Managing your Water Utility with Integrated GIS

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Abstract: After many years of providing flat rate water services, billed on a semi-annual basis to its 20,000 customers, Citrus Heights Water District found itself confronted with a Federal mandate to install meters for all its customers. The realization that the District would have to manage a $12M capital improvement plan to install the meters, transition its entire residential customer base to the concept of paying for metered water, move to a bi-monthly billing process and account for the corresponding cash flow implications caused the District to seriously question whether its older technology systems were up to the task at hand. Upon quick review, the resounding answer was "No Way".

In 2001, the District embarked on an IT Master Planning activity. The result of this planning activity was a series of recommendations to completely replace all of the core information systems of the District with a set of highly integrated applications. Key to the success of this strategy was the implementation of new financial systems, customer information systems (CIS) and maintenance management systems (CMMS). The cornerstone of these systems was to be a fully integrated geographical information system (GIS) that brought all of these applications together to support office, field and management requirements.

In less than 18 months, Citrus Heights Water District has installed a complete ESRI GIS system for their entire service area containing 20,000 service/meter locations and 250 miles of buried infrastructure. The 20,000 customer account records have been tied to this map with a new customer information and billing system from Cogsdale. A full function maintenance management system from Azteca has been installed and integrated with the GIS for recording all field work orders and maintenance activity. The system provides full wireless capabilities to 15 field personnel, including full GIS services, using Sprint services and a highly secure VPN architecture. The CIS and the CMMS both feed a new financial system from Microsoft/Great Plains to comply with GASB-34 requirements. Integration between these core components is designed to insure that information is entered as close to the originating source as possible, with full quality and security control.

What were once four separate islands of information, with paper map books and work order sheets for visual reference, is now a fully functional,

integrated solution, ready to comply with whatever the next mandate or opportunity for more efficient work process might be.

INTRODUCTION

This paper describes the experiences of the Citrus Heights Water District as it confronted the need to make substantial changes in its operational business processes in response to regulatory requirements imposed through Federal mandates. The District's response involved the development of a technology strategy, the acquisition of four major application software packages and an 18 month implementation project. The focus of this paper is on how a small public water agency can make substantial progress in a relatively short period of time by implementing a fully integrated, enterprise information management solution to address its requirements.

PROBLEM STATEMENT

In 1992 Congress passed the Central Valley Project Improvement Act which required all federal water customers in California, such as Citrus Heights Water District, to meter water consumption. The district had until 2005 to convert all flat rate services to metered services. The District began installing meters in 2000. The realization that the District would have to manage a $12M capital improvement plan to install the meters, transition its entire residential customer base to the concept of paying for metered water, move to a bi-monthly billing process and account for the corresponding cash flow implications caused the District to seriously question whether its older technology systems were up to the task at hand. Upon quick review, the resounding answer was "No Way". In addition the District realized that their average staff age was increasing rapidly and that key personnel would be retiring within the next 10 years. Like most other agencies, significant institutional knowledge about assets, customers and financial management is retained by employees. It was decided that this institutional knowledge was going to have to be captured and recorded in order to be of benefit to future managers of the District.

STRATEGY

In 2001 the District formed a Technology Improvements Committee (TIC) whose charter was to set a strategy for acquiring the technology needed to administer the CIP program, manage the infrastructure once the meter installation project was complete and become the central repository for all of the District's institutional knowledge. The committee was made up of managers from all departments of the District. District management believes strongly in outsourcing non-core business processes. Hiring a technology manager did not make sense based on their size. As such, the District decided to outsource their technology support as well. Based on this strategy, the TIC decided to issue an RFP for a Technology Master Plan. Their selection process resulted in the selection of Westin

Engineering, Inc. as the firm to partner with to assist in preparing the Technology Master Plan.

THE PLAN

The Technology Master Plan project was started in September of 2001. The Master Plan addressed all the major business processes of the District:

- Customer Service
- Billing and Collections
- Financial Management
- Asset Management
- Construction
- Operations
- Maintenance Management
- Conservation
- Meter Reading
- Field Service
- Water Quality
- Technology Management

Customer Service, Billing and Collections, Meter Reading, Conservation, Field Service, Water Quality

The original Customer Information System was developed in-house using DOS programs and was designed for flat rate billing with limited metered billing capabilities. The system was approaching its tenth year in production and the District knew that they would require a more robust system to handle the increased demands that a fully metered environment would place on the District. In addition, new processes would need to be developed to improve the efficiency and timeliness of cash collections, the capturing and recording of field service activities and the management of meter and customer information.

Financial Management

The original financial management system, while adequate for basic financial management capabilities, did not provide advance features that currently available financial systems software packages support. Each of the financial management processes was analyzed: payables, receivables, fixed assets, procurement, payroll, human resources, budgeting, general ledger and job costing. The district assessed each financial process to determine if automating the process would provide substantial, meaningful benefit to the District. After careful consideration, the District decided not to implement the full suite of financial functions avoiding the temptation to install software modules for the sake of installing new software. Since payroll was already outsourced and functioning adequately, it was decided not to bring payroll in-house as the benefits of this approach did not outweigh the added costs. It was also decided not to automate the procurement process or human resources management functions at this time. Due to the limited amount of internal job cost data, (most capital improvement projects are outsourced), it was decided to use the CMMS for job cost capture and reporting rather than implement a separate job costing module. However, should the situation change each of these functions could be added to the District's financial management system at anytime in a fully integrated system.

Construction, Operations, Maintenance and Asset Management

The current asset management processes at the District were entirely manual and paper based. The work order system was 30 years old and used paper work order forms that were manually completed for materials, labor, and equipment costing. The infrastructure maps were 20 year old ink-on-mylar maps that were wearing out. All of the district's as-builts and asset documentation was stored in cabinets on paper or kept in District personnel's head. There was no SCADA system to monitor or control the water system. Hydraulic modeling was a tool the District wanted to utilize, but had not yet begun. Construction, operations, maintenance and asset management had the greatest opportunity for providing improvements in efficiency by applying technology.

Geographic Information Systems

The District had not implemented any form of Geographic Information System but had a strong preference that the processes for capturing, recording and maintaining the districts assets should be fully integrated with GIS. Since both customers and assets are geospatially distributed, the GIS should be the best tool for managing both customer and asset data. All major data elements - customer, asset and maintenance- should be available through the GIS for analysis. The GIS should be the central integration platform for the entire District.

With a vision and scope for information technology clearly defined, the District's Information Technology Master Plan could be developed. A critical objective of the project was to be able to manage the metered infrastructure environment without an increase in head count. To achieve this objective, new business processes would have to be developed to improve operational efficiency. During the business process review activities, opportunities for improvements were identified. All of the process improvements were analyzed to determine their impact on new system requirements. The process reviews also provided the requirements for the new systems. The final step was to develop the cross functional processes for the new systems. This involved defining how CIS processes would interface with maintenance processes, how engineering processes would interface with maintenance, and how maintenance processes would interface with engineering and then back to CIS. These enterprise business process models were then used to develop the systems integration requirements for the District. Once all of the requirements were defined, application software products could be selected to meet the requirements.

Due to the extensive nature of the technology improvements planned for the District, it was decided to phase the application implementations. In order to accomplish the goals and objectives for a completely integrated system, applications were broken down into core and supporting. The core applications would have to be in place before other supporting technologies could be implemented. The core applications would be financial management (FIS), customer management (CIS), maintenance management (CMMS) and mapping and infrastructure management (GIS). The supporting applications would be document management, SCADA, hydraulic modeling, and enterprise reporting (Portal).

The final stage of the IT Master Plan was to select the technology platform and software applications for the Phase I implementation. Since simplicity and standardization was critical for developing a cost effective integrated system, it was decided to use a Microsoft platform for the solution. This would involve Windows servers and clients and SQL Server for the RDBMS. HTML based applications were also a desired part of the technology platform envisioned for the District. This would support easy end-user deployment in the office and eventual mobile deployment to field personal as well. This approach would also help to reduce on-going maintenance costs as upgrades would not have to be rolled out to all clients.

The planning process included a search for HTML, Microsoft and SQL server based solutions that provided some level of integration off the shelf. Since integration was to provide many of the efficiency improvements, applications that were already integrated were given higher value in the selection process. The search for solutions in the lower to mid sized market segments did not result in the identification of many HTML based applications. As such, a decision was reached that the solution set would have to initially be client-server based.

ESRI ArcGIS was selected as the GIS platform. It provided the most complete and comprehensive suite of tools to support geospatial analysis and data management and it would run on a Microsoft/SQLServer based platform. It was also decided that the CMMS needed to be integrated with GIS as most of the District's assets are linear. This would require finding a CMMS system that was integrated with ArcGIS. The system that met the requirements of the District was Cityworks from Azteca Systems. This system is fully integrated with ArcGIS out of the box. This left the financial and customer management applications left to be selected. There was a high desire to find an integrated FIS and CIS. Several candidate solutions were identified that had integrated financial and customer management functions. After reviewing several of the solutions it was decided to purchase Cogsdale Corporation's, Customer Service Management solution that is built on top of Microsoft's Great Plains financial management suite. This selection accomplished several objectives as the financial and customer information systems where integrated and were optimized for Microsoft's SQL Server platform. Each candidate vendor's solution was further investigated by visiting customer sites and observing the systems in use. The District decided that the individual solutions selected met their needs. Costing proposals were obtained from each vendor for software licensing and installation support and estimates for the program management oversight costs for the entire implementation were added to the plan. At this point the master plan was completed. While the application areas of Phase II have been decided, no cost data was provided as the details of Phase II will need to be updated once Phase I is complete. With the IT Master Plan complete, the District had a complete roadmap for guiding them through their technology improvements.

THE SOLUTION

With the completion of the Master Plan, the District was ready to begin the implementation phase of the project. The Board of Directors approved the Master Plan in September 2002 and the implementation was schedule to begin in November. The District engaged Westin to provide program management for the entire implementation phase. Since the vendors had already been selected and cost proposals obtained, all that had to be done was to contract with the vendors to provide the software and implementation services necessary to implement the software. Contracting was complete in October and implementation was scheduled to start in November. Realizing that implementing four applications concurrently would be a large strain on the limited District resources, it was decided to take a two track approach. Finance (FIS) and customer service systems (CIS) would be implemented in one track and maintenance management (CMMS) and GIS would be implemented in a parallel track. Different departments would be involved in each track so resource utilization would not interfere with the implementation.

Finance and Customer Service Systems:

Since the chart of accounts is the critical component for FIS and CIS, the FIS was selected to be implemented first, followed by CIS. The FIS was to be comprised of general ledger, accounts payable, fixed assets, budgeting and advance reporting. The financial system was scheduled to go-live January 1, 2003. System setup, conversion and training were completed and the system went live January 1, 2003, two months after the project started.

CIS implementation began in January 2003. This implementation required substantially more work as historical data had to be converted into the new system. The CIS implementation was scheduled to complete and go-live in September 2003. The CIS solution would include billing, service orders, credit and collections, meter reading import, revenue management, device manager and EFT modules. One of the main business drivers for the project was the pending change from flat rate billing to metered billing. Flat rate billing is much simpler to manage than metered billing. As such, entirely new business processes had to be developed to manage the metered billing environment. New processes for routes, billing cycles, meter re-reads, cash receipts and field service had to be developed to support the metered environment.

The District also had to start recording and tracking service orders. This meant that most customer calls would now result in a service order being created, a new transaction that had previously only been recorded on paper notes. Service orders also implied substantial communications between office personnel who initiated the service order with field personnel who were executing the orders.

GIS and CMMS:

The second application track involved implementation of the GIS and the CMMS. The GIS was initiated first because the selected CMMS relied on the GIS for the asset database. Implementation activities began in January 2003. The District had

84 ink-on-mylar maps that were to be converted, but did not want to be responsible for maintaining the base-map, parcels and streets. Fortunately, Sacramento County, in which the District resides, was willing and able to provide the base map to the District. The County will also update and distribute new base maps to the District as needed.

In addition to the base map, a database scheme had to be developed for the GIS. Fortunately, Azteca provided a water utility specific database scheme that provided the required elements to support their CMMS system. This scheme only had to be modified slightly to accommodate the elements that the District wanted to capture themselves in the GIS.

With the base map and the database scheme secured and defined, the conversion activities could begin. The overall District was divided into 9 segments. Each segment would be converted and validated then uploaded to the production GIS environment. The conversion process began by piloting an area of the District. This pilot was used to validate the data conversion approach and the symbology that would be used to label features and attributes. The attribute data was limited and included such items as acquisition year, size, type of material, feature sub type, and other needed data fields. Data conversion required substantial time and was completed in September 2003. A map book application was developed to publish a paper based map of the District that was similar to their old paper map books that were used by field and office personnel. The GIS system went live in October of 2003.

Configuration of the CMMS system had begun in April of 2003. Discussions were held to determine how maintenance activities were going to be tracked and recorded. The types of work orders, and data elements that were going to be used were also determined during this early time period. The tracking of labor, material and equipment costs was reviewed to determine how to best set up the system to record, track and report maintenance cost data. The discrete work activities that the District wanted to track were identified and setup in the system. A significant amount of time was spent reviewing and identifying what data elements to track. While the District wanted to capture required data elements, they did not want to burden the workforce by requiring large amounts of data capture.

It was during this time that a decision on how to role out the work orders was decided. While the IT Master Plan presented a mobile solution, it was not certain that the technology currently existed to enable full map display and work order processing to occur remotely with adequate performance. There are significant differences in work processes between a paper based system where field crews complete work on paper work orders for later entry into the system and a paperless work order system where field crews are entirely responsible for entry of data in the field. The decision on how the work orders would be rolled out to the field required time to test both potential solutions.

Since a client server environment was being implemented, the only practical solution for mobile deployment was a Citrix or Windows Terminal Server approach. It was decided to pilot the mobile solution as this solution would require significant time to

develop and test. For pilot purposes, Windows Terminal Server was selected since it is bundled with Windows 2000 server. Using a standard laptop with a CDMA cellular card and VPN software from the firewall vendor, the mobile solution was setup for testing.

As expected, the performance was not very good. Significant delay existed especially to bring up the map. In addition, six logins were required to get to the CMMS application. This was too many logins to be practical, especially for field and maintenance crews. In addition, whenever the connection was lost the user had to re-login six times to get back to the application. It was becoming apparent that this solution was not going to be very practical for everyday use. For the mobile solution to be useful, the performance had to be improved and the logins had to be reduced. It was decided to put the mobile pilot on hold and continue with the CMMS setup while alternatives were discussed on how to improve mobile performance and usability. The initial CMMS setup was complete by July 2003 and was suspended pending final setup and testing after the GIS and mobile decision were complete.

After the GIS was complete in September of 2003, the CMMS implementation activities once again started. The final CMMS implementation activities involved data conversion of inventory and final testing of work order processing with the fully functioning GIS system. During this time a potential solution was discovered that could possibly eliminate the performance and login problems of the mobile solution. The mobile pilot began again with the addition of new VPN software and what was observed was short of astonishing. The delay problem all but disappeared and the login count reduced to three. In addition, the VPN software would maintain a connection even if the cell connection disconnected. Once a cell signal was again available, the user's session would continue where it was at the time the connection broke. This eliminated the need to re-login, at all, during the day as mobile users traveled throughout the District. Now, the mobile solution stayed active all day, only required three logins to get to the application and had performance that was more than acceptable to all users. Based on this, the decision was made to implement work orders using a completely paperless mobile based solution. The District could now rely on the crews and service personnel to enter the data elements into work orders instead of printing paper, writing activity on paper and having an office person enter the data in the system and complete the work order. This was going to not only save significant office time but also save field time since all GIS and CMMS data would be available to field crews real-time in their vehicles.

Now that all the system's database schemes had been finalized and all application setup was substantially complete, the integration component of the project could begin. The integration work began in November of 2003. As outlined in the Master Plan, CIS customer data would be integrated to the service point in the GIS as well as the customer database in the CMMS. Meter data from the CIS would also be integrated to the GIS. In addition, the service orders from the CIS would be integrated to the service requests in the CMMS. This would enable field personnel to obtain customer, owner, connection and meter information at each service point

from the map. With this data integrated to the GIS, staff could make geospatial queries against CIS data elements. In addition, consumption, rate, route, collections and other CIS data elements can be plotted on a map as well. Along with the GIS integration, the CIS customer data was also integrated to the CMMS. Users can create service requests or work orders in the CMMS using actual CIS customer data. There is no duplicate database to maintain.

The final integration element involved integrating the CIS service orders to the CMMS. This was the main integration as a major business process disconnect existed between CIS and CMMS at this point. Most customer calls are taken in the CIS. The calls that result in a field service order usually get created and printed out by field service staff. Field service staff will take the service order call and complete the required tasks. Upon completion, the service order is closed by office personnel in the CIS. If the service order requires a work order then a separate work order must be created in the CMMS and worked and tracked in that system. The CIS service order usually is not associated to the work order that it created. This creates information disconnects in that the customer service representatives usually do not know about the corresponding work order. The solution to this problem was to have customer service representatives create the service order in the CIS, and if it required a field service action, the service order would be automatically created in the CMMS as well. All field personnel obtain their service requests from the CMMS and not the CIS. When the service request is complete in the CMMS, the related service order in the CIS is closed as well. However, if the service request requires a work order, then a work order is created in the CMMS and is associated to the originating service request. The service order is not closed until the work order is complete in the CMMS. With this integration the process for creating, working, tracking and closing a service order/request is uninterrupted. It flows from the CIS to the CMMS and back to the CIS when complete.

All service requests are dispatched to field personnel wirelessly via the mobile laptops and no additional work processes are needed to dispatch a service request to field personnel after it is created in the CIS. The request is dispatched to field service personnel within minutes of it being created. When it is closed the status is also updated in the CIS from the mobile laptop within minutes. This has created a very efficient process that has significantly reduced the time to complete a service order.

The CMMS went live April 1st 2004 with full mobile support. The district is already improving other processes that can leverage the capabilities of the CIS, GIS and CMMS. This brought to a close a 17 month long process to implement and integrate financial, customer, geographic and maintenance management systems and deliver the information to field personnel real-time remotely in their vehicles.

This project would not have been successful with out the dedication of District's staff who participated in the project. The Citrus Heights Water District is located in suburban Sacramento area of California. They have 24 full time employees and serve approximately 20,000 customers with potable water service.

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