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Pressure-Sensing Technology Mitigates Nonrevenue Water Loss

For more than two years, Aqua Pennsylvania has used remote pressure-sensing technology to identify pressure transients, reduce water main breaks, and mitigate nonrevenue water.

BY ANDREW STRASSNER, ELIZABETH LOUGHNANE, MICHAEL HENRY, AND SHANE HUETH

MAIN BREAKS are a normal part of operating a water utility and can be caused by many factors, including sudden pressure fluctuations or ground movement resulting from extreme weather. In fact, according to the American Society of Civil Engineers' 2021 Infrastructure Report Card, a water main break occurs every two minutes in the United States, and an estimated 6 billion gallons of treated water are lost each day.

Despite their frequency, main breaks can create major issues for water utilities and customers, including drops in water pressure or loss of water service. By using advanced pressure-sensing technology, water utilities can implement a proactive approach to mitigate these unplanned operational disruptions.

MITIGATING MAIN BREAKS

For more than two years, Aqua Pennsylvania (Aqua PA) has been using a pressure-sensing technology, SEMPER Remote Pressure Monitor (RPM) from AMERICAN Flow Control (www.american-usa.com), to identify pressure transients, reduce main breaks, and mitigate nonrevenue water loss throughout its water system of roughly 5,900 miles of pipeline. Aqua PA provides water and wastewater services to more than 1.5 million residents across the state of Pennsylvania and is a subsidiary of Essential Utilities, which provides water, wastewater, and natural gas services to more than 5 million people in nine states.

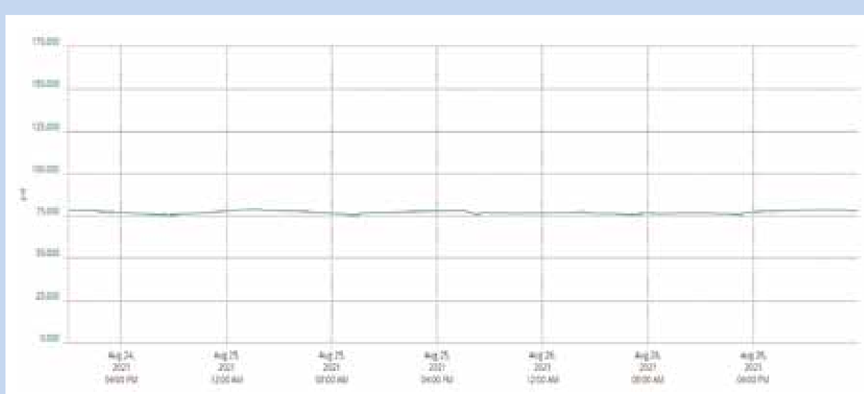
Once deployed and recording, the devices provide utility operators and distribution managers with a better understanding of system pressure dynamics by identifying and locating pressure transients within the water system. Although Aqua PA is familiar with impulse detection technology and had invested in impulse monitoring in the past, previous units weren't as portable and couldn't be used as easily for lift-and-shift applications. The ability to move the pressure monitors provides a more complete picture of pressure wave signatures and trends as well as the locations of potential sources.

APPLICATION DETAILS

The work in Aqua PA's Chalfont system, located in Bucks County outside of Philadelphia, is an example of the technology's efficiency in pinpointing pressure transients. It's an isolated water system serving about 4,000 residents, with four wells, three tanks, two pressure zones, and approximately 30 miles of water pipeline. Mike Henry, Aqua PA's distribution maintenance manager for

Figure 1. Before Pressure-Monitoring Implementation

A chart shows the Chalfont system pressure data without impulse technology.



The pressure-monitoring devices consistently indicated transients on one side of a pressure-relief valve but not the other, allowing Aqua PA to better pinpoint or triangulate a transient source.

Chalfont, requested the use of the RPM devices after noticing an uptick in main breaks—specifically service saddles and asbestos–cement main splits.

The maintenance team developed a monitoring plan and deployed the devices on local hydrants to record pressures within the target area. Within a few days of deployment, Aqua PA isolated the problem to a specific pump within one of Chalfont's pressure zones that was causing transient pressure swings exceeding 100 psi. This was detected thanks to the RPM units' ability to collect up to 256 pressure measurements per second, which provides visibility to transients that Aqua PA was unable to detect using traditional pressure gauges. Without such high-frequency-sampling capability, the transients might have otherwise gone undetected.

To address the issue, Aqua PA installed a soft-start control on a pump for less than $5,000 and observed a significant reduction in transients. Although the pump still produces 20-psi pressure swings when turned on and off, this is much better than the 100-psi swings recorded before the change to a soft-start control was made.

The installation and response reduced main breaks by 80%—despite the water system's experiencing a more extreme winter than the year before—and reduced service line leaks by 100%. In total, the $5,000 soft-start device resulted in an estimated savings of more than $50,000 in the first year. In addition, the Chalfont system reported a 23% reduction in nonrevenue water year over year following the soft-start installation.

Figures 1–3 highlight the importance of having the pressure-sensing devices deployed in the system. A traditional supervisory control and data acquisition (SCADA) system collects pressure at sampling intervals on the order of several seconds to minutes, resulting in apparent pressure profiles like that in Figure 1, which depicts a smooth operation. But the high-rate RPM pressure data, shown in Figure 2, reveals transient waves occurring in the system. The vital insights occur when the data collected by the units are correlated with pump or valve operations. In the example of the Chalfont system, the transient surges occurred each time the pump came on by overlaying the pump status data with the RPM high-rate pressure data. Figure 3 shows Chalfont pressure data after the soft-start device was installed.

DEVELOPING NEW TOOLS

Aqua PA is taking this approach in systems across Pennsylvania and seeing reductions in pressure transients and main breaks throughout its distribution system since the pressure-monitoring devices have been deployed. The company operates more than 120 pressure zones in southeastern Pennsylvania and continues to explore options to improve its pressure-monitoring capabilities in each zone and across other states.

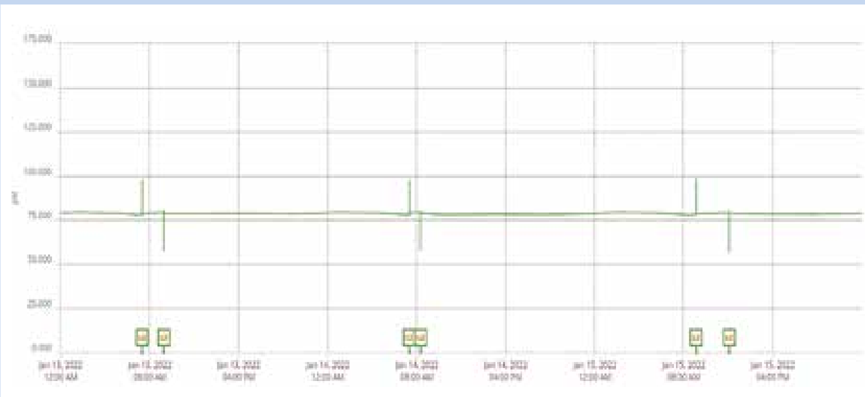
Aqua PA's asset management team has created some useful tools to identify areas with potential transient issues,

Figure 2. After Pressure-Monitoring Implementation

A chart shows the same Chalfont system pressure data shown in Figure 1 with impulse technology.

Figure 3. Transient Reduction

A chart shows the Chalfont system pressure data (with impulse technology) following the soft-start device installation.



which greatly expedited the company's ability to mitigate and thus reduce costs associated with breaks, leaks, and nonrevenue water. This includes main break heat maps (Figure 4) and charting break trends over time for each pressure zone to identify target pressure zones for monitoring with the RPM units.

The pressure-monitoring devices are primarily being installed on hydrants and pressure-reducing valves (PRVs). Because the devices are precisely synchronized in relation to one another, Aqua PA is better able to pinpoint or triangulate a transient source.

The data from these devices indicate that transients were most often located within the boundaries of a pressure zone, and Aqua PA began monitoring zones at PRV control connections, with results consistently showing transients on one side of the valve but not the other. This pressure zone relationship was significant and caused the company to evaluate its main break data more closely to identify which zones were seeing more main breaks. Aqua PA is now consistently leveraging the pressure-monitoring data with SCADA applications to guide meaningful action to mitigate damage-causing transients.

Trimble Unity software (www.utilities.trimble.com) gives the account administrator and/or user the ability to view both active and inactive sites, manipulate the device's pressure-sensing and impulse parameters, and prioritize alerts to personnel within the organization. The software integrates with geographic information system-based software from Esri (www.esri.com) and CityWorks (www.cityworks.com) to optimize asset management and workflow processes within Aqua PA.

Apart from identifying and isolating sources of transients through pressure data interpretation, Aqua PA is also using the pressure-recording devices for ad hoc events such as planned outages and weather events. During Hurricane Ida in 2021, Aqua PA was able to view data from the units and provide feedback for calibration to its modeling and distribution teams so adjustments could be made in real time. In addition, the pressures recorded by the units helped validate the hydraulic model. The units are battery powered and have cellular data communications and can be placed in areas that don't have traditional SCADA, allowing for insights into system pressure that weren't available before.

Because of the successful implementation of the pressure-monitoring devices in southeastern Pennsylvania, Aqua's Corporate Engineering Group is expanding the scope of the technology. The devices are being used to improve visibility, help maximize operational efficiency, and enhance water system modeling across Aqua's eight-state service area.

Figure 4. Main Break Heat Map

Aqua PA used main break heat maps and other useful tools to identify areas with potential transient issues prior to the soft start installation.