threatened
Sullivantia sullivantii	Reniform sullivantia	Threatened
Vaccinium uliginosum	Alpine bilberry	Threatened
Valeriana edulis	Valerian	Threatened
Viola lanceolata	Lance-leaved violet	Threatened
Viola nuttallii	Yellow prairie violet	Threatened
Woodsia glabella	Smooth woodsia	Threatened
Woodsia scopulina	Rocky Mountain woodsia	Threatened
Lichens		
Buellia nigra	Lichen	Endangered
Caloplaca parvula	Lichen	Endangered
Dermatocarpon moulinsii	Lichen	Endangered
Leptogium apalachense	Lichen	Endangered
Lobaria scrobiculata	Lichen	Endangered

TABLE F-2 (Cont.)

Scientific Name	Common Name	State Status[a]
Lichens (Cont.)		
Parmelia stictica	Lichen	Endangered
Pseudocyphellaria crocata	Lichen	Endangered
Umbilicaria torrefacta	Lichen	Endangered
Cetraria oakesiana	Lichen	Threatened
Coccocarpia palmicola	Lichen	Threatened
Parmelia stuppea	Lichen	Threatened
Mosses		
Schistostegia pennata	Luminous moss	Endangered
Fungi		
Fuscoboletinus weaverae	Fungus	Endangered
Psathyrella cystidiosa	Fungus	Endangered
Psathyrella rhodospora	Fungus	Endangered

[a] Endangered = the species is threatened with extinction throughout all or a significant portion of its range within Minnesota. Threatened = The species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range within Minnesota.

Source: Minnesota Department of Natural Resources (2007).

TABLE F-3 Species Listed as Threatened or Endangered under State of Nebraska Statutes

Scientific Name	Common Name	State Status[a]
Mammals		
Mustela nigripes	Black-footed ferret	Endangered
Vulpes velox	Swift fox	Endangered
Glaucomys volans	Southern flying squirrel	Threatened
Lutra canadensis	River otter	Threatened
Birds		
Grus americana	Whooping crane	Endangered
Numenius borealis	Eskimo curlew	Endangered
Sternula antillarum athalassos	Interior least tern	Endangered
Charadrius melodius	Piping plover	Threatened
Charadrius montanus	Mountain plover	Threatened
Reptiles		
Sistrurus catenatus	Massasauga	Threatened
Fish		
Macrhybopsis gelida	Sturgeon chub	Endangered
Notropis heterolepis	Blacknose shiner	Endangered
Notropis topeka	Topeka shiner	Endangered
Scaphirhynchus albus	Pallid sturgeon	Endangered
Acipenser fulvescens	Lake sturgeon	Threatened
Phoxinus eos	Northern redbelly dace	Threatened
Phoxinus neogaeus	Finescale dace	Threatened
Insects		
Cincindela nevadica lincolniana	Salt Creek tiger beetle	Endangered
Nicrophorus americanus	American burying beetle	Endangered
Mussels		
Leptodea leptodon	Scaleshell mussel	Endangered
Plants		
Gaura neomexicana coloradensis	Colorado butterfly plant	Endangered
Penstemon haydenii	Hayden’s (blowout) penstemon	Endangered
Salicornia rubra	Saltwort	Endangered
Cypripedium candidum	Small white lady’s slipper	Threatened
Panax quinquefolium	Ginseng	Threatened
Platanthera praeclara	Western prairie fringed orchid	Threatened
Spiranthese diluvialis	Ute lady’s-tresses	Threatened

[a] Endangered = nearing extinction. Threatened = facing endangerment.

Source: Nebraska Game and Parks Commission (2009).

TABLE F-4 Species Listed as Threatened or Endangered under State of South Dakota Statutes

Scientific Name	Common Name	State Status[a]
Mammals		
Mustela nigripes	Black-footed ferret	Endangered
Lutra canadensis	River otter	Threatened
Vulpes velox	Swift fox	Threatened
Birds		
Falco peregrinus	Peregrine falcon	Endangered
Grus americana	Whooping crane	Endangered
Numenius borealis	Eskimo curlew	Endangered
Sternula antillarum athalassos	Interior least tern	Endangered
Charadrius melodius	Piping plover	Threatened
Cinclus mexicanus	American dipper	Threatened
Haliaeetus leucocephalus	Bald eagle	Threatened
Pandion haliaetus	Osprey	Threatened
Reptiles		
Tropidoclonion lineatum	Lined snake	Endangered
Graptemys pseudogeographica	False map turtle	Threatened
Heterodon platirhinos	Eastern hognose snake	Threatened
Fish		
Fundulus diaphanous	Banded killifish	Endangered
Macrhybopsis meeki	Sicklefin chub	Endangered
Notropis heterolepis	Blacknose shiner	Endangered
Phoxinus neogaeus	Finescale dace	Endangered
Scaphirhynchus albus	Pallid sturgeon	Endangered
Catostomus catostomus	Longnose sucker	Threatened
Macrhybopsis gelida	Sturgeon chub	Threatened
Margariscus margarita	Pearl dace	Threatened
Phoxinus eos	Northern redbelly dace	Threatened

[a] Endangered = nearing extinction. Threatened = facing endangerment.

Source: South Dakota Department of Game, Fish, and Parks (2008).

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