https://doi.org/10.1002/opfl.1172

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Water utilities have made great strides in the last few years regarding water loss control. Now, an Arkansas utility has applied a promising new tool for identifying potential leak locations. BY CHELSEA ODLE

SATELLITE IMAGING TECHNOLOGY HELPS UTILITIES REDUCE NONREVENUE WATER

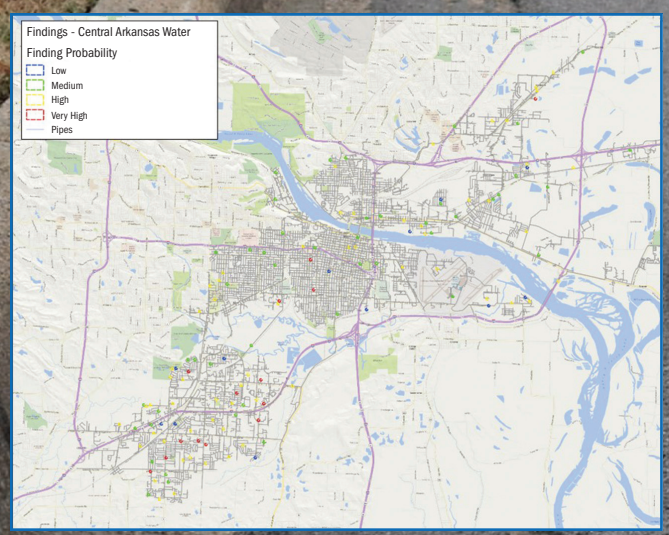
KEEPING NONREVENUE WATER levels as low as possible is a primary goal of every water utility. Numerous best practices, advanced leak detection equipment, and innovative vendors vie for the attention of utility leaders when it comes to putting a stop to leaks. Now, satellite imaging technology suggests one answer to leak detection starts in outer space. Whether it's the solution utilities have been looking for depends on factors that are unique to each utility, and those factors should be weighed before investing in satellite imagery.

Central Arkansas Water (CAW), located in Little Rock, found the technology useful in locating nonsurface leaks when paired with best practices in leak detection and monitoring. The utility plans to continue its proactive emphasis by focusing on upgrading detection equipment and developing a new map layer for easement inspection and assessment.

CAW contracted with Utilis, an Israeli satellite-based leak detection company, in late 2017. The company launched its commercially available product in late 2015 and has since conducted more than 100 projects around the world. When CAW signed its contract, it was one of six US clients adopting the technology—a number that jumped to 52 by the end of 2018.

PHOTOGRAPH: CENTRAL ARKANSAS WATER

L-band satellite radar imagery is used to identify likely leak locations (inset). CAW work crews checked each potential leak site with traditional acoustic leak detection equipment, saving an enormous amount of time in the process.



A PROACTIVE APPROACH

Based on data gathered by its satellite technology, Utilis delivered a report to CAW in December 2017—about two weeks after it collected a satellite image—suggesting 156 possible leak sites across 747 miles of pipe. Although CAW maintains more than 2,500 miles of pipe, the satellite imaging company conducted its pilot study in only a portion of CAW's distribution area.

CAW work crews took the report's findings and checked each potential leak site with traditional acoustic leak detection equipment, determining that 37 percent of potential leak sites (58) actually had a leak (Figure 1). There were 87 sites in which no leak was found, and 11 sites were neither confirmed as leaking or quiet (sites to be re-examined).

"Even though the success was only about 40 percent, it still pointed us in the right direction to look for nonsurfacing leaks," said Blake Weindorf, CAW's director of distribution. "This technology doesn't necessarily help you find the big breaks and large amounts of water loss. But for us, it started us looking in a direction that's more proactive rather than reactive. Traditionally, we'd wait until our nonrevenue water would go above 8 or 9 percent and then start looking for leaks."

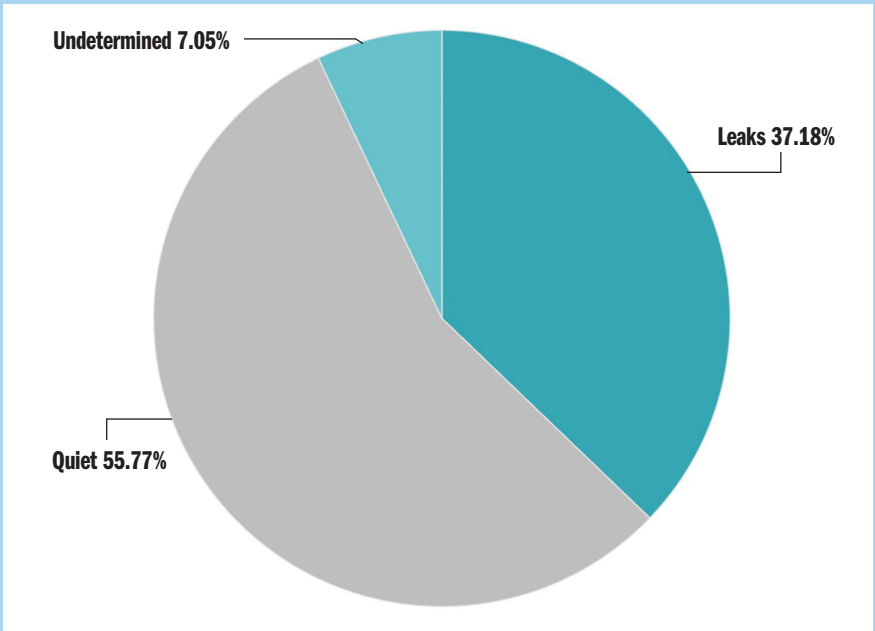
Before using the satellite image–led review of possible leaks, CAW's leak detection crew typically proceeded by responding to customer reports of a leak or low-pressure event as well as to requests from distribution system operators who suspected leaks in the system. In 2018, the utility's 12-month running average for nonrevenue water dropped by more than six percentage points from a near all-time high of 14 percent in 2017 to about 7.5 percent as of October 2018 (Figure 2).

The satellite imaging pilot study was one element of CAW's overall leak detection efforts. During dry months, after the pilot study was concluded, the utility's leak detection team diligently inspected mains and easements along major roadways, making a special effort to track water back to a storm drain. Often this led to finding a leak several blocks away.

According to Weindorf, CAW soon saw the fruits of its effort. In 2016, at its highest point in the year, CAW's nonrevenue water was calculated at just under 12 percent. The next year it almost reached 15 percent, which is the Arkansas Department of Health's action level. AWWA's 2006 benchmark median is 9.5 percent; with all its efforts, CAW's level measured below that benchmark in 2018.

Figure 1. Pilot Project Results

Out of 156 possible leaks found via satellite imagery, CAW found 58 to be credible leaks confirmed with listening equipment.



TECHNOLOGY DETAILS

Satellite image–led leak detection technology doesn't actually detect a leak in a pipe. Rather, it detects the signature of drinking water in soil, providing the ability to detect leaks of all sizes.

According to Matt Phillips, CAW's distribution coordinator, most of the leaks found during the utility's pilot study were small and didn't account for much water leaving the system. However, unreported and nonsurfacing leaks that continue for a long time can add up to a large volume, making them as important to find as large breaks. Although some of the leaks were in places crews may never have found, others had been spotted by crews, or reported by customers, before the leak detection crew found them in the satellite imaging report (see inset image, page 11).

The technology uses L-band satellite radar imagery to identify likely leak locations. *Radar*—an acronym meaning radio detection and ranging—is an object-detection system that uses electromagnetic waves in the radio or microwave domain to determine an object's range, angle, or velocity. Radar signals are reflected especially well by materials of considerable electrical conductivity, including wet ground.

The satellite radar signals illuminate a selected area of interest, and the reflected images are bounced back and collected

Although the technology doesn't pinpoint an exact leak location, it reports a radius where the leak is likely to be.

by the satellite. These images can be processed to omit the noise and isolate the signs of potable water underground. The satellite imagery provider overlays the images with utility data and delivers a target map of likely leak locations. By directing crews to high-potential target areas, time and effort are saved compared with relying only on traditional leak detection methods and inspecting an entire service area without such clues.

POSITIVE RESULTS

During the first leg of the field review of the 156 possible leaks identified in the satellite images, CAW had an average success rate of 3.3 leaks per day. That's a significant improvement over the assumed average .75 leaks per day found by crews using traditional leak detection technology alone. Based on these results, by using satellite imaging, CAW would require only about 20 days for a team to verify the 747 miles of pipe included in the utility's pilot study, compared with an estimated 250 working days to verify the same area using traditional methods alone.

Satellite imaging also removes some of the challenges associated with traditional leak detection approaches, such as hard-to-reach locations. Also, the satellite imaging company can overlay its data onto a utility's map to plot pipe material, age, leak history, and other important parameters. Moreover, the company's report of potential leaks isn't limited only to the utility's assets. Of the confirmed leaks in the CAW pilot study, 43 percent of them (25) were on customer lines and not on the utility-owned pipe segment. CAW valued this information because it allowed the utility to improve customer service by notifying customers of likely leaks on their respective premises.

Although the technology doesn't pinpoint an exact leak location, it reports a radius where the leak is likely to be. With this information, a large buffer area is used by the crews on the ground to listen for a leak. Some crews were surprised that leaks were found by this approach in unlikely areas.

According to Weindorf, satellite technology won't yield the highest results if a utility's team members aren't embracing it to its fullest potential.

"If your staff is close-minded, it's not going to be successful," he said. "You have to have a staff willing to be innovative and accept this as a new tool in your toolbox. We were very thorough in our investigation. We had a higher success on the front end—upward of 65 percent of the first half of the possible leaks we checked."

NEXT STEPS

CAW's next steps include focusing on promoting a proactive approach so leak detection is in the forefront of the minds of all service crews while in the field. The utility also plans to add a layer to its interactive mapping software that will provide detailed data and history on easements throughout its distribution system, as leaks in easements often go unnoticed longer than those occurring in roadways and near residential or commercially developed areas.

In addition, the utility plans to invest in new listening equipment in 2019. After bringing that equipment online and accomplishing the added easement inspection layer, the utility will reassess its nonrevenue water status.

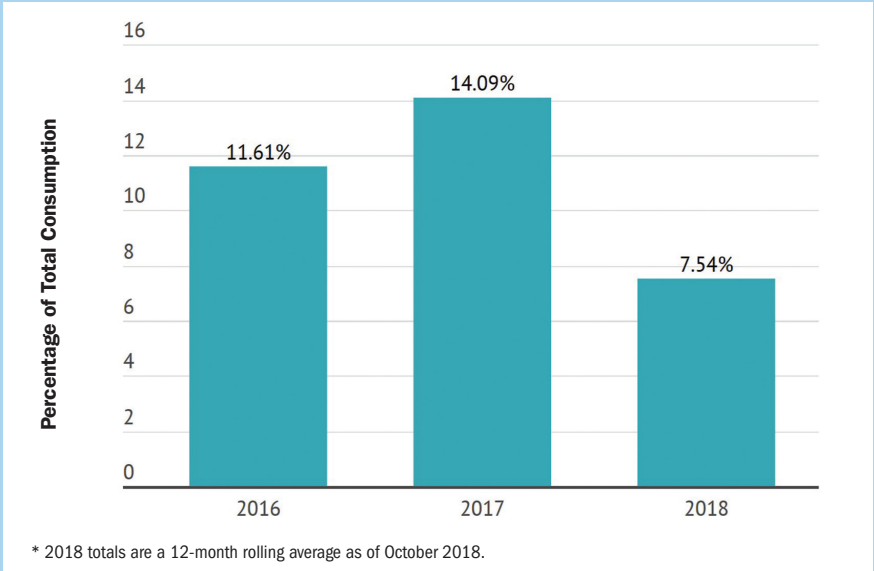
When deciding whether satellite-based leak detection technology would bring enough return on its investment, a utility should consider the following factors:

- The time it would otherwise take workers to survey their service area for leaks
- Whether finding leaks on customer lines would be beneficial
- Only a percentage of the possible findings reported from the satellite image will be determined to be actual leaks, and most of the leaks found are likely to be small in scale

CAW staff thought the satellite image pilot program was beneficial enough to consider budgeting for a second image in a few years.

Figure 2. Nonrevenue Water Savings

CAW's nonrevenue water was on the rise in 2017. After using satellite imagery and focusing on leak detection, the utility reduced its nonrevenue water considerably in 2018.



* 2018 totals are a 12-month rolling average as of October 2018.