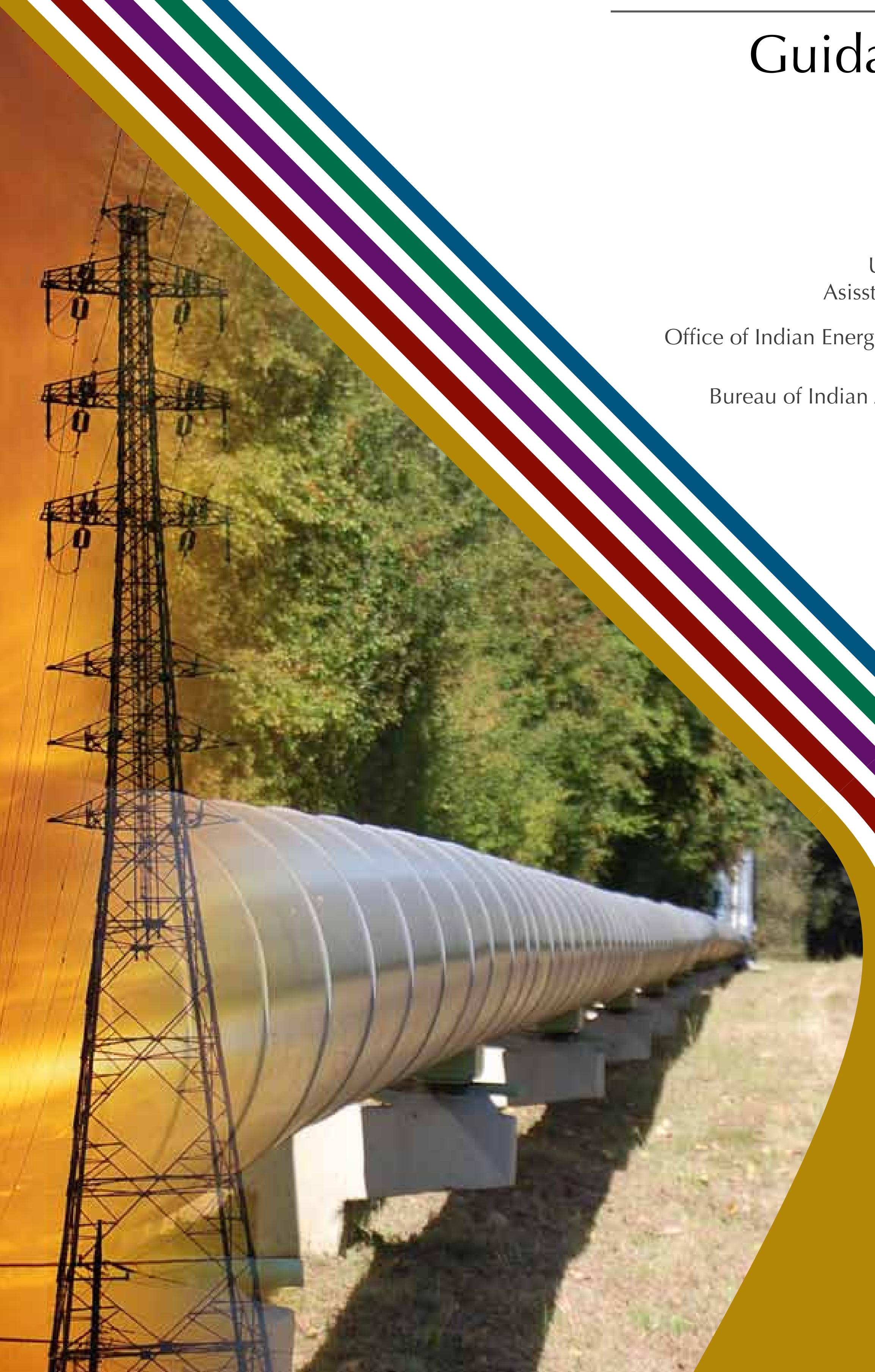
Energy Transport Corridor Siting for Tribal Planners

Guidance Manual

January 2010



Sponsored by
U.S. Department of the Interior
Asisstant Secretary for Indian Affairs

Office of Indian Energy and Economic Development
and
Bureau of Indian Affairs, Office of Trust Services

Prepared by
Argonne National Laboratory

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Argonne National Laboratory
Environmental Science Division
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ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
APLIC	Avian Power Line Interaction Committee
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	best management practice
DEMD	Division of Energy and Mineral Development
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute
FAA	Federal Aviation Administration
ft	foot, feet
GIS	geographic information system
IEED	U.S. Department of the Interior, Office of Indian Energy and Economic Development
JEDI	Job and Economic Development Impact
KML	Keyhole Markup Language, KML file extension
KMZ	complex KML file extension
kV	kilovolt
m	meter
MTR	military training route
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NHRP	*National Register of Historic Places*
NPS	National Park Service
NREL	National Renewable Energy Laboratory
OHV	off-highway vehicle
ROW	right-of-way

ACRONYMS AND ABBREVIATIONS (Cont.)

SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
SHPO	State Historic Preservation Office/Officer
SUA	special-use airspace
SWF	Small Web Format
TEEIC	Tribal Energy and Environmental Information Clearinghouse
TERA	Tribal Energy Resource Agreement
THPO	Tribal Historic Preservation Officer
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compound

OVERVIEW

Energy transmission issues present major constraints to energy development in the United States, including on tribal lands. Energy development in many areas is hampered by the lack of access to and/or lack of capacity within the existing transmission system. These issues affect oil and gas pipeline transportation as well as electricity transmission. Many efforts have been launched at the national, regional, and state levels to address these transmission constraints. However, to date, none of these planning efforts has specifically addressed the need for, the value of, or the process for establishing transmission corridors across tribal lands. For the most part, tribes have not been integrally involved in recent transmission planning efforts at any level. This exclusion of tribes and tribal lands may adversely impact grid development overall but, most importantly, it may limit economic and energy development opportunities for tribes.

Many tribes could benefit from additional expertise and guidance to conduct effective on-reservation transmission system planning, which would allow them to effectively engage themselves in the off-reservation planning processes that could significantly affect their reservation. In response to this, the Assistant Secretary-Indian Affairs—through the Office of Indian Energy and Economic Development (IEED) and the Bureau of Indian Affairs (BIA), Office of Trust Services—has created several tools and resources to assist tribes. This guidance manual is one of the tools and it presents a process that tribes can use to site energy transmission facilities, including both pipelines and electricity transmission lines, allowing integration with other long-term land use planning efforts.

As supported by the Energy Policy Act of 2005, Section 1813, "Indian Land Rights-of-Way Study," the initial planning and, ultimately, approval of energy corridors by individual tribal councils for on-reservation transmission facilities are necessary for tribes to be able to integrate with and benefit from the nation-wide efforts to update and upgrade the energy grid.

Transmission system planning is a complex process comprised of many different steps. Once a tribe has identified a need for a transmission system connection, it must engage with transmission system operators, energy developers, and financers to assess connectivity requirements, the regional and local transmission system infrastructure and available capacity, interconnection requirements, project financing options, and environmental impacts. While each one of these activities is complicated, may have multiple steps, and can translate into barriers or delays to a project, the focus of this guidance manual is on providing a process for identifying and resolving the environmental impacts related to siting of energy transmission corridors.

Specifically, the manual recommends that tribes be proactive in designating energy transport corridors across their lands. An energy transport corridor is a designated strip of land across the landscape that is determined to be most appropriate for siting energy transmission facilities based on the opportunities or needs for transmission connectivity, environmental considerations, and other siting concerns. The designation of energy transport corridors can (1) ensure future development is planned and conducted in a manner that minimizes environmental, cultural, and socioeconomic impacts; (2) streamline individual transmission project reviews and approvals; (3) promote development of energy resources on tribal lands; and

(4) support the expansion of services to tribal members and businesses. Tribes with large tracts of land that are situated in areas of heavy energy development and/or have potentially developable energy resources will benefit the most from energy transport corridor planning. While the recommended process is applicable for energy corridor planning, it also provides an orderly process for conducting timely and effective reviews and approvals of individual rights-of-way.

This manual focuses on the environmental issues and other siting concerns that may be associated with the installation of transmission infrastructure. These issues include natural and cultural resource impacts, visual impacts, land use conflicts, land ownership patterns, physiographic constraints, and regulatory requirements (such as federal agency consultations). The process recommended in this manual provides a step-by-step process for identifying and resolving environmental and other siting issues, consulting stakeholders, and presenting relevant information to decision makers. It recommends specific methods, approaches, and information management technologies that are widely used to support transmission system planning efforts. The appendices include information about environmental impacts and appropriate mitigation measures, as well as a catalogue of potentially relevant information sources.

Supporting information about energy development on tribal lands and associated environmental issues has been developed by the IEED and made available to tribes through the Tribal Energy and Environmental Information Clearinghouse (TEEIC) Web site (http://teeic.anl.gov). The BIA and IEED intend to host a series of educational workshops for sharing the guidance included in this manual along with information about other aspects of transmission system planning. Workshops will be hosted in various regions and workshop materials, along with this guidance manual, can be downloaded from the TEEIC.

1 INTRODUCTION

1.1 OBJECTIVE

The objective of this manual is to provide tribes with the guidance and information needed for siting energy transport facilities on tribal lands. The process recommended is applicable for siting energy corridors as well as for the approval of individual rights-of-way (ROWs). The manual was developed by Argonne National Laboratory on behalf of the U.S. Department of the Interior's Office of Indian Energy and Economic Development (IEED) and Bureau of Indian Affairs (BIA), to provide assistance to tribes in energy transmission system planning.

Transmission lines and pipelines provide the most reasonable means to transport energy (electricity, natural gas, and crude oil) over long distances. Transmission lines and pipelines are often proposed on tribal lands either for tribal purposes or by non-tribal right-of-way proponents. Energy transport corridors capable of accommodating multiple electric transmission or pipeline projects provide more efficient use of tribal land than does a proliferation of individual projects. Designated energy corridors may also be used for routing overhead or underground communication lines, e.g., fiber-optic cables.

This guidance document can be used to support designation of energy corridors or approval of rights-of-way on tribal lands, both to meet a tribe's own electric transmission and pipeline siting needs and to authorize use of tribal lands for energy transport by others (e.g., utilities and transmission system operators). The guidance is focused on identifying and resolving issues associated with siting a corridor or right-of-way, including topographic constraints, potential environmental impacts, and concerns about cultural resources.

This guidance does not cover the critical first task of transmission system planning — that is the analysis of whether an energy transport corridor is needed and where potential interconnects to existing transmission facilities are located. Instead, this guidance addresses the processes required to site a corridor or right-of-way once the need for one has been established. More information about transmission system planning, including resources on the topic, is provided in the *Energy Systems Planning* text box.

Energy Systems Planning

Energy transmission system planning involves engineering and economic analyses in close coordination with other parties (e.g., transmission system operators, energy developers, financiers) to determine the need for transmission facilities in a given location or region and may include critical issues such as energy resource assessment, market evaluation, and project financing. Procedures for completing this important requirement are not covered in this guidance, but the process is assumed to have been completed or to be underway prior to corridor siting and designation. More information can be found in the DOE Tribal Energy Guide, available at http://www1.eere.energy.gov/tribalenergy/guide, and at the Bonneville Power Administration Transmission System Planning website, available at http://www.transmission.bpa.gov/system_planning.

1.2 ENERGY TRANSPORT CORRIDORS

An energy transport corridor is a continuous strip of land of sufficient width to accommodate one or more rights-of-way for electricity transmission facilities or oil or natural gas pipelines. A corridor can be multi-use and include both transmission lines and pipelines, as well as other uses, such as grazing or roads. For additional clarification, see the *Energy Transport Corridor vs. Right-of-Way* text box.

> **Energy Transport Corridor vs. Right-of-Way**
>
> *Right-of-way:* A land use authorization by a governmental authority to allow construction and operation of a specific energy transport project on identified tribal lands. "Right-of-way" (ROW) is also used to refer to the lands so authorized.
>
> *Energy corridor:* A designation applied to identified tribal lands where the construction, operation, or upgrade of one or more energy transport projects is preferred. Use of designated corridors can assist in minimizing the adverse impacts which could result from the proliferation of separate projects although identifying the location for the wider pathways may be more challenging. Construction, upgrade, or operation of each project within a designated corridor will require an authorized ROW and appropriate environmental review.

Energy corridor designation can serve multiple purposes. It can ensure that future energy transmission development occurs in a planned fashion that avoids or minimizes impacts to natural and cultural resources. It also can promote transmission development across tribal lands to benefit the tribe economically, whether to produce revenue solely from the transmission project, to facilitate the development of energy resources on tribal lands, or to provide better service to tribal members and businesses. Tribes that will benefit the most from designated energy corridors are those with large tracts of land that are situated in areas of heavy energy development and/or have potentially developable energy resources to market.

Individual tribes may decide to proactively designate energy transport corridors in advance of any right-of-way applications, in response to one or more applications, or for internal tribal purposes. In some cases, the priority may be to connect potentially developable energy resources on tribal lands with external networks. In other cases, the priority may be to enhance the tribe's utility service or internal infrastructure. And, in other cases, the priority may be to determine the most appropriate location for siting transmission lines and pipelines that cross tribal lands without any specific internal connectivity. The guidance material in this manual will support all of these corridor or right-of-way designation activities. It can be used to proactively designate corridors as well as to evaluate specific right-of-way applications.

1.3 CORRIDOR DESIGNATION AUTHORITY AND REGULATION

Designation of energy transport corridors on tribal lands is entirely subject to tribal authority, although the responsible tribal authorities may seek technical assistance from the U.S. Department of the Interior (DOI). Approval of a ROW for a specific project must be done in accordance with all applicable legal and regulatory requirements. The specific requirements will vary depending on whether the designation is executed at the tribe's request by the BIA, under a Tribal Energy Resource Agreement (TERA), or under the self-governance provisions of Title III of Public Law 93-638.

For the most part, state regulations do not apply to energy development activities on tribal lands, including energy transmission projects.[1] A suite of federal environmental regulations apply, including numerous permit requirements. Environmental impact analyses are required either under the provisions of the National Environmental Policy Act (NEPA) wherever there is a federal agency action or, in the case of a TERA process, in accordance with requirements for substantively equivalent analyses.

Responsibility for energy transport corridor identification and siting will vary by tribe. Project management should include specialists in realty management, environmental planning, and geographic information systems (GISs). The corridor designation process should involve tribal government, internal staff, tribal members, and other stakeholders.

Conditions of approval to develop energy transport facilities on tribal land, whether within a designated corridor or not, should include a project-specific proposal, plan of development, environmental impact analysis, identification of possible impacts, required Best Management Practices (BMPs) and mitigation, as well as other requirements such as bonding and compliance with applicable regulations of other jurisdictions.

1.4 CORRIDOR USE

The designation of energy transport corridors can help tribes ensure that future development occurs in a planned manner with minimal environmental impacts. For this reason, a tribe may require that future right-of-way applicants locate their proposed project in a designated energy transport corridor. On its own merits, a designated corridor should be attractive to project proponents because the corridor designation process effectively screens out significant environmental issues and other siting concerns. With some certainty, a project proponent could anticipate a relatively quick and favorable project review.

Corridors designated by tribal land management agencies may vary considerably in width, ranging from the minimum width necessary to site a project, to many miles wide. Wider corridors have the potential to accommodate multiple projects and potentially reduce the impacts of multiple independent rights of way. They also allow flexibility in project siting, especially if not all siting requirements and supporting data are available at the time of corridor designation. This allows corridor designation to be made at a broader planning level, while anticipating the more rigorous analysis required for final project approval.

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[1] Energy development activities, including the associated environmental aspects, are subject to regulation by federal agencies. In cases where a federal agency has delegated authority for a regulatory program to a state agency (e.g., delegated authority for Clean Air Act or Resource Conservation and Recovery Act programs), it has retained authority over activities on tribal lands.

1.5 GUIDANCE

The following chapters provide step-by-step guidance for energy transport corridor identification and designation.

- Chapter 2 describes a detailed four-step process for potential corridor identification, analysis, and designation.
- Chapter 3 presents information on technological applications that have been demonstrated to facilitate and enhance the four-step corridor siting process.
- Appendix A describes, in general terms, the potential impacts associated with transmission lines and pipelines and potential mitigation measures.
- Appendix B lists available resources relevant to both transmission system planning and siting of energy transport corridors and rights-of-way.

2 ENERGY TRANSPORT CORRIDOR SITING

The siting of energy transport corridors on tribal lands can support a number of purposes:

- To connect tribal energy generation facilities to off-site energy transport facilities, such as substations connected to the electric transmission grid, or large oil or gas pipelines providing for long-distance energy delivery. This would support the sale of tribal energy to the outside market.

- To facilitate energy delivery either onto or within tribal land to serve tribal energy demand areas (e.g., communities and industry). This would support local energy consumption.

- To guide developers seeking energy transport ROWs across tribal lands to locations specifically designated for this use. In this case the transmission line or pipeline may cross tribal land but not connect to any facilities on that land.

Siting energy transport corridors poses many challenges, including siting constraints such as unsuitable topography, the presence of sensitive or valued resources, special land use designations and restrictions, and other considerations. In some locations, it may not be possible to site an energy corridor without encountering one or more constraints. In such cases, the ultimate corridor location will represent a compromise among multiple siting constraints and a desired corridor location, and will require extensive input and direction from the appropriate tribal land manager, tribal government departments, and tribal members; industry partners; and potentially, consultation with federal, state, and local representatives.

The siting of energy transport corridors or individual transport project ROWs will include consideration of the potential that future project development within a corridor could adversely affect natural and cultural resources. Environmental impact assessments may be required for corridor or ROW siting by one or more federal environmental laws, such as NEPA (see Chapter 1).

Even if not required by federal law, performing environmental impact analyses during corridor designation will help identify the type, magnitude, and significance of impacts that may occur at a particular corridor location, and thus, provide decision makers with the information needed to determine if a specific corridor location should be approved or modified in some way that would make the potential impacts acceptable.

The designation of energy transport corridors and authorization of individual project ROWs could also require the identification and development of mitigation measures and monitoring requirements. Mitigation measures are used to offset potential impacts of project development, and can be incorporated into corridor siting. For example, the impact analyses may have shown that future project development in a particular corridor location could result in significant impacts to natural and/or cultural resources. However, the use of specific mitigation measures at that location may reduce the magnitude of future project impacts to a level that is considered insignificant. In this example, the proposed corridor location, with the appropriate mitigation measures, may be approved instead of modified.

Additional information regarding environmental impact assessment, mitigation, and monitoring may also be found on the Tribal Energy and Environmental Information Clearinghouse (TEEIC) website (http://teeic.anl.gov/am/index.cfm).

2.1 ENERGY TRANSPORT CORRIDOR SITING PROCESS

Energy corridors represent locations that have been "zoned" for use in locating infrastructure for the transport and distribution of energy (electricity transmission lines, oil and natural gas pipelines) while avoiding sensitive and valued natural and cultural resources and land use and regulatory constraints to the maximum extent possible. Once located, the energy corridors could facilitate future energy transport projects by streamlining individual project siting, evaluation, and decision-making. Energy corridor locations on tribal lands can be selected using a systematic four-step siting process (Figure 2.1). These steps are summarized below.

- ***Step 1 — Locate an Unrestricted Energy Transport Corridor***. In this step, a potential energy transport corridor (which may be an individual route or a network of routes) is identified on tribal lands and possibly on adjacent non-tribal lands (including allotted land). The initial corridor locations will be based solely on the "need" that is driving corridor development (i.e., to bring energy onto tribal land and distribute to tribal energy demand areas, or to allow a proposed non-tribal energy transport project to cross tribal lands). The underlying need for an energy corridor will be identified in most cases by the energy transmission planning that the tribe is undertaking (see the *Energy Systems Planning* text box in Chapter 1). In this step, the location of a corridor is considered 'unrestricted,' as it does not yet consider environmental, natural resource, cultural resource, land ownership, or regulatory issues, and will consist of one or more straight-line segments connecting a start and end point.[2] Most, if not all, of the corridor siting that occurs in Step 1 will be conducted by tribal energy planners and developers (possibly working with their industry partners).

- ***Step 2 — Revise the Location of the Unrestricted Energy Transport Corridor to Avoid Siting Constraints***. The unrestricted energy transport corridor developed in Step 1 is now examined and revised (i.e., adjusted on the landscape) to avoid or minimize the effects of known resource, land use, and regulatory constraints (such as the presence of cliffs and ravines, valued cultural resources, important wildlife areas, designated preservation areas on tribal land or on adjacent non-tribal lands, etc.). During this step, opportunities are also considered for adjusting the corridor (or a portion of the corridor) to

[2] Note that the use of the terms "restricted" and "unrestricted" in this guidance manual has no relationship to whether the ownership of the land is in trust or restricted status.

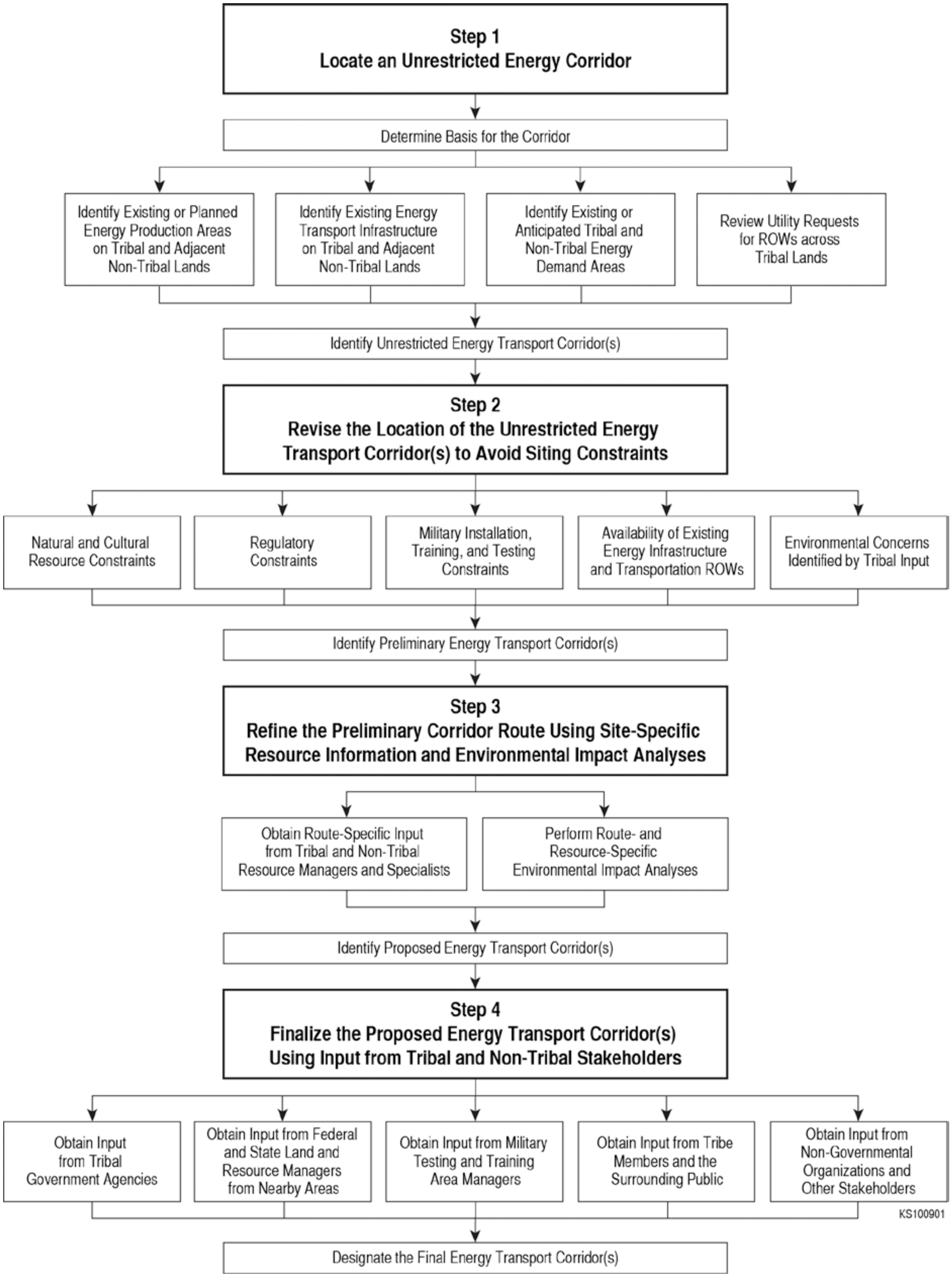

FIGURE 2.1 Four-Step Process for Siting Energy Transport Corridors or Rights-of-Way.

locate it adjacent to existing energy transport infrastructure (i.e., electric transmission lines, pipelines) or transportation corridors (e.g., roads, rail lines). At the conclusion of Step 2, the preliminary energy transport corridor is no longer ‘straight line’ in nature, but rather, likely includes numerous twists and turns that seek to avoid or minimize siting constraints. As in Step 1, most of the corridor revision that occurs in this step will be done by tribal government staff.

- ***Step 3 — Refine the Preliminary Energy Transport Corridor***. In this step, the previously developed corridor is further refined using location-specific input from local tribal and non-tribal land and program managers and energy planners, and results of any environmental impact analyses conducted for the corridor route. The managers and staff evaluate the location of the preliminary corridor on their respective administrative units and may recommend adjustments to the route or network locations, and/or identify possible mitigation, to further avoid impacts on important or sensitive resources and to ensure consistency with resource management and energy planning objectives. The impact analyses identify the nature, magnitude, and significance of impacts to important resources that could occur if an energy transmission project were to be constructed and operated within the preliminary route. The corridor or ROW route may need to be adjusted at locations where the analyses identify a potential for unacceptable impacts to one or more important resources.

- ***Step 4 — Finalize the Proposed Energy Transport Corridor***. In this last step, the proposed corridor location is provided to tribe members and tribal government agencies and officials for review. If the proposed corridor or ROW would extend onto non-tribal land, the proposed corridor location should also be provided to the appropriate federal, state, and local government land and resource managers and energy planners, non-governmental organizations, the non-tribal public, and other stakeholders for their review as well. These organizations and individuals are asked to identify any concerns or resource conflict issues that may not have been identified and addressed in earlier steps of the siting process. The location of the proposed energy transport corridor is evaluated and revised, as appropriate, in response to any concerns raised by the review comments. During Step 4, the location of the energy transport corridor may be further refined to incorporate any new information from reviewers and to further avoid resource conflicts to the fullest extent possible. The conclusion of Step 4 is a decision by the appropriate tribal entity to designate one or more energy transport corridors on tribal lands.

2.2 STEP 1 — LOCATE AN UNRESTRICTED ENERGY TRANSPORT CORRIDOR

The first step in identifying energy transport corridors on tribal lands is the development of an “unrestricted” energy transport corridor. This corridor, which may consist of a single route or network of routes, is considered "unrestricted" because its development does not consider physical, environmental, or regulatory constraints, or land ownership. As a result, the unrestricted corridor will consist of one or more straight-line paths that, if developed, would meet tribal energy transport needs.

Corridor Siting Step 1

Step 1 develops an unrestricted energy transport corridor that meets specific tribal energy transport needs or issues, including:

- The export of tribally generated energy,
- The import of externally generated energy onto tribal lands,
- The distribution of energy within tribal lands to energy demand areas, and
- Requests for energy transport ROWs across tribal land.

Development of the unrestricted route or network does not consider physical, environmental, or regulatory constraints or land ownership.

2.2.1 Why Is the Energy Transport Corridor Needed?

The location of an energy transport corridor on tribal land will be driven by the underlying energy transport need being addressed by a tribe. This need will depend, at least in part, on whether the need is initiated by the tribe or a non-tribal entity (such as a pipeline or electric utility company), and whether the tribe is being proactive or reactive with regard to energy transport. Proactive energy transport siting actions are taken in anticipation of future energy transport needs and proposals, while reactive siting actions are taken to address outside industry requests for paths across tribal land.

Examples of proactive energy transport needs include:

- A tribe wishes to develop solar or wind energy resources on tribal land with the intent to market the produced power to non-tribal customers. To do this, the tribe would need to establish one or more electric transmission routes that connect the future generating facility to the local electric transmission grid. Such energy transport routes would originate on tribal land (at a tribal energy production site, such as a wind farm) and extend onto non-tribal lands to connect to the electric grid, and ultimately, transport electricity to energy demand areas outside of tribal lands.

- A tribe wishes to bring energy onto tribal land in order to supply known and expected energy demand areas, such as tribal communities and industrial sites. This will require one or more energy transport routes coming from outside energy sources onto tribal land, and a subsequent network of additional routes to specific tribal demand areas.

- A tribe is planning to develop energy-generating facilities on tribal land and use that energy to meet tribal energy demands. In this case, energy transport routes and networks would be wholly restricted to tribal lands.

In contrast, a tribe may receive a request from an outside entity that is planning to develop a long-distance pipeline or electric transmission line, and is looking at the possibility of crossing tribal land. The tribe reacts to this outside request and sites an energy ROW that crosses its land along a path that is acceptable to the tribe and its stakeholders, and that also meets the needs of the applicant.

Ultimately, the underlying need driving the establishment of energy transport corridors will directly affect the initial location of any energy transmission route or network. Needs originating with external non-tribal entities, as well as tribal needs for importing or exporting energy, may result in interaction with non-tribal governments, land management agencies, energy planners, and energy developers to address corridor-siting considerations on adjacent non-tribal lands.

2.2.2 Identify Areas of Current and Likely Future Energy Production Areas on Tribal and Non-Tribal Land

Where Are Existing Energy Production Facilities or Areas Located? The location of existing nearby energy production facilities is important in the development of energy transport corridors, because these may represent 'starting' locations for future corridors leading onto or across tribal land. Existing energy production facilities may include fossil fuel (i.e., coal, natural gas, oil) and nuclear electric generating plants, hydroelectric generating plants, wind farms, solar plants, biomass power plants, geothermal generating facilities, and oil or natural gas well fields. The locations of these facilities should be mapped relative to the location of the tribal land. For example, existing wind farms in eastern New Mexico, Colorado, and Wyoming (see Figure 2.2) could provide electricity to tribal lands in the Four Corners region and other areas of the Southwest. Similarly, developers seeking a long-distance natural gas pipeline to connect the fields of southwestern Wyoming with energy demand areas such as Phoenix may seek authorization to cross some tribal lands.

Where May Future Energy Production Facilities be Located? As energy demand in the United States increases, new generating facilities will be constructed to meet growing demand, with tribal land being a likely location in some cases.. In addition, many states have identified areas for future renewable energy development, while some federal agencies have established (or are developing) programs to guide renewable energy development (e.g., wind, solar, and geothermal energy).[3] As generating facilities are developed, energy transport corridors will be needed to connect these new facilities to energy demand areas. Depending on the energy

[3] As an example, the U.S. Bureau of Land Management has established programs for both wind and geothermal energy development and is currently evaluating a solar energy development program. In addition, Western Area Power Administration (Western) is evaluating a program to guide wind energy development in its Upper Great Plains Region. The U.S. Fish and Wildlife Service is partnering with Western to evaluate its own program for wind energy development on easements in the same region and is also developing voluntary guidelines for wind turbine siting throughout the United States.

source and associated generation technology, some areas may be more likely to be developed for energy production than others (Figure 2.2).

Sources of Information: A number of federal agencies provide information on the availability of energy resources in the United States. For example, the IEED Division of Energy and Mineral Development (DEMD) assists tribes in evaluating their energy resource development opportunities, including conducting resource assessments and assisting with development strategies and business negotiations. In addition, the National Renewable Energy Laboratory (NREL) has developed a number of analytical models for assessing the potential development of renewable energy resources, and makes this information available publically (e.g., see http://www.nrel.gov/renewable_resources/). Similarly, the U.S. Geological Survey conducts assessments of oil and gas resources throughout the United States, and also makes this information readily available (http://energy.cr.usgs.gov/oilgas/noga/). The TEEIC website includes information on the geographic distribution of various types of energy in the United States (http://teeic.anl.gov/er/index.cfm), and additional sources of information on the distribution of energy resources and generating facilities are presented in Chapter 3 of this Guide. Appendix B provides Web-based sources of information about energy resource assessment.

2.2.3 Identify Existing Energy Transport Infrastructure on Tribal and Non-Tribal Lands

What Energy Transport Infrastructure Occurs on Tribal Land? It is important to know the nature and location of energy transport infrastructure currently present on tribal lands. This infrastructure may include electric transmission lines and substations, and oil/petroleum product and natural gas pipelines and compressor stations. Existing ROWs for electric transmission lines or pipelines represent possible locations for future transport projects (it may be possible to expand an existing ROW to include additional infrastructure), while substations and compressor stations represent locations from which new energy transport infrastructure can branch out to service new areas on tribal land.

What Energy Transport Infrastructure Occurs on Nearby Non-Tribal Lands? Energy transport infrastructure on nearby non-tribal land represents locations from which to direct new transport infrastructure onto tribal land, whether to supply tribal demand or to cross tribal land to non-tribal demand areas. Conversely, infrastructure on non-tribal lands may serve as a target for tribally originated energy transport projects, connecting energy produced on tribal lands to non-tribal markets.

Sources of Information: Up-to-date information on the nature and location of energy transport infrastructure is proprietary, and thus, not readily available. Interested parties can purchase this information from commercial sources, or it may be available through an energy developer that is partnering with a tribe to locate, build, and operate a pipeline or transmission

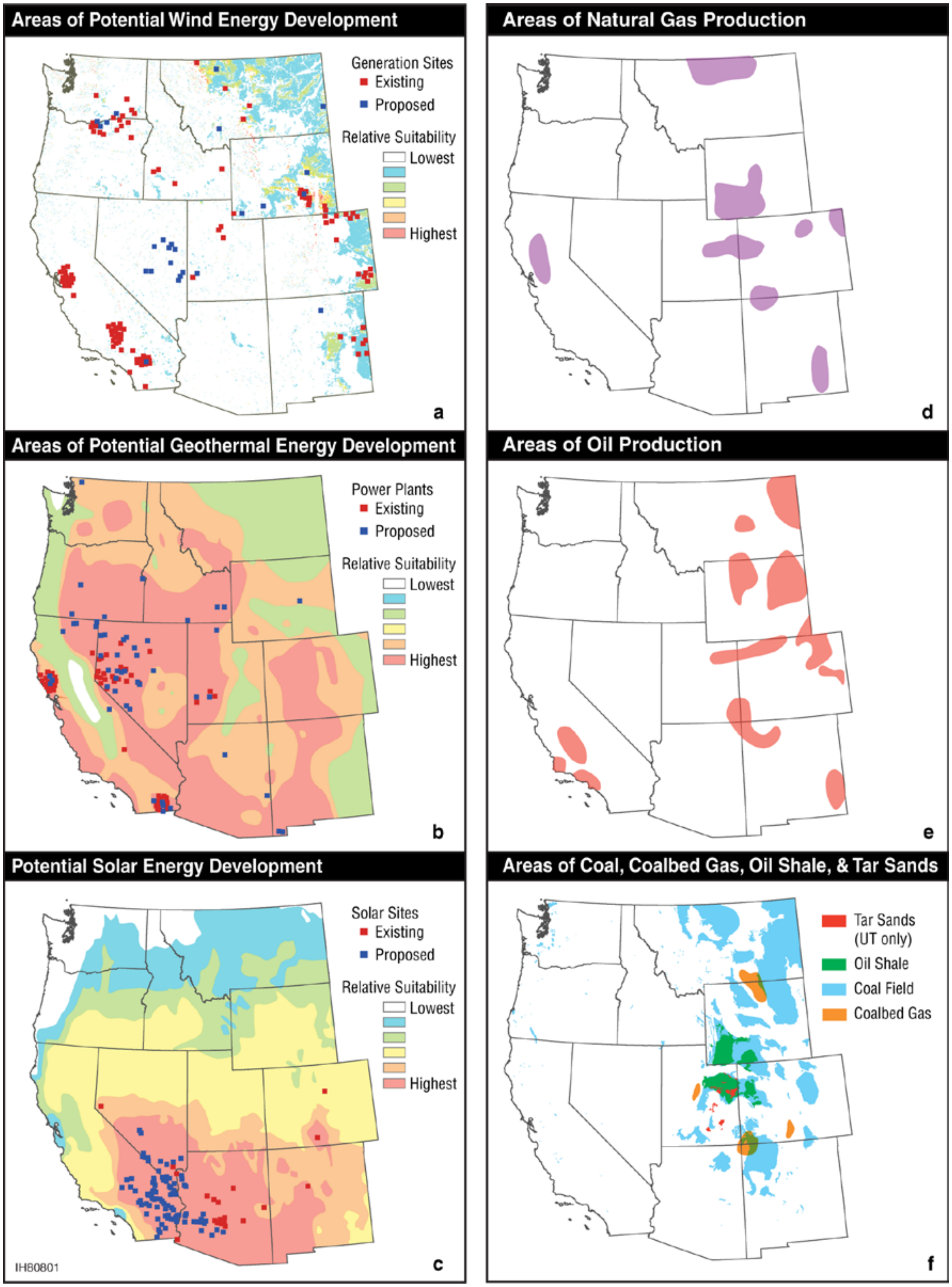

FIGURE 2.2 Areas of Existing, Planned, or Potential (a) Wind Energy, (b) Geothermal Energy, and (c) Solar Energy Development; and Areas of (d) Natural Gas Production, (e) Oil Production, and (f) Coal, Coalbed Gas, Oil Shale, and Tar Sands Resources in the Western United States (Sources: USGS 2005; Western Resource Associates 2008).

line. Information on energy infrastructure is discussed in Chapter 3 of this Guide. Information on ownership of allotted land is available to tribes from the BIA Land Title and Records Office.

2.2.4 Identify Existing or Anticipated Tribal and Non-Tribal Energy Demand Areas

Where Are Existing or Anticipated Energy Demand Areas on Tribal Land? Energy demand areas are locations of high energy demand from residential communities and commercial or industrial facilities. These areas represent not only current locations of energy demand, but also locations that could grow in population, and thus, have an increased energy need in the foreseeable future. Knowing the locations of existing and future tribal energy demand areas is important as these areas represent the ultimate endpoints of future energy corridors bringing energy from outside sources onto tribal lands and/or distributing energy within tribal lands. In general, demand areas will be towns and cities, residential developments, commercial areas (such as shopping areas and malls), and industrial areas (e.g., manufacturing plants).

Where Are Existing or Anticipated Energy Demand Areas on Non-Tribal Lands? Tribal lands may be located near non-tribal areas with existing or anticipated energy demand areas (e.g., the pueblos located immediately north and south of the Albuquerque metropolitan area). As a result of the energy demands of such non-tribal areas, energy suppliers may be seeking to secure and develop energy transport ROWs to these non-tribal demand areas. In some locations, tribal lands may be located between energy generating facilities and non-tribal energy demand areas, and energy suppliers may be considering negotiating with a tribe to cross tribal lands for their energy transport projects. Tribes may proactively identify such situations for their lands and wish to develop energy transport corridors in preparation of external ROW requests. Knowledge of non-tribal demand areas may also aid in siting energy transport corridors from existing or planned tribal generating facilities (such as wind farms and solar energy facilities) to these areas.

2.2.5 Review Utility Requests or Plans for Energy Transport ROWs Across Tribal Lands

As energy demand increases in the future and new generation facilities are planned and developed, tribes may expect to be approached by industry or others for approval of access routes across tribal land near proposed development of energy transport projects. Requests for specific routes or for general pathways across tribal land may come from individual utilities and from state, regional, and national energy transport organizations that have been examining energy supply, demand, and transport issues on a regional or national scale. In some cases, utility planning may be relatively mature (e.g., the project will likely occur, although the exact path is not yet settled), or may be in very early stages of development (e.g., 'a transport route will likely be needed in the next five years and the general path could take it across tribal land'). A large number of corridor proposals in a given area would indicate an underlying need for additional energy transport capacity along a particular path to connect energy supply and demand areas.

Sources of Information: Utilities seeking ROW authorization to cross tribal land are likely to contact the appropriate tribe directly with a specific proposal. To find information about proposed or planned utility corridors that could involve tribal lands, tribes should consult with the following sources of information:

- State utility agencies (such as the California Energy Commission) regarding energy transport projects being evaluated under a state's authorization process;
- The Federal Energy Regulatory Commission, which oversees interstate natural gas pipelines and non-federal hydroelectric projects;
- Federal land management agencies such as U.S. Bureau of Land Management (BLM) or the U.S. Forest Service, which receive and authorize requests for energy transport ROWs; and
- Regional energy planning organizations (such as the Western Governors Association and the Western Utility Group).

2.2.6 Identify an Unrestricted Energy Transport Corridor(s)

After identifying the locations of energy generation and demand areas, energy transport infrastructure, and proposed future energy routes, the next step in the siting process is to identify straight-line (shortest distance) paths connecting energy generation areas with energy demand areas while considering the locations of existing energy transport infrastructure and future energy planning activities. These straight-line routes are considered to be 'unrestricted' because they do not take into account land ownership, land use regulations, topographic conditions, or the presence of valued natural and cultural resources. For example, Figure 2.3 depicts a proposed 'unrestricted' network for new electric transmission for the eastern United States. Note that the proposed routes all consist of straight segments and clearly do not take into account land ownership, regulatory constraints, and resource concerns. While it is unrealistic to think that an energy transport project would follow such straight-line paths, such unrestricted corridors clearly address the energy transport goals and objectives. Such unrestricted corridors also serve as the basis from which more realistic, location-specific energy transport planning and siting can occur.

What Is the Outcome of Step 1? At the conclusion of Step 1, a tribe will have identified an unrestricted energy transport corridor on the basis of the locations of:

- Existing and future energy generation facilities or areas,
- Existing and future energy demand areas,

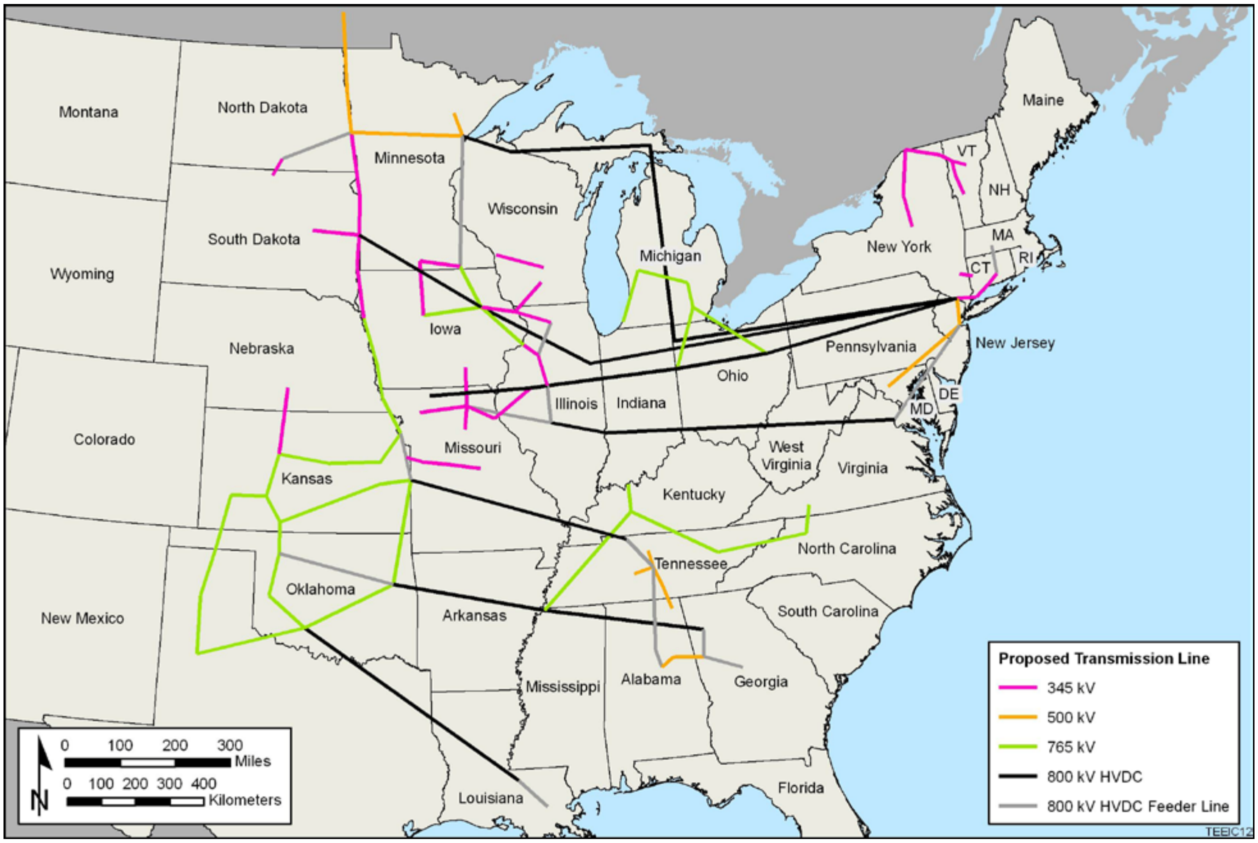

FIGURE 2.3 New Electric Transmission Lines Proposed by Midwestern Grid Operators for the Eastern United States (Based on JCSP 2008).

- Existing energy transport infrastructure, and
- Energy transport corridors proposed or suggested by industry and energy planning entities.

The unrestricted energy transport corridor thus identifies general paths for energy transport that would meet tribal energy objectives.

As an example, suppose that a tribe is developing a solar energy facility on its lands with the intent to sell the electricity to the outside market. In order to do so, the tribally generated electricity must be transported from the solar farm to the electric transmission grid. An examination of the existing electric transmission infrastructure in the vicinity of the tribal solar farm shows that the nearest electric substation to which the tribal energy could be delivered is located about 15 miles east of the tribal boundary. In this example, the Step 1 unrestricted corridor would be a straight-line route connecting the proposed solar farm to the substation 15 miles to the east (Figure 2.4).

2.3 STEP 2 — REVISE THE UNRESTRICTED CORRIDOR ROUTE TO AVOID SITING CONSTRAINTS

Step 2 revises the unrestricted energy transport corridor to avoid known environmental and regulatory constraints while still meeting the specified tribal need for the corridor. In addition, the location of the unrestricted corridor is also examined for opportunities to follow existing utility and transportation ROWs (e.g., roads and rail lines), thereby minimizing the placement of future energy transport projects in 'greenfield' (undeveloped) locations where there could be greater impacts to valued natural and cultural resources.

How Is the Unrestricted Corridor Route Revised? The unrestricted energy transport corridor developed in Step 1 does not consider physical, environmental, or regulatory constraints, or land ownership. In Step 2, siting constraints are identified and used to adjust the path(s) of the unrestricted corridor to avoid conflicts with these constraints to the extent possible. These siting constraints may include, but not be limited to:

- The presence of important natural and cultural resources,
- The presence of military training and testing areas in nearby non-tribal lands, and
- Regulatory stipulations that prevent siting of certain activities or infrastructure on tribal or nearby non-tribal lands.

Table 2.1 lists examples of such siting constraints. In addition to these constraints, corridor or ROW siting on tribal and non-tribal land may also be influenced by land ownership issues and, in some cases, by the issue of split estate. Tribal lands may have a mix of ownership (tribal fee land, tribal trust land, allotted land, federal land, and private land) that results in a 'checkerboard' pattern of ownership. In split estate situations, the surface and subsurface rights (such as the rights to develop minerals) for a piece of land may be owned by different parties. Corridor or ROW siting must consider these land ownership issues.

In an earlier example from Step 1, a tribe identified the need for an energy transport corridor to export electricity from a tribal solar farm to the outside market. Tribal planners identified a 15-mile-long unrestricted route that leaves the tribal land from its eastern boundary and proceeds to the nearest electric substation located 15 miles to the east (Figure 2.4). During Step 2, examination of land ownership along the unrestricted route crossing non-tribal lands shows the presence of a National Park along much of the eastern boundary of the tribal land (Figure 2.5). The National Park Service (NPS) manages its parks for very specific conservation purposes, and probably would not grant a ROW authorization across the park. Thus, the path of the unrestricted corridor would need to be adjusted to either the north or south so that it would

TABLE 2.1 Potential Energy Transport Corridor Siting Constraints on Tribal and Non-Tribal Lands

Siting Constraint Categories	Type of Area or Resource to be Avoided[a]
Existing laws, regulations, and policies	Restricted lands designated for conservation or some other specific use should be avoided. Such lands might be identified in tribal regulations or land use plans. On adjacent non-federal lands, similarly designated lands must be avoided (e.g., federally designated wilderness areas, wilderness study areas, roadless areas, wild and scenic rivers, national parks, national monuments, national recreation areas, national wildlife refuges, and national natural landmarks).
Resources that are ecologically, culturally, scientifically, educationally, and/or recreationally important	Lands where potentially sensitive or significant resources are present should be avoided. Such lands might be identified in tribal land use plans or they may be known to tribal staff or members. On adjacent non-tribal lands, similar areas should be avoided. These may include national conservation areas, areas of critical environmental concern, national recreational areas, special recreation management areas, historic and scenic trails, state parks, important cultural and historic properties, national natural and historic landmarks, world heritage sites, research natural areas, experimental forests, and important paleontological sites.
Military installations and training and testing areas	Military special-use airspace on tribal and non-tribal lands. On adjacent non-tribal lands, military bases and training and testing areas.
Public concerns	All of the above, except military facilities and training areas may be seen by the public as reasons to limit energy transport development.

[a] Some areas or resources may fall into multiple siting constraint categories.

now exit tribal land in an area not bordered by the NPS land (Figure 2.5). Similar situations may arise where tribal lands may border national wildlife refuges, military installations, state lands, and other similarly restricted lands.

In some cases, there may be multiple options for adjusting the corridor route to avoid a particular siting constraint, whether on tribal or on adjacent non-tribal lands. In such cases, it may be useful to identify more than a single route revision, and evaluate several different alternative routes as other siting constraints are considered. It is possible that there may be no single route siting revision that would avoid all siting constraints. Rather, there may be several route options, some avoiding certain subsets of constraints while others avoid different subsets of constraints. Thus, it may be necessary to carry several route options forward into Step 3 (or even to Step 4) of the siting process.

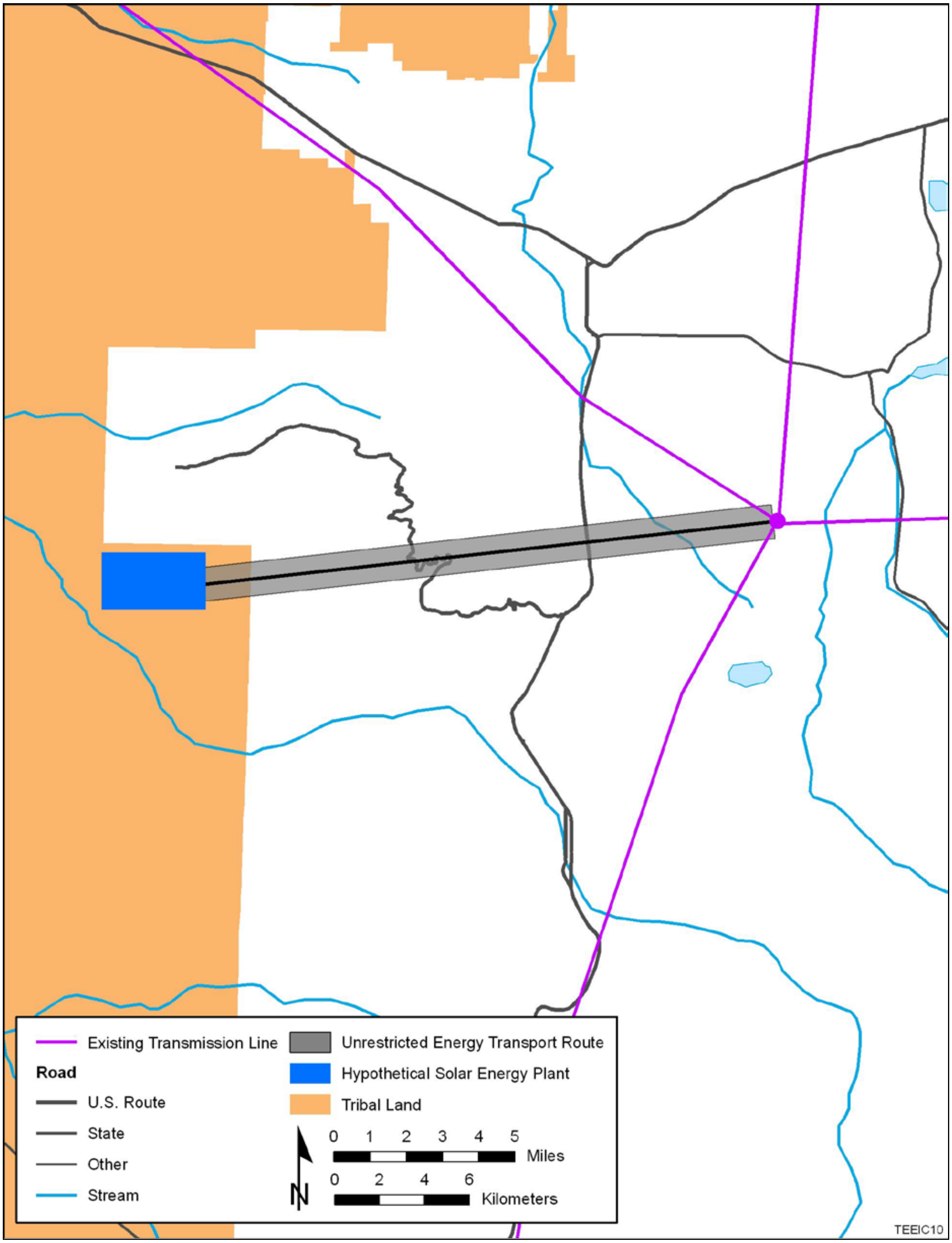

FIGURE 2.4 Hypothetical Unrestricted Energy Corridor Connecting a Tribal Solar Plant to an Electric Substation Located on Non-Tribal Land.

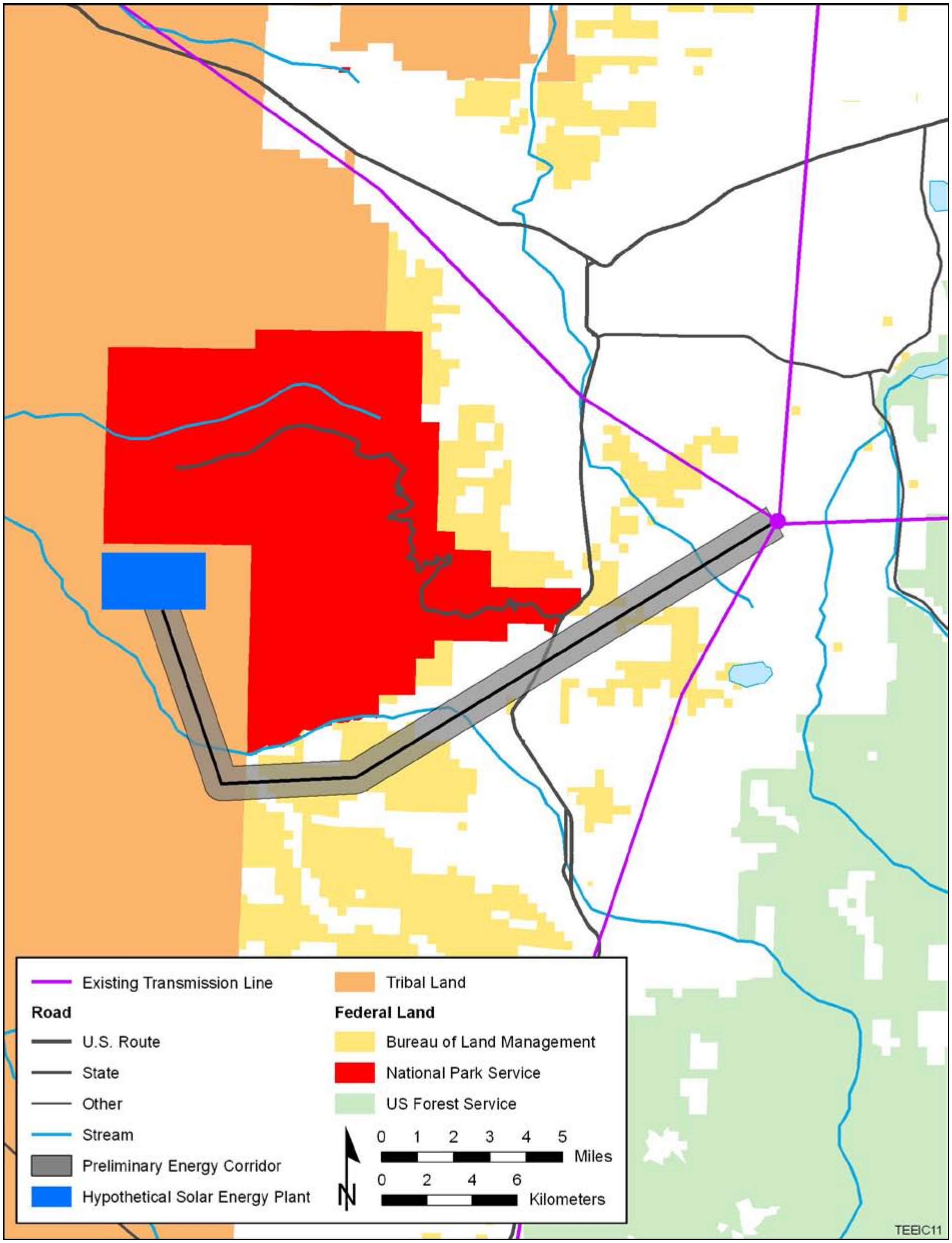

FIGURE 2.5 Hypothetical Unrestricted Corridor Adjusted to Avoid Intersecting a Siting Restraint (Area Shown in Red).

2.3.1 Natural and Cultural Resource Constraints

Natural and cultural resource constraints arise from requirements to protect valued resources.. Examples of natural resources that could present siting constraints include wetlands, old growth forest, wild game habitat, and traditional fisheries. Cultural resource types that could affect corridor location include archeological sites (e.g., prehistoric village sites, railroad camps), structures (e.g., prehistoric cliff dwellings, historic farmsteads), landscape features (e.g., battlefields, historic and prehistoric trails), sacred places and landscapes, and traditional gathering grounds. Many of these resource constraints have associated regulatory protection. Discussions with tribal government staff, tribal members, tribal associations, or other local organizations may be needed to identify resource constraints on tribal land. Discussions with non-tribal entities (e.g., federal resource management agencies, other tribes) are critical to fully identify such constraints on adjacent non-tribal lands. In addition, tribes often have interests on non-tribal lands where they have treaty rights or retain some interest in preservation or protection because of historic use, sacred site values, or for other reasons to lands that they ceded, granted, relinquished, sold, or lost rights to under a treaty, other agreement, or law. These lands are sometimes referred to as "ceded areas."

Sources of Information: Each tribe has numerous entities that oversee the protection of tribally sensitive resources. For example, many tribes have a Tribal Historic Preservation Officer (THPO), whose role is to oversee the protection of culturally important tribal resources. THPOs are typically involved in the planning and compliance work needed for road, school, housing, and economic development construction. The THPO (and other tribe-specific individuals or groups) will be knowledgeable about important cultural and natural resources both on and off tribal land. For energy transport routes that originate on tribal land but would then cross onto non-tribal land, it may be necessary to contact THPOs from other tribes, to help determine whether the proposed energy corridor may encounter a resource or area that is important to a different tribe. Regional and national groups, such as the All Indian Pueblo Council and the National Association of Tribal Historic Preservation Officers may be helpful in such instances.

For other than tribally sensitive resources that may occur on adjacent non-tribal lands, there are numerous local, state, and federal agencies and organizations that could assist in identifying resource constraints on non-tribal lands. For corridors crossing federal or state lands, each potentially affected agency (e.g., a BLM Field Office, a U.S. Forest Service Ranger District, a state natural resources department, or the State Historic Preservation Office) should be contacted for information on natural and cultural resources that may occur along the unrestricted energy transport corridor. To help identify which non-tribal organizations may need to be contacted, Step 2 activities should include the identification and mapping of land ownership along the unrestricted corridor route.

2.3.2 Regulatory Constraints

Because the development of an unrestricted corridor in Step 1 did not consider any regulatory constraints, it is likely that portions of the unrestricted corridor route will cross lands that have laws or policies that govern allowable land uses or protect resources. For corridors on tribal lands, constraints may exist by virtue of tribal government regulations or tribal land use or resource management plans, and in some cases, federal regulations (e.g., U.S. Fish and Wildlife regulations protecting endangered species and critical habitat, U.S. Army Corps of Engineers requirements related to protection of wetlands). For portions of corridors that extend onto non-tribal lands, there will be numerous federal, state, and local regulations and policies that may affect the siting of the corridor on a particular parcel of non-tribal land. For example, federally designated wilderness areas, wild and scenic rivers, national parks, national recreation areas, and national wildlife refuges all have underlying federal statutes, regulations, and policies governing the types of activities that may occur on those lands, which in some cases prohibit any type of energy infrastructure development. While many resources are afforded protection by legislation, others are protected by virtue of agency plans and policies.

How a particular regulation, statute, or policy may affect the location of an unrestricted corridor will depend on the applicable regulation. Some may allow for an energy transport project but with strict project authorization and development requirements (e.g., environmental impact assessment, mitigation and monitoring requirements, and infrastructure design requirements), while others may completely prohibit such land use for energy transport projects. In the earlier example of the need for a corridor to connect a tribal solar farm to a substation located on non-tribal land, Step 2 identified a possible land ownership constraint, with a national park directly in the path of the Step 1 unrestricted corridor. One option to address this constraint would be to reroute the corridor so it would no longer pass through the park. Alternately, discussions with the NPS park managers might identify one or more routes through the park where the existing park land use plan would allow for a new transmission line ROW (e.g., collocated along an existing transmission line and ROW through the park).

Sources of Information. The determination of which statutes, regulations, and policies may affect a proposed tribal energy corridor will depend on the ownership of the land crossed by the corridor, and the underlying regulations, statutes, or policies that govern that specific land. Examination of the ownership of adjacent non-tribal lands that would be crossed by the unrestricted corridor will identify the appropriate federal, state, and local government agencies that should be contacted regarding regulatory stipulations for those lands. Additional information on the environmental laws and regulations that will apply to tribal energy development activities may be found on the TEEIC website (http://teeic.anl.gov/lr/index.cfm).

2.3.3 Military Installation and Training Area Constraints

During Step 2, the location of the unrestricted corridor should be examined for possible conflicts with military installations and training and testing areas in which corridor placement may be prohibited or restricted to specific areas. Military installations and training and testing areas are not located on tribal lands, and thus, would not be expected to affect the locations of proposed energy transport routes or networks that are solely on tribal land. However, unrestricted corridors leaving tribal land may intersect one or more military installations. At these locations, the unrestricted corridor will need to be adjusted to avoid the installation.

In addition, many parts of the country (including tribal and non-tribal lands) have military training routes (MTRs) and special-use airspace (SUA) where low-level military aircraft flights may occur regularly; in some locations, aircraft may be operating at altitudes of 100 ft or less above the ground surface. Depending on the type of energy transport project infrastructure anticipated to occur in a corridor, some energy transport projects (such as a 500 kV electric transmission line) may conflict with an MTR or SUA, while other types of infrastructure (e.g., underground natural gas pipeline) may pose no such conflicts. In the case of potential conflicts, it may be necessary to relocate portions of the unrestricted transport route to avoid or minimize intersecting the MTR or SUA, to the extent practicable.

Sources of Information. Information on the locations of military installations, MTRs, and SUAs may be obtained from the Department of Defense. Military installations near the tribal land may be good starting points for obtaining such information.

2.3.4 Availability of Existing ROWs

The development of a preliminary energy corridor should identify the presence of existing utility and transportation ROWs (such as existing transmission lines, highways, and rail lines) in the vicinity of the unrestricted corridor. Existing ROWs should be examined for possible use in locating the energy transport corridor. Consideration of existing ROWs can expedite the siting and designation of energy transport projects, because for many of these ROWs, project-specific impact analyses may have already been completed (especially on non-tribal lands). Where possible and allowable, the location of an unrestricted energy transport route or network paths should be adjusted to align with existing ROWs (Figure 2.6). By collocating new energy transport facilities with existing infrastructure, the development of "greenfield" (undeveloped) locations may be avoided or minimized, thereby reducing the potential level of project-related impacts to valued natural and cultural resources.

Sources of Information. Up-to-date information on the nature and location of energy transport infrastructure may be proprietary, and thus, not readily available. Such information can be purchased from commercial sources, or may be available through an energy developer that is partnering with a tribe to locate, build, and operate a pipeline or transmission line. Information on energy infrastructure is discussed in Chapter 3 of this Guide. Information on transportation infrastructure may be available from a variety of sources. Tribal agencies that oversee transportation infrastructure on tribal lands may provide maps showing roads on tribal lands. All states have a department (e.g., New York Department of Transportation; Idaho Department of Transportation, Division of Highways) that oversees transportation issues and can provide maps and other information on road and rail systems in a particular state. The U.S. Geological Survey has topographic maps that show roads and rail lines; these may be accessed at http://nationalmap.gov/. Google Earth (Google 2009a) may also be used to help identify existing ROWs in the vicinity of the unrestricted corridor.

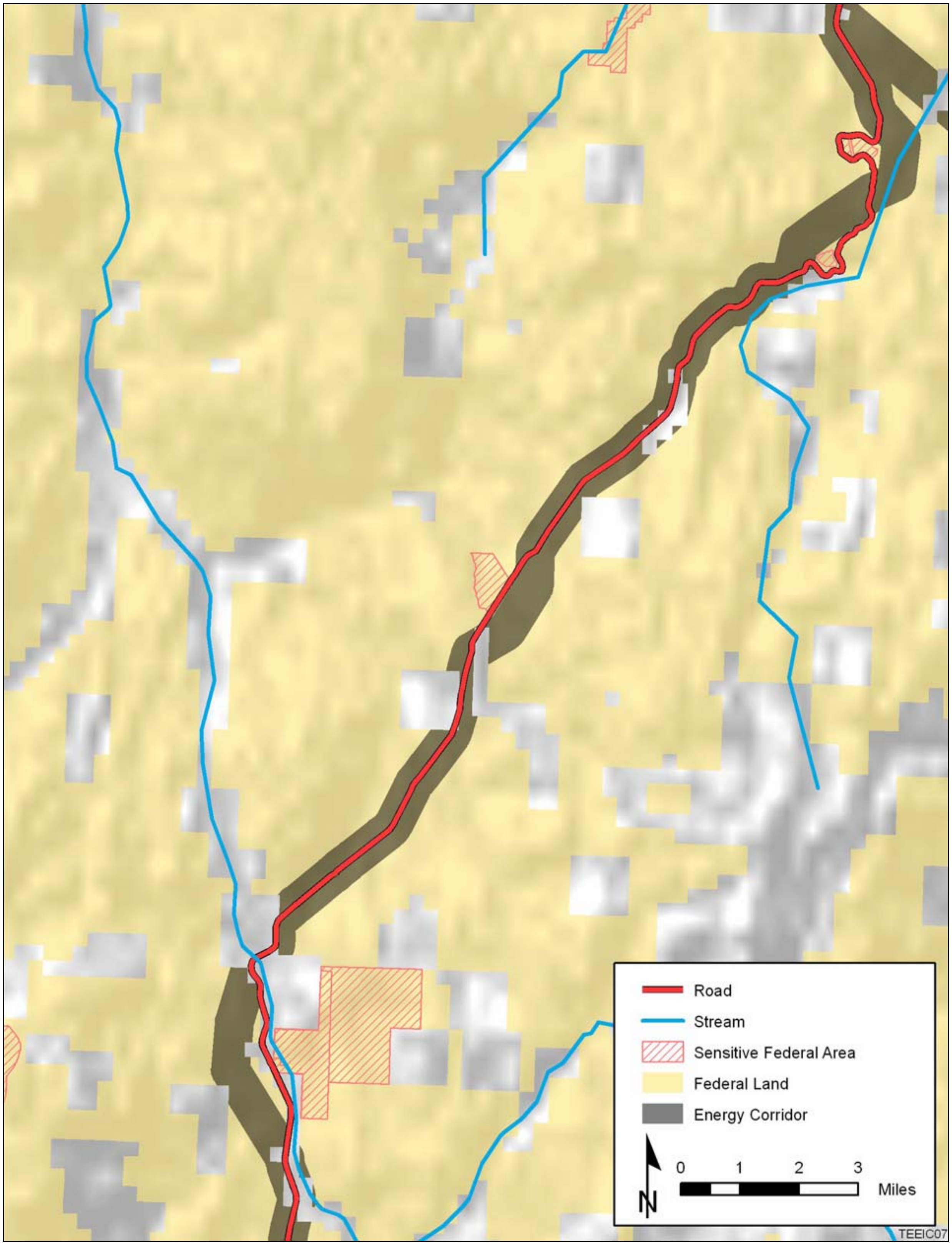

FIGURE 2.6 Hypothetical Corridor in the Vicinity of an Existing Transportation ROW. At this location, the corridor has been adjusted to collocate it alongside an existing road.

2.3.5 Environmental Concerns Identified by Tribal Input

Depending on how the planning for and identification of the unrestricted corridor was conducted, the corridor planners may have provided information during Step 1 to a variety of tribal government departments and/or tribe members. If so, input received from those tribal groups or tribe members should be examined to identify any issues or concerns that may indicate a need to adjust some portions of the unrestricted route or network.

2.3.6 Identification of the Preliminary Energy Transport Corridor

Once the applicable constraining factors are identified and tribal input considered, the unrestricted energy transport corridor developed in Step 1 is revised. Some or all of the unrestricted corridor will be adjusted to minimize, to the extent practicable, potential conflicts with the applicable constraining factors. The revised corridor route will be much less “straight line” in nature.

What Is the Outcome of Step 2? At the conclusion of Step 2, a preliminary energy transport corridor is identified that meets the underlying tribal energy transport needs while also avoiding many valued resources and lands, complying with most statutory and regulatory provisions, avoiding military training and testing areas and restricted airspace, and being responsive to concerns raised by tribal government agencies, tribal associations, and tribe members. From the earlier example of connecting a tribal solar facility to the electric grid, the tribal planners would have identified the national park as an area to be avoided.

Additional adjustments to the corridor route to further avoid sensitive resources and areas will be made during Steps 3 and 4 of the corridor siting process.

2.4 STEP 3 — REFINE THE PRELIMINARY CORRIDOR ROUTE USING SITE-SPECIFIC RESOURCE INFORMATION AND ENVIRONMENTAL IMPACT ANALYSES

In Step 3, the tribal and, if appropriate, federal, state, and local land and resource managers and their staffs examine the preliminary energy transport corridor.. Portions of the preliminary corridor route may need additional adjustment, to the extent practicable, to further avoid important resource and regulatory constraints. Such adjustments also help ensure that the corridor location and characteristics are consistent with management responsibilities on the tribal and non-tribal lands.

In addition, environmental impact analyses should be conducted that examine the potential for valued resources to be adversely affected by any projects developed within the preliminary corridor route. Such analyses help identify possible impacts that could be incurred by one or more resources from the construction and operation of an electric transmission line or a pipeline in the preliminary corridor or ROW route. Such analyses may not only identify specific locations in which resources may be impacted, but also identify the likely nature of the impact, as well as the potential magnitude and significance of any such impacts. Environmental analyses will also assist in the identification of possible mitigation measures and best management practices that may be implemented to reduce the likelihood or magnitude and significance of possible impacts. The results of the environmental analyses could be used to move the preliminary corridor route at some locations to avoid or minimize the likelihood of adverse environmental impacts.

In Step 3, the corridor planners should contact and involve the groups and individuals that are responsible for managing the lands and resources that occur directly along the preliminary route or network. While such interactions may have occurred in Step 2, these may have only included higher-level resource and land managers, and not necessarily individual specialists that work with the resources on a daily basis. These staff may include planning and realty specialists, legal and regulatory specialists, wildlife ecologists, archeologists, geologists, and others (e.g., foresters, range conservationists, mineral development specialists).

For example, the development of a preliminary energy transport route may have only included interaction with a subset of resource staff from one tribal agency. In Step 2, these staff members provided information that was used to help revise the unrestricted corridor route to avoid major, obvious conflicts with land use constraints. Information provided in Step 2 may have identified relatively broad areas of concern to avoid, to the maximum extent practicable (such as areas of sage grouse habitat). In Step 3, other tribal agencies or organizations may be consulted, or it may be appropriate to ask the resource specialists who were initially consulted to use their unique, site-specific knowledge of sensitive resources, management activities, and compatible land uses to provide additional route adjustments (together with detailed supporting rationale) to further minimize potential conflicts with other siting constraints not identified during Step 2. In addition, environmental analyses would be conducted for the corridor route to provide impact information on sensitive resources in the area. In this example, sage grouse specialists may identify the locations of specific sage grouse nesting sites that would absolutely need to be avoided, while identifying other locations within the broader sage grouse area in which an energy corridor could be sited with relatively little impact to this resource.

During Step 3, land and resource management staff should also be asked to help identify possible mitigation measures that could be used to avoid or minimize potential project impacts. This information will be useful in planning actual project design, construction, and operation.

What Is the Outcome of Step 3? Step 3 results in a proposed energy corridor that is sited, to the extent practicable, to avoid important natural resource, cultural, and regulatory constraints, minimize or avoid potential environmental impacts if developed, and is as consistent as possible with land and resource management responsibilities on tribal and non-tribal lands. As was previously discussed under Step 2, the tribal corridor planners may have identified more than one corridor siting option, each of which presents a somewhat different compromise between avoiding siting constraints and meeting tribal energy planning needs. It is this proposed energy corridor (or corridors) that the responsible tribal government agencies should release to all tribal members and organizations and stakeholders for their review and comment, and discussions initiated with non-tribal governments for their consideration.

2.5 STEP 4 — FINALIZE THE PROPOSED ENERGY TRANSPORT CORRIDOR USING INPUT FROM TRIBAL AND NON-TRIBAL STAKEHOLDERS

In Step 4, the tribal planners may make adjustments to the proposed corridor or ROW route to address comments and concerns raised by tribal and non-tribal stakeholders on the corridor route proposed in Step 3 of the siting process. The corridor planners should examine the comments received from the public tribal, federal, state and local governments; nongovernment organizations (e.g., The Wilderness Society); and other stakeholders. Additional resource information may also be provided during this step by tribal and non-tribal land and resource managers. On the basis of this stakeholder input, the tribal planners may adjust the proposed corridor or ROW route. If the proposed changes do not conflict with the siting constraints identified in Steps 2 and 3, and still meet tribal energy needs, the tribal leaders will then make a decision on the final dimensions, location, and function of the energy transport corridor. If adjusting the proposed route changes the proposal such that the underlying tribal energy need for the corridor or ROW is not met, the planning process may need to revisit the preceding steps of the planning process.

In some areas, it is possible that there may be relatively little adjustment to the corridor route between Steps 2 and 4 of the siting process. In other areas, major changes may occur between the preliminary corridor route identified in Step 2 and the parameters of the final route selected in Step 4. As previously discussed, the degree of change in the route of an energy transport corridor will depend on the

- Lands crossed by the proposed corridor,
- Siting constraints identified for those lands,
- Level of detail regarding the nature and location of valued natural and cultural resources present along the corridor route, and
- Degree to which the known constraints can be addressed (through corridor rerouting and/or mitigation).

2.6 OVERSIGHT OF USE AND OCCUPANCY OF CORRIDORS OR RIGHTS-OF-WAY

Once a tribe has designated an energy corridor or ROW route, all applications for use of the corridor or ROW will be evaluated by the appropriate tribal authority. Through this review, appropriate BMPs and mitigation measures will be identified to ensure that the proposed energy transmission project is planned, implemented, operated, and eventually removed in a manner that protects natural and cultural resources. Compliance with applicable regulatory requirements, including tribal and federal (e.g., Endangered Species Act, National Historic Preservation Act) requirements, will be mandatory for all proposed projects. Where appropriate, specific BMPs and mitigation measures, as well as other tribe-specific management controls and performance standards, will be specified in the ROW authorization. These will be identified on the basis of the project-specific application and supporting site-specific environmental evaluations. Potentially appropriate mitigation measures are discussed in Appendix A.

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3 APPLICATION OF INFORMATION TECHNOLOGY FOR CORRIDOR SITING

3.1 GEOGRAPHIC INFORMATION SYSTEM (GIS) CAPABILITIES AND THEIR APPLICATION TO ENERGY CORRIDOR SITING

Geographic Information System (GIS) software provides tools to manage, visualize, and analyze geographic data. Land management issues such as energy corridor siting are spatial in nature, therefore, there is a natural benefit to using GIS technology in the decision-making process. Typically, these efforts involve a complex combination of siting issues including physiographic setting, sensitive environmental and cultural resources, land ownership, land use designations, and existing infrastructure. Spatial data representing these issues are often available at little or no cost, and GIS software provides many useful capabilities for energy corridor siting.

On the most basic level, GISs provide a means of visualizing information in a spatial context using an interactive map. Layers of different information, such as land ownership and existing infrastructure, can be superimposed on a map, and information linked to items on the map can be easily accessed and queried. GIS tools provide the means to measure distances and areas, including combinations of spatial information such as the number of miles of transmission lines within a certain category of land jurisdiction. GIS tools provide the means for more advanced analysis, including determining optimum routes based on a set of siting criteria, determining how visible a potential project would be from different viewing points, and three-dimensional (3D) visualization.

GIS tools provide many ways of sharing information, including publishing static paper-based and electronic maps, and interactive digital maps distributed by e-mail, webcast, free desktop viewers, and the Internet. These methods allow rapid and detailed communication with stakeholders at all stages of the planning process. In some cases, tribal planners may not have access to GIS software, data, or the expertise required to use these tools in their own organization. There are many advantages to using GIS to support planning and decision making activities and most entities involved in energy and transmission planning use these tools. Investments in software, data, and training are likely to translate into improved planning efforts and tribes that make these investments will be better positioned to integrate themselves into the development activities going on around them.

This section presents an example siting exercise to show how to use GIS tools at each step of the process. The example has a variety of characteristics typically encountered during energy transmission corridor siting. The GIS database was assembled using publicly available data sources; however, the map projection has been altered and place names will not be used, since the example is purely hypothetical. Figure 3.1 shows a map of the location, including shaded relief, transportation, land jurisdictions, and a hypothetical electric transmission line.

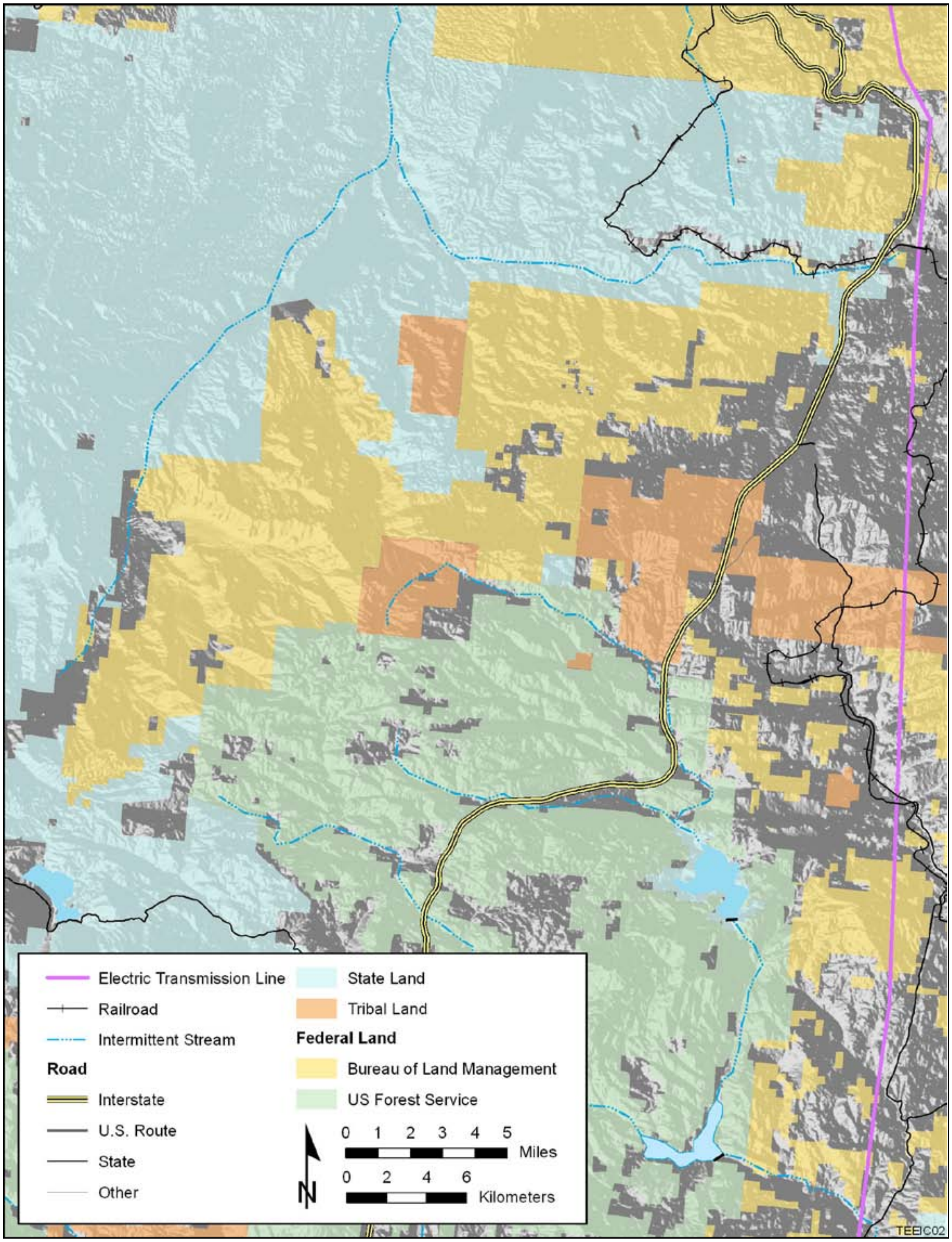

FIGURE 3.1 Study Area with Shaded Relief, Transportation, Land Jurisdictions, and Hypothetical Existing Electric Transmission Line.

The study area includes regions with tribal, federal, state, and private land crossed by an interstate highway. It has areas with high topographic relief, lands with prohibitions to development, sensitive cultural and ecological resources, and limited existing electrical transmission lines. This example evaluates a 3,500-ft-wide corridor connecting a proposed wind farm to the existing electric transmission line.

A 3,500-ft-wide energy corridor is considerably wider than the electric transmission ROW would need to be just for this purpose, however, the intent is to provide preliminary routing guidance for the anticipated project while not prescribing a route that might prove to be problematic for siting later. It also allows for the possibility of co-locating other projects in the corridor, potentially reducing impacts to surrounding areas if they were sited independently.

The specific technical steps needed in the GIS software will not be described in detail, but the process will be described at a level a GIS professional could replicate with the appropriate data.

3.2 GIS DATA SOURCES AND DATABASE COMPILATION

The energy corridor siting process requires a large variety of data ranging from physical land characteristics to land jurisdictions and protections. A detailed list of the GIS layers used for this study is provided in Table 3.1, with details about the Spatial Data Standards for Facilities, Infrastructure, and Environment categories and names used in the database, and the data sources.

Depending on the GIS databases available to tribes contemplating energy corridors in their areas, database compilation may be a minor task or a lengthy project. This example assumes that most of the database content would be obtained from diverse sources, and that tribal planners would develop a new database focused on the region of interest. Planners should define a map projection at the start of the planning process that fits well with the location and scale of the analysis area. For local regions a Universal Transverse Mercator (UTM), or State Plane projection is generally preferred; however, for larger regions that exceed the extent of a UTM zone or state, a projection such as Lambert Conformal or Albers Equal Area is generally preferred. We recommend storing the full database in the same projection and not using a geographic coordinate system (with coordinates in degrees) so that map views are not distorted, and area and length calculations can be made in the same units as the map view.

The software used in these examples is Environmental Systems Research Institute (ESRI) Arc/Info 9.3.1 with the Spatial Analyst extension (ESRI 2009); however, most GIS and remote sensing software can provide the same capabilities. Adobe Connect (Adobe 2009a) is the software used in the webcasting examples, along with Google Earth (Google 2009a) for 3D visualization. Google Earth is distributed as a free product via Internet download.

Following standards for the GIS database organization is very helpful for managing the many layers needed for energy corridor siting. In this example, we loosely follow the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE 2009) developed

TABLE 3.1 GIS Layers Used in the Study with SDSFIE Categories and Data Sources

SDSFIE Category	Theme	SDSFIE Layer Name	Source Organization	Source
Cadastral	Land Ownership	Agency_Owned_Area	BLM National Integrated Lands System	http://www.geocommunicator.gov
Fauna or Flora	Critical Fish Habitat	Habitat_Site_*	National Marine Fisheries Service	http://www.nmfs.noaa.gov/gis/data/fisheries.htm
Fauna or Flora	Critical Species Habitat	Habitat_Site_*	U.S. Fish and Wildlife Service	http://ecos.fws.gov/imf/imf.jsp?site=ecos
Hydrography	Stream Centerlines	Surf_Wat_Course_Centerline	USGS National Atlas	http://www.nationalatlas.gov/atlasftp-na.html
Hydrography	Water Bodies	Surf_Water_Body_Area	USGS National Atlas	http://www.nationalatlas.gov/atlasftp-na.html
Improvement	National Trail	Recreation_Trail_Centerline	National Park Service	http://science.nature.nps.gov/nrdata/
Landform	Surface Elevation	Dem_NED	USGS National Elevation Dataset	http://seamless.usgs.gov/index.php
Landform	Shaded Relief	Hillshade_NED	USGS National Elevation Dataset	Made from Dem_NED layer using GIS
Land Status	Area of Critical Environmental Concern	Land_Restriction_Area_ ACEC	U.S. Bureau of Land Management	Sources vary depending on location. Consult BLM web sites for online data, or local staff for internal data.
Land Status	National Conservation Area	Land_Restriction_Area_ NCA	U.S. Bureau of Land Management	http://www.blm.gov/nils/GeoComm/home_services. html
Land Status	Roadless Area	Land_Restriction_Area_ Roadless	USDA Forest Service	Geospatial Service and Technology Center
Land Status	Wilderness Area	Land_Restriction_Area_ Wilderness	U.S. Bureau of Land Management	http://www.blm.gov/nils/GeoComm/home_services. html
Land Status	Wilderness Study Area	Land_Restriction_Area_ Wilderness_Study	U.S. Bureau of Land Management	http://www.blm.gov/nils/GeoComm/home_services. html
Military Operations	Military Training Route	Military_Flight_Corridor_ Area	U.S. Department of Defense	U.S. Department of Defense
Military Operations	Special Use Airspace	Special_Use_Airspace_Site	U.S. Department of Defense	U.S. Department of Defense
Transportation	Major Roads	Road_Centerline_NHPN	U.S. Bureau of Transportation Statistics	https://www.bts.gov/pdc/user/products/src/ products.xml?p=2994

TABLE 3.1 (Cont.)

SDSFIE Category	Theme	SDSFIE Layer Name	Source Organization	Source
Transportation	Railroads	Railroad_Centerline	U.S. Bureau of Transportation Statistics	https://www.bts.gov/pdc/user/products/src/products.xml?p=2994
Utilities	Electric Transmission Lines	Electrical_Cable_Line	Hypothetical	Made internally for this example
Utilities	Energy Transmission Corridor	Energy_Corridor_Poly	U.S. Bureau of Land Management	Sources vary depending on location. Consult BLM web sites for on-line data, or local staff for internal data.

primarily by the U.S. Department of Defense. This standard has a hierarchical set of categories used to organize layers by theme, with a systematic naming convention. In addition, metadata provides detailed descriptions of the source, scale, quality, content, distribution limitations, publisher, map projection, and technical details about the data, which allow them to be used appropriately. Metadata (descriptions of the content of a GIS layer) should be maintained for each layer in the GIS. While most widely used GIS data have metadata, it is still common for lesser-used, more specialized GIS layers to lack metadata. This can lead to inadequate data analysis.

3.3 USING GIS FOR DEVELOPMENT OF AN UNRESTRICTED CONCEPTUAL ENERGY TRANSPORT ROUTE OR NETWORK

This stage of corridor planning is mainly conceptual, but illustrating it using the GIS is beneficial. System users should create layers to depict existing or planned production and demand locations, and existing energy transport infrastructure. In addition, they should identify and map existing corridors and ROWs, where available, for baseline information. Figure 3.2 shows the example study area with a planned wind farm development on tribal land and an unrestricted conceptual energy transport route to connect it to existing transmission lines in gray. Also depicted are existing major roads, railroads, electric transmission lines, and an existing corridor on BLM land.

3.4 USING GIS TO LOCATE PRELIMINARY ENERGY TRANSPORT CORRIDOR(S) BASED ON EXISTING AND AVAILABLE DATA AND INFORMATION TO ADJUST A CONCEPTUAL ROUTE

After identifying an unrestricted energy transport route, further investigation helps to identify constraints that may influence viable siting choices. Chapter 2 discussed categories of potential constraints. In this example, mountainous terrain is evident and areas with steep slopes will be less suitable. There are several reservoirs and lakes; however, the streams that exist in the area are intermittent. Categories of federally protected areas in the study area include designated wilderness areas, wilderness study areas, roadless areas, specially designated areas, national conservation areas, areas of critical environmental concern, and national trails. Critical habitat for several threatened and endangered species is present. Low-level military training routes occur in the north and west areas of the study area. Some of these issues are prohibitive to corridor siting while others are undesirable yet possible.

Figure 3.3 shows a view of the study area with a simplified representation of the constraints, as detailed in Table 3.2. Areas with prohibitive constraints are highlighted in red, while less restrictive constraints are highlighted in yellow. A preliminary energy transport corridor that takes into account the constraints identified in the previous paragraph is shown in gray, and areas preferred for energy corridor siting, such as tribal land and existing ROWs, are highlighted in green.

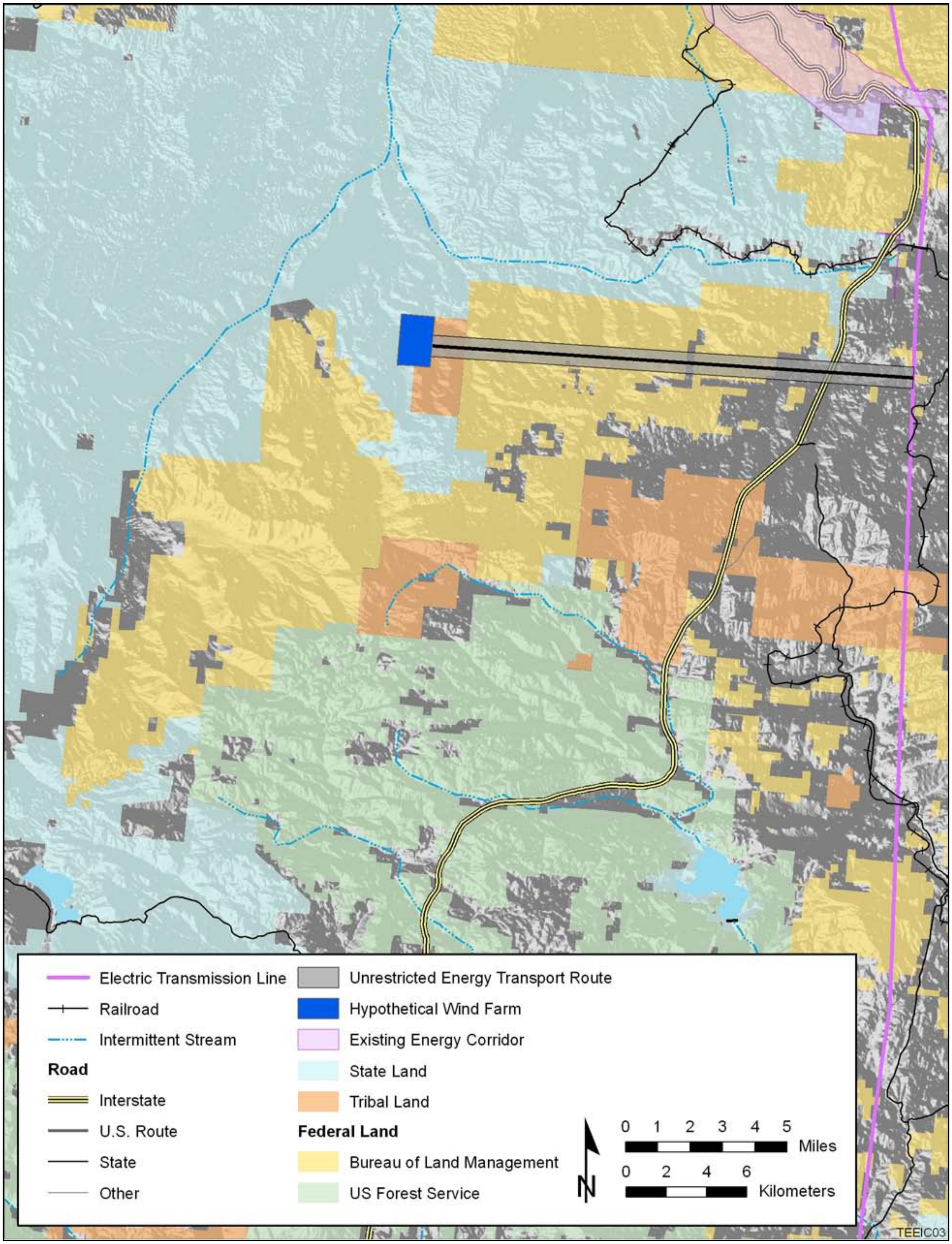

FIGURE 3.2 Unrestricted Conceptual Energy Transport Route in the Hypothetical Study Area.

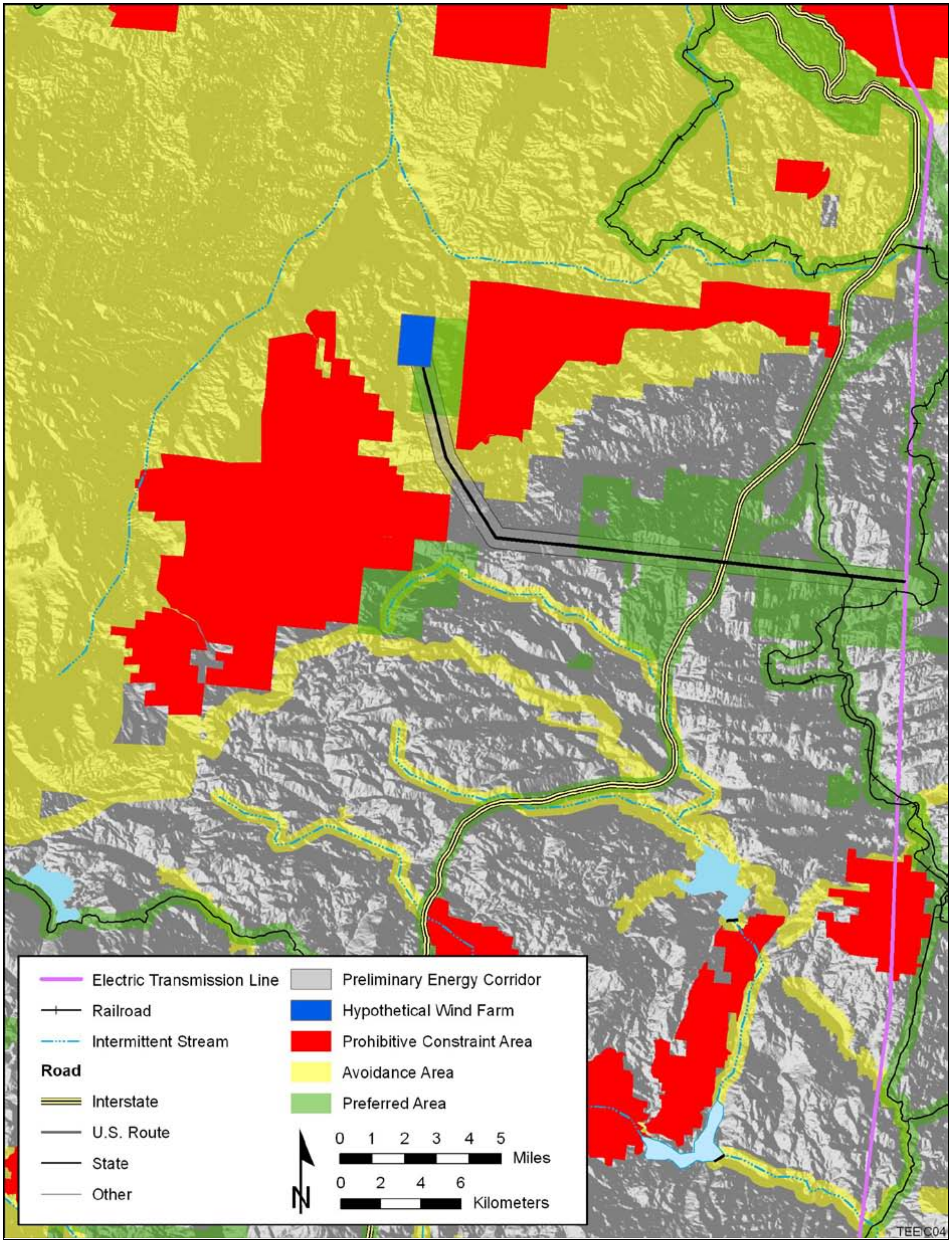

FIGURE 3.3 Preliminary Energy Transport Corridor with Prohibitive and Avoidance Constraint Areas, and Preferred Areas.

TABLE 3.2 Input Layers Used for Example Cost Surface Analysis

Layer	Cost Type	Cost Value(s)[a]
Topographic Slope	Avoid steep slopes	0 (Flat) to 5 (Steepest)
Wilderness Area	Prohibited	Excluded from analysis
Wilderness Study Area	Prohibited	Excluded from analysis
Roadless Area	Prohibited	Excluded from analysis
Lake or Reservoir	Prohibited	Excluded from analysis
Area of Critical Environmental Concern	Avoid	+1
National Trail	Avoid	+1
National Conservation Area	Avoid	+1
Critical Habitat	Avoid	+1
Low Level Military Training Route	Avoid	+1
Stream or River	Avoid	+1
Existing Corridor	Prefer	−1
Railroad ROW	Prefer	−1
Road ROW	Prefer	−1
Tribal Land	Prefer	−1

[a] Since cost cannot be negative, a constant was added to the cost surface to make all values positive.

3.5 USING TERRAIN CHARACTERISTICS AND OTHER COST-RELATED INFORMATION TO CHOOSE EFFICIENT ROUTES

Geographic information systems provide analytical methods for minimizing the costs or other quantitative measures of suitability for routes. To perform the analysis,

- Know the starting and ending locations of the route,
- Identify the cost or suitability variables, and
- Ensure the availability of corresponding spatial data for the variables.

This work can be done at early stages of the energy corridor siting process to determine initial route alternatives, or later in the process to validate, optimize, or compare identified route alternatives. In this case, the analysis uses the general routes identified in the previous steps, with the goal of producing specific 3500-ft-width corridor choices. This analytical approach supports widths ranging from a narrow ROW sufficient only for a single project, to wide corridors capable of supporting multiple projects and uses.

Perform this example analysis using raster, or cell-based tools. Raster data store spatial information in rows and columns of rectangular cells. Satellite images and digital elevation models are examples of data stored in raster formats. Each cell of a raster layer contains one or more numeric values indicating a value or color. For this work, code the cells used for analysis with a value indicating the cost of a project traversing the cell. These costs can be relative to adjacent cells, or estimates of actual construction and maintenance costs. Determine cost values based on a set of siting variables as described in the following text . Costs may be difficult to quantify, but the important thing is to determine, as accurately as possible, a value that allows cells (and ultimately routes) a quantitative comparison. The choice and weighting of values is subjective and depends on the needs of the analysis, the available data, and the subject of the study. Cell sizes should be small enough to provide a level of detail appropriate for the analysis; however, reducing cell size can dramatically increase the processing time and data volume. The quality and resolution of the input data layers is also an important consideration. In this case, the subject of the study is a 3,500-ft-wide corridor. The digital elevation model data in the GIS database has a resolution of 30 m (about 98.4 ft), which provides a width of about 35 cells for the corridor. This resolution is more than adequate for modeling; however, using a larger cell size could reduce processing time.

Table 3.2 lists the combination of input layers to use to produce a relative cost for each cell. For example, using the topographic slope layer could help account for the higher cost of traversing a steep slope as opposed to a flat area. In each cell location, add the costs to determine the total cost, resulting in a raw cost surface layer. Code areas with a prohibitive constraint, such as a wilderness area closed to corridor designation, with “no data” values, which eliminate those areas from consideration later in the process.

The larger the number of cost input layers and issues addressed, the more difficult (and subjective) the assignment of costs becomes. Therefore, it is important to carefully determine the inputs used to calculate costs, try different assumptions, and compare results to determine if more appropriate alternatives result after changing the inputs.

To model a corridor width wider than the cell resolution, (in this case, 3,500 ft vs. 30 m), process the raw cost surface layer with a statistical function that sums the costs within half the corridor width distance of each cell. To ensure that corridors fully avoid prohibitive constraint areas, the statistical function should output “no data” for cells closer than half the corridor width of the constraint area.

A cost surface is conceptually similar to an elevation surface, and determining the least-cost route is similar to determining the route a drop of water would take flowing downhill. To determine a least-cost path along the surface, the GIS software computes the cumulative cost of traversing a series of cells to reach the specified location representing one end of the corridor route. Then, it analyzes the results to determine which path between a source and destination has the lowest cost. Another useful analysis is the quantitative comparison of the relative costs of computed or manually determined alternative routes.

Potential visual impacts are not included in this example; however, they could be included in the cost surface by computing viewsheds from a set of vantage points and assigning a higher cost to areas most visible from the vantage points. See Section 3.8 for more information on viewshed analysis.

The analysis yields a least-cost corridor centerline; however, since the cost surface was pre-processed to sum the costs for the 3,500-ft-diameter area around each cell, it represents the best route for the wider corridor. Then, examine the results in the GIS with the input layers in the background, to observe how well the process took into account the input constraints. In some cases, there may be “choke points” between prohibitive constraint areas that cannot accommodate the full corridor width. If narrowing the corridor in such areas is an option, then repeating the process with a narrower corridor assumption for the input cost surface will allow examination of routes through such choke points.

Figure 3.4 shows four corridor alternatives resulting from the cost surface analysis, superimposed on the constraint map. Note how the corridors avoid prohibitive constraints, minimize other constraints, follow ROWs, and avoid steep slopes. Corridor B was the least costly route. Although it includes a larger avoidance area, it takes advantage of an existing railroad ROW and has a shorter length than the other routes. Figure 3.5 shows the relative costs of the four corridor alternatives and the preliminary energy transport corridor based on the cost surface. The paths generated by the GIS process are highly dependent on the cost surface; however, there may be some very important siting issues remaining. The next steps in the process provide a way for internal management and staff, and later a broader audience, to evaluate the proposed route and identify issues and alternatives that may lead to further changes.

3.6 APPLYING GIS TOOLS TO REFINE CORRIDOR LOCATION(S) USING INTERNAL MANAGEMENT AND STAFF TO ENSURE CONSISTENCY WITH TRIBAL PROGRAMS, PLANNING, AND ENVIRONMENTAL REQUIREMENTS

By this stage, the GIS will have a considerable amount of information useful for addressing the corridor siting issue, and the ability to interactively view and query the map is very useful for communicating the issues to internal management and staff. The GIS can rapidly produce static maps and distribute them electronically or in hardcopy form; however, they usually fall far short of a live presentation using the GIS. We recommend using one of the following methods to employ the GIS for internal communication:

- Computer projection: The GIS software can be used interactively in a meeting room with a projector. Participants ask the GIS operator to manipulate the map, and if desired, edit proposed changes to the corridor during the meeting.

- Internet Webcast: If not all the participants are in the same location, using Internet webcast technology is a very effective means of sharing the GIS information with the participants. Adobe Connect (Adobe 2009a) is one example of this technology. The software allows participants to share a computer display live on the Internet, and accessed using a standard Internet browser.

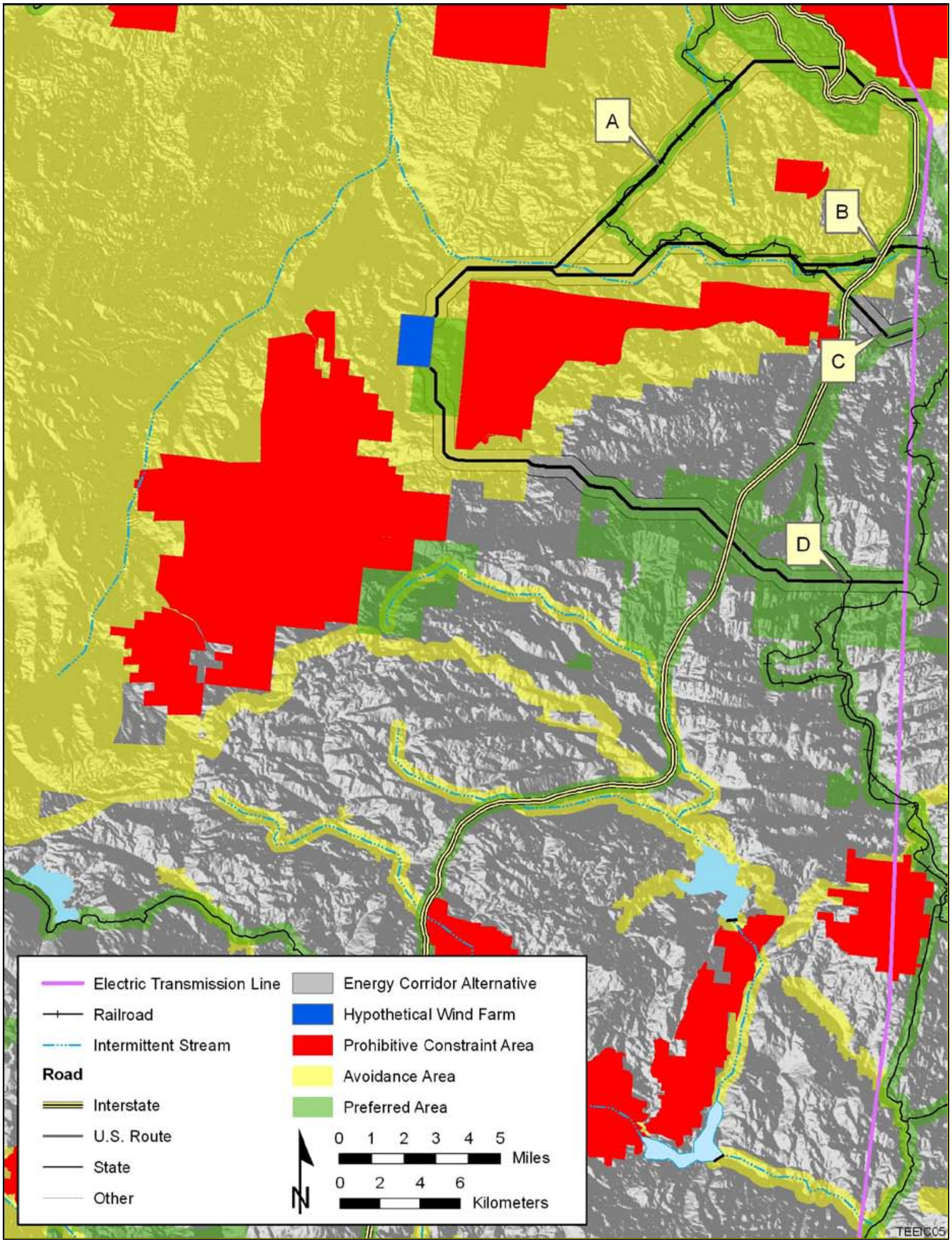

FIGURE 3.4 Preliminary Energy Corridors Generated by Cost Surface Analysis, Superimposed on Constraint Map.

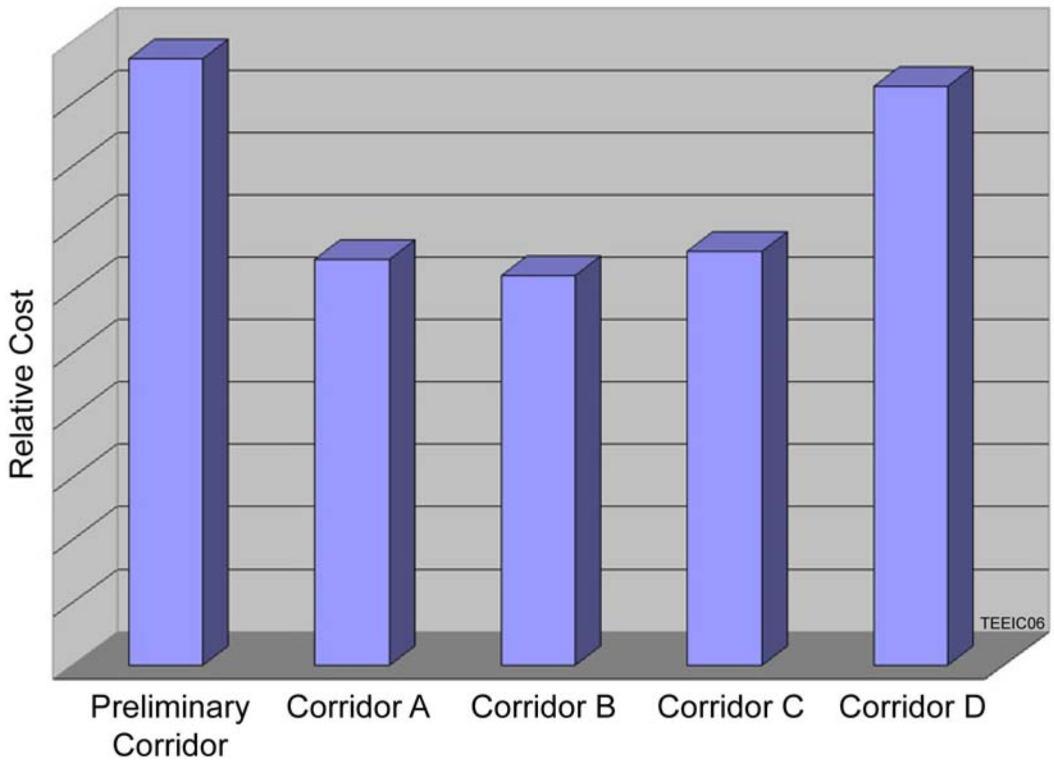

FIGURE 3.5 Relative Costs of Corridor Alternatives.

- ArcReader project: The ESRI ArcGIS publisher extension allows for export of the GIS project to an interactive map with a similar, but more limited interface than the commercial desktop software. Users download and install the free ArcReader software from ESRI to view the map. ArcReader projects can be distributed on a shared network, or a DVD. Any GIS data used for the map must be accessible to the users.

- GeoPDF files: Map2PDF is a second-party ArcGIS extension available from TerraGo Technologies (TerraGo 2009). It produces Adobe PDF files with extra enhancements that provide basic GIS function such as zooming, panning, turning layers on and off, and querying features. The files are viewed with Adobe Reader software (Adobe 2009b) with a free TerraGo extension.

Consulting with internal management and staff may result in corridor adjustments based on factors not evident in the GIS database. Once there is consensus on identification of the best corridor alternative, the next step in the process is review by a broad stakeholder audience.

3.7 USING GIS TOOLS TO FURTHER REFINE CORRIDOR LOCATION(S) USING EXTERNAL CONSULTATION, AND COORDINATION/DOCUMENTATION OF APPROPRIATE ENVIRONMENTAL ANALYSIS AND COMPLIANCE

Any of the above communication methods can work well for including a broader audience with a full range of stakeholders. Since different participants will have different levels of interest in the project, different needs, and varying access to technology, it's necessary to provide a variety of ways for them to access the information, including hardcopy maps as the most basic information. In addition to the approaches above, the following methods are useful for reaching some audiences:

- Interactive GIS web site: There are many approaches to publishing live GIS data on the Internet, most of which require some programming expertise or software investment. Examples include using the Google Maps API to develop a web application that displays selected GIS information over the standard Google Map display. ArcGIS Server is an ESRI product which allows a standardized map viewer similar to the desktop project to be rapidly published, or with programming, custom tools and capabilities can be added.

- Downloadable data: Some stakeholders have their own GIS systems and databases and will be interested in simply having a copy of the proposed corridor footprint to view in their own system. We recommend distributing the data in a non-proprietary format such as shapefiles, so that more applications can read it. Metadata should be produced for any GIS data being distributed.

- Keyhole Markup Language (KML): The KML format (or KMZ for larger or more complex information) is another alternative format for data distribution. It can be directly exported from the GIS, and viewed in 3D using Google Earth and other applications.

Consulting with a broader stakeholder audience can identify new issues or ideas that may lead to further changes to the corridor route. Including this audience at the appropriate stages is essential to the process, and providing information that is both useful and easy to access will result in much better communication.

3.8 USING VIEWSHED ANALYSES TO PREDICT AND POTENTIALLY REDUCE VISUAL IMPACTS

Future projects constructed in an energy corridor, particularly electric transmission towers, may include impacts to scenic resources. Although determining the scenic value of a landscape has a subjective element, systematic methods have been established for visual resource inventory and to determine potential visual impacts of projects. For example, the BLM Visual Resource Inventory Handbook (BLM 1986a) provides methods for scenic quality evaluation, which include factors such as landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Public concern for scenic quality is assessed with a procedure for sensitivity-level analysis, and finally, zones are established based on visibility from travel routes and observation points. The BLM Visual Resource Contract Rating Handbook (BLM 1986b) provides a systematic process to analyze potential impacts of proposed projects and activities. The U.S. Forest Service has a similar procedure for assessing scenic values of the lands it manages.

GIS viewshed analysis uses line-of-sight calculations to identify the area from which the planned infrastructure could be seen, and how many observer points could observe it. Necessary inputs include an elevation surface and a layer representing the observer locations of interest. Optional parameters include the observer height, height of the infrastructure or object of interest, and the maximum viewing distance. Using a corridor centerline for the observer input yields a map of the areas from which the centerline would be visible.

Alternatively, using roads, trails, or scenic overlooks for the observer input yields a map of the areas most viewed in the landscape. The result of this analysis can be used as an input to a cost surface used to optimize a corridor route in order to favor routes with lower visibility. Consider not only whether a project in the corridor would be visible from an observer point, but also how significantly the view would be impacted and the number of observers likely to visit the location. By combining the results of several viewshed analyses, a cost layer can be compiled which takes number of observers and viewing distance into account.

Figure 3.6 shows the results of two viewshed analyses. Shades of blue indicate the areas from which a potential project following the Corridor B centerline would be visible, assuming an observer height of 2 meters, tower heights of 45 meters, and a maximum viewing distance of 5 miles. Shades of red indicate areas viewable from roads, using the same assumptions. Darker shades indicate places from which more of the subject could be viewed. The 3D view vantage points in the map are discussed in the next section. Note that the railroad ROW the corridor follows for part of its route is comparatively less visible than areas to the north or south of the ROW.

When considering visual impacts it is worth noting that existing pathways in a landscape, such as roads, typically follow routes with many of the same routing factors useful for siting corridors, and therefore the same pathways are typically identified for corridors. However if reducing visual impacts from roads is preferred, then carefully consider how to use these competing variables during least-cost routing analysis.

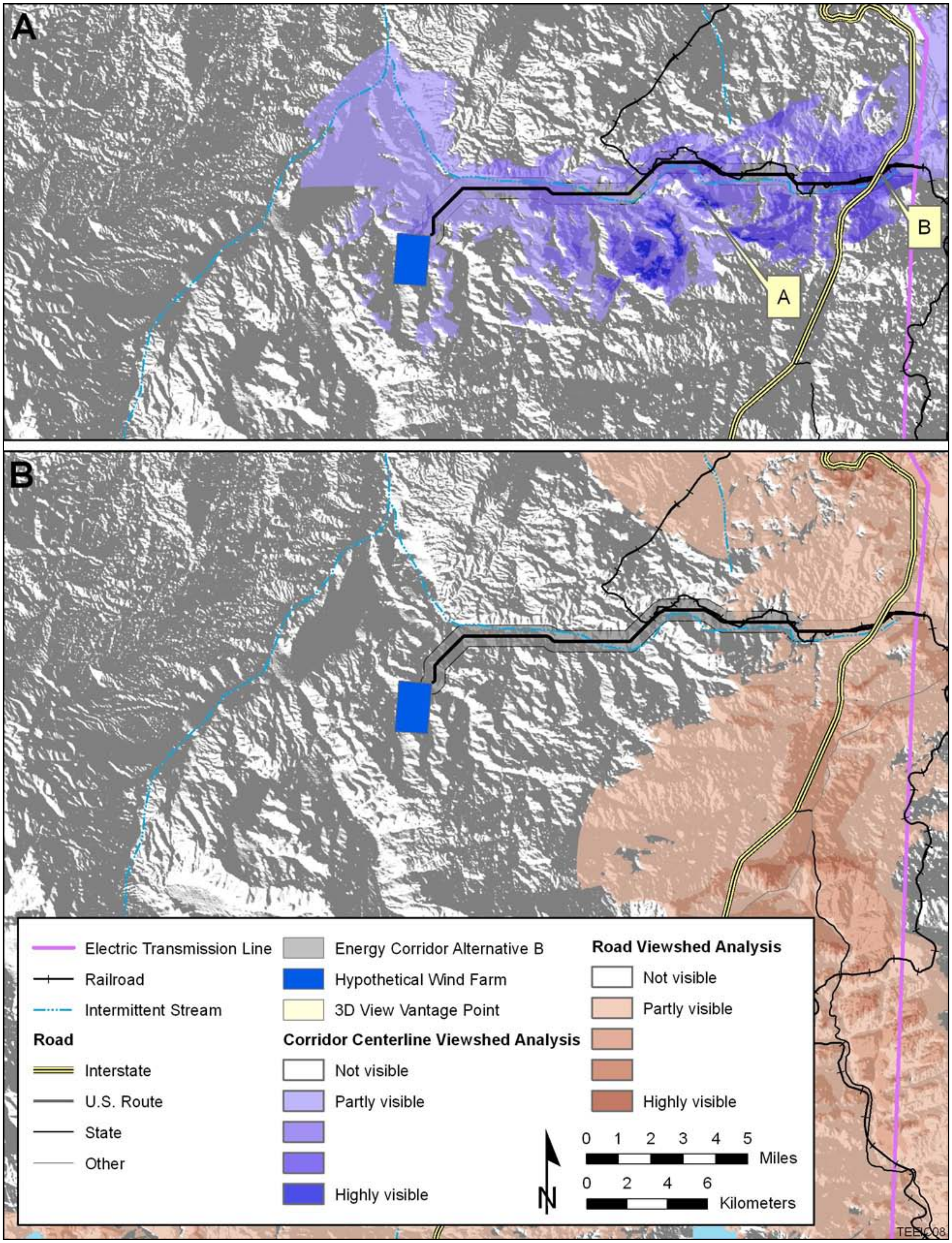

FIGURE 3.6 Viewshed Analysis Results for Corridor Centerline (A), and Roads (B).

3.9 USING VISUALIZATION SIMULATION TECHNOLOGIES TO DEPICT PLANNED PROJECTS

Although corridor designation does not entail a visible change to the landscape, understanding how future projects within the corridor might look is an important part of planning and communication with stakeholders. It may also be useful to create visualizations of the current conditions for stakeholders who may not be able to visit the site, and to document the current conditions. There are many options for creating visualizations, including:

- Google Earth perspective views with GIS layers and/or 3D models added,
- ESRI ArcScene or ArcGlobe tools (which require the ESRI 3D Analyst extension),
- Site photographs converted to digital panoramas,
- Site videos converted to interactive spherical video, and
- Photorealistic visualizations created with Visual Nature Studio (3D Nature 2009) or similar software.

Visualizations should be carefully planned and presented so they provide helpful information while not overstating uncertain details of future projects. For example, if transmission tower locations, sizes, and spacing have not been determined, presenting simulations showing highly realistic towers in a real setting may lead viewers to assume incorrectly that the exact tower locations and other project details are known. As an alternative, providing photographs of existing infrastructure in other locations may be sufficient to show the kinds of structures that could be constructed, without implying that project details are known. Typically, visualizations depicting specific infrastructure in specific locations would be produced at the project planning stage, after corridor designation.

GIS layers can be easily viewed in Google Earth by exporting to KML format. Figures 3.7 and 3.8 show views from vantage points A and B, respectively, shown on Figure 3.6. It is very informative and easy to present proposed corridor locations in this way. If adding 3D models of infrastructure is desired, Google SketchUp (Google 2009b) provides basic tools to create the models. Google SketchUp is distributed as a free product via Internet download. It may be necessary to purchase a more advanced software product, or a library of pre-made 3D models, in order to prepare more realistic or complex visual simulations.

The ESRI 3D Analyst extension includes ArcScene and ArcGlobe tools, both of which can produce 3D visualizations. The main advantage of these tools is direct access to the same data used in the GIS, without conversion, and more control of feature symbolization. The ESRI 3D symbol library includes examples of electric transmission towers, wind turbines, solar panels, and many other 3D objects that can be added to a scene. Detailed imagery comparable to Google Earth is available from free ESRI Internet map services.

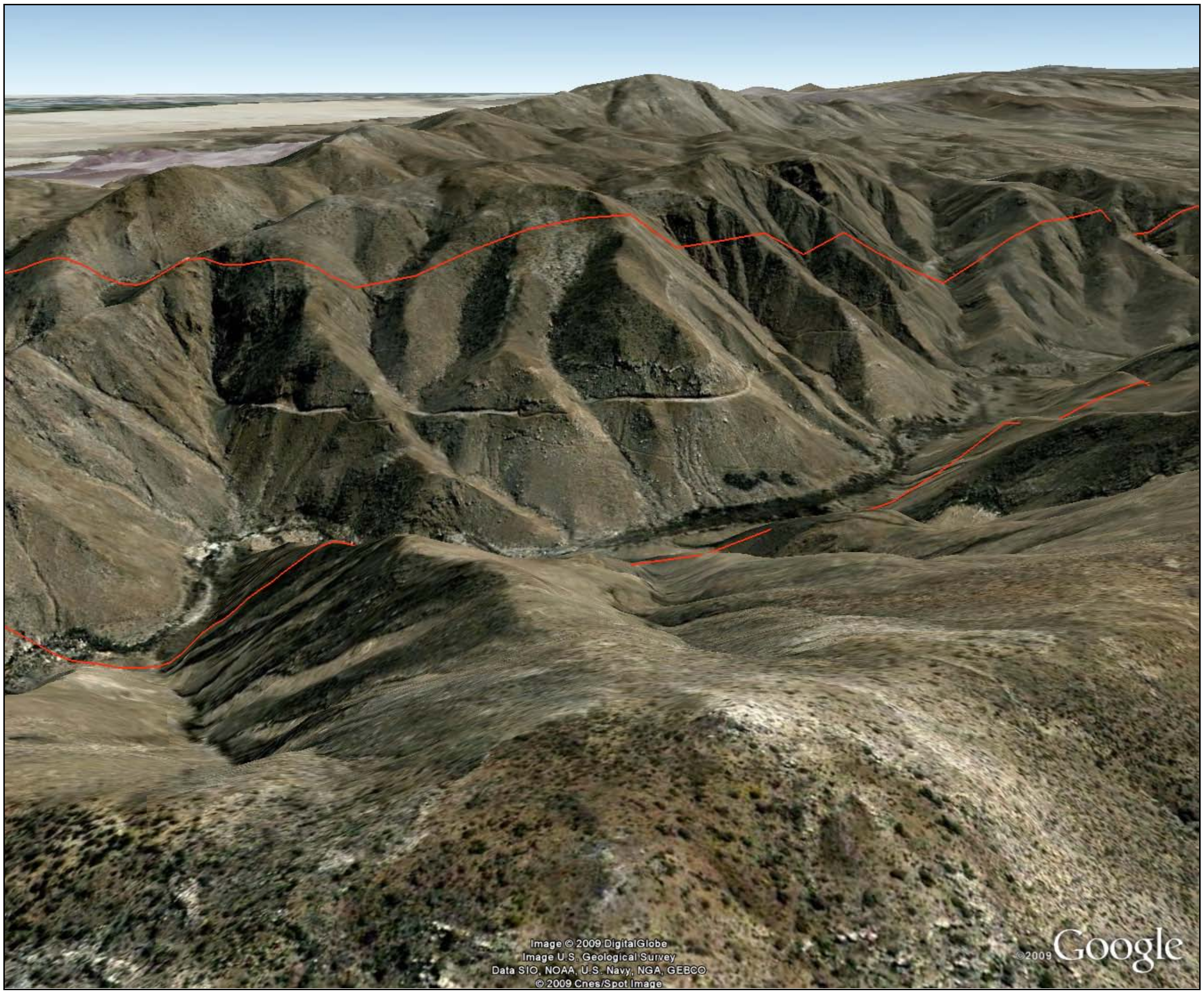

FIGURE 3.7 Google Earth 3D View from Vantage Point A Toward the Northwest.

Interactive photo panoramas created from digital photographs are a useful way to illustrate the characteristics of a site for stakeholders, and they can be published on the Internet. A series of vantage points in the corridor area should be identified and documented with a sequence of photographs in all directions. The locations should be recorded on a map or by collecting a coordinate with a Global Positioning System receiver. Software such as PTGui (PTGui 2009) is used to stitch the photos together into a panorama image, from which a Flash Small Web Format (SWF) file can be created, using software such as Pano2VR (Garden Gnome Software 2009). The resulting file can be added to Internet web pages and viewed with standard web browser software. It is difficult to add GIS information or proposed infrastructure to the images, so this approach is most useful for showing the existing landscape.

More advanced visualization of the existing landscape using interactive panoramic video is offered by Immersive Video Solutions (2009). This vendor films video using a 360 degree

FIGURE 3.8 Google Earth 3D View from Vantage Point B Toward the West.

camera mounted on an aircraft or vehicle, then converts it to web publishable form. During playback, viewers have full control to look in any direction and pause. The camera location can be depicted on a GIS map in an integrated viewer.

Visual Nature Studio (3DNature 2009) is an example of a software package that can create photorealistic visualizations of proposed projects, including videos. It provides tools to combine GIS data, images of vegetation and textures present in the region, and 3D models of infrastructure, into high quality visualizations. Although the products of such software packages can be very informative, and the software can be used to create highly accurate and realistic simulations, they are time consuming and expensive to create. Furthermore, skilled operators and accurate data are required to achieve the best results.

Regardless of the approach used, visualizations of proposed corridors can provide an effective way to communicate important information to stakeholders throughout the planning process.

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APPENDIX A

POTENTIAL IMPACTS AND MITIGATING MEASURES ASSOCIATED WITH ENERGY TRANSMISSION PROJECTS

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APPENDIX A

POTENTIAL IMPACTS AND MITIGATING MEASURES ASSOCIATED WITH ENERGY TRANSMISSION PROJECTS

Impacts resulting from designation of energy transport corridors are related to the zoning effect of allocating linear land parcels to future development. The potential environmental impacts associated with development of typical energy transmission (electric transmission lines and oil and gas pipelines) projects will depend on specific factors such as the length of the transmission line or pipeline, the amount of land disturbed by construction activities, the amount of land occupied long term by facilities, and the location with respect to other resources (e.g., wildlife use of the site, distance to surface water bodies), and so forth. Potential impacts vary by development phase, i.e. Site Evaluation, Construction, Operation, and Decommissioning, and are discussed in the Potential Impacts section in general terms. Measures to avoid or mitigate impacts are identified in the following Mitigation Measures section. This Appendix does not substitute for a project-specific environmental analysis or for any required National Environmental Policy Act (NEPA) or National Historic Preservation Act (NHPA) or tribal environmental or cultural resources reviews. It may, however, be useful in the conduct of such reviews.

A.1 POTENTIAL IMPACTS

A.1.1 Energy Transmission Site Evaluation Impacts

Site evaluation phase activities are temporary and are conducted at a smaller scale than those at the construction, operation, and decommissioning phases. Potential impacts from these activities are presented below, by the type of affected resource. The impacts described are for typical site evaluation activities, such as limited ground clearing, vehicular and pedestrian traffic, borings for geotechnical surveys, and positioning of equipment. If excavation or access road construction is necessary at this stage, impacts to resources would be similar in character, but lesser in magnitude, to those for the construction phase.

Route and access road selection that avoids major environmental impacts is ideal. Therefore, additional activities that could occur during this phase are field surveys for recording significant resources present in the potential project area (e.g., threatened and endangered species, wetlands, archaeological sites). These surveys are typical of the short, and limited-disturbance activities that occur during the site evaluation phase.

The following impacts may result from site evaluation activities.

Acoustics (Noise)

Activities associated with site surveying and testing would generate low levels of temporary and intermittent noise.

Air Quality

Impacts on air quality during surveying and testing activities would be limited to temporary and local generation of vehicle and boring equipment emissions and fugitive dust and would not likely cause an exceedance of air quality standards nor have any impact on climate change.

Cultural Resources

The amount of surface and subsurface disturbance is minimal during the site evaluation phase. Cultural resources buried below the surface are unlikely to be affected; while material present on the surface could be disturbed by vehicular traffic, ground clearing, and pedestrian activity (including collection of artifacts). Surveying and testing activities could impact cultural resources having an associated landscape component that contributes to their significance, such as a sacred landscape or historic trail, depending on the placement of equipment and/or level of visual intrusion.

Surveys conducted during this phase to evaluate the presence and/or significance of cultural resources in the area would assist developers in routing and designing the project to avoid or minimize impacts to these resources.

Ecological Resources

Impacts to ecological resources (vegetation, wildlife, aquatic biota, special status species, and their habitats) would be minimal and localized during surveying and testing because of the limited nature of the activities. The introduction or spread of some nonnative invasive vegetation could occur as a result of vehicular traffic, but this would be relatively limited in extent.

Surveys conducted during this phase to evaluate the presence and/or significance of ecological resources in the area would assist developers in routing and designing the project to avoid or minimize impacts to these resources (e.g., wetlands, migratory birds, and threatened and endangered species).

Environmental Justice

Site evaluation phase activities are limited and would not result in significant high and adverse impacts in any resource area; therefore, environmental justice is not expected to be an issue during this phase.

Hazardous Materials and Waste Management

Impacts associated with the use, storage, and disposal of hazardous materials and waste would be minimal to nonexistent, because the amounts and types of hazardous materials used are minimal during this phase.

Human Health and Safety

Health and safety issues include working in potential weather extremes, and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects.

Land Use

Site evaluation activities would likely result in temporary and localized impacts to land use. These activities could create a temporary disturbance in the immediate vicinity of a surveying or monitoring site (e.g., disturb recreational activities or livestock grazing). Site evaluation activities are unlikely to affect mining activities, military operations or aviation.

Paleontological Resources

The amount of subsurface disturbance is minimal during the site evaluation phase and paleontological resources buried below the surface are unlikely to be affected. Fossil material present on the surface could be disturbed by vehicular traffic, ground clearing, and pedestrian activity (including collection of fossils).

Surveys conducted during this phase to evaluate the presence and/or significance of paleontological resources in the area would assist developers in routing and designing the project to avoid or minimize impacts to these resources.

Socioeconomics

The activities during the site evaluation phase are temporary and limited and would not result in socioeconomic impacts on employment, local services, or property values.

Soils and Geologic Resources

The amount of surface disturbance and use of geologic materials are minimal during the site evaluation phase, and soils and geologic resources are unlikely to be affected. Surveying and testing activities would be unlikely to activate geological hazards or increase soil erosion. Borings for soil testing and geotechnical surveys provide useful site-specific data on these resources. Surface effects from pedestrian and vehicular traffic could occur in areas that contain special (e.g., cryptobiotic) soils.

Transportation

No impacts on transportation are anticipated during the site evaluation phase. Transportation activities would be temporary and intermittent and limited to low volumes of heavy- and medium-duty construction vehicles (e.g., pickup trucks) and personal vehicles.

Visual Resources

Surveying and testing activities would have temporary and minor visual effects caused by the presence of workers, vehicles, and equipment.

Water Resources

Minimal impact to water resources, local water quality, water flows, and surface water/groundwater interactions is anticipated. Very little water would likely be used or generated during the site evaluation phase. Any water needed could be trucked in from off-site.

A.1.2 Transmission Project Construction Phase Impacts

Typical activities during the construction phase of an energy transmission project include ground clearing and removal of vegetative cover, grading, excavation, blasting, trenching, drilling, vehicular and pedestrian traffic, and project component construction and installation. Activities conducted in locations other than within the project right-of-way (ROW) include excavation/blasting for construction materials (such as sands and gravels), access road and staging area construction, and construction of other ancillary facilities such as compressor or pump stations.

The following impacts, presented by resource, may result from energy transmission construction activities.

Acoustics (Noise)

Sources of noise during construction would primarily occur from equipment (bulldozers, chainsaws, pile drivers, and diesel engines). Other sources of noise include vehicular traffic and blasting. Whether the noise levels exceed U.S. Environmental Protection Agency (EPA) guidelines or local ordinances would depend on the distance to the nearest residence. If near a residential area, noise levels from blasting and some equipment operation could exceed the EPA guidelines, but would be intermittent and extend for only a limited time.

Air Quality

Emissions generated during the construction phase include vehicle emissions; diesel emissions from large construction equipment and generators; volatile organic compound (VOC) emissions from storage and transfer of fuels for construction equipment; small amounts of carbon monoxide, nitrogen oxides, and particulates from blasting activities; and fugitive dust from many sources such as disturbing and moving soils (clearing, grading, excavating, trenching, backfilling, dumping, and truck and equipment traffic), mixing concrete, storage of unvegetated soil piles, and drilling and pile driving. Air quality impacts could also occur if cleared vegetation is burned.

Cultural Resources

Potential impacts to cultural resources include:

1. Complete destruction of the resource if present in areas undergoing surface disturbance or excavation;

2. Degradation or destruction of near-surface cultural resources on- and off-site resulting from changing the topography, changing the hydrological patterns, and soil movement (removal, erosion, sedimentation);

3. Unauthorized removal of artifacts or vandalism as a result of human access to previously inaccessible areas; and

4. Visual impacts resulting from large areas of exposed surface, increases in dust, the presence of large-scale equipment, machinery, and vehicles for cultural resources that have an associated landscape component that contributes to their significance, such as a sacred landscape or historic trail.

The accumulation of sediment mentioned above could serve to protect some buried resources by increasing the amount of protective cover.

Ecological Resources

Adverse impacts to ecological resources could occur during construction from:

1. Erosion and runoff;
2. Fugitive dust;
3. Noise;
4. Introduction and spread of invasive nonnative vegetation;
5. Modification, fragmentation, and reduction of habitat;
6. Mortality of biota;
7. Exposure to contaminants; and
8. Interference with behavioral activities.

Site clearing and grading, coupled with construction of access roads, towers, and support facilities, could reduce, fragment, or dramatically alter existing habitat in the disturbed portions of the project area. Wildlife in surrounding habitats might also be affected if construction activities (and associated noise) disturb normal behaviors, such as feeding and reproduction.

Environmental Justice

If significant impacts were to occur in any of the resource areas and these were to disproportionately affect minority or low-income populations, there could be an environmental justice impact. Issues that could be of concern are noise, dust, visual impacts, and habitat destruction from construction activities and possible impacts associated with new access roads.

Hazardous Materials and Waste Management

Solid and industrial waste would be generated during construction activities. The solid wastes are expected to be nonhazardous and consist of mostly containers and packaging materials, miscellaneous wastes from equipment assembly and presence of construction crews (food wrappers and scraps), and woody vegetation. Industrial wastes would include minor amounts of paints, coatings, and spent solvents. Most of these materials would likely be transported off-site for disposal. Commercial-grade timber could be sold, while slash may be spread or burned near the construction site. Other hazardous materials would include dielectric fluids in electrical equipment used in substations and pump and compressor stations; lubricants and coolants added to prime mover equipment in pump and compressor stations; and compressed gases (for welding), solvents and cleaning agents, and corrosion control paints and coatings used for pipelines. Impacts could result if hazardous wastes were not properly handled and were released to the environment.

Human Health and Safety

Potential impacts to worker and public health and safety during construction of an energy transmission project are the same as those associated with any construction project involving earthmoving, use of large equipment, transportation of overweight and oversized materials, and construction and installation of industrial facilities. This could include the potential for helicopter crashes if they are used for delivery of equipment or for construction in rugged or inaccessible areas. In addition, health and safety issues include either working at heights or in trenches, working in potential weather extremes, and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects.

Land Use

Impacts to land use could occur during construction if there were conflicts with existing land use plans and community goals; conflicts with existing recreational, educational, religious, scientific, or other use areas; or conversion or cessation of the existing commercial land use of the area (e.g., mineral extraction). During construction, most land use impacts would be temporary, such as removal of livestock from grazing areas during periods of blasting or heavy equipment operations; curtailing hunting near work crews; or temporary effects to the character of a recreation area because of construction noise, dust, and visual intrusions. Long-term land use impacts would occur if existing land uses are not compatible with an energy transmission project, such as remote recreational experiences. Within forested areas, ROW clearing could result in the long-term loss of timber production.

Impacts to aviation are possible if the project is located within 20,000 ft (6,100 m) or less of an existing public or military airport or if proposed construction involves objects greater than 200 ft (61 m) in height. The Federal Aviation Administration (FAA) must be notified if either of these two conditions occurs and would be responsible for determining if the project would adversely affect commercial, military, or personal air navigation safety. Similarly, impacts on military operations may occur if the project is located near a military facility and that facility conducts military testing and training activities that occur at low altitudes.

Paleontological Resources

Potential impacts to paleontological resources during construction include: (1) complete destruction of the resource if present in areas undergoing surface disturbance or excavation; (2) degradation or destruction of near-surface fossil resources on- and off-site resulting from changing the topography, changing the hydrological patterns, and soil movement (removal, erosion, sedimentation); and (3) unauthorized removal of fossil resources or vandalism to the locality as a result of human access to previously inaccessible areas. The accumulation of sediment mentioned above could serve to protect some localities by increasing the amount of protective cover.

Socioeconomics

Direct impacts would include the creation of new jobs for construction workers and the associated income and taxes generated by the project. As an example, the number of construction workers required for a 150 mile (241 kilometer) length of gas pipeline is only about 230 annual direct workers (fewer than 175 for an equivalent length of a transmission line or a petroleum pipeline). Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the expanded workforce or that provide project materials, and associated income and taxes. Construction of an energy transmission project may affect the value of residential properties located adjacent to the ROW (there are conflicting reports on whether this would be adverse, beneficial, or neutral).

Soils and Geologic Resources

Surface disturbance, heavy equipment traffic, and changes to surface runoff patterns can cause soil erosion. Impacts of soil erosion include soil nutrient loss and reduced water quality in nearby surface water bodies. Impacts to special soils (e.g., cryptobiotic soils) could also occur.

Sands, gravels, and quarry stone would be excavated for use in the construction of access roads; concrete for foundations and ancillary structures; for improving ground surface for lay-down and crane staging areas; and, as necessary, for backfill in pipeline trenches. Mining operations would disturb the ground surface, and runoff would erode fine-grained soils, increasing the sediment load farther down in streams and/or rivers. Mining on steep slopes and/or on unstable terrain without appropriate engineering measures increases the landslide potential in the mining areas.

Possible geological hazards (earthquakes, landslides) can be activated by excavation and blasting for raw materials, increasing slopes during site grading and construction of access roads, altering natural drainage patterns, and toe-cutting bases of slopes. Altering drainage patterns accelerates erosion and creates slope instability.

Transportation

Short-term increases in the use of local roadways would occur during the construction period. Heavy equipment would need to be continuously moved as construction progresses along the linear project. Shipments of materials are not expected to significantly affect primary or secondary road networks, but would depend on the ever-changing location of the construction site area relative to material source. Overweight and oversized loads could cause temporary disruptions and could require some modifications to roads or bridges (such as fortifying bridges to accommodate the size or weight). Weight of shipments is also a parameter in the design of access roads for grade determinations and turning clearance requirements.

Visual Resources

Potential sources of visual impacts during construction include: visual contrasts in the landscape from access roads and staging areas; and conspicuous and frequent small-vehicle traffic for worker access and frequent large-equipment (trucks, graders, excavators, cranes, and, possibly, helicopters) traffic for project and access road construction. Project component installation would produce visible activity and dust in dry soils. Project construction may be progressive, persisting over a significant period of time. Ground disturbance (e.g., trenching and grading) would result in visual impacts that produce contrasts of color, form, texture, and line. Soil scars and exposed slope faces could result from excavation, leveling, and equipment movement.

Water Resources

Water would be required for dust control, making concrete, and consumptive use by the construction crew. Depending on availability, it may be trucked in from off-site or obtained from local groundwater wells or nearby surface water bodies.

Water quality can be affected by:

1. Activities that cause soil erosion;

2. Weathering of newly exposed soils causing leaching and oxidation that can release chemicals into the water;

3. Discharges of waste or sanitary water;

4. Herbicide applications; and

5. Contaminant spills, especially oil.

Applying sand and gravel for road construction, layout areas, foundations, etc. can alter the drainage near where the material is used. The size of the area affected can range from a few hundred square feet (for a support tower foundation) to a few hundred acres (for an access road).

Surface and groundwater flow systems could be affected by withdrawals made for water use, wastewater and stormwater discharges, and the diversion of surface water flow for access road construction or stormwater control systems. Excavation activities and the extraction of geological materials may affect surface and groundwater flow. The interaction between surface water and groundwater may also be affected if the two are hydrologically connected, potentially resulting in unwanted dewatering or recharging.

A.1.3 Energy Transmission Operations Impacts

Typical activities during the operation and maintenance phase include: operation of compressor or pump stations, ROW inspections, ROW vegetation clearing, and maintenance and replacement of facility components.

Environmental impacts that could occur during the operation and maintenance phase would mostly occur from long-term habitat change within the ROW, maintenance activities (e.g., ROW vegetation clearing and facility component maintenance or replacement), noise (e.g., compressor station, corona discharge), the presence of workers, and potential spills (e.g., oil spills).

The following potential impacts may result from the operation and maintenance of an energy transmission project.

Acoustics (Noise)

Sources of noise during the operation and maintenance phase would include compressor or pump stations, transformer and switchgear at substations, corona discharge from transmission lines, vehicles and machinery, and aircraft overflights for inspection. The primary impacts from noise would be localized disturbance to wildlife and recreationists.

Air Quality

Vehicular traffic and machinery would continue to produce small amounts of fugitive dust and exhaust emissions during the operation and maintenance phase. These emissions would not likely cause an exceedance of air quality standards nor have any impact on climate change. Trace amounts of ozone would be produced by corona effects from transmission lines (e.g., less than 1.0 part per billion which is considerably less than air quality standards). Routine venting of pipelines and breakout tanks (for liquid petroleum products and crude oil) would also cause localized air quality impacts.

Cultural Resources

Impacts during the operations and maintenance phase could include damage to cultural resources during vegetation management and other maintenance activities, unauthorized collection of artifacts, and visual impacts. This threat is present once the access roads are constructed and the ROW is established, making remote areas more accessible to the public. Visual impacts resulting from the presence of the aboveground portion of a pipeline, transmission lines, and associated facilities could impact cultural resources that have an associated landscape component that contributes to their significance, such as a sacred landscape or historic trail.

Ecological Resources

During operations and maintenance, adverse impacts to ecological resources could occur from:

1. Disturbance of wildlife from noise and human activity;
2. ROW maintenance (e.g., vegetation removal);
3. Exposure of biota to contaminants; and
4. Mortality of biota from colliding with transmission lines or aboveground pipeline components.

Ecological resources may continue to be affected by the reduction in habitat quality associated with habitat fragmentation due to the presence of the ROW, support facilities, and access roads. In addition, the presence of an energy transmission project and its associated access roads may increase human use of surrounding areas, which in turn could impact ecological resources in the surrounding areas through:

1. Introduction and spread of invasive nonnative vegetation,
2. Fragmentation of habitat,
3. Disturbance of biota,
4. Collision and/or electrocution of birds, and
5. Increased potential for fire.

The presence of an energy transmission project (and its ancillary facilities) could also interfere with migratory and other behaviors of some wildlife.

Environmental Justice

` Possible environmental justice impacts during operation include the alteration of scenic quality in areas of traditional or cultural significance to minority or low-income populations. Habitat modification, noise impacts, and health and safety impacts are also possible sources of environmental justice impacts.

Hazardous Materials and Waste Management

Industrial wastes are generated during routine operations (e.g., lubricating oils, hydraulic fluids, coolants, solvents, and cleaning agents). These wastes are typically placed in containers, characterized and labeled, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility as a standard practice. Other wastes include the sludge removed from pipeline pigging operations. Impacts could result if wastes were not properly handled and were released to the environment. Environmental contamination could occur from accidental spills of herbicides or, more significantly, oil from a pipeline accident.

Human Health and Safety

Possible impacts to health and safety during operations include exposures to electromagnetic fields (EMF), accidental injury or death to workers during operation and maintenance activities, and accidental injury or death to the public (e.g., from off-highway vehicle (OHV) collisions with project components or from airplane collisions with transmission lines). In addition, health and safety issues include working at heights, working around energized equipment, working in potential weather extremes, and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects. There is an increased potential for fires from electrical discharges from energized equipment.

Land Use

Land use impacts would be minimal, as many activities could continue within the ROW (e.g., agriculture and grazing). Other industrial and energy projects would likely be excluded within the ROW. In addition, construction of facilities (e.g., houses and other structures) would be precluded within the ROW and roads would only be allowed to cross ROWs, not run along their length). Recreation activities (e.g., OHV use and hunting) are also possible, although restrictions may exist for the use of guns, especially for aboveground pipelines or transmission lines. The ROW and access roads may make some areas more accessible for recreational activities. Activities centered on solitude and scenic beauty would potentially be affected. Military operations and aviation could be affected by the presence of transmission lines. For example, transmission lines could affect military training and testing operations that may occur at low altitudes (e.g., military training routes).

Paleontological Resources

Impacts during the operations phase would be limited to unauthorized collection of fossils. This threat is present once the access roads are constructed and the ROW established, making remote areas more accessible to the public.

Socioeconomics

Direct impacts would include the creation of new jobs for operation and maintenance workers and the associated income and taxes paid. Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the expanded workforce or that provide project materials, and associated income and taxes. The number of project personnel required during the operation and maintenance phase would be about an order of magnitude less than during construction. Therefore, socioeconomic impacts related directly to jobs would be minimal. Potential impacts on the value of residential properties located adjacent to an energy transmission project would continue during this phase.

Soils and Geologic Resources

Following construction, disturbed portions of the site would be revegetated and the soil and geologic conditions would stabilize. Impacts during the operation phase would be limited largely to soil erosion impacts caused by vehicular traffic and machinery operation during maintenance activities. Any excavations required for pipeline maintenance would cause impacts similar to those from construction, but to a lesser spatial and temporal extent. Herbicide would likely be used for ROW maintenance. The accidental spills of herbicides or pipeline product would likely cause soil contamination. Except in the case of a large oil spill, soil contamination would be localized and limited in extent and magnitude.

Transportation

No noticeable impacts to transportation are likely during the operation and maintenance phase. Low volumes of heavy- and medium-duty pickup trucks, personal vehicles, and other machinery are expected to be used during this phase. Infrequent, but routine, shipments of component replacements during maintenance procedures are likely over the period of operation.

Visual Resources

The aboveground portions of energy transmission projects would be highly visible in rural or natural landscapes, many of which have few other comparable structures. The artificial appearance of a transmission line or pipeline may have visually incongruous “industrial” associations for some, particularly in a predominantly natural landscape. Visual evidence of these projects cannot be completely avoided, reduced, or concealed. Additional visual impacts would occur during maintenance from vehicular traffic, aircraft, and workers. Maintenance, replacement, or upgrades of project components would repeat the initial visual impacts of the construction phase, although at a more localized scale.

Water Resources

Impacts to water resources during the operation and maintenance phase would be limited to possible minor degradation of water quality resulting from vehicular traffic and machinery operation during maintenance (e.g., erosion and sedimentation) or herbicide contamination during vegetation management (e.g., from accidental spills). However, a large oil pipeline spill could potentially cause extensive degradation of surface waters or shallow groundwater.

A.1.4 Transmission Decommissioning/Site Reclamation Phase Impacts

Transmission facilities are removed after their useful life in a process called decommissioning. Following decommissioning, the ROW may be restored to resemble its original condition or reclaimed to some standard that results in stable environmental conditions. Typical activities during the decommissioning and site reclamation phase include removal of aboveground components and gravel from access roads and other ancillary facility sites, breaking up of concrete pads and foundations, recontouring the ground surface, and revegetation. Potential impacts from these activities are presented below, by the type of affected resource.

The following potential impacts may result from decommissioning and site reclamation of an energy transmission project.

Acoustics (Noise)

Sources of noise during decommissioning would be similar to those during construction and would be caused primarily by construction equipment and vehicular traffic. Whether the noise levels exceed U.S. Environmental Protection Agency (EPA) guidelines or local ordinances would depend on the distance to the nearest residence. Near residential areas, noise levels could exceed EPA guidelines but would be intermittent and extend for only a limited time.

Air Quality

Emissions generated by activities during the decommissioning and reclamation phase include vehicle emissions; diesel emissions from large construction equipment and generators; and fugitive dust from many sources such as structure removal, backfilling, dumping, reclamation of disturbed areas (grading, seeding, planting), and truck and equipment traffic.

Cultural Resources

Decommissioning activities would have little potential to impact cultural resources because these resources may have been removed professionally prior to construction, or may have been already disturbed or destroyed by prior activities. The collection of artifacts could continue to be a problem if access roads are left in place or if the restored ROW still affords remote access. Visual impacts of the energy transmission project would be mitigated if the site were restored to its preconstruction state. However, despite the physical removal of the project, the impact of a scarred environment would likely remain.

Ecological Resources

Impacts to ecological resources from decommissioning and reclamation activities would be similar in nature to the impacts that occur during construction, but of a reduced magnitude. There would be a temporary increase in noise and visual disturbance associated with the removal of project facilities and site reclamation. Negligible to no reduction in wildlife habitat would be expected, and injury and mortality rates of vegetation and wildlife would be much lower than they would be during construction. Removal of aboveground structures would eliminate the impacts to wildlife that occur during operation (e.g., bird collisions with transmission lines and habitat fragmentation). Following site restoration, the ecological resources at the project site could eventually return to preproject conditions depending on the end use selected for the ROW.

Environmental Justice

If significant impacts were to occur in any of the resource areas and these were to disproportionately affect minority or low-income populations, then there could be an environmental justice impact. Issues that could be of concern during decommissioning and site reclamation are noise, dust, and visual impacts, as well as possible restoration of fish and wildlife populations for subsistence users.

Hazardous Materials and Waste Management

Substantial amounts of solid and industrial waste would be generated during the decommissioning and dismantling of the energy transmission project. Much of the solid material could be recycled and sold as scrap or used for other projects; the remaining nonhazardous waste would be sent to permitted disposal facilities. Industrial wastes (oils, hydraulic fluids, coolants, solvents, and cleaning agents) would be treated similarly to maintenance wastes during operation (put in containers, characterized, and labeled, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility). Impacts could result if these wastes were not properly handled and were released to the environment.

Human Health and Safety

Potential impacts to worker and public health and safety during decommissioning and site reclamation would be similar to those during construction; and relate to earthmoving, use of large equipment, dismantling of industrial components, and transportation of overweight and oversized materials.

Land Use

Upon decommissioning, land use impacts resulting from construction and operation of an energy transmission project could be largely reversed depending on the end use selected for the ROW. No permanent land use impacts would occur during this phase.

Paleontological Resources

Decommissioning activities have little potential to impact paleontological resources because these resources would have been removed professionally prior to construction, or would have been already disturbed or destroyed by prior activities. Fossil collection could continue to be a problem if access roads are left in place or if the restored ROW still affords remote access.

Socioeconomics

Direct impacts would include the creation of new jobs for workers during decommissioning and site reclamation activities and the associated income and taxes paid. Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the workforce or that provide project materials, and associated income and taxes. No adverse effect to property values is anticipated as a result of decommissioning. Site reclamation could result in values of residential properties that were adjacent to the ROW becoming equivalent to similarly developed residential areas that were not affected by the energy transmission project.

Soils and Geologic Resources

Activities during decommissioning that would result in impacts to soils include removal of access roads, substations, buildings, aboveground and portions of belowground pipelines, transmission line components, and other ancillary structures. Surface disturbance, heavy equipment traffic, and changes to surface runoff patterns could cause soil erosion. Soil erosion impacts include soil nutrient loss and reduced water quality in nearby surface water bodies. Upon completion of decommissioning, disturbed areas would be contoured and revegetated, which would minimize the potential for soil erosion. Impacts to geologic resources would not be expected.

Transportation

Short-term increases in the use of local roadways would occur during decommissioning and site reclamation. Overweight and oversized loads could cause temporary disruptions to local traffic.

Visual Resources

During decommissioning, impacts on visual resources would be similar to those encountered during construction. These impacts are related to road redevelopment, temporary fencing of the work site, intermittent or phased activity persisting over extended periods of time, removal of portions of buried structures, and the presence of idle or dismantled equipment, if allowed to remain on site. Restoring a decommissioned site to preproject conditions would entail recontouring, grading, scarifying, seeding and planting, and perhaps, stabilizing disturbed surfaces. Newly disturbed soils would create a visual contrast that would persist at least several seasons before revegetation would begin to disguise past activity. Restoration to preproject conditions may take much longer. Invasive nonnative plant species may colonize newly and recently reclaimed areas. Nonnative plants could produce contrasts of color, form, texture, and line.

Water Resources

Water would be used for dust control for road traffic, dismantling of towers, pipelines, substations, and other buildings, and for consumptive use by the construction crew. It might be trucked in from off-site or obtained from local groundwater wells or nearby surface water bodies, depending on availability.

Water quality could be affected by activities that cause soil erosion, weathering of newly exposed soils causing leaching and oxidation that can release chemicals into the water, discharges of waste or sanitary water, spills of residual product remaining in the pipeline, and herbicide application or spills. Upon completion of decommissioning, disturbed areas would be contoured and revegetated to minimize the potential for soil erosion and water quality-related impacts.

Surface and groundwater flow could be affected by withdrawals made for water use, wastewater and stormwater discharges, and the diversion of surface water flow for access road reclamation or stormwater control systems. The interaction between surface water and groundwater could also be affected if the two resources are hydrologically connected, potentially resulting in unwanted dewatering or recharging of any of these water resources.

A.2 MITIGATION MEASURES

Resource-specific mitigation measures can be applied to avoid or minimize impacts from an energy transmission project. In order to identify and implement appropriate mitigation measures, first the potential impacts of a project on a specific resource must be assessed. Then, project- and site-specific factors must be evaluated to determine whether the impact can be avoided or mitigated, what action can be taken, how effective the mitigation measure will be, and the cost-effectiveness of the measure. This section discusses mitigation measures in general terms, based on the general discussion of impacts described in the Potential Impacts section.

Generally, although there is some overlap, these mitigation measures should be viewed as being over and above the requirements of applicable laws and regulations.

The following sections provide examples of mitigation measures that might be appropriate for each potentially affected resource area, depending on site- and project-specific conditions. A final set of mitigation measures for any project should be developed in consultation with the appropriate federal resource management agencies and stakeholders. These consultations should be conducted during the project development process and preferably prior to final project siting and design.

A.2.1 Acoustics (Noise) Mitigation Measures

Noise impacts are related to the source of the noise (e.g., vehicles, construction equipment, workers, explosives, and project facility components) and the proximity to the noise receptor (e.g., humans and wildlife). Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- To the extent practicable, site the right-of-way (ROW) to avoid residential areas and important wildlife habitat areas (e.g., rookeries, raptor nesting areas, calving areas).
- Consider noise impact early in the design process for compressor or pump house facilities.
- Locate all stationary equipment (i.e., compressors and generators) as far as practicable from nearby residences.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

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

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Site Evaluation

- Proponents of an energy transmission project should take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.

Construction

- Limit noisy construction activities (including blasting) to the least noise-sensitive times of day (weekdays only between 7 a.m. and 10 p.m.).
- Whenever feasible, schedule different noisy activities (e.g., blasting and earthmoving) to occur at the same time, since additional sources of noise generally do not add a significant amount of noise. That is, less-frequent noisy activities would be less annoying than frequent less-noisy activities.
- Notify nearby residents in advance if blasting or other noisy activities are required during the construction period.

Operation and Maintenance

- Use exhaust silencers, quieter cooling fans, and optimized acoustical pipe lagging (acoustical wrapping) to minimize compressor noise.

Decommissioning/Site Reclamation

- Repeat mitigation measures used to minimize noise impacts during construction during the decommissioning/site reclamation phase.

A.2.2 Air Quality Mitigation Measures

Impacts to air quality are related to the project footprint (e.g., land disturbance) and project emissions (e.g., fugitive dust and other contaminant releases to air). Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Surface access roads and on-site roads with aggregate materials, wherever appropriate.
- Minimize the amount of disturbance and areas cleared of vegetation.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Reduce project-related greenhouse gas emissions in a manner appropriate to the nature and scale of project operations and impacts.
- Enact fugitive dust and vehicle emission controls.
- Use dust abatement techniques on unpaved, unvegetated surfaces to minimize airborne dust during earthmoving activities, prior to clearing, excavating, backfilling, compacting, or grading, and during blasting.
- Establish and enforce speed limits to reduce airborne fugitive dust.
- When feasible, shut down idling construction equipment.
- Revegetate disturbed areas as soon as possible after disturbance.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Site Evaluation

- Proponents of an energy transmission project should take measurements to assess the existing criteria air pollutant levels at a given site and compare them with the anticipated levels associated with the proposed project.

Construction Practices

- Cover construction materials and stockpiled soils if they are a source of fugitive dust.
- Cover storage piles at concrete batch plants if they are a source of fugitive dust.
- Keep soil moist while loading into dump trucks to minimize fugitive dust.
- Keep soil loads below the freeboard of the truck to minimize fugitive dust.
- Minimize drop heights when loaders dump soil into trucks.
- Tighten gate seals on dump trucks.
- Cover dump trucks before traveling on public roads.
- When possible, schedule construction activities during periods of low winds to reduce fugitive dust.
- Conduct any slash burning in compliance with open burning permit requirements.

Operation and Maintenance

- Power compressors and pumps by electric motors where strict air emission rules would preclude the use of gas or oil.

Decommissioning/Site Reclamation

- Repeat mitigation measures used to minimize air emissions during construction during the decommissioning/site reclamation phase.
- Train workers to handle construction debris during dismantlement to reduce fugitive emissions.

A.2.3 Cultural Resources Mitigation Measures

Impacts to cultural resources are related to the project footprint (e.g., land disturbance) and altered access to the project area. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Conduct a records search to determine the presence of known archaeological sites and historic structures within the area of potential effect. Identify the need for an archaeological and/or architectural survey.

- Determine whether sites and structures within the area of potential effect meet the significance criteria for listing as eligible sites on the *National Register of Historic Places* (NRHP).
- Consult with tribal governments early in the planning process to identify traditional cultural properties, sacred landscapes, and other issues and concerns regarding the proposed energy transmission project.

- Evaluate the visual impacts to historic trails if the project includes remnants of a National Historic Trail, is located within the viewshed of a National Historic Trail's designated centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP. Include mitigation measures for visual impacts as stipulations in the Plan of Development.

- Prepare and follow a cultural resources management plan, if cultural resources are present at the site or if areas with a high potential to contain cultural material have been identified.

- Use existing roads to the maximum extent feasible to avoid additional surface disturbance.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Follow guidance in the cultural resources management plan. For example:

  – If resources eligible for listing on the NRHP are present, modify the Plan of Development to avoid significant cultural resources. If avoidance is not possible, conduct appropriate cultural resource recovery operations or alternative mitigations as determined in consultation with the appropriate State Historic Preservation Offices (SHPOs), and Native American tribes, as required by the National Historic Preservation Act.

  – Periodic monitoring of significant cultural resources in the vicinity of the development may be required to reduce the potential for looting and vandalism. Should loss or damage be detected, consult with the appropriate SHPO and other potentially affected tribes immediately to determine additional protective measures or further action to mitigate the impact.

- An unexpected discovery of cultural resources during any phase of the project shall result in a work stoppage in the vicinity of the find until the resources can be evaluated by a professional archaeologist and the need for compliance with the Native American Grave Protection and Repatriation Act can be assessed.

- Obtain all required permits, such as those under the Archaeological Resources Protection Act, and keep the location of any archaeological sites secret, as allowed by that Act.

- Educate workers and the public on the consequences of unauthorized collection of artifacts.

- During all phases of the project, keep equipment and vehicles within the limits of the initially disturbed areas.

A.2.4 Ecological Mitigation Measures

Impacts to ecological resources are related to the project footprint (e.g., land disturbance; habitat destruction, modification, and fragmentation; erosion; and hydrological alterations), project emissions (e.g., fugitive dust and other contaminant releases to air), resource use (e.g., water extraction), and the physical presence of the project facilities (e.g., collision risk for birds). Many impacts can be reduced or avoided when considered the siting and design a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Use existing facilities and disturbed areas (e.g., access roads, graded areas) to the extent feasible to minimize the amount of disturbance.

- Configure new access roads to avoid high-quality habitats and minimize habitat fragmentation.

- Locate and arrange construction staging areas in a manner to preserve trees and other woody vegetation to the maximum extent practicable.

- Locate site access roads to minimize stream crossings.

- Identify important, sensitive, or unique habitat and biota in the project area, and design the project to avoid (if possible), minimize, or mitigate potential impacts to these resources. The design and siting of the project should follow appropriate existing guidance, as available and applicable.

- Identify wetland crossings prior to construction to minimize the span over or trenching within them and to avoid the more environmentally sensitive or wetter portions of the wetlands.

- Contact appropriate federal agencies and interested stakeholders early in the planning process to identify potentially sensitive ecological resources that may be present in the area of the energy transmission project.

- Review existing information on species and habitats in the project area.

- Locate support towers, pipeline trenches, access roads, and facilities in areas least likely to impact important, sensitive, or unique habitats (such as wetlands).

- Locate individual project facilities to maintain existing stands of quality habitat and continuity between stands.

- Design stream crossings to provide in-stream conditions that allow for and maintain uninterrupted movement and safe passage of fish.

- Avoid locations that are heavily used by migratory birds and bats.

- Design permanent facility structures to discourage their use by birds for perching or nesting.

- Avoid or minimize the use of guy wires.

- To reduce the operational and avian risks that result from avian interactions with electric utility facilities, design and construct transmission lines in conformance with the Avian Protection Plan Guidelines (published by the Avian Power Line Interaction Committee [APLIC] and U.S. Fish and Wildlife Service [USFWS] in 2005) and the Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (published by APLIC in 2006).

- Avoid locating transmission lines in areas with a high incidence of fog and mist.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Instruct all survey and monitoring personnel on the protection of ecological resources, laws pertaining to the collection and removal of these resources, and the purpose and necessity of protecting them.
- Develop a habitat restoration management plan that identifies vegetation, soil stabilization, and erosion reduction measures, and requires that reclamation activities be implemented as soon as possible following facility construction activities.
- 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.
- Instruct all employees to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship, nesting) seasons. In addition, do not permit pets at the project site.
- Conduct in-stream activities during low-flow periods and avoid activities when the area is being used by important aquatic species (e.g., salmonid spawning or migration).
- When feasible, reduce the extent of habitat disturbance by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.
- Maintain noise-reduction devices (e.g., mufflers) in good working order on vehicles and equipment.
- Apply erosion controls that comply with federal standards. Apply practices such as jute netting, silt fences, and check dams near disturbed areas.
- Use certified weed-free mulching.
- Reclaim all areas of disturbed soil using weed-free native grasses, forbs, and shrubs. Undertake reclamation activities as early as possible on disturbed areas.
- Refuel in a designated fueling area that includes a temporary berm to limit the spread of any spill.

- Use drip pans during refueling to contain accidental releases and under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.

- Address spills immediately per the appropriate spill management plan, and initiate soil cleanup and soil removal if needed.

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

- Access roads should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
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- Do not use fill materials that originate from areas with known invasive vegetation problems.

- Use approved seed mixes in revegetation efforts.

- Use certified weed-free mulch when stabilizing areas of disturbed soil.

- Limit herbicide use to nonpersistent, immobile herbicides and apply in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications. Select herbicides for use that have low human toxicity, are effective against target species, and have minimal effects on non-target species and the environment.

- Report observations of potential wildlife problems, including wildlife mortality, to the appropriate wildlife agency.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Site Evaluation

- Conduct surveys for federal-protected species and other species of concern within the project area.

- Evaluate avian and big game use (including the locations of active raptor nest sites, waterfowl staging areas, crucial winter and summer use areas, and migration corridors) of the project area by using scientifically rigorous survey methods.

- In consultation with state wildlife agencies, establish spatial and temporal restrictions on activities that could disturb raptors during their breeding season.

Construction

- Retain all ground-level vegetation and stumps left after cutting, unless there removal is necessary to install support structures, the pipeline, or other ancillary facilities.

- Initiate habitat restoration activities as soon as possible after construction activities are completed within a given area.
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- Schedule construction activities to avoid important periods of wildlife courtship, breeding, nesting, lambing, or calving.

- Establish buffer zones around raptor nests, bat roosts, and other biota and habitats of concern such as rare plants.

- Use explosives only within times and at distances from sensitive wildlife or surface waters specified by federal agencies.

- Use dust abatement techniques on unpaved, unvegetated surfaces to minimize airborne dust.

- Cover construction materials and stockpiled soil if they are a source of fugitive dust.

- If construction in wetlands cannot be avoided, activities should be done when the soils are dry or frozen and/or wide-tracked or balloon-tired equipment, timber corduroy or timber mat work areas, or some combination should be used.

- Where support structures or pipelines would be placed in wetlands, excavate and stockpile topsoil separately from subsoil. Replace soils into the excavated area in the reverse of the order in which they were removed.

- Biologists should accompany construction crews to ensure sensitive resources are identified and avoided.

- Isolate the in-stream work area(s) and capture and release fish from the work area(s) under the supervision of a competent fisheries biologist qualified to capture fish.

- In the event that a federally listed species is found during construction, work in the area will be stopped and the USFWS would be immediately notified.

Operation and Maintenance

- Mark shield wires with highly visible devices such as colored spheres or flappers at key water crossings or other areas where a transmission line crosses high-value habitat for birds (particularly waterfowl and raptors).

- Monitor the ROW, access roads, and ancillary facilities regularly for invasive nonnative plant species establishment, and initiate weed control measures immediately upon evidence of invasive species introduction or spread.

Decommissioning/Site Reclamation

- Remove all aboveground structures from the project area.

- Reestablish grade and drainage pattern to the extent practicable.

- Salvage topsoil from all decommissioning activities and reapply during final reclamation.

- Restore the vegetation cover, composition, and diversity to values commensurate with the ecological setting.

- Repeat mitigation measures used to minimize impacts to ecological resources during construction during the decommissioning/site reclamation phase.

- Monitor all disturbed areas for restoration and revegetation success.

A.2.5 Environmental Justice Mitigation Measures

Mitigate any impact that has been determined to adversely affect and cause a disproportionate effect on minority or low-income populations[4] through appropriate measures, specific to the impact. For example, if impacts on visual resources are causing a disproportionate adverse effect on minority or low-income populations, mitigate the visual resource impacts to address the environmental justice issue.

A.2.6 Hazardous Materials and Waste Management Mitigation Measures

Hazardous materials and waste management impacts are related to the type or project and its footprint (e.g., land disturbance, types of hazardous materials required to construct the project or that would be transported by the project, and the types and amounts of waste generated by the project), and type and amount of accidental spills of hazardous wastes that could occur during the lifetime of the project. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Prepare a comprehensive list of all hazardous materials to be used, stored, transported, or disposed of during all phases of activity.
- Develop a hazardous materials management plan addressing storage, use, transportation, and disposal (interim and final) for each item in the comprehensive list. The plan should identify specifics regarding local and federal emergency response.
- Develop a waste management plan identifying anticipated solid and liquid waste streams and addressing determination, inspection and waste minimization procedures, storage locations, and waste-specific management and disposal requirements. Include a recycling strategy to be practiced by workers during all project phases.
- Develop a spill prevention and response plan for addressing storage locations of hazardous wastes, spill prevention measures, training requirements, waste-

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[4] According to the U.S. Bureau of the Census, minority populations are identified where people identifying themselves as belonging to one or more minority racial groups (e.g., Hispanic, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian, or Other Pacific Islander) make up more than 50% of the population in an affected area or a meaningful percentage in comparison to the general population. Low-income populations include individuals who fall below the poverty line.

specific spill response actions, spill response kits, and notifications to authorities.

- Develop a herbicide management plan.

- Investigate the historical use of the area to be disturbed with regard to the potential presence of hazardous materials.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Implement plans for hazardous materials management, waste management spill prevention and response, stormwater management, and pesticide management. Train employees to promptly contain, report, and/or clean up any oil or hazardous material spill.

- Provide secondary containment for all on-site hazardous materials and waste storage, including fuel.

- Containerize and periodically remove wastes for recycling or for disposal at appropriate off-site permitted disposal facilities.

- Provide portable spill containment and cleanup equipment in all vehicles.

- Select pesticides that are low in human toxicity, known to be effective against the target species, and have minimal effects on non-target species and the environment.

- Keep vehicles and equipment in good working order to prevent oil and fuel leaks.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Decommissioning/Site Reclamation

- Remove aboveground project components from the project area and either recycle, sell as scrap, or properly dispose of at licensed waste disposal facilities.

A.2.7 Health and Safety Mitigation Measures

Impacts to health and safety are related to the project footprint (e.g., land disturbance), topography of the project location, project emissions (e.g., fugitive dust and other contaminant releases), type and complexity of project construction and operation, and potential for interaction of the public with the project. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Incorporate sufficient setbacks in the project design to mitigate impacts of electromagnetic field (EMF) exposure to nearby residences if an impact is expected.
- Plan project to minimize interference with television and radio transmission and avoid interference with public safety communication systems.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Develop and implement a health and safety plan to be followed throughout all phases of a project.
- Provide occupational health and safety orientation training to all employees consisting of basic hazard awareness, site-specific hazards, safe working practices, and emergency procedures.
- Consider public safety during helicopter flights (e.g., avoid populated areas, schools, areas being crop dusted).
- Conduct daily safety assessment meetings to identify potential safety issues (e.g., site access, construction, work practices, security, transportation of heavy equipment, traffic management, emergency procedures, wildlife encounters, and fire control and management) and measures to mitigate them.
- Provide fire suppression equipment in all vehicles.
- Use appropriate procedures for storage and transportation of blasting equipment and explosive materials, including appropriate signage indicating its location.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Construction Practices

- Hold contractor crew safety meetings at the start of each workday to go over potential safety issues and concerns.

- Install grounding devices on all fences that cross or run parallel to a transmission line.

- Ensure that employees are trained, as necessary, in tower climbing, cardiopulmonary resuscitation, first aid, rescue techniques, and safety equipment inspection and use.

- Secure construction sites at the end of the workday to protect the equipment and the general public.

- Should contaminated media be unexpectedly encountered during construction, stop work and call an environmental specialist to characterize the nature and extent of the contamination and determine appropriate measures to prevent its spread and to protect health and safety.

Operation and Maintenance

- Purge gas from the pipeline or pipe components prior to welding or cutting activities.
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- Eliminate problems of induced currents and voltages onto conductive objects sharing a transmission line right-of-way.

A.2.8 Land Use Mitigation Measures

Impacts to land use are related to the project footprint (e.g., land disturbance and modification), project emissions (e.g., fugitive), and the physical presence of the project facilities (e.g., compatibility of the project with existing land uses). Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Consult with Department of Defense to identify and address any issues regarding the energy transmission project and military operations.
- Notify the FAA early in the planning process to identify air safety measures.
- Contact local stakeholders early in the process to identify sensitive land uses, issues, and local plans and ordinances.
- Establish a reclamation plan to ensure that all temporary impact areas are restored.
- Consolidate infrastructure requirements (transmission, roads) for efficient use of land.
- Distribute a proposed schedule of construction activities to all potentially affected landowners and nearby residents so they know when they might experience construction-related disruptions.
- Minimize the amount of land disturbance, and develop and implement stringent erosion and dust control practices.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Keep gates and fences closed and in good repair to contain livestock.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Site Evaluation

- Conduct a preblast inspection of privately owned structures near any blast site (e.g., less than 500 ft). Notify each affected landowner about the blasting before it is conducted.

Construction

- Repair underground drainage tile damage on agricultural lands.

- Repair compacted or rutted agricultural lands.

- Dewater open trenches in a manner that does not damage adjacent agricultural land. If this cannot be done, compensate the landowner appropriately.

- Compensate farmers or ranchers for crop or forage losses and restore compacted soils.

A.2.9 Paleontological Resources Mitigation Measures

Impacts to paleontological resources are related to the project footprint (e.g., land disturbance) and altered access to the project area. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

It should be noted that paleontological resources are considered trust resources on tribal lands. Bureau of Indian Affairs (BIA) policy is to issue permits for excavation of paleontological resources with landowner consent. The landowner retains the right to sell any paleontological resources excavated on tribal lands. Measures to mitigate impacts would be implemented only if the landowner's intent was to preserve the paleontological record in place.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Consult with the BIA and the landowner to determine how paleontological trust resources will be handled for the project. If in situ preservation of the paleontological record is desired, the following mitigation measures could be applicable.

- Determine whether paleontological resources exist in the project area based on the sedimentary context, a records search of finds in the area, and/or a professional paleontological survey.

- Develop a paleontological resources management plan for areas with a high potential to contain significant fossils of scientific value.

- Prepare a mitigation plan for avoiding resources, removing fossils, and monitoring construction activities.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Follow guidance in the paleontological resources management plan. For example:
  - Monitoring of all excavation and earthmoving in sensitive areas by a professional paleontologist may be required.
  - A discovery of a paleontological specimen during any phase of the project could result in a work stoppage in the vicinity of the find until it is evaluated by a professional paleontologist.
  - Periodic monitoring of known significant paleontological resources in the vicinity of the development (including areas where new road access has been provided) may be required to reduce the potential for looting and vandalism. Should loss or damage be detected, additional protective measures or further action (e.g., resource removal by a professional paleontologist) may be required to mitigate the impact.
- Educate workers on the consequences of unauthorized collection or sale of fossils.
- Use existing roads to the maximum extent feasible to avoid additional surface disturbance.
- During all phases of the project, keep equipment and vehicles within the limits of previously disturbed areas.

A.2.10 Socioeconomic Mitigation Measures

Socioeconomic effects of an energy transmission project are relatively localized and small in scale. They are predominantly positive effects and no mitigation measures are typically necessary. There are no legal requirements for mitigation of socioeconomic effects.

A.2.11 Soils and Geological Resources Mitigation Measures

Impacts to soils and geological resources are related to the project footprint (e.g., topographic disturbance; habitat destruction, erosion, and hydrological alterations), resource use (e.g., sand and gravel extraction), and construction procedures (e.g., blasting requirements). Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Identify unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, slope angles, and geologic structure).

- Place access roads to follow natural topography, and avoid or minimize side hill cuts. New roads should avoid going straight up grades in excess of 10%. Design roads with eventual reclamation in mind.

- Design runoff control features to minimize soil erosion.

- Minimize the amount of land disturbed as much as possible. Use existing roads, disturbance areas, and borrow pits and quarries. Minimize vegetation removal.

- Construct drainage ditches only where necessary. Use appropriate structures at culvert outlets to prevent erosion.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Clean and maintain catch basins, drainage ditches, and culverts regularly.

- Obtain borrow material from authorized and permitted sites.
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- Inspect and maintain project facilities regularly, including access roads, to ensure erosion levels remain the same or less than current conditions.

- Reclaim or apply protective covering on disturbed soils as quickly as possible.

- Apply erosion controls, such as jute netting, silt fences, and check dams.

- In areas of potential wind erosion, apply gravel to access road surfaces.

- Use special construction techniques in areas of steep slopes, erodible soils, and stream crossings.

- Maintain vegetative cover within the ROW to prevent erosion and monitor periodically to assess erosion.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Construction

- Save topsoil removed during construction and use to reclaim disturbed areas upon completion of construction activities.
- Install appropriate roadway drainage to control and disperse runoff.
- Avoid creating excessive slopes during excavation and blasting operations.
- Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.
- Conduct blasting to minimize the occurrence and velocity of flyrock (e.g., by use of blasting mats) and ground vibration to safe levels.

Decommissioning/Site Reclamation

- Repeat mitigation measures used to minimize impacts to soils and geologic resources during construction during the decommissioning/site reclamation phase.
- Use topsoil removed during the beginning of the project or during decommissioning activities to reclaim disturbed areas.
- Reestablish the original grade and drainage pattern to the extent practicable.
- Stabilize all areas of disturbed land using weed-free native shrubs, grasses, and forbs.

A.2.12 Transportation Mitigation Measures

Impacts to transportation are related to the project location and footprint (e.g., type and extent of project-related traffic on existing roads and the extent of access roads required to be established), existing traffic patterns, and condition and weight-limits of existing roads. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Consult with local planning authorities regarding traffic. Address specific issues (e.g., school bus routes and stops) in a traffic management plan.
- Develop a traffic management plan for site access roads and for use of main public roads.
- Use existing roads to the extent possible.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Instruct and require all personnel and contractors to adhere to speed limits to ensure safe and efficient traffic flow.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Construction

- Limit construction vehicle traffic on public roadways to off-peak commuting times to minimize impacts on local commuters.
- Employ traffic control flaggers and post signs warning of construction activity and merging traffic, when necessary, for short interruptions to traffic flow.
- Repair any damage to local roads caused by construction traffic.
- Install gates on access roads to reduce unauthorized access when requested by property owners.

Decommissioning/Site Reclamation

Limit decommissioning vehicle traffic on public roadways to off-peak commuting times to minimize impacts on local commuters.

A.2.13 Visual Resources Mitigation Measures

Impacts to visual resources are related to the project footprint (e.g., land disturbance; habitat destruction, modification, and fragmentation; and topographical alterations), project emissions (e.g., fugitive), the physical presence of the project facilities (e.g., landscape compatibility, scale contrast, and spatial dominance), and existing viewer expectation. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Involve the public in decision making regarding visual site design elements for proposed energy transmission projects. Possible approaches include conducting public forums; offering tours; using computer simulation and visualization techniques in public presentations; and conducting surveys regarding public perceptions and attitudes about energy transmission projects.
- If a scenic river or other similar water bodies are to be crossed by a transmission line, locate support structures as far back as possible to minimize visual impacts.
- Integrate support towers and other aboveground facilities with the surrounding landscape.
- To the extent practicable, avoid the placement of support towers, substations, aboveground pipeline segments, and compressor or pump stations on high land features and along "skylines" that are visible from nearby sensitive view points. The presence of these structures should be concealed or made less conspicuous.
- Design and construct conspicuous structures to harmonize with desirable or acceptable characteristics of the surrounding environment.
- Consider aesthetic offsets (e.g., visual screens) as a mitigative option in situations where visual impacts are unavoidable, or where alternative mitigation options are only partially effective or uneconomical.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Consider site-specific landscaping in selected areas to provide screening for year-round residents whose property abuts the project.
- Maintain the right-of-way with low-growing natural vegetation that requires minimal maintenance and is consistent with local vegetation.
- Keep areas around support towers, aboveground portions of pipelines, and other facilities clean and free of debris.
- Do not apply paint or permanent discoloring agents to rocks or vegetation to indicate survey or construction activity limits. Use survey markers, flagging, or other suitable materials to delineate limits.

A.2.14 Water Resources Mitigation Measures

Impacts to water resources are related to the project footprint (e.g., land disturbance; erosion; and hydrological alterations), number of water bodies crossed or impacted by project-related activities, resource use (e.g., water extraction), and likelihood of water resource contamination. Many impacts can be reduced or avoided when considered during the siting and design of a project during the site evaluation phase.

Siting and Design Mitigation Measures

Siting and design considerations that mitigate impacts include:

- Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, slope angles, and geologic structure).
- Research local hydrogeology. Identify areas of groundwater discharge and recharge and their potential relationships with surface water bodies and groundwater quality. Avoid creating hydrological conduits between two aquifers.
- Construct drainage ditches only where necessary. Use appropriate structures at culvert outlets to prevent erosion.
- Do not alter existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.
- Use special construction techniques in areas of steep slopes, erodible soils, and stream crossings. Cross water bodies at right angles to the channel and/or at points of minimum impact. Natural drainage patterns should not be altered or restricted.

- Minimize the amount of land disturbed as much as possible. Use existing roads, borrow pits, and quarries.

- Develop a stormwater management plan to ensure compliance with regulations and prevent off-site migration of contaminated stormwater or increased soil erosion.

- Identify water body crossings prior to construction to minimize the span over or trenching within them and to avoid the more environmentally sensitive portions of the water bodies.

- For most stream crossings, locate transmission line support structures as close as possible to the edge of the stream buffer to allow for taller vegetation, thus minimizing trimming requirements and potential thermal warming of normally shaded water bodies.

General Mitigation Measures

General mitigation practices and principles that could apply to any or all phases of an energy transmission project include:

- Use only nonpersistent, immobile herbicides.

- Refuel in a designated fueling area that includes a temporary berm to limit the spread of any spill.

- Maintain appropriate erosion control along permanent access roads.

- Clean and maintain catch basins, drainage ditches, and culverts regularly.

- Restore the banks of water bodies to their natural condition.

- Use existing bridges or fords to access the right-of-way.

- Reclaim or apply protective covering on disturbed soils as quickly as possible.

- Apply erosion controls, such as jute netting, silt fences, and check dams.

Project Phase-Specific Mitigation Measures

Mitigation measures specific to a particular phase of an energy transmission project include:

Construction

- Save topsoil removed during construction and use it to reclaim disturbed areas upon completion of construction activities.
- Avoid creating excessive slopes during excavation and blasting operations.
- For in-stream construction, use isolation techniques such as berming or diversion to limit the exposure of disturbed substrates to moving water.
- Consider trenchless technology for pipeline crossings of streams (e.g., suspension crossings or directional drilling).
- Closely monitor construction near aquifer recharge areas to reduce potential contamination of the aquifer.
- Obtain borrow material from authorized and permitted sites.
- Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.
- Where access roads would cross a dry wash, restrict the road gradient to 0% to avoid diverting surface waters from the channel.

Operation and Maintenance

- Ensure that vegetative cover is maintained within the right-of-way and regularly monitor for indications of erosion.
- Maintain equipment and vehicles to minimize the risk of accidental fuel spillage.

Decommissioning/Site Reclamation

- Repeat mitigation measures used to minimize impacts to water resources during construction during the decommissioning/site reclamation phase.

APPENDIX B

AVAILABLE RESOURCES FOR TRANSMISSION SYSTEM PLANNING AND SITING OF ENERGY TRANSPORT CORRIDORS AND RIGHTS-OF-WAY

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APPENDIX B

AVAILABLE RESOURCES FOR TRANSMISSION SYSTEM PLANNING AND SITING OF ENERGY TRANSPORT CORRIDORS AND RIGHTS-OF-WAY

The list below shows existing online data sources or assessment tools that may be useful to tribes in transmission system planning and/or siting.

B.1 ENERGY RESOURCE ASSESSMENT

USGS National Oil and Gas Assessment: http://energy.cr.usgs.gov/oilgas/noga/
Information on major oil and gas basins in the United States, including geologic reports, reserve estimates, production history, and land ownership. GIS data available to download or to view online.

USGS National Coal Resource Assessment:
http://energy.er.usgs.gov/coal_assessments/ncra/summary.html
Information on coal resources in the United States, including geologic reports and resource assessments. GIS data available to download.

USGS Coalbed Methane: http://energy.cr.usgs.gov/oilgas/cbmethane/index.html
Information on coalbed methane resources in the United States, including geologic reports, information on environmental considerations, and resource assessments.

USGS Geothermal Research: http://energy.usgs.gov/other/geothermal/
Information on geothermal resources in the United States, including geologic reports and resource assessments.

NREL Wind Energy Research: http://www.nrel.gov/wind/
Information about wind energy resources and technologies for both utility-scale and small-scale development. Includes wind resource maps for the United States (http://www.nrel.gov/wind/resource_assessment.html). GIS data available to download at http://www.nrel.gov/gis/.

NREL Solar Energy Research: http://www.nrel.gov/solar/
Information about solar energy resources and technologies for both utility-scale and small-scale development. Includes concentrating solar power resource maps for the United States (http://www.nrel.gov/csp/maps.html). GIS data available to download at http://www.nrel.gov/gis/.

NREL Energy Analysis: http://www.nrel.gov/analysis/
Analytical models and tools for assessing potential development of renewable energy resources. Includes technology analysis models, the Job and Economic Development Impact (JEDI) model, energy technology cost and performance data; benefits analysis models, and market analysis models. GIS data for renewable energy resources available to download at http://www.nrel.gov/gis/.

NREL Geothermal Resources and Technologies: http://www.nrel.gov/geothermal/
Information about geothermal energy resources and technologies for both utility-scale and small-scale development. Includes geothermal technologies analysis models and tools (http://www.nrel.gov/analysis/analysis_tools.html).

DOE Tribal Energy Guide: http://www1.eere.energy.gov/tribalenergy/guide
Information about usable energy resources on tribal lands, including biomass, geothermal, hydropower, solar, wind, and fossil fuels.

B.2 TRANSMISSION SYSTEM PLANNING

DOE Tribal Energy Guide: http://www1.eere.energy.gov/tribalenergy/guide
Information about electric grid systems, electric power terminology, power production in the U.S., electric utilities, electricity policy, interconnection issues, and integrated resource planning.

Bonneville Power Administration Transmission System Planning:
http://www.transmission.bpa.gov/system_planning
Information about transmission system planning studies and transmission system open access transmission tariffs. Includes interconnection information and transmission system business practices.

B.3 ENVIRONMENTAL IMPACT ASSESSMENT

Tribal Energy and Environmental Information Clearinghouse:
http://teeic.evs.anl.gov/am/assess
Information about how to conduct impact analyses for specific energy projects including how to identify needs, how to collect needed data, and develop project-specific mitigations.

B.4 ENVIRONMENTAL RESOURCE AND LAND USE DATA

Sources of U.S. Government and other GIS data are rapidly developing and improving. Internet sites such as Geodata.gov provide comprehensive indexes of and links to data distribution sites. Clearinghouses such as Geocommunicator.gov, Seamless.usgs.gov, Datagateway.nrcs.usda.gov, and NationalAtlas.gov provide access to many popular layers from different agencies, while other Web sites concentrate on one agency or theme. Most states, and many counties and municipalities provide GIS data clearinghouses for their jurisdictions and typically provide larger scale data than federal data sources. For example, Montana has a Natural Resource Information System at http://nris.mt.gov/gis which has a very comprehensive statewide GIS database. Specialized themes or larger-scale GIS data are often available from government and private organizations with interest in specific locations or subjects, however it can take some extra effort and communication to identify them and obtain data.

Geodata.gov, Geospatial One Stop
http://geodata.gov
Geodata.gov is intended to be the first place to go for locating U.S. GIS data and related products. It provides search capabilities and links to all major U.S. government GIS data sources, many of which are also included below.

ESRI Data and Maps
Distributed on a set of DVSs with commercial ESRI products.
This source includes a diverse and high-quality set of ready to use GIS layers. Consult the Help.htm document for layer-specific redistribution rights which vary from internal use only, to freely distributable with proper metadata and source attribution.

Bureau of Land Management, National Integrated Lands System
http://www.geocommunicator.gov
Provides GIS map services which stream GIS data via the Internet to ESRI GIS software applications. Includes many GIS layers, such as Federal Surface Management Agency, Public Land Survey System, base map layers, mining and minerals, and many energy-related layers. This source also provides interactive maps for users lacking ESRI GIS software.

U.S. Department of Agriculture, Geospatial Data Gateway
http://datagateway.nrcs.usda.gov
Provides automated, location-specific GIS data distribution system for many natural resource layers, including hydrologic units, watershed boundaries, topographic map imagery, quadrangle map indices, elevation data, orthophotography, geographic names, land use/land cover data, soils, and climate data.

U.S. Geological Survey, National Map Seamless Server
http://seamless.usgs.gov
Clearinghouse focused primarily on topographic information, which includes orthoimagery (aerial photographs and satellite imagery), scanned topographic maps, elevation, geographic names, hydrography, boundaries, transportation, structures, and land cover

U.S. National Atlas, GIS Map Layers
http://www.nationalatlas.gov/atlasftp-na.html
Provides of hundreds of national map layers in GIS format. Although useful, National Atlas data may not be the most detailed or current data available for a particular theme.

National States' Geographic Information Council, GIS Inventory
http://gisinventory.net
Data clearinghouse providing primarily standardized parcel data from county and other local government sources, but many other data layers are available.

U.S. Geological Survey, National Elevation Dataset
http://gisdata.usgs.gov
Provides best available elevation data available across the United States, including higher-resolution Light Detection and Ranging (LIDAR) data in some locations.

U.S. Geological Survey: Center for Biological Informatics
http://biology.usgs.gov/cbi
Data clearinghouse providing links to biological resource data.

U.S. Geological Survey: Geologic Hazards
http://geohazards.cr.usgs.gov
USGS geologic hazards information site with GIS data for some hazard types.

National Park Service, Data and Information Clearinghouse
http://www.nps.gov/gis/data_info
Provides wide variety of National Park Service GIS data.

National Park Service, National Archaeological Database
http://www.cast.uark.edu/other/nps/nadb
Searchable bibliographic inventory of over 350,000 reports on archeological investigation and planning, mostly of limited circulation, representing a large portion of the primary information available on archeological sites in the U.S.

U.S. Fish and Wildlife Service, National Wetlands Inventory
http://www.fws.gov/wetlands/data
Provides wetland GIS data including classification nomenclature, which describes the habitat.

U.S. Census Bureau, TIGER Line Shapefiles
http://www.census.gov/geo/www/tiger
Provides jurisdictional and census-related boundaries with geographic entity codes that can be linked to U.S. Census Bureau demographic data.

U.S. Census Bureau, Demographic Data
http://factfinder.census.gov
Provides U.S. Census Bureau population, housing, economic data that can be linked to jurisdictional and census-related boundaries.

U.S. Department of Agriculture, Natural Resources Conservation Service
http://soildatamart.nrcs.usda.gov
Provides tabular and spatial data on soils.

GeoCommunity, GIS Data Depot
http://data.geocomm.com
Commercial Web site providing free and low-cost access to many U.S. Government GIS data layers, including scanned topographic maps, digital elevation models, orthophotography, Federal Emergency Management Agency floodplain maps, Defense Mapping Agency vector product format layers, U.S. Fish and Wildlife Service National Wetlands Inventory data, and others. Some layers have value added in that they can be obtained in commonly used GIS formats, while others are now available more conveniently from the source agencies.

Platts, Energy Data
http://www.platts.com/Products.aspx?xmlFile=gisdata.xml
Commercial vendor of energy-related GIS data and other information for electric, natural gas, oil, coal, and petrochemicals.

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