THE APPLICATION OF SPATIAL ANALYSIS IN SELECTING ENERGY TRANSMISSION CORRIDORS

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ABSTRACT

Energy development and transport in the Western United States are complex and contentious public issues with significant environmental, economic, and engineering challenges. The Energy Policy Act of 2005 requires the Departments of Energy, Interior, Defense, and Agriculture to develop energy "corridors" that maximize the efficiency of delivery systems, streamline the approval process required to develop energy transmission projects on federal lands, and minimize impacts on the environment. The geographic extent is large, covering 11 Western states. Constraints involve spatial data such as topography, biological resources, land ownership, geology, and existing infrastructure. Because of these factors, the feasibility of the project depends on Geographic Information System (GIS) technology to bring together the complex database development, analysis, modeling, visualization, and cartography required. This paper describes the unique challenges and approaches to this project from the perspective of GIS professionals.

THE ENERGY POLICY ACT OF 2005

On August 8, 2005, the Energy Policy Act of 2005 (the Act) became law. Section 368 of the Act directs the Secretaries of Agriculture, Commerce, Defense, Energy, and the Interior (the Agencies) to designate west-wide energy corridors (corridors) on the federal lands they manage in 11 Western states. The states included are Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Once these corridors are established, the Agencies will amend their respective land use plans to streamline the process of siting and permitting use of the land for oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities.

The Agencies have determined that designating corridors constitutes a major federal action that may have a significant impact upon the environment within the meaning of the National Environmental Policy Act of 1969. For this reason, the Agencies intend to prepare a Programmatic Environmental Impact Statement (PEIS) to address the environmental impacts from the Proposed Action and the range of reasonable alternatives. The Department of Energy and the Bureau of Land Management will be co-lead Agencies for this effort, with the U.S. Department of Agriculture's (USDA's) Forest Service (USFS) participating as a cooperating Agency.

ENERGY CORRIDORS

At a minimum, energy corridors will specify a centerline, a width, and compatible uses. In effect, this will make them parcels of land that have been identified through the land use planning process as being preferred locations for existing and future utility rights-of-way that can accommodate one or more new or upgraded rights-of-way.

Energy corridors may accommodate multiple pipelines, electric transmission lines, and related infrastructure such as

maintenance roads, compressors, or pumping stations.

The benefits of designating energy corridors include:

- Streamlining and expediting the processing of energy-related permits and projects,
- Providing applicants for individual rights-of-way within designated corridors with a clear set of actions required by each of the Agencies to implement projects in designated corridors,
- Establishing a common set of best management practices,
- Reducing duplicative assessments of generic environmental impacts by focusing further impact assessments on site-specific (on-the-ground) environmental studies to determine route suitability and appropriate mitigation,
- Ensuring needed interagency coordination as part of the application process, and
- Encouraging new and innovative technologies to increase corridor capacity.

Transmission line and right-of-way

SCOPE

The combined area administered by the Agencies in the project area is over 587,000 square miles, almost fifty percent of the total area of the 11 Western states. It would take over three hundred 1:250,000-scale and over nineteen thousand 1:24,000-scale United States Geological Survey (USGS) topographic

maps to analyze the federal land involved.
Topographic maps, however, contain only a portion of the information that was needed in the establishment of the corridors. Also needed were spatial data on:

- Previous studies and recommendations;
- Current energy infrastructure, including electricity, natural gas, and wind power;
- Natural hazards, including fault zones and areas prone to landslides, floods, and volcanoes;
- Areas covered by existing land use plans as well as land use plans being written; and
- Protected areas, including National Parks and Monuments, Designated Wilderness Areas, Wilderness Study Areas, critical habitat for threatened and endangered species, and many others.

It was obvious from the start that the project could not be accomplished without a heavy reliance on Geographic Information System (GIS) technology. The challenge lay mostly in gathering existing data from Web-based federal clearinghouses, nationally coordinated data calls in the Agencies, and data from the Agencies' various local jurisdictions, such as districts and field offices for BLM and National Forests for USFS.

DEVELOPMENT OF THE GIS DATABASE

Just a few years ago this project would have been unfeasible. The state of federal clearinghouses has improved greatly since that time, making it possible to download detailed, well-documented datasets with huge areas of coverage in minutes. While the ideal of a "one-stop shop" has not quite been attained, much of the data used in this project came from only a handful of giant data clearinghouses, such as:

- GeoCommunicator (http://www.geocommunicator.gov/GeoComm/index.shtm),
- National Park Service (http://www.nps.gov/gis/data_info/),
- Seamless Distribution System (http://seamless.usgs.gov/),
- EarthExplorer (http://edcsns17.cr.usgs.gov/EarthExplorer/),
- The National Atlas (http://www.nationalatlas.gov/), and
- geodata.gov (http://gos2.geodata.gov/wps/portal/gos).

Although the big federal data portals offer a huge variety of data, some data still needed to be downloaded from smaller and more specialized sites.

Energy infrastructure data also needed to be available for decision makers at the beginning of the project. This data is not available to the public. Through a license agreement with the National Geospatial-Intelligence Agency, detailed data on transmission lines, power stations, pipelines, pump stations, and other infrastructure were added to the GIS database.

Because the energy corridors can only exist on real property managed by the Agencies, cadastral data on federal land ownership was vital to the project. Office of Management and Budget (OMB) Circular A-16 assigns the BLM as lead

agency for cadastral data. Their product is the National Integrated Land System (NILS), available through GeoCommunicator (see above). These data received updates and improvements through the life of the project, making close coordination between the BLM and Argonne essential.

Lastly, the GIS database needed to include the many previous proposals for energy corridors that had been made by various consortiums and energy companies. An earlier effort by the BLM had mapped corridors recommended by five different groups. After receiving public scoping comments for the PEIS, the number of different groups who made recommendations in the form of maps, GIS data, and comments increased dramatically (see http://corridoreis.anl.gov). All of these were incorporated and considered as the decision makers began the task of developing the preliminary draft corridor locations.

Lowering pipe with a sideboom

From the beginning of the data acquisition phase, the GIS database was organized using a “master” ArcMap project that was built to be presented to the decision makers

It was decided that all project data would be projected to an Albers Equal-Area projection. Although ArcMap’s “project-on-the-fly” capability is usually a convenience, assigning a common projection for all data avoided confusion and improved the efficiency of analysis and processing tasks. Although it was deemed unfeasible to structure the attribute data tables according to the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE), it was decided to conform to SDSFIE naming conventions as much as possible while maintaining adequate identification for individual datasets.

Lastly, ESRI's Personal Geodatabase (PGDB) technology was chosen as the desired format for the GIS database. By creating a PGDB for each SDSFIE "entity set," the PGDBs remained at a manageable size.

THE GIS DATABASE AND THE DECISION-MAKING PROCESS

A structured approach for the corridor siting analysis was designed to begin with general energy transmission considerations with the intention of adding an increasing number of siting issues in a hierarchical approach.

To implement the structured process, Agency decision makers convened at Argonne to develop a first draft of the energy corridor locations and associated alternatives. The speed and reliability of the GIS database that had been assembled was essential to the agency discussions and decision-making.

The ArcMap master project was used to project the GIS data onto a large screen in a multimedia conference room. The operator of the GIS had two screens available, one of which was used to keep menu and tool bars out of sight of the decision makers. This technique proved to be simple and highly effective in allowing the participants to interact with the data by making requests to the operator. With over seventy data layers and about two gigabytes of data, ArcMap's functionality kept the technical aspects of the GIS database out of the spotlight, so the decision makers could focus on the task at hand.

FIELD DATA CALL

With the first preliminary draft of energy corridor locations and alternatives added to a PGDB feature class, the next step was to incorporate the knowledge and expertise of state and local field offices from each of the Agencies. To present the first draft to local federal managers, Agency decision makers and Argonne staff attended meetings with local federal resource managers on a state-by-state basis. This allowed each group to view the ArcMap master project and the first draft of the energy corridor locations much as they had been viewed by Agency managers in the first workshop. After these state and local meetings, an ArcReader file was published from the ArcMap master project used in the first workshop and about one hundred and seventy DVDs were distributed to project participants within the Agencies. Specific instruction went out with the data call requesting a review of the draft corridor locations and refinement of the lines, as needed. After this local field input, Agency decision makers met again to discuss issues that had arisen since the first data call.

With the proposed revisions and narratives from the Agencies, Argonne staff began to edit the draft corridor locations using the GIS data and written narratives received from the first data call. At this point, nodes were established as a point feature class where segments met. The nodes were numbered from west to east, then the segments were named to refer to the nodes they connected.

A second data call requested review of the new corridor locations against existing land management plans. For this data call, a file exchange website with password protection was developed to

allow better access to the ArcReader project and the GIS database. The results of this data call are still being added to the database.

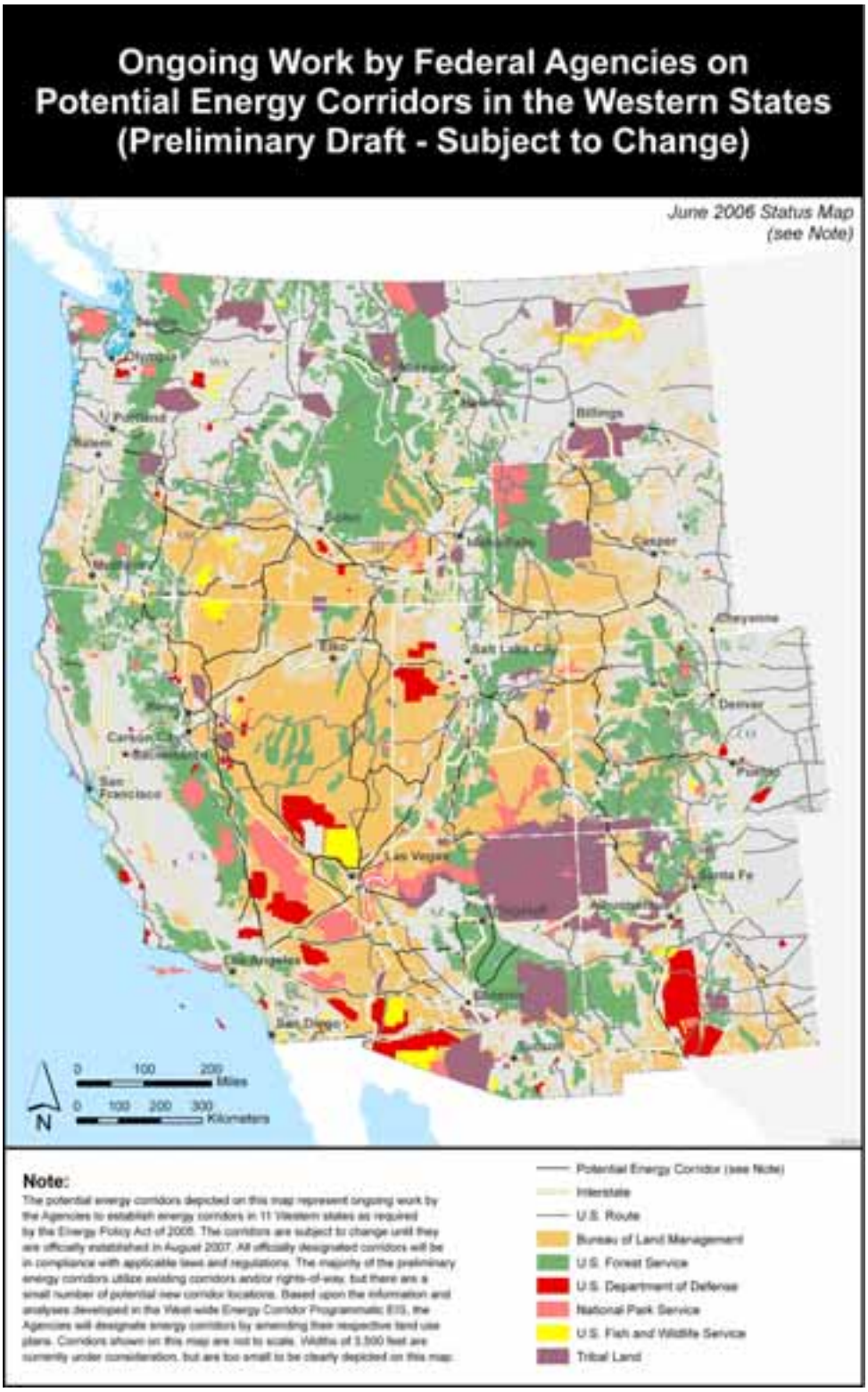
To address state and local issues, federal resource managers have requested "one-on-one" communications. This is being done through "webcasts" using conference calling centers and Genesys Web conferencing technology (http://genesys.com). Using this method, local managers, agency decision-makers, land use planners, and technical support staff are able to talk on a conference phone while viewing the GIS database via the ArcMap master project as it is broadcast on the Web. Although granting of control to remote conference participants is an option of the Web conferencing technology, it is not usable for editing GIS data. However, participants can see and discuss corridor routing issues and based on verbal instructions potential new corridor routes can be considered. This technique has resulted in highly efficient and effective communications between the state and local offices of the Agencies and Argonne.

Data projected at the January 2006 Workshop

A WORK IN PROGRESS

On June 9 2006, a map was released on the public project website (http://corridoreis.anl.gov/) showing the status of the energy corridor lines. Using the Linear Referencing Tools available in ArcToolbox, only the lines crossing properties administered by the Agencies are depicted. The total length of energy corridors shown in this preliminary

status map is 6,044 miles in 3,958 sub-segments.



June 2006 Status Map of West-wide Energy Corridors

(Segments are broken by nonfederal parcels between federal land.) With the current default width of 3,500 ft, the total area of the land zoned for these preliminary draft energy corridors is 4,529 square miles.

Since June 9th, the public project website has been visited over six hundred and fifty times per day. The map has been downloaded about four hundred times per day. These numbers are expected to increase over the life of the project, indicating a high level of interest on the part of all stakeholders. Because of numerous requests for greater detail, state-by-state maps were provided on the public website on June 23rd.

The ArcMap master project at the time of this publication contains more than three hundred and thirty data layers. The GIS database includes 7 gigabytes of vector data and 34 gigabytes of raster elevation data. The master project is periodically published to an ArcReader project for use as a reference by the team writing the PEIS. This has cut down significantly on the number of paper maps required for analysis.

It is important to remember that the energy corridors being examined are still a work in progress, and will be until they are officially established in August 2007. The technologies discussed in this paper will contribute to the soundness of the final decisions.

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