Tracking Water Service Facility History within ArcMap

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Paper Abstract

This paper presents the development of an application to manage service history of hydrants and water valves in a water system. This application is integrated with ArcMap to manage status changes of these facilities. Current statuses of these features are depicted in ArcMap and ArcIMS. Having this information available has provided greater efficiency between the water controllers and field crews by making sure water features get fixed in a timely manner. In addition, water features with a high failure rate can be identified and researched to discover the reasons for such failures.

Introduction

The City of Anaheim is located in Southern California consisting of 50 square miles with a population around 337,000. The City operates its own water utility, which contains 744 miles of water mains, 61,097 water meters, 27 active wells and 13 reservoirs. Anaheim generates 75% of its water supply from the active wells and 25% is imported from the Metropolitan Water District. The average daily distribution of water is 66.6 million gallons. The Water Field/Operation Section of the Water Services Division is responsible to provide high quality water by maintaining equipment and devices, treating, pumping, and distributing water. In order to perform their duties the Water System Operators control the City's SCADA system, track water valve and hydrant service status changes, dispatch service orders, and perform after hours customer service. ArcGIS ArcView was installed at the Water System Command Center in 2002 and was widely accepted by the Water System Operators. ArcMap is running a custom Extension developed in-house by the Water Utility GIS Analyst accessing ArcSDE Feature and Table data. It had become apparent to one of the Senior Water System Operators that an automated process was needed to track the water valve and hydrant service status change cards. In addition, the information should be available through the GIS system for other Water Sections to access.

The Water System Operators performed the tracking of water valve and hydrant service status changes manually. The process included creating an index card that held the facilities ID number, date, time, operator name, district map number, and a short description of the reason why the service had changed. This card was then filed on a rack until the status changed again. Once the status changed, the service card was filed in a drawer with the rest of the historical status change cards. The manual tracking of these service changes limited the exchange of information between other Water Service Sections.

Data Design

A comprehensive data assessment was conducted to uncover all available information related to hydrants and water valves. Three main sources of information were found for hydrants and three main sources of information were found for water valves. They each had a Service Status Change Card, a GIS Feature Class in ArcSDE, and a database table with location information. Figure 1 displays the data structures for each Feature Class. They both are up to date and are maintained by GIS Operators within the Water Services Department.

WTR.HYDRANT	
OBJECTID	ESRI reserved field
PRESSUREZONE	Pressure Zone # Reference
INSTALLDATE	Date Feature was Installed in the Field
ROTATION	Graphic Rotation of Feature
LIFECYCLESTATUS	The Stage of Facilities Lifecycle
SUBTYPE	The Type of Feature
PROJECTNO	Project Number Reference
PLANNO	Project Plan No Reference
DETAIL	Exist in Detail Area
WATERTYPE	Type of water flowing through the pipe
FH	Feature Identifier - Primary Key

WTR.WATERVALVE	
OBJECTID	ESRI reserved field
PRESSUREZONE	Pressure Zone # Reference
INSTALLDATE	Date Feature was Installed in the Field
ROTATION	Graphic Rotation of Feature
LIFECYCLESTATUS	The Stage of Facilities Lifecycle
SUBTYPE	The Type of Feature
PROJECTNO	Project Number Reference
PLANNO	Project Plan No Reference
DETAIL	Exist in Detail Area
WATERTYPE	Type of water flowing through the pipe
VALVENO	Feature Identifier - Primary Key
DIAMETER	The Size of Valve
NORMALLYOPEN	Is Valve Open as Normal Operation

Figure 1

Figure 2 displays the data structures for the related table information that retains location attributes about each feature. This data is also up to date and is maintained by GIS Operators within the Water Services Department.

HYDRANTBOOK	
OBJECTID	ESRI reserved field
FH	Feature Identifier - Primary Key
STREETNAME	Street Hydrant is on
LOCATSIDE	N, S, E, or W side of Street
LOCATDIST	Distance from Street Intersection
LOCATDIR	Direction from Street Intersection
LOCATST	Cross Street Name

VALVEBOOK	
OBJECTID	ESRI reserved field
VALVENO	Feature Identifier - Primary Key
MAINST	Street the Valve is on
CENTERM	Distance from MAINST Cline
CURBM	Distance from MAINST Curb
INTERST	Cross Street Name
CENTERI	Distance from INTERST Cline
CURBI	Distance from INTERST Curb

Figure 2

It was important to try to keep the same workflow that the Water System Operators were familiar with when issuing a Service Status Change Card. The application gains a much better chance of being successful rather than being shelved because it was too complicated to use.   It was decided that the information recorded on the Service Status Change Cards would be the same fields used in creating the ServiceHistory database table. A separate ServiceHistory database table would be created for its perspective Feature Class.   Figure 3 shows the ServiceHistory database tables for hydrants and water valves.

FHSERVICEHISTORY	
FH	*Feature Identifier - Primary Key*
OPERATOR	*Opertor changing status*
REMARKS	*Description information*
INSERVICE	*Boolean Identifer*
SERVICEDATE	*Date of Service Change*
SERVICETIME	*Time of Service Change*
CURRENT_LOG	*Boolean identifying the record as the current setting.*

VALVESERVICEHISTORY	
VALVENO	*Feature Identifier - Primary Key*
OPERATOR	*Opertor changing status*
REMARKS	*Description information*
INSERVICE	*Boolean Identifer*
SERVICEDATE	*Date of Service Change*
SERVICETIME	*Time of Service Change*
CURRENT_LOG	*Boolean identifying the record as the current setting.*

Figure 3

All three pieces of information for each Feature Class relate to one another based on their Primary Key Fields. Now that there was a way to record Service Status Changes in a table, the next step was to try to symbolize the feature in ArcMap based on the current status. The current status would be kept in the INSERVICE field that would be used to symbolize the features' status in ArcMap. Since this field has to be edited to reflect status changes, the INSERVICE field was added to HydrantBook and ValveBook tables because the Water System Operators did not have ArcEditor to edit the feature attributes. The relationship design is depicted in Figure 4 where the hydrant feature is joined to HydrantBook table, which is then related to FHServiceHistory table. This configuration hold true for the water valves as well.
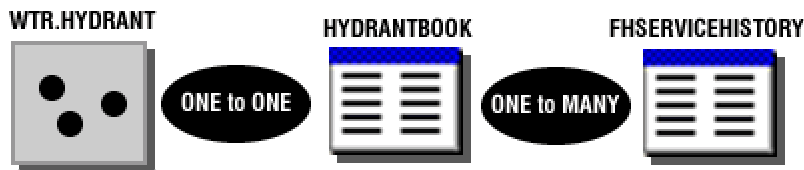

Figure 4

The Fire Department expressed some interest in seeing a list of hydrants that were out of service within each Fire Station Zone. The information the Fire Department needed for reporting these Hydrants happened to already exist in HydrantBook table except for the Fire Station Zone and Fire District Map Number. These fields were added to HydrantBook table shown in yellow in Figure 5 and incorporated into the daily maintenance process.

HYDRANTBOOK	
OBJECTID	*ESRI reserved field*
FH	*Feature Identifier - Primary Key*
STREETNAME	*Street Hydrant is on*
LOCATSIDE	*N, S, E, or W side of Street*
LOCATDIST	*Distance from Street Intersection*
LOCATDIR	*Direction from Street Intersection*
LOCATST	*Cross Street Name*
. . . .	
INSERVICE	*Current Service Status*
FIRE_STATION	*Fire Station Zone #*
FIRE_DISTRICT	*Fire District Map Page#*

Figure 5

Log Service Tool

ArcMap allows the integration of applications through the use of Visual Basic for Applications (VBA), Visual Basic (VB), and other Component Object Model (COM) compliant development languages. Hydrants and water valves required their own separate tool to track the service status. These Log Service Tools were created in Visual Basic 6 as binary Dynamic Link Library's (DLL)'s. This allows the source code to be hidden eliminating the end user from tampering with the application. The DLL's were loaded into the ArcMaps' Normal Template through the Customize Interface Dialog.

The user interface needed to be easy to use for non-technical users and informational to the Water System Operators request. A single form was the optimal choice reducing multiple clicks and streamlining the information needed for the Water System Operators to react swiftly responding to Field Crew request. As seen in Figure 6, the lower half of the form is the same layout of the manual Service Status Change Form the Water System Operators were use to working with.

Figure 6

In the Table View section of the Tool, the default listing is the "Currently Out of Service" features. Additional types of listings are "Currently In Service", and "Service History". The Table View shows exactly who, what, where, and when about a Service Status Change. All the features in the Out of Service data listing are depicted as green symbols in ArcMap. The features in the In Service data listing are red symbols. This coloring scheme coincides with the colors used by the SCADA system where red means active and green means inactive. This reduced the possibility of confusion when comparing the SCADA system and GIS Feature Service Status.
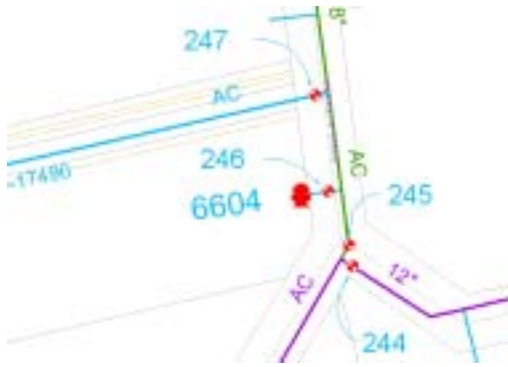
Before Service Change   **After Out of Service Change**
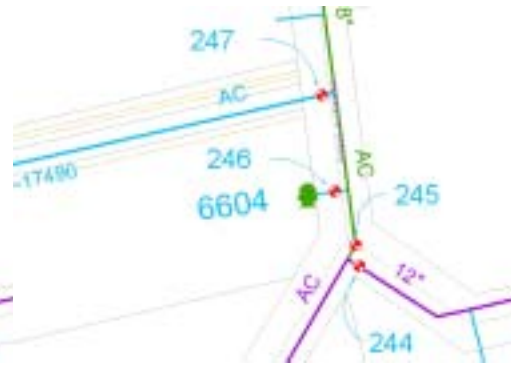
Create Service Record button creates a blank service record and enables the Hydrant Service Information fields for editing. The only information required by the Water System Operator is the Hydrant Number, Operator Initials, Service Type, and Remarks. Date and Time are already populated. Apply button must be clicked in order to save the new record.

Add New Service Record Workflow
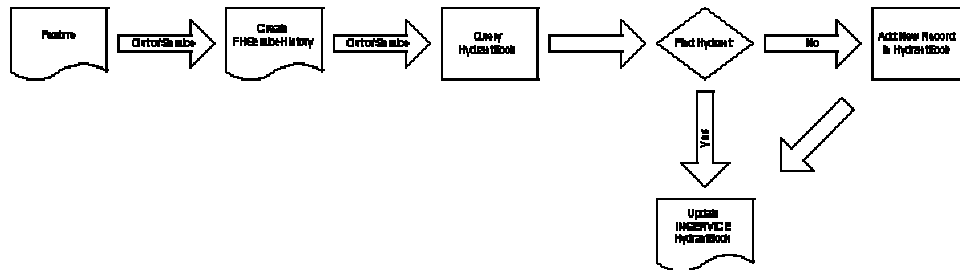
Enables the Water System Operator to edit a Service Status Change Record selected in the Table View.

Deletes the currently selected record in the Table View from the ServiceHistory database table. HydrantBook INSERVICE field is updated if the ServiceHistory record Current Log value equals 1 (True).

Creates an InService record from the selected Out of Service record. The RTN stands for Return to Normal.

Prints a formatted report from the current display in the Table View portion of the form.

Results

The Log Service Tool with the creation of a ServiceHistory database table accomplished the initial goals and more. The Water Service Operators now have an electronic cataloging tool for Service Status Changes. The distribution of information was accomplished with the current statuses being viewed through the use of ArcGIS ArcView or through ArcIMS with the ArcMap Server Module. In addition, an intranet web page using ASP was created for the Fire Department to access current public hydrant outages based on Fire Station Zones. Transmission & Distribution, Water Production, and Water Engineering Divisions are all viewing and accessing the same information eliminating the discrepancies generated from multiple sources. This in turn has generated an increase in the confidence in using GIS instead of the hard copy maps.

Analysis can quickly be accomplished to help support Transmission & Distribution Division schedule maintenance to Out of Service features. Statistics can be run to create justification to increase the frequency of the Valve Exercise Program to reduce valve failures. The Capital Group of Water Engineering can use the data to determine if the placement of a Hydrant needs to move due to the amount of Out of Service records based on auto accidents.

Future Enhancements

- Expand the tracking to accept other water system features such as Pumps and Pump Stations.
- Track non-water system features such as Dispatch Orders.
- Integrate Log Service Tool into a single tool for many feature types.
- Automate Hydrant Out of Service request if a relationship exist with the Water Valve Out of Service request.
- Provide a single feature query display in Table View
- Add Context Menu to the Table View for Zooming Functions.

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