Developing Data Acquisition Methods for Updating the City of El Segundo Water System Map

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Introduction

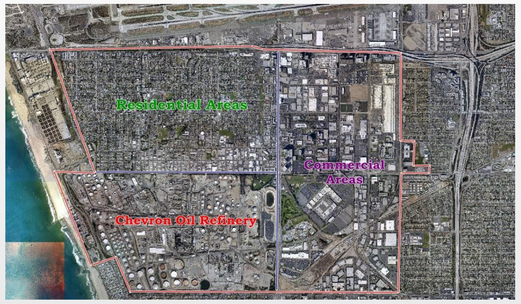


Figure 1. *City of El Segundo, California*

In 2014, a 30-inch major water pipe burst in the city of Los Angeles and wasted about twenty million gallons of drinking water amid severe drought. The broken pipe was constructed nearly 100 years ago, and corrosion caused the water main to burst. LA's other aging water pipes also present potential hazards. Maintaining an up-to-date GIS based water system network is one way to help identify water mains at risk of breaking.

This project focuses on developing data acquisition methods for updating the GIS based water system network for the City of El Segundo. El Segundo is located in Southern California, and divided into three distinctive districts: residential areas, commercial areas, and Chevron Oil Refinery as shown in Figure 1. The water infrastructures in the city include water mains, water service lines, water valves, water meters, fire hydrants, and fire service lines. Figure 2 shows common water meter boxes found in the residential areas, and Figure 3 shows an example of a fire service and compound water meter in the commercial areas. All the feature points and lines for the water infrastructure were edited and managed in ArcMap 10.3, and data was collected in the field using several different methods.

Figure 2. *Water Meter Box*

Figure 3. *FDC and Compound Water Meter*

Data and Data Sources

In order to update the El Segundo Water System Map, I heavily relied on existing datasets which I referenced when updating feature geometry and attributes. I used aerial imagery and Google Street Map to digitize and street data to update related information. The water meter spread sheet was acquired from the Water Department to collect data. Various other data were acquired as shown Table 1.

Table 1. *List of data and data sources used in the project*

Dataset	Source
Orthophoto	LARIAC 2,3, and 4
Water Meter Spread Sheet	City of El Segundo Water Department
Parcel, Curbs, Street Data	City of El Segundo Public Work Department
Google Street Map	Google
Valve Book, Water Index Map	City of El Segundo Engineering Department
Engineering Drawing	City of El Segundo Engineering Department

Methodology

Figure 4. *The Overall Workflow for the Project*

Figure 4 shows the general process that I followed as I work on updating the water system map. After collecting data for water infrastructures, I established the water network based on the information acquired through data collection. And then I added and edited GIS layers in order to maintain an up-to-date water system map. Various data acquisition methods were used, including digitizing with an orthophoto and Google Street Map, utilization of engineering drawings, a field survey with GPS equipment, and coordination with staff from the Water Division. All the data collection methods listed here were required to complete the project. Figure 5 and 6 exhibit the digitizing processes with Orthophoto and Google Street Map. Figure 7 and 8 describe the field survey process for water valves using Trimble 7X GPS Equipment. Figure 9 and 10 show examples of an engineering drawing and valve book that were used for updating attribute table.

Figure 5. *Digitizing with Orthophoto*

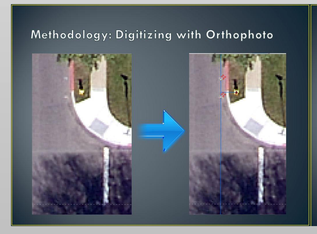


Figure 6. *Digitizing with Google Street Map*

Figure 7. *Trimble Geo 7X GPS Equipment*

Figure 8. *Field Survey for Water Valves*

Figure 9. *Engineering Drawing*

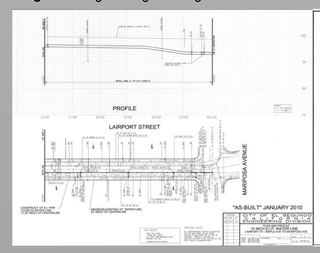
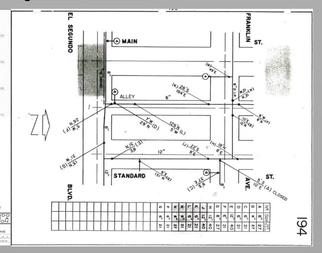


Figure 10. *Valve Book*



Results

Figure 11. *FDC & Water Meter in Commercial Areas*

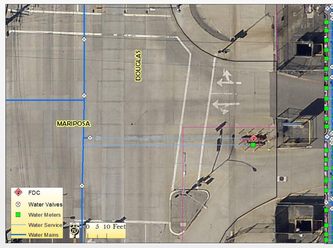


Figure 12. *Water Meters in Residential Areas*

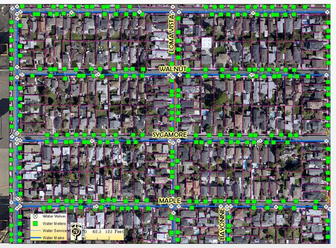


Figure 13. *Water Valves at Intersection*

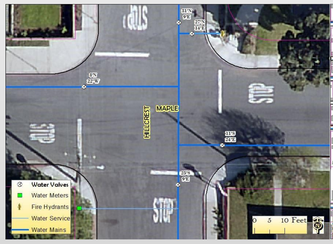
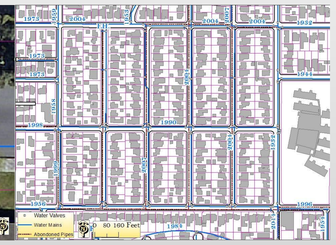


Figure 14. *Water Mains with Construction Year*



As shown in Figure 11, the compound water meter and Fire Department Connection were digitized using an orthophoto. Those feature points for water valves were acquired by using either an orthophoto or Google Street Map. The orthophoto provides a clear view to identify where water valves are located. The water main and service lines were drawn using Valve Book, Water Index Map, and Engineering Drawing.

In residential areas, water meters were easily collected by using GPS equipment because they were consistently located near their entrances as shows in Figure 12. However, it was a bit tricky in business areas because they were randomly distributed and usually more than one meter was assigned to one business building. In addition, because there were a lot cars and structures near the water meters, data collection using an orthophoto and Google Street Map was challenging in business areas. Most data was collected though using GPS equipment in business areas, and it took a longer time to complete data collection, compared to the water meters in residential areas.

A majority of feature points needed for this project were acquired thorough exploring different generations of orthophotos and Google Street Maps as it shown Figure 13. This method was easiest and most accurate way to collect data for this project. Each intersection has about 4-5 water valves so that water mains are connected through all the water valves.

Figure 14 illustrates water mains with information about construction year and shows how the water network is established. The information for the water pipes were acquired from utilization of engineering drawing, Valve Book, and Water Index Map.

The El Segundo Water System Map was successfully completed after including all the water infrastructure features.

Timeline

Table 2. *Timeline for the Project*

LAYER	START	END
Water Valve	Oct 2014	Jan 2015
Fire Hydrant	Oct 2014	Jan 2015
Water Main	Jan 2015	Feb 2015
Water Meter	Feb 2015	Aug 2015
Fire Service	Jul 2015	Aug 2015
Water Service	Jul 2015	Aug 2015

The data acquisition for the water valves started in October 2014, and data acquisition for the water meters started in February 2015. The final project was completed in August 2015. The entire project took about a total of 600 hours.

Discussion

Table 3. *Comparative Effectiveness for Methods*

Methods	Time Efficiency	Cost Efficiency	Accuracy	Feature Accessibility
Digitizing	Very High	Very High	Very High	Low
Utilization of drawings	High	High	Medium	Medium
Field Survey	Low	Low	High	High
Coordination with Staff	Very Low	Very Low	High	High

Table 3 explains all the methods used for this project and their level of efficiency. **Digitizing** is a data collection method using an orthophoto and Google Street Map. Both time and cost efficiency for this method were very high, and the quality was very high as well. However, this method was limited because many objects were not visible from imagery. **Utilization of Drawings** is a data collection method using blueprints including the Valve Book, Water Index Map, and Engineering Drawings from various departments. Both time and cost efficiency were high, but its quality was relatively lower than the digitizing method because information from the engineering drawings was often outdated and handwritten, which made information unreliable. A **field survey** with GPS equipment took time and cost more than any other methods, however, its quality was high, and it allowed me to access all the features. This method was the most important data collection method, and a majority of data of this project were acquired through this method. **Coordination** with the Water Department employee was the last step to find features that I was unable to locate through all the previous methods Therefore, the most efficient way to collect data for this project was to digitize using the orthophoto and Google Street Map, however, the field survey was the most important part for this case because it allowed me to access all the features. Thus, these methods should be consecutively executed to minimize time and cost.

Conclusion

The water system map in the City of El Segundo is now completed and readily available to various departments within the city. For this project, I ultimately collected data for over 5,000 water meters and updated data for 2200 water valves, 2300 water pipes, 5700 water service lines, 600 fire hydrants, and 300 fire sprinkler systems. Many departments within the city will benefit from this water system map, and it will allow the city to efficiently manage and maintain its water system infrastructure.

Figure 15. *Final Map of the Residential Areas*

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