TROUBLE UNDER FOOT

The rising toll of water main breaks, sinkholes and hidden leaks requires a new approach

By Suzan Chin-Taylor

Sinkholes and washed out infrastructure are a growing problem for municipal utilities as failing water mains erode surrounding soil.

Water main breaks are often associated with cold weather freeze-thaw cycle effects, but in recent years, the number of breaks, subsequent sinkholes and leaks have been on the rise regardless of season or climate.

Some municipalities with the means to take a proactive approach to the growing problem have been able to stay ahead of the wave and mitigate catastrophic impact, but for many municipalities it's tough to get out of the reactive mode.

"One of the challenges for an asset owner is having enough data to make a truly informed decision," explains Michael Twohig, project director for subsurface mapping at DGT Associates of Boston. "Unlike sanitary sewers, there aren't many easy and inexpensive options to test water pipelines from the inside. Ultrasonic testing can be used for larger lines to check the wall seam thickness or corrosion, but it is very difficult to perform this over the entire pipeline. Spot inspections are helpful, but again, it doesn't guarantee the integrity of the entire line, so even with rigorous testing, it may not preclude the system from having failures in between the tested locations."

Trenchless technology has helped extend the life span of water delivery systems, but many sections have reached or gone well beyond their intended design life and the best resolution is replacement.

According to a recent study by The University of Utah, water main break rates have increased by 27% in the past six years. The majority of those breaks are occurring in cast iron and asbestos cement, which make up almost half of the water mains in North America. Smaller municipalities experienced twice the number of breaks as larger metropolitan areas, and the overall rise in breaks is expected to grow exponentially over time. The study goes on to advise utilities across the country to "rapidly accelerate pipe replacement schedules to avoid

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Water main breaks are hardly a new phenomena, but aging infrastructure is leading to growing problems. A recent University of Utah study shows water main breaks have increased 27% in the past six years.

potentially serious economic and social impacts.

"An average of 0.8% of installed pipe is replaced each year across the country. This equates to a 125-year national pipe replacement schedule. Pipe replacement rates should be between 1% and 1.6%, equivalent to 100- and 60-year replacement schedules, respectively. In general, pipe replacement rates need to increase."

Not so obvious effects

"There are quite a few ramifications to having a water pipeline failure, with the most obvious being the inconvenience to the customers and residents," Twohig says. "It's the one we always think about, but there are many larger challenges that happen in the surrounding environment. For example, in the Boston area where we are located, there have been several breaks that have impacted hospitals and flooded basements and patient care facilities."

Remediation and reconstruction costs can be high. In addition, erosion of material from a break makes an area highly susceptible to sinkholes. Even after a repair is made, leaks may have been in existence for extended periods, making it difficult to measure the extent of material loss. Sinkholes may not appear for weeks, months or even years after a repair has been made, creating a false sense of security for the community after the immediate crisis and repair work is done.

"Budgets will always be a challenge, and some things you will not be able to prevent. But there are some things that municipalities can do to help reduce the damage and make things more manageable and less stressful for their response teams," Twohig says.

A robust and accurate mapping of assets, their age, composition, community information and demographics is critical to performing work efficiently. The added benefit of this is the ability to make well-informed decisions on whether to fast-track lines that may need replacement or identify those that are candidates for rehabilitation with less-invasive trenchless technology.

Be prepared

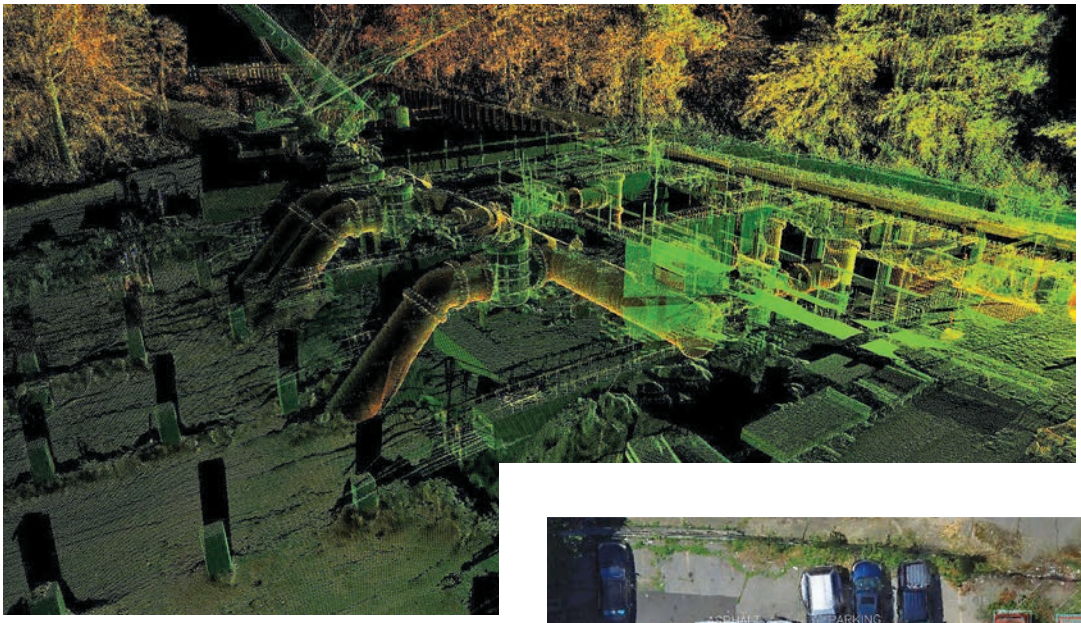
Applying the Boy Scouts motto to water system data has even more value beyond the obvious maintenance and repair needs. In areas that have been identified as high risk, ensuring that all valves are functioning properly is critical.

"Having a highly detailed inventory of where all of the assets are, in particular shut-off valves and facilities and also the proximity or spatial awareness to other critical facilities or utilities, can be of incredible value to first responder crews that need to be able to locate the valve quickly to reduce the impact of the incident," Twohig says. "When you're in a foot or two of water in the middle of the night during freezing conditions, it isn't easy for crew members to figure this out quickly."

Having asset data and maintenance records available on mobile devices is also proving helpful. Cloud-based systems can even query the names of other asset owners who need to respond to an emergency One Call ticket before repairs can begin.

GIS is essential but has some limitations, as it is intended to be primarily informational. It was not designed to be exact, like a survey-grade drawing. In addition to helping crews quickly pinpoint exact locations of shut-off valves and the composition of infrastructure to prevent as much damage as possible, having survey drawings tied into GIS can offer valuable insight about the surrounding area and any other assets or infrastructure that could be impacted. All of this information can help other utilities and crews be as prepared as possible in the event of a catastrophe.

Take for instance a major water main break in Philadelphia's downtown business district during a summer heat wave. When the main broke, spilling approximately 15 million gallons of water, the flood spread in multiple directions and closed surrounding streets. Over 1,000 customers were without power for an extended period in the extreme heat, and businesses were completely shut down. The break left mud and debris for



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Accurately mapping infrastructure is critical for effective response to main breaks and mitigating the peripheral damage they cause.

FIGHTING THE CURRENT

Certain areas are more prone to water leaks, breaks and sinkholes, including those exposed to a high influence or subjected to electrolysis.

For example, waterlines or other buried utilities situated close to subway or electrified rail systems would be subjected to electrolysis. In San Francisco, waterlines located close to a streetcar line experience accelerated water leaks and premature failures due to the influence of stray current.

"On one of the pipeline projects our firm worked on in metropolitan Boston, asset owners claimed that in the area of streetcar systems, there was one line that was losing over a hundred pounds of metal a day due to accelerated corrosion from stray current," says Michael Twohig, project director for subsurface mapping at DGT Associates.

Cathodic protection can help prevent the acceleration of this pipeline corrosion from electrolysis and has been used successfully in the past. The "sacrificial anodes" are buried next to pipelines to rust away and stop or prevent the acceleration of the nearby pipeline's corrosion.

"For municipalities that need to prioritize due to budget constraints, adding locations in these high-voltage areas to the priority list for more testing, rehabilitation or replacement is worth considering to avoid inevitable and more rapidly developing waterline failures," Twohig says.

blocks around the site with one major street being closed indefinitely. It took months to fix the crater created by the break, and the financial impact to businesses and a major hospital in the affected area was estimated to be in the millions.

Communities rarely have the patience for long failures, so having the necessary information to reduce response and corrective time is a huge advantage.

Drones and heat mapping

The use and application of drones is another proactive approach to assessing water system health. In addition to surveying and mapping, drones can be equipped with remote sensing technologies such as infrared that can utilize thermal deviations to help identify possible leaks and potential sinkholes earlier than visual inspections. They can be preprogrammed with specific flight paths to inspect and record a systems' health status in high-risk areas and populate even more detail in an agency's current GIS database.

Leak detection programs also help cities stay ahead of catastrophic breaks and leaks, but they often come with a hefty price tag. Designed to be deployed throughout a system to detect water loss that can be indicative of a pipeline that's about to rupture, they can be tied to GIS and asset management systems to dispatch a crew before the break happens.

This level of monitoring and maintenance can be very effective, but it requires a large investment that many cities simply haven't found the budget to implement. For those cities looking to move to a more proactive mode within their budgets, Twohig suggests using "heat mapping" to help prioritize.

"The use of heat maps is becoming commonplace in many industries. Whether it's in politics or other metrics that you're trying to evaluate, it's a very intuitive, visual-orientated approach."

For municipalities, the map of their environment would be populated with the number of incidents. As the incident number grows, the color would change from green to yellow to orange to red. Once at the red level, managers can direct available budgets to be focused in those hot areas.

"When you have a large system with a limited budget, having a heat map helps you pinpoint readily where you need to dedicate resources to stay ahead of catastrophic failures," Twohig says. "You may not prevent everything, but you will be able to shift more in the direction of maintaining your assets proactively and perhaps have fewer sleepless nights worrying about or dealing with breaks and the aftermath." ✦