USGS
science for a changing world

Implementation Plan for *The National Map*

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U.S. Department of the Interior
U.S. Geological Survey

The National Map

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1 Executive Summary

The National Map is a resource that stimulates the economic and environmental health of the Nation by enabling and communicating geographic science. *The National Map* is composed of integrated, high-quality geospatial information for the Nation that allows land managers, policy- and decisionmakers, and researchers at all levels of government and within academia to describe the Earth's land surface and its dynamic nature. *The National Map* will ensure the development, availability, and integration of continuously maintained and nationally consistent basic geospatial data and correlative research and applications for a greater scientific understanding of how the Nation's land surface is changing.

This report describes the implementation plan for *The National Map*. It is organized to provide high-level information on *The National Map,* its relationship to the President's Management Agenda, the process used to guide the implementation, and details on the important elements of developing *The National Map*.

The National Map directly supports the President's Management Agenda and priorities of the Secretary of the Interior for (1) science-based decisionmaking, by making available to scientists and the public accurate and reliable basic geospatial data and information produced through partnerships with organizations in every sector and (2) electronic Government, by simplifying and enhancing the delivery of data, information, and tools to citizens consistent with the principles of the Geospatial One-Stop (GOS).

In the past, the U.S. Geological Survey (USGS) played the primary role in the United States for the collection of basic geospatial data through the USGS Topographic Map. Today current, high-resolution, continuously maintained, basic geospatial data often reside with State, local, and Tribal governments, the private sector, and other Federal agencies. These organizations collect, manage, and store geospatial data in response to their specific needs. In general, they have no mission requirement to make these data available for secondary use or integrate the data on a national scale.

The USGS is uniquely suited to provide the leadership, in cooperation with partners, to develop and maintain *The National Map*. The success of *The*

Under the leadership of the USGS, and through partnerships with other Federal agencies, State and local governments, tribal nations, the private sector, academia, libraries, and the public, *The National Map* will provide the following:

- **Digital orthorectified images of the land's surface. Such imagery will provide much of the feature information now symbolized on topographic maps.**
- **Satellite imagery of the Earth's surface, used for a wide variety of applications including fire fuels analysis, land characterization, and global charge analyses.**
- **Surface elevation data, including bathymetry.**
- **Vector feature data for hydrography, transportation (such as roads, railways, and waterways), structures, and boundaries of government units and publicly owned lands.**
- **Geographic names such as those for physical and cultural features.**
- **Land cover data that classifies the spatial extent of major land cover types.**
- **Geographic applications and models to address scientific and land management issues.**
- **Scientific knowledge that enhances the benefits of geographic information by government, industry, and the general public.**

National Map will depend heavily on the development of sustainable partnerships. Moreover, an open process using the Internet and other methods will be employed to maximize external participation.

The USGS will lead this effort by –

- Guaranteeing national data completeness, consistency, and accuracy;
- Conducting geographic analysis, remote-sensing research, and cartographic and geographic information science research;
- Organizing the awareness, availability, and utility of *The National Map*;
- Being the catalyst and collaborator for creating and stimulating partnerships;
- Developing geospatial data standards;
- Integrating and certifying basic geospatial data from participants; and
- Being the owner and producer when no other data sources exist.

The USGS will implement a systematic process to guide the development of *The National Map*, including the following:

- The establishment of an architecture and team structure that follows an established Federal Enterprise Architecture (FEA) model, designed to facilitate major aspects of *The National Map* from various perspectives and levels of detail;
- A comprehensive and coordinated mechanism for development and implementation, including a formal method of communication to describe *The National Map* elements; and
- A staged approach to implementation, with a number of short-term goals, primarily focused on the geospatial data aspects of *The National Map,* planned through the end of fiscal year (FY) 2005 (Stage I) and longer term concepts with an enhanced science and applications focus extending to FY 2006 and beyond (Stage II).

Primary Goals for the Elements of *The National Map*

Partnerships	Implement, maintain, operate, and foster *The National Map* through partnerships with a wide variety of organizations.
Standards	Ensure nationally consistent and integrated data that support a wide variety of science and government applications in a heterogeneous, distributed computing environment.
Base Data Themes	Ensure availability of accurate and timely geospatial data in eight themes at appropriate resolutions.
Archive	Provide an archive for the historic preservation of data and science applications in *The National Map*.
Products and Services	Provide analog and digital products and services from *The National Map* that include paper products, interoperable Web services, digital browse images, data downloads, and scientific reports.
Science and Applications	Promote geographic integration and analyses and provide access to tools for specific applications and modeling.
Workforce	Ensure that the skills of the workforce are appropriate to accomplish the goals of *The National Map*.

Implementation of *The National Map* is a complex endeavor. In addition to the establishment of a systematic process to guide the endeavor, *The National Map* has been divided into seven logical elements that are critical to its design and function: partnerships, standards, base data

themes, archive, products and services, science and applications, and workforce. For each element of this implementation plan there is a primary goal (see sidebar); an explanation of its importance; strategies, and plans to accomplishing the goal; major accomplishments to date; and risks and challenges for the future.

Stage I of *The National Map* implementation plan is underway. In Stage I, the World Wide Web is being used to make available the most critical eight base data themes of geospatial data (elevation, orthoimagery, hydrography, geographic names, land cover, transportation, structure, and boundaries), and some science, applications, and data derived from the use of these base themes. Stage I will last to the end of FY 2005. Major accomplishments to date include the following:

- Defined the vision for *The National Map* in concert with our partners
- Offered the vision for *The National Map* for public comment resulting in 122 responses
- Commissioned the National Research Council (NRC) to evaluate the concept of the vision for *The National Map*.
- Commissioned NRC to study research opportunities in geography at the USGS that will be used to help guide *The National Map*.
- Carried out eight pilot partnership projects in FY 2002; full analysis and report of lessons learned will be available in September 2003.
- Conducted a cost benefit analysis of *The National Map*.
- Created the Comprehensive Urban Ecosystems Studies (CUES) initiative to demonstrate the usefulness of *The National Map* for assessment, monitoring, and decisionmaking in critical urban ecosystems.
- Used *The National Map* for several national-scale scientific applications, such as determining the status of declining populations of amphibians.
- Created data content standards in conjunction with the GOS initiative for the elevation, orthoimagery, and hydrography data themes.
- Developed methodologies to integrate higher resolution, partner-produced data into the National Elevation Dataset (NED).
- Completed, in cooperation with State and Federal partners, once-over coverage of orthoimagery for the conterminous United States at 1-meter resolution (220,000 images).
- Expanded partnerships and improved mapping strategies for the second generation National Land Cover Dataset (NLCD 2001).
- Developed data content standards defining boundary and structures features, attribute, and attribute domains for *The National Map*.
- Developed *The National Map* viewer and made available the data from the following national datasets: National Elevation Dataset, National Hydrography Dataset (NHD), National Land Cover Dataset, Geographic Names Information System (GNIS), Digital Orthophotoquad (DOQ).

A number of important actions have been identified for completing Stage I of the implementation of *The National Map*. The highest priority actions include the following:

- Develop key partnerships.

- Acquire the tools and training to implement a systematic process to guide *The National Map* development (for example, collection of additional requirements, system design, and project management).
- Initiate a formal process for documenting design and implementation of *The National Map*.
- Initiate a process for managing requirements of *The National Map*.
- Develop and implement Design Teams to focus on the major elements of *The National Map.*
- Conduct an analysis of user requirements.
- Develop *The National Map* information technology system based on the identified requirements.
- Change the scope of the workforce.

Stage II of *The National Map* implementation incorporates and continues key aspects of Stage I (for example, development, maintenance, and dissemination of the eight base themes of geospatial data) but moves from an effort focused primarily on data to one that focuses more heavily on research, science, and applications focus. Stage II of *The National Map* will not only include the basic geospatial information, mapping capabilities, and the ability to download data but will also accommodate the potential to share models and applications. In addition, researchers will be able to access computer power from *The National Map's* larger participants and link to the Geosciences Network (Geon) Grid, an advanced geospatial application of Internet II being developed through the National Science Foundation (NSF). This technology will help facilitate geographic research that will integrate and complement continuing data activities.

The major challenges anticipated in the implementation of *The National Map* include the following:

- Developing and maintaining *The National Map* with those States that have a limited geospatial infrastructure.
- Achieving the necessary partnerships to implement *The NationalMap* without additional incentives.
- Increasing the role of science and applications in *The National Map* in an environment of limited resources.

The NRC in its report, "Weaving a National Map: Review of the U.S. Geological Survey Concept of the National Map," states, "*The National Map* vision of the USGS is ambitious, challenging, and worthwhile… Technically, the project may be feasible; organizationally it will require a significant investment in restructuring . . . ." The USGS recognizes the significant challenge of (1) providing the necessary leadership to facilitate the development of a national coalition of partners and participants in *The National Map* endeavor and (2) reengineering the activities, skills, and distribution of its workforce as necessary to lead this effort. This implementation plan is a significant initial step in this process of leadership and change, and the plan will be improved over time through review and feedback of interested participants in the geospatial community, the Administration, and the Congress. The USGS is committed to the success of *The National Map* and the promise for an improved tool and process to support the critical challenges of the 21st Century and beyond.

2 Introduction

2.1 The Vision of The National Map

The U.S. Geological Survey was established in 1879 to provide scientific information and aid the development of the United States. Within the first 10 years of its establishment, the USGS recognized that it needed topographic maps to support that scientific activity. Numerous other ancillary benefits result from the production of the topographic data.

Now, the ability to produce topographic data has become fairly common and the scientific issues addressed with topographic and related data have grown. The technology to produce and use the data has grown as well. However, the scientific knowledge needed to address these complex issues and to use the tools has not grown as rapidly. It is the vision of *The National Map* to do three things:

- Harness and improve the vast and increasing storehouse of topographic (geospatial) and related data and make those data available for the long term.
- Channel the existing and develop new understanding of those natural and human processes that affect the land surface.
- Ensure that this vast amount of data and knowledge is integrated and delivered in ways that are most useful to support the current and future needs of the Nation.

The National Map is revolutionary in that it will not be static and it will provide more than data to the user. It will provide not only vast amounts of knowledge but also tools to support decisionmaking.

The success of *The National Map* will depend heavily on sustainable partnerships. The USGS will seek partnerships and business arrangements with other organizations to develop and operate *The National Map*. USGS staff will be located across the Nation to work directly with partner Federal, State, or other public organizations, Tribal nations, private industry, and universities. Federal agencies will identify needs and develop and execute plans for collaborative data development and maintenance. The role of the USGS in these relationships could range from being the organizer of consortia to working with other agencies to support the inclusion of their data in *The National Map*. State, regional, Tribal, and local partners will coordinate or undertake area-specific geographic data development to meet their needs and, where interests align, to maintain and operate *The National Map* for their areas. Private organizations will provide analysis and visualization tools, under contract or license. The USGS will work with university faculty on relevant research topics. Libraries will support public access to *The National Map*. The USGS will encourage volunteers to help detect and report changes to maintain *The National Map*.

Guaranteed availability of *The National Map* will allow Federal agencies to concentrate on data unique to their mission needs and to avoid expending resources to find, develop, and integrate basic geospatial data each time they are needed. By providing open Internet access to geographic information that meets government needs, the benefits of *The National Map* will be accrued to all users.

Under the leadership of the USGS, and through partnerships with other Federal agencies, State and local governments, tribal nations, the private sector, academia, libraries, and the public, *The National Map* will provide the following:

- Digital orthorectified images of the land's surface. Such imagery will provide much of the feature information now symbolized on topographic maps.
- Satellite imagery of the Earth's surface, used for a wide variety of applications including fire fuels analysis, land characterization, and global charge analyses.
- Surface elevation data, including bathymetry.
- Vector feature data for hydrography, transportation (such as roads, railways, and waterways), structures, and boundaries of government units and publicly owned lands.
- Geographic names such as those for physical and cultural features.
- Land cover data that classifies the spatial extent of major land cover types.
- Geographic applications and models to address scientific and land management issues.
- Scientific knowledge that enhances the benefits of geographic information by government, industry, and the general public.

Changes affecting *The National Map* will be captured and integrated with existing data in a process of continuous update, rather than through cyclical inspection and revision. Currentness will be measured in days and months rather than years. Data will be seamless and consistently classified, enabling users to extract information for irregular geographic areas, such as counties or drainage basins, and to spatially analyze the information. Data resolution and completeness will vary depending on geographic area and need. For example, *The National Map* will contain higher resolution elevation data in areas of subtle relief variation, such as flood plains, to support hydrographic modeling. Content will be mapped in its true geographic position. This process will eliminate the offsets and feature generalizations that exist in data derived from existing maps. Positional accuracy will be sufficient to vertically and logically align features from different data themes. Thus, a river course will correspond to land surface slope, and boundaries will align with corresponding features, such as roads or rivers. *The National Map* will contain data for many areas that surpass the standards that have been applicable to primary series topographic maps. All content of *The National Map* will be documented by metadata that comply with Federal Geographic Data Committee (FGDC) Standards supporting the National Spatial Data Infrastructure (NSDI).

The USGS will also conduct geographic analysis and monitoring to provide local, regional, and national perspectives on land surface change. These investigations of natural and human-induced changes on the landscape will add knowledge and understanding to *The National Map* and develop new applications for *The National Map*.

The USGS will provide the national leadership to develop and maintain *The National Map*. This leadership includes being (1) a guarantor of national data completeness, consistency, and accuracy; (2) a leader in geographic analysis, remote-sensing research, and cartographic and geographic information science research; (3) an organizer responsible for awareness, availability, and usefulness of *The National Map*; (4) a catalyst and collaborator for creating and stimulating partnerships; (5) a leader in the development and implementation of national geospatial data standards; (6) an integrator and certifier of basic geospatial data from other participants; and (7)

the owner and producer of content for *The National Map* when no other suitable and verifiable source for those data exists. The USGS will also ensure the quality of *The National Map* data by developing standards, by devising and implementing quality assurance procedures, and by promoting process certification criteria for content providers.

This implementation plan for *The National Map* provides a concept and a method of moving forward to meet national needs for basic geospatial data and geographic applications. The vision of *The National Map* is documented in "*The National Map: Topographic Mapping for the 21st Century*" (U.S. Geological Survey, 2001: Reston, Va., Office of the Associate Director for Geography). This document is available at –

http://nationalmap.usgs.gov/nmreport.html

2.2 Document Organization

This document is organized to provide high-level information on the vision and process that will be used for *The National Map*, followed by sections that provide more detailed information. The Introduction explains why *The National Map* is important and reviews key concepts from *The National Map* vision. Section 3 (The Relationship to the President's Management Agenda and Other Priorities) explains the relationship of *The National Map* to the National Spatial Data Infrastructure, the FGDC, and the Geospatial One-Stop (GOS). Section 4 (Process) explains the overarching process plan with very high level estimates of timing, including plans for progress reports and new iterations of the Implementation Plan. Section 5 (Elements) describes several high-level elements that are critical to the design and function of *The National Map*; that is, Partnerships, Standards, Base Data Themes, Archive, Products and Services, Science and Applications, and Workforce. For each element, there is a primary goal, an explanation of why that element is important; strategies, and plans for accomplishing the goal; accomplishments to date; and risks and challenges for the future. To lead the development of *The National Map*, the USGS Geography Discipline's three programs, Land Remote Sensing (LRS), Geographic Analysis and Monitoring (GAM), and Cooperative Topographic Mapping (CTM) are coordinating their activities. This plan does not capture all aspects of these three programs; instead, it focuses on the areas affected by the implementation of *the National Map*. Costs of implementation are not addressed in this document but will be addressed in the future. Finally, Section 6 (Management) discusses other broad management issues, such as compliance with Federal directives and the relationship of *The National Map* to the various levels of planning in the USGS and the Department of the Interior (DOI).

2.3 Need for *The National Map*

Governmental jurisdictions are inherently geographic. All governments benefit from geospatial data that locate and classify lands and waters; describe the distribution of peoples, economic activities, infrastructure, and natural resources; and document the products of their domains. The National Academy of Public Administration (1998) identified the following 12 broad Federal functions that require geospatial data: property rights and voting rights; revenues from property; transportation, navigation, and commerce; public lands and marine sanctuary management; agriculture and natural resource development; environmental protections and ecosystem management; community and economic development (including utilities, housing, and public

works); emergency management; public service delivery (health, education, social, criminal justice); national defense; earth system sciences and geographic information technologies; and public information.

Geospatial data required by the Federal government are also created and used by State, regional, local, and Tribal governments; private industry; nongovernmental organizations; and individual citizens. Paper maps and digital forms of geospatial data underpin an increasingly large segment of the Nation's economy. The economic multiplier of freely available public-domain geospatial data is substantial. Entire industries are built around these data. Basic geospatial data should be considered and supported as part of the NSDI. A 1997 National Research Council (NRC) report concluded that:

> "Spatial data have helped form a foundation for commercial enterprises, such as delivery services, and have also led to enhanced market analyses. At the same time, the use of spatial data has reduced costs and increased efficiencies in a wide variety of areas where it is necessary to manage large networks of geographically dispersed facilities, most notably in the utility industries, transportation, and local governments. Policies and practices of open and affordable access to spatial data have contributed to U.S. leadership in the world markets of spatial data technologies and applications."

During the development of *The National Map* vision, the USGS interviewed key customers and individuals familiar with the development and use of geospatial data from 5 Federal, 2 State, and 2 regional government agencies; 9 private industry organizations; 1 educational organization; 4 professional organizations; and 15 leaders and scientists in the USGS. The draft of the report was offered for public comment and resulted in 122 responses. A second directed review was also conducted.

The following excerpt from "*The National Map* - Topographic Mapping for the 21st Century" describes current and developing geospatial data needs and the implications of new capabilities identified during the development of the report.

> "*There continues to be an unmet need for a common set of basic spatial data.* The Federal Government, other public and private organizations, and individuals need a common set of basic spatial data that they can expand and enhance to meet their mission, business, or individual needs. Not only must these data be developed, but they must also be maintained. These data would provide an enterprise level of spatial data for the Federal Government.
>
> *For some places, large amounts of data are available; for others, very little.* For areas for which spatial data exist, the data developed by different jurisdictions are not consistent. For other areas, little data, or data of unknown or poor quality, exist. Existing data should be used as a starting point for areas for which they are available. Investment is needed where data are lacking.
>
> *A standing collection of basic spatial data is needed*. There is a need to develop and maintain a standing inventory of these data. In spite of improvements in remote sensing

and other technologies, a capability to develop all basic spatial data "just in time" is unlikely. The need to analyze changes in the landscape through time also requires an inventory of data.

*These data must have the following characteristic*s:

- *Currentness.* Natural and human processes change even the most "timeless" features, such as elevations, and some features, such as a network of roads, can change very quickly. Data must accurately reflect the current state of the landscape. Reasons to maintain currentness range from ensuring correct results from analyses to gaining the confidence of those using the data. Continual maintenance is needed to ensure that the data typically are current in terms of days or months, not years.

- *Usefulness for any arbitrarily defined geographic are*a. Public and private organizations use spatial data to meet mission and business needs, and these needs often have different "footprints" on the landscape. For example, census data concern the geographies of census and political units; work on water resource problems often concerns watersheds; and responses to natural disasters concern the areas affected. For the Federal Government, these areas may be as small as individual farms or fields, or as large as ecosystems and sometimes the entire Nation. The data must have a consistent classification and minimum criteria for completeness and positional accuracy. Inconsistencies must be resolved among data collected over different areas or by different jurisdictions, as must inconsistencies among different themes of data.

Both digital and paper forms of basic spatial data are needed; paper maps should be derived from a master set of digital data. Much as word processing and other office productivity software have not eliminated paper documents, basic spatial information in the forms of both digital data and paper maps will continue to be needed. Data portrayed on maps must be consistent with those provided in digital form and should be derived from those digital data.

Technology will continue to evolve and will provide new ways to collect, maintain, access, and use basic spatial data. There will be few technical limitations to meeting needs for spatial data; indeed, the future promises an expanding number of possibilities for spatial data collection, maintenance, access, and use. Advances in computing hardware and broadband and wireless communications will provide the basic ability needed to store, process, and communicate data. The trend of including Global Positioning System and "locationally aware" technologies in cell phones and other personal electronic devices promises increased use of spatial data and intriguing new ways of collecting and maintaining these data. Standards, including those for open geographic information technology and processing methods, will be key to capitalizing on these technologies. For the foreseeable future, it appears likely that human

intervention will be required to interpret features such as roads and buildings from remotely sensed data.

The Internet will continue to provide new ways for disseminating and using spatial data. The Internet will be the enabling technology that will increase the public and private sectors' and individuals' use and awareness of spatial data. Evolving from a means to view content and purchase products, the Internet will encourage the development of more holistic spatial services, stand-alone devices, specialized applications, customized spatial queries, and interactive capabilities. The result of these changes will be a proliferation of specialized devices that require spatial data accessed over the Internet to operate.

Common needs and interests offer opportunities for partnerships to collect, maintain, access, and use basic spatial data among Federal agencies, and with other public organizations, notably State and regional organizations. Although the missions of Federal agencies vary, and often are different from those of State, regional, local, and tribal governments, there are overlapping needs and interests in a common set of basic spatial data. Common needs can be met more quickly by pooling resources. The challenge of organizing these resources is substantial.

Private sector investments in capabilities to collect, maintain, access, and use basic spatial data, and in the development and maintenance of data, provide opportunities to meet Federal needs. The private sector currently collects, under contract, basic spatial data that meet Federal specifications. Moreover, some privately held data developed and maintained for other markets could meet Federal needs.

Volunteers may be an untapped means of maintaining basic spatial data. With the advent of "locationally aware" capabilities in cell phones and other personal electronic devices, volunteers knowledgeable about changes in their locales could be a useful source of information needed to maintain basic spatial data.

Policies and other rules for accessing and sharing basic spatial data, such as licenses, must allow the data to flow as needed to meet Federal mission needs. The Federal Government needs basic spatial data only as much as these data help meet mission needs. The trend for the Federal Government to carry out programs and evaluate results by working with State and other public entities, the private sector, nongovernmental organizations, and the public will continue to grow. Basic spatial data must be available for use by those carrying out programs and for reuse by different combinations of organizations for follow-on work and long-term understanding of change. The ability to share data widely also increases the opportunities for partnerships to fund data collection and maintenance. Therefore, licenses and other policies for basic spatial data use must allow for data sharing among partners that carry out, monitor, or evaluate Federal activities.

Federal leadership and commitment are needed to ensure that basic spatial data are available to support Federal agencies in accomplishing their missions. Without leadership, agencies are likely to expend funds in areas outside their mission

responsibilities to obtain these data. A coordinated approach to developing and maintaining these data would reduce duplication and expense.

As the Nation's civilian mapping agency, the USGS mission is to lead in the development and maintenance of this common set of basic spatial data. A new approach is needed. The current approach of inadequate cycles of updates and independent lines of digital data and paper maps will not meet the needs of the Federal Government. USGS leadership and participation, such as that demonstrated in interagency data development efforts for orthorectified imagery, elevation, hydrography, land cover, and geographic names data, are needed to foster partnerships and approaches to provide needed basic spatial data."

In addition to the requirements for geospatial data by the Federal government, the Nation needs Federal leadership in the integration and application of geographic information. The NRC Report, "Research Opportunities in Geography at the U.S. Geological Survey" (National Academy of Sciences (NAS), 2002) recommended this role for the USGS:

"The Geography Discipline produces valuable spatial data for users ranging from private citizens and corporations to governmental agencies at all levels. The Geography Discipline should now expand its activities to assume its proper role among the other disciplines at the USGS by engaging in fundamental geographic research, investigating the processes and forms that explain the dynamics of location, space and place. The investment in such research will change the Geography Discipline, but it will pay enormous dividends for the nation by improving the science done in other disciplines, integrating new knowledge, and data generated by USGS and others, reducing losses from hazards, improving management of natural resources, enhancing the quality of life, and aiding in wise development."

Government entities often lack the expertise to know which geographic information to use or how to use it effectively. *The National Map* will provide that knowledge. *The National Map* researchers conduct research for data integration, management, distribution, and applications with the objective of providing a national geographic knowledge resource that is flexible enough to meet today and tomorrow's needs. The benefits of this knowledge extend to academia, industry, and the general public.

3 Relationship to the President's Management Agenda and Other Priorities

The National Map directly supports the President's Management Agenda and priorities of the Secretary of the Interior for (1) science-based decisionmaking, by making available to scientists and the public, basic geospatial data and information produced through partnerships with organizations in every sector and (2) electronic government, by simplifying and enhancing the delivery of data, information, and tools to citizens consistent with the principles of Geospatial One-Stop. The USGS also develops and maintains the standards for three of the NSDI/Geospatial One-Stop Framework datasets – digital orthoimagery, elevation, and hydrographic data. The geospatial data that are made available also support the Recreation One-Stop and Disaster Management e-Government Initiatives.

The following excerpt from "*The National Map* - Topographic Mapping for the 21st Century" describes the National Spatial Data Infrastructure.

> *"The National Spatial Data Infrastructure provides the context for developing and maintaining basic spatial data.* The National Spatial Data Infrastructure is the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and nonprofit sectors, and the academic community. The goals of the National Spatial Data Infrastructure are to (1) reduce duplication of effort among agencies, (2) improve quality and reduce costs related to geographic information, (3) make geographic data more accessible to the public, (4) increase the benefits of using available data, and (5) establish key partnerships with States, counties, cities, tribal nations, academia, and the private sector to increase data availability. Under Executive Order 12906, the FGDC coordinates the Federal Government's development of the National Spatial Data Infrastructure. The National Spatial Data Infrastructure encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data. The 17 Federal agencies that are members of the committee cooperate with organizations from State, local, and tribal governments, the private sector, and the academic community to develop the National Spatial Data Infrastructure. The USGS participates in the committee and leads several of its activities."

The National Map concept aligns with the goals of, and is one of several USGS activities that contribute to, the National Spatial Data Infrastructure (NSDI).

The needs for basic standardized geospatial data for the Nation are recognized in the Administration's Geospatial One-Stop e-Government initiative led by the Department of the Interior. Geospatial One-Stop is a multiagency initiative to provide a geographic element for use in all e-Government activities across local, State, Tribal, and Federal government. Seven geographic data themes are identified as NSDI/Geospatial One-Stop "framework" data themes. Framework data will form the foundation for numerous "applications ranging from homeland security, emergency management, and disaster response to economic development, natural resource stewardship, public safety, transportation planning, management of invasive species, zoning decisions, and disease management" (from *Geospatial One-Stop Office of Management and Budget (OMB) Capital Asset Plan (Exhibit 300)*, February 4, 2002). The USGS has been

designated as the lead agency for three of the seven framework data themes. *The National Map* will be the vehicle for implementing the Geospatial One-Stop initiative for the three USGS-led framework themes. Moreover, for the additional Geospatial One-Stop framework data themes included in *The National Map*, the USGS will partner with the Geospatial One-Stop lead agencies. Table 3-1 summarizes the NSDI/Geospatial One-Stop (GOS) Framework and *The National Map* base data themes.

Table 3-1: Crosswalk of NSDI/Geospatial One-Stop Framework and *The National Map* base data themes

Theme	NSDI/GOS Framework	*The National Map*
Elevation	Yes	Yes
Orthoimagery	Yes	Yes
Hydrography	Yes	Yes
Transportation	Yes	Yes
Governmental Units	Yes	Yes
Geographic Names	No	Yes
Structures	No	Yes
Land Cover	No	Yes
Cadastral Data	Yes	No
Geodetic Control	Yes	No

There are related information systems in the USGS, such as the National Biological Information Infrastructure, the Geographic Data Explorer, and the National Water Information System. The USGS Geographic Information Officer chartered an ad hoc team to review these systems and *The National Map*. The team has concluded that these systems (1) can be characterized as key data source systems, (2) are directly related to the USGS mission, (3) are discipline-oriented, and (4) are not duplicative or redundant. GOS and the Enterprise Geographic Information Management are characterized as infrastructure/architecture systems and are dependent upon data source systems such as *The National Map*.

The relationship among the NSDI, Geospatial One-Stop, and *The National Map* can be summarized in the following:

- NSDI is a *concept* defined as including all aspects of geospatial data.
- Geospatial One-Stop is a communications *portal* for geospatial information content and related information.
- *The National Map* is geospatial information *content* in the form of data and applications.

The last two are activities that include processes and procedures required for their smooth operation. Common aspects of the two sets of processes and procedures will result in overlaps, but there are some distinct differences between GOS and *The National Map*.
Table 3-2 provides details about the relationships among the NSDI, the FGDC, Geospatial One-Stop, and *The National Map*.

Table 3-2: Relationship of The National Map to Geospatial One Stop and related activities

	NSDI	FGDC	Geospatial One-Stop	*The National Map*
What it is	*Concept and related strategy*: The technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.	*Coordination structure*: A Federal interagency committee responsible for facilitating Office of Management and Budget Circular A-l6 related activities and implementation of the NSDI.	*Communications mechanism*: An electronic government initiative sponsored by the Office of Management and Budget, to enhance government efficiency and improve citizen service.	*Information content and applications*: A resource that stimulates the economic and environmental health of the Nation by enabling and communicating geographic science.
Purpose	Reduce duplication of effort, improve quality and reduce costs of geographic information, make geographic information more accessible to the public, and increase the benefits of using available data.	Lead and support the NSDI strategy, spatial data policy development, management, and operational decisionmaking.	Make available easier, faster, and less expensive access to geospatial information for all levels of government and the public.	Provide trusted, integrated, seamless, and continually maintained geospatial base data and archives, along with related models and applications.
Means	A national strategy provides broad goals and objectives for improving use of, access to, and development of geospatial data.	Use procedures and committee structures to carry out interagency coordination and implementation of the NSDI, in accordance with existing law, statute, and policy.	Provide an Internet portal through which data providers can make data available for discovery and viewing; develop standards for framework data; sponsor data inventories; and (anticipated) provide a marketplace to document planned data investments.	Working with partners, implement strategy to assure nationwide base data, research, and applications. Coordinate, perform or underwrite: • Data integration, certification, providing seamless and trusted data where data are available, and data development where no data are available. • Related operations and archive of data to ensure continuous availability of data. • Access to data, monitoring of use, and user satisfaction. • Needed research and applications.

	NSDI	FGDC	Geospatial One-Stop	*The National Map*
Participation and roles	By definition, anyone with an activity that involves geospatial data.	Federal focus for interagency coordination; selected agencies lead interagency coordination of identified themes.	Participants provide access to their data. Opportunities available to participate in development of information content standards. Open, with government-to-government focus.	Participants have a role in data integration, maintenance, data access, coordination, management, and science applications. Participates in FGDC and Geospatial One-Stop activities for coordination, standards, content provision, and other responsibilities. Open; with government-to-government focus.
Information content *(see Table 3-1 for additional information)*	In a conceptual way, all geospatial data. Strategy emphasizes need for seven data themes termed "framework".	The coordination structure has none per se; agencies provide content. Emphasis for information content coordination is on thirty-four data themes (including the "framework" themes) for which selected Federal lead agencies coordinate national coverage and stewardship.	The portal has none per se; participants provide content. Provides access to metadata and views of geospatial data made available by participants through an Internet portal.	Eight base data themes (including five of the NSDI Framework themes), and related scientific models and applications. A structured process will allow participants to provide additional data to *The National Map* themes. Make content available through Geospatial One-Stop and other methods.
Standards	An element of the strategy to provide common and repeated rules, conditions, guidelines or characteristics for data, and related processes, technology and organization.	Adopt, adapt, or develop standards applicable to the Federal Government and provide a consolidated Federal voice to national standards activities.	Adopt, adapt, or develop standards and Internet protocols necessary for efficient and effective Internet implementation of NSDI. Complete FGDC work on information content standards, with initial emphasis on "framework" themes.	Encourage and promote use of standards for database creation and develops and assures conformance to standards, guidelines and characterizations for technology and applications. Participate in development of information content and other standards in FGDC and Geospatial One-Stop processes.
Clearinghouse	An element of the strategy to provide access to documented spatial data and metadata.	Develop clearinghouse concepts, provide tools for implementation, and make available resources for implementation.	Extend clearinghouse concept through an Internet portal, and provide tools for data access.	Provide content through NSDI clearinghouse and GOS portal. Use clearinghouse / portal to identify and link to "best available" data and scientific applications.

	NSDI	FGDC	Geospatial One-Stop	*The National Map*
Partnerships	An element of the strategy to encourage cooperation and reduce duplication.	Encourage partnership development and expansion among Federal agencies.	Encourage partnerships through greater awareness of existing data and planned data development.	Develop and maintain sustained partnerships needed to assure availability of *The National Map* themes and related research and applications.
Metadata	An element of the strategy to encourage a common approach to data documentation.	Encourage metadata development and expansion among Federal agencies.	Take advantage of metadata as a foundation for data discovery.	Develop and use metadata as a foundation for *The National Map* data coordination, delivery, and application to science.

4 Process

The National Map will transform the Geography discipline of the USGS in many ways – systemically, technologically, and organizationally. Its development requires a systematic process to guide this transformation. In this regard, the following important decisions have been made about the overall process:

- An open process, using the Internet and other methods to involve all interested participants, will be used to maximize external participation in the process.
- A team structure has been established following a business architecture model, the Zachman Framework, designed to describe all major aspects of *The National Map* from various perspectives and levels of detail.
- A formal mechanism will be used for *The National Map* development and implementation to ensure that a comprehensive, coordinated procedure is followed – an important approach for the size and scope of the project and organization affected.
- A formal method of communication called Unified Modeling Language™ (UML) will be used to describe *The National Map* elements.
- A staged approach is envisioned for implementation, with a number of short-term goals primarily focused on the basic geospatial data aspects of *The National Map* planned through the end of FY 2005 (Stage I), and longer term concepts with an enhanced science and applications focus (Stage II).

> **"[The] risk to computer projects does not arise from technical failure, but from a steady drift in intent which persistently widens the gap in expectations between the technologists and their customers. It is a short-term view of the value of systems that ultimately leaves an organization with hundreds or even thousands of inconsistent and non-interoperable solutions. Software must be readily adaptable to changes in workflows, and acquire independence from operating systems and hardware-specific solutions. Looking out into the future beyond five years carries an enormous advantage over short-term thinking, provided that interest rates are low and risks are manageable."**
>
> Paul A. Strassmann in *The Squandered Computer: Evaluating the Business Alignment of Information Technologies*

4.1 Open Process

To maximize participation in the development of *The National Map*, an open process will be used. A Web site, open to the public, will be established to explain that the USGS is seeking input from all sectors. The Web site will provide (1) information about plans and ideas in the full range of subjects for *The National Map* and (2) a structured mechanism for providing input. Input will also be sought through other mechanisms, such as letters, meetings, and contacts through liaisons.

The Web site also will include discussion forums organized by topic where individuals can post suggestions and receive replies. An e-mail list processing system will connect those who choose not to use the Web. For security reasons, these forums will be moderated (that is, individuals must get permission to post a message) but will not be edited. The Web site will include a news posting section for the various teams to alert interested parties of current events and design decisions.

The Web site also will include an open-source software development section where interested parties can contribute software to *The National Map.* It is envisioned that fully robust software for *The National Map* will be developed by using the open source paradigm. The community at large will develop this software. Though the USGS will contribute, it will not be the primary developer.

Open processes are often used in the system development community. It allows for much more extensive dialogue involving many participants and, for that reason, typically leads to better end products and a greater level of participation by those involved in the process. Since participation is critical to the success of *The National Map*, the USGS has determined that an open process will help achieve more satisfactory results.

4.2 *The National Map* and The Zachman Framework

4.2.1 Zachman Framework

The Enterprise Architecture perspective provided by the Zachman Framework (see Table 4-1) has been used in many FEA development efforts, including the FEA Program Management Office, and is being used to structure *The National Map* implementation planning effort. A supporting team structure has been defined and is in place within the USGS to carry out through the design, development, and implementation work to construct this architecture for *The National Map*.

The Zachman Framework is a method for organizing all documents and analyses that are necessary for a major development project. The cells in the framework provide a way to organize information so that it can be analyzed and is readily available to all in an organization. One way to think about the cells is that they are storage bins holding information about what information an organization needs to do its work, how it does its work, where it does its work, who does its work, when its work is done, and why its work is done. This information ranges from general (scope perspective) to detailed (detailed representation perspective). The methodology and tools used to gather the information for a particular cell need to be documented, along with where the information is kept.

A major advantage of the Zachman Framework is that it lays out a direct path to the actual design and development of computer applications and business practices. In a large project, such as *The National Map*, that is implemented by people in different locations and over a significant

Table 4-1: Zachman Framework© (Used with the permission of John Zachman)

	WHAT	HOW	WHERE	WHO	WHEN	WHY	
	DATA	**FUNCTION**	**NETWORK**	**PEOPLE**	**TIME**	**MOTIVATION**	
SCOPE {contextual} Planner	List of Things Important to the Business Entity = Class of Business Thing	List of Processes the Business Performs Process = Class of Business Procecess	List of Locations in Which the Business Operates Node = Major Business Location	List of Organizations Important to the Business People = Major Organizational Unit	List of Events / Cycles Significant to the Business Time = Major Business Event / Cycle	List of Business Goals / Strategies Ends / Means = Major Business Goal / Strategy	**SCOPE** {contextual} Planner
BUSINESS MODEL {conceptual} Owner	e.g. Semantic Model Entity = Business Entity Relationship = Business Relationship	e.g. Business Process Model Process = Business Process I/O = Business Resources	e.g. Business Logistics System Node = Business Location Link = Business Linkage	e.g. Work Flow Model People = Organizational Unit Work = Work Product	e.g. Master Schedule Time = Business Event Cycle = Business Cycle	e.g. Business Plan End = Business Objective Means = Business Strategy	**BUSINESS MODEL** {conceptual} Owner
SYSTEM MODEL {logical} Designer	e.g. Logical Data Model Entity = Data Entity Relationship = Data Relationship	e.g. Application Architecture Process = Application Function I/O = User Views	e.g. Distributed System Architecture Node = I/S Function (Processor, Storage, etc} Link = Business Linkage	e.g. Human Interface Architecture People = User Work = Deliverable	e.g. Processing Structure Time = System Event Cycle = Processing Cycle	e.g. Business Rule Model End = Structural Assertion Means = Action Assertion	**SYSTEM MODEL** {logical} Designer
TECHNOLOGY MODEL {physical} Builder	e.g. Physical Data Model Entity = Segment/Table/etc. Relationship = Pointer/Key/etc.	e.g. System Design Process = Computer Function I/O = Data Elements/Sets	e.g. Technology Architecture Node = Hdw/System Software Link = Line Specifications	e.g. Presentation Architecture People = User Work = Screen Formats	e.g. Control Structure Time = Execute Cycle = Component Cycle	e.g. Rule Design End = Condition Means = Action	**TECHNOLOGY MODEL** {physical} Builder
DETAILED REPRESENTATION {out-of-context} Subcontractor	e.g. Data Definition Entity =Field Relationship = Address	e.g. Program Process = Language Statement I/O = Control Block	e.g. Network Architecture Node = Address Link = Protocal	e.g. Security Architecture People = Identity Work = Job	e.g. Timing Definition Time = Interrupt Cycle = Machine Cycle	e.g. Rule Specification End = Sub-condition Means = Stop	**DETAILED REPRESENTATION** {out-of-context} Subcontractor
FUNCTIONING ENTERPRISE	e.g. : DATA	e.g. : FUNCTION	e.g. : NETWORK	e.g. : ORGANIZATION	e.g. SCHEDULE	e.g. STRATEGY	**FUNCTIONING ENTERPRISE**

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time span, good organization and completeness of information are critical its success. The Zachman Framework helps to ensure alignment, facilitate integration, and make quick response to changes possible. The information gathered in the framework can be reorganized into other presentation frameworks as needed and provides the basis for matrices and models.

It is important to note that the Zachman Framework does not describe a process for developing or changing a system but is focused on describing a system as a snapshot in time. The Zachman Framework provides the context for teams at various levels to be assigned appropriate roles and responsibilities in planning and carrying out the implementation strategy.

4.2.2 Team Structure

The USGS is using teams to accomplish the tasks of *The National Map.* The team structure, shown below in Figure 4-1, parallels the perspectives of the Zachman Framework. Communications flow in both directions between the levels. Members from one team may serve on crosscutting teams to help ensure integration and improve communication.

A **Steering Committee**, made up of the Geography Senior Staff (GSS), has oversight and ownership of *The National Map* architecture. The committee provides business direction and resolves business issues, interprets and provides the vision for the organization, and ensures that the strategic plan is current and that it implements the vision. The GSS Steering Committee reflects the "Scope" (Row 1) of the Zachman Framework described in Table 4-1.

The **Advisory Board** provides an external perspective to the Steering Committee and informs the steering committee about external requirements and needs for *The National Map.* This board has not yet been established.

The National Map **Business Model Team (BMT)** works closely with the Steering Committee and the System Design Team (SDT) to oversee and coordinate the content of *The National Map* architecture. This team reflects the "Business Model" (Row 2) of the Zachman Framework and is responsible for planning the implementation of *The National Map*. In addition, the BMT is responsible for a portion of the "System Model" (Row 3). System architecture is the implementation-independent part of *The National Map* that includes defining the functional requirements and in broad terms how they will be met. It organizes *The National Map* into logical business systems. The BMT works closely with the SDT, who will design the actual implementation of the architecture.

The **System Design Team (SDT)** reflects both the "System Model" (Row 3) and the "Technology Model" (Row 4) of the Zachman Framework. The team works closely with the BMT to identify the elements of *The National Map*, to coordinate the element design and interfaces between elements, and to ensure that the element designs align with the Business Model and System Model Perspectives (Rows 2 and 3) to meet the requirements of the customers. The SDT is responsible for the technical architecture and the translation of the technology-independent architecture (developed in Row 3) to implement the design.

The **Design Teams (DTs)** develop the detailed design and build or create the elements defined in *The National Map* Architecture System Design. The DTs coordinate subelement design to ensure that the subelement designs align with the element designs. These teams reflect the Detailed Representation (Row 6) of the Zachman Framework.

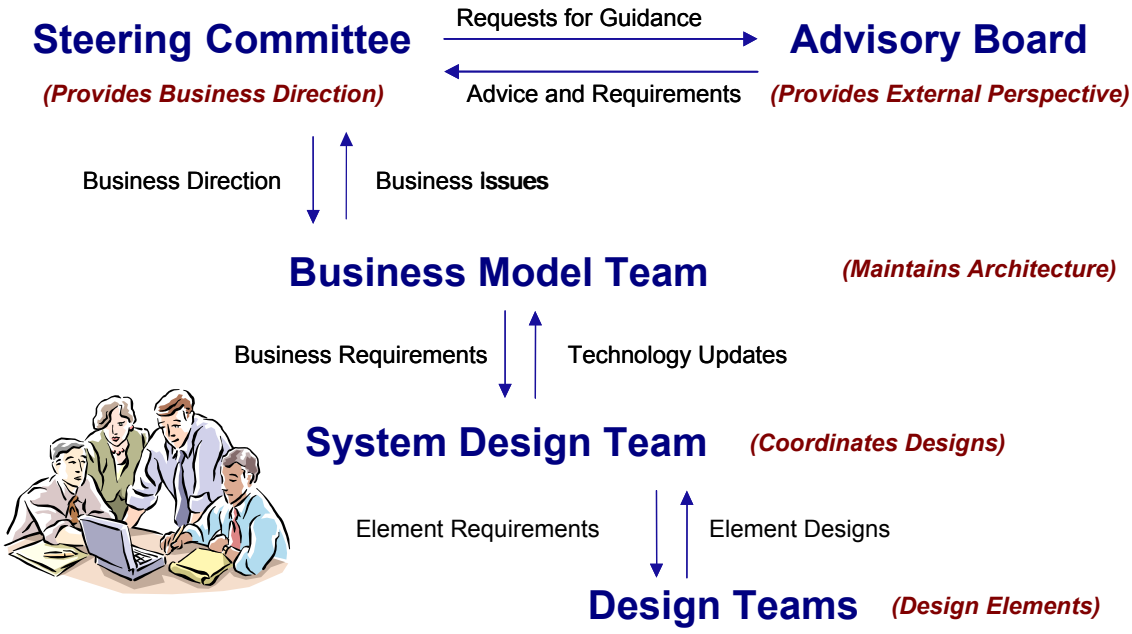


Figure 4-1: *The National Map* team structure

4.3 Best Practices for System Development

Six core best practices ("Industry Proven Best Practices," Rational software from IBM web site) for *The National Map* development are being used to guide the efforts. These best practices are:

- Proactive management of change and evolving development activities
- Iterative development of *The National Map* elements
- Focused management of user requirements
- Ongoing verification of *The National Map* element quality
- Employment of element architecture to enable reusability and ability to be tailored
- Accomplishment of analysis and design through visual models

The first four best practices will be met through a development approach known as operational prototyping. This process has been chosen as most appropriate for the large and complex nature of this project. Operational prototyping uses the development of rapid prototypes as a means to evolve and test aspects of *The National Map*. Operational prototyping provides a more structured developmental process than an evolutionary prototyping approach (Alan Davis, "**Operational Prototyping: A New Development Approach," *Software* (IEEE Computer Society),** September/October 1992). Operational prototyping allows *The National Map* requirements to be appropriately modified early in the process by testing out concepts. A supporting implementation, employing proven best practices and evolving, configurable architectures will be followed to guide these activities.

A particular systematic system development process that uses operational prototyping must be specified. An example is the Unified Development Process (Jacobson and others, 1999). A requisite supporting tool suite (providing project management, requirements management, modeling and construction, testing, change and configuration management, and documentation capabilities) is being procured. The phases of the unified development process are shown below. The process steps align with the Zachman Framework so that the various implementation teams' responsibilities and levels of effort can be nominally projected.

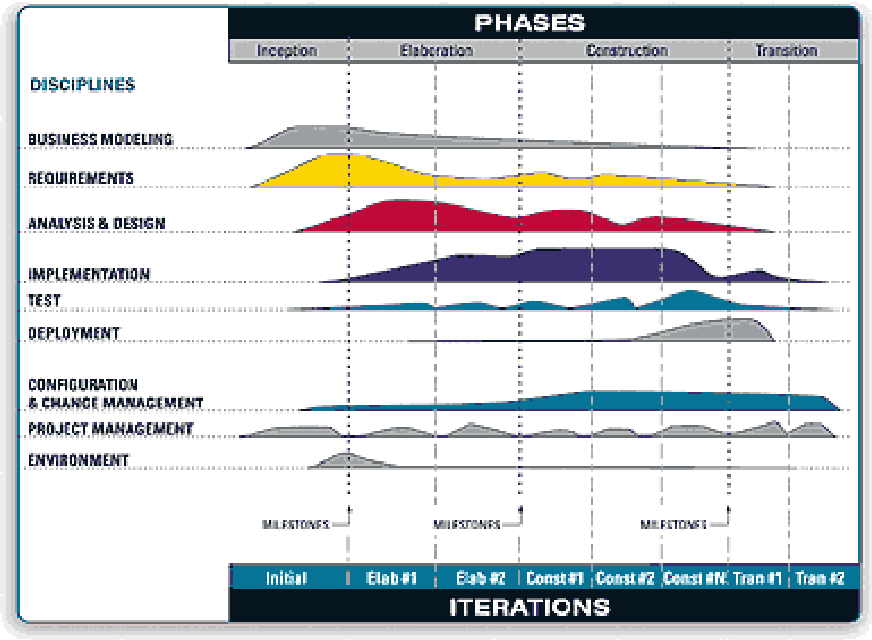


Figure 4-2: Unified Development Process

The Unified Development Process as shown in Figure 4-2 consists of a series of phases related to the work being accomplished. The first phase is the inception phase where high level ideas and requirements are defined. These requirements are refined and fleshed out in the second (elaboration) phase. Once the requirements are understood construction begins in the third phase. A transition is made from construction to operations and maintenance in the fourth phase. A fifth or production phase is not represented on this diagram.

The vertical Y-axis of the diagram represents workflows. These workflows roughly represent the rows in the Zachman Framework. The top row shows when business modeling activities are performed (equivalent to Zachman Row 2). Business modeling does not stop at the end of the inception phase but continues until almost the end of the process. The second row in Figure 4-2 is requirements modeling. Requirements modeling (or logical modeling) is equivalent to Row 3 of the Zachman Framework. This step results in an implementation independent description or architecture for the project. The implementation, test, and deployment rows of Figure 4-2 combined represent Rows 4 (technology model) and 5 (detailed representation) of the Zachman Framework. The configuration and change management, project management, and environment rows of Figure 4-2 are important parts of the project not addressed by the Zachman Framework because Zachman does not address the design process. It only addresses the elements of an enterprise.

The bottom X-axis label “Iterations” indicates that within each phase, the work is addressed in an incremental fashion according to the operational prototyping process.

The outputs of the first two phases are the creation of Unified Modeling Language (UML) diagrams and databases carefully documenting what are to be constructed. These diagrams and databases are used to determine the impacts of future enhancements and adaptations to *The*

National Map. These diagrams can also be generated into a form compatible with the Department of the Interior's standard software for enterprise architecture, the Popkin System Architect suite. Using this approach, only those proposed changes whose models demonstrate compatibility will be considered for inclusion in *The National Map*.

The fifth best practice, "Employment of component architecture to enable reusability and ability to be tailored," has been adopted as well. The elements of *The National Map* that make up the component architecture are not just information technology elements, but represent all the aspects of *The National Map* system. For example, partners – the people that make up the partnering community, their needs, and our relationships with them – are a key element to success and a concern of this best practice.

The elements of *The National Map* as defined to date include the following:

- Partnerships,
- Standards,
- Base data themes,
- Archive,
- Products and services,
- Science and applications (included data derived from applications), and
- Workforce.

Implementation goals, strategies, accomplishments, and plans are provided for each element in the next section of this implementation plan.
The sixth best practice, "Accomplishment of analysis and design through visual models," are accomplished through a common representation language, UML. It is a means for communicating the products of analysis and design work. For complex design aspects of *The National Map* design, UML helps prevent confusion about what *The National Map* is supposed to be and how it should function. UML assists in achieving the following:

- Predictable and measurable progress,
- Enhanced team communication, and
- A common understanding of tasks and responsibilities.

4.4 Staged Approach

The USGS has chosen to employ a staged approach for undertaking the development and evolution of *The National Map*. This approach will be supported by a selected development process and methodology.

Stage I of *The National Map* implementation is underway and focuses on providing geospatial data and information using current technologies. Stage II incorporates technologies that are emerging, including those that will be widely available in the coming years through evolving enhanced technologies.

In Stage I, the World Wide Web will be used to make available the most critical eight base themes of data (elevation, orthoimagery, hydrography, geographic names, land cover, transportation, structures, and boundaries), and some science applications and data derived from these base themes. The USGS expects Stage I to last an additional 2 years, to the end of FY 2005. This document focuses on the activities needed to accomplish Stage I. Details of plans are given in the element section of this document. A milestone worth noting in Stage I is at the end of FY 2004 when the current implementation will have been established and documented. Requirements for *The National Map*, not addressed in Stage I, will be addressed in the inception phase of Stage II using operational prototypes.

Stage II is a long-term strategy. It incorporates and continues key aspects of Stage I, but moves from an effort focused primarily on data to one that focuses more heavily on research, science, and applications than Stage I. Stage II of *The National Map* will not only include the basic geospatial information, mapping capabilities, and the ability to download data, but will also accommodate the potential to share models and applications. In addition, researchers will be able to access computer power from some participant organization's servers that are linked through *The National Map*. We anticipate accomplishing this by linking *The National Map* to the Geon Grid, an advance geospatial application of Internet II being developed through the National Science Foundation (NSF). This technology will help facilitate geographic research as a science that will integrate and complement continuing data activities.

To help minimize project risks during both stages of the process operational prototyping will be used to develop *The National Map* Business Architecture and ensure alignment of Stage I and II goals and activities. Operational prototyping is a systematic method in which ideas and techniques are tested by using a series of rapid prototypes. Also, as already noted, an open process will be used to maximize participation in the development of *The National Map*. That is, a Web site will be established to explain that USGS is seeking input from all sectors, provide information about current ideas in the full range of subjects for *The National Map*, and provide a structured mechanism for providing input. Input will also be sought through other mechanisms as well, such as letters, meetings and contacts through liaisons.

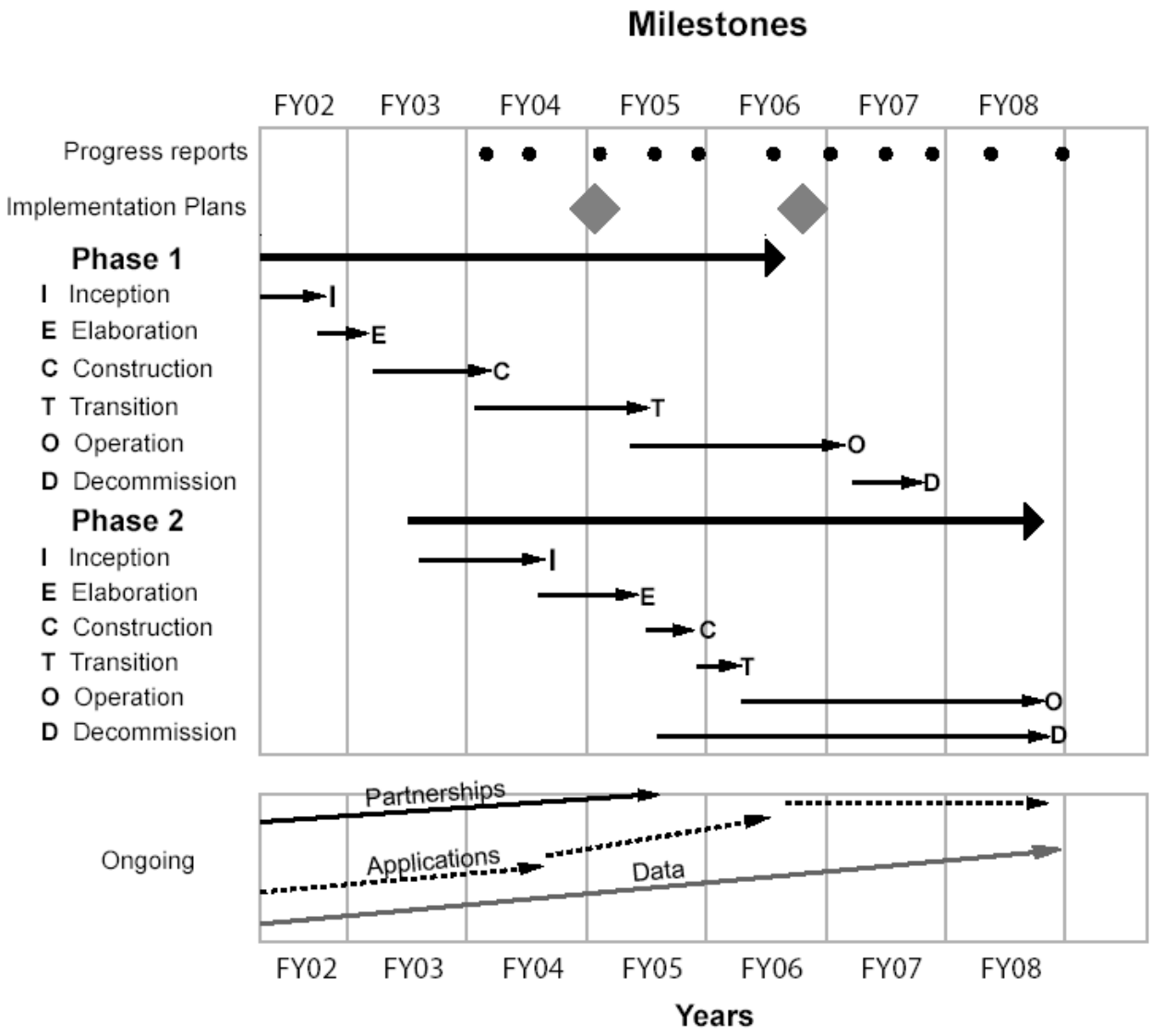


Figure 4-3: ***The National Map*** **staged approach.**

Figure 4-3, *The National Map* staged approach, shows a timeline of major events envisioned for the implementation of *The National Map*. Reports on the progress of implementation will be issued every 6 months. A revised implementation plan will be issued every 2 years.

The figure shows the major phases of development under a systematic process (inception, elaboration, construction, transition, and operation phases) for each of the two stages. Stage I has been underway for about 2 years and will begin the operational phase by the end of FY 2004. This does not mean that all the partnerships that are needed for Stage I will be established by then. New partnerships will continue to be established in Stage I during FY 2005. However, the system will have well-established, basic functionality that is not being enhanced. No further development will be undertaken during the remainder of the Stage I development process.

The inception phase of Stage II began during the last quarter of FY 2003 with the adoption of a formal planning process that includes input from an open Web site that invites external review and contributions. The system requirements will be fully and formally defined using those processes. It is estimated that Stage II would begin operation by the middle of FY 2006. At that time, some Stage I functions will be absorbed into Stage II functions. Others Stage I functions will be decommissioned.

There will be ongoing and increasing needs for partnership development, along with increasing requirements for data and applications. New types of partnerships might be initiated when Stage II begins construction. In Stage II there will be increasing work with partners in developing and providing access to models and applications. Those models will enable analysis of increasingly complex issues.

5 Elements

Through FY 2002, work on *The National Map* focused on seeking external review of the vision, conducting pilot implementations to prove the concept, and strengthening relations with partners by involving them in the refinement of this vision. The goal of this implementation plan is to lay out the road map for moving from existing business practices to those that are necessary for accomplishing *The National Map* vision. The plan will help communicate the implementation strategy to a wide range of audiences:

- Partners who want to know specifically how the USGS can better coordinate joint efforts,
- DOI and OMB officials and staff who have program and budget oversight responsibility,
- Congressional officials and staff,
- USGS supervisors, project chiefs, managers, and task leads with responsibility for project formulation and execution, and
- Senior managers with responsibility for program oversight and reporting to external officials.

The elements of *The National Map* include the following:

- Partnerships,
- Standards,
- Base data themes,
- Archive,
- Products and services,
- Science and applications (including data derived from applications), and
- Workforce.

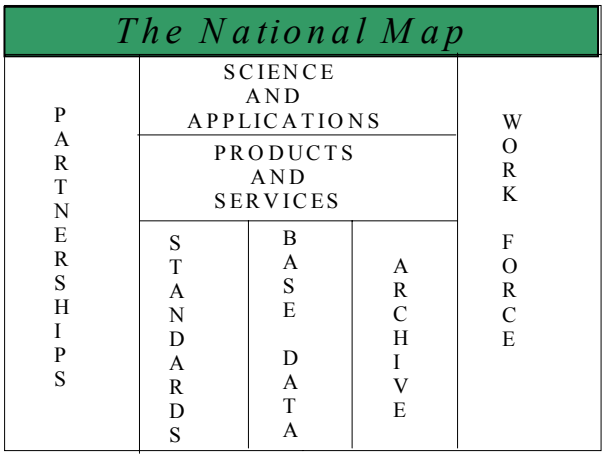


Figure 5-1: Elements of *The National Map* and the relationship among them.

Each element has a primary goal. This section outlines the objectives and strategies for accomplishing the goals, accomplishments to date, and risks and challenges for the future. Some elements have sub-elements with additional goals and objectives that nest under the primary goals. The costs of implementation are not addressed in this document, but will be addressed in the future. This is a living document that frames a plan of work and ensures alignment with *The National Map* capital asset plan and business case, the bureau budget justification, the bureau and Departmental enterprise architectures, *The National Map* program assessment rating, and partner priorities.

The primary goals for each element are summarized below:

Partnerships
Goal: Implement, maintain, operate, and foster *The National Map* through partnerships with a wide variety of organizations.

Standards
Goal: Ensure nationally consistent and integrated data that support a wide variety of science and government applications in a heterogeneous, distributed computing environment.

Base Data Themes
Goal: Ensure availability of accurate and timely geospatial data in 8 themes at appropriate resolutions.

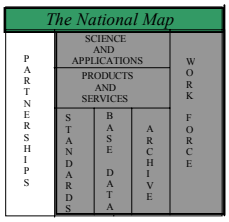
Archive
Goal: Provide an archive for the historic preservation of data and science applications in *The National Map.*

Products and Services
Goal: Provide analog and digital products and services from *The National Map* that include paper products, interoperable Web services, digital browse images, data downloads, and scientific reports.

Science and Applications
Goal: Promote geographic integration and analyses and provide access to tools for specific applications and modeling.

Workforce
Goal: Ensure that the skills of the workforce are appropriate to accomplish the goals of *The National Map.*

5.1 Partnerships



Goal: Implement, maintain, operate, and foster *The National Map* through partnerships with a wide variety of organizations

The success of *The National Map* depends, in large part, on an ability to capitalize on partnerships established over the last 100 years and to establish and maintain new relationships with the wide variety of organizations that work with basic geospatial data. In the past, the USGS played a primary role in the collection of these data, but today the most current, highest resolution, continuously maintained, basic geospatial datasets often reside with State, local, and Tribal governments, private entities, and other Federal agencies.

Although these organizations collect, manage, and store basic geospatial data in response to their specific needs, in general they have neither a mission requirement to make these data available for secondary use nor the capability to integrate these data on a national scale. Wide availability for secondary use and national integration are primary functions of *The National Map*. The role of the USGS is to lead the formation of partnerships with these organizations and to use those partnerships to (1) provide public access to their accurate and reliable datasets whenever possible, (2) develop protocols for data integration, (3) develop data maintenance processes, and (4) promote the use of these data.

In carrying out its role, the USGS will link data from many partners, and to do that, the USGS must establish and enforce some minimum standards for quality and consistency. The USGS will continue to promote open standards for data content, metadata, and interoperability. The skills and abilities required to develop these relationships and formal agreements are also different from the skill needed for the partnerships we employed in the past. The philosophical approach the USGS takes to partnering, the incentives that can be offered to partners, and the expectations of the partners are all aspects of partnering for *The National Map* that are changing. This will require an innovative program of offerings and partnering opportunities.

The major strategies to achieve the partnership goal are detailed in the following sections.

Partner Requirements Strategy

Objective: Establish a formal process to assess and understand partner needs and integrate this information into the design and development of *The National Map.*

Successful partnerships with Federal, Tribal, State and local government organizations, the private sector, academia, and volunteers will require an effective process to incorporate their requirements and feedback into *The National Map*.

Step 1: Develop and implement a well-defined and transparent collaboration process to fully integrate and incorporate partners' requirements and feedback into Stage I operational processes of *The National Map* in the areas of agreements, standards, incentives, Web viewer and Web

Mapping Services (WMS), licensing, data maintenance, remote sensing, and geographic research. Use a combination of workshops and national meetings or conferences of the Public Interest Organizations (PIO) to initiate the collaboration process.

Step 2: Identify a mechanism to evaluate and incorporate partners' requirements and feedback into Stage II planning and development processes of *The National Map*.

Step 3: Build a sustainable partner constituency for *The National Map* at the national level. The use of an external advisory board for *The National Map*, similar to that of the Geospatial One-Stop, will be investigated.

Step 4: Establish a communications process to keep partners fully informed of *The National Map* development and implementation.

Partner Roles and Responsibilities Strategy

Objective: Develop a process to characterize the attributes and roles of the organizations and Government entities that partner with *The National Map.*

Step 1: Characterize key attributes of the roles of potential partners (Federal, Tribal, State, county, city, private sector, academia, PIOs, and volunteer partners). Classify and rank potential partners by these attributes to help establish priorities for partnering.

Step 2: Develop effective mechanisms to coordinate geospatial data activities with other Federal agencies, including creating new Memoranda of Understanding (where appropriate), establishing points of contact with agencies, and communicating the status of activities with and among the partnership community. This will build upon the existing USGS strategy for Federal points of contact.

Step 3: Work with State, county, and local governments to identify statewide coordinating mechanisms (for example, NSDI I-Teams) that enable and facilitate the development of *The National Map*.

Step 4: Work with PIOs interested in geospatial issues to develop national strategies to support user needs and requirements. The approach involves establishing a contact person at the national level for relationship building, and engaging the constituencies in support of *The National Map*.

Step 5: In collaboration with industry, develop a partnering strategy to encourage involvement in the development of applications and technology associated with *The National Map*. In particular, the strategy should encourage technology development, and data distribution and use. The strategy should also include processes by which liaison staff and others can bring private sector partnerships forward in the discipline using Cooperative Research and Development Agreements (CRADA) and other mechanisms.

Step 6: Provide leadership in developing a volunteer program for *The National Map*, in concert with partners, that identifies potential tasks for volunteers, establishes guidelines for volunteer agreements, and determines volunteer development and certification needs.

The Role of the Private Sector in *The National Map*

It is critical to the success of *The National Map* that a strong relationship exists with the private sector. Currently, *The National Map* makes use of the private sector as suppliers for hardware, software, and data. In the future, it is expected that private industry will have an enhanced role in *The National Map*. Specifically, the role of the private sector in *The National Map* may include:

Use and value-added applications
Private industry will be major users of *The National Map.* Ready access to more current and comprehensive data will allow commercial, value-added applications to be developed and will encourage new market developments. Through innovative applications, private industry will, in turn, help demonstrate the utility of *The National Map*.

Distributing data
Private industry will provide the majority of tools and infrastructure associated with data distribution. As the USGS reduces its retail sales activity associated with maps, imagery, and digital data, there will be an increased reliance on business partners and other private sector organizations to provide these services. In some cases, the USGS may simply contract with private industry for these services. However, the USGS will also look to develop agreements with private industry that allows data to be provided to the public at lower cost while providing reasonable compensation to industry.

The objective of *The National Map* is to have data available in the public domain without use restrictions. A concern of the private sector has been the need by businesses to protect their investment through licensing and copyright. Several activities are underway to help resolve these issues, including an ongoing study on licensing and use restrictions by the National Research Council of the National Academy of Sciences.

Identifying requirements
Private industry will be encouraged to submit requirements and contribute ideas and comments through the open process.

Developing systems
Functional requirements for *The National Map* will be provided to private industry and responses/comments will be solicited. Also, it is expected that the private sector will provide the majority of the development effort. The USGS does not plan a large internal software engineering effort in the implementation of *The National Map*.

Producing data
As *The National Map* is implemented, partnerships arrangements with key players are being sought from the geospatial data community, including the private sector. The USGS has historically interacted with the private sector through contract mechanisms and business partner relationships to procure and supply data and services. The USGS will continue to use professional services contracts with surveying and mapping organizations for geospatial data, particularly orthoimagery, elevation, hydrography, and land cover, over areas where there are limited Federal, State, or local governmental partnership opportunities. Regardless of the source of funds or the method of acquisition, private industry will be the primary source for data production.

Archiving
Private industry will play a significant role in providing the majority of the tools and infrastructure for archiving functions, wherever they are performed. There will be an enhanced role for the private sector to support operational services for archives. In the future, there may be privately held/owned/managed archives as part of *The National Map*.

Research
The National Map will require investments in several areas including research in multidimensional models, representation and propagation of uncertainty, data integration, data fusion, and generalization of geospatial data content. A substantial amount of this research could be conducted in the private sector.

Partnership Prioritization Strategy

Objective: Work collaboratively with partners to target specific partnering opportunities.

A flexible, responsive prioritization strategy that merges partner needs and USGS stewardship responsibilities should be developed, at a minimum, annually.

Step 1: Develop a list of partnering opportunities for data, research, archive/access, distribution, analysis, and other key areas in support of *The National Map,* based upon partner and USGS requirements.

Step 2: Prioritize partnering opportunities, blending partner needs with internal *The National Map* priorities (see Partner Requirements Strategy), balancing the need to obtain long-term relationships with State and local organizations while being responsive to critical short-term needs.

Step 3: Conduct an ongoing inventory of priority urban area data holdings, identify potential partnerships for the high-priority urban areas, and identify how this activity is coordinated with the inventory needs of other Federal agencies.

Step 4: Prepare a partnership coordination plan in collaboration with PIOs and the Federal Geographic Data Committee to coordinate a potentially large number of partnerships for *The National Map*.

Partnership Incentives Strategy

Objective: Identify innovative and viable incentives for partners to participate in *The National Map.*

With limited USGS financial resources to offer partners to participate in *The National Map*, the USGS partnering staff will need to use new and creative incentives to increase participation. For example, the USGS is working closely with the U. S Census Bureau to determine whether State and local geospatial data can be used to update the Census Bureau's MAF/TIGER Accuracy Improvement Project (MTAIP) database. Incorporation of State and local data into the MTAIP database is a significant incentive for State and local governments to provide their geospatial data for Federal use without restriction. In the longer term, the USGS will seek to obtain additional funding through the appropriations process to help build partnerships for *The National Map*.

Step 1: Develop incentives for participation in partnerships for *The National Map* that can be used by USGS staff in negotiations with prospective partners. The analysis of the lessons learned from the pilot partnering projects will be used as a starting point. Ideas from existing and potential partners will be solicited with particular focus on those that are innovative and non-financial.

Step 2: Define flexible guidelines, including boundaries for when the USGS will or will not use incentives to implement partnerships for *The National Map*. The guidelines will identify individuals within the USGS that have the authority to make decisions on use of partnership incentives.

Step 3: Seek financial resources for incentives, through budget initiatives and other means, to support *The National Map* partnering activities.

Step 4: Prepare guidelines on how to apply existing resources to the highest-priority partnerships. The guidelines will address performance measures necessary to evaluate effectiveness of the resource allocation decisions.

Distributed Offices Strategy

Objective: Establish an appropriate number of distributed offices to foster *The National Map.*

The Geography discipline within the USGS must further disperse its personnel geographically to increase the opportunities for partnerships with the other USGS disciplines, governmental entities, academia, Tribal nations, and the private sector to support the development and maintenance of *The National Map*.

Step 1: Assess the results of current partnering staff relocations. Modify the criteria and process, if necessary.

Step 2: Develop a long-term strategy for continued distributed office growth, including a cyclic review process to evaluate the effectiveness of each office.

Distributed Office Staffing and Location

The USGS is relocating its workforce (see Figure 5-2) from traditional Mapping Centers (blue star) to field locations, either existing or planned for 2003 (red square). Employees, who are clustered in the five Centers across the Nation, will be given the opportunity to transfer to other USGS locations where they can more easily work with State and local governments and industry. These offices are co-located with other USGS staff and with State and other partners. Co-location fosters sustained working partnerships for maintaining and integrating basic geospatial data and for applying *The National Map* to geographic issues. An additional benefit of increased deployment of these personnel into local area offices is the potential for increased cooperation with other USGS disciplines through co-location and participation in multidisciplinary research.

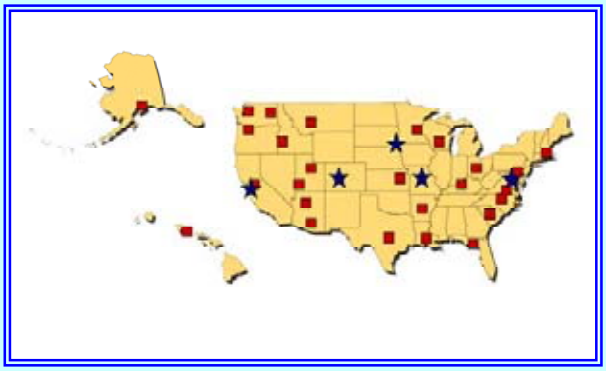


Figure 5-2: USGS Geography Discipline distributed offices

Licensed, Copyrighted, and Restricted Use Data Strategy

Objective: Develop a consistent practice for handling licensed, copyrighted, and restricted use geospatial information for *The National Map* that is transparent and easily understood by the public.

Licensing and restricted use policies encumber potential data contributions from many types of sources, including some Federal agencies, Tribal nations, States, local governments, and the private sector. A consistent practice is needed to deal with data that have use restrictions. The USGS is participating in the National Research Council's (NRC) study of data licensing and its implications for *The National Map*. The USGS will build on the National Research Council's recommendations.

Step 1: Develop interim guidelines, for approval by *The National Map* Steering Committee, on incorporating or accessing data that have use restrictions.

Step 2: Use approved interim guidelines and the outcome of the NRC Committee Report on Licensing Geographic Data and Services to develop a licensing and restricted use geospatial information policy.

Step 3: Identify actions and incentives to encourage State and local governments to evolve their restricted-use data policies toward a more open and flexible model.

Step 4: Develop a strategy to use increased amounts of commercial remotely sensed imagery.

Partnership Evaluation Strategy

Objective: Develop a method for measuring partnership successes and failures, and for improving the partnership program to better meet the needs of *The National Map.*

The USGS should provide leadership in establishing a method for measuring partnership successes and failures and for improving partnerships for *The National Map* to better meet the partners' needs.

Step 1: Develop a partnership review process using information gathered through the formal feedback process, listening sessions, advisory groups, *The National Map* partnership community, and the USGS staff.

Step 2: Using partnership performance measures that are currently under development, identify and evaluate partnerships which contribute most toward the implementation and maintenance of *The National Map*. These measures will change over time as *The National Map* grows and expands.

Recent Partnership Accomplishments

- Expanded distributed offices in support of Geography discipline priorities (see sidebar).
- Developed new partnership support tools through the "Partnerships with Purpose" Web site, including templates and a decision tree to assist with agreement type selection.
- Developed a mechanism for collecting information about partner datasets.
- Gathered and assessed lessons learned information from *The National Map* Pilot Partnerships Projects (see sidebar).
- Collected and analyzed partner recommendations from several previous venues (listening sessions, conference workshops, *The National Map* Vision document review) to establish a benchmark to guide future partner requirements and collaboration efforts.
- Established statewide *The National Map* partnerships with seven states (CA, MT, MO, AR, TX, DE, NC).
- Participated in dozens of State, regional, and local government conferences and workshops to "get the word out" about *The National Map* and the pilot partnerships projects.
- Established an excellent working relationship with the Geospatial One-Stop and FGDC staff in anticipation of further coordination activities.
- Developed Memoranda of Understanding with the National Association of Counties (NACo) and the National States Geographic Information Council (NSGIC) to begin working with these organizations and their constituents on coordinating the implementation of *The National Map*.

The National Map **Pilot Partnerships Projects - Lessons Learned**

To initiate *The National Map* program, the USGS worked collaboratively with the geospatial community to conduct eight pilot partnerships projects in FY 2002 (see Figure 5-3). The purpose of these projects was to test the vision and program concepts on a manageable scale to discover what the challenges and opportunities are for implementation of *The National Map* on a national scale.

The project areas represented a wide range of characteristics of various partnership and data development scenarios. Project area size ranged from 225 to 6,440 square miles, covering 4 to 145 7.5-minute quadrangles. Twenty-nine partners of various types (for example, county government, State government, academia, tribal government, private sector, etc.) participated with the USGS in these pilot partnerships projects. Eleven have signed formal agreements with the USGS to participate in *The National Map*.

Some of the lessons learned include

- A large effort is required to work with many small local governments; a consolidated approach through State coordination groups may be more cost effective.
- There appears to be a need for greater flexibility and creativity in an approach of defining and developing *The National Map* through collaboration with partners.
- The effectiveness of face-to-face meetings as a foundation for establishing a relationship reinforces the need for a greater presence on the landscape.
- Partners desire to formalize content and standards/specifications, and be assured that proposed *The National Map* standards have been coordinated with other Federal standards activities (for example, GOS).

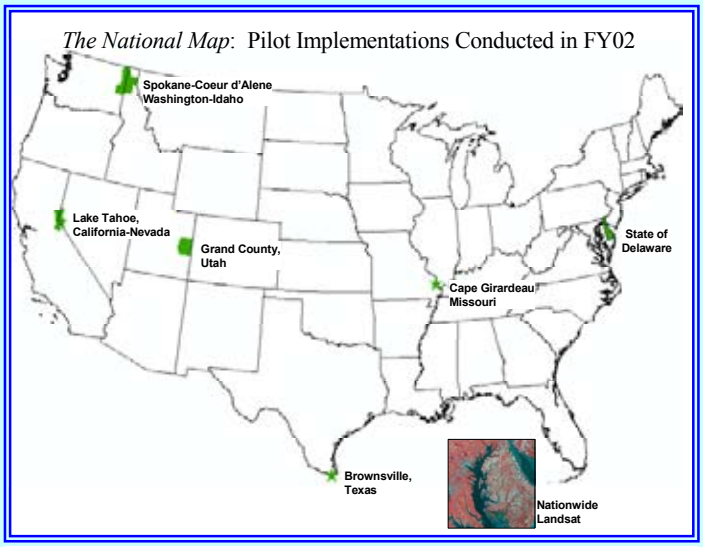


Figure 5-3: Geographic location of *The National Map* pilot partnership projects

Two-Year Partnership Plan

- Develop an implementation best practices model for *The National Map*.
- Develop Statewide implementation plans for *The National Map*.
- Implement processes that give partners a direct role in the development and implementation of *The National Map*.
- Continue to place USGS partnering and technical support staff in field-based offices in each region, using established guidelines, to better position the USGS to develop *The National Map* implementations and applications with State and local entities.
- Work with data theme leads to establish and communicate minimum content standards; a process for partners to have a voice in the standards development process must be included.
- Work with partners to develop a strategy and multi-year plans for *The National Map* implementations to work toward long-term data development and maintenance partnerships.
- Establish a Broad Agency Announcement (BAA) that improves and streamlines the USGS's ability to fund private sector and other partners in support of *The National Map* data and applications development.
- Actively pursue funding to support *The National Map* partnerships through the FY 2005 budget initiative and through the three Geography discipline programs.
- Use technology transfer partnerships and business practices (agreements, workshops, patents, copyrights, licenses, and other innovative arrangements) to support the research and applications development needs of *The National Map*.

Two-Year Partnership Milestones

- Conduct one or more requirements/feedback gathering sessions in each of the 3 USGS regions in FY 2004 (and beyond).
- Add 5 new field-based offices across the country in FY 2004 and continue to relocate technical support staff to new and existing field-based offices.
- Finalize Memoranda of Understanding with at least 3 PIOs and initiate specified coordination efforts such as establishment of issue resolution teams (FY 2004).
- Develop 5-10 additional *The National Map* implementation agreements each fiscal year.
- Implement an approved set of interim guidelines for handling licensed and restricted use data based on *The National Map* implementations lessons learned and the ongoing NRC licensing study (FY 2004).
- Implement a BAA in FY 2004 to help streamline the process for the flow of funds from the USGS to external organizations.
- Implement and continue to refine the new partnership evaluation process which evaluates *The National Map* implementations in terms of partnership costs and benefits.

Long-Term Partnership Plan

- Work collaboratively, using established processes, with Federal, Tribal, State, local, and private sector partners to guide the evolution of *The National Map*.
- Work with statewide coordination groups to establish long-term strategies and plans for developing, maintaining, and evolving geographic data, Web mapping services, and applications for the State and *The National Map*.
- Establish an appropriate number of distributed offices made up of resident liaisons, data assessment and integration specialists, and web mapping experts, who are empowered to define partnerships and add implementations to *The National Map*.

Long-Term Partnership Milestones

- Partnering staff and technical support are located in most States.
- Long-term *The National Map* maintenance agreements are in place with most States.
- A functioning partner collaboration process is in place and includes an ongoing process for partner requirements and feedback incorporation.

Partnership Challenges and Risks

- Scope, Maturity Level and Acceptance of State Geospatial Coordinating Organizations

Statewide implementations of *The National Map* will be difficult in those states with a matrix of data and Web mapping service providers rather than a single body with the authority to act on behalf of the State. Limited resources within the USGS dictate that partnering with all counties (or others) within a State will not be possible and does not leverage the inherent role of the State in the hierarchy of government from Federal to State to local levels. It may be possible to work with States to establish a coordination infrastructure. Currently, those States with existing coordination bodies are being targeted for statewide implementations.

- Distributed Offices

Staffing, funding, and other support for distributed offices will be a challenge. Priorities for locating and staffing these offices will be established to guide their establishment regardless of enacted funding levels. There is a need to transition resources from centers to distributed teams.

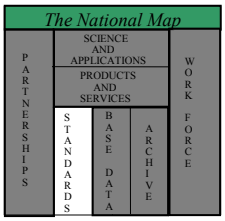
- Partnerships Seed Funding

Some seed funding should be made available to establish partnerships with new government organizations, many who have licensing and (or) cost recovery issues associated with their data.

- Program Transition

To successfully transition from the role of data producer to coordinator and integrator, the USGS needs to refocus program reporting from its current data focus to making coordination, integration, and applications the centerpieces of the program.

5.2 **Standards**



Goal: Ensure nationally consistent and integrated data that support a wide variety of science and government applications in a heterogeneous, distributed computing environment.

Standards are the mechanism by which national data are made consistent and distributed systems interoperable. Without data standards, features from one partner (roads, for example) might appear disconnected as they meet features maintained by another partner. Without information technology standards, the many elements of *The National Map*, hardware, software, and applications, will not work together consistently. Both kinds of standards are needed to be successful.

Standards Objectives

- *The National Map* will use open standards.
- The USGS will develop, in cooperation with partners and industry, a taxonomy for *The National Map* that identifies the standards that are needed for all parts of the system.

The National Map will rely heavily on standards for e-government and geospatial data. The world of standards is rapidly changing and evolving, but especially in these two areas. Openness is now an important characteristic. "Open" means available to all (at a reasonable fee) and a consensus process that is open to the entire industry. Open standards help ensure portability of applications and data and help avoid over dependence on specific vendors. Most open standards have evolved through the wide participation of academia, business, government, and industry in various formal standards bodies. These include the International Telecommunication Union (ITU), the International Organization for Standardization (ISO), the American National Standards Institute (ANSI), the National Institute of Standards and Technology (NIST), the INTERNET Engineering Task Force (IETF), and the Institute of Electrical and Electronic Engineers (IEEE). Standards developed through such organizations have a very wide base of support that significantly improves their viability in the marketplace[1].

- The USGS will participate in a broad range of standards setting activities. Consistency with OMB Circular A-119 will require not only making use of the standards from the formal bodies listed above but also participating in the standards activities of those bodies when they affect *The National Map*. This effort must be balanced with participation in the activities of other organizations, not cited in Circular A-119, that will have a significant impact on the standards environment for *The National Map* including the FGDC, the Geospatial One-Stop e-government initiative, and the OpenGIS Consortium.

[1] Interagency FEA Working Group, E-Gov Architecture Guidance - Draft, Version 2.0, July 2002

- *The National Map* must also manage the development and implementation of standards that are specific to *The National Map*. *The National Map* is an information resource that is provided to the public. It will be produced in partnership with all levels of government, the private sector, the academic sector, and the public sector. This diverse group of partners will be able to produce a nationally consistent product by adhering to well-defined product specifications and procedures developed for *The National Map*. The USGS will seek input and feedback from partners on proposed specifications for *The National Map*.

- A significant amount of the effort put toward managing standards will have to be dedicated to educating partners about standards strategies and helping them comply.

The National Map will adopt and use voluntary industry standards in which the interrelationships of system components are fully defined by interface specifications available to the public and maintained by group consensus. *The National Map* will acquire and integrate only elements that conform to these standards specifications. Nonproprietary architectures and solutions are the goal; however, initially only partially and selectively compliant solutions may be attainable. *The key requirement is that the data distributed through The National Map must be free of proprietary software dependencies.* Implementation of *The National Map* will depend on Internet and Web standards, Extensible Markup Language (XML), portals, new integration models, such as Message Brokers and XML Web Services, and the increasing use of hosting or Application Service Providers. All of these will help isolate *The National Map* from traditional interoperability issues of the underlying hardware and software platforms[2]. This strategy is consistent with the President's e-government initiative.

Standards Accomplishments

- Created data content standards in conjunction with the Geospatial One-Stop initiative for the elevation, orthoimagery, and hydrography data themes.
- Helped initiate the coordination of Geospatial One-Stop standards effort with the InterNational Committee for Information Technology Standards (INCITS) technical subgroup for Geographic Information Systems (L1).
- Coordinated a content standard for structures with the FGDC Working Group for the Department of Homeland Security (DHS) and the INCITS L1.
- Lead the revision of the national standard for Spatial Data Transfer (INCITS 320:1998) to assure that it aligns with the Geospatial One-Stop standards.

Two-Year Standards Plan

- Establish a definitive list of standards that are needed to meet the requirements of *The National Map*, such as standards for data themes, data content, data exchange, data format, data structure, data accuracy, data presentation, application interface, and communications protocol.
- Identify existing standards developed by organizations outside the USGS that can be adopted by the USGS to minimize development of standards specific to *The National Map*.

[2] CIO Council, *Federal Enterprise Architecture Framework*, 1999

- Develop standards where no appropriate standard currently exists.
- Establish a standards review and approval process that includes *The National Map* developers, data stewards, policy-level managers, and external data partners.
- Participate in relevant external standards development activities.
- Implement a partnership accreditation process that ensures that data provided by partners meet established criteria.
- Implement a standards maintenance process for *The National Map* that is responsive to policy changes, external standards activities, and changing partner requirements.

5.2.1 Geospatial Interoperability Issues

The National Map is currently making use of the Internet as the primary mechanism for improving the availability of geospatial data. Initially the Internet was not a particularly good tool for distributing map data, but recent work by industry consortia has produced a number of useful enhancements that greatly improve the utility of the Internet for mapping applications. The body of documents that describe these enhancements are often referred to generically as geospatial interoperability specifications. How *The National Map* will make use of these is an important issue.

The OpenGIS Consortium (OGC) develops geospatial interoperability specifications. Many of these specifications implement one or more of the geospatial data standards of the ISO, the ANSI, or the FGDC. Where the OpenGIS Consortium specifications support the Federal geospatial standards objectives, they can greatly simplify commitment to those objectives by helping embed the ISO, the ANSI, and the FGDC standards in commercial off-the-shelf (COTS) software offered by geographic information vendors. The USGS intends to use the OpenGIS Consortium specifications whenever possible. Where the OpenGIS Consortium specifications support the objectives of *The National Map* and do not conflict with Federal standards objectives, they will be endorsed for use by *The National Map*. At this time, the only specification that the USGS has endorsed is WMS version 1.1.1. The USGS is also actively involved in a review of the Web Catalog Service (WCS), and is participating in the development of catalog specifications.

These and several other OpenGIS Consortium specifications could be useful to *The National Map*, but they are at varying levels of development. Although it may be too soon to decide whether these additional specifications will provide the USGS with needed functionality and standards support for *The National Map*, the standards evaluation process listed above is needed to make that determination.

The USGS will require compliance with emerging OpenGIS Consortium specifications only when it is clear that (a) the specification does not conflict with Federal standards objectives, (b) the specification is useful to the implementation of *The National Map,* and (c) the specification is mature enough to provide help and structure for partners and development teams.

For cases where the specifications are either not mature or not available, development teams and partners for *The National Map* will not be constrained by the schedule for the OpenGIS Consortium certification or availability of vendor tools.

The USGS will not require that partners publish Web services that require a specific vendor implementation.

- The primary application programming interface (API) to *The National Map* will be through the catalog.
- Many applications (the general viewer for *The National Map*, data extracting and downloading, on-demand map generation, and so on) will be built to make use of the catalog API.
- Partners are encouraged to develop their own advanced applications (for example, Web-enabled models and advanced or specialized viewers) and should not be constrained to use any particular toolset.
- Consistent symbolization is a long-term objective for the Web browser application, which may not be supportable in the short term.
- Map product generation is required.
- Data product extraction and downloading (online or offline media) are required.

Interoperability Accomplishments

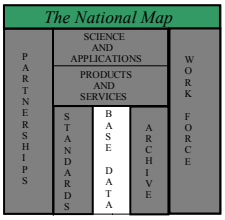
- Implemented a Web-view of *The National Map* content using the OpenGIS WMS specification (version 1.1.1).

A phased approach has been planned to introduce catalog Web services, more consistent symbology using Styled Layer Descriptors (SLD), the downloading of datasets, and the generation of map products.

Two-Year Interoperability Plan

- Establish an interoperability policy group that can periodically review the applicability of the OpenGIS Consortium specifications for use by *The National Map.*
- Provide technical assistance to partners in installing and configuring WMS connectors.
- Determine the technical impacts of dealing with a mixture of the OpenGIS Consortium and proprietary services in both the catalog and *The National Map* general viewer.
- Research other "catalog" strategies to evolve to more advanced technologies.

5.3 Base Data Themes



Goal: To ensure availability of accurate and timely geospatial data in eight themes at appropriate resolutions

Based on the common and most important needs, eight "base themes" were chosen for *The National Map*: elevation, orthoimagery, hydrography, geographic names, land cover, transportation, structures, and boundaries. The first priority for *The National Map* is to ensure that complete, current, and interoperable data are available for those themes. For most of these themes, *The National Map* already provides access to national coverage.

The success of *The National Map* will derive from the USGS's demonstrable record of technical achievement and from its record of forging partnerships to bring these enormous projects to completion. The collaborative success of the USGS and its many partners in producing complete national coverage of digital orthoimagery has been followed up with similar partnerships for such projects as the National Elevation Dataset (NED) and the National Hydrography Dataset (NHD). These national themes are well underway and will both provide a template for *The National Map* and become even more useful when arrayed with other themes. The power of these national layers is partially in their uniformity, national consistency, and integration of content – making them appealing to the user communities' applications.

For each theme, there are several resolutions (levels of detail), and the goals for national coverage vary by resolution depending on the uses of the data. For instance, orthoimagery (orthorectified imagery) is needed at low (for example, Advanced Very High Resolution Radiometer (AVHRR) or Moderate Resolution Imaging Spectroradiometer (MODIS) images), medium (for example, Landsat images) and high (for example, commercial satellite data and aerial photography) resolutions for the entire Nation. Higher resolution orthoimagery provides a level of detail needed for selected regions (for example, urban areas). Higher resolution elevation data are sometimes needed for low gradient areas (for example, flood plains or coastal regions).

It is not sufficient to have complete coverage of the country. There must be a mechanism to update that coverage as well. To attain maximum coverage, partnerships must be developed to maintain and serve some of the geospatial data. Therefore, a critical measure of success of *The National Map* will be the progress in establishing maintenance partnerships.

Currentness of data also is a key measure of success. Each theme may require a different method of update or a different update cycle. For example, elevation data may be updated at regular intervals whenever better or higher resolution data are acquired. Some types of data require updates soon after a change occurs. For instance, the impacts of fires and floods can represent changes in land use and land cover that may be very important to land managers. Also, many States monitor changes to roads and can potentially update information within days of a change. Geographic names or boundary changes have a similar potential for update. Medium-resolution imagery captured by satellite is typically captured every 8 to 16 days and these present

opportunities for very timely updates. On the other hand, high-resolution imagery is more expensive to collect, and will need to have a collection cycle established that will meet the needs of the partners and end users.

The ability to receive and serve data in a timely manner is another important aspect of data exchange. The program must monitor and make changes to *The National Map* to accommodate changes in data volume and demand to ensure that *The National Map* provides good customer service.

Coverage Strategy

As recognized in the NRC report, Weaving a National Map: A Review of the USGS Concept of *The National Map*, the USGS already provides some continuous, nationally consistent datasets consistent with *The National Map* vision. The National Atlas has been built using coordination and partnerships. The atlas focuses on using standards to offer integrated, nationally consistent small-scale databases. The data are owned and maintained by different Federal agencies, and updates are provided to the USGS for inclusion in the National Atlas.

There are also some categories of data for which continuous and consistent data are available at a scale of 1:24,000 (1:12,000 for orthoimagery). These data categories include most of those identified by the FGDC as "framework" layers; to these are added layers for which the USGS has other mission responsibilities. The strategy of the USGS is to provide these data layers as part of *The National Map*. Priorities among the themes and geographic priorities at different data resolutions have been established to balance requirements against available resources. Framework layers from the National Atlas currently serve as the foundation for more than 500 thematic map layers now presented in nationalatlas.gov and will continue to do so for national assessments, analyses, and syntheses.

Current Theme Priorities

The base data themes can be grouped and will be listed in order of priority. First, because they are NSDI framework layers that are the responsibility of the USGS, elevation, orthoimagery, and hydrography are the highest priority, in the order listed. Elevation is needed to orthorectify aerial photographs to make orthoimages, and orthoimages provide context for all the other layers. Hydrography supports the USGS Water Resources programs, as well as those of other agencies.

The USGS has legislated responsibility for the Board on Geographic Names. The names theme greatly enhances the other layers shown in *The National Map*, and provides valuable geographic reference.

Land cover is the next priority, built from Landsat imagery, captured and archived by the USGS and produced in cooperation with other Federal agencies. The satellite image data are highly processed and analyzed according to a consistent land cover classification scheme that was defined by the USGS and its partners.

The remaining layers include transportation, boundary, and structure data. Because of widespread interest and availability in transportation data (especially roads) and boundaries in the geospatial community, the USGS anticipates meeting most needs through partnerships that

would enable others' data to be displayed, downloaded, and have all other capabilities available through *The National Map*. Structures also enjoy widespread interest in the community, although potential cost, differences in needs, and challenges in maintaining currentness may require a more conservative approach. In the interest of completeness, the USGS will seek to partner with those agencies that have responsibility for these themes over large or significant geographic areas.

Further, it is recognized that some areas have larger scale, more current or additional themes. These areas by their nature are limited in extent. As partners with data are identified, their data can be added to *The National Map*, providing greater coverage. The USGS focus will be to identify partners who have data in one or more of the layers of *The National Map* and who would be interested in participating in *The National Map*. For small-scale and applications requiring generalized data, National Atlas data will be maintained as base layers.

Current Geographic Priorities

Much like the topographic maps that preceded it, *The National Map* must support many different uses and users. Modern geographic information systems create a demand for greater flexibility and variety of geospatial data than that previously provided by topographic maps. We believe that this demand cannot be met adequately with a single strategy. There are two distinct strategies for ensuring the coast-to-coast, border-to-border geographic extent of *The National Map*. "The USGS concept of *The National Map* has two principal components, each dependent on the other. The first is a nationally consistent digital map coverage maintained at one or more uniform scales. The second is a patchwork of varied scales including high-resolution local data." The National Research Council has suggested a "blanket and quilt" metaphor to describe these two components.

Priority for the "Blanket"

Some interests, such as those of science and regulatory agencies, need data wherever an issue, event, or problem occurs. The result is a need for consistent data in all areas of the Nation or in locations that cannot be identified in advance. The "blanket" serves these needs. In addition to the small-scale, nationally complete and consistent blanket provided by the National Atlas datasets, *The National Map* provides a series of nationally complete and consistent, medium-resolution blankets. These medium-resolution blankets are currently provided by the USGS through a series of Internet-accessible datasets and services.

The following constitute immediate priorities for these blankets:

- Continue to maintain and expand the datasets available through the National Atlas
- Continue work to complete seamless, nationally consistent blankets for the priority themes at the higher resolutions currently identified as needed for national applications
- Develop a common "look and feel" for the Web services currently provided for these blankets
- Establish National Geospatial Synthesis teams to help partners contribute their data to *The National Map*
- Use the National Geospatial Synthesis teams to collaborate with Geospatial One-Stop to provide a simple and intuitive "look and feel" for the services currently provided by the USGS for its national datasets

- Develop tools and services to integrate existing national datasets

Priority for the "Quilt"

Other interests have relatively fixed or recurring geographic areas of activity. Some examples are provided below. These maps help illustrate how the geographic extent requirement for some data are not distributed evenly over the country. They also demonstrate what the geographic priority might be for building the quilt described by the National Research Council.

The following maps are provided for illustrative purposes only and are not exhaustive. Although not portrayed on the maps, the States of Alaska and Hawaii, commonwealths and trusts are not included, but would contain similar themes.

Public safety (Figure 5-4). These areas include places subject to natural and manmade disasters to which the Federal government often responds. These places include those subject to potentially large losses of life and property, such as urban areas, or those important to continuity of government. The emergency response and related communities routinely call on the USGS to provide spatial data to support preparation, response, and recovery efforts, especially for disasters that cover large areas.

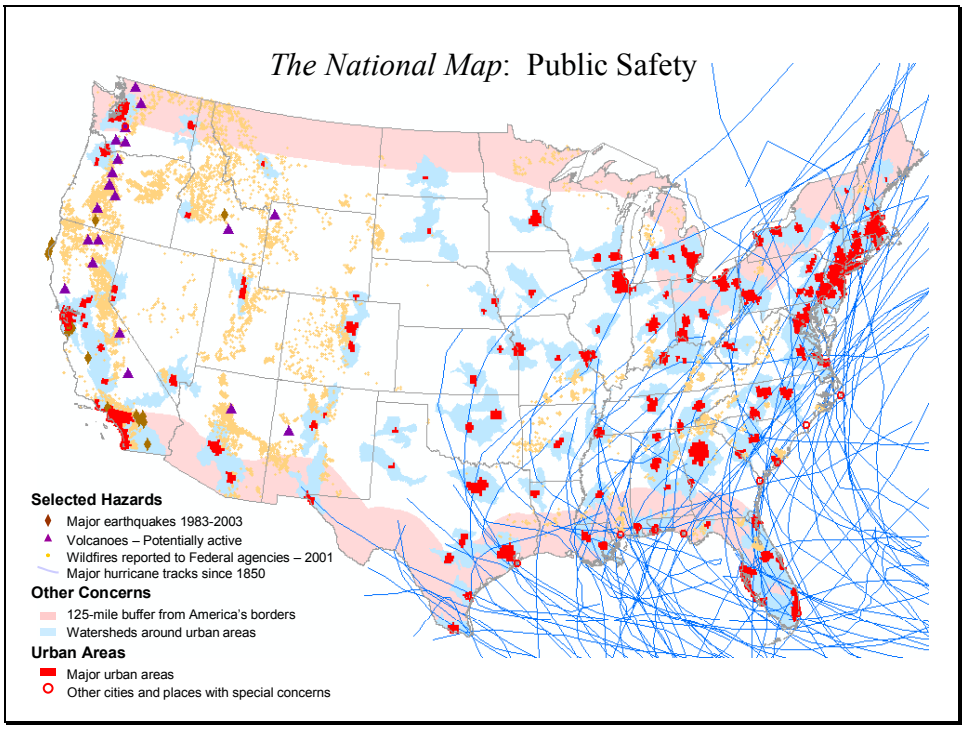


Figure 5-4: Areas of the United States with specific public safety needs.

- Infrastructure (Figure 5-5). Providing services essential to modern America, these features are distributed across the country. Spatial data support the planning, management, and protection of these vital assets. Completed in the last century, USGS topographic maps have been the only consistent border-to-border and coast-to-coast compilation of these features. In *The National Map*, the USGS will continue this service using methods adapted to the needs and technology of this century.

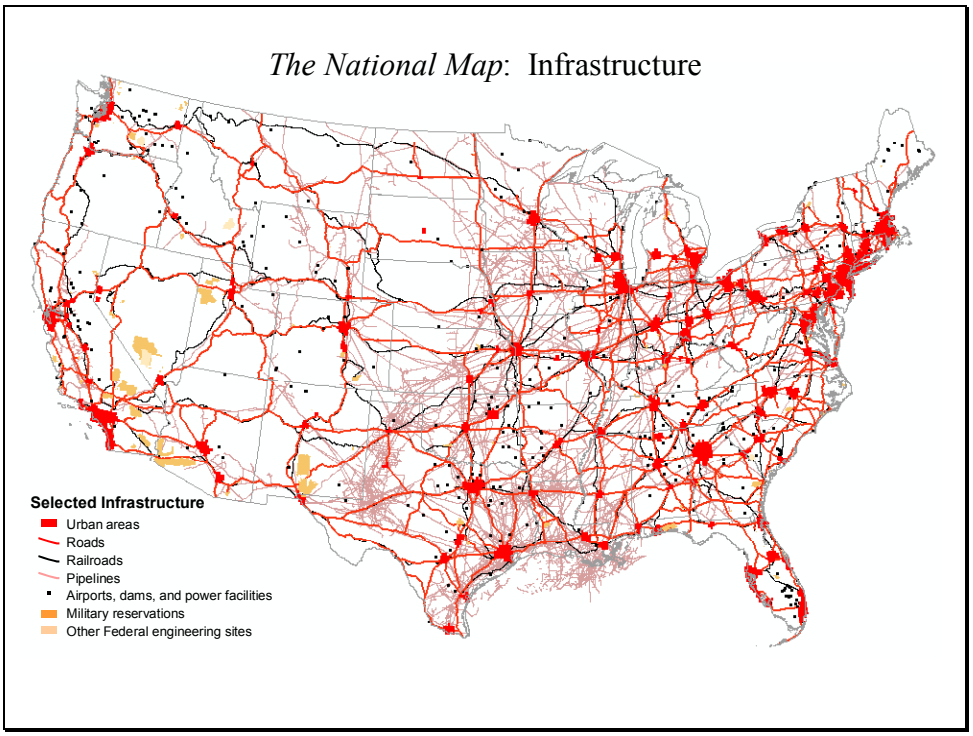


Figure 5-5: Selected critical infrastructure features of the United States.

- Federal and Indian Lands (Figure 5-6). Unique to the Federal government, and of special interest to the Department of the Interior, are lands for which the Federal government has direct management, or trust, or other regulatory responsibilities. USGS maps and data routinely are used to support decisionmaking about these places.

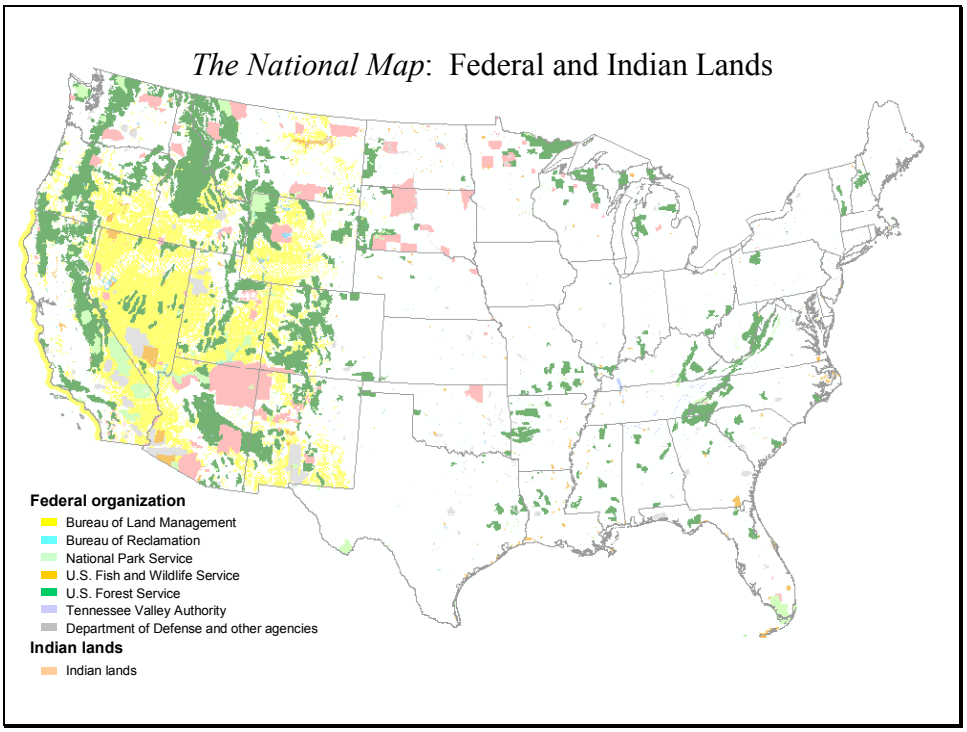


Figure 5-6: Federal and Indian lands.

From the information above and other information, the USGS proposes selected geographic areas as being of special interest for implementations of *The National Map* (Figure 5-7). General groupings (in order of interest) would include America's urban areas and their watersheds, and Federal and Indian lands, especially those managed by DOI and areas near America's borders. Some advantages of this strategy include (1) attention to areas where data partnerships may be more readily available (in "data-rich" urban areas or with sister Federal agencies), (2) attention to immediate interests of the Administration (public safety) and to ongoing interests of the Department (including Interior and Indian lands, as well as other geographic areas identified by Interior agencies), and (3) geographically concentrated efforts to provide several data layers to support the full capabilities of *The National Map*.

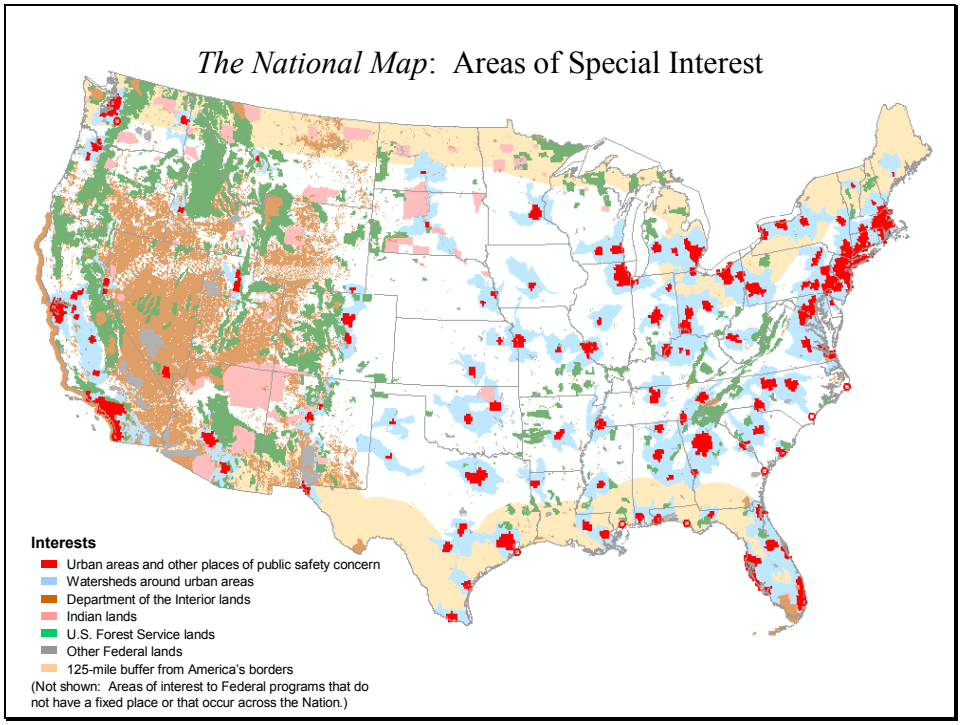


Figure 5-7: Areas of special interest for *The National Map*.

The USGS proposes that attention be paid to pursuing the development of *The National Map* in these areas of special interest, but that managers be allowed leeway to pursue critical and time-sensitive opportunities that would strongly advance implementation of *The National Map* in other geographic areas. Two simple examples are (1) the ability to extend the geographic area of activity to conform to the boundaries of participating local jurisdictions and (2) to address issues of local interest.

The following are immediate priorities for these quilts:

- Focus on building high-resolution orthoimagery for the high-priority urban areas
- Establish National Geospatial Synthesis teams to work to join map services among *The National Map* partners, to investigate feature and coverage services, and to create geoprocessing application services
- Use the National Geospatial Synthesis teams to work with selected urban area partners to develop strategies for building high-resolution patches of *The National Map* quilt that can be self-supporting
- Continue to encourage State agencies or consortia to manage *The National Map* "quilt patches" for their State for either some or all of *The National Map* themes

National Civil Applications Program (NCAP) Support for *The National Map*

NCAP provides the infrastructure to support source acquisition and management, data exploitation, product generation, data and product archive, and dissemination of data and products derived from classified remote sensing data. Data from classified remote sensing sources is utilized when no other source of data is available, or feasible for use. Support for *The National Map* includes providing alternate sources for production of digital orthophotoquadranqles (DOQs), revision of digital line graph (DLG) data, creation of digital elevation models (DEM), integration of multisource remote sensing and Geographical Information Systems (GIS) data. These data are used to create image-derived products that support disaster response efforts, in addition, the data are used (1) in studies and analyses that support broad science initiatives related to land and resource management, the environment, socioeconomics, and hazards, and other scientific and public policy studies; and (2) in researching and developing applications of advanced sensor concepts to support bureau and Department science missions.

Various components of the NCAP are critical to supporting DOI responsibilities assigned under the Civil Applications Committee (CAC) Charter, which is signed by the Secretary of Interior, the Director of Central Intelligence, the Director of the OMB, and the National Security Advisor to the President.

5.3.1 Elevation Theme

Elevation is one of the 7 National Spatial Data Infrastructure (NSDI) identified by OMB in Circular A-16. Elevation data represent terrain characteristics, and serve as the foundation for all other data themes of *The National Map*. Elevation data are needed for rectifying and correctly georegistering the orthoimagery; the data also are critical for integrating hydrographic data, which supports both hydrologic and hydraulic modeling. Additionally, many applications ranging from resource development to fire-suppression operations rely on highly accurate high-resolution elevation data for complex modeling and simulation activities.

The overall goal of the elevation theme activity of *The National Map* is to increase the amount of data available through the National Elevation Dataset (NED) at a resolution of 10-meter post spacing or better. By the end of FY 2005, approximately 60 percent of the conterminous U.S. will be available through the NED at 10-meter post spacing. Additionally, methods are being developed that will (1) integrate higher resolution partner-produced data into 3-meter post

spacing, and (2) enable seamless elevation coverage for the Nation's urban areas and their associated watersheds.

The USGS is a member of the National Digital Elevation Program (NDEP), a consortium of Federal agencies that was established to coordinate activities related to elevation data. The USGS will cooperate with NDEP and its member agencies, especially the Federal Emergency Management Agency (FEMA) regarding elevation data generated to support its flood map modernization program. USGS participation will include (1) gathering and analyzing requirements identified by consortium members, and (2) leading the development of national elevation standards (or guidelines). Through the NDEP, requirements-driven USGS program needs will be pooled with those of other Federal agencies and State and local governments to develop multiagency data-acquisition partnerships. New data collection will be funded through cooperative mechanisms, matching requirements to funding sources, as well as through data exchange agreements, such as data-for-services agreements.

Due to the large volume and the need to ensure ready access for *The National Map*, the USGS will provide integrated elevation data from a central location. The USGS uses the NED as the elevation theme of *The National Map*. To support the NED, the USGS will develop partnerships and methodologies to convert data from multiple sources and in a variety of formats and data models into the NED. The USGS works through the NDEP, via the technical subcommittee, to promote a common understanding of elevation data among Federal users, and has supported the development of user guidelines and specifications that are employed in the production and procurement of elevation data.

Elevation Accomplishments

The development of the NED is a significant accomplishment. The NED is an online seamless representation of the terrain characteristics, and is available as a 30-meter (one arc-second) post spacing product for the entire conterminous U.S. Approximately 45 percent of the country also is covered in NED format at a 10-meter (1/3 arc-second) post spacing. Both the 10- and 30-meter products can be downloaded as a user-defined area via the Internet, free of charge from nationalmap.usgs.gov.

Two-Year Elevation Plan

- Continue building the NED with the best available high-resolution elevation data.

The USGS anticipates significant requests for 3-meter (1/9 arc-second) post spacing elevation data, and is already beginning to integrate these high-resolution datasets into the NED.

- Continue to emphasize the gathering of data for the Nation's urban areas and the associated watersheds to support hazards and disaster studies, mitigation, and response and recovery activities.

Long-term Elevation plan

- Explore capabilities for generating topographic contours from the NED.

These contours could be used in two ways: (1) manipulation for online activities, and (2) production of a hard-copy map where contours would appear similar to the traditional USGS topographic map products.

- Build a nationwide 10-meter post spacing product, with a higher-resolution 3-meter post spacing product available over the Nation's urban areas and their associated watersheds.

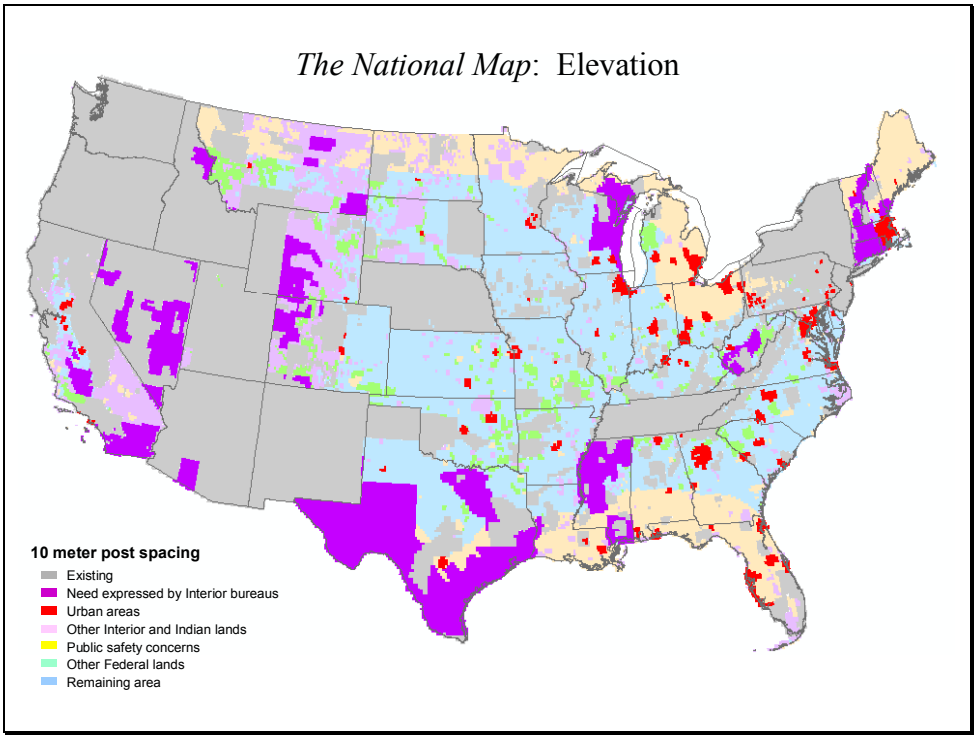


Figure 5-8: Priority needs for 10-meter elevation data.

By the beginning of FY 2003, elevation coverage with 10-meter post spacing was available for approximately 37 percent of the Nation (Figure 5-8). Special attention is now focused on urban areas and areas of interest to the Department of the Interior.

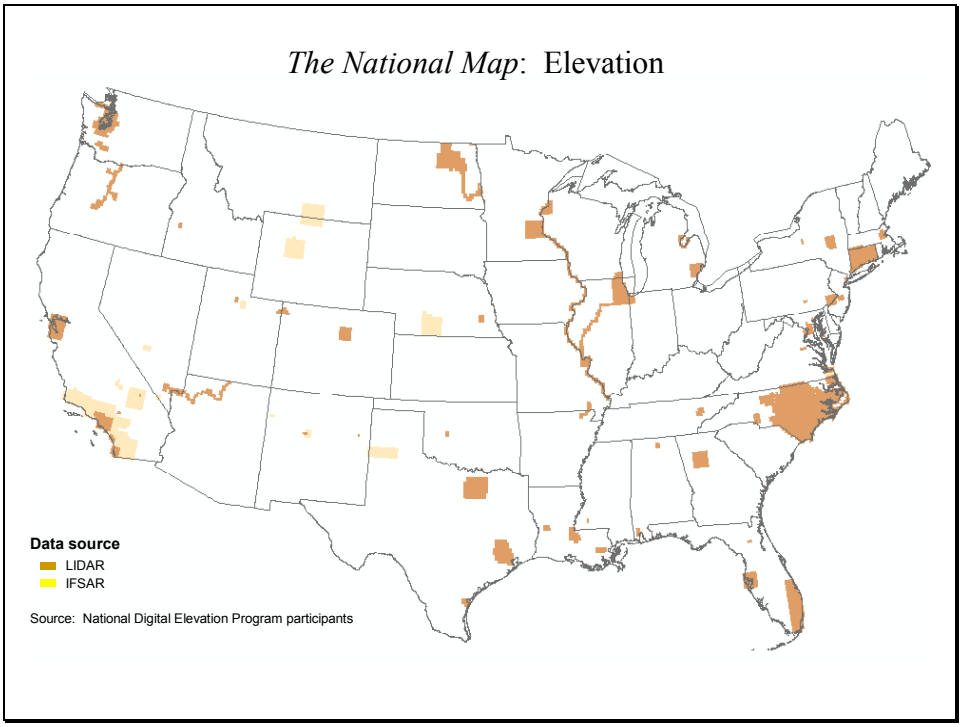


Figure 5-9: Potential data sources for 3-meter elevation data.

- Develop data with a 3-meter post spacing and to increase or improve the USGS's 10- and 30-meter data holdings (Figure 5-9) where Light Detection and Ranging (LIDAR) and Interferometric Synthetic Aperture Radar (IFSAR) data are readily available at no or low cost from partners.

The USGS processes will ensure that existing data, such as available nationwide coverage of 30-meter elevation data and data needed to support map graphics and orthophoto production, will be maintained through the integration of higher resolution data.

Management challenge: Improved elevation data greatly enhances *The National Map* implementation, but USGS can't do this alone. Partnerships and cost sharing are necessary to acquire and serve high-resolution data.

- By FY 2006, derive multiresolution, high-accuracy elevation data primarily from advanced collection and processing techniques, such as IFSAR, LIDAR, and automated photogrammetry.

Acquisition activities will be focused on places where elevation data are known to be deficient, either because of changes on the ground (for example, in areas of mountaintop removal or areas of subsidence), poor original source materials, or where more detailed data are available from other organizations. The resulting multiresolution, best-available, seamless dataset will support the development and integration of several themes of *The National Map*. These activities include (1) rectifying high-resolution orthoimagery, (2) automatically extracting or generating hydrographic and hypsographic overlays (elevation contours or other products derived from elevation data), and (3) generating new specialized data layers.

- Stress technology assessment, process development, and cartographic research for optimum elevation-data gathering and processing techniques; specifically, LIDAR, IFSAR, and photogrammetric technologies will be compared and assessed.

The USGS's research activities will include (1) developing alternate data presentation techniques, (2) integrating data with a goal of producing multiresolution elevation databases and (3) developing Web-based access in support of *The National Map* effort.

5.3.2 Orthoimagery Theme

Digital orthoimagery is one of seven NSDI framework geospatial data themes identified in OMB Circular A-16. The USGS is designated as the lead Federal agency for the orthoimagery theme. Sources for orthoimagery may be scanned film or digital imagery from either airborne or space-based sensors. Many geographic features, including those in other framework data themes, can be interpreted and compiled from digital orthoimagery. Accurate, timely, high-resolution orthoimagery can be critical to support the compilation of framework features. In remote areas of the country, medium- to low-resolution satellite orthoimagery may offer sufficient image detail and may be more timely. Digital orthoimagery provides a background or reference theme of *The National Map* that allows other data to be placed in context with surrounding features and attributes. Generating high-resolution orthoimagery also has a side benefit: high-resolution elevation data can be acquired as a companion product.

For small-scale applications (such as the National Atlas), the USGS can acquire daily observations from earth observing satellites such as AVHRR and MODIS. For medium-scale applications where 15- to 30-meter resolution is required, imagery can be acquired from Landsat every 8 to 16 days. With cloud cover considerations, it is reasonable to expect that the Landsat pilot project that began in FY 2002 will provide imagery for a database that can be kept current to within 1 year.

The USGS will maintain orthoimagery standards for the Federal government and will promote an acquisition and dissemination policy for the orthoimagery theme of *The National Map*.

Users of digital orthoimagery data may be found at all levels of the public and private sectors and include Federal, State, Tribal, and local government officials; GIS specialists; high-school and college students; nonprofit organizations; and private business partners. The various uses of orthoimagery include, but are not limited to, mapping, environmental assessments, emergency assistance, security assessments, recreational needs, and tax assessments. Multispectral imagery can be processed to identify and monitor a range of cultural and natural phenomenon

Two-Year Orthoimagery Objectives

- Ensure that complete multiple-resolution national coverage of digital orthoimagery is available via *The National Map*. This coverage ranges from 1-foot to 1-kilometer ground resolution.
- Complete coverage for urban area partnerships at 1-foot or finer resolution and implementing a strategy to ensure refreshing of this coverage every 2 years.
- Implement a process that would use orthoimagery for detecting land surface changes and updating other base theme data of *The National Map*.

- Establish at least 20 partnerships with Federal, State, Tribal, and local agencies to maintain orthoimagery and to assure availability in *The National Map*.
- Establish methods for procuring a range of commercial remote-sensing data for *The National Map.*

Long-Term Orthoimagery Objectives:

- Continue to satisfy the Nation's requirements for digital orthoimagery through *The National Map*.
- Regularly update and maintain digital orthoimagery database to ensure that the National orthoimagery coverage is renewed at least every 10 years.
- Update the medium-resolution imagery datasets from sensors such as Landsat at least annually.

The USGS is the lead agency in the National Digital Orthophoto Program (NDOP), a consortium that was established to develop and maintain National orthoimagery coverage through partnerships with Federal, State, local, Tribal, and private organizations. As a result of that program there is now full digital orthoimagery coverage of the conterminous United States at 1-meter resolution. The USGS is also heavily involved in developing an implementation plan for the U.S. Commercial Remote Sensing Policy, which was signed by the President on April 25, 2003. The policy calls for developing a long-term partnership between the Federal government and the commercial remote-sensing industry. In support of national security requirements, the USGS has begun a high-resolution urban areas partnership program. This program also will feed up-to-date higher resolution orthoimagery into *The National Map.*

Key Federal partnerships at this time are with the National Imagery and Mapping Agency (NIMA), the Department of Homeland Security (DHS), the Bureau of Land Management (BLM), and the U.S. Forest Service (USFS). NDOP and the urban areas programs have supported these partnerships in the past and will continue. However, the USGS strategy will shift from producing orthoimagery data to ensuring access and dissemination of data; data production will be performed by the commercial sector. The USGS may continue to produce Landsat data.

Many States, including North Carolina, Florida, and Louisiana, are currently engaged or about to enter into new agreements to acquire imagery in partnership with the USGS. Some States, such as New York, have vigorous orthoimagery programs and already are acquiring their own data from the commercial sector. The USGS will work with those States to ensure that their data become part of *The National Map,* whether through direct data acquisition or agreements to disseminate or provide access through *The National Map*.

In the past, the requirements of local governments for orthoimagery were funneled primarily through their memberships in State consortiums and organizations, such as the National States Geographic Information Council or the National Association of Counties. Currently, many cities and counties have acquired high-resolution orthoimagery directly from commercial data providers and are rapidly becoming important sources for these data. Strategies for encouraging partnerships between the USGS and local government are evolving.

Strategies for Supporting Orthoimagery Activities are as follows

- Cost sharing through renewed use of cooperative agreements, joint funding agreements (JFA), and inter-agency agreements.
- Work-share and data-exchange agreements, such as those fostered by the NDOP or the agreement between the USGS and the USFS.
- Greater use of cooperative research and development activities (CRADA) to help foster emerging technology.
- Use of Government-wide contracts to acquire commercial remote-sensing data on attractive terms to the Federal Government.
- Institute the use of business partner agreements for purchasing data and support services for *The National Map.*

Recent Orthoimagery Accomplishments

- Completed acquisition of full coverage of the conterminous U.S. at 1-meter resolution resulting in over 13 terabytes of data consisting of 220,000 images.
- Acquired historical Systeme pour l'Observation de la Terre (SPOT) satellite data over the U.S.
- Completed, in cooperation with National Aeronautics and Space Administration (NASA), the formulation phase of the Landsat Data Continuity Mission (LDCM). A LDCM mission decision is expected in late FY 2003.
- Developed Federal standards for orthoimagery that are the basis for many State and national orthoimagery specifications.
- Loaded and served urban area partnership datasets from the seamless server.
- Created a medium-resolution imagery database for *The National Map* from satellite data.
- Established links to several partners who provide 1-meter orthoimagery distribution services.
- Successfully managed the NDOP program, which led to the full national coverage.
- Worked with NDOP to assist in creating technical and programmatic foundations for successful orthoimagery programs at other Federal and State agencies.
- Worked with NDOP to facilitate use of orthoimagery in the mapping industry.
- Changed the way the USGS procures data through the use of the private sector and qualifications-based selection process to produce the majority of the USGS orthoimagery.
- Demonstrated, through a CRADA with Microsoft, a model for data access and dissemination through partnerships. The USGS is learning how to establish distributed databases for *The National Map*, a critical component of *The National Map* concept. This activity also is being performed in collaboration with the Geospatial One-Stop initiative.
- Began a high-resolution partnership program to collect selected data themes including orthoimagery over urban areas in the U.S. (for example, Mecklenburg County, North Carolina).
- Adopted a flexible approach to partnerships that is essential in acquiring access to local data while respecting the local rights to the data.

Two-Year Orthoimagery Plan

- Develop the infrastructure for orthoimagery data dissemination and access. This includes developing a mechanism that will allow business partners to provide access to digital data.
- Implement the Commercial Remote Sensing Policy.
- Upgrade the existing orthoimagery storage capacity in expectation of large urban area files and databases.
- Create a multiresolution seamless orthoimagery database from the low-resolution satellite and the high-resolution urban imagery.
- Migrate current TerraServer and TerraService operations to a seamless service for *The National Map*.
- Continue to develop distributed database infrastructure

Two-Year Orthoimagery Milestones

- Develop and implement a renewal cycle for urban area partnership projects by the end of FY 2004.
- Complete urban area orthoimagery coverage by the end of FY 2005.
- Develop the additional infrastructure and civil coordination mechanisms to foster use of commercial imagery and services by the end of FY 2005.
- Complete a study of new data distribution methods and upgrade the datasets to meet the new archive and user requirements by the end of FY 2004.

Long-Term Orthoimagery Plan

- Fully implement a distributed database infrastructure consistent with "*The National Map* topographic Mapping for the 21st Century" (USGS, 2001, Reston, Virginia)
- Develop a mechanism for the long-term maintenance of this infrastructure.
- Enhance user access to USGS's remotely sensed data (planned start during FY 2005 with completion before the end of FY 2007).
- Improve mechanisms to ensure that the USGS is fully able to support the Nation's geospatial data needs for disaster remediation, response, and recovery (planned start during FY 2005 with completion before the end of FY 2007).
- Conduct research and development for serving historical orthoimagery (planned start in FY 2005).
- Design and implement methods to browse and serve historical data.

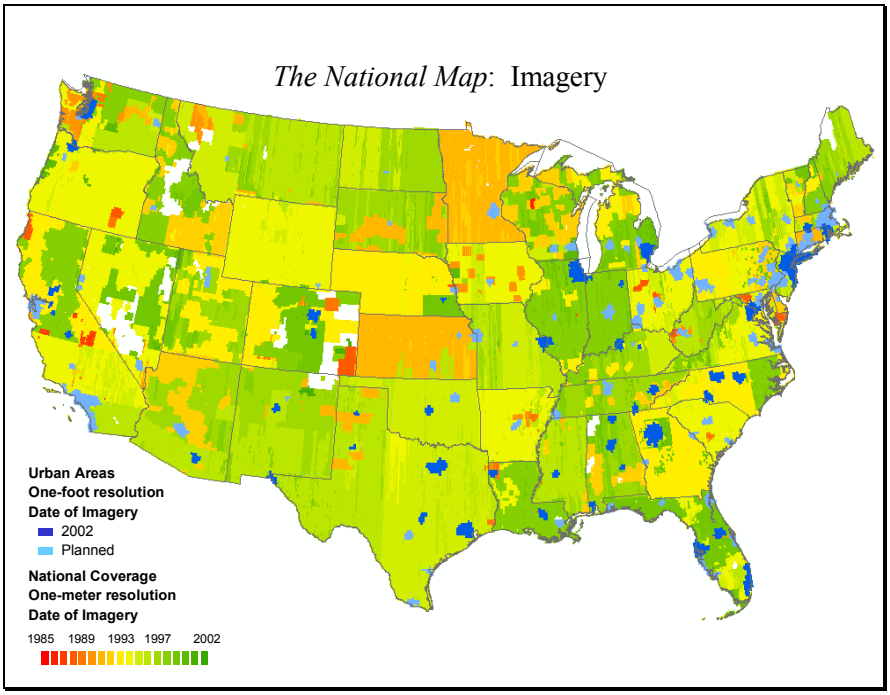


Figure 5-10: Current and planned orthoimagery availability

The USGS has started to acquire and process higher resolution (0.3-meter) color orthoimagery for urban areas. The resulting database provides detailed imagery that is current to within 2 years. Although these data represent approximately 4 percent of the Nation's land area, they include more than 80 percent of the U.S. population.

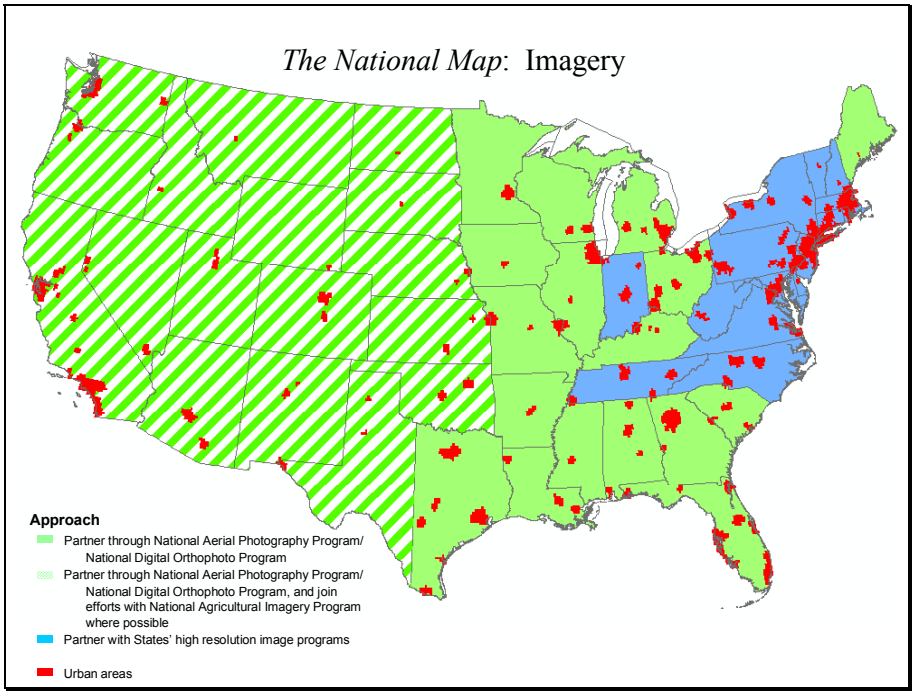


Figure 5-11: Imagery and partnering strategy

Completing orthoimagery coverage of the conterminous United States and Alaska at 1-meter and finer resolutions and providing for data maintenance will require the cooperation of USGS partners, such as members of the NDOP and the NSGIC.

In the near term, the USGS proposes a three-part approach for 1-meter imagery as follows:

- For States in the West for which seasonal images yield similar results (striped green in Figure 5-11), provide imagery through the NDOP and coordinate these efforts with those of the National Agricultural Imagery Program (NAIP), administered by the Department of Agriculture, where feasible. For example, the USGS might fund coverage over Federal lands (which NAIP generally avoids) to complement NAIP's attention to agricultural lands. Additional funding may be available from the USFS and State partners. Issues to be resolved include the definition of the actual program of work to be pursued under the new NAIP and the quality of orthophotos that will be produced through NAIP.
- Create partnerships with State organizations that have or are developing high-resolution (usually 2-foot or finer) imagery programs (blue in Figure 5-11).
- Create partnerships with the remaining States (solid green in Figure 5-11), as well as with Federal and other organizations to develop winter imagery that complies with specifications developed through the NDOP and Geospatial One-Stop.

In addition to its 1-meter National coverage, the USGS is pursuing higher resolution imagery over urban areas (red in Figure 5-11). The USGS has partnerships with State, Federal and local agencies that have public safety and other concerns. Managing this activity from its acquisition stage through dissemination will be a major focus over the next 1 to 3 years. The USGS will rely heavily on its Federal and State partners to provide resources for data. The USGS roles in this activity will be as project coordinator, data broker, contractor to private-sector data providers, and quality-assurance or quality-control provider for high-resolution orthoimagery.

By 2008, a new model for acquisition and access to higher resolution orthoimagery data from State and local programs will replace the Federal model. Seamless 1-meter (or finer) orthoimagery for the entire United States (including Alaska) will be available from multiple archives in a nonproprietary format at no charge or for the cost of delivery. A primary role of the USGS will be to encourage and facilitate partnerships for creating, maintaining, and providing access to base orthoimagery data for *The National Map*. The USGS will be the ultimate source for base orthoimagery for use during Federal emergencies and for archiving purposes, but the dissemination of orthoimagery will be primarily the responsibility of its partners: the States, academia, and the private sector.

5.3.3 Hydrography Theme

Hydrography is one of 7 NSDI framework geospatial data themes identified in OMB Circular A-16. The USGS and the Environmental Protection Agency (EPA) share the lead agency responsibility for hydrography.

The surface-water feature theme of *The National Map* is the National Hydrography Dataset (NHD). NHD is a comprehensive set of geospatial data that contains information about surface-water features such as lakes, ponds, streams, rivers, springs, and wells. Surface-water features are combined to form "reaches," which provide the framework for linking water-related data to the surface water drainage network.

Reach

A reach is a continuous, unbroken stretch or expanse of surface water. In the NHD, this idea has been expanded to define a reach as a significant segment of surface water that has similar hydrologic characteristics, such as a stretch of stream or river between two confluences, or a lake or pond. Reaches also are defined for unconnected (isolated) features, such as an isolated lake or pond.

Source: NHD

Beginning in the early 1980s, EPA created a series of "reach" files to support their water-quality reporting and monitoring. The first file — Reach File Version 1 (RF1) — was created using 1:500,000-scale aeronautical charts. In the late 1980s, EPA created Reach File Version 3 (RF3) using the USGS's 1:100,000-scale DLG data that was developed in partnership with the U.S. Bureau of the Census. RF3 data had some problems that the user community found unacceptable. The USGS was just beginning to develop a new data model to replace the DLG data, so the timing was perfect. EPA and the USGS began work on what was to become the National Hydrography Dataset (NHD). The program is now reaching the mid-point for developing nationwide "high resolution" data coverage at a scale of 1:24,000 (1:63,360 for most of Alaska). The program is in the second year of major high-resolution production and technical development.

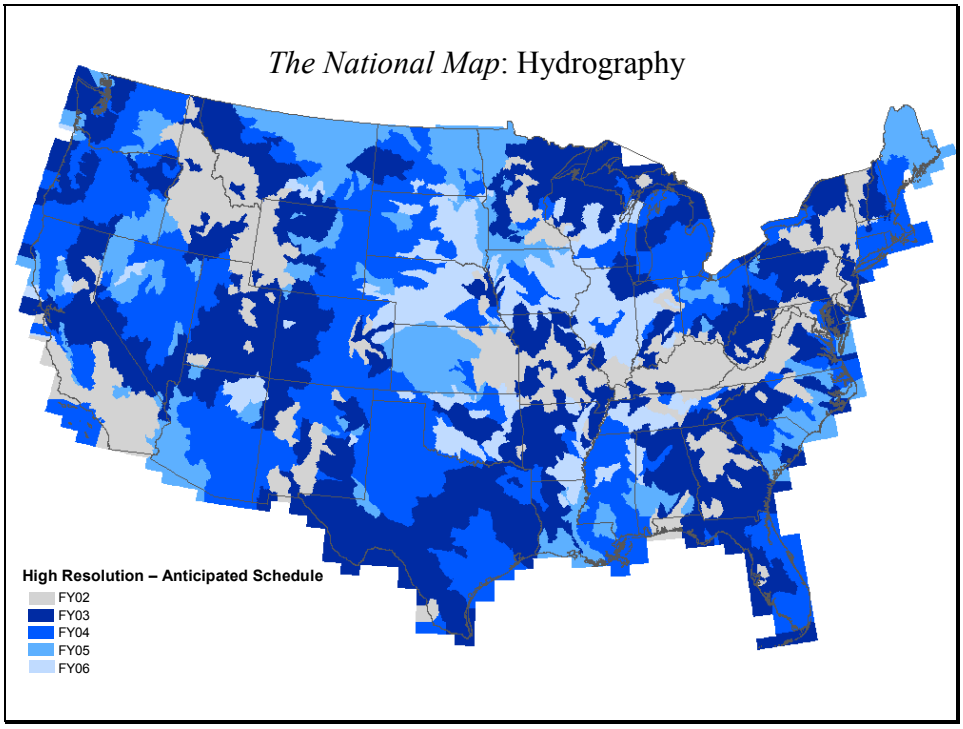


Figure 5-12: Anticipated schedule for completing the high-resolution NHD

Two-Year Hydrography Objectives

The hydrography theme will launch several major partner programs, including high-volume programs with the U.S. Forest Service (USFS), which will affect almost half of the hydrologic units in the country. The partnership with the USFS will serve as a catalyst for launching several State partnerships throughout the country. The volume of production in FY 2003 will create the momentum necessary to position the NHD as the premier program for hydrography in the Nation, will serve to attract other Federal, State, and local agencies that may not have yet established partnerships with the USGS. FY 2003 is a critical year for the NHD program because (1) production processes must be fully operational, (2) the capacity must be developed to handle the volume, (3) the capability must exist to form new partnerships, and (4) new volume will compete with other priorities for a limited-growth budget. FY 2003 also is a pivotal year for technology with the launching of next-generation technologies including advanced data structures, Web mapping, and updating databases through Web-based transactions.

In FY 2005, the effort will begin shifting from building the NHD to maintaining the currentness of the data and improving its quality by incorporating more detailed data from local data sources, starting with urban areas. The USGS plans to accept and integrate more detailed data developed in State and local government compilation activities as well as updates reflecting changes in hydrography caused by floods and other major events. This strategy assumes the implementation of a new (COTS) database management structure to replace the custom-built structure developed a decade ago. Included in this strategy are improved web-mapping capabilities, the development of a data stewardship program, and the ability to accept updates provided by partners via the Internet.

Long-Term Hydrography Objectives

The USGS will maintain of hydrography standards for the Federal Government and will promote an acquisition and dissemination policy for hydrographic data based on those standards. Much of the hydrography content standard for Geospatial One-Stop is based on the interagency work to develop the NHD.

Partnerships are a key element for building and maintaining hydrographic data. Low-resolution data, for which coverage is available for the conterminous United States and Hawaii, were developed in cooperation with the EPA and other Federal and State partners. The USFS is a strong partner in the current high-resolution hydrography effort, and its participation has catalyzed partnerships in several States (see partnership map). The EPA also has modified its grant programs to allow participants to use funds to create partnerships for hydrography data development.

Strategies for supporting the hydrography theme are as follows

- Cost sharing. Cooperative agreements, joint funding agreements, and interagency agreements, are the most successful mechanisms and the primary means for acquiring data.
- Work-share agreements and data exchanges. These types of arrangements have been created in several areas where money is not available, but time is; however, they agreements generally extend the production schedule because other priorities often compete with them.
- Innovative Partnerships. Many States have the resources and the interest to manage the work in-house.

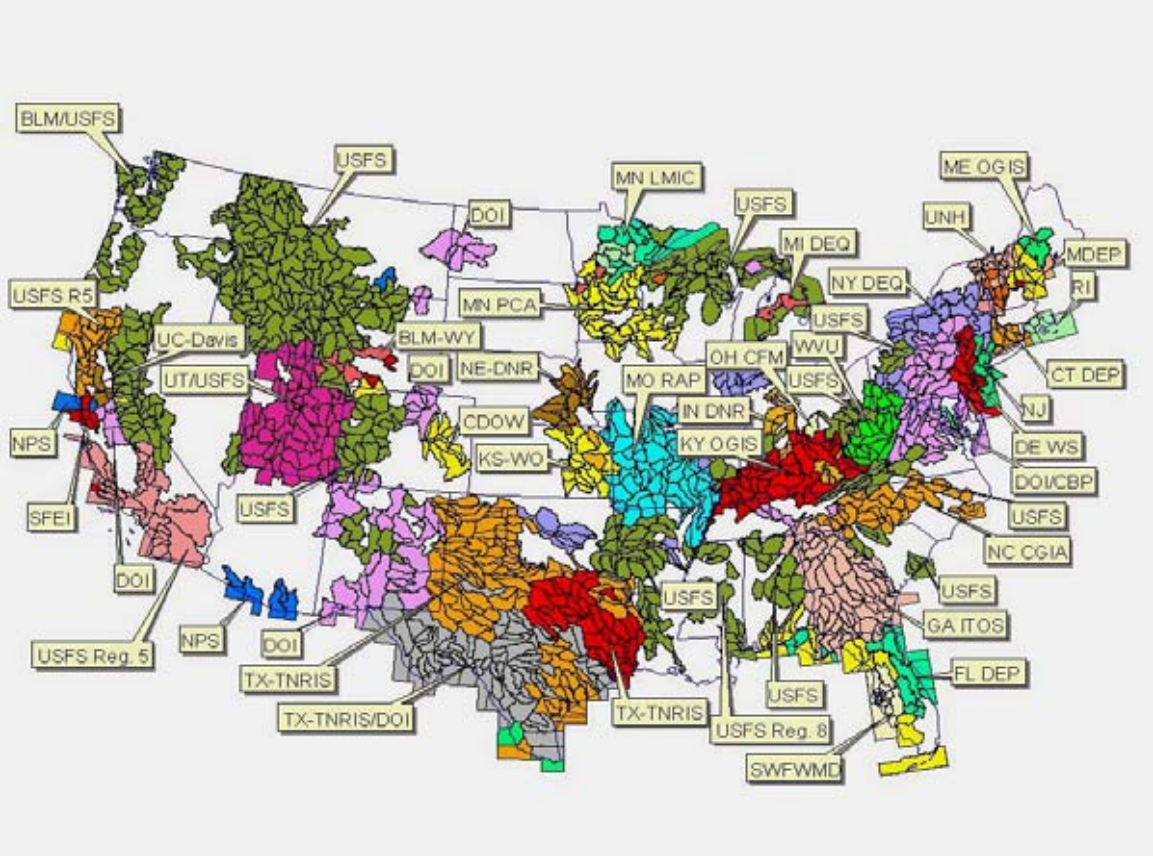


Figure 5-13: Current high-resolution NHD partnerships

Hydrography Accomplishments

- Hydrography data were classified by watersheds. The information from the EPA's RF3 file was transferred to the NHD. The EPA is now using the NHD for their programs.
- Surface-water data for the whole country is now available and may be downloaded at no charge to the user.
- Every stream in the Nation has a reach code for linking and sharing information. Two agencies, the USGS and the EPA, are using and maintaining the same database.
- Several States are developing high-resolution data. Kentucky was the first State to begin developing 1:24,000-scale NHD data, and completed that task in early 2003. Missouri, West Virginia, Utah, Georgia, Florida, Texas, and New York are close to having Statewide coverage. Coverage for the States of North Carolina, Indiana, Michigan, Minnesota, New Hampshire, Connecticut, and Maine is being developed as funding becomes available.
- The National Park Service (NPS) is using the NHD for their programs; the USGS and the NPS also are working on a joint funding agreement. The Bureau of Land Management (BLM) also has worked with the USGS in several areas to create coverage for the high-resolution NHD.
- The NHD has been and will continue to be improved and updated. Users of the data at the local level are in the best position to provide updates. Because the reach code is scale independent and stable, the existing data may be enhanced with high-resolution data

without losing the original investment. The database is designed to assign unique identifiers to every feature, attribute, and relationship. With this design, a user can create, modify, or delete features, attributes, and relationships and all changes can be tracked. Local data stewards will be responsible for authoritatively adjudicating revisions and changes to the hydrographic data among their constituents. The USGS will be able to integrate the data on a much more timely basis than what is currently possible.

Two-Year Hydrography Plan

- Move to a new database design.
- Enlist data stewards to maintain the data at the State and local level.

Long-Term Hydrography Plan

- Link the values for flow volume and velocity to the NHD reaches.
- Completely link other National databases to the NHD, including all EPA's water-quality monitoring sites, the U.S. Army Corps of Engineers' (USACE) National Inventory of Dams, and the USGS's National Water Information System (NWIS) stream gages.
- Integrate FEMA flood-mapping data.
- Describe the USFS, the NPS, and the BLM aquatic habitat using the NHD.
- Link State's water-rights data to the NHD.

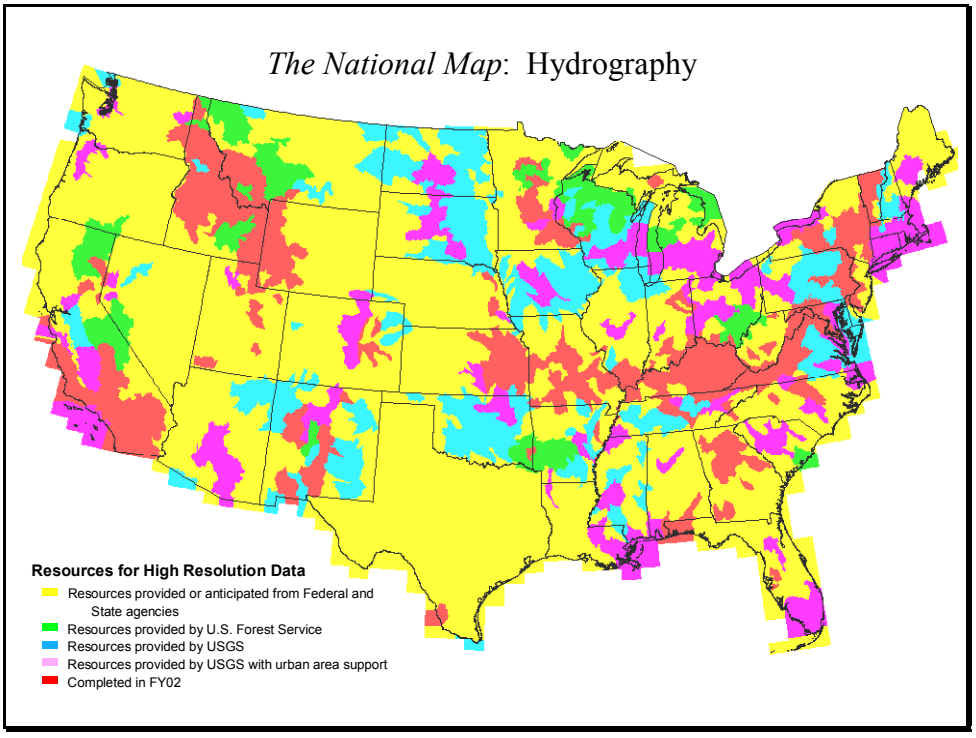


Figure 5-14: High-resolution hydrography contributors

5.3.4 Geographic Names Theme

The geographic names activity consists of two major focus areas: (1) staff support to the interagency United States Board on Geographic Names (USBGN), as well as to the Advisory Committee on Antarctic Names (ACAN) of the USBGN; and (2) oversight and maintenance of the Geographic Names Information System (GNIS). Over the next 5 years, both aspects of the activity will continue at the same level in support of *The National Map*. The activity already has in place a foundation for achieving many of the goals of *The National Map*; in particular, partners such as the USFS, BLM, NPS, and NOAA's Office of Coast Survey, provide maintenance to the GNIS. The USGS also has State agency contacts in 49 of the 50 States, as well as in Guam and Puerto Rico, many of whom have expressed an interest in helping to maintain records for their respective jurisdictions.

For the past 26 years, the GNIS Phase II Data Compilation Program has used mapping funds to award resource-sharing contracts, usually to universities or State agencies, to collect geographic names and attribute data for features not labeled on USGS topographic maps. To date, only Alaska, Kentucky, Michigan, and New York have not completed or are not currently going through this procedure.

The GNIS was recently redesigned to allow spatial queries of the database. The new database supports the goals of *The National Map*, in some cases has anticipated them, and is ready to accept additional feature attributes to meet other requirements as *The National Map* defines them.

5.3.5 Land Cover Theme

Land cover is a fundamental requirement for operational land management and for geographic research. Users include Federal and State government officials who manage land and natural or biological resources, or who monitor biodiversity and environmental quality. Government and university researchers depend on land-cover information to support a wide range of research activities ranging from urban growth to global climate and population change, and from fire-fuel mapping to national forest inventories.

Land Use versus Land Cover

Land cover characterization is determined primarily from medium-resolution remote-sensing satellite data such as Landsat. What covers the land; for example, structures, pavement, trees, or fields; can be determined from these sources, but generally, how the land is being used cannot. Therefore, land cover data does not distinguish between residential and commercial areas or between cropland and golf courses where land use data does.

Source: USGS

The USGS's Land Cover Program began in 1996 in recognition of the large and growing demand for land-cover data and information. Currently, the program supports the mapping of land cover at global and regional scales using satellite data, and the collection and analysis of data, to study land cover changes.

The National Land Cover Dataset (NLCD) contains data at 30-meter resolution. Data sources include Landsat imagery and 1:24,000-scale aerial photography. NLCD 1992 is complete and available on *The National Map* viewer. NLCD 2001 mapping has been underway since 2001, and has a well-defined plan. NLDC 2001 data are loaded as mapping zones are completed.

Two-Year Land Cover Objectives

- Complete 8 mapping zones in FY 2003, 19 in FY 2004, and 22 (not yet identified) in FY 2005 (Figure 5-15).

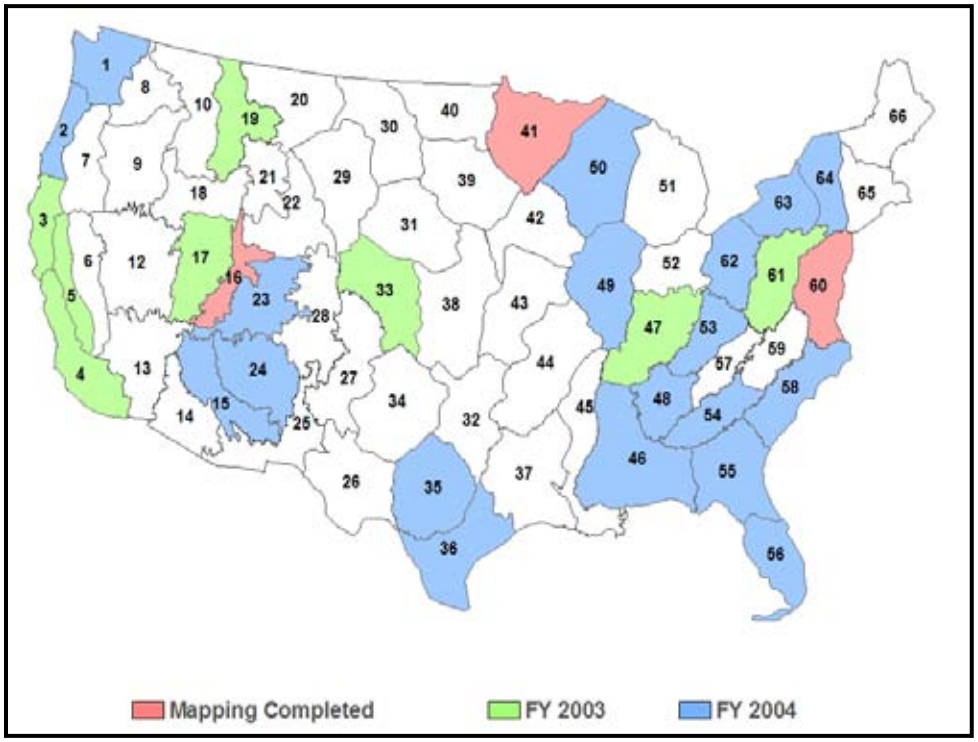


Figure 5-15: National Land Cover Dataset 2001

Long-Term Land Cover Objectives

- Finish mapping the remaining zones by the end of FY 2006.
- Complete the accuracy assessment for NLCD 2001.
- Continue building the FY 2005 satellite image database for the Multi-Resolution Land Characteristics (MRLC) program.

Limited, large-scale (1:24,000) land-cover mapping is currently being done in connection with specific research projects and is performed by the USGS at its Rocky Mountain and Mid-Continent Mapping Centers using digital orthophotoquadrangles (DOQs). These data are produced on a quadrangle basis in response to

MRLC

Due to the escalating costs of acquiring satellite images, in 1992 several federal agencies agreed to operate as a consortium in order to acquire satellite-based remotely sensed data for their environmental monitoring programs. Original members of the Multi-Resolution Land Characteristics (MRLC) consortium were the U.S. Geological Survey (USGS), Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA) and the U.S. Forest Service (USFS). Later joining the consortium were the National Atmospheric and Space Administration (NASA) and the Bureau of Land Management (BLM).

Source: USGS

user requirements, and are normally funded by a reimbursable agreement. There is no plan for the Geography discipline to map a full national coverage at 1:24,000 scale. The NLCD database design will accommodate high-resolution data as needed, and tests will be done to prove the concept of incorporating locally produced data following the philosophy of *The National Map.*

The NLCD is designed to allow mapping zones to be completed by the USGS, Multi-Resolution Land Characteristics (MRLC) Consortium partners, or commercial contractors. The MRLC consists of members from the USGS, EPA, NOAA, USFS, BLM, NPS, National Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), and NASA. In addition, the Commonwealth of Kentucky is a mapping partner. EPA is a funding partner and the remaining members are work-share partners some of whom provide some funding to the USGS. This arrangement has been extremely effective in attracting NLDC mapping partners from the MRLDC members. The USGS coordinates the activities of the MRLC Consortium.

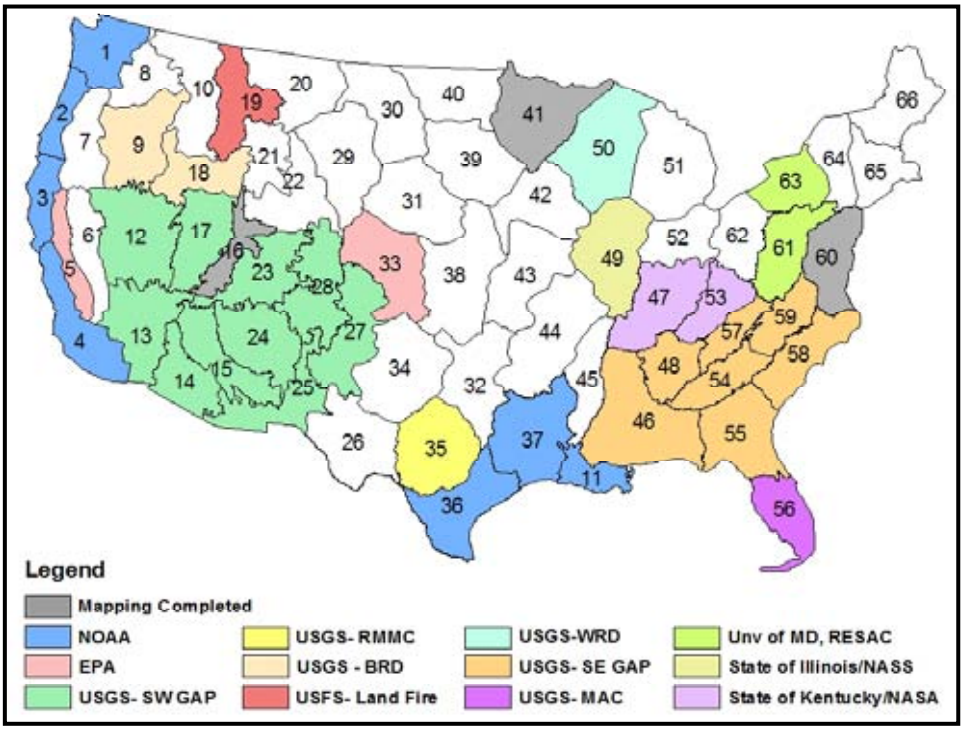


Figure 5-16: National Land Cover Dataset (NLCD 2001) partner contributions

Land Cover Accomplishments

- Completed Landsat (5 and 7) coverage of the conterminous United States at 30-meter resolution for 1992 and 2001 at 3 scenes per path/row.
- The NLCD 1992, which contains seamless land cover in 21 Anderson classes, is available for viewing and downloading from *The National Map's* GISDATA viewer and the seamless Web site.
- Completed the design for the NLCD 2001 using advanced techniques and additional supporting data. This approach was so successful that it has been approved and

implemented by NOAA, the USGS Biology discipline, the Commonwealth of Kentucky and two commercial firms.

Two-year land cover plan:

- Complete loading the NLCD 2001 data for viewing and Internet access.
- Complete the mapping of all 50 States and Puerto Rico by the end of FY 2005.
- Collect a set of imagery for the MRLC Consortium to support partner programs and begin NLCD 2010.
- Incorporate high-resolution data in the NLCD.

Long-term land cover plan:

- Establish the NLCD as the repository for land cover-data at both regional and local levels.

5.3.6 Transportation Theme

Because of widespread investment in and immediate need for transportation data (especially road data) by many Federal, State, and local agencies in the United States, the USGS's strategy is to seek the best mix of data sources to integrate into the transportation theme of *The National Map*. These sources include State and local governments, the commercial sector, and the U.S. Census Bureau.

Several ongoing pilot partnership projects of *The National Map* include a task to integrate available transportation data. The USGS has met with several commercial providers of road data and has discussed options for incorporating these data into *The National Map*. At the U.S. Census Bureau's invitation, the USGS participates in that agency's Accuracy Improvement Program and anticipates receiving samples of transportation data from that program soon.

The USGS plans to take advantage of accurate and up-to-date transportation data collected by the Census Bureau in their program. As the Census Bureau makes them available the USGS will use them to replace older, restricted-use transportation data currently in *The National Map*. Early Census Bureau emphasis will be on urban areas; in some areas, statewide implementations of *The National Map* also will yield improved transportation data.

The USGS anticipates using the transportation standards that are being developed in Geospatial One-Stop as the basis for its activities. Ideally, these standards will be ready for implementation in FY 2004, in part to take advantage of the Census Bureau's anticipated production schedule.

5.3.7 Boundary Theme

Data defining the boundaries of governmental units and publicly administered lands are held by many public entities and are not readily accessible. Governmental units often are the basis for selecting geographic areas of coverage for other data themes. Boundary data are used in making decisions on jurisdiction and assigning responsibilities for emergency responses and disaster-recovery planning.

The USGS has an important role, in partnership with the U.S. Census Bureau, in coordinating the development, maintenance, and dissemination of boundary data as part of *The National Map*. The U.S. Census Bureau has indicated a willingness to provide boundary data. Technical issues remain about providing these data to the public via a Census Bureau Web-mapping service. Initially, the Census Bureau will acquire new boundary data in urban areas. The experience that the USGS and the Census Bureau gain acquiring and managing boundary data for urban areas will help in developing long-term partnerships with States for providing boundary data.

Governmental units include the following:

- **The Nation,**
- **States and statistically equivalent areas,**
- **Counties and statistically equivalent areas,**
- **Incorporated places and consolidated cities,**
- **Functioning and legal minor civil divisions,**
- **Federal- or State-recognized American Indian reservations and trustlands, and**
- **Alaska Native regional corporations.**

Source: Federal Geographic Data Committee

The overall goal for the boundary theme is to provide public access to nationwide coverage of boundary data, as defined in *The National Map* data standards. The boundary theme participants will acquire updates of existing data from other Federal, State, regional, and local governments and from the commercial sector. The archive of these data may consist of databases distributed among the partners who provide the data. The USGS will hold and distribute of these data if no partnerships can be developed.

For the near term, the 1:24,000-scale digital boundary data maintained by the USGS will be the base data theme for boundary data. Over the next 5 years, the USGS will investigate, collect, and use (when feasible) other high-resolution data sources. The program will pursue partnerships whenever the results are data or products that meet *The National Map* criteria. The USGS expects these partnerships to include State and local governments and the U.S. Census Bureau.

Boundary Objectives

- A boundary data model that supports known content requirements and product generation requirements of users.
- Processes for assessing and integrating boundary data acquired through existing partner agreements, urban areas, and pilot partnership projects.
- Adaptable processes that allow *The National Map* to absorb boundary data from wider and more disparate sources as more long-term partnerships are established.

Boundary Accomplishments

- Developed an interim boundary data content standard defining boundary feature, attribute and attribute domains.
- Participated in the development of GOS data content standards for governmental unit data and adapted *The National Map* boundary content standard to be compliant with the GOS standard.
- Met existing customer requirements for revision of vector DLG boundary data by transitioning that work to commercial-sector contracts.

Two-Year Boundary Milestones

- Complete the transition from the 1:24,000-scale DLG-3 as a base theme to an Open GIS Consortium compatible map service for boundary data by the end of FY 2003.
- Refine user requirements for boundary data (using experience from urban areas and *The National Map* pilot partnership projects) as part of *The National Map* and develop processes for integrating disparate boundary data from State, regional, and local sources by the end of FY 2004.
- Finalize an agreement with Census Bureau to archive and serve *The National Map* boundary data by the end of FY 2004.

Long-Term Boundary Milestones

- Provide technical support and assistance for boundary data production and maintenance to partners, as needed beginning in FY 2005.
- Implement agreements with States, through distributed offices, to provide boundary data beginning in FY 2005.
- Acquire and archive additional boundary data from other Federal, State, regional, and local government agencies, and from the commercial sector beginning in FY 2006. The archive of these data may consist of databases distributed among the partners who provide the data.
- Resolve access issues to data from partners to meet *The National Map* requirements beginning in FY 2006.
- Acquire, archive, and distribute boundary data for those areas of the Nation where no partnerships can be developed beginning in FY 2006.
- Expand validation tools to support the various data models of boundary data provided by partners beginning in FY 2006.

5.3.8 Structure Theme

A structure is something, such as a building, that is constructed. For many years, map features that represented structures were determined to be of low priority in relation to other information on USGS maps. However, the evolution of computer and GIS technology has changed the availability of data about structures and their use with other geospatial data in decisionmaking by urban planners. Recent terrorist attacks in the U.S. have pushed the need for accurate information about critical infrastructure to the forefront in order to prevent and respond to acts of terrorism or natural disasters.

The USGS has assumed the role of coordinating the development, maintenance, and dissemination of structure data as part of *The National Map*. The National Imagery and Mapping Agency (NIMA) and the department of Homeland security (DHS) will be key partners in obtaining structures data and in determining how these data will be distributed to ensure their proper and safe use in protecting national security. Partnerships for structure data will be diverse and involve a multitude of government agencies and members of private industry. Data accessibility issues will be complex and will be further complicated by national security issues.

The long-term goal for *The National Map* structure theme is to acquire current data from other Federal, State, regional, and local governments and from the commercial sector. The archive of

these data may consist of databases distributed among the partners who provide the data. The USGS will hold and distribute these data if no partnerships can be developed. Data access will be via both the Web and conventional media. Technological developments in automated feature extraction from analog and digital sources will enhance the currency and completeness of these data. Funding will be primarily from cooperative agreements among the governmental agencies and commercial sector companies who participate in maintaining and operating the structure theme of *The National Map*. Volunteers also will play a significant role in gathering structure data.

Developing a strategy for structure data includes two challenges: (1) deciding which structures must be captured as features in the structure database and which can be represented indirectly as part of the orthoimagery theme and (2) keeping the information current because these features change much more often than features such as topography and hydrography. The USGS has participated in efforts to define those structures important to national security needs. Early results have identified the need for items identified on USGS topographic maps and encoded in the GNIS, such as public buildings, schools, and hospitals. As part of its urban area activities, the USGS plans to update and improve the geographic location information of these structures in the GNIS.

In 2003, the USGS built on information from pilot partnership projects and user assessments to formulate data standards for structures for *The National Map*. The USGS also will identify options for archiving these data, and making them publicly available. As the information content becomes better defined, the USGS will assess the role of the U.S. Census Bureau and other Federal agencies in contributing and holding structure data. From 2003 to 2005, the USGS will investigate, collect, and use (when feasible) other high-resolution data sources toward building and maintaining a feature-based data theme for structures in *The National Map*. Developing a mechanism to share data from current product-based partnerships will be a major challenge for the structure theme of *The National Map*.

Two-Year Structure Objectives

- Define *The National Map* structure data with respect to critical infrastructure used for Homeland Security Infrastructure Program (HSIP) applications.
- Develop a plan to transition volunteers that have supported map revision in the past to acquiring structure data for *The National Map.*
- Introduce volunteers to new structure data definitions and requirements, and train them on acquiring geographic location information on structures.
- Develop a mechanism to transfer structure information from analog files and digital data provided by volunteers to *The National Map* structure data.
- Determine what is needed for *The National Map* to fulfill base-map data content requirements for critical infrastructure in support of homeland security.
- Refine requirements for structure data and develop prototype processes for integrating structures data from State, regional, and local sources, using experience from urban areas and *The National Map* pilot partnership projects.
- Resolve feature overlap issues with transportation and hydrography themes.
- Determine the ability of the Census Bureau to archive and serve *The National Map* structure data.

- Implement agreements with States, through distributed offices, to provide structure. Supplement with data from volunteers.
- Develop the capability of volunteers to supply positions and attributes for structures.

Long-Term Structure Objectives

- Develop partnerships with NIMA, DHS, and other Federal, State, regional, and local governments, and with the commercial sector to share structures data. The archive of these data may consist of databases distributed among the partners who provide the data.
- Expand validation tools to support various data provided by partners.
- Resolve access issues to data from partners to meet *The National Map* requirement for data available in the public domain.
- Ensure content of structure data is consistent between USGS and GOS standards.

Structure Accomplishments

- Developed data content standards defining structure features, attributes, and attribute domains.
- Identified a subset of the structure data required for the Homeland Security Infrastructure Picture (HSIP) that will be provided by *The National Map*.
- Developed a plan to use volunteers to support acquisition of structure data.

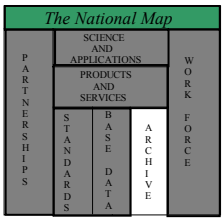
Two-Year Structure Plan

- Identify structure data content and develop a data model and format for the structure data theme consistent with user requirements including product generation requirements.
- Develop the infrastructure for acquiring and disseminating structures data from urban area, from pilot partnerships, and from volunteers. A business process for partners to maintain and serve these data must to be defined.
- Build processes for assessing and integrating data from partners.

Long-Term Structure Plan

- Implement partnerships with other Federal, State, and local agencies, and the commercial sector to provide current structure data through Web-mapping services on the Internet.
- Implement of a geospatial Web catalog service and a distributed database infrastructure that supports dissemination of structure data to the public.
- Maintain existing partnerships and develop new partnerships to deliver current.

5.4 Archive



Goal: Provide an archive for the historic preservation of data and science applications in *The National Map*.

The National Map archive provides for the historic preservation of data in *The National Map.* Data are archived in order to preserve them as a permanent historic record of the technology and science of *The National Map* and to support the mission to study and monitor long-term geographic changes. *The National Map* content is archived by retaining versions of datasets or feature-based transactional information.

The USGS currently maintains archive collections containing data of many types that have come from a variety of sources. The diversity of the collections reflects the many advancements in science and technology that have occurred. As technology advances the USGS must keep pace with changes in the nature volume of data produced.

Figure 5-17:Archive at the USGS EROS Data Center in Sioux Falls, S.D.

The implementation of *The National Map* has created new archive requirements both in the nature and volume of data to be archived. The nature of the data is different because it is from seamless datasets. The volume is increasing due to the increased frequency of update. An additional requirement is to coordinate the archiving of data that is held and served by partners.

Two-Year Archive Objectives

- Maintain the existing archives for current collections.
- Establish standards for archival of *The National Map*. Standards and processes will be established for archiving seamless data. The standards will apply to data that are archived internally as well as data that are archived by partners.
- Establish procedures for internal archiving the base data themes.
- Establish procedures for certifying the archives of partners. A process will be developed to assure that the partner archives meet the archive requirements of *The National Map*.
- Implement the technical infrastructure required for archiving *The National Map.* Hardware, software and network bandwidth will be put in place to archive temporal versions of seamless datasets.
- Begin to archive temporal versions of seamless datasets.

Long-Term Archive Objectives

- Develop a comprehensive archive for *The National Map.* The existing archive collections will be included in an architecture, which will allow access to a comprehensive set of historic data.
- Provide common processes to provide access to archived data and applications.

Partners who provide and maintain data in *The National Map* will be asked about their capabilities and willingness to archive the data that they provide. This will be part of the process of negotiating agreements with partners. The archiving procedures used by partners will be examined to determine if they will serve the needs of *The National Map*. If archives held by partners can serve the archive requirements, there is no need for the USGS to archive the data. In cases where the partners are unable or unwilling to archive the data, the USGS will provide the capability to archive data supplied by partners.

To accomplish this goal, *The National Map* will take advantage of the considerable expertise and experience that has been gained in developing and maintaining the National Satellite Land Remote Sensing Data Archive (NSLRSDA).

In 1992, Congress directed the Department of the Interior (DOI) to establish a permanent Government archive containing satellite remote sensing data of the Earth's land surface, and to make these data easily accessible for study. Kept in the USGS EROS Data Center (EDC) near Sioux Falls, South Dakota, this collection of information is known as the NSLRSDA. It is a comprehensive, permanent, and impartial record of the planet's land surface derived from more than 40 years of satellite remote sensing.

Over the past three decades, the Nation has invested money to acquire and distribute data worldwide from the Landsat series of satellites — more than 418,000 gigabytes. This collection from Landsats 1 – 5 and 7, including image data from the Enhanced Thematic Mapper Plus (ETM+), Thematic Mapper (TM), and Multispectral Scanner (MSS) sensors, forms the core of NSLRSDA but does not complete it. The archive includes more than 34,000 gigabytes of data from the Advanced Very High Resolution Radiometer (AVHRR) sensor aboard NOAA's polar orbiting weather satellites and more than 950,000 declassified intelligence satellite photographs. In addition to these data, the planned archive holdings include data from:

- NASA's Moderat-resolution Imaging Spectroradiometer (MODIS) instrument, part of the Mission to Planet Earth's Earth Observing System.
- The Advanced Spaceborne Thermal Emissions and Reflection (ASTER) sensor, a cooperative effort between NASA and Japan's Ministry of International Trade and Industry.
- The Shuttle Radar Topography Mission (SRTM), a joint venture of NASA and NIMA.

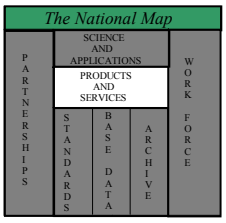
The USGS has traditionally been a user and a manager of satellite land remote sensing data. Nearly three decades of information extraction from satellite remote sensing data have demonstrated the broad utility of these data. Information derived from Landsat data, for example, has permitted scientists and program managers to study more effectively problems related to water, energy, and mineral resources, to understand the effects of natural disasters, to protect the quality of the environment, and to contribute to the Nation's economic and physical

development. Central to the application of these data is the reliable collection, maintenance, and distribution of a record of the Earth's surface; a record, that is comprehensive, historical, permanent, and impartial.

Over the past three decades, the Nation has invested more than $3 billion for the collection and distribution of Landsat Earth observation data. In 1992, the Congress assigned to the DOI long-term responsibility for managing, preserving, and providing access to these and other land remote sensing data (Public Law 102-555). Through s Presidential Decision Directive in 1994 and the National Space Policy in 1996, the President reaffirmed DOI's role by directing it to "maintain a national archive of land remote sensing data and other surface data, making such data available to U.S. Government and other users." In turn, the DOI delegated to the USGS the responsibility for the NSLRSDA. The USGS is responsible for managing, maintaining, and providing access to an extensive and continually increasing archive of satellite remote sensing data. By the end of 2003, the archive will have grown to more than 1,300,000 gigabytes. User demand for these data is expected to grow significantly. The total holdings by the year 2005 are projected to be 1,400,000 gigabytes of data.

One of the major systems recently developed for managing data in the archive is the Geospatial Data Architecture (GDA). The GDA has been developed to unify disparate archive collections and serve as a storage system for the long-term preservation and indexing of file-based data. It maintains a centralized index of data held in geographically distributed archive collections. The GDA contains all of the quadrangle format standard geospatial data files produced by the USGS, including DEM, DLG, digital raster graphic (DRG) and DOQ data. Intermediate products, such as tagged vector contours, and source data (noncompliant with standards but deemed beneficial to the Nation) are archived in the GDA. The GDA is also capable of indexing collections of physical items such as photographs and historic maps.

5.5 Products and Services



Goal: Provide analog and digital products and services from *The National Map* that include paper products, interoperable Web services, digital browse images, data downloads, and scientific reports.

To develop a strategy for delivering products and services, the USGS must study the range of users and their requirements for *The National Map,* along with their current and future capabilities. The processing and bandwidth requirements to prepare and deliver products must be carefully considered.

The USGS must also consider the Federal Government's role relative to that of the commercial sector in the distribution of geospatial information products. The USGS will continue to promote the growing commercial market for geospatial products and services, and will work with business partners to maintain the proper balance of roles as *The National Map* is implemented. The USGS will take advantage of commercial sector capabilities whenever practical.

The plan for hosting and serving data for *The National Map* is to configure a network of geographically distributed servers, owned and operated by the USGS and partner organizations including other Federal agencies, State and local governments, non-governmental organizations (NGOs), and commercial vendors, who agree to provide map, data, and Web services for use in *The National Map.* Due to requirements for redundancy to ensure continual availability of this data for homeland security and emergency response purposes, there will also be mirror sites and fail-over backup sites included in this network. Each of these server nodes will publish their data as some combination of map services, data services, and Web services according to the type of data they are providing and the access they agree to support for *The National Map*.

The table below describes products and services as they were delivered prior to *The National Map* (baseline), as they are being delivered now (accomplishments to date) and how they will be delivered when *The National Map* is fully operational:

Before *The National Map* (baseline)	*The National Map* as it exists today	Future state of *The National Map*
Printed maps or quadrangles	Scanned maps from kiosk CRADA	Map-on-demand – paper maps
Digital geospatial data – fixed format and media – map centered	FTP access – Seamless national databases on Internet (data download)	Continuously maintained by USGS and partners – data download – distribution includes partner data
Published scientific studies	Internal availability – limited access to models	Download models – run interactively on Internet – knowledge transfer
Custom maps	Web mapping services	Geo-web services – scientific tool box

Table 5-1: Comparison of products and services before *The National Map*, now, and in the future.

Products and Services Objectives

- Provide accessibility over the World Wide Web through multiple Web-based services and interfaces, including an image service (Web mapping), feature services (data streaming in support of location-based services and metadata browsing), and coverage services (raster data extract). The USGS will revise and refine these services and interfaces on the basis of customer feedback.
- Provide the means to access and use data from other Federal agencies and other organizations, using open, standards-based technology and processing methods, such as those being developed through the OGC and the FGDC.
- Generate up-to-date topographic maps through kiosks and over the Internet. From commercial sector partners or by means of the Internet from *The National Map* viewer, users will be able to procure up-to-date printed topographic maps with which they are familiar or custom topographic maps made to fit their requirements. Customer feedback should be used for revising the topographic map product.
- Demonstrate emerging technology such as "geospatial Web services" by developing Web-enabled decision support tools.
- Link existing and future decision support tools and models to *The National Map*.
- Improve access to remotely sensed data.
- Ensure timely access to information derived from U.S. classified remotely sensed data (consistent with security dictates) to address land and resource management, environmental, socioeconomic, hazards, disasters, and other scientific and policy issues.

5.5.1 *The National Map* Directory and Viewer(s)

A key element in the implementation of *The National Map* is the delivery of *The National Map* products and services from a network of distributed servers through Web-based data viewers. An initial focus has been on Internet viewers for geospatial data themes currently available in *The National Map*. A plan is being developed for bringing prototype applications together and branding them with a common look and feel. For the near term, many of the viewers and most of the applications will concentrate on featuring selected data themes or geographic areas (e.g. combining *The National Map* services together with local data). This approach will allow developers the flexibility to ensure that the right data are linked to the right services for well-defined applications. It will also provide the user with the ability to customize map views and Web services for a particular application.

In addition to providing a general-purpose data viewer, *The National Map* will provide customized access to geospatial data for specific applications (for example, fire science and amphibian research). These applications will provide users with the ability to create standardized and customized printed maps for use in the field and will allow users to work with their own customized views of geospatial data.

To implement these capabilities in a rapid and cost-effective manner, the USGS is building upon functionality that exists in commercial off-the-shelf applications and is customizing these applications for the specific needs of *The National Map*. *The National Map* will evaluate and potentially make use of features in the draft OpenGIS Consortium catalog specification.

Two-Year Viewer Plan

- Enhance basic functionality (for example, display, print, download, feature query).
- Add capability to open the viewer to a specific extent from another application (for example, select a GNIS feature and zoom to extent).
- Investigate and incorporate OGC's Web Feature Services into viewer.
- Link and (or) add modeling and applications functionality to the viewer.
- Integrate user preferences into basic interface.
- Implement an issue-tracking system.
- Implement a formal software engineering process.
- Develop increased use of application monitoring.
- Implement a user feedback process.
- Track ongoing OGC developments to understand how they relates to *The National Map* viewer.
- Investigate the need for a simplified viewer.
- Implement consistent symbology.

Two-Year Viewer Milestones

- Work on Web viewers and reduce the number available on *The National Map* Web site by the end if FY 2003.
- Add instant refresh capability to the viewer by the end of FY 2003.
- Add data download capability for vector data by the end of FY 2003.
- Provide direct query of the official GNIS database and display of the results in the viewer by the end of FY 2003.

Long-Term Viewer Plan

- Refine symbology.
- Develop and refine a seamless (as much as possible) presentation of disparate data sources.
- Evaluate what has been achieved, what still needs to be done, and what the state of current technology is, and reengineer the viewer accordingly.

5.5.2 Map Services

Map and feature services are provided for seven of eight themes of *The National Map* at full coverage. Structures are available only for small coverage, usually served by partners. Map services are provided under a continuity-of-operations plan that is described below. At the time of this writing, these services are capable of serving (rendering) over 2.5 million maps per week.

Map services are to be provided as compliant with OGC WMS 1.1 or newer. Map services are to be published in many map services and directory services in order to increase chances for discovery; examples include the GOS portal and the FGDC registry.

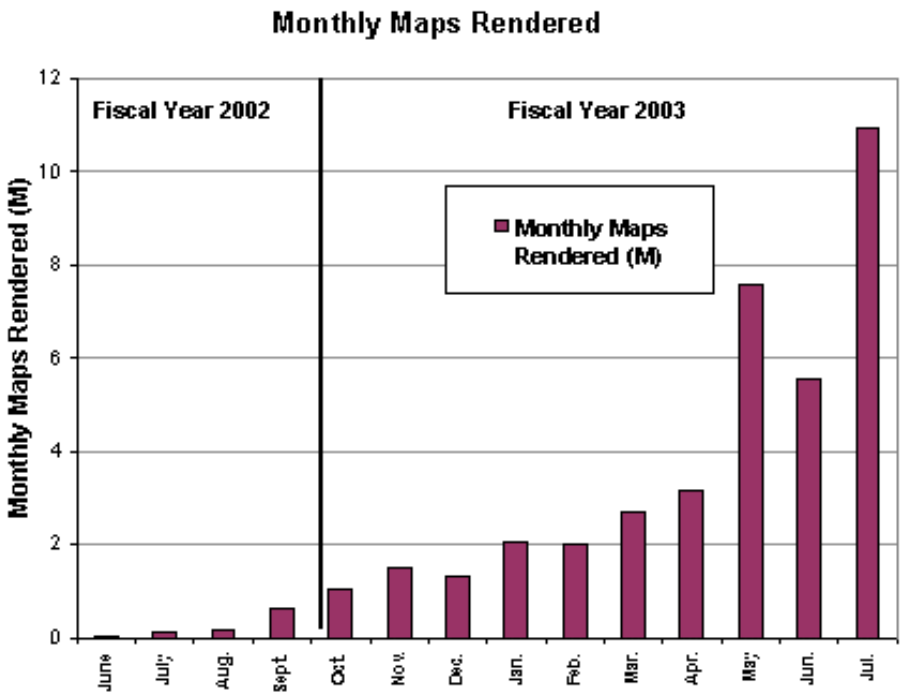


Figure 5-18: Graph showing the number of maps served (rendered between June 2002 and July 2003.

5.5.3 Geospatial One-Stop (GOS)

The Geospatial One-Stop (GOS) e-government initiative provides key direction to the implementation plan for *The National Map*. *The National Map* will be the foundational piece of the geospatial data and services that GOS seeks to bring together. GOS users should find *The National Map* to be a key source of trusted geospatial information that can be combined and compared with other geospatial data. In turn, users of *The National Map* will benefit from the viewer functionality and geospatial data standardization provided by GOS.

When the GOS portal went operational (http://geodata.gov) on June 30, 2003, it featured *The National Map* as the GOS base map. Building on this base map, the user can select other thematic content from over 3,000 Federal, State, and local Web sites that serve geospatial data.

The GOS portal demonstrates the win-win nature of the collaboration between *The National Map* and GOS. *The National Map* provides trusted content for GOS users who need a base map of imagery and cartographic reference information. GOS provides users of *The National Map* with new functionality (for example, layer ordering and transparency control) but, more important, provides thematic content far beyond the basemap or framework layers of *The National Map*.

Geospatial One-Stop Coordination Accomplishments

- *The National Map* was featured as the base map for http://geodata.gov (geospatial one-stop operational portal)

Two-year Geospatial One-Stop Coordination Plan

- Improve map services provided by *The National Map* to GOS users by improving layer-list grouping.
- Add (publish) a Terraserver/Terraservice 1-meter orthoimagery map service.

5.5.4 Map-on-Demand

Sales and distribution of existing maps products are to transition to the commercial sector beginning in FY 2004. Many USGS topographic maps have low-volume sales and low-demand from users. Innovative proposals show promise for generating single copies of these maps when they are needed.

Map-on-Demand Objectives

- Explore and develop partnerships with the commercial sector for distribution of products.
- Determine architecture and infrastructure needed for print-on-demand among private sector partnerships.
- Develop connectivity between *The National Map* viewer and potential product distribution partners.

5.5.5 Data Download

Distributed data delivery, including online downloads and media products, are required to supplement public access to map services for users who require access to *The National Map* datasets for models and analysis. To facilitate user access to these datasets, a user interface will be built such that users may obtain data from a distributed server network. Data may also be accessed on demand through Web services that are configured to read single or multiple sets of data values from *The National Map* servers to provide support for modeling capabilities. Viewer download capability will connect directly to *The National Map* data access site.

The National Map Web site will provide for both downloading of data online and ordering of products on media. FY 2003 statistics for the Seamless Server show 5.7 terabyte (TB) of data delivered as free online downloads and 1 TB of data delivered on media. In 5 years, as more partners are added to *The National Map* distributed server network, it is anticipated that this will grow to 100 TB of data per year. It is expected that while online delivery, particularly through Web services, will grow dramatically, new media, such as removable disk drives, will also be increasing.

Data delivery began in 1999 with the development and implementation of the Seamless Server http://seamless.usgs.gov This work began with NED data delivery and has expanded to include SRTM and urban areas orthoimagery. The original system allowed 10 megabytes of data to be downloaded at a time. The enhanced Seamless Server that went online in the fall of 2002 was

redesigned to improve user access with a more robust download capability. It has been extremely well received. Some user comments are shown below:

> October, 2002 – USGS Information Technology Specialist from the Earthquake Hazards Program:
>
> > "Wow! I am very impressed and appreciative. The [Internet map service] IMS site is great! I'll use it as a model to build mine."
>
> January, 2003 – Overseas customer:
>
> > "A quick email to congratulate you on an excellent site"
>
> February, 2003 – Customer from private industry:
>
> > "You need to be commended on this new system of data acquisition. This is by far the best data distribution system I know of on the Web, and I know a lot of them."
>
> May, 2003 – Customer from private industry:
>
> > "Love it."
>
> July, 2003 – From a planning commission:
>
> > " The Seamless Data Distribution System is incredible! The speed, ease of use, and support info is outstanding. The USGS's emergency management group at the Council of Governments is already using portions of the hi resolution imagery for the Amarillo, Texas area."

Key partners for *The National Map* data access site will be States, county or local governments, Federal agencies, and commercial industry. Most will deliver data in the public domain, but some will have license restrictions and some will sell their data. *The National Map* data access site will accommodate these different models.

Two-Year Data Download Plan

- Deliver vector data as well as raster data.
- Create a "SWAT team" of technical staff who will be able to assist partners in setting up their servers to deliver data in conjunction with *The National Map* data access site.

Web sites will be provided with executable code to deliver data from their servers. User access will be coordinated through the main site on the expanded Seamless Server. One such site is currently under construction as a partnership with Eastern Region Geography (ERG). It will serve as a prototype for studying how to expand the data access site concept to more partners.

Long-Term Data Download Plan

- Include all partners of *The National Map* in the data access site.
- Make data delivery for Geospatial One Stop a priority.
- Coordinate with Environmental Systems Research Institute (ESRI), OGC, and other vendors who provide GIS software to ensure compatibility of the data delivered with popular GIS packages.
- Comply with standards.

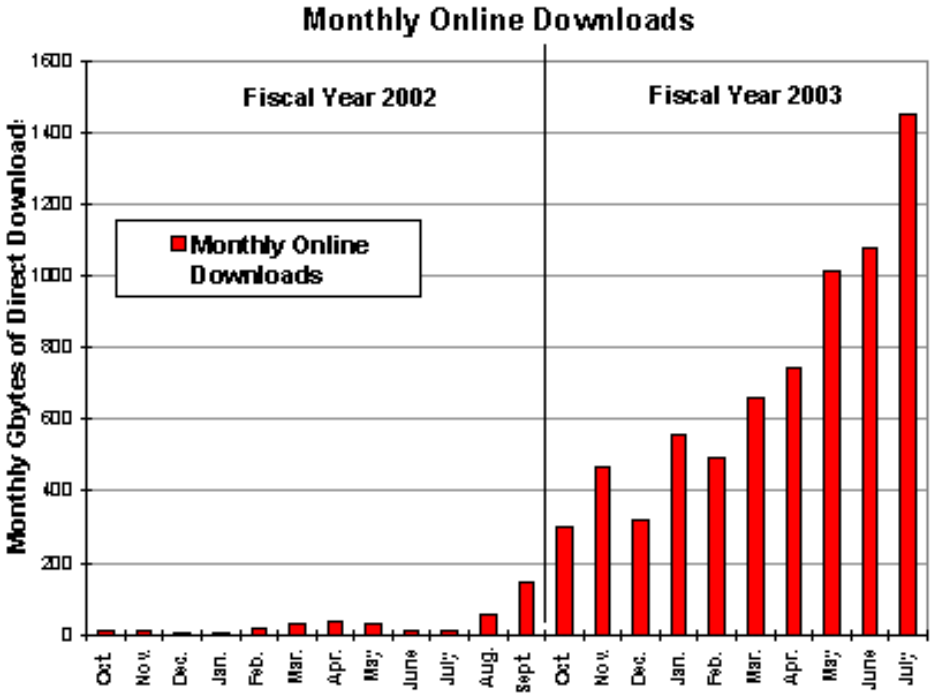


Figure 5-19: Monthly volume of data downloaded from the seamless server between June 2002 and July 2003.

5.5.6 Continuity of Operations

The National Map will utilize the Internet as a primary (but not the only) means of data distribution. Interoperable Web services are to be served in a manner that is as nearly continuous as is economically feasible. This will involve tradeoffs and difficult decisions. It is very important that the USGS carefully and completely develop functional requirements that will help guide these decisions.

As the data producer when no other sources for needed data exist, *The National Map* will require hardware configurations capable of storing and serving large datasets. This in turn requires a full-featured Relational DataBase Management System (RDBMS) and considerable storage to provide real-time access to full-resolution data. Near-line storage should be investigated for applications that do not require real-time or near-real-time access to data. Very large databases will present challenges for backup and for maintaining continuous operation. Technology such as Redundant Array of Inexpensive Disks (RAID) will be employed to the extent practical, given RDBMS performance considerations. Backup techniques should take into account the need to minimize downtime in a reload situation, and should provide for offsite backup in the event of a catastrophic failure.

Reduction of single points of failure

A server architecture has been designed to minimize single point failures through the use of redundant hardware components and software that detects slow or non-responsive services and

automatically switches to alternate devices. The technology employed in this architecture also includes network (mirror site) and internal fail-over as well as round-robin type load balancing. To the extent possible, *The National Map* should use these techniques to approach continuous operations for critical map and data services.

Database Drawoff (Non-Internet)

The National Map relies on partners to help deliver data, and this requires technology that will assist us in routinely moving large datasets and database updates. Doing so will require a database synchronization stragegy. Data products on CD/DVD media are simply inadequate to this task. In addition, it is anticipated that there may be times when the Internet will not be available when it is most needed. Some of the USGS's partners are either reluctant to rely on the Internet or are prohibited in some cases from using the public Internet for emergency response activities. For these reasons, *The National Map* should exploit technology that allows for database check-out and check-in at the level of a "portable database" complete with data and database management software. The hardware devices that support this emerging technology can be as simple as an external disk drive. Higher volume can be attained on multiple drive configurations called "data bricks". These devices can be shipped between data providers or to customers who require large datasets or entire databases.

5.5.7 Scientific Results

The National Map will provide links to scientific reports and results that are geographically referenced and available through a Web browser. This functionality will provide information and results of scientific research and applications.

An example of scientific reports is the Status and Trends report series. This series will be a primary outlet for highlighting the results of geographic analysis and monitoring research while helping to focus on the Nation's urgent environmental and geographic issues. The initial report (1) will describe the current state of the Nation's land surface, the factors driving land-use change, the direction of regional trends, and the environmental, social, and economic effects of change, and (2) will project trends in land surface change. The Status and Trends report will also provide resource managers and the American public with a reliable reference tool and source of information to better understand the dynamic nature of the Nation's landscape and the consequences of natural processes and human actions. As the program matures, future reports will reflect a truly national assessment of land surface change and a synthesis of geographic analysis and monitoring research investigating this change.

5.5.8 Land Remote Sensing Products and Services

The USGS, through *The National Map*, will improve the availability of its remotely sensed data to the Nation. All data will be accessed through the Internet, with browse capability available in real time. Newly acquired data will be available to users within hours and will benefit hazard and emergency response managers. Data can be searched for and ordered online through *The National Map* or through business partners, AmericaView members, or affiliate archives. Increased numbers of data users will be supported through educational outreach and through the development of user assistance tools. Customer needs and requirements related to how to fill

historical data gaps, how to provide access to archived datasets, and what types of products are needed are still to be determined.

Two-Year Land Remote Sensing Product and Services Milestones

- Complete a study of new data distribution methods and upgrade datasets to meet the new archival and user requirements by the end of FY 2004.
- Review support for distributors, such as *The National Map* and Business Partners, and implement any identified improvements by the end of FY 2004.
- Develop and implement a plan for upgrading access to data by the end of FY 2004.

Long-Term Land Remote Sensing Product and Services Milestones

- Enhance user access to USGS remotely sensed data beginning in FY 2005 to be completed by the end of FY 2007.
- Improve mechanisms to ensure that the USGS is fully able to support the Nation's geospatial data needs in times of a local disaster beginning in FY 2005 to be completed by the end of FY 2007.
- Develop and begin operation of the new distribution plan to bring all datasets up to access requirements beginning in FY 2005 to be completed by the end of FY 2007.

A plan under consideration would augment the orthoimagery theme of *The National Map* by providing access to a seamless mosaic of global satellite data. The NSLRSDA is essential to *The National Map* because it stores the current and historical land remote sensing data that provide orthoimagery and other products for *The National Map*. Since the retention of historical versions and the NSLRSDA is quite large, a strategy is needed that will function immediately (status quo) and then gradually make incremental developments that are based on user requirements, taking into account the available technology, business decisions (for example, cost/benefits), priorities, and available resources.

Two-Year Landsat Data Delivery Milestones

- Develop and implement an initial version of the satellite data theme for *The National Map* using Landsat data from 2000 by the end of FY 2004.
- Incorporate additional, more recent data from Landsat and other sources by the end of FY 2005.
- Conduct needed research for extending functions to multiresolution global datasets by the end of FY 2005.
- Conduct needed research and development for delivering and serving historical data by the end of FY 2004.

A long-term objective for land remote sensing products and services is to use increased amounts of commercial remotely sensed imagery, extend the traditional role of the USGS to include commercial imagery archiving, access, and data management services, and provide Federal civil community leadership in the review and development of national commercial imagery and space policy. The continued growth of a competitive and capable commercial remote sensing industry significantly augments the Nation's operational capacity to collect and use remotely sensed data. The USGS will expand its capability to provide selected data and technical services in support of

the USGS and civil community operational needs and also will participate in developing National remote sensing strategies for earth science applications.

Two-Year Commercial-Source-Data Access Plan

- Develop contracts to obtain, archive, and distribute data from the Space Imaging Corporation, Digital Globe, and Orbimage archives.
- Add the capability to utilize commercial partners for more recent imagery.
- Establish precedents and identify needs for a new bureau imagery policy.
- Establish and execute interagency agreements for data validation between the management and engineering staffs of government and vendor organizations.
- Maintain a network of facilities to ensure proper and accurate calibration of the Nation's aerial camera assets.

Long-Term Commercial-Source-Data Access Plan:

- Increase the availability of remotely sensed imagery from all sources through cooperative agreements, partnerships, and data purchases.
- Coordinate with other agencies in operational interfaces and develop joint commercial and civil agency strategies and initiatives.
- Increase USGS leadership in the review and (or) development of national space policies and initiatives, Executive Branch Circulars, Presidential Decision Directives, and Public Laws, and in the licensing of new commercial partners.
- Organize a network of laboratories, in-situ sites, test fields, and methodologies for data validation and sensor calibration.
- Support the development of a next-generation calibration methods that can handle large- and small-format aerial and digital sensors.

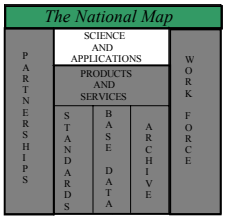
5.5.9 Commercial Partnerships

The existing models for data distribution within the Geography discipline will evolve as partners review the implementation plan for *The National Map*. A cohesive strategy is needed that builds on the existing partner product-distribution mechanisms, such as the Business Partner retailer program.

Two-Year Commercial Partnership Plan

- Establish a partner data-distribution forum, including existing business partners of the Geography discipline, to review and discuss the distribution model for *The National Map*. Use the International Map Trade Association (IMTA) focus group representatives — National Geographic Maps, Beartooth Mapping, DeLorme Maps, TopoZone, MapLink, and MapMart — as the initial group.
- Prepare a plan to evolve the Business Partner retailer program to better meet *The National Map* distribution requirements.
- Investigate the merits of a potential consultative group on product and data distribution by partners.

5.6 Science and Applications



Goal: Promote geographic integration and analyses and provide access to tools for specific applications and modeling.

Figure 5-20: *The National Map* science continuum.

The continuum of science presented in Figure 5-20 highlights the connection between the data components (describing and monitoring phenomena) and the science and applications component (understanding, modeling, and predicting phenomena) presented here. As stated in the National Research Council report "Research Opportunities in Geography at the U.S. Geological Survey" (National Academy of Sciences, 2002, Washington, D.C.):

"The Geography Discipline excels at data management, the descriptive first step in science. The Geography Discipline also provides value-added components to convert the data to useful information. … The Geography Discipline should now progress to the next steps in science: cutting-edge modeling and prediction that provide knowledge required by decision makers."

A program of science and applications is essential to meeting the goals of *The National Map.* As with other components of *The National Map,* research and development is also based on partnerships. Needs of partners will guide applied investigations; university and commercial partners will be cultivated to assist with fundamental research and development. All three Geography discipline programs will contribute to this effort since all are needed to cover the full domain of the discipline. The Geographic Analysis and Monitoring Program will conduct geographic analysis to address the rates, causes, and consequences of landscape change over time, will use that knowledge to model change processes for predicting conditions, and will evaluate the tradeoffs that arise from policy and management decisions. The value of *The National Map* will be demonstrated through case-study applications that concern specific environmental, natural resource, and economic issues. The USGS will continue to develop cartographic techniques that improve data integration, management, and dissemination. The Land Remote Sensing Program will investigate future sensors, data, and applications for mapping and monitoring the Earth's surface. All three Geography discipline programs, as well as other bureau programs, are involved in geographic information science, which will enhance capabilities in knowledge, discovery, visualization and modeling, and risk communication.

5.6.1 Geographic Analysis

Geographic Analysis Objectives

- Integrate geographic analyses with *The National Map* to provide user-oriented applications and models to address scientific and management issues.
- Define system architecture requirements for applications and models in *The National Map*.
- Contribute additional themes to *The National Map* as the demand for science and applications activities expands.

A robust applied geographic analysis component is critical to the long-term viability of *The National Map.* This component will promote the use of *The National Map* by scientists and decision makers who benefit from a geographic framework in addressing their scientific and management issues. Today's scientists and decisionmakers have an abundance of geographic data and information available to them, as well as the use of geographic information systems to process and visualize this information. However, government and private partners often lack the expertise to know which geographic information to use or how to use it effectively. *The National Map* science and applications component will promote geographic integration and analyses and provide access to models and tools for specific applications.

Geographic Analysis Strategies

In FY 2003 the Geographic Analysis and Monitoring Program within the USGS identified six focus areas: Biogeophysical Processes, Ecosystem Studies, Analytical Methods, Earth Systems Science, Synthesis and Applications, and Policy and Economics. During FY 2004 this program will refine and prioritize current programmatic objectives and plans around these six scientific focus areas and the goal of *The National Map* to promote geographic integration and analyses.

The USGS has initiated local, regional, and national studies, which feature the results of geographic data integration and demonstrate how to use these results to support policy and management decisions. *The National Map* is a tool for scientists and practitioners to use; Web-enabled tools will help integrate information from data in *The National Map* and communicate research results through a common graphical interface. In the Stage I implementation (described in Section 4), the USGS will use *The National Map* to demonstrate geographic integration and analyses across spatial scales and information sources. Also, pilot studies will investigate the utility of *The National Map* for partners' management planning and decisionmaking. Many of these initial studies will involve other USGS disciplines and existing external partnerships and will foster the development of more sophisticated applications for decisionmaking in Stage II of the implementation plan. These studies will (1) help identify new or refine existing data requirements for *The National Map* and (2) assess future technology and its application to *The National Map*. Stage II will enable users to make their own applications available to *The National Map*, further enhancing the use of geographic knowledge across government, industry, and the general public.

To prepare for Stage II, the Geographic Analysis and Monitoring Program has begun an effort to better address the modeling and forecasting requirements for *The National Map* by conducting a survey of scientists within the USGS in order to build a descriptive database of environmental

models. By documenting modeling activities being conducted throughout the USGS and other research institutions and through subsequent analyses of the database, the USGS will set priorities and focus the future modeling efforts within *The National Map* to provide researchers and practitioners with selected specialized data and tools they need. The Geography discipline will also increase communication and coordination with other bureau geospatial data distribution activities such as the National Biological Information Infrastructure, GEO-Data Explorer, and Enterprise WEB. These activities do not duplicate *The National Map,* but are complementary and will benefit from increased technical exchange.

The National Map will be a tool scientists use to augment their research and a tool to deliver their scientific information; the USGS will take requirements from science and use them to design an architecture that supports the delivery of scientific information. Scientific applications require that *The National Map* adapt to accepting and delivering a wide spectrum of map themes, including derived themes from modeling efforts. *The National Map* can be invaluable as a source of information, but its ultimate usefulness will depend on its ability to deliver the "next generation" or "derivative" information provided by scientific investigation.

Geographic Analysis Accomplishments

Science and applications projects are ongoing across the Geography discipline with partners in Federal, State, and local government, in private industry, and in university organizations. In FY 2003, a request from the discipline's three bureau programs was sent out to bureau scientists to identify and initiate integrated studies in urban ecosystems to model the relationship between science applications and *The National Map*. Many of these projects are linked with existing partnerships and science investigations. In addition, many of the scientists working on regional and national studies have acknowledged the utility of the existing data to their scientific analyses and the potential for *The National Map* to communicate their research results. These scientists, working with others in the bureau and in other institutions, have begun linking the data derived from their geographic analyses back into *The National Map* as well as linking their models and applications to *The National Map*. Below are examples of ongoing geographic analysis projects to communicate not only current activities but also plans for the future.

***The National Map* and Comprehensive Urban Ecosystem Studies (CUES)**

The Geography discipline is leading the development and application of the Comprehensive Urban Ecosystem Studies (CUES) initiative. The objective of this initiative is to focus USGS's and partners' resources on the integrated assessment and monitoring of critical urban ecosystems. *The National Map* will make scientific results and geospatial data from these CUES available via a portal. Current CUES areas are Sacramento, Calif., Denver, Colo., Washington, D.C., Charleston, S.C., St. Louis, Mo., Tampa Bay, Fla., and Lake Tahoe, Calif. All three bureau programs within the Geography discipline programmatically and financially support these CUES. The milestones for each of these ecosystem studies are presented in individual project plans jointly developed by the USGS and a group of partners. The majority of the CUES are planned for Stage I completion by the end of FY 2004. Many, if not all, of these projects will be extended through FY 2006 using the operational prototyping approach to define appropriate new objectives and milestones.

The Sacramento, Calif. study, examines the need to develop a cost-effective, market-oriented approach to meet the goals and standards for water quality in the Sacramento River watershed. It

illustrates how local-scale implementations of *The National Map* will support decisionmaking. Federal agencies (for example, the USGS and the EPA), State and local governments (for example, Sacramento Regional County Sanitation District, and California Regional and State Water Quality Control Boards), academic institutions (for example, University of California – Davis), and the private sector (e.g., Larry Walkers Associates) are collaborating to conduct a watershed analysis. They will rely on data themes from *The National Map*, including orthorectified imagery, elevation, hydrography, geographic names, and land cover, to develop maps of areas within the Sacramento River watershed that are impacted by mercury contamination. These derivative maps will provide the foundation for an integrated environmental, economic, and statistical map-based approach oriented toward water quality issues.

The Colorado Front Range has experienced phenomenal urban growth and significant changes in land cover and land-use practices over the past 50 years. Collective partnerships with Douglas County, the Denver Regional Council of Governments, the USGS Front Range Comprehensive Assessment project, and the Consortium for Advancing the Monitoring of Ecosystem Sustainability in the Americas (CAMESA) Colorado Pilot Study will provide insight into the impacts of urban growth and the resulting increased air pollution, traffic congestion, hazard risk, demand for natural resources (including water availability and quality), and loss of wildlife habitat. These impacts are classified into areas of high risk for potential decisionmakers. Tools and information for collaborative decisionmaking will be provided through *The National Map*. To date, collaborative partnerships are progressing to identify and understand the primary concerns and issues facing our partners and how *The National Map* addresses them. Stage I of the Colorado CUES is expanding collaboration with Douglas County. This collaboration is identifying key partners within the county and key decisions that will be addressed in the study. Coordination meetings with the Front Range Comprehensive Assessment project have initially identified Class I air quality issues in Rocky Mountain National Park and the surrounding national forests for Stage II of the CUES. The USGS Rocky Mountain Mapping Center is also playing a coordination role in bringing together Federal partners in the CAMESA Colorado Pilot Study and promoting *The National Map* as key partner in this significant large-scale assessment.

Washington, D.C., is the center of the U.S. Government, and the region is home to over six million people. Focused and coordinated efforts will be required on the part of Federal, State, and local governments to address homeland security needs and to accommodate the demands of this expanding population on regional and local water supplies and other natural resources. *The National Map* will bring scientific data and expertise to address issues facing the region. One application under development will identify water supplies at risk as a result of inadvertent contamination from point-source and non-point-source pollution, as well as from the potential introduction of toxic chemicals or pathogens. *The National Map* elevation, hydrology, and land cover data, integrated with hydrologic and geologic analysis and modeling, will enable the development of improved models and provide area governments with tools to better protect public water supplies.

Charleston, S.C., is a major seaport and commercial hub, and the site of the Charleston Air Force Base and several U.S. naval facilities. In addition to port and municipal security concerns, Charleston must also address the threat from natural hazards. The city was heavily damaged by a

magnitude 7.5 earthquake in 1886; an event of similar magnitude would have far more devastating consequences today. Charleston also faces significant risk of flooding and wind damage from major hurricanes; the area incurred over $9 billion in damage from Hurricane Hugo in 1989. The Charleston CUES project will bring scientific data and expertise to bear on critical issues facing the region, including storm-surge and flood risk, long-term impacts of sea-level rise, earthquake risk, airborne diseases, and invasive species. In recent cooperation with the EPA, the project developed several demonstration scenarios for catastrophic releases of toxic contaminants. Figure 5-21 shows a simulated plume from a mock catastrophic release of phosphorus trichloride, overlain on a USGS orthophoto.

Figure 5-21: Modeling of plume spread from mock contaminant release in Charleston, S.C

The St. Louis, Mo., CUES is focused on the development of partnerships and the collection of data required by local, regional, State, and Federal organizations and agencies to address issues such as urban growth, habitat fragmentation, hazard response and mitigation, and public safety. In addition, the USGS is initiating research activities investigating data integration and temporal representation issues, as well as trends in regional land-cover change. To date, partnerships have been developed and data are being acquired from a variety of agencies and organizations. In addition, several geographic research projects have been initiated. These include developing tools to automate the integration of the various thematic and image datasets, examining the

representation and application of the temporal dimension of *The National Map*, and analyzing the past 30 years of land-cover change in the region. Future activities will focus on the maintenance of existing partnerships and data, the development of new partnerships, and the acquisition of new or more current data. Future research activities will include the application of data integration tools to improve the collection and use of *The National Map*, and the development of models to help us understand the temporal dimension of geospatial data and predict the consequences regional land cover change.

The Tampa Bay, Fla., Integrated Science Study is a five-year investigation of the environmental health of the Tampa Bay estuary, one of the largest estuaries in the Gulf of Mexico at 2,600 square miles and representative of the threats faced by the critical transitions between terrestrial and marine ecosystems. Tampa Bay and its environs have experienced phenomenal urban growth and significant change in land cover and land-use practices over the past 50 years. Figure 5-22 illustrates these changes.

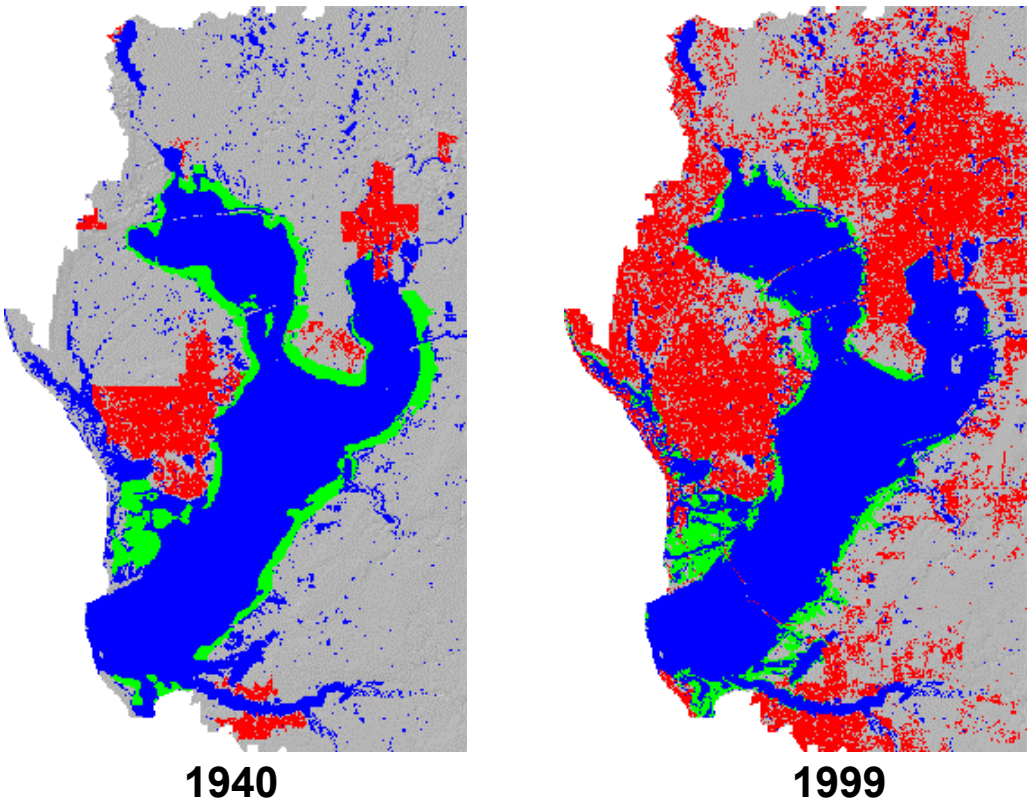


Figure 5-22: Tampa Bay population growth and seagrass decline between 1940 and 1990. Following World War II, urban growth increased significantly in the Tampa Bay region as shown in red on these two images. During the same period seagrasses (depicted in green) declined in areal extent from more that 16,700 ha. To 8,300 ha, due largely to nutrient loading in Tampa Bay.

The Tampa Bay CUES project involves collaboration with more than 100 partners who will be contributing geospatial datasets that will demonstrate the depth of analysis and discovery possible when a full-fledged, multi-scale geographic database is available. Furthermore, it will provide an assessment of future developments that will be needed to make *The National Map* a viable public resource. This CUES project will (1) define the current status and health of Tampa Bay, (2) forecast the effects of anthropogenic modifications and the future outlook on Tampa Bay health, (3) place changes in the Tampa Bay area into a larger geographic context — regional, national, and global — so that the crucial scales of impacts and interactions can be understood, (4) link baseline land surface information to process and characterization studies being performed by collaborators, (5) contribute to the National Estuaries Assessment, and (6) provide a strategic foundation for integrated science in other Gulf of Mexico estuaries. An activity unique to this project is the real-time monitoring of four intensive-study sites with a future Web site to allow a user to pick a collection point and display the current (or past) data collected by a particular sensor. A major objective of the Tampa Bay Integrated Science Study is the development of an integrated suite of process models that will be available for scientists, managers, and decisionmakers to access and apply. Web services will be implemented that enable modeling capabilities and that provide access to data values directly from *The National Map*.

Lake Tahoe, Calif., is a high-priority-focus area for Federal and State agencies in the West. Maintaining the clarity of this pristine alpine lake under continuing pressure of urbanization is a primary goal of the USGS in working with the two States, four counties, and the development policy in the lake basin. One of the Geography discipline's initial pilot sites for regional planning agency, the Tahoe Regional Planning Agency (TRPA) that administer implementing *The National Map* was the Lake Tahoe basin. Through cooperative agreements with California and Nevada State agencies, the U.S. Forest Service, and Washoe, Douglas, El Dorado, and Placer Counties, cartographic data have been assembled, integrated, and served online. The USGS is an active partner in developing the Tahoe Integrated Information Management (TIIMS) database together with TRPA. In addition to building the prototype, the USGS has conducted two research projects in the basin. These use the databases to add to scientific knowledge of the causes of the decline in lake clarity and to apply economics as well as scientific findings to TRPA's decisionmaking process for building-permit allocation. One of the research projects is the development of the Tahoe Decision Support System (TDSS). The TDSS was created to help the basin managers keep abreast of changes in environmental conditions as they work to maintain the vibrant recreational, economic, and natural attributes of the basin. In collaboration with the TRPA, the EPA, and the Desert Research Institute, the USGS built a prototype decision-support system called the Tahoe Constrained Optimization Model, which was used as a pilot study in the Upper Truckee River watershed. It generates numerical results and detailed maps that enable decision makers to effectively envision the outcomes of different management scenarios (Figure 5-23). The TDSS expands beyond a single watershed and incorporates additional environmental criteria and indicators for decision making in the Lake Tahoe Basin.

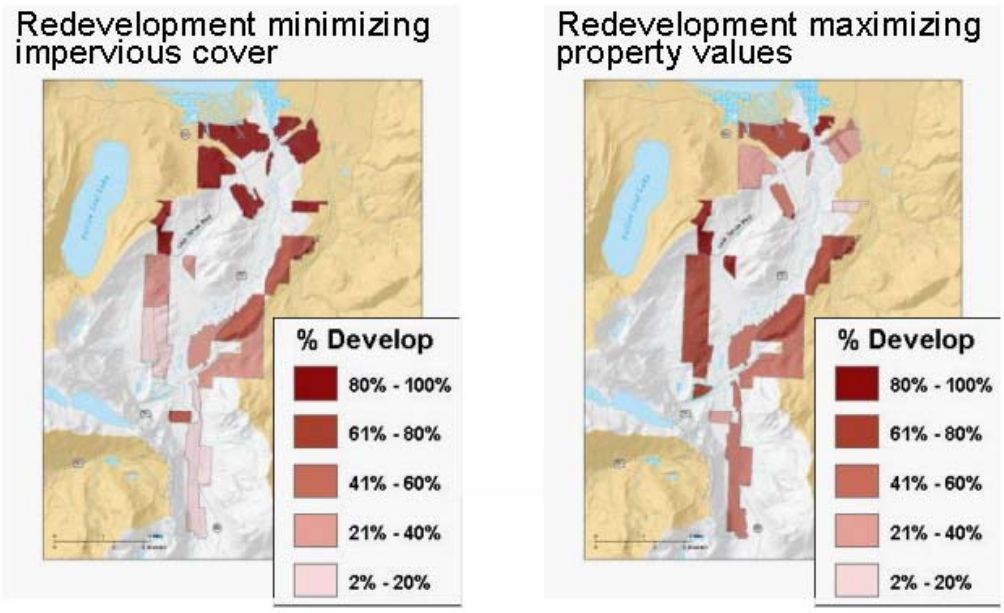


Figure 5-23: Lake Tahoe basin management scenarios.

Examples of Regional-Scale Applications

The USGS has been conducting integrated, regional analyses through the Place-Based Studies Program. For FY 2005 the USGS will import the extensive data collection for these sites into *The National Map* and challenge the USGS Place-Based Studies Program to make the applications and models available through *The National Map* architecture. Examples of regional-scale applications are described in the following paragraphs.

Nutrient transport in Cedar River watershed, Iowa

A Central Region Integrated Science Project is being conducted with the Water and Biology Disciplines to study nutrient transport in the Cedar River watershed. This area is also a National Water-Quality Assessment Program (NAWQA) study unit. The approach involves the integration of the land cover and elevation themes of *The National Map* with water quality information and nutrient source information, such as historical agriculture and census data. The study utilizes new techniques that link the land surface with the water features in spatial models.

Tampa Bay, Florida, bathymetric/topographic elevation model

The first of several joint projects demonstrating the merging of bathymetry data from NOAA's National Ocean Service (NOS) Hydrographic Survey Database System and the USGS's National Elevation Dataset into a single DEM was conducted for Tampa Bay (Figure 5-24). In each case, the NOAA and USGS data will be supplemented with recent high-resolution third-party data, which will be incorporated into the DEM, making use of a newly developed datum transformation tool and quality standards developed in this project. As this approach is implemented on a broad scale, the result could be the development of a mutually-agreed-upon "national shoreline". For NOAA and the USGS it represents the beginning of a new way of doing business with each other that will reduce duplication of effort and better meet the needs of State and county agencies. The applications benefiting from the bathymetry/topographic

elevation model include (1) improved hurricane evacuation plans (2) improved and consistent geospatial data for county planners (3) better siting of habitat restoration projects and (4) detailed electronic nautical charts.

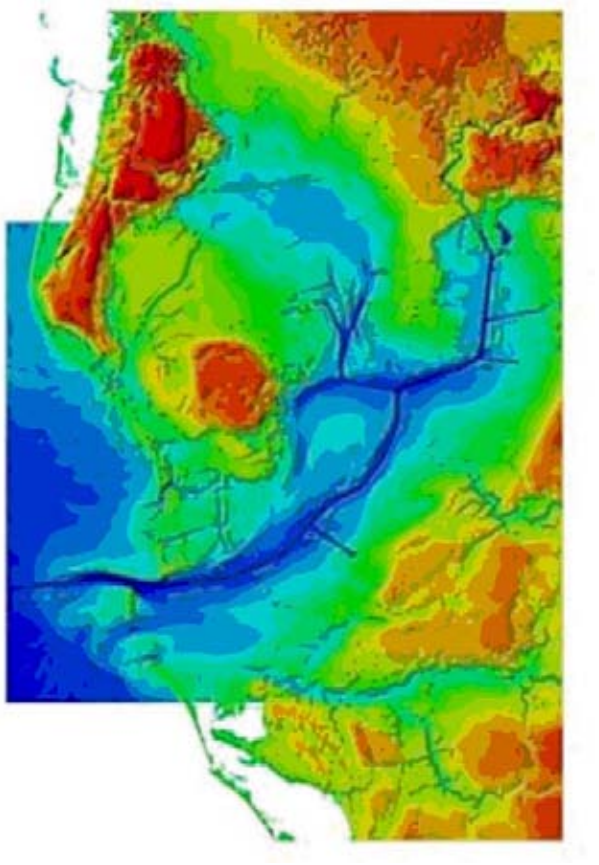


Figure 5-24: Tampa Bay bathymetric/topographic elevation model.

Alaska geospatial data

A number of agencies in Alaska (currently about 44 Federal and State agencies, and non-governmental organizations) require a primary repository and access point for a number of different types of geospatial data. The Alaska Geographic Science Office operates and maintains the Alaska Geospatial Data Committee's (AGDC) NSDI Clearinghouse to serve that purpose. This Clearinghouse's database holdings, structure, and user interface are currently being converted to *The National Map* defined format and standards, thus ensuring that the large data holdings rapidly become incorporated into *The National Map***.** These data themes range in spatial from municipalities (for example, Anchorage, Juneau, and Fairbanks) to boroughs (for example, Matanuska-Susitna) to a number of Alaskan statewide databases at varying levels of detail, from 1:63,360 scale (e.g., land ownership) to 1:250,000 scale (for example, DEMs, DLGs, and DRGs), to 1:1,000,000 and greater scales (statewide datasets such as Ecoregions, permafrost, and vegetation condition datasets). Some of these datasets will be used to fill one or more of the eight base data themes as "best available data" for the State; other database themes will be incorporated because they are used by scientists and Federal and State resource management personnel (for example, ecoregions, land cover, forest health). In addition, the conversion of the AGDC database over the next five years to *The National Map* will provide the scientific and public user access to other USGS data for Alaska via *The National Map* portal.

Urban areas on the U.S./Mexico border

The bi-national integration of data from *The National Map* and Mexico's national mapping agency for selected cities along the U.S./Mexico border provides Web-based planning tools to evaluate local infrastructure needs and to derive quality-of-life measures for urban areas. Through partnerships between the USGS and the U.S. Department of Housing and Urban Development, the Mexican National Institute of Geography, Statistics, and Informatics, and the Mexican Social Development Agency, national map data are integrated with local geospatial and demographic data, including U.S. and Mexican census data themes for the sister cities of Eagle Pass/Piedras Negras, El Paso/Juarez, Douglas/Agua Prieta, and Nogales/Nogales. The Web-

mapping portal ensures that users can view the most current data available from each country by streaming information directly from various data holdings in the U.S. and Mexico.

Examples of National Scale Applications

The National Map provided the national geographic reference frame for the integration of specific study sites within the USGS amphibians project. The goals of the Amphibian Research and Monitoring Initiative (ARMI) are to determine the status of amphibians in the United States, to research the causes for declines, and to supply scientific information to researchers, land managers, and policymakers about how to halt or reverse declines. The Geography discipline contributes to these efforts by providing geographic integration across spatial scales, information sources, and disciplines. A key means for accomplishing this integration is through the development of a Web application that builds upon the data themes and technology of *The National Map*. The Web application (http://armi.usgs.gov) is national in scope and will provide investigators with a means for viewing ARMI amphibian data against a backdrop of environmental data themes.

Other Web applications that build upon *The National Map* are also being developed for ARMI. One application focuses on potential stressors of amphibians and will include the ability for ARMI scientists to query and download combinations of data themes that can support analyses of patterns of amphibian declines relative to patterns of terrestrial, aquatic, and climatic features. Another application will showcase modeling results from geospatial analyses of terrestrial and aquatic habitats in Yellowstone National Park and will demonstrate how these results can be used to support decisions regarding field survey strategies, land management, and amphibian conservation (Figure 5-25).

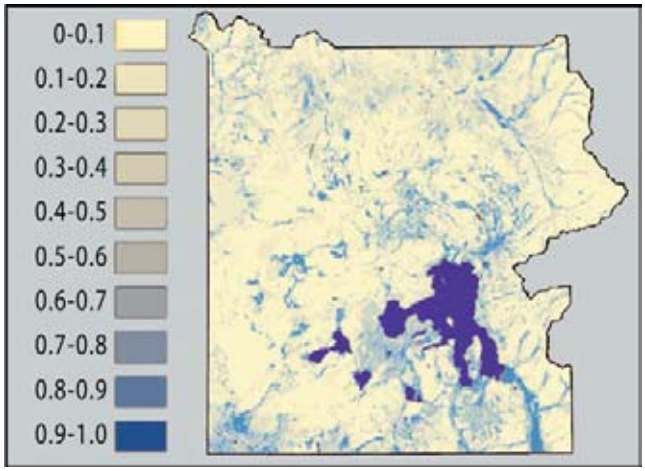


Figure 5-25: Predictive models help biologists locate potential amphibian habitats and assist land managers with making decisions about habitat conservation. The example above shows the probability of wetland occurrence in Yellowstone National Park for 1993.

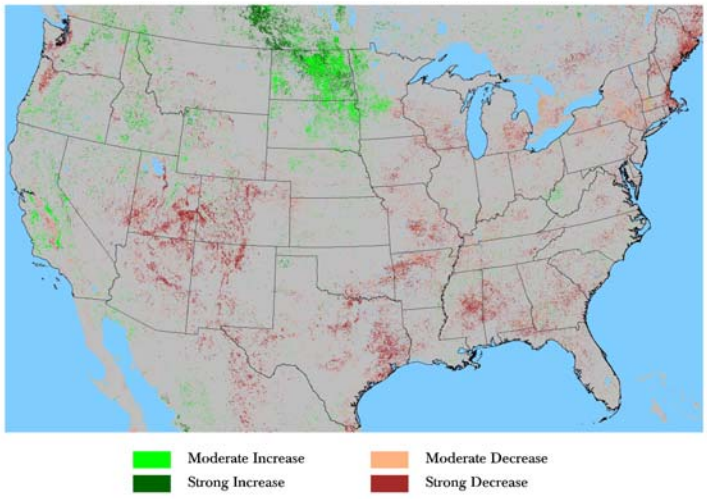


Figure 5-26: Seasonally integrated normalized difference vegetation index (NVDI) trends, 1989 - 2000, in Central North America.

The use of satellite imagery provides a unique vantage point for observing seasonal dynamics of the landscape. The USGS has developed a dataset of seasonal metrics derived from the multi-temporal 1-km resolution AVHRR satellite sensor normalized difference vegetation index (NDVI) observations for the conterminous United States. By analyzing the time-series vegetation index computed from the AVHRR data, phenologic metrics are derived, such as onset, end and duration of growing season. The datasets summarize the timing of important seasonal vegetation phenomena (Figure 5-26) and may be used as indicators of global change. These datasets will be available from *The National Map* portal in Stage I. Organizations such as the National Drought Mitigation Center will integrate these metrics and climate-based drought indicators to provide a timely and spatially detailed drought monitoring product near the end of Stage II of *The National Map* implementation. Similarly, collaboration with the U.S. Forest Service utilizes the phenological metrics and real-time measurements of the vegetation index and weather data to compute fire potential (Figure 5-27). These national scale maps will be integrated with *The National Map* for two purposes first, to take advantage of the availability of the framework themes to augment the utility of the maps for research and operational activities and second, to take advantage of the technology to serve map information and data to the user.

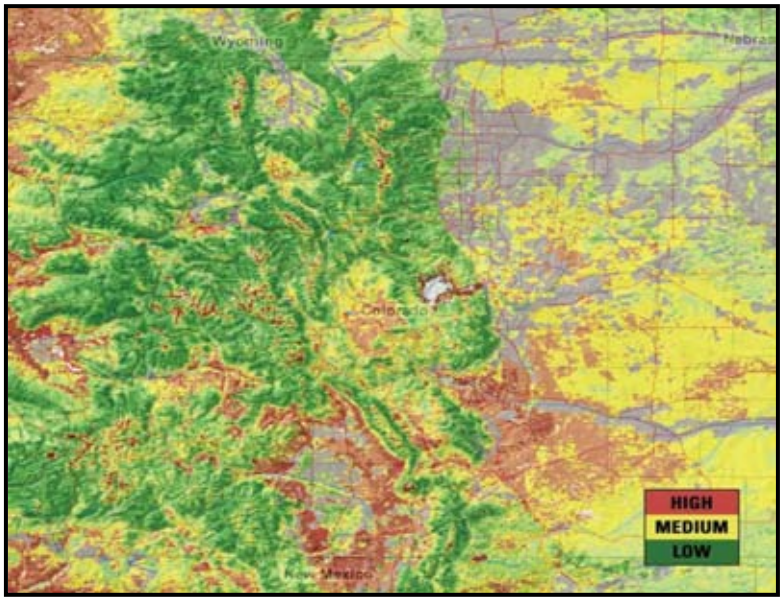


Figure 5-27: Fire potential hazard over some of the Rocky Mountain States.

Status and Trends and *The National Map*

A long-term goal of *The National Map* and Geography's Geographic Analysis and Monitoring Program (GAM) is to measure and report on the status and trends of the Nation's land resources. The mapping and monitoring of land surface change forms the core of status and trends science.

Current geographic research is focused on the development of inventory and monitoring techniques and statistical methods for national assessment and synthesis of rates, trends, causes, and consequences of contemporary land surface change. *The National Map's* first national assessment of status and trends report will be published in FY 2006 and will synthesize results from studies conducted by regional and sector teams that assess how the Nation's land surface is changing. A national assessment report is planned for release every 5 years.

In Stage II, the geospatial synthesis of this national assessment will be available through *The National Map* portal. In addition, starting in FY 2004 and continuing each subsequent year, a series of topical reports will be prepared that directly link to the 5-year status and trends theme. The reports will be on the following geographic analysis topics:

- *The Geographic Face of the Nation* (a summary of peer-reviewed articles on the geography of the United States interpreted form land cover data)
- *Land Cover Trends* (peer-reviewed articles discussing contemporary land cover change in selected ecoregions)
- *Fire Science* (peer-reviewed articles illustrating how remote sensing is used to monitor fire dangers and assess fire effects)
- *Urban Dynamics* (peer-reviewed articles reviewing changes and mechanisms contributing to change in urban areas)
- *Policy and Economics* (articles on policy, economics and decision-support science linked to geographic analysis)

Long-Term Status and Trends Objectives

- Conduct long-term monitoring of the state and trends of the Earth's land surface as critical input for regional and national policy decisionmaking.
- Analyze and interpret the record of land use dynamics that includes land use and land cover change to enhance understanding of the physical and social drivers of land surface change.
- Analyze, model, and predict the consequences of historical and projected land surface changes on ecosystem health, taking into account natural and human-induced stimuli at regional scales.

5.6.2 Remote-Sensing Applications and Development

Remote-Sensing Applications Objective

- Demonstrate the applicability of remotely sensed data to *The National Map* through fundamental sensor research, applications development, and technology transfer.

The USGS has an ongoing program of remote-sensing research and development to identify the airborne and satellite sensors and data for the real-time monitoring requirement of *The National Map*. Applications of remote-sensing technologies are advancing at an ever-increasing rate as new sensor platforms come online, user awareness of the systems' capabilities increases, and the costs associated with processing capacity continue to fall. New sensor technology is expected to provide data at unprecedented rates, with continually improving spatial and spectral resolution. The remote-sensing research and data utilization component includes fundamental sensor

research that focuses on practical objectives designed to demonstrate the applicability of remotely sensed data to the solution of real science problems. The Geography Discipline sponsors research through direct support of USGS scientists and collaboration with scientists from the USGS and other Federal agencies, as well as grants to academic researchers.

Remote Sensing Applications Accomplishments

- Creation of an operational calibration laboratory for airborne digital camera systems
- Development of a scientific instrument farm on the USGS EROS Data Center campus, in Sioux Falls, S.D., to provide objective data for calibration of sensor systems, validation of remote-sensing data, and characterization of the local ecosystem
- Monitoring of dynamic geologic features, such as volcanoes, in collaboration with the Geology Discipline by using interferometric synthetic aperture radar (InSAR) technology (Figure 5-28)
- Assessment of the effects of agricultural practices on human health
- Detecting and monitoring short-lived events, in particular dust storms in the Mojave Desert and sediment influx onto the reef in Hawaii
- Design and implementation of a new digital airborne imaging system based on a digital camera with 3 spectral bands capable of collecting digital images having less than a foot spatial resolution, 10 bits per band, and individual band gain control with applications for habitat mapping and monitoring
- Detection, mapping, and monitoring air quality, in collaboration with other USGS disciplines, with remote sensing in the Salton Sea and Mojave Desert region with a potential of mapping air quality in urban areas

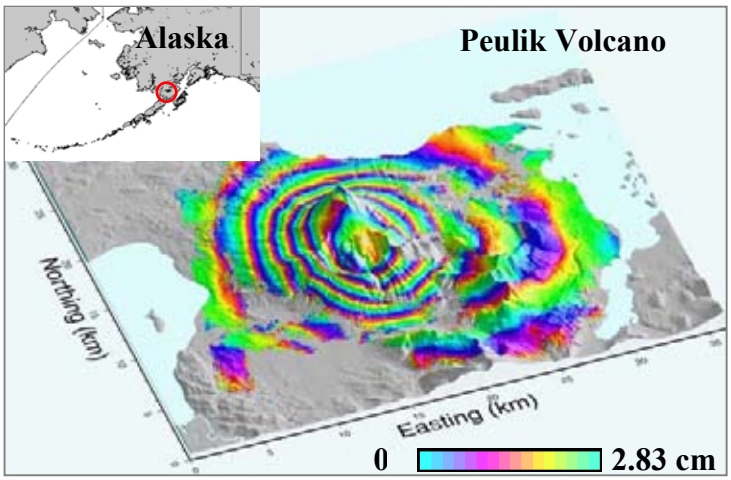


Figure 5-28: Interferometric synthetic aperture radar (InSAR) satellite technology reveals inflation at Mount Peulik volcano, Alaska, between October 1996 and September 1998. From Zhong Lu and others, 2002, Journal of Geophysical Research, v. B107, no. 7.

5.6.3 Cartographic Research

Cartographic Research Objectives

- Enhance the capability to use, deliver, and integrate geospatial data through research and applications in cartographic sciences.

The National Map will require research investments in several areas involving representation of geographic data to support a wide variety of applications. Basic research in multidimensional models covering spatial, temporal, and classification space will provide a foundation. Representation and propagation of uncertainty will be critical due to the variety of source data

that will be utilized. Research in data integration, data fusion, and data normalization will be required to achieve the nationally consistent look, feel, and behavior being sought. Generalization of geospatial data content, level of detail, and presentation level for creation of specific digital datasets with a specified level of content and for specific output products in cartographic form in both digital softcopy and printed hardcopy forms is a major research requirement for *The National Map.*

Cartographic Research Strategies

General investigation of cartographic needs for *The National Map* has begun with basic problems of integrating various datasets from different models and scales of source material. The long-term strategy is to build a comprehensive system that allows integration of geospatial data from USGS partners and supports output generation to user-defined specifications. The implementation of this strategy requires significant investment in basic and applied research in geographic information science. Drawing from the University Consortium for Geographic Information Science's (UCGIS, http://www.ucgis.org) research agenda, the Geography Discipline's strategy is organized into near-term and long-term challenges focusing on the following topics.

Two-Year Geographic Research Plan Topics

- Spatial data acquisition and integration
- Automated generation of cartographic representations
- Data integration
- Spatial clusters
- Institutional geographic information system (GIS) and geographic information partnering
- Creating products in a distributed Web-service environment
- Data and database synchronization
- Semantic mapping
- Space and space/time analysis and modeling
- Uncertainty in geographic information and modeling methods
- Visualization
- Gradation and representation of indeterminate boundaries
- Geographic data mining and validation
- Web-service-based modeling
- Geographic information security

Long-Term Geographic Research Plan Topics

- Spatial ontologies
- Spatial cognition
- Location-based services
- Pervasive computing
- Dynamic modeling
- Model bases

Geographic Research Accomplishments

Specific research examining both data integration and standards to support integration is being supported by the Geography discipline. The data integration research is being implemented with empirical testing of actual datasets using the urban areas of St. Louis and Atlanta and five specific data layers: digital orthographic imagery from the Urban Areas Partnership Project, transportation, hydrography, land cover, and elevation. The analysis process is using a combination of interactive and automated techniques to establish completely integrated data for the two urban areas. Among the accomplishments are automatic ground control point location (developed at the University of Southern California and contracted to the USGS) between transportation and orthographic images, and transformation and fusion of the datasets. In addition to the empirical work, a theoretical base is being developed using cartographic theory such as Topfer's Radical Law.

Another area of investigation is standards for data integration within *The National Map*. What level of standardization is appropriate? Standards vary according to the different features in a geospatial dataset. Transportation will require different standards than hydrography. The Geography discipline's standards effort is being conducted in coordination with other organizations that set cartographic and geospatial data standards including the FGDC and the OpenGIS Consortium. Ultimately, the objective is to be able to use the standards as a base and examine the metadata of a particular dataset to determine if it is compliant with the requirements of *The National Map* and can be integrated with other datasets.

5.6.4 Geographic Information Science

Geographic Information Science Objective

- Provide expertise and knowledge in simulation, modeling, numerical computation, and visualization techniques that enable cutting-edge modeling and support decisionmakers.

Geographic information science is the study of natural systems through the use of computer modeling and the development of tools and techniques that facilitate that analysis and the visualization of those analyses. A January 2003 report entitled *Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure* stated the effects of the computing sciences on the future of the scientific method. An abbreviated list of these effects on *The National Map* follows:

- The classic two approaches to scientific research, theoretical/analytical and experimental/observational, have been extended to computer simulation and modeling to explore new possibilities and to achieve new precision.
- The enormous speedups of computers and networks have enabled simulations of very complex systems and phenomena, as well as visualization of the results from many perspectives.
- Advanced computing is no longer restricted to a few research groups in a few fields, such as weather prediction and high-energy physics, but pervades scientific and engineering research, including the biological, chemical, social, and environmental sciences, medicine, and nanotechnology.

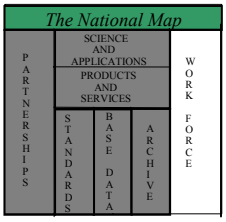
- Crucial data collections in the social, biological, and physical sciences are now online and remotely accessible – modern genome research would be impossible without such databases, and soon astronomical research will be similarly redefined through the National Virtual Observatory.
- Groups collaborate across institutions and time zones, sharing data, complementary expertise, ideas, and access to special facilities without travel.
- Researchers can combine raw data and new models from many sources and utilize the most up-to-date tools to analyze, visualize, and simulate complex interrelations.
- Researchers can collect and make widely available vast amounts of information (the outputs of all major observatories and astronomical satellites, satellite and land-based weather data, three-dimensional images of anthropologically important objects), leading to a qualitative change in the way research is done and the type of science that results.
- Researchers can work across traditional disciplinary boundaries: environmental scientists will take advantage of climate models, physicists will make direct use of astronomical observations, social scientists will analyze interactive behavior of scientists as well as others.
- New computer systems can simulate more complex and exciting systems (cells and organisms rather than proteins and DNA; the entire Earth system rather than air, water, land, and snow independently).
- Researchers can visualize the results of complex datasets in new and exciting ways and create techniques for understanding and acting on these observations.
- Researchers can work routinely with colleagues at distant institutions, even ones that are not traditionally considered research universities, and with junior scientists and students as genuine peers, despite differences in age, experience, race, or physical limitations.

Geographic Information Science Objective Accomplishments

- Increased knowledge of high-performance computing via a Geography discipline-wide research projection on Beowulf clustering. Members of this project performed research into low-cost computing technologies and applied them to current computational problems in the USGS. As a result, the discipline's scientists have increased understanding of the performance and implementation of computer-intensive models and large-image processing problems.
- Researched the role of Internet Supercomputing, an investigation funded by the USGS Director's venture capital process.
- Performed research in extending concepts learned in the Beowulf clustering project to the desktop – extending computational concepts to the office network.
- Investigated low-cost three-dimensional (3D) data visualization hardware and software (the Geowall) in partnership with the University of Illinois, Chicago's Electronic Visualization Lab (EVL), the University of Minnesota, and others.
- Investigated low-cost, tiled display technologies with the EVL.
- EROS Data Center information science researchers became partners on the NSF-funded OptiPuter project.
- Investigated the use of hand-held computers in a field environment, bringing computational resources into the field.
- Researched the visualization of time-series data utilizing multimedia (movie) techniques.

- Studied new image-data compression techniques in a high-performance computing environment.
- Began modeling of hyperspectral spaces (higher dimensionality studies).
- Investigated edge detection and vectorization techniques for automated feature extraction. Also examined techniques to improve algorithms such as the Hough Transform to draw reference lines between valid endpoints.

5.7 Workforce



Goal: Ensure that the skills of the workforce are appropriate to accomplish the goals of *The National Map*.

The Geography discipline is committed to a long-term plan to maintain and enhance the skills and knowledge of the USGS workforce through training, career development, and rotational assignments. Every effort will be made to ensure that the employees receive the training needed to conduct the business of the program. Likewise, whenever required, efforts will be made to train cooperators, partners, and volunteers in the skills and knowledge to successfully achieve *The National Map.*

Currently, the Geography discipline workforce has:

- Many employees with expertise in manual and digital map production, located primarily in 5 field centers.
- A few employees with expertise in data integration and data management activities.
- A growing level of expertise in geographic research, integrated science studies, and geographic data applications.
- A small core group of individuals with specific knowledge of partnership development processes

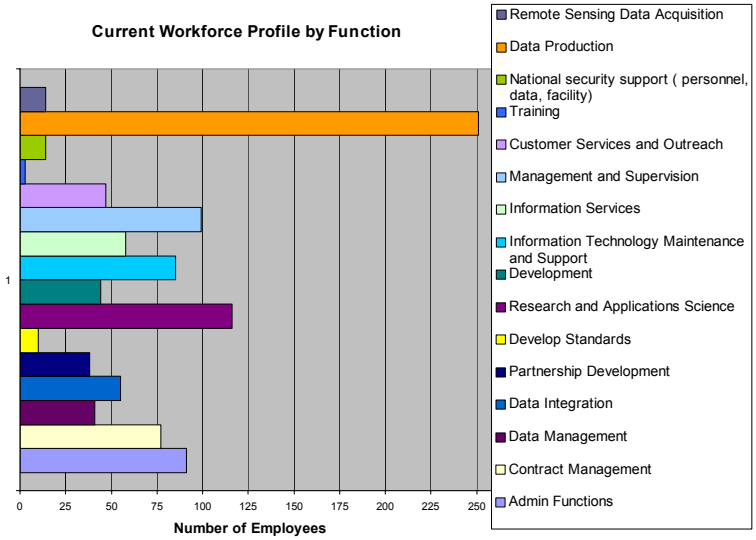


Figure 5-29: Employees in the USGS Geography Discipline by function.

5.7.1 Future Workforce Profile

In Stage II of *The National Map*, Geography Discipline employees will be located in a greater number of offices throughout the country, co-located when possible with other partners or USGS disciplines.

The workforce of the future will be much smaller than today's, and will consist of very few map production and production support employees (Figure 5-29). Data will be acquired by sharing partner datasets and (or) through contracting. Because the workforce will be smaller, there will be fewer administrative, computer support, and supervisory personnel. More employees will have technical skills related to database development, analysis and evaluation of datasets, integration of data for specific applications, and GIS analysis tools to perform science and research studies.

The number of scientists and GIS specialists devoted to geographic research and integrated studies will grow slightly but will be a much higher proportion of the future workforce.

Skills related to liaison and partnership development will be in high demand, and knowledge of formal cooperative and partnership agreement devices will be more prevalent than it is in 2003. An understanding of customer requirements and geospatial applications will be considered critical to support customer needs and ensure that *The National Map* is capable of meeting those needs. Figure 5-30 portrays the gaps and excesses between the current workforce and the workforce of the future. Negative numbers represent an excess of employees in the function. Positive numbers represent a current shortage in the function.

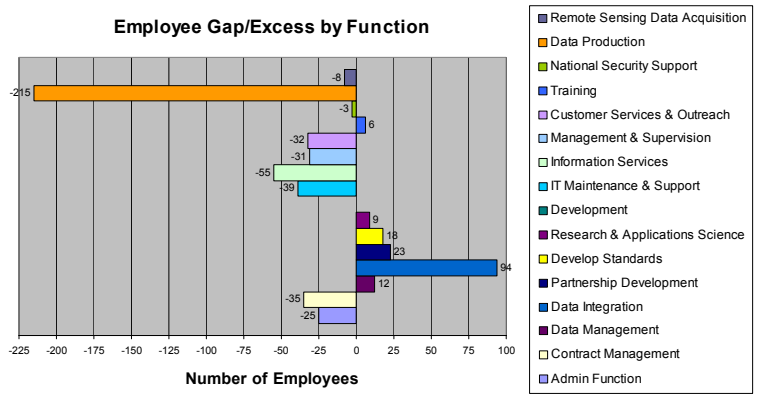


Figure 5-30: The difference between current and future employee functions in the USGS Geography Discipline. Negative numbers represent an excess of employees in the function. Positive numbers represent a current shortage in the function.

To summarize, the future workforce will:

- Be smaller
- Include very little expertise in map production processes
- Have many employees with expertise in data integration and data management
- Understand and use a broad range of options to develop formal partnerships
- Have a cadre of scientists recognized for their contributions to geographic and integrated earth science research
- Be distributed in more locations across the Nation

5.7.2 Workforce Strategy for FY 2004

The most difficult aspects of building the workforce of the future are the need to downsize the current workforce and to distribute people into more, but smaller, field offices. This problem is exacerbated by the shortage of funding. If the discipline funding level remains level or decreases, or if external drivers influence the amount of work that must be contracted, then the discipline will not be able to continue its downsizing through attrition alone.

In FY 2004, the Geography discipline plans to achieve the actions listed below. Mangers estimate that these actions will not accomplish all of the workforce goals to the extent needed. It is anticipated that further adjustments to the size, skills balance, and location of the workforce in FY 2004 and out-years will need to occur.

- Employees have been offered the opportunity to relocate voluntarily to specific distributed office sites. A few employees have accepted the offer and are in the process of moving. This number, however, falls far short of the future goal.
- The USGS has submitted a request for authority to offer Voluntary Separation Incentive Pay (VSIP) and Voluntary Early Retirement Authority (VERA) to qualified employees. The plan proposes an application period beginning Oct. 1, 2003, and ending Jan. 3, 2004. All employees requesting the VSIP or VERA will be required to retire or resign before the end of the application period. Only employees performing work in functions designated for reduction, such as map production, production support, management, administration, and hardcopy map delivery will be offered the VSIP.
- A skills assessment inventory of all Geography discipline employees is being conducted. This information will be used to develop training strategies, and conduct training targeted to specific skills and functions. The ability to formulate a strategy based on skills assessment data will ensure that training programs are expedient and will allow the discipline to develop efficient funding strategies.
- With the budget flexibility gained with VSIP authority, a recruitment strategy will be developed to plan limited hiring for critical core skills related to data integration and geographic research. The strategy will also develop methods to make more use of student hiring programs to develop career tracks while employees are finishing their education.
- Existing qualified employees will be given the opportunity to move to career ladders established under the Research Grade Evaluation Guide.
- The Geography Discipline's Western Region training program will be ported to other regions.

6 Management

Management encompasses conducting and directing the business of *The National Map*. This section outlines management aspects that apply to all elements of *The National Map*. These include Federal directives, performance management, risk management, and financial management. Management of each element of *The National Map* must be aware of these aspects and approach them in a consistent manner from planning through execution. The elements are designed in accordance with *The National Map* Implementation Plan, which is one part of a broader planning environment.

6.1 Federal Directives

Existing Federal directives affect the planning, implementation, and execution of *The National Map*. Management of each element of *The National Map* adheres to and implements one or more of these directives. Of special interest are the Freedom of Information Act , the Rehabilitation Act, the National Archives and Records Administration, The Office of Management and Budget (OMB) Circular A-16, OMB Circular A-119, OMB Circular A-130, and the Federal Enterprise Architecture (FEA).

6.1.1 Freedom of Information Act (FOIA)

The National Map follows the USGS policy regarding the FOIA by making its records available to the public to the greatest extent possible in accordance with the provisions and spirit of the FOIA, 5 U.S.C. 552. The FOIA, as amended, is based on the principle of openness in government and generally provides that any person has a right, enforceable in court, of access to Federal agency records, except to the extent that such records (or portions thereof) are protected from disclosure by one of nine exemptions or by one of three special law enforcement record exclusions.

According to the USGS Manual, “record" means all films, books, papers, maps, photographs or other documentary materials, regardless of physical form or characteristics, made or received by the USGS pursuant to Federal law or in connection with the transaction of public business and preserved by the USGS as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the USGS, or because of the information value of data contained therein.

6.1.2 Rehabilitation Act

The USGS is committed to providing access and is making every possible effort to ensure that all electronic and information technology developed, procured, maintained, or used by the USGS is accessible to people with disabilities, including both employees and the customers served, as required by the Rehabilitation Act of 1973, Amendments of 1998, Section 508.

The Geography discipline adheres to the USGS plan to integrate the evolving requirements of Section 508 into the business processes of *The National Map*.

6.1.3 National Archives and Records Administration (NARA)

NARA is authorized to inspect the records management practices of Federal agencies for the purpose of "rendering recommendations for the improvement of records management practices and programs" (44 U.S.C. 2906).

The Geography discipline's ever-increasing information dissemination responsibilities necessitate a strong commitment to the management of the information, often over long-time periods. The Geography discipline must manage large volumes of information concerning the global environment to answer critical questions.

6.1.4 E-Government

In 2001, President Bush initiated several government reform efforts, collectively known as the President's Management Agenda (PMA), to make the Federal Government more results oriented, efficient, and citizen centered. One element of the PMA is Expanding Electronic Government. It includes detailed information about the initial set of 24 cross-agency e-government initiatives, one of which is Geospatial One-Stop, and other related efforts, such as the FEA.

6.1.5 E-Government Act of 2002 (P.L.107-347)

OMB summarized the E-Government Act of 2002.
The act --

- Codifies and expands the e-government leadership role of OMB through the establishment of an Office of E-Government and Information Technology headed by a presidentially appointed administrator
- Authorizes several initiatives (E-Rulemaking, Geospatial One-Stop, E-Records Management, E-Authentication and Disaster Management) and endorses the FirstGov.gov portal
- Sponsors ongoing dialog with State, local, and tribal governments, as well as the general public, the private, and nonprofit sectors to find innovative ways to use information technology to improve the delivery of government information and services
- Establishes an E-Government Fund, administered by General Services Administration, to support IT projects approved by OMB that enable the Government to conduct activities electronically
- Authorizes funding through FY 2007

6.1.6 OMB Circular A-16

OMB Circular A-16 provides direction for Federal agencies that produce, maintain, or use spatial data either directly or indirectly in the fulfillment of their mission. It establishes a coordinated approach to electronically develop the National Spatial Data Infrastructure (NSDI) and establishes the Federal Geographic Data Committee (FGDC).

The Geography discipline follows FDGC standards for metadata. *The National Map* will be compliant with standards and practices developed through the Geospatial One-Stop initiative in

support of e-government. The Geography discipline actively participates in FGDC activities and is the lead agency for the following framework themes: elevation, digital orthoimagery, and hydrography. It also is the lead agency for the earth cover and geographic names NSDI themes.

6.1.7 OMB Circular A-119

OMB Circular A-119 establishes policies on Federal use and development of voluntary consensus standards and on conformity assessment activities. Public Law 104-113, the "National Technology Transfer and Advancement Act of 1995" codified existing policies in A-119, established reporting requirements, and authorized the National Institute of Standards and Technology (NIST) to coordinate conformity assessment activities of the agencies.

The Geography discipline participates in the development of voluntary consensus standards, such as those developed by the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO), and uses these standards as fully as possible.

6.1.8 OMB Circular A-130

OMB Circular A-130 establishes policy for the management of Federal information resources. It references relevant acts to provide guidance in records management, electronic information dissemination, information protection and security, management of information systems and information technology, enterprise architecture, and capital planning and investment control that links mission needs, information, and information technology.

The Geography discipline strives to pursue best practices in these areas and complies with Federal, Department of the Interior, and the USGS policies through ongoing and incremental improvements. This compliance includes preparation of the Exhibit 300, the Program Assessment Rating Tool (PART), and certification and accreditation of *The National Map* computer systems.

6.1.9 Federal Enterprise Architecture (FEA)

The Geography Discipline subarchitecture in support of *The National Map* is part of the USGS architecture that in turn is part of the Department of the Interior (DOI) architecture that ultimately fits into the FEA. The Clinger-Cohen Act of 1996 established the requirement for the FEA to maximize the benefits of information technology for the U.S. Government.

The Office of Management and Budget (OMB) places budgetary emphasis on an organization's enterprise architecture, and the Geography Discipline's Associate Director identified the architecture as one of the four foundation pieces to ensure the success of *The National Map*.

The Geography discipline's subarchitecture provides a framework for organizing and implementing *The National Map* through a logical progression of aligning programs with the vision for the future. The subarchitecture helps establish work dependencies, helps component developers see how they fit into the whole, and helps potential partners see how they can participate.

Because the Geography discipline's subarchitecture began before the DOI and the USGS architectures were mature, the initial team captured the information in a way to make revision easier. Both the DOI and the USGS have efforts underway to develop department and bureau architectures in support of the FEA. The Geography discipline's teams that continue the architecture efforts will revise the subarchitecture so that it is consistent with the higher level architectures as they evolve as well as add more detail.

Five reference models (Business, Performance, Data, Application-Capability, and Technical) of the FEA provide that detail. The Performance Reference Model (PRM), shown in Figure 6-1, identifies a common set of general performance outcomes and metrics that agencies use to achieve much broader program goals and objectives. The PRM will be designed to integrate with and complement OMB's development of the Program Assessment Rating Tool (PART) and Common Measures Initiative.

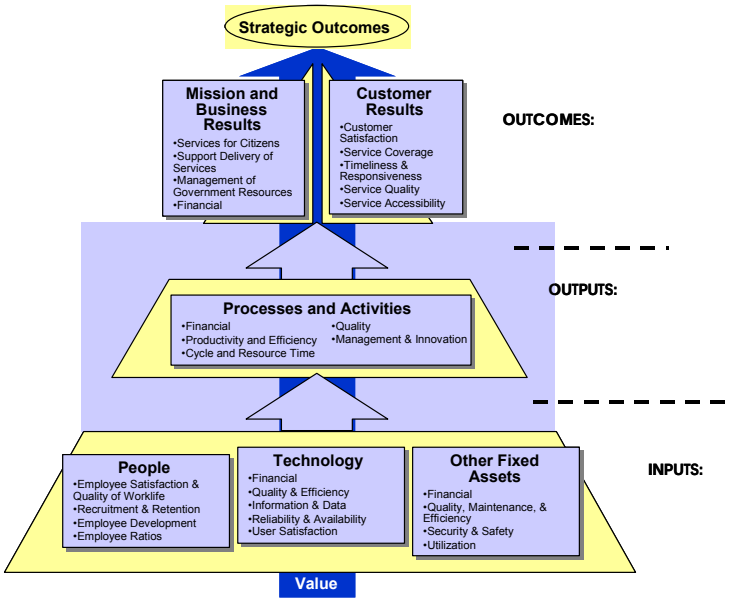


Figure 6-1: Federal Enterprise Business Architecture (source FEAPMO)

6.2 Relationship to Other Planning Efforts

Many existing documents and practices make up the planning process, as shown in Figure 6-2. Each document or information source serves a specific purpose and cannot be replaced by other documents or information sources or eliminated without changing bureau, Department, and Federal planning processes. It is important that the information in one planning document is consistent with the information in another planning document or information source. More detail is provided about the DOI Strategic Plan, the USGS Strategic Plan, the 5-year program plans, and the annual program plans in the following sections.

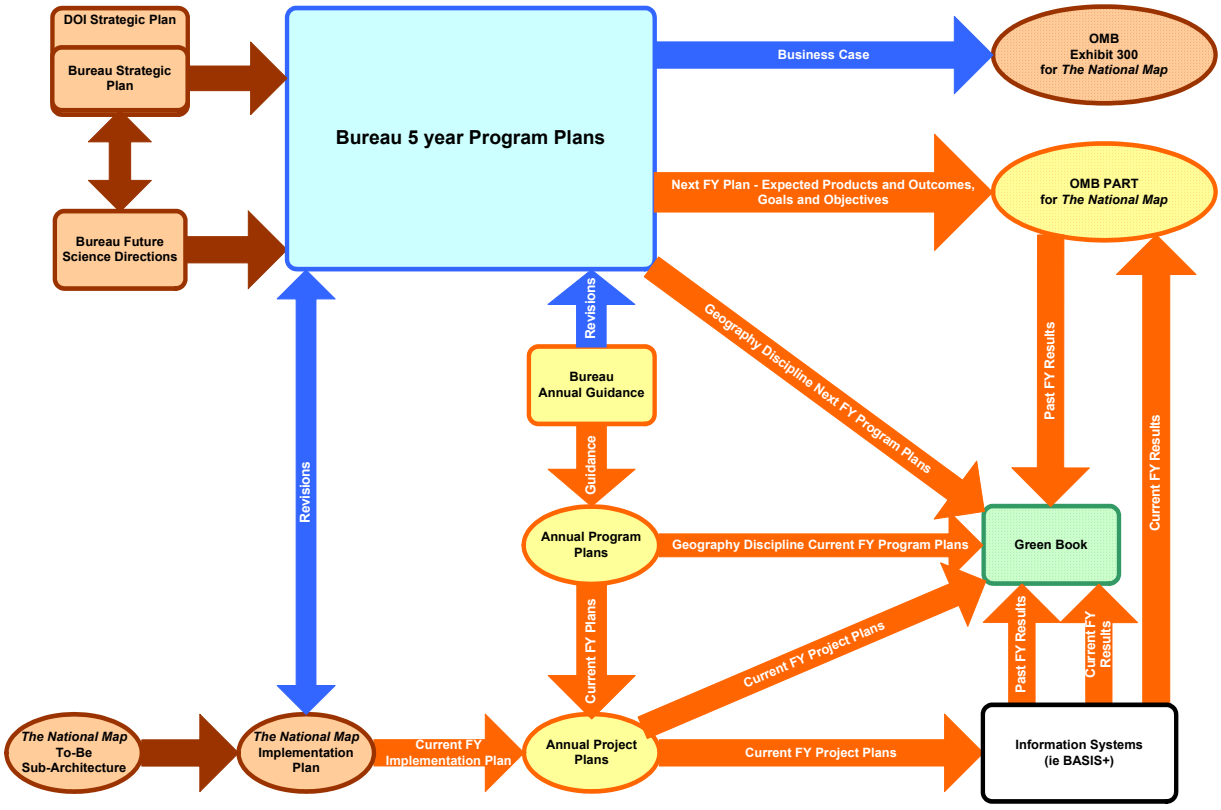


Figure 6-2: The planning process for *The National Map*.

6.2.1 DOI Strategic Plan

The Department of the Interior's Strategic Plan revolves around four major mission goal areas: Resource Protection, Resource Use, Recreation, and Serving Communities. The framework of the Strategic Plan consists of these four core missions, intermediate and end outcome goals, and performance measures to demonstrate success at accomplishing the mission.

The USGS Geography discipline is focused on Serving Communities. As discussed in the Introduction of the document, geographic science and products are ultimately focused on helping inform decisionmaking by land managers, the public, and others.

In particular, geographic science serves the strategic goal of advancing knowledge through scientific leadership and informing decisions through the application of science. *The National Map* will be the key mechanism for the USGS to continue to advance with the changing geographic, communications, and information technologies to provide the latest tools to understand and communicate geographic information.

Many key performance measures from the Department of the Interior Strategic Plan will be tracked, including the following:

- The end outcome of sound methodology, accuracy, and reliability of science for research activities will be measured by the percentage of science that is validated through appropriate peer review.
- For the intermediate outcome of expanding the scientific knowledge base, the USGS will track the average percent of U.S. land coverage for *The National Map* layers.
- Output measures include the number of long-term data collections and large data infrastructures maintained and the number of new partner nodes established for *The National Map*, where a node represents a partner serving data.
- For the intermediate outcome of leading and facilitating exchange and use of knowledge, the USGS will track the number of formal workshops and training sessions provided to customers, the number of informal conference outreach exhibits, and the number of new NSDI partnership agreements, all as output measures.
- For the intermediate outcome of expanding the scientific knowledge base, the USGS will track intermediate outcome measures related to content and expansion of knowledge base for Landsat 7, including the data capture success rate, the percentage of data available from the archive within 24 hours of capture, and the percentage of data sent to customers within 24 hours of payment.
- Output measures include the number of long-term data collections and the number of new partner nodes (States that are receiving data) established under AmericaView.
- For the intermediate outcome of enhancing the quality and objectivity of science and leading and facilitating exchange and use of knowledge, the USGS will track outputs including the number of systematic analyses and investigations delivered to customers (publications), the number of new decision-support systems, and the number of formal workshops and training sessions provided to customers. The output measure of percentage of science validated through appropriate peer review also applies to this outcome.
- For the intermediate outcome of enhancing the quality and objectivity of DOI science and leading and facilitating the exchange and use of knowledge, the USGS tracks intermediate outcome measures for exchange of knowledge (number of requests to the GAM Program from outside for science), and output measures including the number of systematic analyses and investigations (publications) delivered to customers, the number of new decision-support systems, and the number of formal workshops or training sessions held.

6.2.2 USGS Strategic Plan

The USGS Strategic Plan guides all bureau planning. The plan serves as the basis for other long-range planning efforts, such as the Future Science Directions, and lays out a broad strategic direction to:

"Combine and enhance USGS's diverse programs, capabilities, and talents, and increase customer involvement to strengthen our scientific leadership and our contribution to the resolution of complex issues." – the *U.S. Geological Survey Strategic Plan 1999-2009*

Strategic Plan goals are advanced in science planning at all levels. For example, the Program Strategic Goal emphasizes the development of predictive tools for scenario building and decisionmaking about natural systems and enhanced real-time hazards information delivery. In another example, the Customer Strategic Goal requires the USGS to actively engage partners, cooperators, and coalitions in science and to develop new products and services that are responsive to and reflective of customer needs. The development of new tools for efficient data integration and access also is a long-term goal. Finally, measures of success are a key feature of the USGS Strategic Plan, and it is expected that all USGS planning efforts align with a performance measurement ethic.

6.2.3 5-Year Program Plans

The bureau 5-year program plans are at the heart of the bureau planning model and provide the basis for annual decisionmaking. In the Geography discipline, there are 5-year plans for each of the three programs: Cooperative Topographic Mapping (CTM), Land Remote Sensing (LRS), and Geographic Analysis and Monitoring (GAM). These plans support the USGS Strategic Plan and articulate, at a minimum, program goals, priorities, outcomes, measures of success, and products over a 5-year period. Customers, cooperators, and partners play a key role in providing input on science needs, emerging issues, and priorities to incorporate into the plans: these participants also provide external review of the plans. Through the Program Coordinators (PCs), the Associate Directors (ADs) lead the development and revision of 5-year program plans and are responsible for understanding and responding to the goals, priorities, and expectations of all regions and all disciplines.

6.2.4 Annual Program Plans

Each project develops an annual project plan. These plans are available in the common business practices system that supports budget and planning (BASIS+).

Annual project planning is the process by which the USGS defines its scientific and operational activities for the coming year. Annual planning begins with the Director's annual guidance statement.

Annual project planning and decisions are based on the objectives and outcomes stated in the 5-year program plans and the Director's annual guidance. Annual planning should be flexible and respond to directives from the Administration and the Congress, budgetary constraints, and

short-term or rapidly emerging issues. It also must provide for integrative project planning and joint goal setting.

6.3 Risk

The implementation of *The National Map* is a great opportunity to provide a wealth of geospatial information and services to the vast number of users across the Nation. This opportunity comes with significant challenges, as would be expected of any effort of this magnitude. Each challenge poses certain risks that may impede success in terms of cost, resource utilization, timeliness, or goal attainment. The risk management process used will allow managers to balance the implementation and economic costs of selected risk mitigation actions to ensure that the agency mission is achieved. Risk assessment will include the identification and evaluation of risks, effects on objectives if vulnerabilities are exploited, and recommendation of alternative options. Risk mitigation will include prioritizing, implementing, and maintaining risk mitigation actions recommended from the risk assessment process. Results of mitigation actions will be evaluated for effectiveness, and alternative actions will be planned as needed.

A full risk management plan will be developed as part of a formal structured system development process. An initial Risk Inventory and Assessment was included in the 2002 Exhibit 300 for *The National Map*.

6.4 Financial Management

Managing finances encompasses the management and administration of the Geography discipline's monetary resources under prescribed policy and guidelines, including budget planning and execution, accounts receivable and payable, cost recovery, and funding procurement. The Geography discipline follows the common business practices of the USGS and Federal regulations, which specify most of the processes used to manage finances. The processes that are within the scope of *The National Map* tend to be interfaces with the systems and processes that support the common business practices of the USGS.

Financial process may be documented in the form of transmittal of regulations or guidance in financial and budget planning. Financial activities (other than chain-of-command direction) may flow between and among all offices as necessary to ensure the coordination and accomplishment of financial activities, perform internal audits, and establish common procedures.

Appendix A. Acronyms and Initialisms

ACAN	Advisory Committee on Antarctic Names
AD	Associate Director
AGDC	Alaska Geospatial Data Committee
ANSI	American National Standards Institute
API	application programming interface
ARMI	Amphibian Research and Monitoring Initiative
ASTER	Advanced Spaceborne Thermal Emission and Reflection
AVHRR	Advanced Very High Resolution Radiometer
BAA	Broad Agency Announcement
BLM	Bureau of Land Management
BMT	Business Modeling Team
CIO	chief information officer
COTS	commercial off-the-shelf
CRADA	Cooperative Research and Development Agreement
CTM	Cooperative Topographic Mapping
CUES	Comprehensive Urban Ecosystem Studies
DEM	digital elevation model
DHS	Department of Homeland Security
DLG	digital line graph
DOI	Department of the Interior
DOQ	digital orthophotoquadrangle
DRG	digital raster graphic
DTs	design teams
EDC	EROS Data Center
EPA	Environmental Protection Agency
ERG	Eastern Region Geography
ESRI	Environmental Systems Research Institute
ETM+	Enhanced Thematic Mapper
EVL	Electronic Visualization Lab, Chicago
FEA	Federal Enterprise Architecture
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FOIA	Freedom of Information Act
FY	Fiscal Year
GAM	Geographic Analysis and Monitoring
GB	gigabytes
GDA	Geospatial Data Architecture
GEON	GEOsciences Network
GIS	Geographic Information System
GNIS	Geographic Names Information System
GOS	Geospatial One-Stop
GSS	Geography Senior Staff

HSIP	Homeland Security Infrastructure Program
IEEE	Institute of Electrical and Electronic Engineers
IETF	INTERNET Engineering Task Force
IMS	Information Management System
IMTA	International Map Trade Association
INCITS	InterNational Committee for Information Technology Standards
InSAR	interferometric synthetic aperture radar
ISO	International Organization for Standardization
IT	information technology
ITU	International Telecommunication Union
JFA	Joint Funding Agreement
LDCM	Landsat Data Continuity Mission
LRS	Land Remote Sensing
MB	megabytes
MODIS	Moderate Resolution Imaging Spectroradiometer
MRLC	Multi-Resolution Land Characteristics
MSS	multispectral scanner
MTAIP	MAF/TIGER Accuracy Improvement Project
NACo	National Association of Counties
NAIP	National Agricultural Imagery Program
NARA	National Archives and Records Administration
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAWQA	National Water-Quality Assessment Program
NCAP	National Civil Applications Program
NDEP	National Digital Elevation Program
NDOP	National Digital Orthophoto Program
NDVI	Normalized Difference Vegetation Index
NED	National Elevation Dataset
NGO	nongovernmental organization
NHD	National Hydrography Dataset
NIMA	National Imagery and Mapping Agency
NIST	National Institute of Standards and Technology
NLCD	National Land Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPS	National Park Service
NRC	National Research Council
NSDI	National Spatial Data Infrastructure
NSF	National Science Foundation
NSGIC	National States Geographic Information Council
NSLRSDA	National Satellite Land Remote Sensing Data Archive
NWIS	National Water Information System
OGC	OpenGIS Consortium
OMB	Office of Management and Budget
PART	Program Assessment Rating Tool

PC	program coordinator
PIO	public interest organization
PMA	President's Management Agenda
PRM	Performance Reference Model
RAID	Redundant Array of Inexpensive Disks
RDBMS	Relational Data Base Management System
RF1	Reach File Version 1
RF3	Reach File Version 3
SDT	System Design Team
SLD	Style Layer Descriptor
SRTM	Shuttle Radar Topography Mission
TB	terabytes
TDSS	Tahoe Decision Support System
TIIMS	Tahoe Integrated Information Management System
TM	Thematic Mapper
TRPA	Tahoe Regional Planning Agency
UCGIS	University Consortium for Geographic Information Science's
UML	Unified Modeling Language™
USACE	U.S. Army Corps of Engineers
USBGN	United States Board on Geographic Names
USFS	United States Forest Service
USGS	United States Geological Survey
VERA	Voluntary Early Retirement Authority
VSIP	Voluntary Separation Incentive Pay
WCS	Web Catalog Service
WMS	Web Mapping Service
XML	Extensible Markup Language