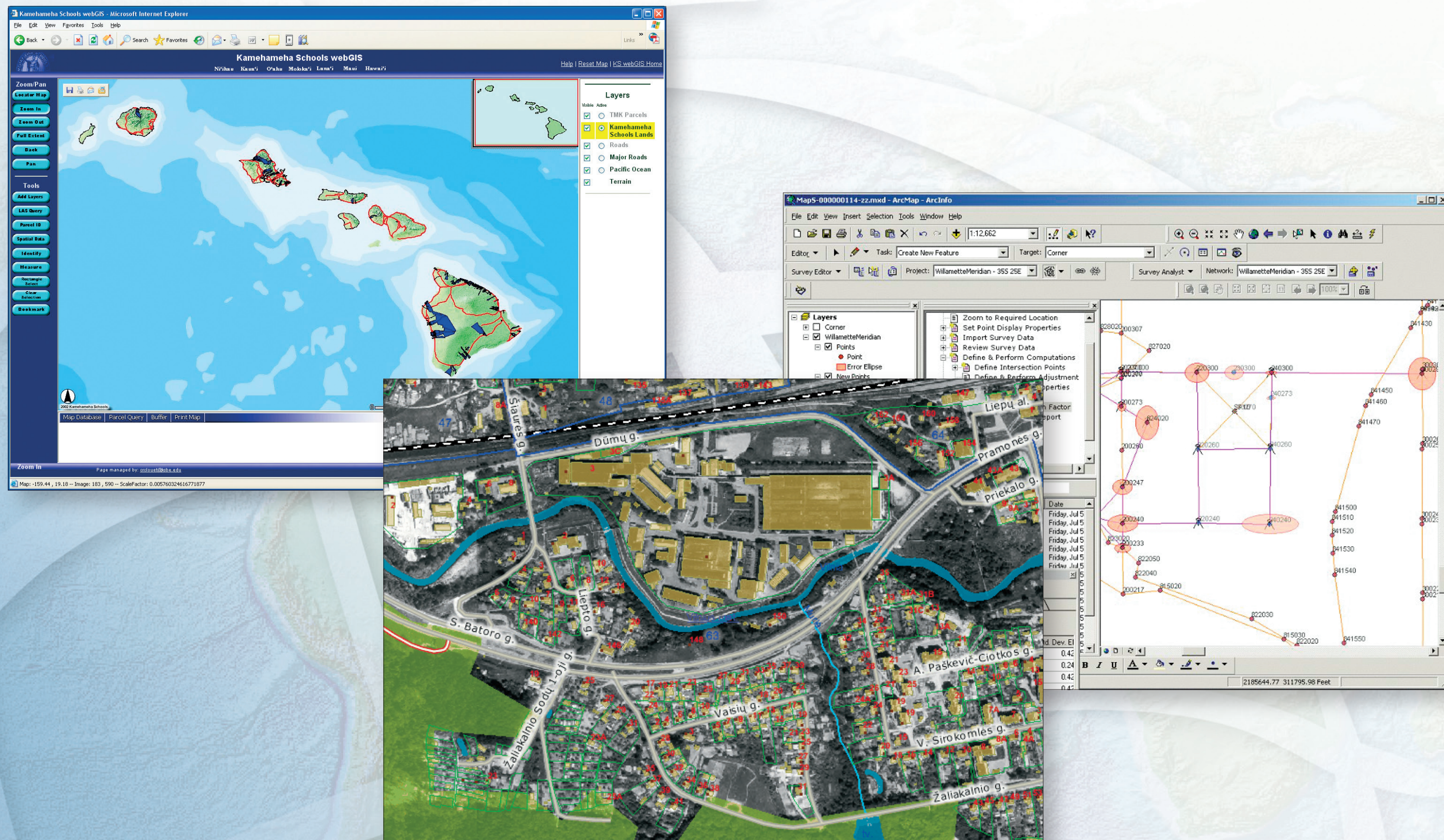
GIS Best Practices

Land Records and Cadastre



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ESRI®

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What Is GIS?

Making decisions based on geography is basic to human thinking. Where shall we go, what will it be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of launching a bathysphere into the ocean's depths. By understanding geography and people's relationship to location, we can make informed decisions about the way we live on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a basemap of real-world locations. For example, a social analyst might use the basemap of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map file databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station.

GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns. GIS applications can be embedded into common activities such as verifying an address.

From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

GIS for Land Records and Cadastre

Accurate, cadastral maps define legal repositories of landownership, value, and location, allowing individuals and businesses to raise capital based on property values. In turn, the capital can be used to purchase other property, start businesses, and pay for higher education, among other activities.

ESRI is the leading provider of GIS software to land records, assessment, and cadastral agencies worldwide. ArcGIS and its extensions can help agencies meet their primary responsibilities of ownership registration, parcel mapping, real property valuation, and data access. ArcGIS provides the tools to more efficiently collect, convert, and improve map data; accurately assess properties; and provide Internet access to this data for the public, businesses, and other organizations.

The following articles, reprinted from *ArcNews* magazine, detail a few of the many applications of GIS technology for land records and cadastral mapping.

Lithuania's National Cadastre System Implements GIS

By Vidmantas Augulis, Head of the GIS Department
Lithuania's State Enterprise Centre of Registers

After wresting its independence from the former Union of Soviet Socialist Republics in 1991, Lithuania underwent a series of significant changes in its governmental structure and direction. One involved the development of laws to restore landownership and organize a system to manage real property, which helps reestablish confidence in a country’s ownership rights and business environment.

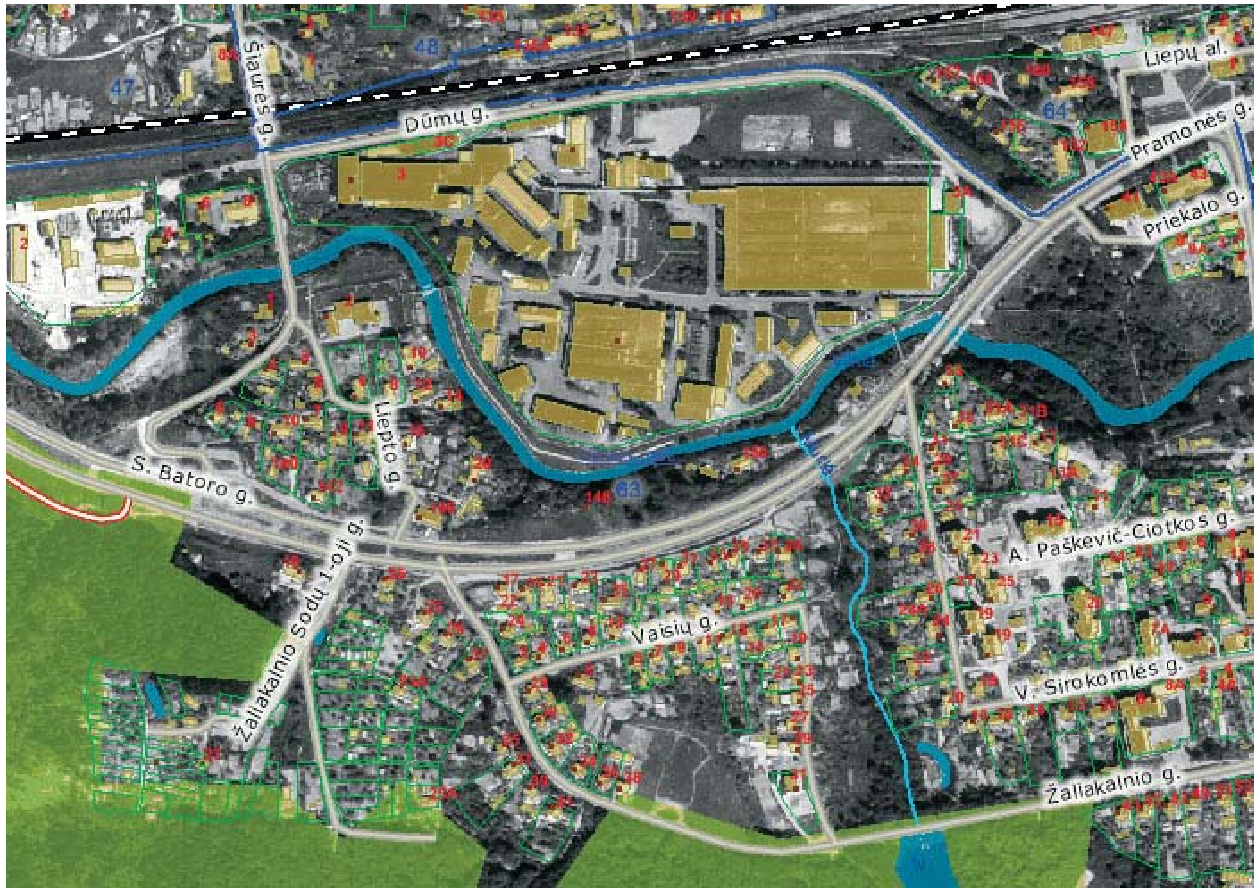
After initial attempts to use existing legal information and topographical maps as a basis for developing a cadastral system to support its landownership program, it was decided that historic survey and data errors were being perpetuated from the old system to the new one. Lithuania's State Land Cadastre Enterprise then formed a special GIS committee to examine the current mapping technology with the directive to implement a digitally based cadastral system in Lithuania.

In 1995, through a special Denmark-Lithuania land survey project and the European Union's Pologne, Hongrie Assistance á Reconstruction Economique (PHARE) program, Lithuania's State Land Surveying Institute implemented a cadastral mapping production system based on ESRI software.

Later, the State Enterprise Centre of Registers (SECR) was established and tasked with integrating all real estate records and cadastre data into a single GIS-based system. Data from the land register and data on buildings, construction projects, houses, and apartments were subsequently integrated into the Real Property Information System. Legal, technical, and geographic records have also been integrated into the system.

SECR's GIS department uses ArcGIS (ArcInfo and ArcView) to administer the central database, integrate data with attributes, and provide maps on the Internet. Thirty-three layers of data are maintained with ArcSDE including administrative boundaries, buildings' center points, address points, and real property value zones.

SECR also performs appraisals of real property. This valuation system strengthens real estate markets and supports value-based taxation. GIS is an important component of its Mass Appraisal System. By accessing parcel, register, and market information from a single database, the appraisal system is used to compute mass values for property located in territories based on prescribed principles within defined time periods using updated market data. It also allows for periodic reevaluation of property values in response to market changes.



Map view of cadastre map Web service with orthophoto map background.
User of the service can switch on and off the orthophoto map.

Lithuanian taxes on property include land tax, which is applied to the value of both urban and rural private land, and real property tax, which is applied to the value of real estate (excluding land). The base value for land tax properties depends on the land's productivity point and is adjusted for such factors as urban ecological conditions, availability of engineering facilities, and so forth. The real property taxable value is equal to the replacement cost adjusted by locality coefficients.

Land parcel datasets are grouped by characteristics essential to land market value such as value zones, purpose of use, agricultural land, size of the land parcel, productivity grade, and recreational use. These valuations are displayed on a map, and the user can access further information in the database through the map or through textual query.

SECR's GIS facilitates the inclusion of many factors in its data model. Tax formulas can be automatically applied and computed. The system is easily updated to reflect market dynamics and ownership discrepancies. Quality control is ensured by comparison of sales costs and appropriate values. Because GIS is database driven, it can facilitate the development of a tax model that can be used to calculate tax liability related to property values.

Presently, the GIS department is implementing a new application called SDEGATE for its Real Property Cadastre and Register (RPCR) central database. The application works by extracting a copy of the data in an area of interest from the central database through ArcSDE, locking this area during editing or reviewing, then committing the data back to the central database. For example, an end user in one of the branch offices can define an area of interest by inputting a polygon representing this area into SDEGATE. SDEGATE checks to see if another user doing geodata updating has locked this area. If this area is unlocked, SDEGATE connects to ArcSDE, extracts the data, sends the data to the user, and disconnects it from the database. SDEGATE then puts a write lock on the area by identifying the area in a special table within the database. No other user can edit those extracted features until the data is committed back to the database. When the end user has made all necessary edits and committed the data back to the database, SDEGATE performs a check of the data upon committing updates to the database and unlocks the area of interest. At any time, an end user can get information about which ArcSDE areas are being edited from any of the GIS computer stations.

SECR has also developed an application for the delivery of cadastral maps, integrated with its RPCR via the Internet, using ArcIMS technology. A user can get a variety of information about a property, including an orthophoto map, administrative boundaries, the boundaries of cadastral units and blocks, land parcels, centerlines of streets, and so on, all from the user's own computer.

(Reprinted from the Winter 2004/2005 issue of *ArcNews* magazine)

Deploying Cutting-Edge Survey Management and Measurement Management Applications

BLM Implements Enterprise GIS in the National Integrated Land System

Managing survey and land records information is a challenge faced by local jurisdictions everywhere. The Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) have this responsibility for approximately 500 million acres of public lands, with BLM managing an additional 300 million acres of subsurface mineral resources. In an era of smaller budgets, increasing workloads, and shrinking workforces, keeping up with this workload is an ominous proposition for any organization. To meet this challenge, BLM and USFS have joined together with a consortium of state, county, and private organizations to develop several applications, which combined constitute the National Integrated Land System (NILS).

NILS comprises several applications including Survey Management, Measurement Management, Land Survey Information System, GeoCommunicator, and a yet-to-be-released application called Parcel Management. The GeoCommunicator application was deployed in 2001 and the Land Survey Information System in April 2002. These two applications (www.geocommunicator.gov and www.geocommunicator.gov/lsi) provide Web access to BLM data and GIS resources.

In October 2002, BLM announced the first deployment of the Survey Management and Measurement Management modules of NILS.

BLM's Survey Management and Measurement Management Applications

In 1999, BLM contracted with ESRI Professional Services to design and implement the NILS enterprise GIS solution. The project began with an in-depth analysis of BLM's business processes required for managing survey and land records data using an integrated "field-to-fabric" approach. On completion of the initial user needs analysis, a system architecture design was developed based on these requirements and the expected user loads. A centralized architecture employing Windows Terminal Server and Citrix technology was designed to maximize performance while minimizing bandwidth requirements from BLM's distributed user base.

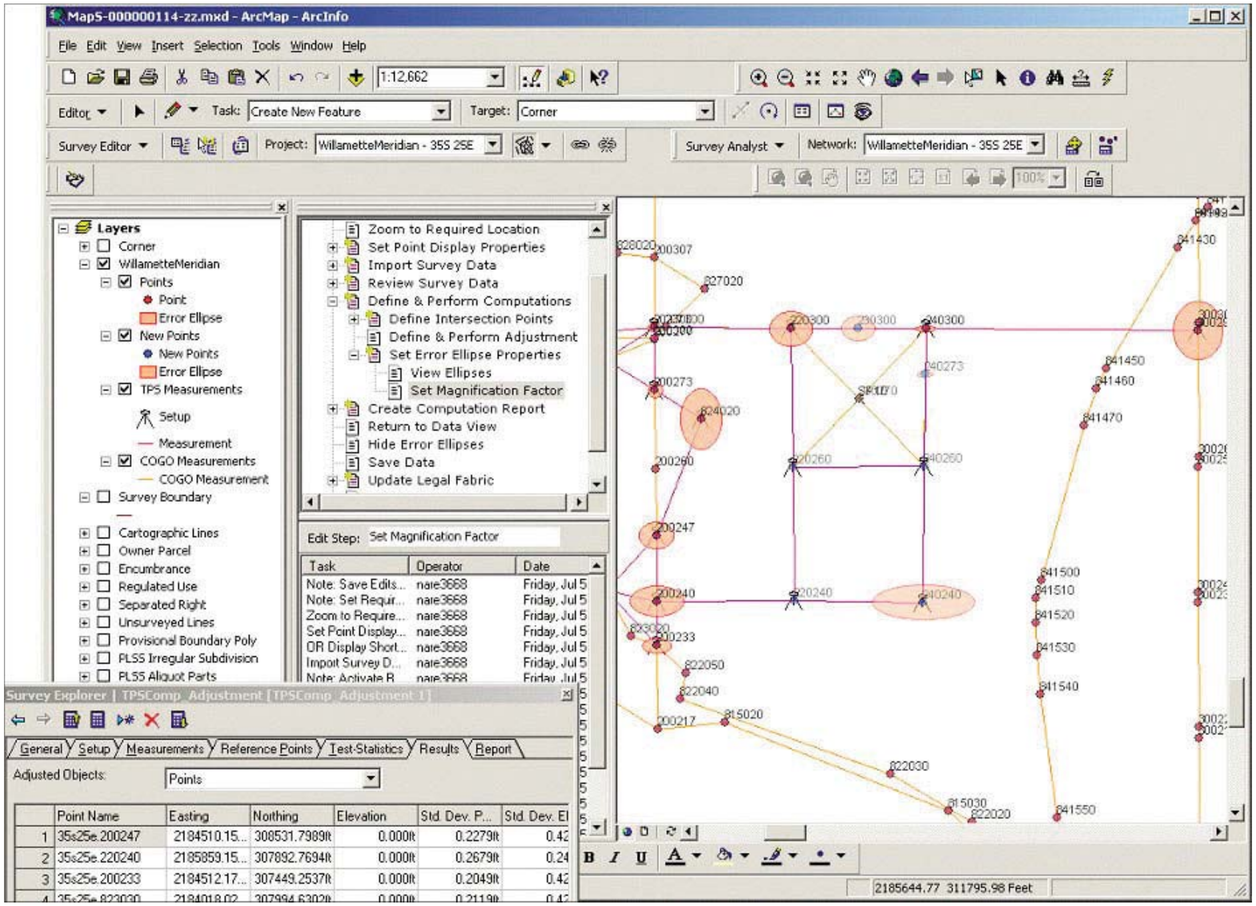
The first release of the Survey Management and Measurement Management applications was deployed in September 2002. These applications include a set of custom components developed by ESRI Professional Services on top of the ArcGIS and ArcGIS Survey Analyst technologies. NILS provides a business solution to land managers that unifies the worlds of surveying and GIS technologies through a nationwide data model, a measurement management engine to analyze survey data, and parcel creation and maintenance tools. The integration of surveying and GIS provides land managers with a complete field-to-fabric technology solution.

"The beauty of NILS is that it provides the tools to allow professional surveyors and GIS technicians to work together in an integrated system to improve the accuracy and value of mapping data that will allow for better decision making," says Jack Craven, director of lands for the U.S. Forest Service.

The release of the Survey Management and Measurement Management modules will serve as the foundation for the entire NILS application by providing new commercial off-the-shelf (COTS) products, custom NILS applications, a land records geodatabase, GIS architecture, and a managed work environment.

"We are very excited about the release of NILS Survey and Measurement," says Bob Anderson, BLM's acting assistant director for Minerals, Realty, and Resource Management. "About 85 percent of our requirements went into the development of ESRI's new ArcGIS Survey Analyst extension and other ESRI software. This is a huge savings to the government and a benefit to everyone to be able to leverage COTS products that are available to everyone."

The NILS geodatabase model is based on ESRI's ArcGIS Parcel Data Model, which was developed by a consortium of cadastral and parcel subject matter experts. The model is based on and meets the requirements of the Federal Geographic Data Committee's Cadastral Data Content Standard. The implementation of the NILS model will include conversion of the data from the NAD27 to the NAD83 datum as well as the development of a seamless national dataset. The survey and parcel data will serve as the foundation for a national multipurpose cadastre.



The Workflow Manager provides users with an ordered series of tasks to guide them through the actions required to complete a job.

The first deployment of the Survey Management and Measurement Management applications includes tools to accomplish the following activities for both public land survey and metes and bounds areas:

- Import the Geographic Coordinate Data Base (a BLM repository of measurement data) into the geodatabase.

- Create legal description lines and polygons.
- Link legal description data to the survey data.
- Edgematch the legal description data.
- Validate the legal description topology.
- Merge survey points that represent the same geographic location.
- Implement merging process business rules.
- Attribute legal description feature classes with their legal descriptions and link them to the measurement management network.
- Implement the quality assurance tools required to validate and verify the integrity of the legal description fabric.
- Automate the business rules for edgematching geometries and validating topology.

Survey Management and Measurement Management are built on top of ArcGIS and the ArcGIS Survey Analyst extension. Several innovative custom software capabilities have also been incorporated into the applications. Among the custom applications is a workflow management framework.

Workflow Manager

A set of custom workflow management tools has been developed to help BLM standardize and automate many of its land management activities. The Workflow Manager guides users through all the necessary GIS and non-GIS tasks required to complete an entire business process.

"Managing the workflow of an entire business process is important to the success of NILS," says Leslie Cone, BLM's NILS program manager. "Much of the valuable institutional knowledge about our core business activities is in the hands of an aging workforce (which is bound to be reduced through attrition) that is spread across the nation. The workflow management tools provide a mechanism for capturing these business processes and standardizing them for use across BLM."

The development of BLM workflows began with the elaboration of detailed use cases by ESRI Professional Services that captured the existing BLM survey and land management activities. These use cases were used as the basis for the development of specific workflow jobs. In a simplistic view, a job represents a (typically large) unit of work, such as a land exchange, that must be tracked and managed through its life cycle.

The Workflow Manager application is browser based and provides the main entry point to the NILS application for the majority of NILS users. In addition to standardizing workflows, it serves as a guide for staff members in their day-to-day activities while providing a mechanism for tracking a job's status and providing accountability and control in BLM work processes. Once an active job has been selected, users are provided with a series of tasks that must be completed to finish a job. The framework supports the assignment of responsibility for each task within a job to a specific individual or user role—only surveyors can do survey tasks, realty specialists are assigned specific tasks, and so on. Once a task is completed, a message can be sent to the person responsible for the next task in the workflow. Within the Workflow Manager interface, users can view and report on jobs, track job status, initiate new jobs, assign job responsibilities, define the job's area of interest, and complete individual job tasks.

When a GIS task is initiated through the workflow, a task assistant tool is provided to guide users through the steps in the querying or editing activities required within ArcGIS.

(Reprinted from the Winter 2002/2003 issue of *ArcNews* magazine)

NILS Data Model Connects Survey and GIS for Cadastral Management

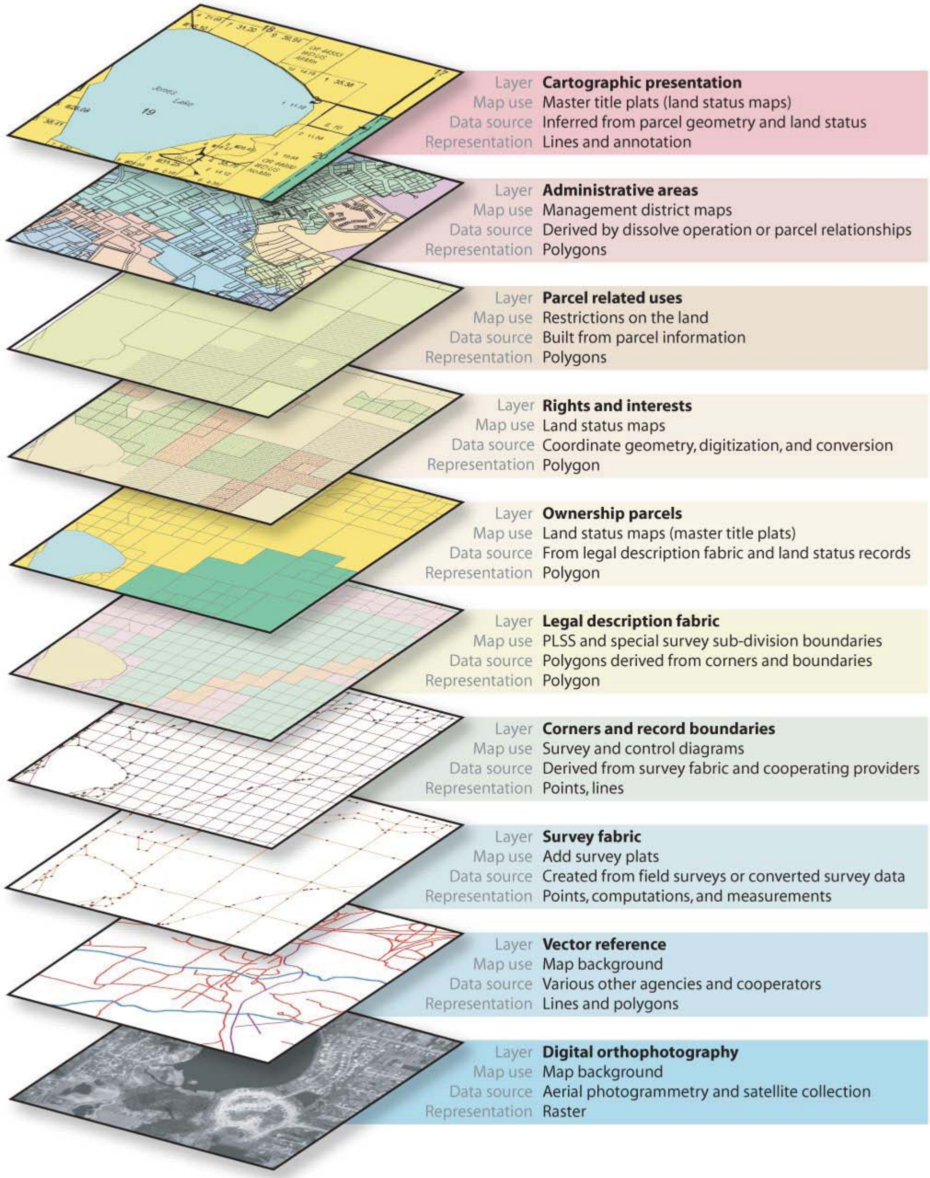
The National Integrated Land System is a joint project between the United States Bureau of Land Management and the U.S. Forest Service in partnership with states, counties, and private industry to provide business solutions for the management of cadastral records and land parcel information in a GIS environment.

The goal of NILS is to provide a process to collect, maintain, and store parcel-based land and survey information that meets the common, shared business needs of land title and land resource management. NILS contains the following four modules:

- Survey Management for centrally managing field survey information
- Measurement Management for survey-based computations to support the cadastre
- Parcel Management for U.S. federal land records management
- GeoCommunicator, BLM's GIS catalog portal for publishing and disseminating NILS information to partner organizations (such as states and counties)

NILS provides the tools to manage land records and cadastral data from field to fabric. This system supports the use of field survey measurement data taken directly from survey equipment, manipulating this data into lines and points and creating legal land and parcel descriptions for use in mapping and land record maintenance.

A key part of the concept is the development of a common data model that unifies the worlds of surveying and GIS. This unification concept is fundamental for land records managers and maintainers of cadastral mapping databases to improve the accuracy and quality of the data. It is also important to create standard land descriptions and cadastral data that can be used by anyone. For example, U.S. counties and local governments rely on the national cadastre as a framework in which to fit local parcel and land records systems.


Layer Cartographic presentation
Map use Master title plats (land status maps)
Data source Inferred from parcel geometry and land status
Representation Lines and annotation
Layer Administrative areas
Map use Management district maps
Data source Derived by dissolve operation or parcel relationships
Representation Polygons
Layer Parcel related uses
Map use Restrictions on the land
Data source Built from parcel information
Representation Polygons
Layer Rights and interests
Map use Land status maps
Data source Coordinate geometry, digitization, and conversion
Representation Polygon
Layer Ownership parcels
Map use Land status maps (master title plats)
Data source From legal description fabric and land status records
Representation Polygon
Layer Legal description fabric
Map use PLSS and special survey sub-division boundaries
Data source Polygons derived from corners and boundaries
Representation Polygon
Layer Corners and record boundaries
Map use Survey and control diagrams
Data source Derived from survey fabric and cooperating providers
Representation Points, lines
Layer Survey fabric
Map use Add survey plats
Data source Created from field surveys or converted survey data
Representation Points, computations, and measurements
Layer Vector reference
Map use Map background
Data source Various other agencies and cooperators
Representation Lines and polygons
Layer Digital orthophotography
Map use Map background
Data source Aerial photogrammetry and satellite collection
Representation Raster

Along with Public Land Survey System (PLSS) data that BLM is well known for managing, the model also includes the full spectrum of rights and interests for the approximately 130 million federal ownership polygons that are managed across 12 BLM jurisdictions. For more information on the data model, select the Land Parcels link at support.esri.com/datamodels.

ArcGIS technology is providing the foundation of NILS. Object-oriented software engineering techniques are being used to extend ArcGIS to meet the specific needs of NILS users. For more information on NILS, visit www.blm.gov/nils.

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The City of Coeur d'Alene, Idaho, Converts Urban Tree Inventory into GIS

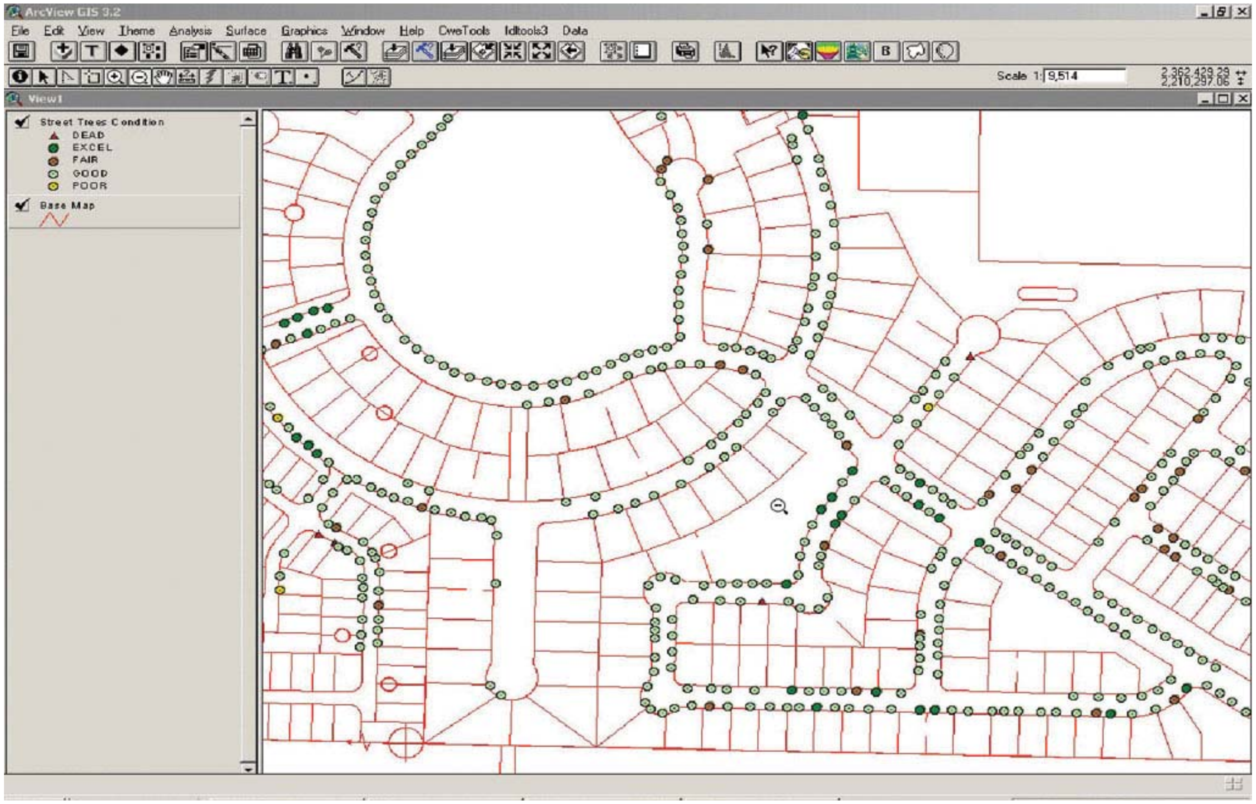
By Adnan Zahoor, GIS Specialist, Idaho Department of Lands

The city of Coeur d'Alene (population 35,000) is situated in northern Idaho on Coeur d'Alene Lake. It is the gateway to a summer and winter resort area as well as a tourist and lumbering center. Tourism continues to prosper and is now one of Coeur d'Alene's primary industries. But Coeur d'Alene is also growing its economy through the addition of numerous small businesses ranging from retail and service concerns to small manufacturers. Coeur d'Alene is poised to be a leading city in the inland northwest in the 21st century and beyond.

Coeur d'Alene's Urban Forestry program had its beginnings in 1974 when there was a tussock moth infestation. A group of three foresters began to meet to advise the city about tree issues. This group became an official Urban Forestry Committee in 1983. One of the duties of the Urban Forestry Committee was to establish a street tree (trees growing within the public rights-of-way) inventory. An inventory of the oldest section of town was done in 1978. An update of that information was started in 1989 with the help of community volunteers. This inventory eventually reached all parts of the city and was completed in 1993. The next update effort was completed in 1998.

Trees are an important part of Coeur d'Alene's general atmosphere and make significant contributions to the quality of life. In addition to aesthetic value, they provide many environmental benefits such as shading radiant surfaces, processing carbon pollutants into oxygen, intercepting rainwater, filtering dust, buffering winds, and moderating noise. Street trees are located where these qualities are particularly important. An inventory of street trees helps the city monitor, manage, and plan for the future of this important resource.

The city initiated an Urban Forestry GIS project in the summer of 2001. It was funded in part by a grant from the Idaho Department of Lands Community Forestry Program in cooperation with the U.S. Forest Service. The purpose of this project was to transfer existing urban tree inventory data into a state-of-the-art GIS.



Dots show street trees matching with other city layers.

Background

From an urban tree management perspective, Coeur d'Alene is divided into 44 tree districts. More than 11,000 street trees of 65 species of various size classes are grown here. The city has actively managed these trees for the last 13 years and kept the tree inventory in dBASE IV format. The city was facing the following problems with the existing street tree inventory:

- Coeur d'Alene was using an old mapping program for street trees. It assigned locations (latitude and longitude) by using the tree inventory address field but was only able to appoint locations for approximately 70 percent of the inventory, so it was not very useful.
- Another problem was the assignment of false addresses to trees next to corner properties (two street frontages) to make the trees show up on the correct street. Since Coeur d'Alene's

urban forestry ordinance makes property owners responsible for the care of the trees in the rights-of-way abutting their properties, the city forester spent a lot of time talking to homeowners regarding public trees next to their property. Relating trees to real addresses is therefore very important in finding the correct information to help them. The false addresses were a real hindrance.

- Existing tree inventories were limited to counting the trees and recording their address, condition, diameter at breast height (DBH), genus, species, and maintenance needs.

Having street tree information available in a GIS format allows viewing of public tree information on city maps in relation to other infrastructure and assists with the following:

- Resource management decisions incorporating tree density within neighborhoods, species distribution, and health/condition patterns
- Planning by city departments to minimize conflicts between trees and other city infrastructure such as tree/traffic sign or tree/streetlight
- Accessing information on individual trees by location to provide answers to tree and site inquiries from the public faster and more accurately
- Making quick visual surveys
- Locating a tree in the field by providing a map indicating its location
- Illustrating needs and situations visually

Keeping the above problems in mind and the useful applications of having street tree information in GIS format, the city decided to do a tree inventory in GIS to assist with management tasks.

In the summer of 2003, the city reviewed all the street trees identified by the inventory as being in poor condition. These are the trees that may have the potential for falling and causing damage, so it is important to assess needed actions, which may range from pruning to removal and replacement. Being able to view the "poor" trees on the map will help the city forester plan efficient travel routes for daily work and quickly pinpoint individual tree locations on the ground. Once specific management actions for each tree have been determined, providing maps of tree locations to tree care contractors will help them in preparing bids and dispatching crews.

New Neighborhood with Small Trees

Coeur d'Alene has one Urban Forestry staff member who looks after all the city's needs related to urban trees. A GIS consultant was hired in the summers of 2001 and 2002 to assist in GIS database design, data collection, and customizing ArcView 3.x software to view and analyze Urban Forestry data. Part-time, temporary student workers were also utilized.

The city already had the tree inventory in dBASE format, which included records such as property address, tree condition, DBH, genus, species, and maintenance needs. The latitude and llongitude information of the trees was not available. Rather than redoing the whole inventory, it was decided to locate the latitude/longitude position of recorded trees. A unique record field (serial number) was added in the original tree inventory dBASE database. Digital orthophoto quadrangles (DOQs) provided a picture of an area. To pinpoint the x,y location of trees, an on-screen digitizing approach was adopted by using high-resolution (1 pixel = 0.5') DOQs as a background layer in ArcView. City street, parcel, and address layers were also loaded in ArcView to help in pinpointing the tree locations.

DOQs were useful in spotting trees and pinpointing their locations, but recognizing the various tree species was difficult. This problem was solved by using the existing tree inventory, which had been done on the ground. Tree inventory personnel walked along the streets, recording each tree and planting spot in progression and linking them to their respective address. Following the same path as the inventory personnel, on-screen digitizing was done by assigning the corresponding database serial number to each tree position.

Those city parcels or places where many merging tree crowns made locating individual trees difficult, or when smaller trees were underneath the crowns of larger trees, field checks were done. After pinpointing the locations of the street trees, the focus was shifted to integrating the GIS database with the existing nongeographic tree inventory database by joining data tables together on a common field in ArcView. For this purpose, the unique record field (serial number) was used. The urban street tree GIS database is now ready and can be easily integrated with other city land record themes as part of a multipurpose land information system.

(Reprinted from the Fall 2003 issue of *ArcNews* magazine)

Mecklenburg County, North Carolina, Archives History on the Web with GIS

By Chaula M. Jain, Programmer Analyst, Mecklenburg County, North Carolina

Mecklenburg County is located in the southwest region of North Carolina with Charlotte its largest city. It is one of the fastest-growing counties in the United States and has a full-fledged GIS system with GIS staff members in a number of departments who are involved in analysis, database design, and application development.

In 2001, the Mapping/GIS Division of the county began the process of scanning and digitally archiving its entire set of full-size Mylar aerial photography, using a scanner that accommodates maps and aerial photographs up to 36 inches wide. Aerial photography from county archives and selected maps of local historical significance from the Public Library of Charlotte and Mecklenburg County have been scanned. The aerial photography currently dates back to 1966. Maps from the archival collection of the library's Carolina Room date back to the 19th century and showcase the elaborate illustrations and painstaking work created by mapmakers of another era.

View of Tryon Street in Charlotte at the Beginning of the 20th Century

Andy Goretti, mapping project manager, initiated the Historical Mapping Project. "Scanning the maps will preserve them for the future," he says. "History buffs will be able to view the maps, and developers and engineers can access aerial photography for their purposes." The project has received complete support of Kurt Olmsted, manager, Mecklenburg County Land Records.

Aerial Archives Using ArcIMS

In September 2002, the county decided to make this huge archive, which grows larger every day, available to the public through the Internet. The Web site, which was originally developed using Active Server Pages and HTML, uses maps that were scanned and processed and can be viewed in JPEG or MrSID format. In addition, a geodatabase was developed for the maps.

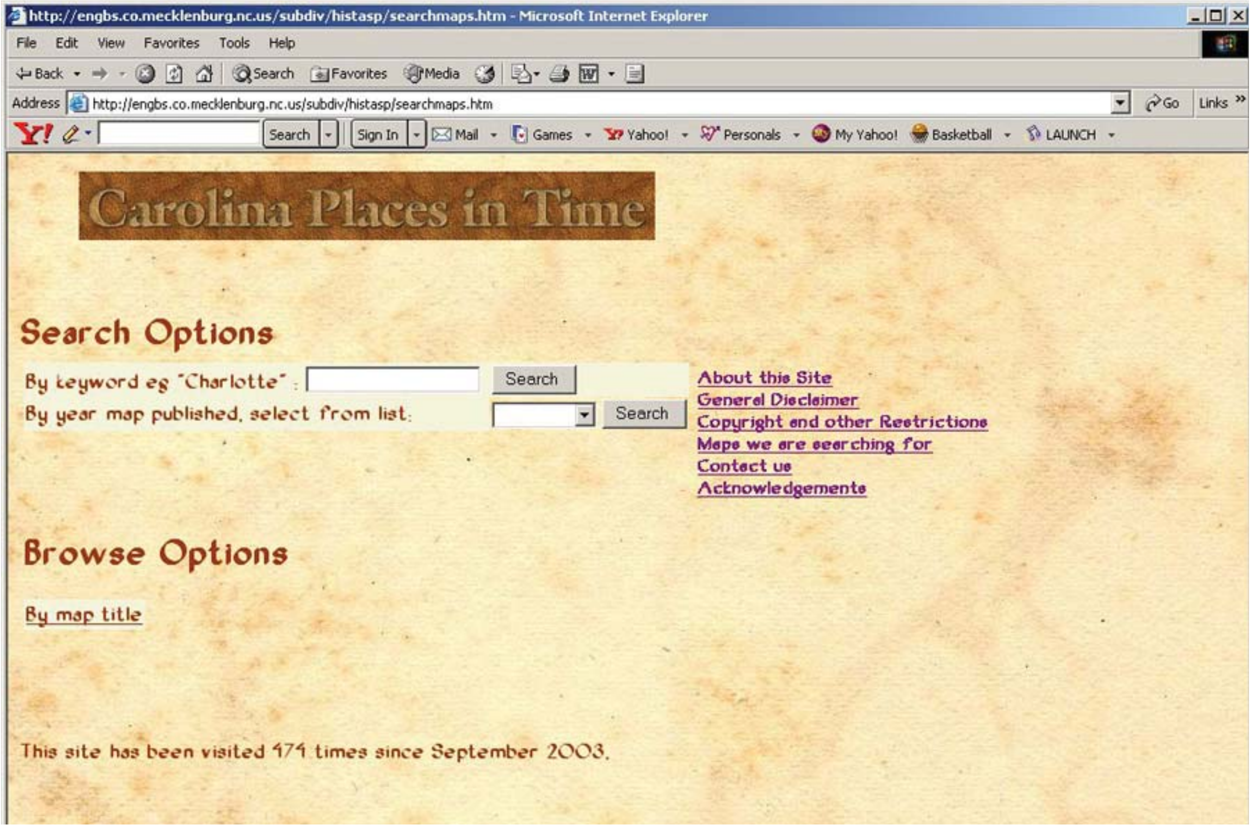
In November 2002, the county decided to add its collection of aerial photography to the Web site and redevelop it using ArcIMS. The county has georeferenced aerial imagery dating back to 1997 and has published these layers along with the parcel layer to show developmental growth. The aerial images can be searched by index number or by parcel number and owner. The interactive mapping/GIS functionality of ArcIMS has been used for overlaying aerial images from different years.

Other layers, including the most current parcel layer, can also be turned on. The user can zoom/pan to a specific area depending on the search criteria. The county has georeferenced imagery for the years 1997, 1999, 2001, and 2002 and is in the process of getting a set for 2003. Mecklenburg County also has a vast collection of nongeoreferenced aerial images, which have been scanned and processed. These have been added to the site in MrSID and JPEG format like the other historic maps, but in the future, the county is planning to georeference these images using ArcGIS software. The nongeoreferenced aerial images on Mylar would be scanned into the ArcMap application of ArcEditor, rubber-sheeted using existing coordinates, and available later in digital format just like the newer aerial images. The Mylar aerial photography dates back to 1966.

The information for this site was displayed at the GIS Day function on November 20, 2002, in Charlotte and received a great deal of interest from the general public—many people wanted to donate historic maps. Mecklenburg County will probably be one of the few local government organizations in the United States to host this kind of information on the Internet.

Local historical societies have already expressed an interest in seeing more maps on the site and offered to bring their maps in for scanning and sharing.

"This has been a fun project for me," says Beverly Lawing, land records specialist, who has helped in scanning the maps and building a database. "I've lived in Charlotte for many years and have enjoyed learning more of its history through contacts with people from the library and historical societies. I'm looking forward to seeing what else we can do together."



The Historic Maps Web Site Search Page

The Web site is a great resource for online research for historians, cartographers, and the general public interested in the history of the region.

"The vision of the project is exactly in keeping with the highest standards of public preservation," says Cameron Holtz, executive director of Historic Charlotte, Inc. "We are making this information available to the widest possible audience and providing a valuable and unique service."

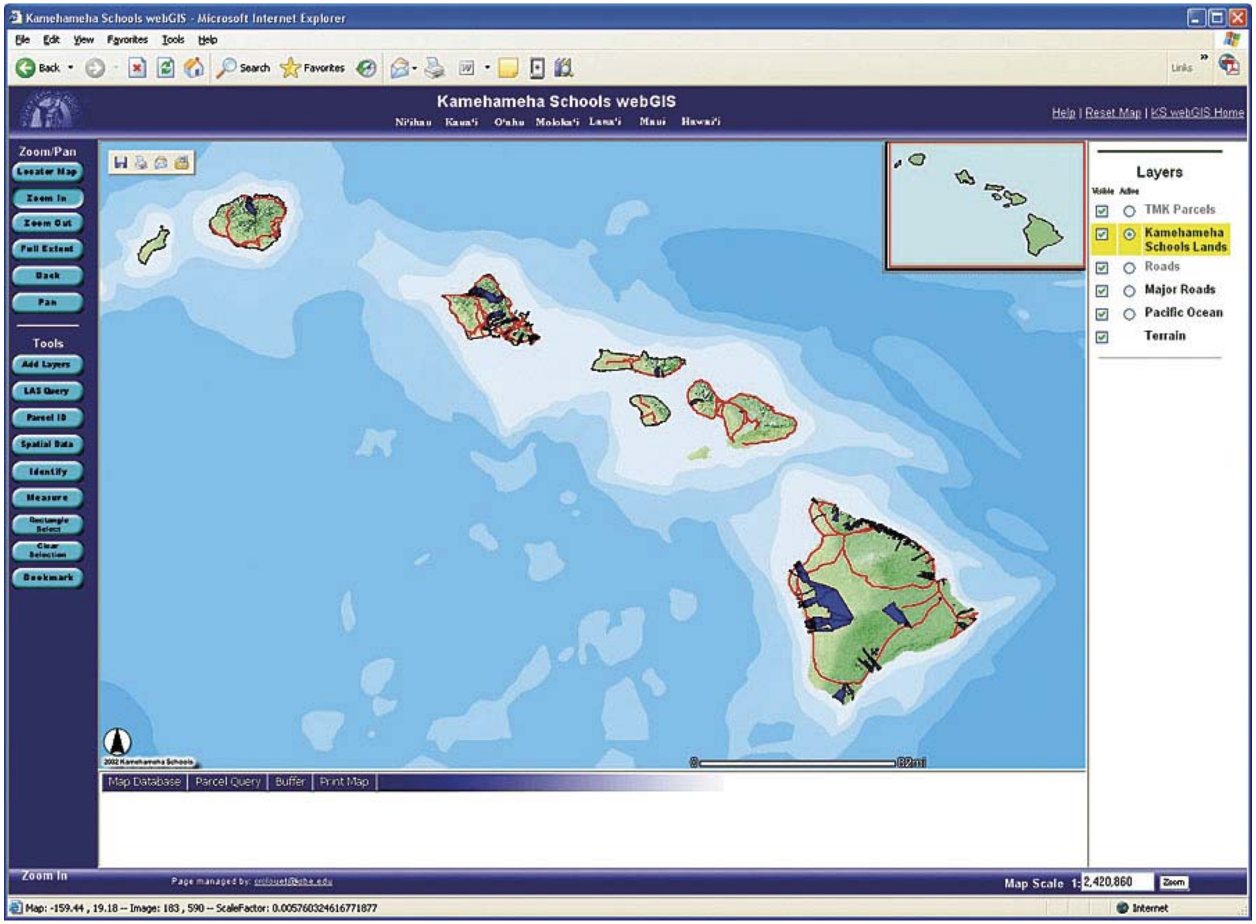
(Reprinted from the Fall 2003 issue of *ArcNews* magazine)

Kamehameha Schools webGIS System

In Hawaii, Land Managers, School Administrators, and Students Now Have Efficient Access to a Variety of Land Data

Approximately 360,000 acres of abundant tropical land in the Hawaiian Islands make Kamehameha Schools (KS) one of the most beautiful locations to go to school. However, the private school system is more internally complex than first impressions would suggest. In the will of Bernice Pauahi Bishop, the great-granddaughter and last royal descendant of Kamehameha the Great, the land was set aside in trust in 1887. KS, the largest private landowner in the state, includes a K–12 campus on Oahu, K–11 campuses on Hawaii and Maui, and 31 preschool sites statewide. In addition, KS gives millions of dollars in grants to college students. The combined 6,500 preschool through grade 12 student enrollment makes Kamehameha the largest independent school system in the United States. Beyond the vast educational establishments located in KS's realm, there is an intricate business system that manages the many tenants that share the area with the schools. The endowment group combines operations in residential, commercial, agricultural, and conservation with other investments funding the schools' maintenance and educational needs.

KS's unique situation produces a problem that is common among many agencies and organizations that rely on a variety of data. Given the number of organizations operating within the vast area, it was important to have accurate and current information to share with the schools, more than 20 land managers, and other KS employees. The KS Land Assets Division accumulates and maintains the different types of information that come from multiple sources. In 1998, the division hired Craig Clouet as its GIS manager and used ArcInfo on UNIX to maintain land information such as location, zoning regulations, who is leasing which area, and other business information.

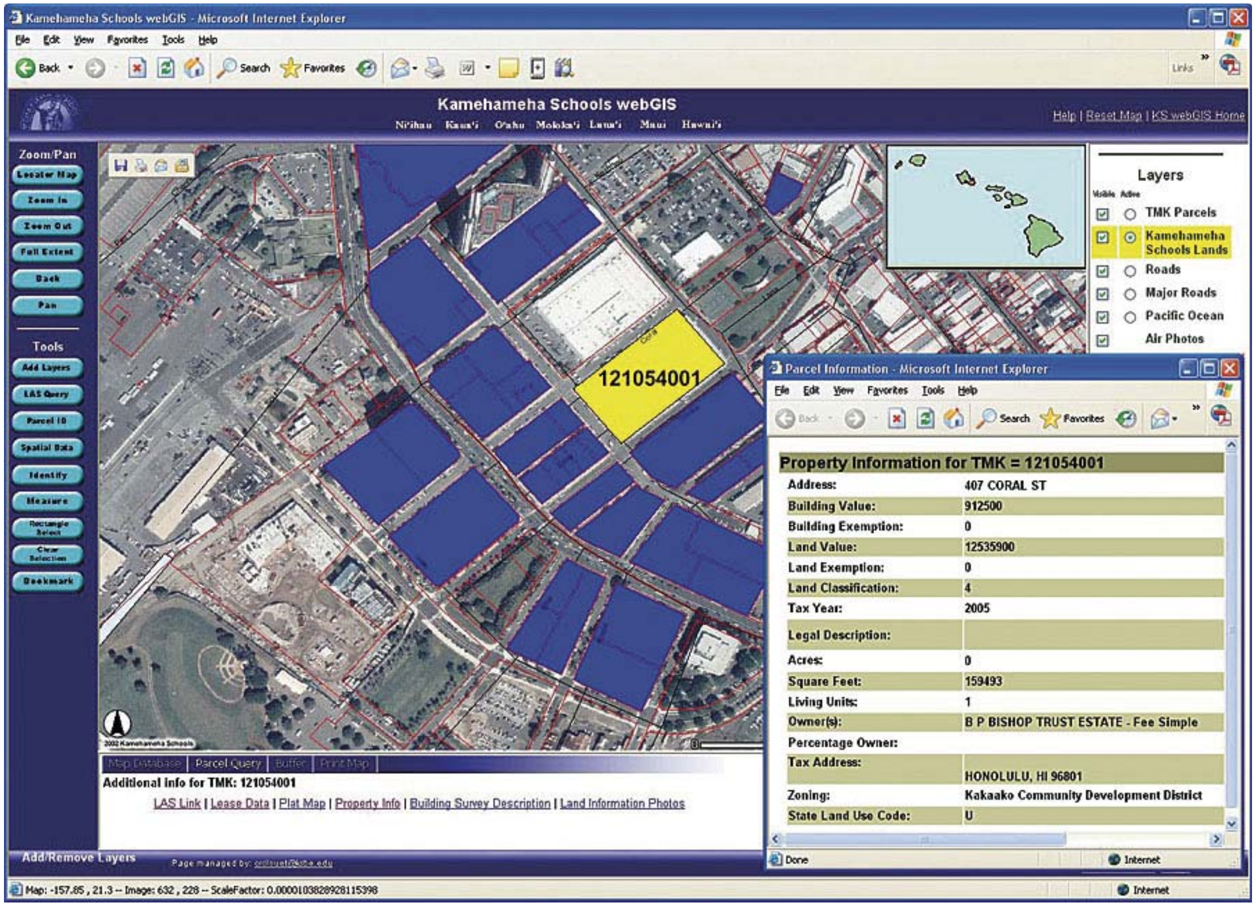


Home Page of the Kamehameha Schools webGIS Showing the State of Hawaii Basemap

Migrating to ArcView facilitated business functions for the KS land managers and enabled them to work with their parcel, leasing, imagery, and feature data. Since KS initially kept school operation separate from the business side of managing the land, the system worked well. However, it was inevitable that as the schools grew, KS needed access to the same land information as business operations.

"Lately there's been more and more 'cross-pollination' where school administration wants to know where to build new preschools," says Clouet. "To find the best location, they want to know where Hawaiians live according to census data. Once they determine the best location for a future school, they need to know other land information, such as zoning and transportation, how close it is to a flood zone, and other information, that helps them serve their students more efficiently."

It became apparent that as more facets of KS were depending on the same data, it needed a system that could handle the robust GIS library of data necessary for 8,000 parcels of land and that would also provide a centralized way to access the information. Clouet determined the best way to do this was to use ArcIMS and ArcSDE to create an accessible Web site for the land managers as well as the school administration and students. Clouet turned to Steve Lettau, a consultant with the Onyx Group (Honolulu, Hawaii), an ESRI business partner, to create the KS webGIS system.



Parcels can be located via the query results screen or by simply clicking the parcel on the map.

"We took the functionality and custom extension in ArcView and put it into ArcIMS," says Lettau. "That's what defined the whole process. With the custom extension built into the ArcIMS Web site, the information wasn't limited to only those with ArcView."

The first step in building the ArcIMS application was data conversion. Most data was in shapefiles and native image file formats, but KS financial information was in an IBM AS/400 mainframe. The data had to be converted to DBF format so it could work with shapefiles.

"Part of the whole process of what we incorporated was moving to ArcSDE and ArcIMS," says Lettau. "We put all the shapefiles in ArcSDE on SQL Server to complete the data transformation."

Once the data was transferred, Lettau added more functionality to the application. Along with identify, zoom in, zoom out, pan, and other basic functionality, there were specific tools land managers needed including links to financial and leasing information, historical maps that contain historical surveys, and other business requirements. This data, along with all-attribute data for the statewide dataset available online, was added to the system and is maintained with ArcInfo.

The end result of Lettau and Clouet's work is a robust Web site that gives users a one-stop location to find the information they need. The KS webGIS contains approximately 150 layers categorized into groups such as demographic, environmental, Hawaiian, parcel and property, political, and physical features. Users can build customized maps using these datasets to perform specific analyses. The system also links to two external databases. One is the land asset system, which contains lease information and other business data, and the other is the map imagery database, which contains historic maps of Hawaii that users can view to learn about the historical significance of the land. Land managers and business professionals who require detailed land information can easily analyze data for future plans as well as maintenance status on current projects. The KS school administrators can access the information necessary to make better decisions and provide the best services to their students. As more information becomes necessary, Clouet plans to expand the system.

"With Web technology and databases, there's no such thing as being finished," says Clouet. "You're always doing the best at the time and need to continually update. Ease of use and improvement of service for end users are the ultimate goals." The next phase of the project involves incorporating a land legacy database that includes cultural information such as how to pronounce an area's name in the Hawaiian language, native songs and chants about the area, and other cultural identifications that maintain identity.

"KS is deeply rooted in the native Hawaiian culture," says Lettau. "If they sell their land, they can never have it back. However, when they own it, they can preserve it and the culture that goes with it."

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