Clayton County (Georgia) Water Authority GIS System (2005—Enterprise System)

System Summary

In less than six years, the Clayton County Water Authority (CCWA) has developed an innovative and cost-effective Geographic Information System (GIS) program that is integrated into the work processes of each department, and empowers users from frontline fieldworkers to upper management. Used as a stand-alone application, the GIS provides users with a tool for analyzing, locating, and querying the hundreds of thousands of assets. The GIS has provided even greater benefit to the organization and its customers as a tool that is tightly integrated with other corporate information systems such as the computerized maintenance management system (CMMS), where all work is performed against a GIS asset, and a detailed maintenance history is developed. Through such tools as well as the custom-built LandMan application used to manage the application of treated wastewater on the 24,000 head spray irrigation facility, GIS is a key component in all work performed at CCWA.

A central feature of the program is the automated processes used to update the system with new data. Using detailed submittal standards and commercial GIS data conversion software, additions to the water and wastewater systems are seamlessly incorporated into the GIS in a hands-free process that results in new data that is available to all users the following day. This process has greatly streamlined the data development process, and enabled our staff to focus on end users, applications, and analysis. It has reduced an update cycle of 2 to 3 years to less than 24 hours, and reduced the labor hours by eightfold.

Another hallmark of the system is the use of "right tech," in which technology is used appropriately, depending on need. Although leading-edge tools, such wireless technology, and data transformation tools are important components of the system, each one is chosen on the basis of its return on investment and its value to the organization. More simple and elegant applications and integrations are often used where "high-tech" solutions would add undue complexity and cost.

Finally, the successes of our program are the result of teamwork across the organization. We never lose sight of the fact that we serve the needs of the rest of the organization: CCWA sells water not GIS. As such, our data and applications are all created with direct input from our end users, and their successful use of the system is a testament to the effectiveness of the program.

Motivation for System Development

The CCWA GIS was developed in response to a need for accurate and timely facility and maintenance information at all levels of the organization. The legacy paper maps were updated infrequently (three to five years), and the process for capturing changes to the system frequently broke down. In addition, the CCWA staff was aging, and a system for capturing system assets was needed to "institutionalize" this critical asset data. Because Clayton County government did not have a GIS program, CCWA had to build not only the data sets specific to water and wastewater, but also a significant portion of the basemap, including streets, edge-of-pavement, building footprints, political boundaries, orthophotos, and parcels (a partial data set only).

GIS was identified as a key component of the year 2000 Master Plan, and development proceeded rapidly as the water distribution and wastewater collection systems were being modeled also as part of the 2000 Master Plan. In addition, a legacy pushpin wall map depicting the 24,000 sprinkler land application facility was rapidly deteriorating. This map was the only updated information on this large facility.

System Benefits Achieved

Without doubt, the GIS has greatly improved the speed and quality of data that is provided to the end users. The update cycle, it was anticipated, would be improved to within several months, but the next-day data updates, to all users, whether on or off the network, have exceeded all expectations. Many data sets that had been previously inaccessible or difficult to access are now instantly accessible to all users. The old process for accessing sewer customer connections required two to four people and approximately one hour to complete. This information is now accessible in seconds by any individual. Quality has improved because of both the enhanced editing environment provided by GIS and the phenomenon of pushing data production "upstream." Our system emphasizes one-time data capture and as such puts the responsibility for quality data in the hands of the contractors, surveyors, and field crews, allowing GIS staff to concentrate on data review and analysis.

In addition to the GIS exceeding expectations, it also has created a number of unanticipated peripheral benefits. One of these benefits is that it has placed technology in the hands of field users. Each of our field crews has a laptop computer in the crew's truck, specifically for accessing GIS data. Many of these users were previously computer-illiterate, and the GIS has enabled these users to apply technology to their daily activities. Now field users download data to their trucks in the morning and refer to specific assets as they perform their work.

Another peripheral benefit is that GIS has been a driver for open databases and other information systems. Previously, the organization's data was "locked" in a legacy AS/400 computer system. The only method for end users to access it was through the inflexible "Green Screen" GUI, or via custom reports prepared by programmers. GIS has driven the use of Client Access and other ODBC connections to the AS/400 data, as well as interfaces for pulling and pushing the data between the AS/400 and the GIS suite of applications.

System Design Issues Encountered and Overcome

The CCWA GIS system design consists of two parts: geodatabase design and system configuration. The geodatabase design was developed during a weeklong database modeling workshop, which involved personnel from every department in the company. Once the final design was put into production, there have been very few design changes (approximately 15 fields have been modified or added in 5 years), indicating that the original design was successful. The only major issues encountered were linking the assets to other enterprise systems and propagating changes across databases. These issues were handled by an "infrastructure ID," which is owned by the GIS system and fed to other enterprise systems.

The system configuration includes the hardware and software installations, both on the client and server sides. Because CCWA has many field personnel who do not have access to the Internet, a primary constraint is data distribution. Internet-based applications are not suitable for at least half of our users, and thus a simple, reliable, and cost-effective field application was essential. Our first attempt was to use ESRI's ArcExplorer. This application did not meet our needs, because of reliability, limited graphics, and the need for constant GIS staff support. This system was replaced with the greatly improved ArcReader, which featured ease of use, foolproof operation, excellent graphics, and ease of distribution.

The other main system configuration challenge was the deployment of the ArcGIS/Cityworks application to office-based staff. Fifteen ArcView 9.1/Cityworks licenses are shared among approximately 45 end users, who access the system at various times of the day from any number of computers. To simplify the deployment of this combined application, it was published using Citrix technology. Although Citrix made certain aspects of rollout and upgrades much easier, it introduced some unforeseen complexities in user profiles, the display of event themes, and database permissions. These challenges were overcome with the combined problem-solving skills of several IT and GIS staff members, and the resulting solutions were documented to ensure future success.

What Differentiates This System from Other Similar Systems?

A number of significant differences exist between our system and other similar systems. The first difference is the as-built conversion process used for converting new assets into the GIS. While a growing number of organizations are requiring electronic as-builts to be submitted, CCWA's program is extremely streamlined and exacting. To obtain final approval on a construction project, contractors are required to submit their as-built drawings in one of several computer-aided design (CAD) formats, exactly in compliance with the CCWA As-Built CAD standards. These standards specify the format of the entire drawing, from file name to layers and layer names, to topology and coordinate system. Once accepted, the drawings are converted (usually within 15 seconds or less) to GIS format, with no further modification. Using Safe Software's Feature Manipulation Engine (FME) software, topology is verified, attributes are created, and layers are mapped to the proper ESRI feature classes with no manual intervention. This process changes a five-step, multihour conversion to a single-step process and changes GIS data creators to GIS data reviewers and analysts. The end result is that data that was submitted and approved one day is processed, verified, and incorporated in our central geodatabase and accessed by all end users the next day (or instantly if the user is accessing the central geodatabase directly).

A second difference is our extensive use of GIS by field staff. This is accomplished by intensive collaboration and training. Every part of our system has been developed with the input of end users. From the look and feel of maps (appearance, layering, scale ranges, data, labels, etc.) to the design of every geodatabase feature class to the details of custom application development, every GIS product is codesigned by end users and GIS staff. As a result, very few changes are needed after deployment, and end users actually use the products. Thus, GIS is fully integrated into the work processes.

Our training program has two elements that ensure end-user success. The first is that testing is mandatory for all training. If a user fails the timed test, he or she must retake the course. If the user fails again, he or she receives personalized remedial training until the user is able to pass. The second element is monthly training courses, which enable us to constantly reinforce GIS skills and knowledge, and eliminate excuses that training is unavailable.

The third difference is our strategic use of technology to maximize the return on investment. Some systems are so enamored with technology that technology becomes an end in and of itself. This overengineering can result in unreliable systems that are prone to failure and do not meet the needs of end users. In our system, we use an approach we refer to as "right tech." With this approach, some problems are solved using leading-edge technology, such as wireless updates to field user computers via 802.11 g wireless communications (this has been in place nearly two years), and SQL Server's Data Transformation Services to move data from the AS/400 database to the Cityworks database and to the ArcReader applications as event themes. Other problems are solved with out-of-the-box solutions such as ArcReader, which has been enhanced to allow for locating addresses. Although ArcReader does not come with the ability to locate addresses, by writing a custom application to generate a file with all possible addresses for our street network and then geocoding the resultant addresses, we were able to give ArcReader this capability and greatly stretch our GIS budget.

Other problems are solved using the "80 percent solution." An example of this is our use of palm pilots for data collection. Rather than using a GIS-based field application, asset identifiers (e.g., Hydrant IDs) were pulled from paper or laptop-based GIS maps and entered into the palm-pilot applications. Data was captured (the asset IDs were reentered at the end of each inspection to ensure data quality) and downloaded at the end of each data to a central database, where it was linked live to the GIS system. This system is reliable, easy to use, and approximately five times as cost-effective as using a comparable GIS/GPS-based PDA.

One more example would be the use of office-grade hardware for GIS computers used in the field. Despite a great deal of debate on the merits of ruggedized versus office-grade laptops, we have experienced great success with the office-grade laptops, with only one failing in three years. We estimate that we have saved nearly $45,000 with this strategy. The GIS team was key in advocating this cost-effective solution for the dissemination of GIS data.

System Hardware, Software, and Data

Hardware

- A GIS server (IBM Netfinity with two processors and RAID 5 array)
- Two Citrix servers (for ArcView 9.1 and Cityworks)
- The Cityworks database server
- Three "power users" high-end GIS workstations
- Three engineering technician workstations (used part-time for some GIS work)
- End-user computers (approximately 150) consisting of office-grade desktop computers or laptops, including approximately 30 field-application laptops
- Approximately five ruggedized laptops

Software

- Two ESRI ArcInfo 9.1 seats
- Three ESRI ArcEditor 9.1 seats
- ESRI ArcSDE 9.0 running on SQL Server 2000
- 20 ESRI ArcView 9.1 seats
- Safe Software Feature Manipulation Engine (FME)
- ESRI Spatial Analyst, GRID, Publisher
- Visual Basic 6.0, Visio 2000

Custom applications

- LandMan GIS
- SDE to Personal GeoDB export Utility
- Infrastructure ID/Date-User Stamp
- AS/400 to Cityworks data pump
- Automatic Map production tools, including an automatic frame-resizing utility

Data

- Water distribution network (water mains, hydrants, valves, tanks, etc.)
- Wastewater collection network (gravity lines, manholes, force mains, lift stations, etc.)
- Raw water network (water mains, valves, intakes, etc.)
- Land application (treated effluent lines, sprinklers, valves, etc.)
- Constructed wetlands (intakes, connections, cells, etc.)
- Hydrology (streams, lakes)
- Basemap (streets, building footprints, edge-of-pavement, parcels [partial], political boundaries, railroads, etc.)

In addition to this data, CCWA maintains a host of data sets, which are used for special projects or are under development. These include elevation contours, DEM data, stormwater features, watershed boundaries, land use, etc.).

Where Are We Now? Future Directions

Current program

There have been few major structural changes to our program during the past year. Instead, we have implemented several enhancements. These include:

- An updated download tool for end users to obtain GIS data and projects from the server. This tool includes a configuration utility for rapidly changing the files that are copied to the end user's system, a message system for sending questions and comments to the GIS section without the use

of e-mail (this system is used because most end users work in the field and are disconnected from the network), a tracking function to record the user and the time and the date the user performed a download, and a browser window for viewing a GIS home page in the field.
- The collection of water meters using mapping-grade (submeter) GPS. This enhancement will support the integration with the new Customer Information System (CIS), scheduled for implementation in 2006.
- Additional data-checking tools to increase the efficiency of our reviews of as-built drawings submitted by contractors. These include functions to flag and annotate errors to decrease the amount of time needed to review each as-built drawing.

The main challenges that we face are training issues and IT infrastructure issues.

- The training issues involve outside contractors changing personnel. It takes several submittals before contractors fully grasp the as-built CAD standards. Once they do, they usually can obtain a drawing approval after two rounds of submissions. Unfortunately, there is frequent turnover among these technicians, and we have to spend time reeducating each new technician, as he or she begins submitting drawings.
- Internally, many of our end users require remedial training. As a result, we have implemented tiered, exam-based training, which helps to determine which individuals are experiencing ongoing problems.
- The IT infrastructure issues involve the upgrade of systems. We are continually challenged by new operating system, server upgrades, and connectivity issues. Our wireless WAN has been down for much of 2005, which means that data downloads to some of our treatment plants have been run over DSL connections—a slow process. Fortunately, new radios for the wireless WAN and some redundancy should solve this problem.

The future will entail additional services and streamlining existing systems.

- We are currently implementing a CIS system, which will involve integrating GIS more directly with the customer-service work flow. Users will be able to view customer data, service requests, and outage information directly in GIS.
- In 2007, CCWA will implement a Stormwater Utility. This utility will be an additional service both for our company and for our GIS section. We will increase every aspect of our system by approximately one-quarter—including end users, data sets, and service requests—while maintaining the current staff size. This will be accomplished through increased automation and economies of scale (i.e., we will use existing systems such as Cityworks and simply add additional modules).

Examples of System Images and Screen Shots

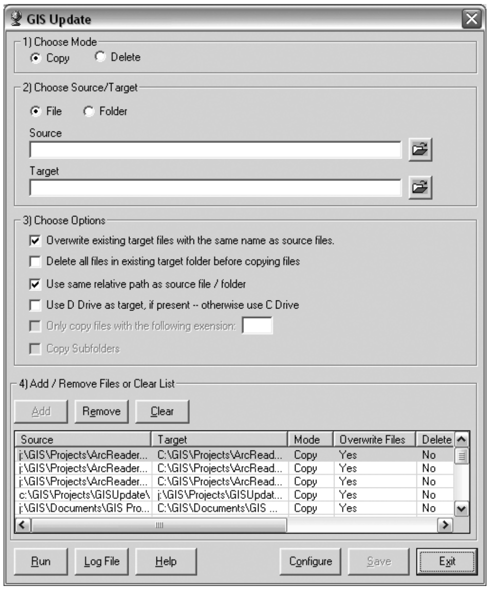

Figure 1. The configuration utility for the user download application.

Figure 2. The GIS Home Page for end users.

Figure 3. The Message Sending Tool for end users.

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