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Environmental Geospatial Information for Transportation

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Environmental Geospatial Information for Transportation

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Edited by
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for the
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Foreword

Geographic information system (GIS) applications have long been in use by natural resource organizations as a way to display and analyze relationships between attributes across large geographic areas. Transportation organizations have been using GIS applications to improve decision making for at least 20 years.

As use of GIS has evolved, so have expectations: GIS has become a means to communicate information among diverse agencies in planning and project decisions. Evolving expectations present issues related to integrating diverse spatial data from a variety of sources, and fostering collaboration among data providers and data users. This Circular documents the second of two Peer Exchange workshops aimed at addressing these issues.

Individuals from state and federal natural resource agencies, regulatory and permitting agencies, and nongovernmental organizations participated. Mid-Atlantic states participants with expertise in information technology, geospatial information technologies, and environmental applications in transportation came together to explore successful applications of environmental geospatial information for transportation, discuss common approaches and issues, and consider methods to facilitate adoption by other organizations.

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- Leni Oman, *Washington State Department of Transportation, Chair*
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Summary of Key Environmental Geospatial Themes

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Geographic information system (GIS) applications have long been in use by natural resource organizations as a way to display and analyze relationships between attributes across large geographic areas. Transportation organizations have been using GIS applications to improve decision making for at least 20 years.

As use of GIS has evolved, so have expectations: GIS has become a means to communicate information among diverse agencies in planning and project decisions. Evolving expectations present issues related to integrating diverse spatial data from a variety of sources, and fostering collaboration among data providers and data users. This Circular documents the second of two Peer Exchange workshops aimed at addressing these issues.

FHWA supported the Peer Exchange. Leni Oman, director of the Office of Research and Library Services at Washington State Department of Transportation (DOT), chaired the meeting and the planning team. In her opening remarks, Oman stated that the goal of the Peer Exchange was to

- Showcase the use of GIS for environmental applications being used in transportation-related decision making;
- Learn how other states are overcoming the challenges of sharing and integrating geospatial data from multiple sources;
- Understand how geospatial technologies can help meet requirements of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy of Users (SAFETEA-LU);
- Learn from others how they have fostered and maintained collaborative partnerships for geospatial information development, sharing, and management; and
- Develop partnerships with organizations in the Mid-Atlantic Region.

BACKGROUND

The first Peer Exchange on Environmental Geospatial Information for Transportation was held in 2003 in Woods Hole, Massachusetts. The event, sponsored by the Office of National Environmental Policy Act Facilitation of FHWA, was intended to share information and document lessons learned by early adopters of innovative environmental data-sharing practices. The workshop was organized around case studies from four states: Florida, Texas, Virginia, and Washington. However, participants came from a range of organizations, including state DOTs, metropolitan planning organizations (MPOs), nonprofit organizations, and natural resources and regulatory agencies. The workshop had two stated objectives, as follow:

- Share experiences in partnering to develop environmental databases that meet the needs of multiple organizations and enable better, faster, and more cost-effective transportation decisions.
- Highlight successful partnering strategies to balance goals, share resources, deal with opportunities and barriers affecting further improvements, and develop information technology (IT) infrastructures that facilitate the sharing of environmental information.

Observations about practices that work and common pitfalls are documented in the workshop proceedings (see Appendix F). The proceedings also identify six next steps for facilitating continued knowledge transfer between workshop participants and among new interested groups, including sponsoring a follow-on peer exchange. The 2006 Peer Exchange that is documented here addresses this and other next steps identified in 2003.

Additional Drivers for a Second Peer Exchange

The 2006 Peer Exchange was sponsored by FHWA Program/Policy Office. In her opening remarks, Shari Schaftlein, Program/Policy Development Team Leader for FHWA, identified a number of "drivers" of FHWA's interest in sponsoring the event:

- FHWA's Linking Planning and NEPA Workshops (see Appendices D and F) have produced recommendations for improving the development and utilization of spatial data and spatial data technologies for the purpose of helping to bridge community and regional visioning with the transportation project development process.
- Executive Order 13274, entitled "Environmental Stewardship and Transportation Infrastructure Project Review," was issued in September 2002 and emphasized transportation project delivery combined with good stewardship of the environment. The ability to meet this mandate is dependent on a common understanding between partnering agencies, which GIS can enhance.
- In the past 5 years, FHWA has used special Congressional stewardship and streamlining appropriations to fund GIS projects in 13 different states. At the same time, a recent AASHTO Center for Environmental Excellence Survey showed that 17 states have contributed funds for data and geospatial projects that support streamlining and have provided funding for resource agency liaisons. These are some of the numerous state and federal initiatives that reflect an emerging trend toward collaboration and technology transfer.
- As spatial data technologies become more accessible and ubiquitous, the public as well as resource agency stakeholders are demanding more dynamic access to systematic, spatially accurate, and visual analysis methodologies.
- The fields of biodiversity, ecosystem management, and watershed management are evolving to reflect a systems approach toward understanding and managing our natural resources. This science advancement, along with a trend toward cooperative conservation and away from command and control regulatory approach, has set the stage for decision support tools that serve many functions—community development, transportation, sustainable economy, and conservation.
- Planning and environmental provisions of SAFTETEA-LU contains three provisions of particular note: Section 6001 Planning Provisions, 6002, the Environmental Process changes;

and 6008, a policy directive on Context Sensitive Solutions. It is unlikely that the legislative intent of these provisions could be fulfilled without advanced geospatial applications.

- Three key federal regulatory agencies have initiated changes that increase the demand for competency in GIS:
  - The U.S. Army Corps of Engineers (USACE) has a Notice of Proposed Rule Making under way regarding wetlands banking that will rely on an evolving geospatial database.
  - The U.S. Fish and Wildlife Service (USFWS) and the Association of Fish and Wildlife Agencies have asked FHWA to be a partner in supporting the use of newly completed State Wildlife Action Plans in transportation and mitigation planning.
  - FHWA is also partnering with the U.S. Environmental Protection Agency (EPA) and many others to launch the Mid-Atlantic Green Highways Partnership.

Focus on Collaboration and Building a Community of Practice

Each of the activities described not only emphasizes advanced applications of geospatial data and technologies but also strives to harness the essential power of collaborative work efforts. Environmental and transportation stakeholders at all levels are evidencing an appreciation of the value of building a community of practice that can support an ecosystem approach to developing infrastructure projects. A community of practice refers to a loosely formed group of interested people involved in networking on technical methods, communication forums on best practices, success stories, and lessons learned, and developing opportunities for consensus building toward a shared vision of environmental and infrastructure planning.

This Peer Exchange was designed to initiate the development of this community of practice for environmental GIS for transportation in the Mid-Atlantic region. Participants included individuals from state and federal DOTs, state and federal environmental agencies, MPOs, academics, nonprofit organizations, and the private sector. A complete list of participants can be found in Appendix C. The agenda (see Appendix A) was organized around encouraging these participants to develop a network of peers, share experiences and challenges, and focus on both technical and institutional issues.

PEER EXCHANGE SUMMARY

The Peer Exchange highlighted several examples of successful collaboration, data sharing, and applications of environmental GIS data and technologies in transportation planning. The Peer Exchange was a success in sharing experiences within the broader transportation planning and resource management communities and clearly demonstrated that transportation planners and resource managers are united in a common vision.

The key takeaway themes from the conference can generally be grouped into three highly interdependent categories:

1. Environmental stewardship, streamlining, and sustainable growth;
2. Importance of effective collaboration; and
3. Building capacity for data management and sharing.

Key issues that were addressed, either by design or by participants in the question and answer sessions, include

- Building the case for GIS—perspectives on building political support and leveraging resources for developing GIS as an essential technical resource;
- State of the practice—updates on progress from participants of the 2003 workshop and an overview of current capabilities and needs in the Mid-Atlantic states;
- Geospatial data needs—an overview of critical data needs and how geospatial data layers are used for environmental analysis;
- Collaboration challenges—experiences in working with partners with competing agendas and limited resources; and
- Future directions and opportunities—visions of what the future might hold, both technical and institutional.

Since a primary objective of this Peer Exchange was to foster a community of practice much of the value was found in the professional connections and resources that were identified. This report seeks to support the substantial achievements of the Peer Exchange workshop by providing a resource for participants and nonparticipants that can help to continue to grow the community of practice that was initiated. To that end, the appendices contain much reference information including but not limited to

- Final meeting agenda;
- Biographies of presenters and panelists;
- Contact information for all participants;
- Descriptions of applications showcased by participants—either in presentations or as posters;
- Responses of Mid-Atlantic states to a preconference questionnaire; and
- References for related initiatives and resources.

BUILDING THE CASE FOR GIS

How and why to build a business case for environmental GIS for transportation was addressed in the Peer Exchange, both explicitly in a programmed session and implicitly through discussions throughout the duration of the meeting. Some key points that emerged include the following:

- Importance of building a constituency to help make the case for funding,
- Evidence provided by regulatory initiatives and federal mandates that staff at high levels recognize the importance of environmental GIS for transportation, and
- Value of showcasing success stories that document time saved (streamlining), cost savings, or improved decisions in building the case and the community of practice.

Developing a constituency for environmental GIS for transportation is seen as critical by Marty Spitzer, professional staff member for the House Committee on Science. He noted that it is clear to participants of the Peer Exchange that tools like GIS allow us to capture and analyze data in a way that improves decision making; however, that message is sometimes not understood by the policy makers. He argued that advocates for environmental GIS for transportation need to be looking now at the next transportation bill and educating policy makers more broadly about geospatial technologies and infrastructure, and the importance of providing funding.

Jill Hochman, director of Interstate and Border Planning for FHWA, emphasized the importance that FHWA places on the adoption and development of geospatial data and technology to promote environmental stewardship and streamlining. That support is evidenced by a number of programs that assist local and regional interests. Some examples include

- "Improved Decision Making Using Geospatial Technology," a workshop held on February 28, 2006, which resulted in an action plan that lists what the transportation community should do to encourage and enhance the use of the technologies.
- The Surface Transportation Environment and Planning (STEP) Cooperative Research Program, which may provide funding for applications of geospatial data and technology.

Identifying these programs can be the first step in communicating with local policy makers about the growing importance of geospatial data and technologies.

Mark Sudol, chief of the Regulatory Branch, USACE, noted that it can take 10 to 15 years to evaluate the successes of the USACE regulatory programs. With such a long period for evaluation, making the case for investment in geospatial technologies with constituents who have a shorter agenda is difficult.

He went on to describe major programmatic and technical advances that are expected to produce improve decisions in a more timely fashion.

1. The watershed approach is a new way of doing business that includes an increased emphasis on coordination and provides a way to do cumulative impact assessments.
2. A new permit tracking system that is expected to be installed in 18 districts by the end of 2006 will enable online applications, online updates and public access. The next version will include spatial data.

These two examples of promoting advances in how business is conducted serve to demonstrate the value of investments in environmental GIS for transportation. The demonstration of success as a means to build the case was repeatedly heard throughout the Peer Exchange. Washington State DOT noted that the popularity of its environmental GIS workbench had persuaded the state to extend the application as a generic GIS workbench. New York noted that success in working with the Department of Environmental Conservation on a GIS-based analysis had helped to build the case for GIS data sharing by building trust. Florida reported that success with its Efficient Transportation Decision-Making (ETDM) process resulted in its adoption by the DOT as a "codified" process. The Maryland State Highway Administration noted that exposing people to best case examples is beneficial in making the case for environmental GIS for transportation.

STATE OF THE PRACTICE

One of the objectives of the Peer Exchange was to foster collaborative partnerships on environmental GIS for transportation in the Mid-Atlantic Region, allowing participants to become aware of activities in other places and build relationships for continued information sharing.

Three opportunities to learn from what colleagues are doing in the field were provided at the Peer Exchange workshop:

- Summary of the state of the practice in the Mid-Atlantic based on a preworkshop survey;
- Panel discussion by participants of the first Peer Exchange workshop in 2003 on the state of their practice and how their programs and applications have grown and changed in the last three years; and
- Poster session showcasing participant's projects.

Note that descriptions of many projects and applications discussed during the Peer Exchange, including abstracts of the posters, are included in Appendix D.

GIS in the Mid-Atlantic

Bill Jenkins, chief of the Environmental Information and Analysis Branch of EPA Region III, compiled and summarized the responses to the Mid-Atlantic questionnaires. The full set of answers can be found in Appendix E, along with a Jenkins's compilation and summary.

The responses included concerns about security and the lack of tools to manage, distribute and analyze the data. The need for IT solutions imply that bringing IT divisions into the community of practice might be important to success. Much data appear to be available, but a lack of tools and funding to harness those data in a shared environment that can leverage use in decision making and funding. Technical resources vary considerably by state.

Many respondents from the Mid-Atlantic states affirmed the potential benefits of environmental spatial data and analysis, particularly in streamlining environmental review. Participants indicated that a community of practice focused on environmental GIS for transportation would foster communication, consistency in practice, leveraging of resources, and sharing of experiences and best practices. Some participants from environmental agencies and MPOs underscored a major issue with adequate funding.

Experiences from the 2003 Workshop Participants

In 2003 FHWA sponsored "Environmental Spatial Information for Transportation: A Peer Exchange on Partnerships." At that meeting, representatives from Florida, Texas, Virginia, and Washington State discussed their successful applications in environmental spatial partnerships. Each state brought four attendees representing members of its partnership. The report detailed the state of the practice of those four states at that time (see Appendix F for resources).

Since then, each of the original four states has continued to see progress in the collaborative process in its state and in the deployment of successful, effective environmental geospatial tools for transportation. The continued demand for functionality on the part of the

users, the growth in numbers of users and data layers, the continued funding, and the evidence of time and money saved in the analysis process are indicators of a thriving Community of Practice.

The following paragraphs briefly describe the progress observed in the four 2003 Peer Exchange states.

Florida

Florida's ETDM process, developed in response to the Congress's Environmental Streamlining initiative, is a new way of accomplishing transportation planning to achieve early agency participation, efficient environmental review, and meaningful dispute resolution. ETDM is carried out through the Environmental Screening Tool (EST), a technological solution that aims to integrate resource and project information from multiple sources, provide quick and standardized analyses of environmental and sociocultural effects of the proposed transportation projects, and support effective communication of results among all stakeholders and the public. EST was developed by using a methodology of rapid software prototyping, frequent user feedback, and flexible architecture designed to adapt to the ETDM evolution process. This resulted in an Internet-accessible interactive database and mapping application that integrates a georelational database of ETDM projects over 350 environmental resource GIS data layers, an automated and standardized GIS-based environmental screening analysis application and numerous tools for data entry, review, and reporting. A more detailed description of the tool can be found in Appendix D.

Since 2003, the ETDM process has been integrated into the normal business practice of the Florida DOT (FDOT) and its partners. FDOT developed and adopted the ETDM manual which codifies its commitment to the process and supporting technology. During the 2 years of operation, the user community has grown to over 500 people including staff from nine FDOT Districts, 26 MPOs, and 24 resource agencies, not including the number of people accessing and interacting with the public access site. Presently, there are over 500 environmental resource GIS data layers in the system and over 600 proposed transportation improvement projects loaded into the EST database, of which 220 have completed a formal screening through the ETDM environmental review process.

Benefits from the use of the EST in the ETDM process include early identification of avoidance and minimization options, improved interagency communication and coordination, and electronic documentation of project information.

Virginia

In 2003, Virginia highlighted two data development efforts, introduced the concept for a comprehensive environmental database that included spatial analysis, and presented a vision for collaboration.

The state Department of Conservation and Recreation presented a collaborative effort with the Virginia DOT (VDOT) to spatially enable conservation sites and stream conservation units for use in regional analysis and project review. The Department of Historic Resources highlighted a collaborative effort with VDOT to develop a web-based application for collecting and presenting data on historic resource sites throughout the commonwealth. In both examples, VDOT funded the majority of the effort and provided some technical assistance or direction.

In 2003, VDOT's environmental division was beginning development of a comprehensive data collection and reporting tool (CEDAR) that would incorporate the department's existing GIS application. The GIS application, or Integrator, had been in place in the agency since 2000 and in 2003 this was being maintained as a stand-alone application.

In 2006, VDOT continues to fund data development efforts with its partner state resource agencies due to staff or funding shortfalls at those agencies. This has led to data sharing agreements with these agencies to ensure that VDOT's GIS Integrator remains current and there is agreement on the acceptable uses of the data. VDOT has expanded from 8 data providers in 2003 to 13 currently.

VDOT began implementation of the CEDAR application in 2004. It is a common tool for managing and documenting environmental activities, decisions, and commitments on a wide range of projects. The application is available agencywide, interfaces with multiple enterprise systems, and integrates the use of the GIS technology into standard business processes. The GIS analysis is a critical first step in conducting the initial environmental review or inventory when a project is submitted to staff through CEDAR. This analysis helps determine the environmental scope of the project and provides a foundation for discussions between VDOT and resource agency staff.

The vision of a distributed information network has been achieved to a large extent within VDOT, but connections with external agencies are still missing. Not all resource agencies in Virginia have matured to this level of technology due in part to funding issues and in part to a lack of statewide emphasis on the benefits of these investments.

Washington

In 2003, Washington State discussed three key environmental GIS collaborative successes:

- Natural Resources Information Portal,
- Framework Data Project, and
- Environmental GIS Workbench.

The state's natural resource and environmental agencies, partnering with the Washington State DOT, cooperatively built the Natural Resources Information Portal website with grant funding (see Appendix F). The portal provides a way to discover available data, contact the data steward, and acquire the data. Initially there were about 100 data sets listed in the portal.

In 2006 the state's Natural Resources Information Portal continues to operate, but only 41 more data sets having been posted. This is a result of (*a*) getting most of the state agency data sets into the original listing in 2003 and (*b*) not being prepared with guidelines and procedures for new organizations to list their data on the portal. Attempts to fund building of the web-based GIS interface to the portal failed. The interagency committee that oversaw portal development has actually continued to operate and provide an interface between GIS data managers of the state's environmental and natural resources.

Framework data projects for hydrography, orthophotos, cadastre, transportation, and elevation were all in progress in 2003. The general perception was that cooperation through the framework community of practice was improving the quality and quantity of available data, but it was unclear exactly what the product of the projects would be and how they would be managed.

In 2006, the framework data projects have delivered four types of data: cadastral, hydrography, orthophotos, and elevation. Mechanisms to manage these data have been established.

In 2003, about 100 people were using the workbench. Inside WSDOT, the Environmental GIS Workbench had been in operation for 4 years. It provided 120 available environmental and natural resource data sets and six tools through a simple menu interface.

The use of the Environmental GIS Workbench has more than tripled in the last 3 years and the number of data sets has increased over sixfold. Currently, about 325 WSDOT environmental, scoping, planning, and project development staff use the application. Over 700 environmental and natural resource data sets are available through the Environmental GIS Workbench. Data are acquired and updated as appropriate from 12 federal, 9 state, and 15 local agencies, plus data from private, tribal, and academic sources. Use of the Environmental GIS Workbench is considered standard procedure for project scoping, environmental documentation of categorical exclusions, and biological assessments, and to support compliance with permit requirements.

Because of the popularity of the Environmental GIS Workbench, the application was rebuilt in 2004 to be a generic GIS workbench accommodating multiple geospatial information needs of WSDOT. Each of five different business areas now has a custom menu with data and tools needed for its business process. The multiple-business area nature of the new GIS workbench has made it easy for environmental factors to be included in the new systems analysis (project scoping) part of the workbench.

Texas

Since 2003, there have been a number of successes in Texas in the analysis, sharing, and development of geospatial environmental data for transportation. These successes have been the result of coordination and cooperation among governmental agencies and the private sector.

A prime example of a spatial analysis project accomplished through multiagency shared effort has been the Texas Environmental Resource Stewards–Texas Ecological Assessment Protocol. It built on work accomplished by Sharon Osowski of the EPA and was developed through the encouragement and support of Dominique Lueckenhoff, also of EPA. In addition, this project had the support of The Nature Conservancy in Texas, Texas Council of Environmental Quality, Texas DOT, FHWA, USFWS, ACE, and Texas Parks and Wildlife Department (TPWD).

The purpose of the project was to identify ecologically important resources across the state to support greater collaborative approaches to strategic ecosystem management. The resulting model allowed for the mapping of avoidance areas for the Tier One Study and the Draft Environmental Impact Statement (EIS) for the proposed Trans-Texas I-69 Project. In addition, the Arc Internet Map Server (ArcIMS) I-69 web viewer developed by Steve Schwelling, in TPWD GIS Lab, provided more detailed data depicting threatened and endangered species sites to avoid. To share data, the ArcIMS I-69 web viewer was developed with funding from the EPA. It was designed to provide TXDOT and the I-69 contractors with web-based access to the threatened and endangered (T&E) species data historically accessed from the TPWD paper maps.

An additional project, the Pineywoods Conservation and Mitigation Area, was a joint effort with TXDOT, USACE, TPWD, the Conservation Fund, HDR Inc., and the Neches River

Corridor, LP. It was a project to develop and verify data for mitigation with the use of 7-in. resolution color infrared (CIR) digital orthophotos, and GIS. Global Positioning Satellite (GPS) system-enabled, field-hardened tablet computers were used for field data collection. These tools helped increase the accuracy and timeliness of the habitat mapping for the 33,400-acre site. It was estimated that without the use of these technologies this 18-month project would have taken several years and hundreds of thousands of additional dollars.

Poster Session

Mid-Atlantic applications showcased as posters at the Peer Exchange ranged from extensive web-based data integration and analysis tools [VDOT, Pennsylvania DOT (PennDOT)] to the integrated application of GIS data for single-project analysis [New York State DOT (NYSDOT)]. See Appendix D for a more detailed description of the posters and other projects and applications described during the Peer Exchange workshop.

GEOSPATIAL DATA NEEDS

Much of the discussion at the Peer Exchange focused on the data needs, the differences between data needed to serve the business functions of DOTs versus the environmental agencies, and how to bridge the gap between these divergent needs. One session addressed how GIS data are used in DOTs and what GIS data are needed by environmental agencies. Another session took a look at specific data needs in the Mid-Atlantic States. This section summarized points made in both sessions and throughout the Peer Exchange.

Transportation Agency Perspective

Frank Desendi, manager of the Geographic Information Division of PennDOT, provided an insightful assessment of environmental GIS for transportation from the DOT perspective. Much of this section is paraphrased from his presentation.

A transportation agency that has deployed GIS technology into its planning processes derives several benefits, as follows.

- Defendable decisions—GIS gives planners and engineers a systematic, repeatable process to target locations of critical need. However, the nature of GIS allows easy and immediate modifications as outputs are evaluated or new priorities arise. The use of objective criteria makes transportation management decisions defendable.
- Data integration—Transportation agencies leverage integration by combining items like roadway classification, traffic counts, roughness, and pavement and shoulder widths. However, current roadway conditions are not the only integration points. Temporal components like historic or candidate projects can be included in an analysis too. Therefore, engineers can review what has been done and what is planned, and then extrapolate future needs.
- Data validation—Tabular reporting does not lend itself well to data validation, particularly where location is a component. Maps, created through GIS, are superb data validation tools. They make it easy to confirm work activities and road conditions are true for a given location. Engineers, planners, and maintenance personnel can quickly look at a map and

identify data errors. Since data analysis is the basis for decision making, decisions can be only as good as the data. Bettering the data leads to improved decision making.

DOTs are seeking ways to improve the delivery of information to decision makers. The approach DOTs are taking is to combine the power of GIS with the ease and accessibility of the Internet. Putting the known benefits of GIS as close as possible to the daily work methods of decision makers is positioning GIS to be an even more effective tool.

However, data traditionally collected and maintained by a DOT are of high resolution and concerns the infrastructure that needs to be maintained or built. The data are designed to meet the business function of building and maintaining infrastructure and improving mobility and goods movement.

Within planning divisions of DOTs, the need for more general environmental data is recognized, but challenges in data availability are apparent. As an example the Maryland State Highway Administration (MDSHA) GIS group acquires data from other state agencies such as the Department of Planning, Department of Natural Resources (DNR), and the Maryland Department of the Environment as well as developing some in-house data (streets and structures). For Environmental Justice data, MDSHA uses outreach through public meetings to get data to the public. Other types of information and data collected by MDSHA include aerial imagery, population surveys (Census), cultural resource data, field surveys, and U.S. Geological Survey (USGS) maps which tend to be outdated and sometimes archived.

Environmental Agency Perspective

Environmental agencies are responding to a plethora of regulatory requirements that cover environmental issues from endangered species to air and noise pollution to environmental justice and Americans with disabilities. Dominique Lueckenhoff, associate director of the Water Protection Division and Director of the Office of Watersheds for the EPA's Region III, listed 49 different items of environmental legislation that affect transportation (see Appendix F). Data needed to meet these legislative requirements for analysis are substantial. More detailed analysis is needed to protect the many aspects of the environment, from subterranean to atmospheric, but more studies require more, and more detailed data. Some of the key environmental data needs discussed during the Peer Exchange include but are not limited to

- Stream mapping (both revisions and new data creation),
- Wetland identification,
- Land cover,
- Soils,
- Cadastral/parcels with addresses, and
- Geologic maps in 1:24000 scale.

In some cases, adequate environmental data are available but only for a limited geographic extent. For example, the Soil Survey Geographic database (SSURGO) produced by the Natural Resources Conservation Service (NRCS) is a potential source of data that can identify wetlands or related soils via queries. But not all areas are fully covered by the SSURGO data. Like SSURGO, most environmental GIS data are available inconsistently across

geographic areas and are not maintained with regularity or metadata. These data needs are extensive and costly.

Challenges for Environmental Geospatial Data for Transportation

From some perspectives, the business case for a DOT to acquire or develop environmental data is diminishing. DOTs are focusing their attention on maintaining existing roadways. The need for environmental data is minimized with this business approach. Furthermore, much of the environmental data a DOT would need simply is not available electronically. The creation of environmental data in a GIS format is labor intensive. Regulatory environmental agencies have not delivered GIS data sets that improve the planning efforts of regulated agencies such as DOTs. Instead of treating the environment as an asset they manage, they have focused on the business of where permits need to be issued. In contrast, a DOT has collected volumes of information about its assets—roads and bridges.

Of the environmental data that have been created, they are often too coarse to be applied by a DOT. A transportation agency performs planning at a scale higher than what current environmental data sets support. Additionally, the very best environmental data sets are dispersed and local. They generally do not encompass the full geographic area required by the DOT.

The proprietary nature of some environmental data sets is also an issue. Environmental data owners sometimes must deny access to data sets for security reasons. The environmental agencies are sometimes reluctant to share wildlife data such as sensitive species and habitat areas due to conservation concerns. The availability of such data can be a resource to those who might not have conservation-minded intentions. In many cases, the environmental agencies have developed an informal relationship with the organization that collected these data and they do not want to jeopardize this relationship by making such data available to everyone. Furthermore, collection of data on private land is essential to identifying green space and biodiversity but can be very sensitive. Private landowners have to be convinced that these data will not be made available to the public.

This can present particular challenges to a DOT. For example, in Pennsylvania, the DOT has been denied access to the endangered species GIS data set. Many of the endangered species in Pennsylvania are aquatic; therefore, Pennsylvania's bridge replacement and rehabilitation planning would be greatly enhanced by knowing where endangered species are an issue. The consequence of this data availability anomaly is that DOTs mount large data collection efforts aimed at project-specific, permit-specific needs. These environmental data may not be incorporated into a larger, comprehensive environmental GIS for transportation data repository.

It was noted that DOTs are paying for a great deal of localized environmental data that it does not store. Once consultants have finished with environmental data they are filed—not delivered to the DOT for inclusion in a GIS. The DOT does not contractually obligate the delivery of the environmental data collected by consultants. The DOT may not need to revisit those data for years. Therefore, a DOT is not irrational but is moving on to the next project.

Cost-sharing advantages are often cited as an advantage of collaborative efforts but can also be a challenge due to varying economies of scale. In some cases, the data needed for a single project are so substantial that it is advantageous to go ahead and collect all the data needed, even if some required data might exist in another form in another organization. In other cases, extensive data needs make the marginal cost of collecting some additional attributes easily

absorbed. In still other cases, smaller projects may be able to afford only the required data collection if a consortium of organizations can pool resources to share in the fixed costs.

Another key data problem for projects which cross state lines is that the shared data do not always match up and often require a licensing agreement. Data gaps occur at the state lines.

Toward Collaboration

The enormous data needs for environmental GIS for transportation, the permit and project focus of regulatory agencies, and the DOT focus on mission critical-infrastructure-based GIS data repositories all constitute challenges to an ecosystems approach to conservation and infrastructure planning. Collaboration within a community of practice was seen by many Peer Exchange participants as the path toward addressing this challenge.

A general undercurrent of the Peer Exchange was the importance of interrelatedness. Shared data lead to collaboration which leads to alliances, which then leads to systems approach to conservation and infrastructure planning, which finally leads to more shared data.

Many participants related experiences in which data sharing led to improved collaboration and analysis and where collaboration led to improved data quality. As an example, in Pennsylvania, the DOT and the Historic and Museum Commission (PHMC) teamed up to deliver historic and archaeological information integrated with roadway information and video logs. The foremost result has been a stronger relationship between the agencies. The targeted outcomes have also been achieved: shorter DOT project review times, decreased DOT consultant costs, a technologically viable PHMC, and a tool that supports research and education.

As noted by MDSHA, awareness of the availability of data and where to get them is a significant issue with MDSHA. In many cases, the data are there but people do not know how to get them or how to use them. A centralized location and standardized procedure to get data would help. A single GIS point person for each office would assist in maintaining awareness of the capabilities of the GIS system and the data available. This step toward improved communication was seen as the first step toward a more comprehensive collaborative protocol.

The Florida experience with the ETDM and the Texas experience with the Ecological Assessment Protocol are collaboration success stories. Another similar effort is in the planning stages in North Carolina. The North Carolina Center for Geographic Information and Analysis is developing "NC OneMap" a vision for the use of geographic information and GIS in North Carolina. The North Carolina Interagency Leadership Team (ILT) has adopted the NC OneMap vision and will build on it to support the need for a comprehensive shared GIS database. The ILT's mission is to successfully balance mobility, natural and cultural resources protection, community values, and economic vitality in the delivery of services to the citizens of the State.

See Appendix D for more information and links to NC OneMap, Texas's Ecological Assessment Protocol, and Florida's ETDM.

COLLABORATION CHALLENGES AND THE COMMUNITY OF PRACTICE

The theme of collaboration and its challenges was apparent throughout the Peer Exchange. Most sessions underscored the various challenges to collaboration, including such issues as

- Propriety data,

- Divergent business drivers,
- Access to information about available data,
- Institutional and organizational barriers, and
- Scarce human and financial resources.

Collaboration in the Highland Action plan by Virginia, Maryland, West Virginia, and Pennsylvania was related as a success story in working across the state boundaries for long-range planning. The state liaisons work together to identify conservation, recreation, and economic development opportunities. It underscored the value of looking at programs with a geographic focus, with intentions of building relationships before urgent situations arise.

Many other success stories clearly identified the environmental streamlining advantages of collaboration and noted further that the collaboration led to further alliances that served for continued growth of the collaboration.

For example, Maryland's DNR worked closely with MDSHA to evaluate watershed mitigation sites, hydric soil, riparian forest buffers, and habitat conservation. MDSHA found this collaborative relationship very beneficial since it saved them time and money. The DNR shares the data on its server and concluded that the cost to maintain those data was minimal; however, the return on benefits was substantial.

Noting frequent references during the Peer Exchange to the divergent business functions of environmental agencies and state DOTs, Keith Miller of the New Jersey Transportation Planning Authority (NJTPA) noted that MPOs could be well suited to serve as collaborating agencies for environmental GIS for transportation data and technologies. MPOs were mandated by Congress in the Federal-Aid Highway Act of 1973 and then further strengthened in subsequent transportation acts. The main role of the MPO is to provide an environment of cooperative and comprehensive input into the transportation planning activities, and to serve as a forum for sharing ideas and information. Additionally, the MPO can serve as the catalyst to bring local environmental expertise and issues into the transportation planning process. In many cases MPOs cross state boundaries, improving their ability to reach out to a wide-ranging group of constituents with a common community of interest. Miller stressed that if MPOs are able to fulfill their mandate, all transportation projects should be fully vetted from both mobility and environmental perspectives before they are approved for the Transportation Improvement Program. The reality is that resource constraints limit the MPOs' ability to fulfill their mandate.

A collaborative environment, initiated through an MPO or some other consortium of stakeholders, may be one way of moving the discussion of environmental GIS for transportation from a focus on project-level review to a focus on programmatic or community-level planning and review.

An example of an effort to move toward this collaborative, programmatic focus was found in the Maryland Green Infrastructure Assessment. This program began in 2000 out of a concern about increasing fragmentation of forested land and lost of biodiversity. The process began by identifying key "umbrella" species and then prioritizing the resources needed to protect those species. With this ecosystem approach the state was able to define hubs of greater than 250 acres with corridors to connect the hubs. The hubs and corridors define the Green Infrastructure adopted by many of the state's counties as an ecological resource for protection.

ANTICIPATING THE FUTURE

The Peer Exchange addressed not only challenges and success stories but also took time out to envision the future. Insights into both technical advances and visions of a collaborative organization were offered by two Peer Exchange participants.

The Future of Geospatial Data Technologies

R. David Lankes presented an intriguing vision of trends in building collaborative, web-based systems. While some of the concepts presented could certainly be used within an organization, the focus and examples were between organizations. The point was to look at high-level trends in Internet development and imagine how environmental and geospatial data can be used to build a rich and diverse community of government agencies, nonprofits, commercial organizations, and the public at large.

The most recent spate of web-based trends can be summed up in the Web 2.0 movement.[1] For many, Web 2.0 has become a buzzword with many shades of meaning. However, the presenter used the term to incorporate emerging best practices in web application design. Many of these practices have emerged from either survivors of the .com era (Amazon, Google, Yahoo!) or from new popular websites (Flickr, Zillow, MySpace). These practices are based on open and lightweight (easy to implement) technologies such as XML, AJAX, Javascript, HTTP, and RSS.

A great deal has been learned about how to build useful collaborative applications on the web. This knowledge is very useful to agencies, organizations, and individuals who seek to better utilize environmental data. By participants building and constantly updating lightweight discrete applications distributed across the Internet, environmental and spatial data can breed a whole new community of dedicated users and supporters. New environmental applications can be developed, tested, and explored much more rapidly. New partnerships between the government, not-for-profit, and commercial organizations can be formed and crucial environmental stewardship activities can be greatly enhanced.

The full text of Lankes's presentation can be found in Appendix G.

The Collaborative Organization

A visionary solution offered by Ira Beckerman, Cultural Resources Section Chief, PennDOT, involved the establishment of a Mid-Atlantic GIS Consortium for the purpose of providing environmental analysis on transportation projects. He offered this as a "straw dog" solution to many of the problems recounted during the Peer Exchange: lack of DOT interest in off-roads GIS, special consideration of sensitive data, recruitment and retention of GIS professionals, and funding.

The Consortium would be nonprofit, possibly in partnership with an established university GIS program, providing services such as

- GIS environmental mapping for all EIS-level projects for partnering DOTs,
- Environmental mapping for MPO planning,

[1] For more information on Web 2.0, see O'Reilly, T., "What Is Web 2.0? Design Patterns and Business Models for the Next Generation of Software," 2005. http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html. Accessed May 5, 2006.

- Environmental analyses for Linking Planning and National Environmental Policy Act (NEPA) initiatives, and
- Developing environmental data for cumulative and secondary impact studies.

The Consortium is envisioned as a stand-alone GIS operation, with equipment, data, and personnel. Initially funded as a pooled-funds venture, eventually, the Consortium would be self-sustaining from fee-for-service operations.

Initially, the main deliverable that the Consortium would produce would be mapping for all EIS-level projects in the region. Key advantages of this arrangement include the following:

- The Consortium would operate outside of state IT requirements.
- Confidential data would be kept more secure, and access could be better controlled.
- Data collected from EIS-level projects could be fed back into the database easily.
- Agencies could begin to look at natural ecosystems and regions and not be limited by state borders.
- This platform permits (and encourages?) the full analytic power of GIS, including use of spatial statistics, modeling, and land use classification schemes.

Beyond EIS-level data layers, the Consortium could produce mapping for use by the Mid-Atlantic MPOs and regional planning organizations (RPOs), consistent with the FHWA's Linking Planning and NEPA initiative, as well as Section 6001 of SAFETEA-LU. Ultimately, the Consortium would be charged with developing analytic methodologies for analysis issues such as cumulative and secondary impacts and suburban sprawl while providing the data resources necessary for others to produce their own mapping products.

A more complete description of this hypothetical consortium can be found in Appendix H.

SUMMARY

The conference highlighted several examples of successful collaboration, data sharing, and the effective use of environmental GIS data in transportation planning. While it is easy to focus on obstacles in the path forward, it is important to share lessons learned from each others' experiences. The Peer Exchange was a great success in sharing experiences within the broader transportation planning and resource management communities.

The key takeaway themes from the conference can generally be grouped into three highly interdependent categories:

1. Environmental stewardship, streamlining, and sustainable growth;
2. Importance of effective collaboration; and
3. Building capacity for data management and sharing.

Environmental Stewardship, Streamlining, and Sustainable Growth

Environmental review streamlining for transportation is a complex issue. It consists of a combination of expert judgment, technological solutions, process negotiation, adaptability, effective collaboration, and compromise between resource agencies and transportation planners.

Many participants noted that environmental review streamlining should be approached cautiously and should not be confused with environmental review "shortcutting." Creating efficiencies in effective environmental review is the goal, not finding ways to sidestep processes that are in place for the protection of our vital natural resources.

Geographic information is critical to environmental review streamlining. However, some participants cautioned that geographic information is not a magic bullet. Human intervention and expert judgment cannot be removed from the equation. Technology, including geographic IT, can be a useful tool but may be fallible.

Importance of Effective Collaboration

Effective collaboration is dependent on trust-based relationships among people. This requires communication, which requires time and commitment on the parts of all collaborating parties.

Trusting relationships in the world of environmental review streamlining requires clear communication of

- Data interpretation procedures;
- Intent of policies;
- Desired outcomes;
- Limitations of data use;
- Competing goals, obstacles, and opportunities; and
- Incentives, including workload sharing, funding, efficiency of data sharing, and other potential gains by collaborating parties.

In the discussions segment, it was noted that effective collaboration is also dependent on gaining management buy-in, building faith in data resources, balancing territorialism, mandating consultation requirements such as SAFETEA-LU's Section 6001, and developing memorandums of agreement between transportation and resource agencies.

Building Capacity for Data Management and Sharing

The concepts pertaining to Web 2.0 presented by Lankes were thought provoking. Successful environmental review streamlining in the future will be dependent on *integration* of data and systems, not *consolidation*.

Building the capacity for data management and sharing is dependent on creating enterprise systems and developing a community of practice. Obstacles to effective data management and sharing that were cited by participants include the IT–GIS divide, turnover of staff, securing management buy-in, bandwidth concerns, data security, and creating information that does not currently exist.

APPENDIX A

Environmental Geospatial Data for Transportation
Agenda

May 3–4, 2006
The Keck Center, Washington, D.C.

WEDNESDAY, MAY 3

7:45 a.m.–8:30 a.m. Continental Breakfast

8:30 a.m.–9:00 a.m. **Opening Remarks**

FHWA Environmental Technology Initiatives
Shari Schaftlein, Program/Policy Development Team Leader, Federal Highway Administration

Workshop Objectives
Leni Oman, Director of Transportation Research, Washington State Department of Transportation

9:00 a.m.–10:00 a.m. **The Case for GIS**

Improving Environmental Data by Leveraging Limited Resources
Marty Spitzer, Professional Staff Member, Committee on Science, U.S. House of Representatives

Improved Transportation Decision Making Using Geospatial Technology
Jill Hochman, Director, Interstate and Border Planning, Federal Highway Administration

Data Sharing and Environmental Geospatial Information in Transportation Permitting: Current Issues and Future Trends
Mark Sudol, Chief Regulatory Branch, U.S. Army Corps of Engineers

10:00 a.m.–10:30 a.m. **GIS in the Mid-Atlantic Region**

Overview of Participants and Background Documents
Bill Jenkins, Chief, Environmental Information and Analysis Branch, Environmental Protection Agency, Region III

10:30 a.m.–11:00 a.m. Break

11:00 a.m.–noon **Enhancing Collaboration on Environmental Geospatial Information: Lessons from the 2003 Exchange**
Leni Oman, Director of Transportation Research, Washington State Department of Transportation, presiding

Virginia
Angel Deem, Environmental Management Program Manager/Comprehensive Environmental Data and Reporting (CEDAR) Administrator, Virginia Department of Transportation

Washington
Elizabeth Lanzer, Environmental Information Manager, Washington State Department of Transportation

Texas
A. Kim Ludeke, GIS Lab Manager, Texas Parks and Wildlife Department

Florida
Pete McGilvray, Technology Resource Manager, Florida Department of Transportation

Noon–1:00 p.m. Lunch

1:00 p.m.–1:30 p.m. **The Future Is Here: The New World for Integrated Environmental Data Systems**
R. David Lankes, Director Information Institute of Syracuse, Syracuse University

1:30 p.m.–2:30 p.m. **Data for Decisions**

A Tour of How GIS Data Is Used in Transportation Decision Making
Frank DeSendi, Manager, Geographic Information Division, Pennsylvania Department of Transportation

A Tour of Information Needed by Environmental Agencies in Environmental Documents and Permits
Dominique Lueckenhoff, Associate Director of the Water Protection Division and Director of the Office of Watersheds, Environmental Protection Agency, Region III

2:30 p.m.–3:00 p.m. Break

3:00 p.m.–4:30 p.m. **Collaborating in a Less Than Perfect World**
Liza Fox, Idaho Department of Transportation, presiding
What to do when your standards are not the same, when your data are not the right resolution, or when the data are old or nonexistent. A round-robin of Mid-Atlantic states on successful uses of environmental data.

Developing a Collaborative Relationship Between Resource and Highway Agencies in Maryland
Christine Conn, Director, Ecosystem Analysis Center, Maryland Department of Natural Resources

West Virginia
Jason Workman, West Virginia Department of Transportation

Delaware Valley Regional Planning Commission
Patricia L. Elkis, Manager of Environmental Planning, Delaware Valley Regional Planning Commission

Group Discussion

4:30 p.m.–5:00 p.m. **Wrap-Up for the Day and Intent of the Evening and Next Day**
Tom Linkous, Chief, Division of Natural Areas and Preserves, Ohio Department of Natural Resources
Roger L. King, Associate Dean for Research and Graduate Studies, Mississippi State University

5:00 p.m.–7:00 p.m. **Reception and Poster Sessions**

Multisensor Data Acquisition for Corridor Planning and Environmental Assessment
Chuck O'Hara, Researcher, Mississippi State University

North Carolina OneMap Initiative and Its Relationship to the Highway Planning and Environmental Review Process
Tim Johnson, Director, North Carolina Center for Geographic Information and Analysis

Ivorybill Project
Robert Fuhler, Section Head—Environmental GIS, Arkansas Department of Transportation

Database Multitasking: Different Ways of Presenting and Cataloging GIS Data
Robert Fuhler, Section Head—Environmental GIS, Arkansas Department of Transportation

Florida's Environmental Screening Tool
Peter McGilvray, Technology Resource Manager, Florida Department of Transportation

The Use of GIS and Mega Projects
Michele Jones, Environmental Planner/GIS Analyst, Maryland State Highway Administration

Web Mapping Engine—A Simple and Easy Way to Use GIS Data Catalog
Kaushik Dutta, GIS Applications Manager, Maryland State Highway Administration

Streamlining, Mitigation and Conservation Remediation for Transportation
A. Kim Ludeke and Duane German, GIS Lab Manager, Texas Parks and Wildlife Department

The Harrison DOT Subresidency, Environmental Issues Related to a Maintenance and Salt Storage Facility Repairs and Remediation
Mauricio Roma, Environmental Specialist, New York State Department of Transportation

WSDOT's Environmental GIS Workbench
Elizabeth Lanzer, Environmental GIS Manager, Washington State Department of Transportation

Trees as Infrastructure in an Urban Environment
Holli Howard, Director of GIS and IT, Casey Trees

5:30 p.m.–6:00 p.m.
and
6:15 p.m.–6:45 p.m.

Presentation
CEDAR Project: A GIS Linked Tabular Database with Network Connectivity
Angel Deem, Environmental Management Program Manager, Virginia Department of Transportation

THURSDAY, MAY 4

7:15 a.m.–8:00 a.m. Continental Breakfast

8:00 a.m.–9:30 a.m. **Growing and Maintaining a Community of Practice in the Region: A Panel from the Mid-Atlantic States**
Kathleen S. Ames, Deputy Director, Office of Planning and Programming, Illinois Department of Transportation, presiding
A discussion by Mid-Atlantic participants on how to increase use of geospatial data in transportation and collaboration for environmental GIS applications. Topics will include benefits, resources available, sharing and maintaining resources, and GIS information for analyses including Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users provisions.

Virginia
Geraldine Jones, Environmental Geographer, Virginia Department of Transportation

District of Columbia
Faisal Hameed, Environmental Program Coordinator, District Department of Transportation

New Jersey Transportation Planning Authority
Keith Miller, GIS and Forecasting Manager, North Jersey Transportation Planning Authority

Group Discussion

9:30 a.m.–10:00 a.m. Break

10:00 a.m.–11:30 a.m. **Critical, Primary Environmental Data Layers Needed in the Region: A Panel from the Mid-Atlantic States**
Robert Fuhler, Section Head—Environmental GIS, Arkansas Highways and Transportation Department
A forum on the primary environmental data layers needed in the region, with an emphasis on those data that may already exist and those that need to be developed or refined. Discussion may include the use of proprietary data and cooperative efforts to find or create those data.

North Carolina
Tim Johnson, Director, North Carolina Center for Geographic Information and Analysis

New York
Mauricio Roma, Environmental Specialist, New York State Department of Transportation

Maryland
Julia Dietz, GIS Coordinator, Project Planning Division, Maryland State Highway Administration

Group Discussion

11:30 a.m.–12:30 p.m. **Key Take-Home Points**
Leni Oman, Director, Office of Research/Library Services, Washington State Department of Transportation

Pennsylvania
Ira Beckerman, Cultural Resources Section Chief, Pennsylvania Department of Transportation

Virginia
Sam Hall, Fish and Wildlife Information Services Manager, Virginia Department of Game and Inland Fisheries

Group Discussion

12:30 p.m. Adjournment

APPENDIX B

Biographies of Speakers and Panelists

Ira Beckerman is currently the Section Chief for Cultural Resources at Pennsylvania DOT (PennDOT) and has worked for the department for 13 years. As Section Chief, he is responsible for the archaeological and historic aspects of design for transportation projects, and supervises a staff of 12 architectural historians and archaeologists. The program includes a partnership with the Pennsylvania Historical and Museum Commission on the cultural resources GIS, as well as the annual sponsorship of the Byways to the Past Conference, a publication series, a historic bridge marketing program, and numerous strategic initiatives. He previously worked for the Maryland State Highway Administration. Ira received a Ph.D. in anthropology with a specialization in archaeology from Penn State University.

Christine Conn is the Division Director for the Ecosystem Analysis Center at the Maryland Department of Natural Resources. The center specializes in GIS analysis and application development to provide ecological and economic landscape assessments and decision-support tools for conservation and restoration efforts. Maryland's Green Infrastructure Assessment, which identifies and prioritizes a network of ecologically valuable lands across the state, has been recently used in several state highway transportation projects. Christine has been with the Maryland Department of Natural Resources since 2000, following several years of teaching biological sciences in universities in New Jersey, Pennsylvania, and Maryland. Christine received her Ph.D. in ecological sciences from Old Dominion University in 1995

Angel Deem works for the Virginia Department of Transportation (VDOT) and is responsible for administering the Comprehensive Environmental Data and Reporting (CEDAR) system, managing the department's environmental GIS program, and managing quality assurance quality control for statewide environmental data management. She has a B.S. in biology with an emphasis on environmental studies from Virginia Commonwealth University. Angel has worked for VDOT's Environmental Division for 12 years.

Frank DeSendi is the manager of the Geographic Information Division in the Bureau of Planning and Research at PennDOT. The division is composed of three sections—Cartography, GIS, and Systems Administration. Cartography is responsible for standard and custom map products published by PennDOT and other Pennsylvania agencies. The GIS section develops custom GIS applications, scenario mapping, data extraction, and reports for the DOT and other agencies. The system administration section maintains the workstation, server, and database infrastructure to support operations. All three sections support distributed GIS operations in each of PennDOT's 11 district offices. Frank is a graduate of Penn State University with a geography degree. He has been at PennDOT for 17 years.

Julia Dietz earned a B.S. degree in geography and environmental planning from Towson University, with an emphasis in GIS. Her responsibilities at the Maryland State Highway Administration (MDSHA) involve coordination and facilitation among MDSHA personnel and its partners. Specifically, as GIS Coordinator for the Project Planning Division, Julia assists personnel by promoting awareness of available GIS data and their uses, obtaining data that are unavailable from other agencies, and facilitating data exchange with other agencies and consultants who use MDSHA's data. She also ensures that MDSHA's GIS users have the tools needed to utilize this data, such as training, software, and hardware.

Patricia L. Elkis is the Manager of Environmental Planning at the Delaware Valley Regional Planning Commission (DVRPC), where she has worked in the Regional Planning Department since 1992. She oversees DVRPC's Open Space Planning Services for municipalities, and also works on greenway planning, sewer and water facilities planning, and projects that promote the principles of New Urbanism. She has worked on DVRPC's long-range plans for the years 2020 and 2025, and 2030. New work includes improving coordination with the transportation planning division on open space and environmental issues related to transportation improvements. Patty received her B.A. in anthropology from the University of Pennsylvania, and her master's in city planning, with a certificate in appropriate technology for developing countries, also from Penn. She is a member of the American Institute of Certified Planners and is a licensed professional planner in New Jersey.

Sam Hall has served as the Fish and Wildlife Information Services Manager for the Virginia Department of Game and Inland Fisheries (VDGIF) since August 2005. The Fish and Wildlife Information Services section is responsible for managing and disseminating geospatial and nongeospatial data pertaining to all of Virginia's wildlife species. Prior to working at VDGIF, Sam served as the GIS manager in the Pipeline and Hazardous Materials Safety Administration of the U.S. Department of Transportation (U.S. DOT). Sam holds a bachelor's degree in environmental sciences from the University of Virginia and a master's degree in geography from George Mason University.

Faisal Hameed is currently working as a Project Manager on various planning, environmental, and design projects at Washington, D.C.'s, Department of Transportation (DDOT). He has a bachelor's degree in chemical engineering and a master's degree in civil engineering with minor in geospatial engineering.

Jill Hochman is the Director of FHWA's Office of Interstate and Border Planning. Jill coordinates and directs development of national policies, guidelines, standards, procedures, and techniques to improve binational planning. She provides direction in developing planning methods, analysis and tools including applications of GIS, spatial data, and deployment of advanced planning methods and leads a program to improve transportation analysis and modeling and use of data, data tools, analysis, and policies. She directs and oversees several grant programs designed to improve investments at national border facilities and in the Delta region. She also directs financial and policy oversight for all planning, environment and realty research and technology programs, including the Surface Transportation Environment and Planning Cooperative Research Program. Jill has worked at the U.S. DOT since 1976 and has

served in many positions across several transportation modal agencies. She was educated at the University of Maryland.

Bill Jenkins serves as the Chief of the Environmental Information and Analysis Branch in EPA's Region III Office. His responsibilities include leading the region's Indicators and Outcomes initiative, assisting the region's program offices and state partners in the integration of data and technology in programmatic decision-making processes, and managing the region's GIS resources. He is currently on an IPA to the Region III office from the Maryland Department of Natural Resources (MDNR). At MDNR, his programmatic responsibilities included developing GIS-based watershed and landscape assessments and analytical tools to prioritize and target areas for restoration and protection such as Maryland's Unified Watershed Assessment, and Green Infrastructure Assessment; and creating integrated assessment, planning, and implementation strategies. His other professional experience, Bill has helped to create Maryland's Nontidal Wetland and Waterway Protection Act, and then subsequently served as the Director of Maryland's Nontidal Wetland and Waterway Protection Program. He has also worked as a county-level environmental planner and an ecologist for a private environmental consulting firm. He has a bachelor's degree in land planning, and a master's degree in natural resource management and planning, both from the University of Maryland.

Tim Johnson is the Director of the North Carolina Center for Geographic Information and Analysis (CGIA), an agency in the North Carolina Department of Environment and Natural Resources. He has 25 years of experience in assisting organizations with implementation of GIS as a decision-support tool. Tim directs the work of CGIA in support of the North Carolina Geographic Information Coordinating Council, including formulation of geospatial data and technology policies and development of implementation plans for Council actions. Tim has provided leadership for the NC OneMap initiative and has most recently worked with other agencies on the Interagency Leadership Team (ILT) GIS initiative. The ILT is a group of 10 state and federal agencies seeking to use GIS as a tool for more effective and efficient transportation planning while recognizing the value of North Carolina's natural and cultural resources. Tim received his master's degree in geography (and GIS) from the State University of New York at Buffalo and his bachelor's degree in geography from Appalachian State University.

Geraldine S. Jones has been an environmental geographer for Virginia's Department of Transportation (VDOT) Environmental Division since April of 2005. Her primary duties include managing and developing environmental GIS data, providing GIS training and support to the Environmental Division, and working with external data providers to obtain updates of layers, define business processes, and develop data sharing agreements. Ms. Jones has seven years of GIS experience in the transportation and environmental fields. Prior to VDOT, Ms. Jones worked as a planner for the Fairfax County Department of Transportation and as a research associate for the Conservation Fund/Freshwater Institute. Ms. Jones earned a M.S. in Agricultural Resource Economics from West Virginia University, and a B.S. in Environmental Resource Management from Virginia Tech.

Roger L. King is a William L. Giles Distinguished Professor and the Associate Dean for research and graduate studies in the Bagley College of Engineering at Mississippi State University. In his present position, he is responsible for the research establishment of the college

of engineering that is presently funded at $60 million per year. He is the IEEE (Institute of Electrical and Electronics Engineers) Geoscience and Remote Sensing Society Liaison to the IEEE–USA Committee on Transportation and Aerospace Technology Policy. He is also the Director of the U.S. DOT-funded National Consortium on Remote Sensing for Transportation—Environmental Assessments. Roger received his B.S. in Electrical Engineering from West Virginia University (1973), his M.S. in Electrical Engineering from the University of Pittsburgh (1978), and a Ph.D. in Engineering from the University of Wales–Cardiff (1988). Roger is a registered Professional Engineer in the state of Mississippi.

R. David Lankes is Director of the Information Institute of Syracuse and an Associate Professor at Syracuse University's School of Information Studies. His past research projects include the Gateway to Educational Materials, the Virtual Reference Desk, and the Educator's Reference Desk. He is currently involved in projects related to the National Science Foundation's (NSF's) National Science Digital Library, and several IMLS studies. David was director of the Education Resources Information Center (ERIC) Clearinghouse on Information and Technology from 1998 to 2003 and co-founded the award winning AskERIC project in 1992. ERIC is a comprehensive, easy-to-use, searchable, Internet-based bibliographic, and full-text database of education research and information that also meets the requirements of the Education Sciences Reform Act of 2002. He was a visiting scholar to Harvard's Graduate School of Education and a visiting fellow at the National Library of Canada.

Elizabeth Lanzer is the Environmental Information and GIS Program Manager, for Washington State DOT (WSDOT). She manages development and operations of data management systems supporting the agency's environmental work including the Environmental GIS Workbench, the Commitment Tracking System, and the Environmental Classification Summary system, as well as about 10 minor systems supporting stormwater, water quality, hazardous materials, compliance violations, and permit tracking. The program provides direct technical services for the use of GPS, building and maintaining web pages, generating GIS map and analysis products, and building small database applications. She is also working with the University of Washington on a research project evaluating several remote sensing technologies for detection of impervious surface areas. Elizabeth has a B.A. in Public Policy from the University of California at Santa Barbara and an M.A. in Administration from the University of California at Riverside. Prior to WSDOT, she worked for the Washington State Department of Natural Resources, and the Washington State Department of Ecology, and was responsible for develop the use of GIS within the organizations.

Tom Linkous is the Chief of the Division of Natural Areas and Preserves (DNAP) at the Ohio Department of Natural Resources. DNAP is responsible for the State Nature Preserve System, the Scenic Rivers Program, and the Natural Heritage Database in Ohio. Prior to his appointment to DNAP, Tom was the head of the Ecological and Permits Section at the Ohio DOT (ODOT) for over 25 years and developed the NPDES Stormwater Management Program for ODOT prior to leaving the department in 2004. Tom has a B.S. degree in Life Science from Otterbein College and an M.S. from Ohio State University in Natural Resources (Fisheries Management). He has been active in TRB since the 1990s, and has served on the Waste Management Committee and currently chairs the Task Force on Ecology and Transportation. He is also a member of the Steering Committee for the International Conference on Ecology and Transportation.

A. Kim Ludeke is the GIS Lab Manager at Texas Parks and Wildlife Department (TPWD). The GIS Lab has been involved in wetlands and habitat delineation for transportation mitigation planning. The Lab has also worked with the EPA and The Nature Conservancy in Texas on the Texas Ecological Assessment Protocol Pilot Project as part of a Tier 1 assessment to highlight areas of environmental sensitivity. Further, the Lab developed and maintains an internet map service site for the EPA depicting the locations of threatened and endangered species in the proposed I-69 and I-35 corridors. Kim is the agency representative to, and the former chair of, the Texas Geographic Information Council. This organization sets GIS policy for the Texas government and helps develop statewide base data sets. Kim has a Biology degree from the University of Texas and a Ph.D. in Park Planning from Texas A&M University.

Dominique Lueckenhoff has over 20 years experience in the environmental field. She currently serves as Associate Director of the Water Protection Division and Director of the Office of Watersheds for the EPA's Region III Office in Philadelphia. In this capacity, she is responsible for direct oversight of a variety of programs under the Clean Water Act covering the states of Pennsylvania, Maryland, Virginia, West Virginia, and Delaware and the District of Columbia and for managing significant allocations of federal funds. She is currently leading the Mid-Atlantic Green Highways Initiative, a public–private effort promoting innovative streamlining and market-based approaches to achieve sustainable solutions for transportation and environmental improvements. Formerly, Dominique was Transportation Liaison and NEPA Project Manager, while operating an Austin-based office, on behalf of EPA Region VI. She was instrumental in providing GIS and other types of technical environmental assistance to the transportation community. She holds an M.S. in Microbiology and Biophysics from the University of Houston and Rice University as a NSF Fellow, and a B.S., cum laude, in Microbiology and Chemistry from the University of Southwestern Louisiana.

Pete McGilvray works for the Florida DOT in the Environmental Management Office. He serves as the Technical Project Manager for the Environmental Screening Tool, a web-based GIS application designed to facilitate Florida's Efficient Transportation Decision Making Process. He also serves as the Project Manager for the Florida Geographic Data Library, a digital inventory of Florida GIS data assets. Pete has more than 7 years of professional information system implementation experience and has worked on numerous transportation GIS initiatives in both the private and public sectors. Pete has a B.S. in Social Sciences and a B.S. in Geography as well as an M.S. in Management of Information Systems from the Florida State University.

Keith Miller is the Manager of GIS and Forecasting at the North Jersey Transportation Planning Authority (NJTPA), the metropolitan planning organization for northern and central New Jersey. He has been at NJTPA for 5 years and his responsibilities include overseeing GIS, data, forecasting, and modeling work that supports the transportation decisions made by the agency. Prior to joining NJTPA, Keith worked for 13 years for an environmental consulting firm, using GIS, data, and water resources models to a study a variety of environmental issues. He earned a bachelor's degree in Environmental Engineering from Rensselaer Polytechnic Institute.

Leni Oman has been employed by the state of Washington since 1989. She is currently the Director of the Office of Research and Library Services with the Washington State Department of Transportation (WSDOT). In this position, she is responsible for managing an innovative

research program and all library resources affecting aspects of all modes of transportation in the state. She is the vice chair of the AASHTO Research Advisory Committee Region 4 and the executive director of the Washington State Transportation Center, a partnership of the University of Washington, Washington State University, and WSDOT. Leni recently completed a rotational assignment at the FHWA Turner–Fairbank Highway Research Center in the Corporate Research and Technology Program. She has assisted with the development of the exploratory advanced research program, the Surface Transportation Environmental and Planning Cooperative Research Program, and as improvement in the Transportation Pooled Fund Program fiscal procedures. Leni serves as the TRB representative for WSDOT and has been a member of the TRB's Conduct of Research Committee since 2004. Leni has a B.A. degree emphasizing Aquaculture studies from Goddard College and an M.S. degree in Veterinary Sciences from the University of Idaho.

Mauricio Roma is an Environmental Specialist with the New York State DOT (NYSDOT). His job responsibilities include the evaluation and preparation of reports, plans, specifications, policies, and procedures to handle waste materials, and the investigation and remediation of contaminated sites. Mauricio has 18 years experience as a hydro geologist. He earned a B.S. in Geology from the University of Salamanca in Spain and a master's degree in Geology from the State University of New York at Albany.

Shari Schaftlein has been the Team Lead for Program/Policy Development in FHWA's Project Development and Environmental Review Office in Washington, D.C., for 2 years. For 11 years previously she was with WSDOT's Environmental Office, where she held the positions of Water Quality Program Manager, Streamlining Initiatives Manager, and Deputy Director. She has also held environmental management positions with the West Michigan Environmental Action Council in Grand Rapids and the Quileute Tribe in La Push, Washington. Her degrees include a B.S. and an M.S. in Environmental Science from Indiana University.

Marty Spitzer serves as professional staff for the Science Committee in the U.S. House of Representatives, chaired by Congressman Sherwood (Sherry) Boehlert (R-NY). A member of the Science Committee staff since 2001, Marty oversees science and technology programs at the EPA and Research and Development at the U.S. DOT, including statistics; and works on a variety of federal agency initiatives designed to promote better data and performance measures. Before joining the Science Committee, Marty served as Executive Director of the President's Council on Sustainable Development at the White House, where he led the Council's work facilitating agreements among business, community, and environmental leaders. He lead an extensive public process to develop the council's seminal report "Toward a Sustainable America," and organized the public–private partnership that held the National Town Meeting for a Sustainable America in communities across the country. He also supported a White House–led effort among federal agencies to develop a set of national sustainable development indicators. Marty has served in various capacities at the EPA. He holds both a law degree and a Ph.D. in Policy and Management from the State University of New York at Buffalo. He holds a B.A. in Economics and History from Binghamton University.

Mark Sudol has been the Chief for the U.S. Army Corps of Engineers (USACE) Regulatory Program since 2002. He attended the University of Rochester on an ROTC scholarship. After

college, Mark signed up for the Navy, where he served for 8 years as a Flight Officer, working as a flight navigator, bombardier, and communications officer. He also worked in anti-submarine warfare. After his service, Mark attended the University of California at Los Angeles, where he started out in a biology master's program before moving on to a doctorate in Environmental Science and Engineering. He began working with the USACE through a summer job but veered into private consulting 2 years after graduation. By January 2000, he was again back at the Corps in the Los Angeles Regulatory Program Office. In September 2002, he became the Chief of the Regulatory Program.

Jason Workman is a Project Manager for the environmental clearance of transportation projects. Environmental clearance is attained through the execution of field surveys; investigation of existing and potential natural resource conditions; and coordination with local, state and federal agencies. Jason prepares environmental documents developed in accordance with the National Environmental Policy Act (NEPA) and the FHWA. He performs wetland delineations, freshwater mussel surveys and stream surveys, and prepares and updates appropriate databases.

APPENDIX C

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APPENDIX D

Applications and Programs Showcased by Participants

Comprehensive Environmental Data and Reporting System

ANGEL DEEM
GERALDINE JONES
Virginia Department of Transportation

Environmental Program Overview

The mission of the Virginia DOT's (VDOT) Environmental Division is to assist in the delivery of the transportation program by providing accountability, regulatory compliance, and team leadership. The Environmental Division is organized into seven program areas: (1) Air, Noise, and Energy, (2) Natural Resources, (3) Cultural Resources and Environmental Data Management, (4) District Programs, (5) Hazardous Materials, (6) Project Study Management, and (7) Consultant Services. Each of VDOT's nine districts has an Environmental Section composed of programs and staff that have a counterpart in the Central Office. Staff in the district offices are responsible for conducting project-related activities and are more hands-on managers of environmental clearance activities while Central Office programs involve statewide administration, technology transfer, and program management. Cultural Resources and Hazardous Materials staffs operate on a regional basis to support multiple districts within a defined area. Another key organizational element is that each District Environmental Section has hired environmental staff based at the residencies to provide environmental guidance and assistance to residency staff.

Environmental team members have lacked a consolidated, automated tool to track the work they perform. A survey of environmental staff uncovered that more than 73 applications are in use by environmental staff members throughout the state. These tools range anywhere from enterprise systems such as Project and Program Management System written in Adabas/Natural to Excel Spreadsheets and Access Databases built to suit individual user needs. Many of these small stovepipes are duplicated from one district to the next and most involve duplicate data entry.

Summary Project Objective

To address the opportunities for business and technical enhancements, the division embarked on a project to develop an automated environmental data system to gather and store environmental data, document decisions and commitments, and implement solutions (both technical and nontechnical) to streamline operations. The CEDAR system is the culmination of the Environmental Division's 5-year effort to streamline its business and technology needs.

CEDAR provides a single-user interface through which environmental staff statewide enter and retrieve data. The focus of the application is to make it easier for environmental staff to perform their duties, with special attention given to meeting the needs of district staff who

handle the majority of the clearance activities. This support will eventually extend to division consultants to ensure consistent improvements. In the future the project will incorporate users from the 20 federal, state, and nonprofit entities with whom VDOT must coordinate environmental clearances.

The critical business objectives being addressed by CEDAR include

- Improved project management;
- Documentation of environmental decisions;
- Communication of environmental commitments;
- Communication of project status;
- Improvement of accountability;
- New basis for program management and trend analysis;
- Streamlining of interagency coordination;
- One tool for all environmental activities;
- Reduction in duplicate date entry; and
- Consolidation of recent IT success (GIS, data warehouse).

CEDAR enables the division and its customers to have current data on the status of various activities for which the division is responsible. One key thrust of the solution is consolidating myriad data sources into a single, authoritative database.

Some other key components of CEDAR include

- **One central repository for projects**—Activities pertaining to all projects will be available in one place. Maintenance, construction, PPTA, and Capital Outlay projects are all tracked in a myriad of tools.
- **All environmental functions included**—Previous efforts have focused on one business unit alone. CEDAR takes a holistic approach to meeting the needs of the environmental program.
- **Electronic file management**—Environmental review process relies heavily on the exchange and management of documents. Resources are committed to mailing, copying, and finding hard-copy documents.
- **Merge of existing successful technologies**—CEDAR did not abandon existing applications. Rather, it incorporates the best of breeds and facilitates interfaces where possible. The GIS Integrator provides a good illustration. CEDAR folds the Environmental Integrator into its GIS application. VDOT will continue to develop data sharing partnerships with review agencies. CEDAR merges GIS functionality with the system's non-GIS modules to allow users to switch between the map and html interfaces. It is also worth noting that specific GIS requirements identified for CEDAR are being applied to VDOT's GIS Integrator to bolster that tool's utility.
- **Scalability and extensibility**—One element lacking in the previous efforts is the ability to expand to meet changing needs. CEDAR provides a platform for Environmental Division's ever-changing, ever-growing responsibilities.
- **Extending functionality to all stakeholders**—CEDAR's initial focus is the needs of VDOT staff. Subsequent phases will bring in users from consulting firms and the federal, state,

and nonprofit entities with whom we coordinate project clearances. Interacting with our stakeholders online will allow for efficiencies for all parties.

The Technology of the Ivory-Billed Woodpecker Survey: State and Federal Agencies Work Together to Apply GIS and GPS to Search for a Rare Bird

ROBERT REED
MAX FARRELL
Arkansas State Highway and Transportation Department

Participants provided a representation of the methodology used to develop survey transects along a proposed highway alignment and the incorporation of a data dictionary for use on Trimble GeoXT GPS units. This poster covers the layout of the transects used for navigation, identification of criteria, the type of results discovered in the field, an overview of the equipment, and finally how those data collected were processed and utilized. Background on the woodpecker once thought extinct is provided, as well as information on the process used to prepare for and carry out the fieldwork and the incorporation of collected data into a GIS.

Database Integration in GIS

BART DUDLEY
Arkansas State Highway and Transportation Department

The Arkansas State Highway and Transportation Department is integrating both GIS and database programs into the Environmental Cursory Review process. Data are compiled from GIS sources for possible highway project locations and transferred to a projects feature class. The feature class then has data added to the attribute table through a database front end from non-GIS sources. Analysis is done on the data, and the database program is used to output a report of the environmental division's findings on constraints for the possible project. In short, the cursory review process uses both GIS technology and database design to produce documents, which help to streamline and improve the highway planning process.

Miscellaneous Applications from Washington, D.C.

FAISAL HAMEED
Washington, D.C., Department of Transportation

Faisal Hameed showcased several progressive GIS-based applications. The first was the 360°-image mapping of the obliques using the "pickometry" software. Mr. Hameed coined this the next version of maps that provide additional information by letting a user move around objects of interest, even determining height and actual coordinates from the images. Second, analyses were shown overlaying existing and proposed corridor improvements in relationship to wetlands. This application demonstrated the areas of the potential impacts which became the opportunities to

begin coordination activities with their resource and regulatory agencies. Third, Mr. Hameed demonstrated the integration of the electronic document management system into the full client GIS interface. Instead of users manually accessing the files over the network, the documents have been spatially enabled and hyperlinked for access through the mapping interface.

Harrison Subresidency: Maintenance Facility and Reservoir Protection, Westchester County, New York

MAURICIO ROMA
New York State Department of Transportation

Mauricio Roma presented a case study on the project level use and management of GIS and environmental data for regulatory decision making. In this case, the New York State Department of Transportation (NYSDOT) did not create data sets but utilized EPA Region II data sets.

The setting was a drinking water reservoir (an end point of New York City Reservoir system).that serves 9 to 11 million people. The water intake is for the reservoir is 300 yards from a NYSDOT maintenance facility which includes a landfill. A stream cuts through the landfill moving toward the reservoir.

A problem arose when landfill was excavated and 10 drums filled with paint were found. A Soil gas survey was done to detect volatile organic compounds associated with the paint drums. To address anomalous reading by the fuel tank areas adjacent to the landfill, the soil gas survey was expanded. Leaking underground storage tanks containing petroleum products were found.

For NYSDOT to assess the problem and to lay the foundation for determining the necessary remedial action, GPS was used to locate the extent of the landfill cap and geotextile layer. These were mapped using GIS. Monitoring wells were installed to determine if there was any migration of the contamination toward the reservoir. GIS was used to map the contaminant plume. The GIS mapping helped to pinpoint key monitoring points and provides good positional accuracy of data points. GIS allowed for working with the regulatory agencies to address remedial system. It was cost-effective and timely because the analysis and decision making could be done in real time with no delay.

Hydrocarbons (HCs) were found in the contaminant plume—benzene, MTBE, methylbenzene, toluene. Remedial action included the injection of air at points along the plume. Good positional accuracy of location of petroleum contamination plume helped to identify the optimal positions for the remedial lines. HC levels were reduced by 99% in 1 year and the plume visibly shrunk on the GIS maps. On the basis of data mapping of the plume, the environmental agency stated it was not a problem or threat to the reservoir.

The business case for GIS is that it helped to build environmental trust with environmental agencies and streamline the regulatory process. GIS facilitated teamwork with the regulatory agencies—particularly the Department of Environmental Conservation—to address an environmental problem.

Stormwater Outfall Mapping Project

MAURICIO ROMA
New York State Department of Transportation

In 1999, the EPA issued a Final Rule that established the NPDES Phase II regulations under the Clean Water Act. These regulations require municipalities and all state DOTs in urbanized areas to develop stormwater management programs. As part of this program, NYSDOT is developing a mapping system, showing locations of all drainage outfalls to waters of the United States and to other municipalities within the urbanized areas.

There are a minimum of 7,000 lane mi of state highways in these urbanized areas in NYSDOT regions, and the department has developed a methodology to obtain these data, and to have the drainage outfalls mapped by January 8, 2008. In addition to being a regulatory requirement, this mapping will be used as an asset management tool to help maintain the department's drainage system. It will also assist state Department of Health and Department of Environmental Conservation personnel to locate and identify illicit nonstormwater discharges.

This project uses an information gathering system to allow field personnel to obtain attributes of the drainage outfalls using GPS technology, and to store this information in a GIS for data maintenance and analysis. Use of GIS makes the process more efficient and accurate, and facilitates data sharing between cooperating municipalities. GIS provides a tool to not only track and manage the outfalls program, but also to effectively utilize the system for integrating with other components of the MS4 program.

As of April 2006, more than 1,800 drainage outfalls have been mapped along state highways and collaborative efforts are being made to incorporate datasets generated by other state entities.

North Carolina OneMap

TIM JOHNSON
North Carolina Center for Geographic Information and Analysis

Under state statute, the Geographic Information Coordinating Council (GICC) was established as North Carolina's (NC) GIS policy group. The GICC's purpose is to make better use of NC's investment in geospatial data and technology. It addresses policies, standards, and common issues facing GIS community, which include addressing the data needs challenges. A large diversity in membership (33 members from local, regional, federal, and state government agencies) helps the council to create innovative ideas and actions. The GICC also advises the state governor and general assembly, which ultimately helps communicate the importance of GIS systems and the need for funding to maintain and update these systems.

In 2003, NC OneMap was developed as the statewide GIS data resource. The vision of NC OneMap was to provide ready access to best available data, share data across agencies using the best available technologies, and ultimately to support decision making at all levels of government in North Carolina.

Currently over 90 agencies including 60 local governments are connected to the NC OneMap database. This allows for the easy refreshing of data at local levels. For example,

orthophotography, parcels boundaries, street centerlines, zoning, and sidewalks can be easily updated by county and state agencies.

The Interagency Leadership Team (ILT) is another important partnership in the NC GIS experience. Member of this team include the NCDOT, the Department of Environment and Natural Resources, Cultural Resources and Wildlife Resources Commissions, the Commerce Department, and the federal transportation and environmental agencies. The team's mission is to develop an interagency leadership plan to successfully balance mobility, natural and cultural resource protection, community values, and economic vitality at the confluence of agency missions. This team was formed in the past couple of years to improve communications and working relationships among NC governmental agencies. Since a shared comprehensive GIS was one of the top goals of this group, the team realized that NC OneMap could meet their needs for a comprehensive GIS with the right data and technology. NC OneMap can provide the geospatial backbone for economic development applications, interagency transportation planning and review, multihazard application, and local and regional applications.

A key issue with the ILT and NC OneMap is easily accessible, current, accurate, and complete data for the agencies to use and which is maintained on a regular basis. Currently, 171 data layers are in serious need of updating including the development of a plan for ongoing data maintenance activity. Of the top 10 priority needs, data updating and maintenance is the most costly. A key example is the updating of orthophotography. The state (25%) and federal (25%) governments assists the counties in the cost of updating of their orthophotography. A schedule for updating is agreed to by local governments with the mapping refreshed flown at a county scale of 1 in. = 200 ft every 4 years (¼ of the local governments every year).

The key challenges facing NC are funding to create and update data, for data maintenance on regular cycles, to develop bandwidth and technology infrastructure statewide, and to address data security for layers protected by statute. GICC's approach to solving the data availability and maintenance problem is to invest 40 million dollars over 5 years for 171 data layers with a 5-year development period. In addition, $4 million will be spent annually for data maintenance. Of the 171 data layers, 16 layers account for about 90% of the $40 million.

NC OneMap and GICC help to improve the relationship among the agencies by providing data for decision making. An analysis showed substantial return on investment in only 2 years after data implementation. Ongoing savings (shortened timelines for transportation project review and completion, and reduction of the number of alternatives studies) substantially exceeded annual data maintenance costs. The business case for NC OneMap investment was an expected $40 million return on investment in 2 years by reducing delay and the avoidance of regulatory problems.

Florida's Environmental Screening Tool

PETE MCGILVRAY
Florida Department of Transportation

Florida's Efficient Transportation Decision Making (ETDM) process, developed in response to Congress's Environmental Streamlining initiative, is a new way of accomplishing transportation planning to achieve early agency participation, efficient environmental review, and meaningful dispute resolution. ETDM is carried out through the Environmental Screening Tool (EST), a

technological solution that aims to integrate resource and project information from multiple sources, provide quick and standardized analysis of environmental and sociocultural effects of the proposed transportation projects, and support effective communication of results among all stakeholders and the public. EST was developed by using a methodology of rapid software prototyping, frequent user feedback, and flexible architecture designed to adapt to the ETDM evolution process. This resulted in an Internet-accessible interactive database and mapping application that integrates a georelational database of ETDM projects; over 350 environmental resource GIS data layers; an automated and standardized GIS-based environmental screening analysis application; and numerous tools for data entry, review, and reporting. For over 2 years of operation with a user community of staff from 7 DOT districts, 26 metropolitan planning organizations (MPOs), 24 resource agencies, and the public, EST has proved successful in supporting the ETDM process. Over 600 projects have been entered in the EST database and over 220 of them have completed the environmental review process. Several examples demonstrate many benefits from the use of the EST in the ETDM process, such as early identification of avoidance or minimization options, improved interagency communication and coordination, and even the use of EST for applications beyond the ETDM purview.

The Problem

The transportation planning process begins when MPOs and Florida DOT (FDOT) are identifying mobility needs. Project needs are matched to available funding for projects, and ultimately a cost-feasible plan is adopted by the MPOs. This is referred to as the long-range transportation plan (LRTP). Similarly FDOT develops a cost-feasible plan for the Florida Intrastate Highway System (FIHS), and for the Bridge Program. Priority projects are selected annually from these cost-feasible plans and are presented to the legislature as the tentative work program. The legislature then approves the work program. The work program is a 5-year program. New projects may await funding for up to 5 years before significant work proceeds. At that point, the project development and environmental (PD&E) process begins, design survey work is conducted, and agency interaction begins. The PD&E process is followed by the design phase.

Many of Florida's permitting agencies would traditionally await the submittal of a permit application before significant effort was expended in project review. This would typically occur at about the 60% level of detail in the design phase. The problems with this process are evident:

- The process involves a long sequence of actions.
- Long time gaps occur between some steps.
- Planning information may be obsolete before PD&E begins.
- Community concerns elicited during planning may not be effectively communicated to designers.
- Agency involvement occurs late in the process after substantial work is performed.
- Too much momentum has built for delivery of the project to allow significant change.

FDOT's Proposed Solution

Working group participants identified early agency involvement as the key to success in a new process. After considerable discussion, it was decided that two opportunities would be provided to agencies to review projects prior to the start of significant engineering work. These opportunities are referred to as the Planning Screen and the Programming Screen.

The Planning Screen occurs in conjunction with development of cost-feasible plans. Project needs are reviewed by agencies who provide information to project planners about the effect that a planned project would have on resources protected or managed by that agency. In urban areas, MPOs provide input about the effect of a project on the community. FDOT provides input about community or sociocultural effects for projects on the FIHS and projects in non-MPO areas of the state. At this early stage of planning, the information provided by agencies helps identify project configurations that would avoid or minimize adverse effects on Florida's natural or human environments. In the case of known unavoidable effects, agencies provide commentary on suggested mitigation measures. This information is used by project planners to alter project cost estimates, and in some cases the project priority might change based on cost feasibility due to adverse effects. Some projects might not advance due to adverse effects.

The Programming Screen occurs before projects are considered for the FDOT work program. Agency input during the Programming Screen is more detailed. The intent during this screen is that agencies provide specific information to identify technical issues that must be addressed by engineers and planners during the project development phase. Agency input during the Programming Screen comprises the NEPA scope of work—the environmental technical work needed to satisfy that agency's statutory responsibility. This input by the agencies will then be used by FDOT to develop a specific scope of work to be performed during project development.

In some cases, agencies will identify that a technical issue is not present. This will allow FDOT to remove that item from the project development scope of work and to focus subsequent engineering and planning work on those key technical issues that really need to be addressed. There will not be a need to prove the negative (e.g., performing a biological assessment when the appropriate agency has already indicated it is not needed). Focused technical scopes are expected to produce cost reduction in Florida's ETDM process.

ETDM and EST Status, May 2006

Since 2003, the ETDM process has matured and saturated into the normal business practice of the department and partners. The department developed and adopted the ETDM manual, which codifies the department's commitment to the process and supporting technology. During the 2 years of operation, the user community has grown to over 500 people including staff from 9 DOT districts, 26 MPOs, and 24 resource agencies, not including the number of people accessing and interacting with the public access site. Presently, there are over 500 environmental resource GIS data layers in the system and over 600 proposed transportation improvement projects loaded into the EST database, of which 220 of those projects have completed a formal screening through the ETDM environmental review process.

Benefits from the use of the EST in the ETDM process include early identification of avoidance and minimization options, improved interagency communication and coordination, and electronic documentation of project information. See specific examples below.

ETDM Benefits Realized

Improved Agency Collaboration

The ETDM process has fostered a team approach to identifying transportation solutions that are responsive to environmental and cultural preservation goals and to community livability objectives. Early collaboration among the FDOT, MPOs, and environmental resource agencies has improved the mutual awareness and understanding of mobility needs and environmental preservation.

The clear definition of transportation project purpose and need statements early in the planning process has facilitated understanding by nontransportation professionals. More attention is given to fully describing in laypeople's terms the project, project context, trends, and forecasts so that the Environmental Technical Advisory Team (ETAT), with its diverse disciplines, missions, and perspectives, can be more effective in assessing potential project effects. This improved understanding has led to early agreement on project purpose and need statements and has minimized contention about the need for transportation projects that were traditionally common before the ETDM process.

Improved Long-Range Transportation Planning

Improved information about potential effects of proposed transportation projects included in MPO LRTPs to environmental and community resources have improved transportation decision making during the plan development process. This awareness of potential project effects to important environmental and community resources has resulted in project proposals to be modified or removed from consideration for implementation. It has also resulted in improved long-range cost estimates for transportation projects that respond to potential environmental mitigation requirements.

Focused Evaluations During Project Development

Project screening events conducted in the ETDM process has facilitated the identification of key project issues early in the planning process and allowed the FDOT to focus resources on the issues that warrant further evaluation during project development. Resources are no longer used to study issues to prove the negative when ETAT members have indicated that there are minimal or no potential effects. Early evaluations have minimized the number of project alternatives that are moved forward to the project development phase for more detailed evaluation.

Shortened Project Delivery

For SR-70, PD&E funds were moved to the design phase and the PD&E was done with a districtwide contract in interim years, advancing the project in the work program by 2 years.

Improved Dispute Resolution Process

Through the ETDM dispute resolution process, the FDOT, MPOs, and resource agencies have successfully identified solutions to potential disputes early in the transportation planning process.

This has removed unnecessary study of project alternatives during project development that are not consistent with resource protection plans. This has resulted in time and cost savings during project development.

Prescreening Activities

In the months preceding the ETAT review period, the district ETDM team conducts a field review of the project corridor to collect existing conditions data and to allow project reviewers to identify and more fully understand potential project issues. Community data are collected in the field with handheld GPS devices and uploaded to the EST to support SCE evaluations, along with pictures of key features. The field team typically consists of a community planner, an environmental scientist, and a representative of the MPO or local government with familiarity of the project area. The team approach allows the sharing of perspectives on the potential for project effects—broadening awareness of team members and improving the quality of project reviews.

Texas Environmental Resource Stewards–Texas Ecological Assessment Protocol

A. Kim Ludeke
Texas Parks and Wildlife

A prime example of a spatial analysis project accomplished through multiagency shared effort has been the Texas Environmental Resource Stewards–Texas Ecological Assessment Protocol. It built on work accomplished by Sharon Osowski of the EPA and was developed through the encouragement and support of Dominique Lueckenhoff, also of EPA. In addition to the EPA, this project had the support of the Texas Nature Conservancy, the Texas Council of Environmental Quality, Texas DOT (TxDOT), FHWA, the U.S. Fish and Wildlife Service (USFWS), the U.S. Army Corps of Engineers (USACE), and Texas Parks and Wildlife Department (TPWD). The purpose of the project was "to identify ecologically important resources across the state in order to support greater collaborative approaches to strategic, ecosystem management."

The three key model aspects were

1. Diversity to model those areas which have the most diverse land cover;
2. Rarity to model what areas have the greatest number of threatened and endangered plant and animal species; and
3. Sustainablity to model human impacts such as fragmentation, urbanization, and other stressors to environmental quality to determine those areas which can sustain ecosystems without human management.

TPWD developed the first two models and the EPA developed both the sustainability and final composite models. The composite model mapped opportunities for protection in each Texas ecoregion. (For a link to the study document go to www.epa.gov/region6/6en/xp/enxp2a4.htm.)

The composite model when combined with the results of the GIS Screening Tool (GISST) helped map avoidance areas for the Tier One Study and the Draft Environmental Impact Statement for the proposed Trans-Texas I-69 recommended reasonable corridor links. (For more information on I-69 go to www.keeptexasmoving.com). In addition, the ArcIMS I-69 web viewer developed by Steve Schwelling in the TPWD GIS Lab provided more detailed data depicting threatened and endangered species sites to avoid.

To share data the ARCIMS I-69 web viewer was developed with funding from the EPA. It was designed to provide TxDOT and the I-69 contractors with web-based access to the threatened and endangered (T&E) species data historically accessed from TPWD paper maps. It allows the user to select a county, zoom into that county, display the respective I-69 proposed corridor links, and overlay the T&E polygons. The point data are buffered based on the reported accuracy of the point location. This is an improvement over the paper maps, for users have often assumed that a point represents a location when usually there is a stated spatial uncertainty associated with that point. Attached to the map features is a link to the database describing the species reported at each respective location. There is scale-dependent Landsat ETM background data and as one zooms in closer, 1:12,000 digital orthophotos.

One can query from the database as well as the map. A species can be selected, its location(s) mapped, and then buffered and intersected with nearby proposed corridor links. This application has security so that the user cannot download the data into an ARCMAP application and the entire site is password protected.

Finally, data development for mitigation focused on the proposed Pineywoods Conservation and Mitigation Area. This project has been a joint effort with the TxDOT, USACE, TPWD, the Conservation Fund, HDR Inc., and the Neches River Corridor, Limited Partnership. The use of 7-in. resolution CIR digital orthophotos, GIS, and verification using field-hardened tablet computers with GPS for field data collection capability helped increase the accuracy and timeliness of the habitat mapping for the 33,400-acre site. It was estimated that without the use of these technologies, this 18-month project would have taken several years and hundreds of thousands of additional dollars.

APPENDIX E

Mid-Atlantic States Questionnaire Responses

Presentation Summary

BILL JENKINS
EPA Region III
Environmental Information and Analysis Branch

Participant survey sent to

- Mid-Atlantic departments of transportation (DOTs),
- Environmental and resource agencies, and
- Metropolitan planning organizations (MPOs).

Long list of partners

- Historical and cultural resource agencies (state and federal),
- Environmental agencies (state and federal),
- Universities (as data repositories),
- Transportation agencies, and
- Nonprofit organizations.

What organizations do you partner with to share environmental GIS data?

Local government agencies and MPOs varied from formal (agreements) to informal relationships.

What other organizations should you be cooperating with to get better data and use of data?

- Historical and cultural resource agencies (state and federal);
- Environmental and regulatory agencies (state and federal);
- Local government agencies and MPOs; and
- Adjoining states and jurisdictions.

How useful are environmental data that have been collected to transportation?

- Very! Helped to streamline process;
- Estimated cost savings of $900,000 per year; and
- Time savings of 2 weeks per project.

How useful are transportation data to the environmental and socioeconomic community?

- DOTs: Very—helps to avoid conflicts, creates more efficient review process and greater predictability and
- Environmental Agencies: Very—helps with "looking to the future," doing growth projections, assessing threats to natural resources and planning for emergencies (wildfires).

How are environmental GIS data collection, management, and distribution organized?

- Varied from "one-stop shop" to each agency maintains and distributes data to something in between (one group coordinating amongst agencies; list of "who has what data").
- A few states are moving forward on an enterprise approach—look to for lessons learned.

Is there a "community of practice" to coordinate activities and practices?

- Mostly yes.
- Varied between formal (appointed high-level groups, groups across agencies) and informal (Environmental Systems Research Institute user group meetings).
- Most recognized the benefits of getting people together as most agencies maintain and distribute their own data.

What tools exist to facilitate sharing of environmental data?

- Good relationships—Trust!
- Memorandums of agreements.
- Internal and public websites for downloading and mapping/FTP sites.
- Manual distribution by CD or DVD.

What needed data would be most improved through cooperation with other organizations (i.e., DOTs and MPOs)?

All, but specifically

- Threatened and endangered species;
- Soils;
- Orthophotography;
- Digital elevation models;
- Public facilities—utilities, school zones;
- Hazardous waste sites;
- Permitted development and planned projects; and
- Historical (old) data.

What needed data would be most improved through cooperation with other organizations (i.e., environmental agencies)?

- Updates of LC,
- LIDAR,
- High-resolution orthophotos, and
- Habitat data.

Does your agency comply with Federal Geographic Data Committee standards?

Yes—or in the process of getting there.

What barriers does your agency encounter or had to overcome in order to share environmental data? (DOTs and MPOs)

- Software compatibility (different versions; non-ESRI shop);
- Old or questionable quality of data, version control (e.g., changed data structures);
- Security concerns about distributing over the Internet;
- IT folks not understanding GIS;
- Dealing with license agreements;
- Medium used to share data;
- Agencies not willing to share; and
- Funding (greater concern for MPOs).

What barriers does your agency encounter or have to overcome in order to share environmental data? (environmental agencies)

- Funding, hiring and retaining qualified people;
- Developing applications to facilitate sharing; and
- Converting legacy data sets to current format.

Topics and issues of interest? (DOTs and MPOs)

- Easier sharing of data—"real-time" data exchange;
- Threatened and endangered species data;
- Decision-support tools for practitioners;
- Using GPS to gather data; dealing with accuracy, metadata, software, including environmental data early in planning process; and
- Regional planning and coordination.

Topics and issues of interest? (environmental agencies)

- Developing enterprise data systems,
- Data delivery via the web, and
- Creating more interactive mapping capabilities and decision-support tools.

What are the incentives to cooperate to share data?

- Streamline the process, save money, increase predictability and certainty.
- Have everyone making decisions based on same data.
- Focus resources where they should be: on big impact projects, identifying impacts upfront.
- Reduce duplication of effort; make more efficient use of resources.
- Make data publicly available supports accountability.
- Build partnerships (trust).
- Advance the mission of all agencies.
- Look to outcomes: Improve the environment for the future and promote sustainable growth.

What tools, resources, or information would help promote the use of environmental data and collaboration on applications to promote more efficient use and higher quality decision making?

- One-stop website containing similar data from different states (MPO);
- Statewide data manager to receive and distribute data sets;
- Real-time data exchange;
- Web feature service;
- Open source code tools;
- Guidelines for acceptable use of data;
- Linking Planning and NEPA;
- Engineers understanding that there is life outside of the roadway;
- Sharing success stories; and
- Integrate (and better understand) land use analysis into transportation planning.

Would a best practices website be helpful?

8 Yes, 2 No, 1 Maybe.

What type of information would help you develop your use of GIS? How would you prefer to access it?

- One-stop web-based data clearinghouse; update data automatically;
- Case studies, best practices, data and use guidelines—website or in print; and
- Monitoring information on habitat improvements.

Do you need additional funding to facilitate additional use of environmental GIS? If so, how much and for what?

- A few DOTs said No.
- Most environmental agencies and MPOs said Yes.
- Environmental agencies need money for data development, management, distribution, and hardware—some DOTs already help pay for a large part of this.
- Need money for long term hardware and software maintenance and upgrades, training and salaries (MPOs and environmental agencies).
  - $5 million every 2 years for statewide for digital orthophotos, LIDAR, updated land cover.
  - $100K to build applications, improve data collection, maintenance, use.

What type of additional resources do you need to facilitate additional use of environmental GIS?

- A few said None.
- Knowledge resources.
- Access to experts.
- Access to training.
- Knowing what resources are available; where and whom to go to?
- Expert advice on field and GPS data gathering and analysis.
- Enterprise GIS (ArcSDE), hardware, software (including maintenance).
- Money to fund staff.
- Greater bandwidth in district and satellite offices.

APPENDIX F

Related Activities and Resources

INITIATIVES AND CONCEPTS

Regulatory Watershed Approach

The watershed approach is a new way of doing business, developed by the U.S. Army Corps of Engineers (USACE). It includes an increased emphasis on coordination, getting away from "site-specific" mitigation, and involving a wide range of options, from complex plans to low-tech single-data solutions. The watershed approach provides for a way to do cumulative impact assessments, long-term permit planning, and improved analysis of linear projects. Impacts can be identified by habitat type and by watershed. Mitigation plans are then based on watershed needs.

www.usace.army.mil/inet/functions/cw/hot_topics/ht_2002/watershed.htm

Exemplary Ecosystem Initiative

In 2002, FHWA identified ecosystem conservation as one of three performance objectives under the agency' "vital few" goal of Environmental Streamlining and Stewardship. As a hallmark demonstration of its commitment to this goal, FHWA agreed to identify a minimum of 30 exemplary ecosystem initiatives in at least 20 states or federal lands highway divisions by September 2007. The agency also developed specific criteria for selecting the initiatives.

The Exemplary Ecosystem Initiative website contains instances of how exemplary ecosystem initiatives in eight states are reducing habitat fragmentation and barriers to animal movement by encouraging the development of more sustainable mitigation sites, stimulating early ecosystem planning, and fostering ecosystem-based research.

www.fhwa.dot.gov/environment/ecosystems/

Green Highways Initiative

The Green Highways Initiative is a voluntary, collaborative, public–private effort designed to identify and promote streamlining and environmental stewardship in transportation planning, design, construction, and operation and maintenance through integrated partnerships, flexibility, rewards, and market-based solutions.

The goal is to foster partnerships for improving on the natural, built, and social environmental conditions in a watershed, while sustaining life-cycle functional requirements of transportation infrastructure (safety, structural, and service levels)—providing for conditions that are better than before.

The Green Highways Initiative was created to promote innovative streamlining and market-based approaches toward sustainable solutions for transportation and environmental

improvements. Partnership development consists of integrated public–private partnerships with federal and state transportation and regulatory and resource agencies, contractors, industry, trade associations, academic institutions, and nongovernmental organizations to develop and champion Green Highways efforts.

www.greenhighways.org/

Surface Transportation Environment and Planning Cooperative Research Program

The Surface Transportation Environment and Planning Cooperative Research Program (STEP) was established by Section 5207 of the Safe, Accountable, Flexible, and Efficient Transportation and Equity Act: A Legacy of Users (SAFETEA-LU). The general objective of STEP is to improve understanding of the complex relationships between surface transportation, planning, and the environment. Congress authorized $16.9 million per year for FY 2006–FY 2009 to implement the program. STEP research includes developing more accurate models, transportation-demand factors, development, and assessment of performance measures and other efforts over time. Twenty-two emphasis areas are proposed including GIS and spatial information. STEP can be a source of funding for applications of Geospatial Data and Technology.

www.fhwa.dot.gov/hep/step/

Executive Order 13274: Environmental Stewardship and Transportation Infrastructure Project Reviews

On September 18, 2002, President George W. Bush signed Executive Order (EO) 13274. This EO established an Interagency Task Force to advance current DOT and interagency environmental stewardship and streamlining efforts, to coordinate expedited decision making related to transportation projects across federal agencies, and to bring high-level officials to the table to address priority projects. The Task Force established an interagency Work Group on Integrated Planning, which recognized the continuing need to more effectively "link" short and long-range transportation planning and corridor-level planning studies performed by state and local governments with resource agency and land use planning processes, and with project-specific environmental reviews, approvals, and permitting processes.

www.fhwa.dot.gov/stewardshipeo/planning.htm

CONFERENCES, MEETINGS, AND WORKSHOPS

White House Conference on Cooperative Conservation

This conference was convened in August 2005 by the Council on Environmental Quality to advance the spirit and objectives of EO #13274 on the Facilitation of Cooperative Conservation. The conference website contains many useful documents and references.

cooperativeconservation.gov/index.html

Data Requirements in Transportation Reauthorization Legislation Conference

This meeting identified data issues associated with surface transportation reauthorization legislation and programmatic proposals. Federal, state, and local officials and practitioners who manage data systems or must assure quality data prepared white papers in advance for discussion during the meeting. Discussions focused on new and expanded requirements and opportunities.

www.trb.org/Conferences/ReauthorizationData/

Improved Decision Making Using Geospatial Technology—Executive Scan and Collaborative Workshop

In the fall 2005, the FHWA Office of Interstate and Border Planning sponsored an Executive Scan Tour that focused on noteworthy practices, business models, and emerging technologies that lead to advancements in cutting edge geospatial technologies. They looked at what organizations did to put these geospatial applications in place, to persuade their executives, managers, and directors to invest in them and to ultimately make better decisions.

The purpose of the Scan Tour was to understand the necessary ingredients for a successful implementation of geospatial technology. The information and experiences gained set the context for the Collaborative Workshop, "Improved Decision Making Using Geospatial Technology" held on February 28, 2006. The workshop was a high-level discussion on the value of geospatial data and technology, how it is implemented, and the challenges. The product will be an action plan that lists what the transportation community should do to encourage and enhance the use of the technologies.

www.gis.fhwa.dot.gov/execscan.asp

International Conference on Ecology and Transportation

The mission of the annual International Conference on Ecology and Transportation (ICOET) is to identify and share quality research applications and best management practices that address wildlife, habitat, and ecosystem issues related to the delivery of surface transportation systems.

The theme for ICOET 2005 was "On The Road To Stewardship!" The 2005 stewardship theme was designed to encourage conference presenters and participants to share information about projects and best practices that show how they are moving beyond regulatory requirements in order to respond to broader scientific and community-driven concerns related to the consideration of ecological concerns in transportation planning, project development, construction, and operations and maintenance.

www.icoet.net/ICOET2005.html

National Symposium on Compensatory Mitigation and the Watershed Approach

The federal agencies working on the National Mitigation Action Plan (MAP) and the Environmental Law Institute (ELI) hosted a symposium on compensatory mitigation and the watershed approach (see Regulatory Watershed Approach above) in Washington, D.C., on May 19 to 21, 2004. Approximately 40 participants from academia and federal, regional, state, and local governments and organizations provided input on watershed-based planning tools and resources that can be used to make compensatory mitigation decisions under §404 of the Clean Water Act.

www2.eli.org/research/watershedsymposium.htm

National Fish Habitat Initiative and Federal Caucus Leadership Meeting

The National Fish Habitat Initiative sponsors the National Fish Habitat Initiative Federal Caucus Leadership Meeting to provide an opportunity for Federal agencies to speak with one voice on aquatic habitat conservation. The second Federal Caucus was held on December 9, 2005, at which a strategies and resources document was approved.

www.fishhabitat.org/

TRAINING

GIS for Environmental Screening and Stewardship Workshop

The GIS for Environmental Screening and Stewardship Workshop is a 1.5- to 2-day workshop that provides a general overview of spatial data technologies and how they can be used to enhance environmental decision making.

Aung Gye, FHWA
Ben Williams, FHWA

Conservation and Transportation Planning Workshops

FHWA, NatureServe, and Defenders of Wildlife are sponsoring three workshops on how conservation planning and transportation planning can be aided by new decision support tools and State Wildlife Action Plans.

Aung Gye, FHWA

Strategic Conservation Planning Using the Green Infrastructure Approach

This introductory course, offered by the Conservation Fund and the U.S. Fish and Wildlife Service (USFWS), provides participants with a strategic approach for prioritizing conservation opportunities and a planning framework for conservation and development—integrating the

green and the gray. Through hands-on class projects, lectures, case studies, and a local field trip, participants will experience firsthand how the green infrastructure approach can be used to connect environmental, social, and economic health across urban, suburban, and rural settings. Participants will also learn how green infrastructure planning can serve as a tool to inform land use decisions and build consensus among diverse interests. This course is designed to be a collaborative learning experience; as such, it is applicable to individuals from a variety of disciplines, sectors, and scales (i.e., national, regional, statewide, local) who are engaged in land use planning and management.

www.conservationfund.org/pagespinner.asp?article=2487

Linking Planning and NEPA Workshops

A two-part series of facilitated workshops (one for executives and one for managers) jointly sponsored by the National Transit Institute and the National Highway Institute, focuses on (1) identifying the current process for performing planning and NEPA studies in support of project-level decisions and (2) developing strategies for achieving greater integration. From the workshops, state agencies develop an action plan to bring about better planning and decision making, environmental stewardship, and streamlined delivery of projects. Data sharing, specifically through the use of GIS, has emerged in these workshops, and action plans as a key component or obstacle to success.

www.nhi.fhwa.dot.gov/training/brows_catalog.aspx
Search for course #151041

DOCUMENTS, GUIDES, AND REPORTS

Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects

Development of Eco-Logical was sponsored by the FHWA Office of Project Development and Environmental Review. It is a guide to making infrastructure more sensitive to wildlife and ecosystems through greater interagency cooperative conservation. It describes ways for streamlining the processes that advance approvals for infrastructure projects—in compliance with applicable laws—while maintaining safety, environmental health, and effective public involvement. As a way to accomplish this, the guide outlines an approach for the comprehensive management of land, water, and biotic and abiotic resources that equitably promotes conservation and sustainable use. Key components of the approach include integrated planning, the exploration of a variety of mitigation options, and performance measurement.

Eco-Logical encourages federal, state, tribal, and local partners involved in infrastructure planning, design, review, and construction to use flexibility in regulatory processes. The report lays conceptual groundwork for integrating plans across agency boundaries, and it endorses ecosystem-based mitigation.

environment.fhwa.dot.gov/ecological/ecological.pdf

State Wildlife Action Plans

The State Wildlife Action Plans have been developed with funding from the State Wildlife Grants Program (SWG). SWG is a proactive approach to strategic habitat conservation and species preservation which encourages state-based entities to implement plans to protect habitat and species. An annual appropriation is made to all 50 states and 6 U.S. territories. The program was developed by the Department of Interior Appropriations Act, which created the State and Tribal Wildlife Grants Program. It is now an annually appropriated funding source for States to address the broad range of their wildlife and associated habitats in a comprehensive fashion. The USFWS Federal Aid Division administers the grant program.

Defenders of Wildlife (www.defenders.org/statewildlifeplans/)
Teaming with Wildlife Coalition (www.teaming.com/)

Technologies to Improve Consideration of Environmental Concerns in Transportation Decision Making, NCHRP 25-22

The final product from NCHRP Project 25-22 is a CD that includes the following items:

1. A report profiling 21 different technologies;
2. A fictional case study demonstrating examples of many of these technologies and their applicability to a portion of the transportation decision-making process; and
3. A transportation decision-making process diagram showing where the technologies are applicable in the process.

Online report available at trb.org/publications/nchrp/cd-14
Webcast discussion: www.itre.ncsu.edu/CTE/TechTransfer/Teleconferences/webcast.asp?ID=37

Technologies to Improve Consideration of Environmental Concerns in Transportation Decisions, NCHRP Project 25-22(02)

Using findings from NCHRP Project 25-22, NCHRP Project 25-22 (02) will identify, profile, and demonstrate eight existing applications of technology in cooperation with state DOTs. A feasibility assessment and sensitivity analysis of these selected applications will be performed to evaluate factors such as their compatibility; universal applicability and potential usefulness to DOTs and other public agencies; and ease of implementation in user-interface, timeframe, budgetary, and equipment requirements.

Andrew Lemer, NCHRP

Improved Linkage Between Transportation Systems Planning and the National Environmental Policy Act

This document is a resource, or toolbox, that can be used to streamline and enhance the transportation planning and project development process. The objective is to help transportation agencies establish a seamless decision-making process that minimizes duplication of effort, promotes environmental stewardship, and reduces delays in project implementation. The toolbox offers a range of strategies that may be carried out under existing laws and regulations, for integrating planning and project development; increasing interagency collaboration; and early consideration of social, economic, and environmental factors.

The strategies in this toolbox are drawn from research, case studies, pilot projects, and experiences of states and metropolitan areas throughout the United States. Many of these strategies were identified in preparation for, or during the delivery of, a series of FHWA and FTA seminars and workshops on Linking Planning and NEPA carried out in 18 states during 2004 and 2005.

www.transportation.org/sites/planning/docs/NCHRP%208-36%2848%29%20Final%20Report.pdf

Environmental Information Management and Decision-Support System: Implementation Handbook

This handbook contains results of research (NCHRP 25-23, Report #481) into environmental information management (EIM) and decision system support (DSS) in multimodal transportation planning, programming, project development, and operations and maintenance. This report is focused on the current and future needs of state DOTs, MPOs, and other large transportation agencies. It gives substantial discussion of GIS and its integral role in an EIM and DSS.

onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_481.pdf

Consideration of Environmental Factors in Transportation Systems Planning

This is NCHRP Report #541, the final report from NCHRP Project 8-38, published in December 2005. The objective of this research was to identify, develop, and describe a process that includes procedures and methods for integrating environmental factors in transportation systems planning and decision making at the statewide, regional, and metropolitan levels.

trb.org/publications/nchrp/nchrp_rpt_541.pdf

Linking Environmental Resource and Transportation Planning—Current State of the Practice

The objective of this upcoming NCHRP Project 25-25 is to provide flexible, ongoing, quick-response research on environmental issues in transportation. This research will be designed to develop improvements to analytical methods, decision-support tools, procedures, and techniques

employed by practitioners to support statewide and metropolitan transportation planning, programming, and development.

Gary McVoy, NCHRP Committee Chairperson

The Ecologic Guide

Written by a steering committee representing nine federal agencies, the purpose of this guide is to make infrastructure more sensitive to wildlife and ecosystems through greater interagency cooperative conservation.

environment.fhwa.dot.gov/strmlng/es2whatsnew.htm

METHODS AND TOOLBOXES

Mid-Atlantic Transportation and Environmental Streamlining Process

The Mid-Atlantic Transportation and Environment Task Force has developed a streamlined process that is specific enough to ensure its effective implementation in all states, yet that allows the states to fit their individual project development processes into its framework. The process was established through this partnership of state and federal transportation and environmental agencies from the Mid-Atlantic. It is intended for use as a general framework that applies to all states. The most significant product of this effort is the integration of additional permitting and environmental review processes with the 1992 Integrated NEPA/404 process. This process should be used as a tool for improving communication among environmental and transportation agencies, increasing the efficiency of the transportation project development process through concurrent environmental reviews, and as a mechanism for avoiding or resolving interagency disputes.

www.epa.gov/reg3esd1/nepa/mate/mate.htm

Texas Ecological Assessment Protocol

The Texas Ecological Assessment Protocol (TEAP) developed by a consortium of agencies including EPA Region VI, TPWD, and The Nature Conservancy, relies on a previously developed methodology and consists of collecting and analyzing existing electronic data available statewide. TEAP is used to evaluate the following three ecological criteria:

1. Diversity—What areas have the most diverse land cover?
2. Rarity—What areas have the highest number of rare species and land cover types?
3. Sustainability—What areas can sustain ecosystems now and in the future?

Report, EPA 906-C-05-001
www.epa.gov/region6/6en/xp/enxp2a4.htm

GIS Screening Tool

The GIS Screening Tool (GISST) is used to assess environmental vulnerabilities and impacts using GIS data and a decision structure. It was developed in a pilot project beginning in 1996 with support from the EPA. The method evaluates characteristics such as soil permeability, erosion potential, soil type, land use–land cover, stream miles, distance to surface water, ground water quality, and rainfall for a determined geographic area. The GISST can evaluate single media and cumulative impacts for environmental assessment projects.

www.epa.gov/earth1r6/6en/xp/enxp2a3.htm

Southeastern Ecological Framework Project

The Southeastern Ecological Framework Project was a GIS-based analysis to identify ecologically significant areas and connectivity in the southeast region of the United States. The states included in the project are Florida, Georgia, Alabama, Mississippi, South Carolina, North Carolina, Tennessee, and Kentucky. The project began in October 1998 and was completed in December 2001 by the University of Florida GeoPlan Center and sponsored by the EPA Region IV Planning and Analysis Branch. Region IV continues to use these data to facilitate EPA programs and to work with state and federal agencies and local groups to make sound conservation decisions. Efforts to apply this methodology to other EPA regions is under consideration.

Southeastern Ecological Framework Final Report:
www.geoplan.ufl.edu/epa/download/sef_report.pdf

OTHER LINKS

U.S. Geological Survey Geospatial Programs Office:
www.usgs.gov/ngpo/

FHWA Streamlining and Stewardship:
environment.fhwa.dot.gov/strmlng/es2whatsnew.htm

SAFETEA-LU Environmental Guidance on Planning and Environment provisions:
www.fhwa.dot.gov/safetealu/reference.htm

Context Sensitive Solutions:
www.contextsensitivesolutions.org

GeoSpatial OneStop:
www.geo-one-stop.gov/

Center for Transportation and the Environment:
itre.ncsu.edu/cte/

Center for Environmental Excellence:
environment.transportation.org

National Mitigation Action Plan:
www.mitigationactionplan.gov/

Environmental Law Institute:
www2.eli.org/index.cfm

APPENDIX G

The Future Is Here

The New World for Integrated Environmental Data Systems

Presentation Summary

R. DAVID LANKES
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This presentation sought to reflect current trends in building collaborative, web-based systems. While some of the concepts presented could certainly be used within an organization, the focus and examples are between organizations. The point was to look at high-level trends in Internet development and imagine how environmental and geospatial data can be used to build a rich and diverse community of government agencies, nonprofits, commercial organizations, and the public at large.

The most recent spate of web-based trends can be summed up in the Web 2.0 movement.[1] For many, Web 2.0 has become a buzzword with many shades of meaning. However, the presenter used the term to incorporate emerging best practices in web application design. Many of these practices have emerged from either survivors of the .com era (Amzon, Google, Yahoo!) or from new popular websites (Flickr, Zillow, MySpace). These practices are based on open and lightweight (easy to implement) technologies such as XML, AJAX, Javascript , HTTP, and RSS.

WEB 2.0 PRACTICES

So what are the practices in building collaborative web applications? The first is the advancement and embrace of social networks. A social network is defined simply as a technology infrastructure that encourages wide and diverse collaboration. An example is building a site where an MPO would put on the web a map of a given neighborhood and invite the community to layer new information upon it. Neighbors might add data layers on abandoned houses or crime sites. Other community members might add personal histories of the neighborhood and its development. Still other neighbors might use the map to report potholes. The point of social networks is to build infrastructure that does not so much provide information as provide a foundation for a community to add information.

One example of this type of community application is Flickr (www.flickr.com/). Here users upload their photos to share with family and friends, and the whole Internet. Other users can comment on these photos and even build thematic collections across multiple users. Imagine if a DOT put up a map, and allowed users to upload photos (either to the DOT or to Flickr and link to the map) linked to the map. Driving video logs of the highway could be supplemented by photos taken in a given location (see this scenic highway, drive it virtually, now look at a picture taken at sunset). The point is not to push information at the user, but let the users be the information.

[1] For more information on Web 2.0, see O'Reilly, T., "What Is Web 2.0? Design Patterns and Business Models for the Next Generation of Software," 2005. http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html. Accessed May 5, 2006.

This linking in the previous paragraph is commonly referred to up as a "mash up." A mash up is linking two disparate web services together in a new way, and often by a third party. For example, the web is replete with examples of people linking Flickr image collections to Google Maps. Flickr did not do it; it simply provided a simple way to link to photos on the web. Google did not do it; it provided a simple way to take web links and tie it to a map. In the Web 2.0 world, Google and Flickr (or any organization) does not envision all potential uses of their technologies but make it easy for others to do so. The irony, of course, is that much of the mapping work currently happening with Google Maps is ultimately because state and federal agencies have made their maps and images readily available. By simply taking these maps and adding basic functionality (display, linking, etc.), these agencies could quickly become the center of the mash-up communities.

In order to position an organization in the Web 2.0 world, however, there need to be several adjustments in how systems, particularly GIS, are approached. In particular, many of the functions of a GIS would need to be broken down and accessible separately. So instead of seeing a GIS as a monolithic system, Internet users (and applications) see it has a lot of small, specialized functions. Users with simple technologies like HTML, Javascript, and XML could get a simple map rendered, for example. They could then link these maps to a call for video driving logs for a stretch of road and images from Flickr and traffic cams to make a comprehensive visitors' guide. The point is that a Web 2.0 organization must provide simple ways to get at discrete data and applications.

Organizations must also be constantly innovating, entering a state of permanent beta. This is not to say that projects never get finished, or that they are not reliable. Rather applications are being updated at a more frequent rate (because smaller changes are needed), and they are exposed for public use and comment much earlier in the development cycle. In this model, software gets better the more people use it. More data are available and more feedback is provided to improve the service, and, with the rise of open source, the developer base expands to include volunteers and developers from other related organizations.

CONCEPTS IN PRACTICE

One example that pulls many of these concepts together is Zillow.com. This site allows a user to zoom into a map populated with satellite and aerial photographs to house hunt. Map data (provided by Microsoft's Live Earth) are overlaid with county property tax records and other calculations such as the home's current price. Much of the data used to make this service viable come from the public record and data gathered within DOTs. It is unlikely that when creating orthophotography these departments saw the data being used in real estate shopping. The point is that by providing these data in an easily integrated way, suddenly the geographic and environmental functions of a department can become economic drivers.

IMPLICATIONS FOR INTEGRATED ENVIRONMENTAL DATA SYSTEMS

There is no doubt that implementing Web 2.0 services would necessitate cultural shifts within organizations. Many of these issues were brought up in the questions after the session. For example, how can you manage complex software development and permanent betas in a

government procurement process? How can you overcome reluctance on the part of government agencies to allow data from the public (often unfiltered) to be stored (and by implication endorsed) by governmental agencies? The answer is to shift from a systems view to an ecosystems view. In this view, functions and data are seen as distributed and vary in their quality and uses. The point is to build small applications and store and preserve data key to an organization, not to store all data or host all functions.

So, imagine a core application provide by an agency. It stores and provides map data over the web. The agency might also provide data overlays core to its business (traffic information, environmental data, and the like). Other agencies might use the core mapping functions to link documents (like environmental impact statements) to a given location. Other organizations, perhaps a community group, could link directory information to the map (who to call about trash collection on a given street). Still other individuals might start a blog about a given city. They could do a restaurant review and use the agency maps to show its location. Readers of the blog could post comments on the review. A not-for-profit organization might link volunteer sightings of endangered species to a given map, complete with cell phone images. None of this community and nondepartmental information resides with the department. Further, the nondepartmental players do not have access to change the department's data.

The point of these examples is that the whole range of possible applications does not have to be envisioned by a single agency. Rather, the agency provides some simple core functions that already meet its organizational mission. The agency is also not responsible for blogs or other third-party applications. It does not endorse them or store them. Rather, it provides baseline public data that the public can use as it sees fit. If an agency discovers useful applications, it could endorse them, or migrate them onto agency servers. But until that point, the agency is providing GIS data just like other agencies provide census data or budget information for the public at large to digest and use.

By making these types of lightweight, easy-to-integrate data available, partnering organizations can build new applications more rapidly. The GIS within an agency can also gain valuable attention and more readily demonstrate its value.

CONCLUSION

A great deal has been learned about how to build useful collaborative applications on the web. This knowledge is very useful to agencies, organizations, and individuals who seek to better utilize environmental data. By building and constantly updating lightweight discrete applications distributed across the Internet, environmental and spatial data can breed a whole new community of dedicated users and supporters. New environmental applications can be developed, tested, and explored much more rapidly. New partnerships between the government, not-for-profit and commercial organizations can be formed, and crucial environmental stewardship activities can be greatly enhanced.

APPENDIX H

A Proposal for a Hypothetical Mid-Atlantic GIS Consortium

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The following is a description of hypothetical collaborative consortium, envisioned as an ideal for addressing the needs of environmental geospatial data for transportation. It was offered by Ira Beckerman, Chief of the Cultural Resources Section of the PennDOTas a part of his summary remarks in the closing session of the Peer Exchange.

A GIS operation should be established in the Mid-Atlantic region for the purpose of providing environmental analysis on transportation projects. The operation (hereafter known as the Consortium) should be nonprofit, possibly in partnership with an established university GIS program (Rutgers, Penn State). Potential services to be provided by the Consortium may include GIS environmental mapping for all environmental impact statement (EIS) -level projects for partnering DOTs; environmental mapping for MPO planning; environmental analyses for Linking Planning and NEPA initiatives; and environmental data for cumulative and secondary impact studies.

The Consortium is envisioned as a stand-alone GIS operation, with equipment, data, and personnel. I think a shop of six to eight operators and supervisor with equipment and software could be self-sustaining. Placing it at an existing college campus with a strong GIS program will provide the peripheral help and support. Initial funding would consist of contributions from partnering state DOTs—New York, New Jersey, Pennsylvania, Delaware, West Virginia, Maryland, Virginia, and others—at an estimate of $400,000 per year per state for a 3-year period (around $10 million for the period). Eventually, the Consortium would be expected to be self-sustaining from fee-for-service operations (see below).

Each DOT and each agency within the Mid-Atlantic has different GIS data; however, it may be possible to reconcile much of those data so that they are usable across state borders. It may be reasonable to establish a standardized mapping protocol based on either Intergraph or ESRI products. My belief is that there is more commonality among mapping standards than among database standards. The difference in data collection and taxonomies are real for most environmental areas, cultural resources included; however, there is some basic commonality, particularly because much of the data follow national guidelines. For example, all states use the Smithsonian Trinomial for numbering archaeological sites and all states use the National Register Criteria for evaluating significance of historic properties. This suggests that there would be a set of common fields for each environmental resource that could be shared in a single table for the Mid-Atlantic states. Each state could add to that table for its own needs, without offending the basic shared data structure. This way, each state could serve its own needs for an environmental resource, as well as sharing data cross-state.

BENEFITS OF THE APPROACH

The main deliverable that the Consortium would produce (at least, at first) would be mapping for all EIS-level projects in the region. There are a number of reasons that a state DOT should subscribe to this approach:

- Agencies would accept the results, since they have a part in establishing standards. There would be no quibbling over the facts.
- The work could be done in a less costly way and more consistently than one-at-a-time by consultants.
- The quality of the work would be assured, since there would be a stable staff at the Consortium.
- For the first 3 to 5 years, the work would be done as quid pro quo for the states' contribution; therefore, there would be no contract needed, and therefore the work could be done as soon as the project is programmed.
- The Consortium would operate outside of state IT requirements.

There are also a number of reasons that agencies should subscribe to this approach:

- Again, this would be consistent data from state to state.
- This approach vividly points out data gaps, giving the agencies a chance to address them.
- Confidential data will be kept more secure, and access can be better controlled.
- Data collected from EIS-level projects can now be fed back into the database easily.
- Agencies can now begin to look at natural ecosystems and regions and not be limited by state borders.
- This platform permits (and encourages?) the full analytic power of GIS, including use of spatial statistics, modeling, and land use classification schemes.

Beyond EIS-level data layers, the Consortium could produce mapping for use by the Mid-Atlantic MPOs and regional planning organizations (RPOs), consistent with the FHWA's Linking Planning and NEPA initiative, as well as Section 6001 of SAFETEA-LU. At this time, there is no mechanism within Pennsylvania to organize and generate environmental mapping for use by the MPOs and RPOs, and I suspect it will be done on individual consultant contracts, possibly in partnership with PennDOT. The advantages to planning organizations are the same as for DOTs above, as well as the following:

- Planning organizations would actually have a vehicle for getting high-quality mapping.
- Mapping provided to the planning organizations would be consistent from region to region, allowing intercomparability.
- It would likely be much cheaper to have a single source provide consistent mapping than outsourcing to multiple consultants (economies of scale).

The advantages to the agencies are the same as for EIS-level projects.

THREE TO FIVE YEARS HENCE

If a Consortium were established as proposed, work need not be limited to serving EIS-level and planning mapping. By setting up the infrastructure of a GIS shop focused on the environment and transportation, other meatier issues could be approached. The Consortium could develop methodologies for cumulative and secondary impacts and carry them out on individual projects. The issue of sprawl could be dealt with in a quantitative manner, rather than by example and anectdote. Finally, we all need to look toward the day when the model of a single-occupancy vehicle (whether fueled by gasoline or electricity) on an ever-expanding roadway network will no longer be the main way we look at transportation. When we come to seriously think about mass transit, car pooling, the new urbanism, and so on, GIS analysis will become ever more important.

The business model of this Consortium is based on states' contributing operating expenses for 3 to 5 years. After that, then what? I would propose that the Consortium should also be marketing its services. The easiest customer will be the very DOTs that funded the Consortium in the first place. Let the Consortium bid on future EIS-level and planning mapping toe-to-toe with private consulting firms. I think a well-operated Consortium would provide a better product less expensively than any private entity. This could be the base of support to keep the doors open. In addition, private toll road companies that may be expected to proliferate in the near term could also be a source of business. As analytic services become more important in the future, these could be provided to DOTs and to resource agencies alike. It is not absurd to consider acquiring planes to conduct orthophotography and provide that to the DOTs. Again, economy of scale might make this workable, rather than an individual state conducting the photographic survey or outsourcing. I think the most important focus for the Consortium should be analysis over mapping. Sooner or later, anyone will be able to produce mapping—witness Google maps. But not everyone will be able to interpret layers.

APPENDIX I

Acronyms and Abbreviations

AASHTO	American Association of State Highway Officials
ACOE	Army Corps of Engineers
BLM	Bureau of Land Management
CAB	Customer Advisory Board
CAPS	Conservation Assessment and Prioritization System
CEDAR	Comprehensive Data and Reporting System
CEE	Center for Environmental Excellence
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIR	Color Infrared Photography
CWA	Clean Water Act
DAFS	Department of Agriculture Forest Service
DELDOT	Delaware Department of Transportation
DHR	Department of Historic Resources
DIS	Department of Information Services
DNR	Department of Natural Resources
DOI	Department of the Interior
DOQ	Digital Orthophoto Quads
DOT	Department of Transportation
DSS	Decision-Support System
DVRPC	Delaware Valley Regional Planning Commission
EEP	Ecosystem Enhancement Program
EIM	Environmental Information Management
EIS	Environmental Impact Statement
ELI	Environmental Law Institute
EMO	Environmental Management Office
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EST	Environmental Screening Tool
ETAT	Environmental Technical Advisory Team
ETDM	Efficient Transportation Decision Making
F.S.	Florida Statutes
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FGDC	Federal Geographic Data Committee
FGDL	Florida Geographic Data Library
FHWA	Federal Highway Administration
FIHS	Florida Interstate Highway System
FNAI	Florida Natural Areas Inventory

FOIA	Freedom of Information Act
FTA	Federal Transit Administration
FTP	File Transfer Protocol
FWS	Fish and Wildlife Service
GAO	Government Accountability Office
GARVEE	Grant Anticipation Revenue Vehicles
GIS	Geographic Information System
GISST	GIS Screening Tool
GIT	Geographic Information Technology
HC	Hydrocarbons
HCP	Habitat Conservation Plan
ICOET	International Conference on Ecology and Transportation
IECC	Interagency Environmental Coordinating Committee
ILT	Interagency Leadership Team
INRDS	Integrated Natural Resources Data System
ISB	Information Services Board
IT	Information Technology
LIDAR	Light Detecting and Ranging
LRTP	Long-Range Transportation Plan
MAP	National Mitigation Action Plan
MATE	Mid-Atlantic Transportation and Environment Task Force
MDSHA	Maryland State Highway Administration
MOA	Memorandum of Agreement
MOST	Management and Oversight of Strategic Technologies
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NAD	North American Datum
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NFHI	National Fish Habitat Initiative
NGO	Nongovernmental Organization
NHP	National Heritage Preserve
NJTPA	North Jersey Transportation Planning Authority
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NYSDOT	New York Department of Transportation
PennDOT	Pennsylvania Department of Transportation
PD&E	Project Development and Environmental
PHMC	Pennsylvania Historic and Museum Commission
PSLC	Puget Sound LIDAR Consortium
RCW	Revised Code of Washington
REF	Regional Ecosystem Framework

SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAMP	Special Area Management Plan
SASSI	Salmon and Steelhead Stock Inventory
SCE	Statewide Compliance and Enforcement
SERP	State Environmental Review Procedure
SIB	State Infrastructure Bank
SIP	State Implementation Plan
SREP	Southeastern Rockies Ecosystem Project
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Project
SSURGO	Soil Survey Geographic (database)
STEP	Surface Transportation Environment and Planning
STIP	Statewide Transportation Improvement Program
STO	State Technology Office
SWG	State Wildlife Grants Program
T&E	Threatened and Endangered Species
TCRP	Transit Cooperative Research Program
TE	Transportation Enhancement
TEA-21	Transportation Equity Act for the 21st Century
TEAP	Texas Ecological Assessment Protocol
TERS	Texas Environmental Resource Stewards
TGIC	Texas Geographic Information Council
TIP	Transportation Improvement Program
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy (Texas)
TNRIS	Texas Natural Resources Information System
TPEAC	Transportation Permitting Efficiency and Accountability Committee
TPWD	Texas Parks and Wildlife Department
TRB	Transportation Research Board
TWDB	Texas Water Development Board
TXDOT	Texas Department of Transportation
URL	Uniform Resource Locator
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VDOT	Virginia Department of Transportation
VGIN	Virginia Geographic Information Network
WAGIC	Washington State Geographic Information Council
WCRP	Wildlife Conservation and Restoration Program
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation
WVDOT	West Virginia Department of Transportation

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. William A. Wulf are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation through research. In an objective and interdisciplinary setting, the Board facilitates the sharing of information on transportation practice and policy by researchers and practitioners; stimulates research and offers research management services that promote technical excellence; provides expert advice on transportation policy and programs; and disseminates research results broadly and encourages their implementation. The Board's varied activities annually engage more than 5,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.
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