SERDP/ESTCP/Legacy Program DoD Cultural Resources Workshop
Background Paper: Knowledge Management

Integrating GIS and GPS Technologies into Cultural Resource Management Strategies

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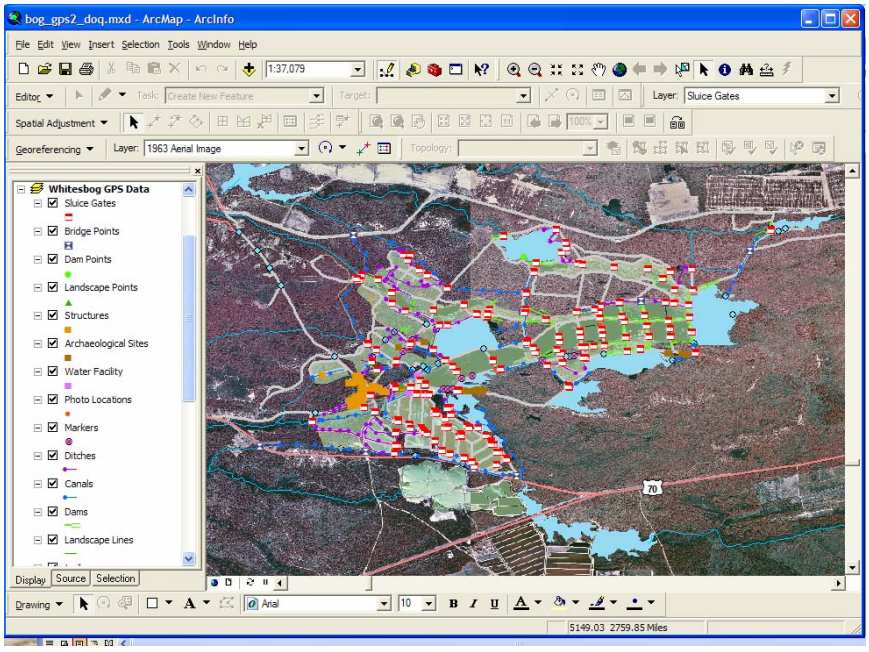
Knowledge management is a broad concept that touches on all subject matter areas, not simply cultural resources, or cultural resource management. The idea that we collect a variety of data, in a variety of formats, in an effort to help ourselves gain a better understanding of a particular subject is universal. For the cultural resource field, we collect data in the form of observations, surveys and documentation in the hope that we can use this information to better understand the context within which we manage important resources. The management of our cultural resource data helps us as historic preservationists identify patterns, examine landscapes, find connections, and understand different cultures.

As we move into the 21st century however, cultural resource specialists must explore all the tools at their disposal, including technologies such as geographic information systems (GIS) that can enhance traditional methods of gathering and interpreting data. Undeniably, technological tools provide the flexibility and power to integrate all the data, in all the formats that cultural resource managers collect, bringing new perspectives to our scholarship, our understanding, and our physical management of resources.

Throughout the field of historic preservation, accurate locational data remains a critical element in our understanding of cultural landscapes, building traditions, settlement patterns and past life ways. Using geographic clues about environmental and human influences on cultural resources can significantly aide in cultural resource management, conservation, as well as physical preservation of sites. Relying completely on our traditional survey and documentation methods, such as measured drawings, written accounts and photographs may cause us to lose sight of the larger environmental factors, resulting in the potential loss of key historical elements of our cultural landscapes.



The Technology

More than simply computerized cartography, GIS software represents real world features as individual map layers, according to feature type, such as roads,

building footprints, county boundaries or archaeological sites. These map layers are stacked on top of each other, allowing users to view all of the data geographically in relationship to each other and in relationship to the earth. Each map feature is also linked to a database containing attribute information that describes what it is, allowing users to query the data like a traditional database, or ask questions based on the geography itself.

Global positioning systems (GPS), a satellite-based navigational system, provides one way to collect accurate geographic coordinates for the various map layers inside the GIS software. GPS works by triangulating the position of a receiver on the earth using satellite signals, and can range in accuracy from approximately 20 meters to sub-centimeter detail. Together, GIS and GPS greatly improve the accuracy of cultural resource mapping, in addition to enhancing our traditional data sets, by allowing us to attach documentation to geographic locations, providing critical contextual information.

Although these two technologies have existed for many years, their primary uses have been within fields other than cultural resource management. Roger Tomlinson began developing the first GIS in the 1960s to help manage natural resources in Canada. Since this initial effort, GIS has grown exponentially into almost every industry and discipline, becoming more sophisticated with every step. In 1993, GPS reached full operational capability, primarily for use by the military, but open to the public. The use of GPS has also grown exponentially since its first limited utility, becoming a part of today's critical commercial and navigational infrastructure, with many applications.

Cultural resource specialists are now beginning to take advantage of these technologies as tools to help them in their daily work. GPS offers a clear alternative to quickly locate important resources with enhanced levels of accuracy, while GIS provides the tools to analyze data, organize data, help interpret data as well as integrate a variety of data types. GIS/GPS applications ranging from survey to documentation to predictive modeling can now be part of daily cultural resource management procedures.

Current Status of Cultural Resource GIS

Today there are over 5 million cultural resources listed on state inventories of historic structures, archaeological sites, landscapes and objects. Many state historic preservation offices (SHPOs) manage their resources through GIS, and some now require locational information collected via GPS. At the National level, each Federal land holding agency keeps its own inventory of historic resources, similar to the states, and most utilize GPS to help locate those sites. In addition, each Federal agency that undertakes a project that may adversely affect a historic property must track those resources and any mitigation effort performed in the process to comply with Section 106 of the National Historic Preservation Act.

Taken by themselves, each of these efforts to perform cultural resource management through the use of GIS and GPS technologies functions effectively within the separate states and Federal agencies. However, data produced at the state or local level should be shared with Federal agencies and vice versa for truly productive cultural resource management, and knowledge management, to take place. Further, data must be shared within the various disciplines of historic preservation, such as museum management, conservation, archaeology, architecture, etc.,

particularly at the Federal level where it remains their responsibility to fully manage cultural properties under their control, as mandated by Section 110 of the National Historic Preservation Act.

For instance, within the Cultural Resource Division of the National Park Service, approximately 15 different databases track cultural resources, landscapes, related documentation, gray literature, and museum objects. In order to better understand the context of each of the resources described in these various databases they should share data, and particularly locational information, however many of the databases have no way to relate to other fields or disciplines, and some do not require the collection of spatial data. Unfortunately, this situation is not unique to the National Park Service, to Federal agencies or even state and local entities.

If cultural resource specialists can agree that locational information remains a key factor in understanding our resources, as well as how to manage them, GIS then becomes the ultimate tool to bring all the data from all the various disciplines together, at local, state and National levels. This integration of data allows cultural resource managers to see the full context of the resources they work with, following the knowledge management flow from the data itself, to integrated information, and finally to a better understanding of the resources.

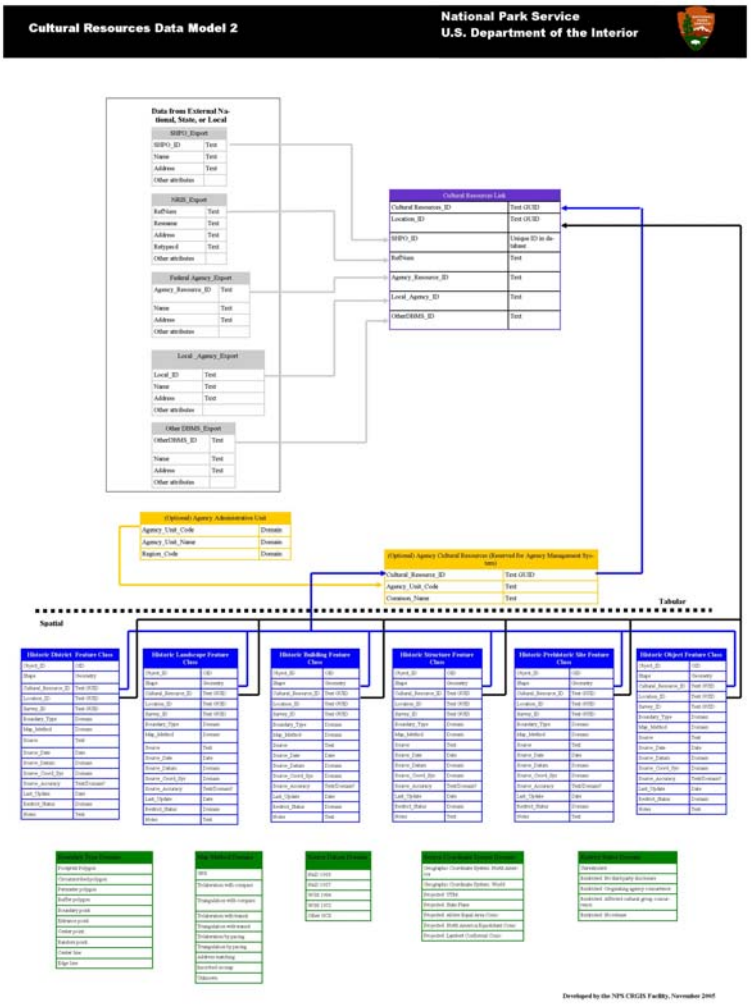
The Role of the National Park Service (NPS)

In order to take full advantage of the powerful tool GIS offers cultural resource managers however, clearly standards must define the spatial data that forms the keystone of the system, allowing data sharing and integration. OMB Circular A-16 defines the set of requirements that Federal agencies must follow when they create, manage or distribute spatial data. In 2002, OMB Circular A-16 identified the National Park Service as the lead agency for developing the cultural resource spatial dataset. Developing this dataset includes a variety of tasks, such as setting data content standards and metadata standards, monitoring progress toward converting paper inventories into digital data, coordinating cultural resource databases with spatial data, eliminating duplication of spatial data, and disseminating best practices information.

As the cultural resource spatial dataset steward under Circular A-16, the NPS must asses the existing standards, identify where there are additional needs, as well as develop and implement standards compliant with the Federal Geographic Data Committee (FGDC). These standards would then guide all Federal agencies in the collection and management of their cultural resource spatial data as they create inventories, perform Section 106/110 activities or nominate resources to the National Register of Historic Places. The standards will open the door to share cultural resource data across Federal agencies, as well as with state and local entities through GIS.

The NPS recognizes the need to establish standards for both legacy data already collected by various agencies, and data to be collected in the future. These standards should describe the collection of cultural resource spatial data, in terms of the geometry itself, the coordinate system to use and entities to create, among many other items. Standards should also describe the relationship of the spatial data to the attribute or descriptive data regarding each resource, as well as the security of any sensitive information that may be contained in either spatial or attribute information. Finally, standards should define what information is contained within the metadata for the spatial dataset as a whole, and for each resource represented within the dataset.

Focusing on the identification of existing standards, the evaluation of gaps in those standards and the development of new standards, the NPS examined the existing cultural resource databases within the Cultural Resource Division of the NPS. Based on the input of subject matter experts from all of the cultural resource disciplines represented, the NPS developed a set of guiding principles that all NPS cultural resource specialists and GIS specialists could agree on to help direct the standard creation process.



From this process, the Cultural Resource GIS Facility (CRGIS) of the NPS developed a draft set of standards describing how to create cultural resource spatial data, how to link spatial data to external databases, how to safeguard sensitive cultural resource information, and what to include in dataset as well as feature level metadata. In 2005, CRGIS began presenting these draft standards to other Federal agencies, and began soliciting existing standards from those agencies to help in the identification of gaps as well as redundancies. At the same time, CRGIS created a draft data model to describe how these draft standards could be implemented within the NPS, and potentially within other Federal agencies.

CRGIS is pursuing a Federal agency-wide workshop to review the draft standards and explore various ways to implement these standards outside the data model prepared for the NPS. This workshop would include State and Tribal Historic Preservation Officers, with the goal to develop consensus and revise the draft standards presented. Following this, CRGIS will field test the standards and begin to shepherd the draft standards through the formal FGDC standard creation process.

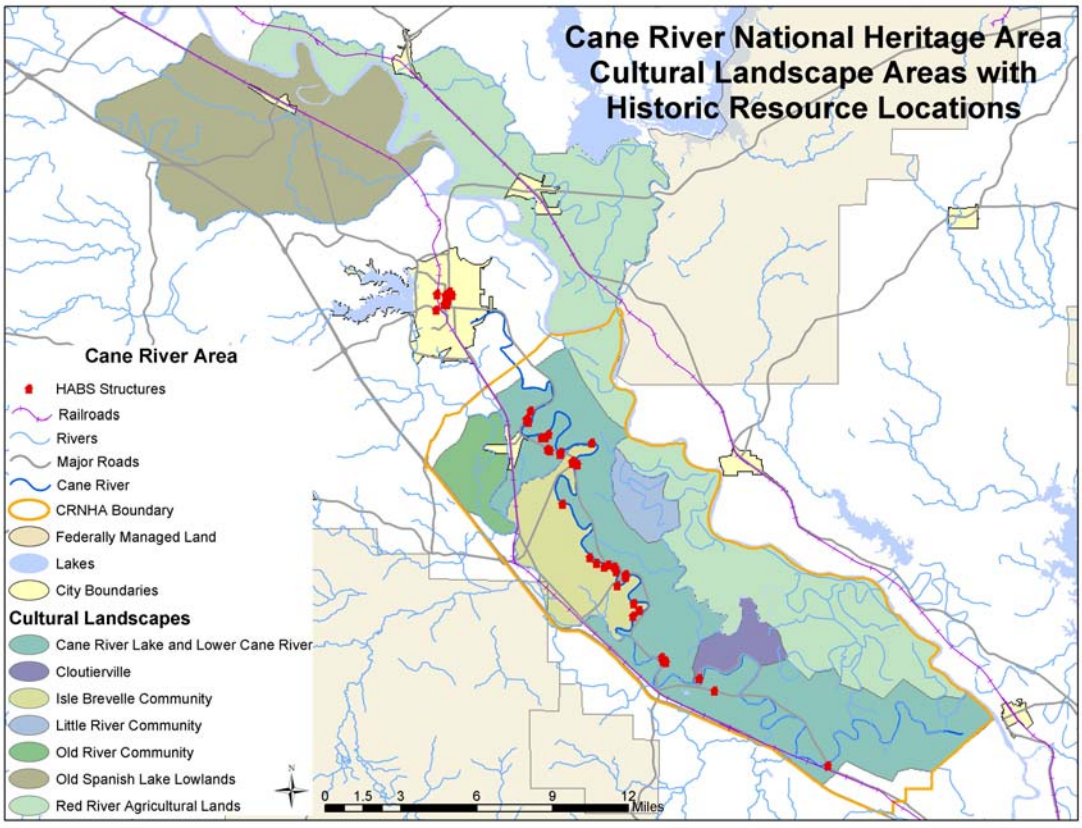
With consensus among the Federal agencies, state and local entities on the creation, development and management of cultural resource spatial data, the cultural resource management community can begin to take full advantage of the power of GIS to help integrate data sets and data types. Without such standards and consensus, individual agencies will continue to use these

technologies to meet their own goals, however the larger goal of sharing data across all boundaries to reach a better understanding of historical context will not be attainable.

Cultural Resource GIS/GPS Examples

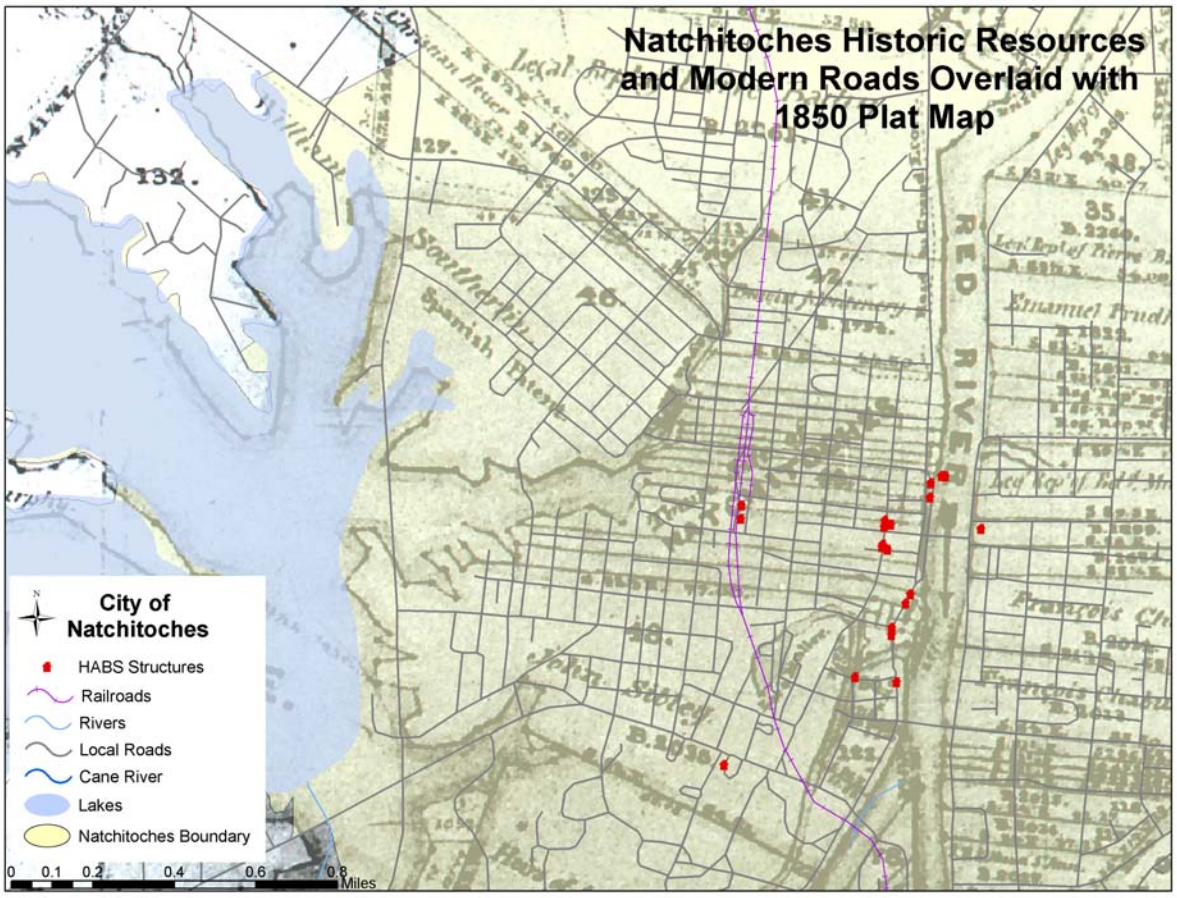
Until the cultural resource community reaches the point where firm cultural resource spatial data standards can be established, Federal, state and local agencies will continue to utilize GIS and GPS technologies to better manage their resources within the context of their own individual projects. Many examples of the use of these technologies exist to illustrate their utility in bringing all aspects of cultural resource management together.

In 2002, CRGIS began working with the Historic American Buildings Survey (HABS) to create a GIS for the Cane River National Heritage Area in Natchitoches Parish, Louisiana. For the Heritage Area Commission, GIS is a powerful tool for preservation planning, resource management and education, linking historical documentation to a complex multicultural landscape visualized through the GIS. Users can watch the landscape change over time and document the history of the heritage area through a variety of data types, such as measured drawings of structures, photographs, historic maps and data collected via GPS.



Helpful for managing such a large and complex landscape, the GIS currently shows the historic resources documented by the NPS through HABS within the context of the modern landscape, such as road networks, as well as within the historic landscape. Drawings and photographs generated by HABS documentation teams link to each resource location. Additional attribute

information allows users to query information such as construction dates, periods of significance, type of construction or cultural affiliation.



Adding other data, such as geo-referenced historic maps allows users to expand their analysis of the landscape. Overlaying current tax parcel maps with 19th century property boundaries for instance, will help the heritage area locate significant historic resources within the modern landscape and target specific areas for protection. As more information is added to the GIS, users will be able to watch the landscape change from the 18th century to the present by overlaying data layers from different time periods, from many different data sources.

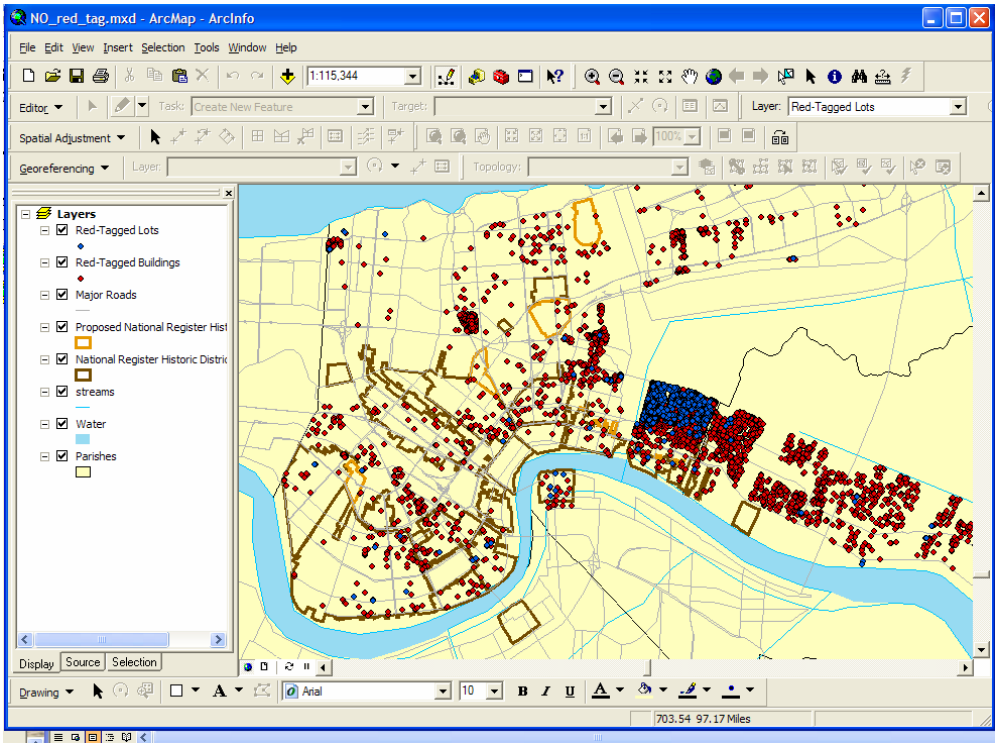
At the Cane River National Heritage Area, a diverse collection of paper documentation, in the form of historic documents, photographs, historic maps and drawings powerfully combines with data collected via GPS, as well as other data gathered for use in the GIS. In this example, the true flow of knowledge management is illustrated, moving from data elements, to data analysis, to products based on information derived from those data elements leading to new understandings of the region, cultural influences in the region, and cultural interactions with the landscape. The heritage area is now able to interpret its complex and multi-cultural history, as it relates to the entire region, for its own use and for public interpretation.

Other examples illustrate how the lack of adequate knowledge management can be mitigated by the introduction of technologies such as GIS and GPS. Hurricanes Katrina and Rita devastated

the Gulf Coast region and created the single largest disaster for cultural resources that the United States has witnessed since the inception of the National Historic Preservation Act. Many Federal agencies responded to the disaster, primarily the Federal Emergency Management Agency (FEMA). For FEMA the Katrina/Rita disaster is the largest Section 106 project ever, and managing the information, as well as the logistics associated with the recovery is critical.

FEMA asked CRGIS to create a strategy for documenting all of the cultural resources which may be adversely affected by FEMA activities, for Section 106 compliance. Using a combination of GPS and GIS, CRGIS constructed a methodology to identify and evaluate all of the affected properties in Orleans Parish, and the surrounding Parishes, in addition to providing a means for historic preservation professionals to review and determine the historic integrity or significance of each property through GIS. CRGIS took the opportunity to incorporate the draft cultural resource spatial data standards in this situation, hoping to impose some structure in the flow of data, and to allow the GIS to truly serve as a knowledge management tool, promoting the sharing of data among all the Federal, state and local government entities involved in the recovery efforts.

In order to comply with Section 106, FEMA must survey and evaluate all potential demolitions for their historic significance, consult with the SHPO to develop concurrence on significance and determine what actions to take to mitigate the adverse affects of destroying historic resources. To accomplish this, FEMA needs accurate locational information for any potential undertaking to understand the scope of the problem. In addition, FEMA needs an accurate evaluation of the historic significance and nature of the resources in question. Finally, to place any potentially historic resource into context, FEMA must have an understanding of the historic nature of the area as a whole and a clear image of the interaction of various resources which might contribute to their significance.



CRGIS developed a GPS survey strategy for the properties slated for demolition using hand-held GPS receivers with a detailed digital survey form attached to each location, recording the historic characteristics, condition, integrity and National Register eligibility of each structure. This highly accurate survey produced a form of documentation, as required by Section 106, leaving FEMA with GPS

documentation and a GIS view of the area showing how all of the resources relate.

Part of the CRGIS strategy included creating a GeoDatabase for the resources to incorporate not only potential undertakings, and their status, but structures identified as potentially eligible for the National Register for mitigation purposes. This GeoDatabase becomes part of the FEMA collection of data for the disaster as a whole, in addition to a form of mitigation itself, as it can be shared with the SHPO, other Federal agencies and local partners all working to help in the recovery efforts.

The survey of structures scheduled for demolition in Orleans Parish is now complete, although survey continues in other Parishes. The successful survey strategy and GeoDatabase implementation of the draft standards in Orleans Parish allowed the Federal and state partners to quickly and digitally form concurrence on National Register eligible properties through the GIS. The GPS documentation of cultural resources, the GIS data produced and the method of reviewing each site for Section 106 purposes is digital for the first time, and now serves as a treatment measure for the first time, providing direct links between FEMA, the SHPO and the City of New Orleans, opening communication and enhancing our understanding of the devastating affect of this disaster on cultural resources as a whole.

The Future of GIS with Cultural Resources

As documentation and data gathering tools, GIS and GPS certainly provide additional perspective and context for cultural resource specialists looking at small or large landscapes. As a communication tool however, GIS provides a critical means to make powerful, visual and quantifiable statements to the public and to organizations responsible for protecting cultural resources. It is important to keep in mind however that GIS and GPS are technological tools which cultural resource managers can take advantage of, not technologies which replace already established methods. These tools can be extremely powerful, but must rely on the underlying data, which truly shows the detail, significance and context of the resources themselves.

Like any other technology, barriers exist to hinder full implementation of their capabilities for cultural resources. Software changes will occur, data formats will change, storage media will adapt to new technologies themselves. Few solutions to these problems exist at this time, other than to insure that the cultural resource community is aware of the trends in GIS and GPS technology and that they change with the changing circumstances.

Choosing to establish cultural resource spatial data standards that focus on data creation and the documentation of that data, outside a particular platform or format helps to insure that any data produced today by cultural resource specialists will transfer from one format or media to the next more seamlessly. Establishing these standards to guide the creation of our spatial data remains the critical element for moving forward however. Without standards to define the basic building block of the GIS, no sharing of data can take place. Losing that tool and opportunity eliminates the possibility of creating a knowledge management system that will add to our overall productivity.

Currently, using technologies such as GIS and GPS is optional for cultural resource managers. Today, cultural resource managers can rely on traditional methods to accomplish most of their

needs. As the number of resources on state, local and Federal inventories grows however, and the need to understand the larger context of these resources increases, GIS and GPS tools will be a required part of our daily cultural resource management strategy.

Cultural resource specialists have proven many times over that GIS technologies are the best way to integrate the variety of data types and datasets we need to fully understand, evaluate and protect our important heritage. GIS continues to serve as the best way to use our data, perform analysis and generate new perspectives as we assess the significance and integrity of our resources. Without standards to guide how we produce the data that contributes to the GIS however, we can not break down the inevitable barriers which technology brings to the cultural resource management world. Having a strong framework to base conclusions off of allows cultural resource specialists to work toward a truly efficient knowledge management system that will contribute meaningful new insight into our understanding of all our cultural resources.

References

GIS Information

1. www.esri.com
Website for Environmental Systems Research Institute, the company that makes the most popular GIS software products, specifically ArcGIS, used by all Federal agencies, as well as most state and local government agencies.

2. www.geography.wisc.edu/sco/gis/history.html
Website for the Wisconsin State Cartographer's Office, which contains a synopsis of the history of GIS and the major milestones reached in the field of GIS. Additionally, the site contains basic definitions of terms related to GIS.

3. www.nps.gov/gis
Website for the National Park Service, National GIS program, containing basic GIS information, as well as data and tools for downloading.

4. www.cr.nps.gov/hps/gis/index.htm
Website for the Cultural Resource GIS Facility of the National Park Service, containing basic information on GIS and GPS, as well as project information and applications within cultural resource management.

GPS Information

1. www.navcen.uscg.gov
Website for the US Coast Guard Navigation Center, containing basic information on the GPS system, constellation of satellites, as well as links to many other GPS internet resources.

2. www.trimble.com
Website for the Trimble company, a major manufacturer of GPS receivers. This site contains tutorials on how GPS works, and explains what types of GPS products are available to the public.

3. www.npg.gov/gis/gps
Website for the National Park Service, National GIS program, GPS component, containing information regarding the history of GPS, and its applications within the National Park Service.

General Information

1. www.whitehouse.gov/omb/circulars/a016/a016_rev.html
Website containing the full text of OMB Circular A-16 which establishes the Federal Geographic Data Committee (FGDC) and designates the National Park Service as the lead agency for developing the cultural resource spatial data theme.

2. Henry, Mark and Leslie Armstrong, ed. Mapping the Future of America's National Parks: Stewardship through Geographic Information Systems (ESRI Press: Redlands, CA), 2004.

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5. McCarthy, Deidre "Exploring the Contributions of the Buffalo Soldiers Through New Technologies," CRM: The Journal of Heritage Stewardship v2 n1 (2005) p. 77-81.

6. Stein, James and Deidre McCarthy "Preserving the Past: Geospatial Technologies Combine to Document and Protect Historic Buildings," GPS World v11 n2 (Feb. 2000).