COMBATING LEAKS WITH INNOVATIVE MONITORING

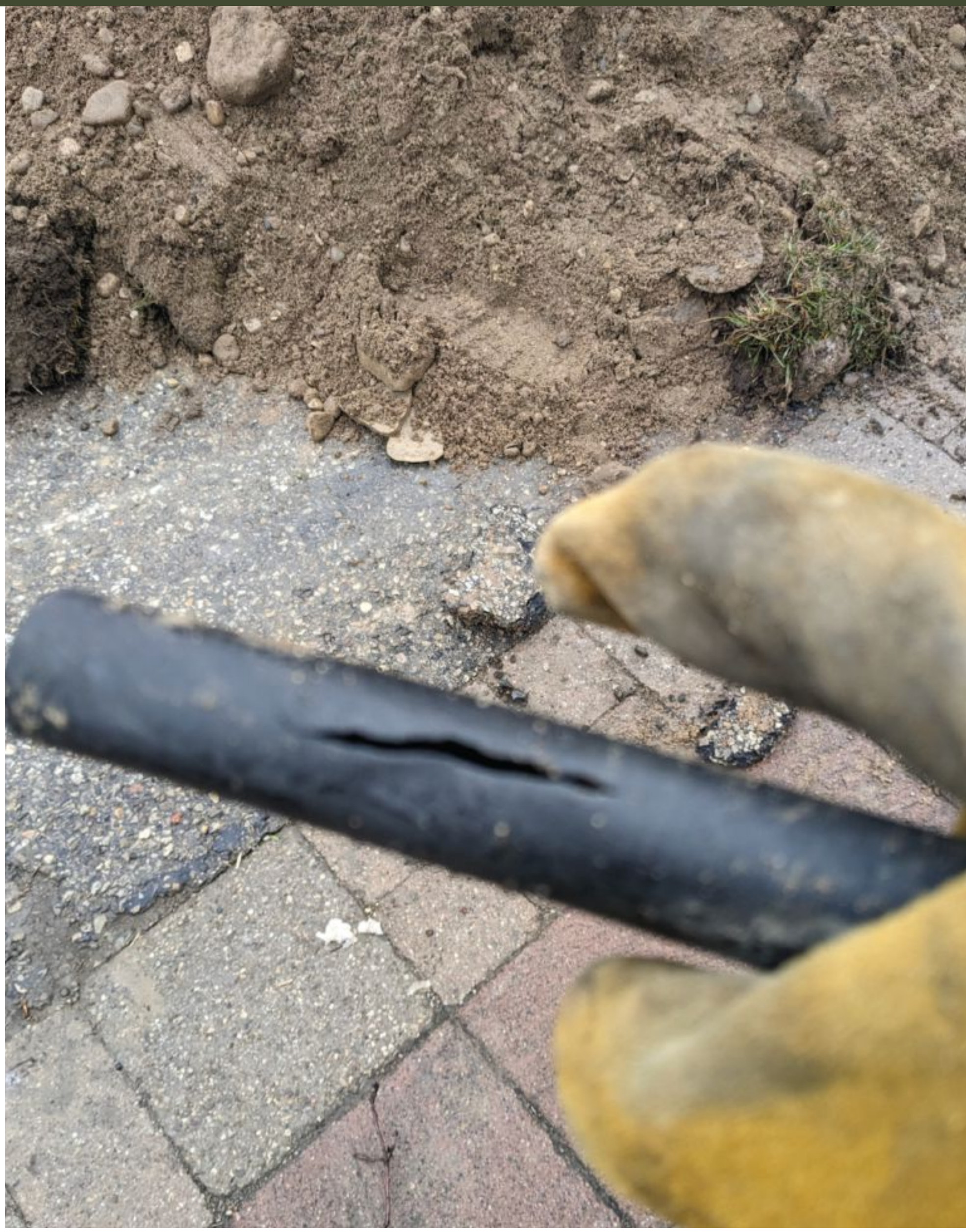
Region of Waterloo Completes Pilot Project Incorporating AI Technology

By Stan Fong

As Canada's drinking water infrastructure continues to age, the prevalence of leaks and the challenges that they pose on utilities also increases proportionally.

When it comes to large leaks, there are many effective solutions available for locating these leaks in a system, including traditional leak surveys and correlator technologies, which try to listen for these leaks through the pipe wall or surrounding soil. Smaller leaks, on the other hand, are often too quiet to be captured by these methods.

Consequently, these types of leaks can account for a significant portion of unreconcilable non-revenue water in older pipe networks. The same can be said for leaks in plastic pipes, which lack the resonant acoustic properties necessary for traditional leak detection



HYD8 – leak geometry a 1.5-in. long crack on a 0.75-in. service connection at time of repair.

approaches. In response, utilities such as the Regional Municipality of Waterloo, in Ontario, have taken a proactive approach to tackle these issues with the help of artificial intelligence (AI) and innovations in sensing.

RMOW-DWS PILOT OVERVIEW

In November 2022, the Regional Municipality of Waterloo (RMOW) installed 10 hydrant.AI units in the Piper area of their water distribution network, as part of a 6-month leak detection and monitoring pilot with Digital Water Solutions Inc. (DWS).

DWS's hydrant.AI technology enables a utility to turn any existing fire hydrant into a "smart" hydrant. A hydrant retrofitted with hydrant.AI provides utilities with real-time water pressure, transient, temperature and acoustic data, alongside AI-powered leak detection, localization and pressure monitoring. Unlike existing acoustic technologies – which listen for leaks outside of the water column – hydrant.AI utilizes a hydrophone to listen for leaks directly in the water, enabling the capture of all leaks, regardless of the leak size or pipe material. Furthermore, their leak detection and pressure monitoring AI is built out of their proprietary autonomous AI engine, which enables hydrant.AI to learn the unique operational profile of each distribution network and subsequently detect and locate leak and pressure anomalies all on it's own, without any user assistance or additional inputs.

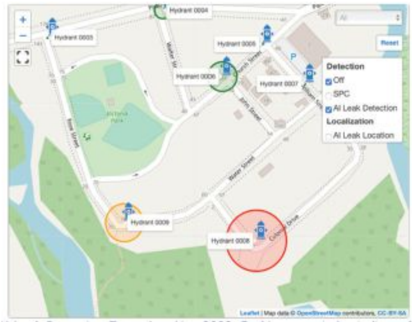
The pilot area was carefully selected by RMOW in order to provide a challenging yet realistic assessment of hydrant.AI's capabilities. A leak survey was performed just prior to the start of the pilot, in which several large leaks were identified and repaired by the utility. Secondly, the entire pilot area is constructed out of PVC and HDPE plastic piping. The following figure shows the layout of the hydrant. AI devices within the Piper Area of Ayr, where this first pilot phase was undertaken.

PILOT SUMMARY

The ability of hydrant.AI to detect leaks in PVC pipes and also detect preexisting leaks (i.e. leaks present prior to the start of the monitoring program) was successfully demonstrated over the course of the Phase I pilot, in which two service leaks were identified by the system and verified in the field. Additional service leaks were also identified in the area after the conclusion of the initial pilot. With the success of the pilot, RMOW agreed to maintain the existing hydrant.AI devices in addition to expanding the monitoring program to a second area.

NOTABLE EVENTS

Leak 1



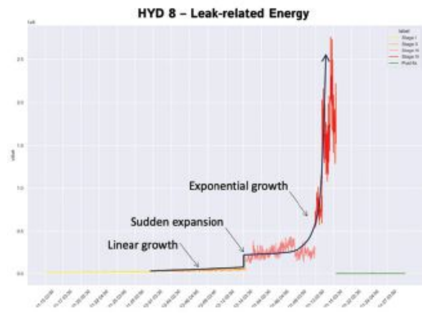
Hydrant.AI Leak Detection Example – November 2022. Red/orange circles indicate a high likelihood leaks.

The first leak (Leak 1) was detected on Day 1 of the acoustic AI deployment (Nov. 15, 2022) and monitored until it was called in by a customer and repaired on Jan. 17, 2023.

The leak was located near HYD8. Leak fingerprinting was used to verify that the leak had begun prior to the start of the pilot. Acoustic noise collected by the devices over a 3-week span in November, showed no indication of the sudden appearance of the leak noise.

Data from the system shows the leak signature clearly present from the outset of the data collection, and this signature disappears when the leak is repaired. The growth in leak energy was monitored through the processed acoustic data and correlated to an increase in leak size (flow rate) and increased exponentially prior to the leak being called in when it eventually surfaced.

The various stages of leak growth were further corroborated by AI models fitted to other data sources, including pressure (available from the hydrant. AI units) and SCADA data. The start of the linear leak growth phase beginning in December 2022 was proceeded by a period of sustained, irregular pressure patterns, as detected by hydrant.AI.



HYD8 leak energy over time.

The autonomous AI engine was also fitted to the Region's SCADA data. Several SCADA anomalies were detected by hydrant.AI throughout this period. The most prominent event occurred on Dec. 14-15, which aligns with the sudden, step increase in leak energy observed.

The leak was repaired by RMOW on Jan. 17, 2023, after being called in by a resident. The leak geometry/size at the time of repair was an approximately 1.5-in. long crack on a 0.75-in. service connection.

- Based on the leak geometry and pressure data DWS estimates that the leak resulted in 3,838,000 L of NRW.
- Based on the estimated leak energy shown in Figure 6, the value of the NRW_1, assuming a run time between Nov. 15 and Jan. 17, is approximately $11,0801.
- Assuming that the leak was present prior to the installation of monitoring devices, as our posterior analysis suggests, the estimated value of the NRW would be $2,518/month1. Offsetting the CO_2 emissions for a leak of this size would require approximately planting six trees/month or recycling 200 lbs of waste/month.[2,3]
- While not a large leak in relative terms, the presence of numerous small leaks of this nature – particularly in PVC networks – represents a fraction of NRW that is currently challenging to reconcile for utilities. The use of smart water technologies, such as hydrant. AI, can provide utilities with the necessary tools to detect, monitor, localize, and repair such leaks in their system.

Leak 2

Leak 2 was identified near HYD6. Excavation by the Region determined that the leak was on the service connection, customer-side. The period of high energy identified by the system is inferred to be the excavation period. Based on a distinct change in the leak fingerprint on Jun 21, 2023, DWS infers that the leak was repaired on this date by the homeowner.

It should be noted that although this leak was on the customer side of the service line, the leak was ahead of the meter, thus there is a cost to the Region associated with the leak in terms of NRW.

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References:
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2. EPA (2020). Waste Reduction Model (WARM), Version 15. U.S. Environmental Protection Agency.
3. McPherson, E. G.; van D. N. S.; Peper, P. J. (2016). Urban tree database and allometric equations. Gen. Tech. Rep. PSW- GTR-253. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 86 p