BlueConduit

Get the lead out

CFPUA's process from locating to replacement of galvanized services

To meet regulatory deadlines and protect public health, CFPUA needed to pinpoint galvanized water service lines quickly and cost-effectively. By pairing historical records with predictive mapping tools from Esri, they built a smarter replacement strategy. At BlueConduit, we complement this approach with machine learning models that prioritize which pipes to inspect and replace first—maximizing efficiency and reducing unnecessary digs. Explore how data-driven decisions can accelerate your replacement program. Read the full post here.

Cape Fear Public Utility Authority (CFPUA) is a public water and sewer authority, serving approximately 200,000 people daily. CFPUA was created in July 2008 as a merger of the City of Wilmington and New Hanover County, North Carolina, water and sewer departments. The goal was to reduce redundancies and focus on providing essential services while saving costs for customers. Across our service area, CFPUA maintains almost 1,200 miles of water mains, 950 miles of sewer gravity mains, and 180 miles of sewer force mains.

Challenge

The US Environmental Protection Agency's Lead and Copper Rule Revisions (LCRR) required public utilities to provide an inventory of water service laterals by the October 2024 deadline. There were several apparent challenges when CFPUA began the process to complete its service line inventory and comply with EPA requirements.

Among the challenges of this inventory project was the requirement that utilities identify the material of the public-owned side of the service line as well as the customer-owned side of the line. This essentially doubled the work CFPUA had anticipated needing to complete and played a significant role in influencing the creative transformation of our approach.

As plans began to form, the team tasked with this process spanned stakeholders within and outside CFPUA. Communicating and translating data to multiple separate stakeholders was identified as an essential aspect to ensure the most efficient job could be carried out across all phases of this project. This included the eventual publication of our inventory to our customers, and the transition to the replacement process for those services that were identified as eligible for replacement.

The large scale and dynamic nature of processes, as well as the involvement of many different people within CFPUA and from outside contractors, led project managers to decide that GIS tools would become an important asset for completing this task on time. With so many separate groups involved, GIS would be the constant medium to connect all project team members and help define their roles and project tasks.

Solution

With a clear deadline and task outlined by the EPA requirements, CFPUA began work to identify all service lines. Staff used GPS locations from CFPUA water meters that were plotted into GIS, ensuring a precise starting place for finding the service line on the public- and customer-owned portions. This list showcased the full scale of work that needed to be done and would act as the main source for editing data, as well as the final product used for submitting to the EPA, informing the public, and transitioning to the replacement phase.

Ruling Out Service Lines with Historical Data

With the spatial locations in place, the next step was consolidating data that had already been acquired, which included historical data, spatial data, and some surveyed inspections previously completed. Using additional GIS layers provided by New Hanover County's GIS Open Data Hub, such as parcel and property data, CFPUA was able to utilize joining techniques in ArcGIS Pro to add the age of a property to its associated service line to help estimate the date of water connection. Similarly, spatially joining install date information from CFPUA GIS layers of the nearest water main attached a second date to help determine the age of the service line.

With the context of the installation date added to the main layer, CFPUA began ruling out the possibility of lead for large portions of the system. Using definitive state, county, and city standards, CFPUA concluded that any service line installed after 1987 would not have been made of lead. Using this 1987 date as a baseline, CFPUA employees dug through filing cabinets for project specification sheets with detailed materials, to identify and rule out neighborhoods that would not require hand digging or additional investigation to determine service line material, in compliance with the terms of the LCRR. Included in these were the original City of Wilmington tap records in ledger books dated back to 1895. Tens of thousands of records existed in the oldest parts of CFPUA's service area. All this data was either directly added into the main layer or used as an extra point of reference for ruling out or verifying the findings and material classifications of service lines.

Lastly, CFPUA had already conducted a comprehensive service line inspection project across downtown Wilmington, the oldest part of CFPUA's service area. The material data for nearly 10,000 publicly owned service lines could be added to the main layer, but the private-owned portions of those lines had yet to be addressed.

Tracking Physical Inspections using ArcGIS Online

Having ruled out many water service laterals using this supplemental data, staff was able to focus on filling in the remaining unknown pieces with physical inspections. CFPUA then contracted out several companies to aid in the inspection work, and the challenge became communicating the specific lines to dig. CFPUA queried out the remaining locations without sufficient data into a layer in ArcGIS Online. This layer was then configured into an ArcGIS Field Maps application, which enabled the surveyors to edit a select number of attributes using defined options from a dropdown list, guaranteeing consistent data records. Coordinating with the surveyors, CFPUA provided them ArcGIS Online logins and the Field Maps application. The data captured was recorded and shared with CFPUA employees in real time. The final data from the field survey could be translated back into the main layer. ArcGIS Dashboards was also used in ArcGIS Online as a data review of the surveys as they happened, showing total holes dug and sorted by material results, along with a chart showing the date of inspection. This helped CFPUA review the results and track work being done. This was necessary for payment and monitoring progress of contracted surveyors.

The process of extracting specific data for surveying, setting up an ArcGIS Online layer to be edited using Field Maps, and then translating the data back to the main layer became a central part of the project repeated multiple times, as we uncovered new places that needed material identification.

Combining GIS and Machine Learning

Despite CFPUA's extensive work ruling out as many service lines as possible, the remaining unknowns to be dug manually for inspection remained too large to complete within the time frame, and further methods would be needed to create a quicker and more cost-

effective solution. CFPUA decided to utilize BlueConduit, to use machine learning software to generate lead likelihood predictions based off all the collected data. Their technology would fill in the gaps of unknown materials with a high level of certainty, which would remove the necessity to survey every service line manually. BlueConduit and CFPUA deployed Esri's Lead Service Line Inventory solution, and CFPUA converted the entire main layer, complete with all added historical data and already completed surveyed results to ArcGIS Online, so BlueConduit had everything located in a single layer for the purposes of complete and accurate prediction results. BlueConduit used the data from ArcGIS Online, ran it through their machine learning technology, and provided recommended inspection sites to strengthen the prediction accuracy. CFPUA could then take those specific recommended sites to populate more Field Map surveys, while extraction, monitoring, and eventually updating into the main layer continued, with the passing of data between BlueConduit, CFPUA, and the surveyors occurring through GIS and Esri's online applications.

Results

After collaborating with BlueConduit, CFPUA finished the service line inventory by the October 2024 deadline. CFPUA confirmed that our water distribution system was lead-free, with a small percentage of service lines being galvanized and eligible for replacement by CFPUA.

Another useful piece of utilizing the Lead Service Line Inventory solution was that it framed the completed inventory data to match what necessary data needed to be sent to the EPA. It also helped frame how we would communicate this inventory in a public-facing map to our customers. Making a few small modifications to the main layer, CFPUA used ArcGIS Experience Builder to generate a web application with an easy user experience for customers to look up their address and see the classification of their service line.

Being able to utilize these Esri tools saved CFPUA an estimated $2 million in further surveying costs. GIS greatly sped up this project, ensuring the deadline would be reached and saving CFPUA and the other companies involved the hassle of large data downloads and transfers by instead being able to log into ArcGIS Online and access the data when necessary. In total, physical inspection identified around 15,000 service lines, and utilizing data integration with GIS and predictive modeling accounted for identifying the remaining 138,000 service lines, or nearly 90 percent of CFPUA's total inventory.

Additionally, having this data in a spatial format allowed for an easy transition into planning phases for service line replacement projects. By querying out the service lines identified as galvanized, CFPUA could quickly begin putting together maps showing the scale and logistics required for replacement work. Having centralized data in GIS became useful again as spatial data such as an address and the associated customer information allowed an easy extraction of a contact list for replacement notifications. Similar tracking and updating of data as service line replacements occur will have a similar workflow as the inventory process, and familiarity with using GIS in this context will allow CFPUA a smooth process for replacement projects.

> "While a solution to the problem was on the horizon in 2020, Esri tools guided the organization in a direction to efficiently and effectively tackle and produce an accurate inventory. Without Esri [ArcGIS] Solutions, the deadline of October 2024 seemed unattainable."
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> **-Gary McSmith, PE Chief Engineer**