Abstract

Flexible and Scalable Solutions for Monitoring Water Distribution and Collection Systems

Presenter: Doug Vermillion

Water distribution and collection systems must be monitored and maintained to minimize water loss, reduce the risk of contamination, and ensure public health. This presentation will examine how remote telemetry equipment may be deployed permanently or temporarily to provide flexible and scalable solutions for data insights and action, emergency response, project planning, shutdowns, and hydraulic model calibration. These devices may be deployed anywhere in your distribution network, have configurable alarms, produce high resolution data, and use near real time communication allowing for faster responses to events.

The presentation will cover specific use cases across drinking water distribution, and storm water/sewerage collection systems, and will define the problem and then cover the solution.

Key takeaways will include:

Distribution Monitoring Use Cases:
- Pressure and Leak Detection
- PRV Monitoring
- Pump Station
- Tank Level

Wastewater and Collections Monitoring Use Cases:
- Rainfall
- Open Channel Flow
- Sewer Overflow
- Lift Stations

Learning Objectives: Understanding how monitoring technology may be permanently or temporarily deployed to help identify and solve problems in water distribution and collections systems.

Flexible and Scalable Solutions for Monitoring Water Distribution and Collection Systems

Doug Vermillion

Solution Architect

330-900-4946

dvermillion@badgermeter.com

Badger Meter

MIDWEST METER INC.

29 October 2026 | © 2026, Badger Meter, Inc. All rights reserved.

Agenda

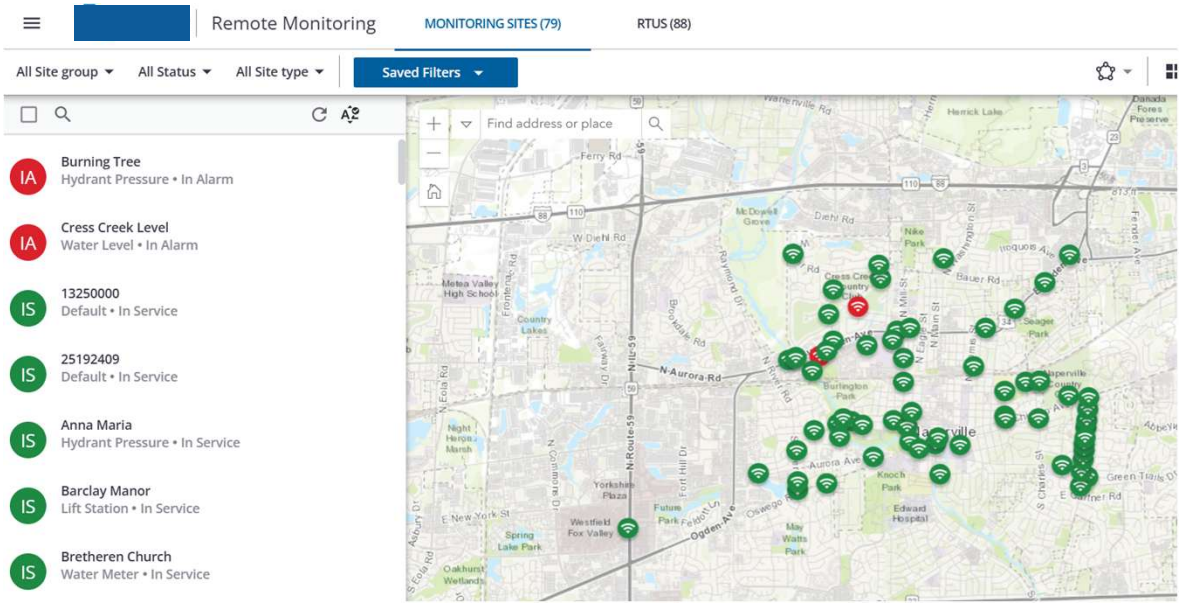
- Review conditions/problems that exist in distribution and collections system. We'll define the problem and then discuss solutions.

- Discuss how monitoring devices can detect unseen and unknown issues as they are developing.

- View analytical tools and data management options.

What is a Network Monitoring System?

Technology driven infrastructure installed in the field that combines sensors, software and data analytics to continuously monitor pressure, flow and quality of water in near real time.



Why Bother With Network Monitoring Systems?

Provide Near Real Time Monitoring with Alarming

- Data, Data, Data
- Visibility into the system and situational awareness
- Proactive vs reactive
- Anticipating risk
- Operations performance
- Modeling and design
- Field responsiveness for any problems
- System efficiency by minimizing energy loss
- Guarantee quality of product and service

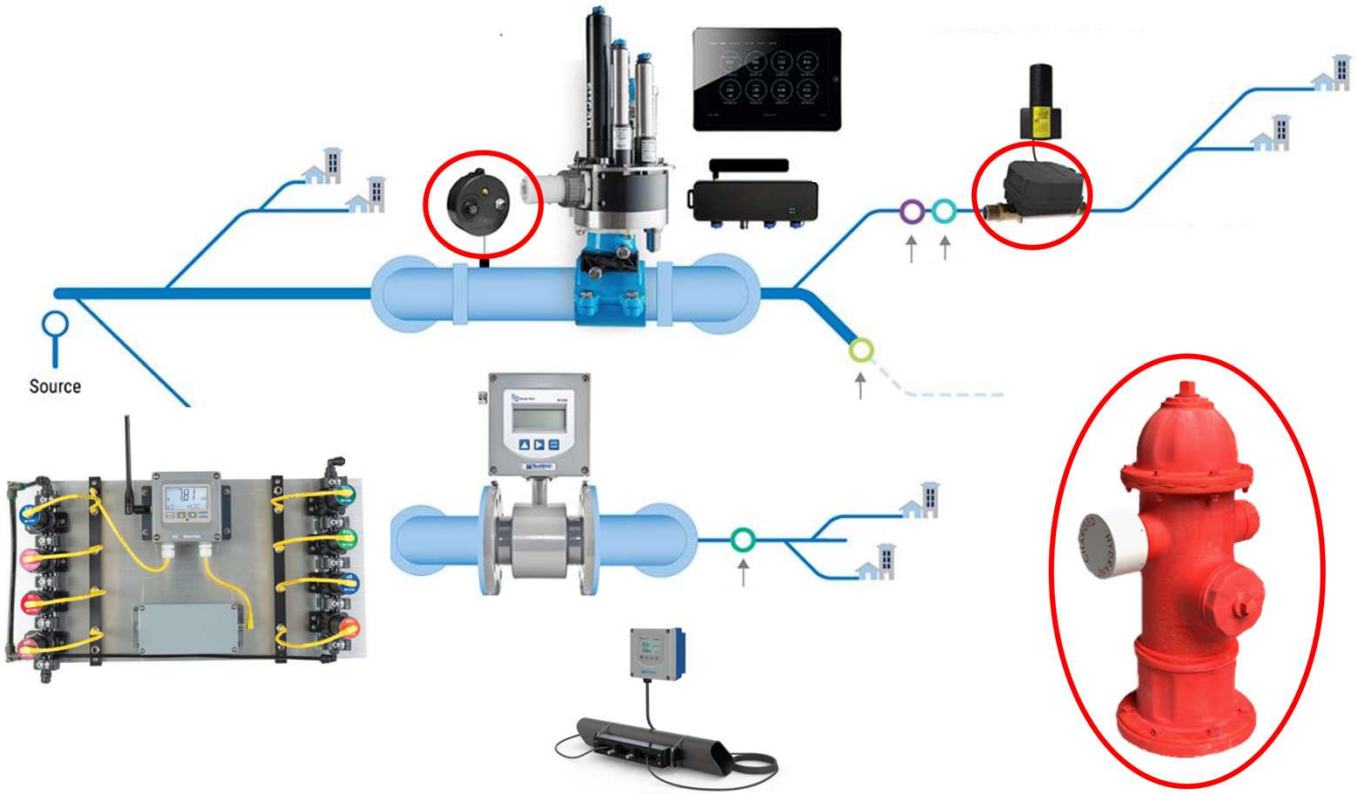
What are Remote Telemetry Units (RTUs)?

RTUs are not control devices but can be used to augment SCADA

- Family of devices for almost any distribution and collections application
- Cellular data transmission
- Programmable settings: sample frequency, data delivery schedule, alarm/alert
- Battery powered
- Ruggedized with submersible options
- Bluetooth communication for field operators
- Web based software with data warehousing, analytics, reporting
- APIs for secure data sharing (SCADA)
- Analog, pulse and digital inputs

Distribution System Network Monitoring

Pressure monitoring, leak detection, District Metering Areas



- Pipe Network Monitoring
- Flushing Optimization
- Pressure Monitoring
- Flow Monitoring
- Leak Detection
- Transient Detection
- Event Detection

Choice Matters: Pressure Monitoring

E-Series with Pressure

1 s/sec : 4x/day

PIPEMINDER Hydrant

128 s/sec : 15min – 6hr intervals
Real-time transient detection and analysis

Hydrant Pressure Recorder (HPR)

1 s/hr – 256 s/sec : 1hr – 24hr intervals
Configurable pressure monitoring, transient detection option, real-time alarming

PR-32 Pressure Recorder

1 s/hr – 256 s/sec : 1hr – 24hr intervals
Configurable pressure monitoring, transient detection option, real-time alarming

PIPEMINDER Standard

128 s/sec : 15min – 6hr intervals
Real-time transient detection and analysis

PIPEMINDER External

128 s/sec : 15min – 6hr intervals
Real-time transient detection and analysis

PIPEMINDER Acoustic

128 s/sec : 15min – 6hr intervals
Real-time transient detection and analysis
Includes leak detection capability

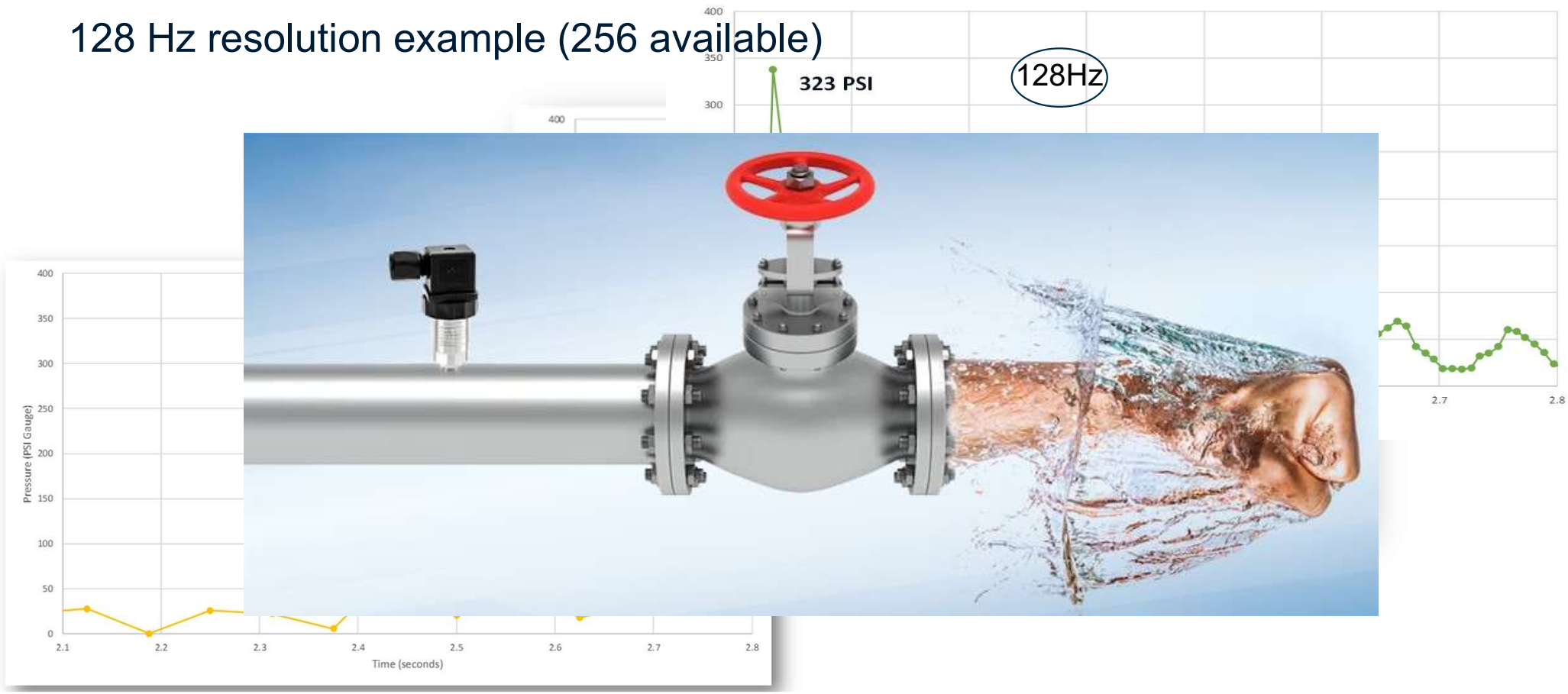
Multi-channel Pressure Recorder (RU-32)

1 s/hr – 256 s/sec : 1hr – 24hr intervals
Configurable pressure monitoring, transient detection option, real-time alarming, 8 data inputs

High Resolution Pressure Data Comparison

Transient = Impulse = Hydraulic Shock = Water Hammer

128 Hz resolution example (256 available)



Distribution Network Pressure Monitoring Applications

Temporary or Permanent:

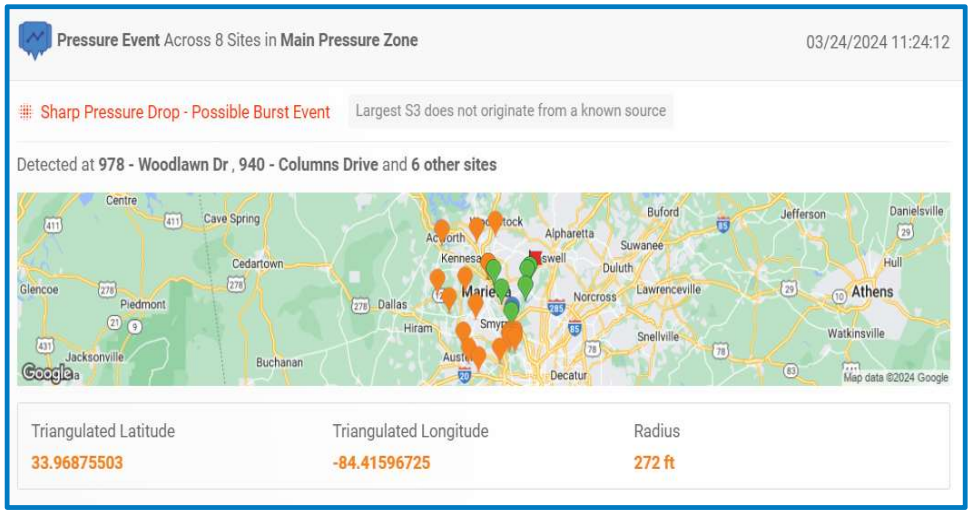
- Pressure investigations, customer complaints
- Fire flow testing, hydrant capacity
- Hydraulic model calibration
- C-Factor Testing
- Asset performance validation
- Real-time event notifications

Distribution Network Pressure Monitoring for Transients

Transient Classification

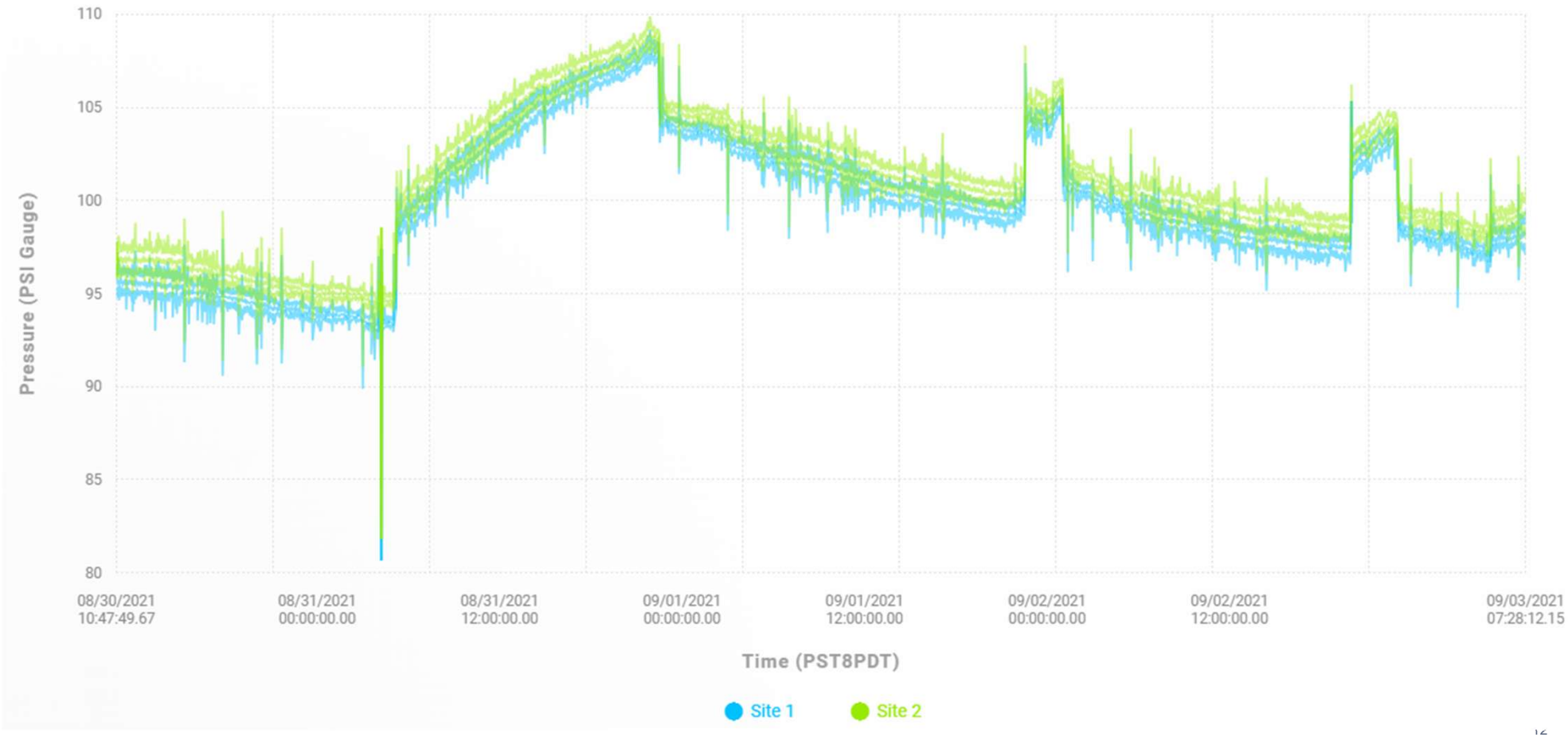
Permanent/Temporary
- Single channel
- Multi channel

Event Triangulation



Hydrant Options

Pressure Data Overlayed: Max & Min Over Time



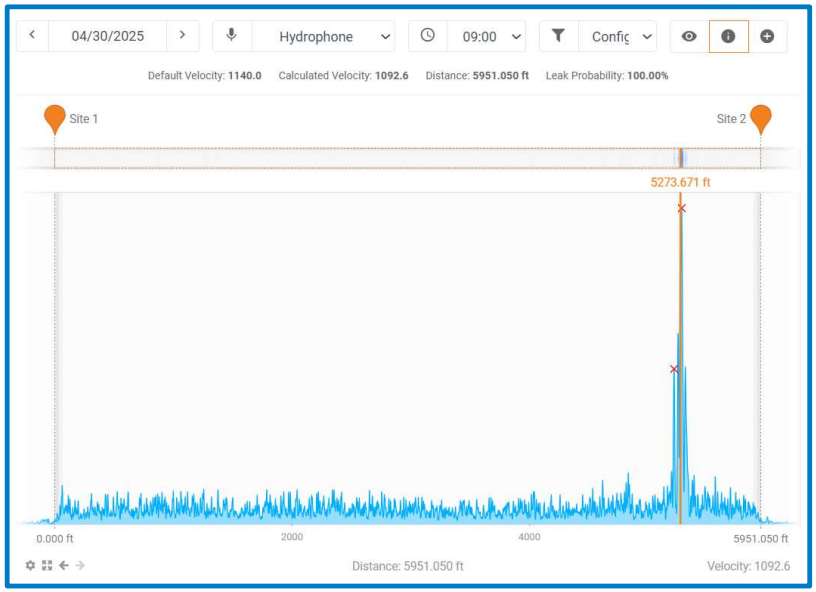
Distribution Network Pressure Transient & Leak Detection

Hydrant

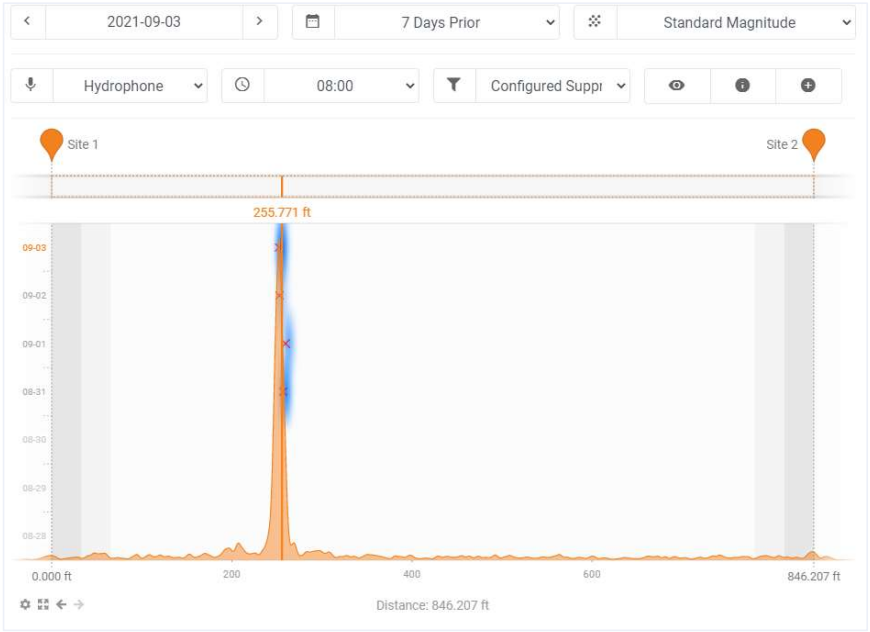
Air Vent

Distribution Network Pressure Transient & Leak Detection

Peak Noise Signal Between Sensors

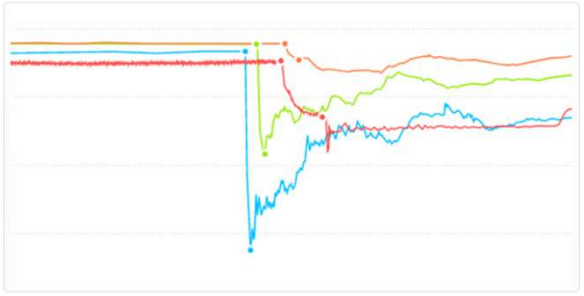


Timing of Noise

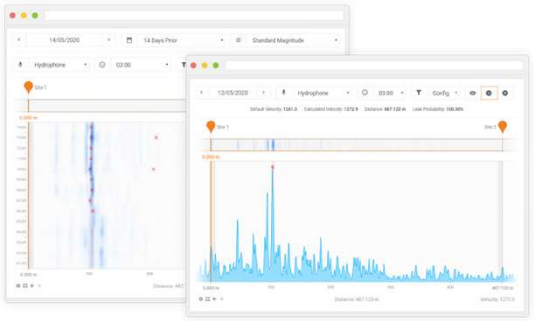


Software Insights

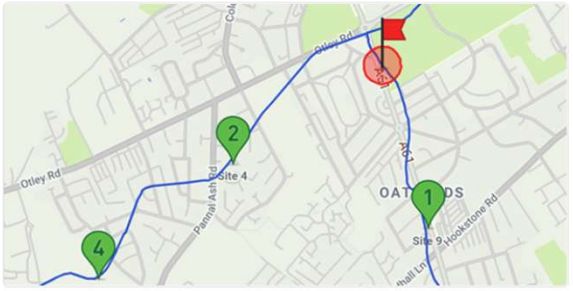
Harmful Transient Detection



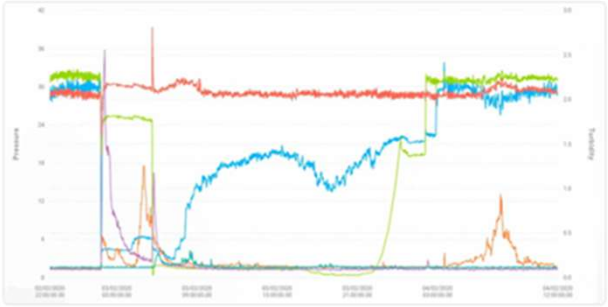
Acoustic Leak Detection



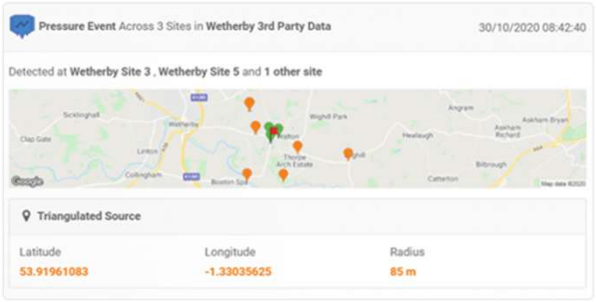
Break Detection & Locating



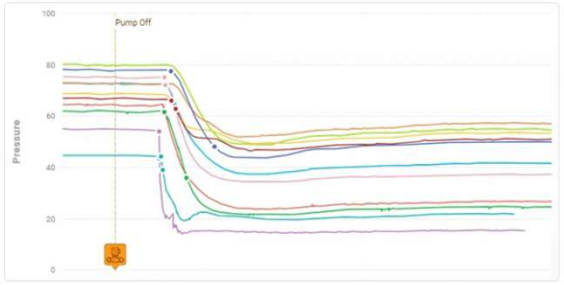
Combined Water Quality & Pressure



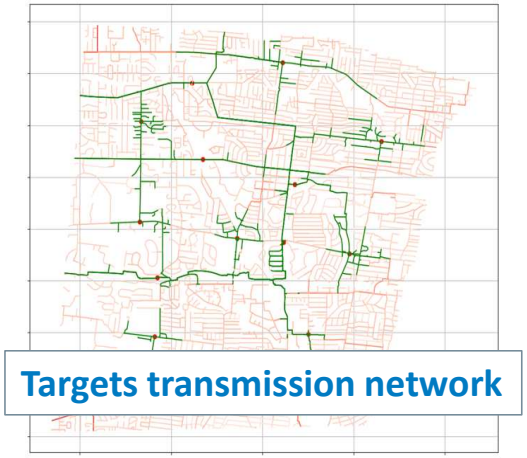
Smarter Event Alerts



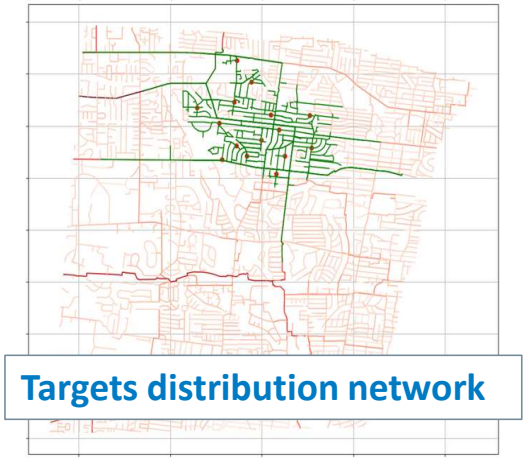
SCADA & Data Integration



Distribution Network: Pressure Transient & Leak Detection



Targets transmission network



Targets distribution network

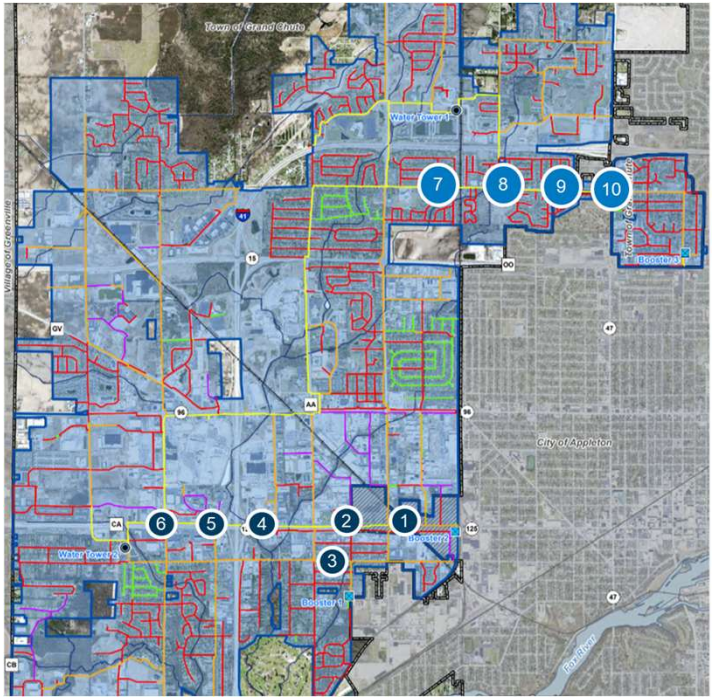
Advisory Services

Devices 1-6

Standard PIPEMINDER devices for measuring pressure transients in a water network. We've placed these strategically to monitor activity from the two booster stations, and partially from the industrial and commercial area (especially hotels), as well as the water tower, which we think will have the largest impact on the water network.

Devices 7-10

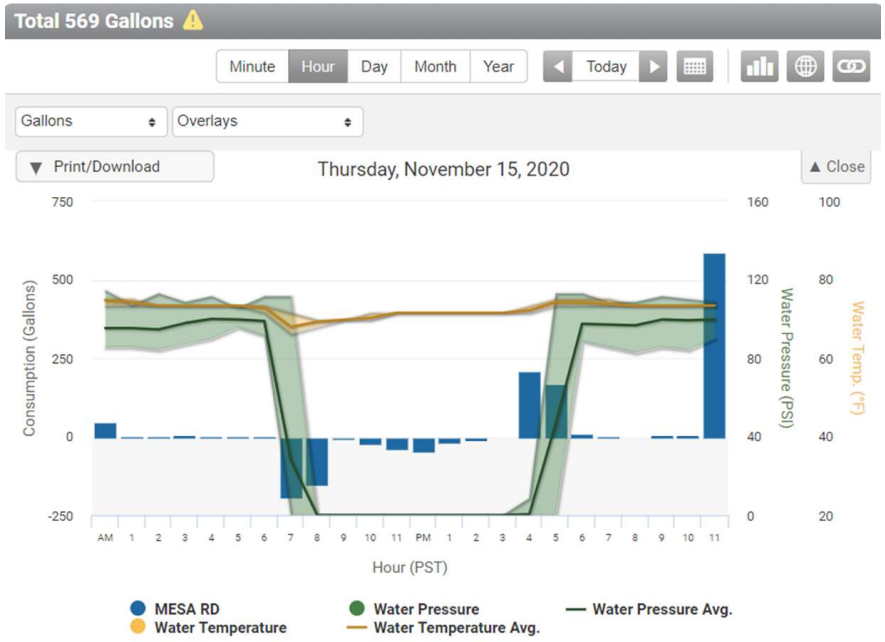
PIPEMINDER Acoustics for detecting leaks on a water main. Spaced ~1500 feet apart to detect leaks on a non-redundant main line on Capital Drive. Additionally, these monitor pressure transients through the network from booster 3.



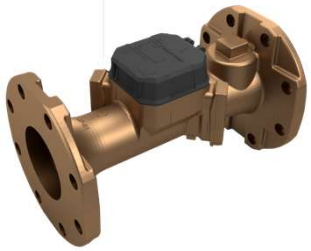
Distribution Network Pressure Zones & Leaks with Meters

Service Line Break & Restoration

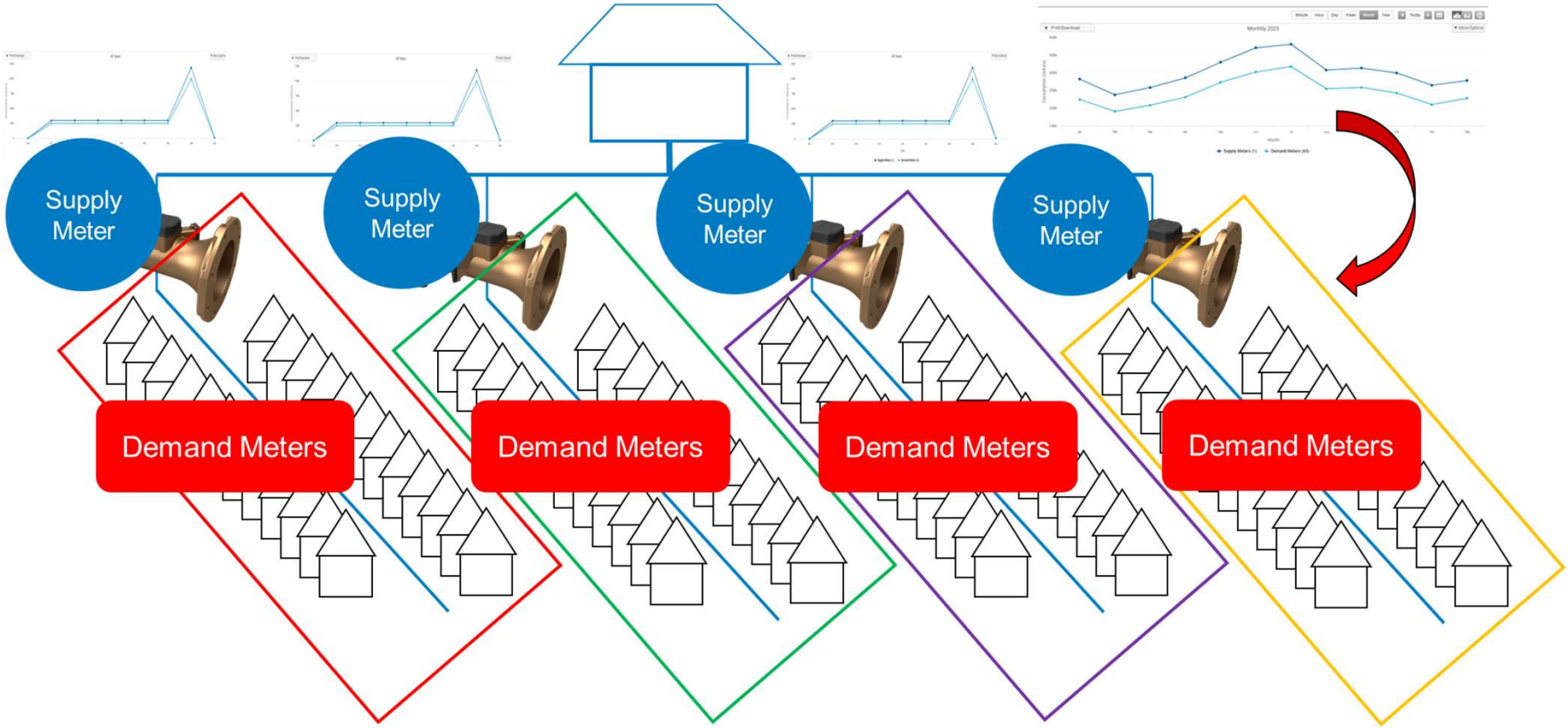
Pressure & Temperature



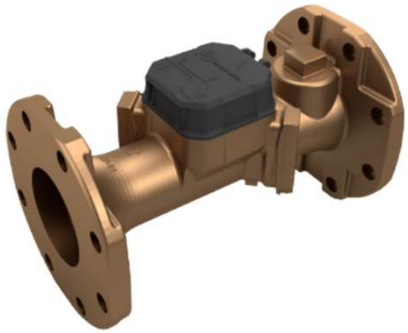
District Meter Areas



Distribution Network Pressure Zones & Leaks with Meters



Distribution Network Location of DMA Supply Meter

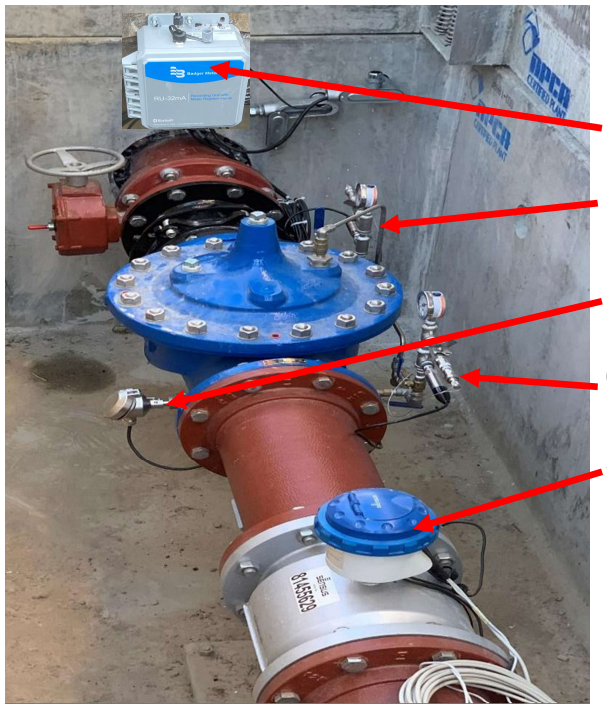


- Booster station
- Pressure reduction valve location (PRV)
- Chlorine booster station
- Existing vault location

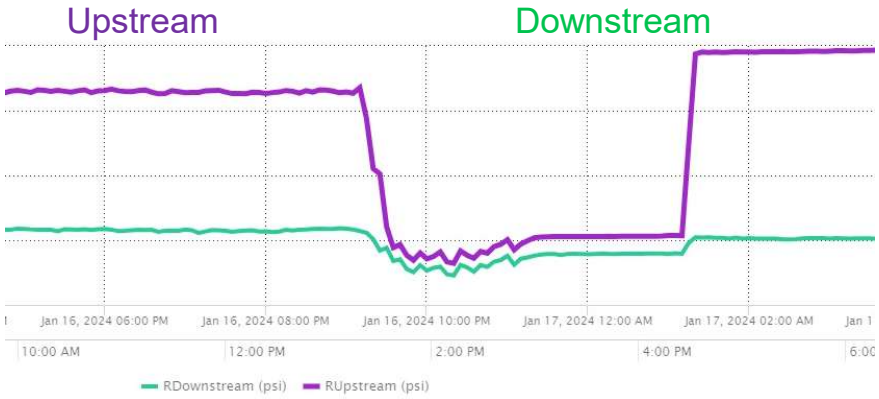
- One-way feeds into closed section
- Multiple way feed into a defined closed section
- Multiple way feed into a one way out section
- Multiple way feed into a multiple way out section

Distribution Network Multi-Channel Applications
PRV, Booster Pump, Well Monitoring

PRV



PRV Pressure Measurements



Multi-Channel RTU

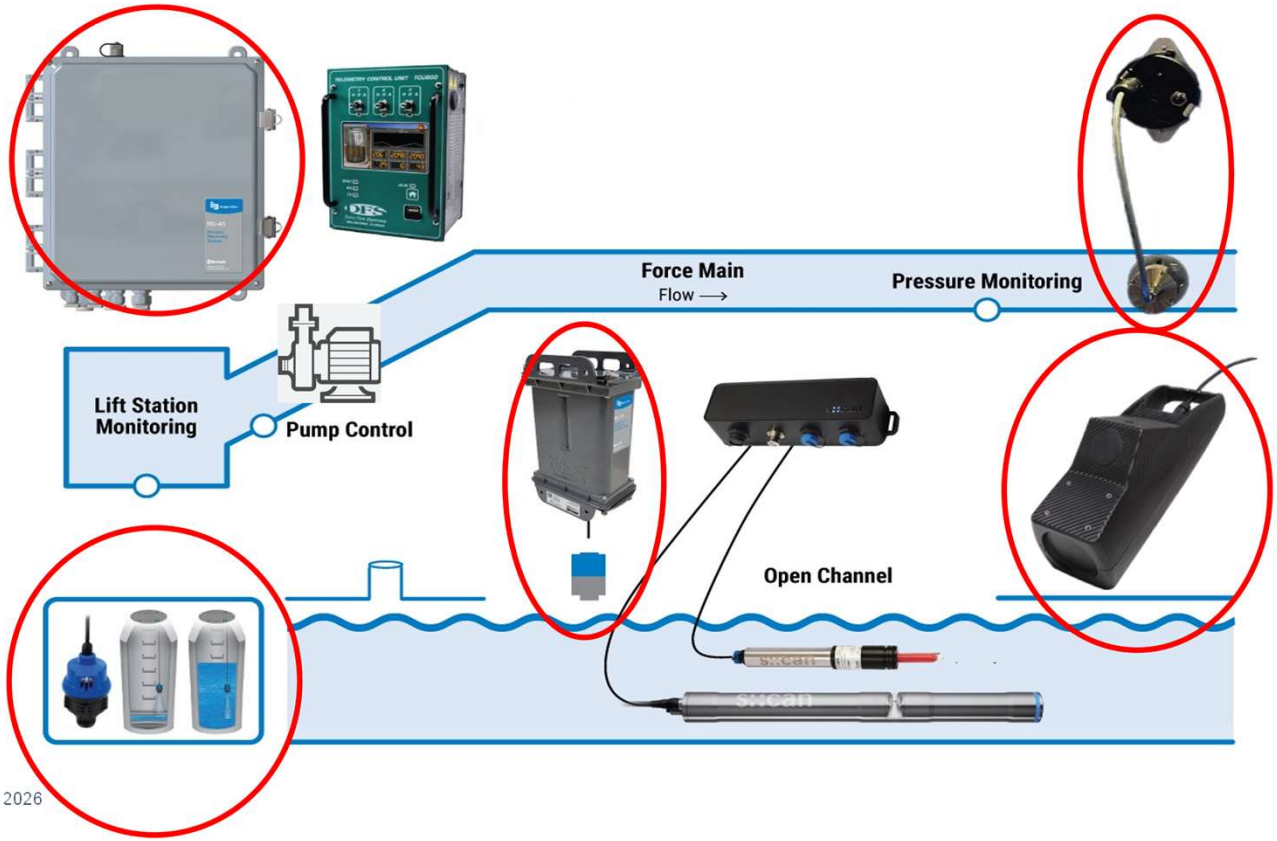
Distribution Network Monitoring
Tower/Well/Etc. Level Monitoring

Convert PSI to Level

Multi-Channel RTU

Collection System Network Monitoring

Sensors and data management systems to track network issues and provide an early warning for process upsets and events which could potentially damage the treatment system or require mitigation efforts.



- Flow Monitoring
- Level Monitoring
- Regulatory Compliance
- Illegal Discharge Detection
- Hydrogen Sulfide Monitoring
- Force Main Monitoring
- I&I Mitigation
- Lift Station Monitoring

Choice Matters: Collections Monitoring

Open Channel Flow (RavenEye)

Contactless, A/V Sensor
Medium to High Flow & Pipes

Submersible A/V (Beluga)

Velocity & Level, Pressure Sensor
Low Profile, Small Flow and Pipes

Ruggedized RTU (Ru-35)

Open Channel Flow, Submersible
Overflow

Rainfall Monitoring (RG-32A)

Year Round, 6” or 8”
I&I Analysis

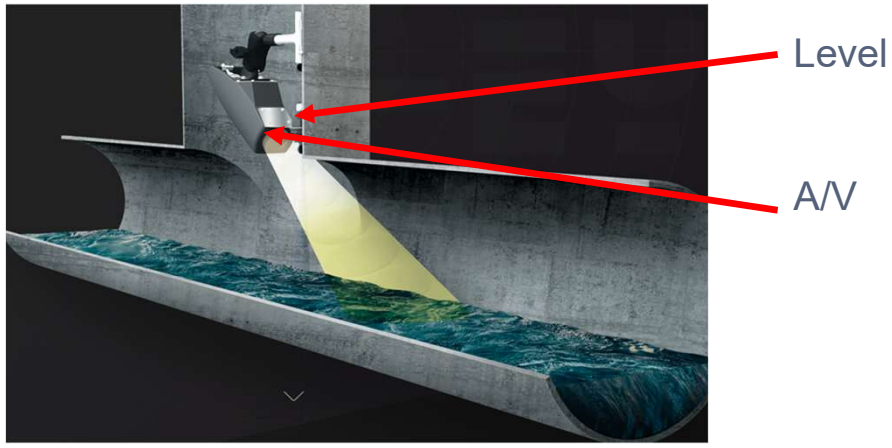
Force Main Monitoring (PIPEMINDER External)

128 s/sec : 15min – 6hr intervals
Real-time transient detection and analysis

Lift Station Monitoring (RS-45)

Up to 24 Inputs, Huge Variety
Ruggedized

Collection System Monitoring: Open Channel A/V w Level



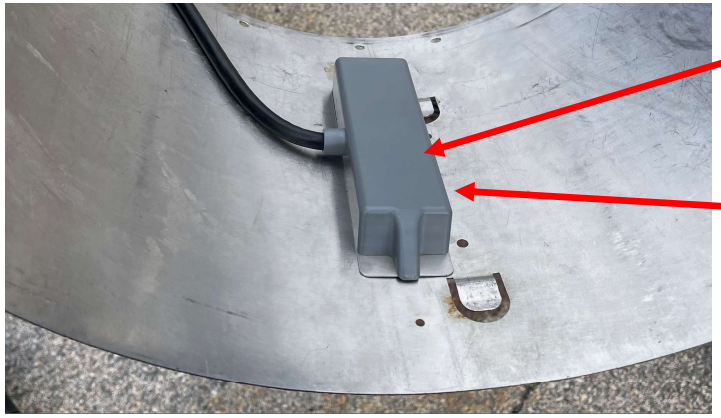
Where:

- Wastewater treatment plant
- Waste and storm water collection
- Industrial discharge
- River, stream, canal, etc.

Applications:

- CSO/SSO Monitoring
- I & I Analysis
- Custody Transfer Billing
- Catchment/Drainage Area Mgt.
- Modelling

Collection System Monitoring: Submersible A/V w Level



Where:

- Wastewater treatment plant
- Waste and storm water collection
- Industrial discharge
- Irrigation
- Partially filled pipes, surcharged pipes
- Harsh environments

Applications:

- CSO/SSO Monitoring
- I & I Analysis
- Custody Transfer Billing
- Open channel flow
- Modelling

Collection System Monitoring: Rainfall

Where:

- Wastewater & collection systems
- Environmental monitoring
- Water operations
- Remote area draining into system

Applications:

- Tracking rainfall intensity/total
- Data collection for situational awareness
- CSO/SSO Monitoring
- I & I Analysis
- Modelling

Collection System Monitoring: Inflow & Infiltration Example

I & I: Unwanted stormwater and groundwater entering the sanitary sewer system

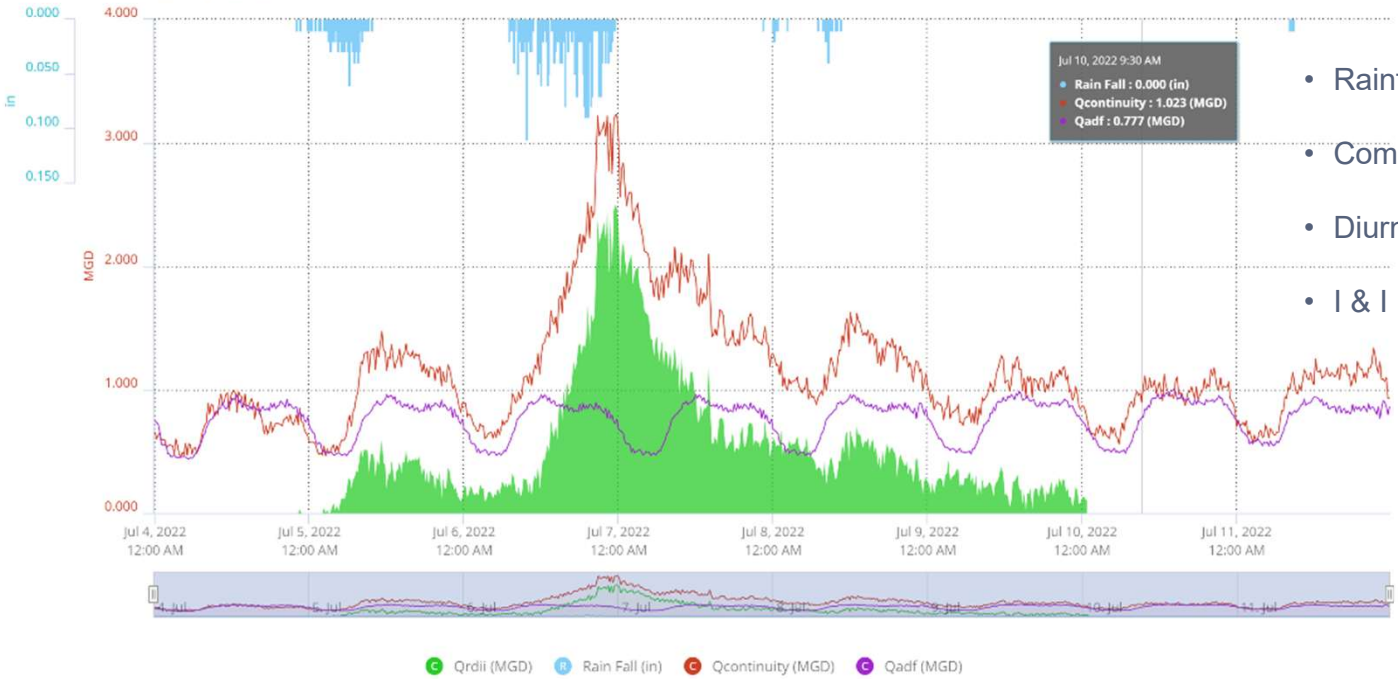
Inflow (Direct Entry):
- Rainwater, snowmelt
- Improper connections, drains, sump pumps, foundation drains, hole in pipe
- Occurs during or immediately after rain or snowmelt events

Infiltration (Seepage):
- Groundwater
- Pipe cracks, manhole walls, loose joints, broken pipe, roots
- Usually highest after storms as water tables rise

Problems Caused:
- Overloads plant, dilutes sewerage
- Causes sewerage backups in homes and overflows
- Increases operations cost to treat mostly clean water
- Environmental, fines, etc.

Solutions:
- Inflow- disconnect improper connections like sump pumps and downspouts
- Infiltration- repair leaky pipes and manholes

Collection System Monitoring: Inflow & Infiltration Example



- Rainfall
- Combined Flow
- Diurnal Flow
- I & I

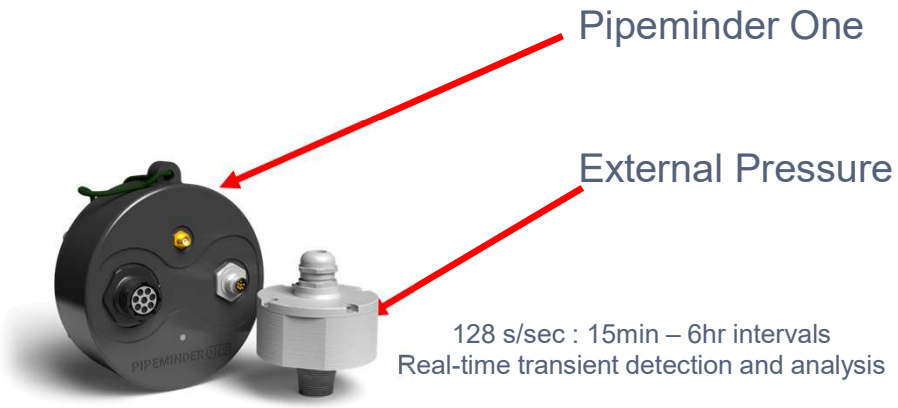
Problem:

- Frustration w. I & I
- System overflow events
- Treatment cost
- Overwhelmed collection & treatment

Solution:

- 5 A/V sites
- 3 rain gauges
- Lift & shift or permanent
- Near real time insights, alerts and alarms

Collection System Monitoring: Force Main



Where:

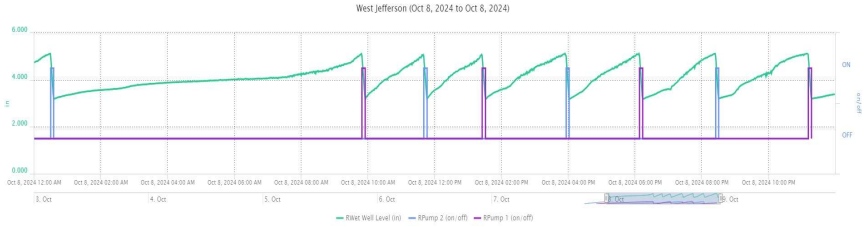
- Wastewater force mains and rising mains
- Pumping Stations
- Remote areas
- Selectively on aging infrastructure

Applications:

- Early burst detection
- Blockage detection
- Pump & valve performance
- Surge analysis
- Long-term monitoring

Collection System Monitoring: Multi-Channel Device
Lift/Pump Station

Battery or AC power



Where:

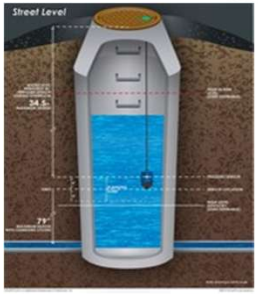
- Lift stations
- Pumping Stations
- Remote areas
- Selectively on aging infrastructure

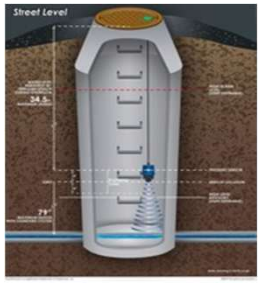
Applications:

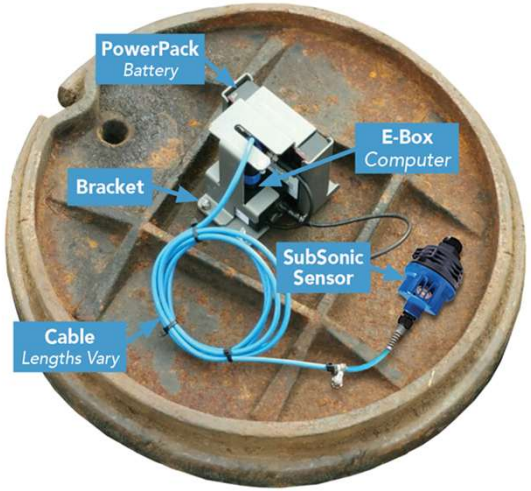
- Pump performance & monitoring
- Level & flow monitoring
- Energy efficiency
- System diagnostics & alarms
- Versatile inputs
  - 24 analog, digital and event signals

Collection System Monitoring: Undercover Options

Level and Pressure



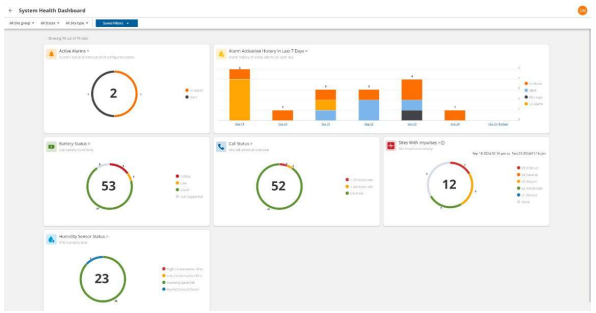




Hydrogen Sulfide

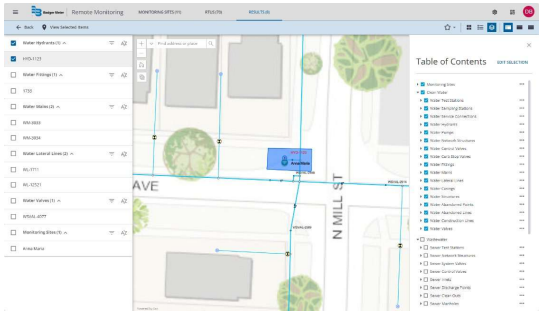
Remote Monitoring: Data Visualization & Reporting

System Health Dashboard

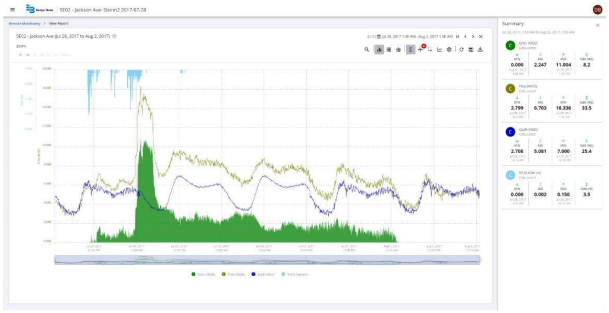


Pressure Impulse Capture

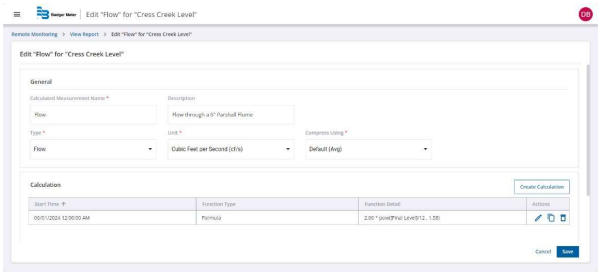
ESRI ArcGIS Integration



Wastewater Flow

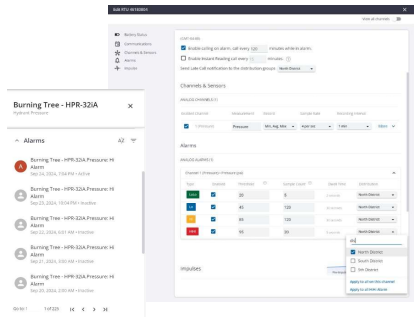


Calculated Measurements



Powerful calculation engine can compute flows, alert on pressure deviations, and much more.

Alarms and Notifications



Advisory Services Available for Pressure/Leak

Questions

Doug Vermillion

Solution Architect

dvermillion@badgermeter.com

330-900-4946

© 2025, Badger Meter, Inc. All rights reserved.

Legal Disclaimer

Statements of fact and opinions stated during the presentation or within these slides are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of Badger Meter, Inc. This information presented is provided "as is" with no guarantees of completeness, accuracy, or timeliness. Badger Meter, Inc. does not make any separate guarantees or warranties, express or implied, regarding the information contained herein. To the fullest extent permissible pursuant to applicable law, Badger Meter, Inc. disclaims all warranties, express or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose.

Badger Meter®

© 2025, Badger Meter, Inc. All rights reserved.

Project Background

SCWA suspected a leak near or below a rail line

- Pipe runs underneath a busy commuter train line
- Small stream visible down the side of the railway
- Exact leak location needed to plan repair project
- Leak detection project initiated in August 2021

Sensor Deployment

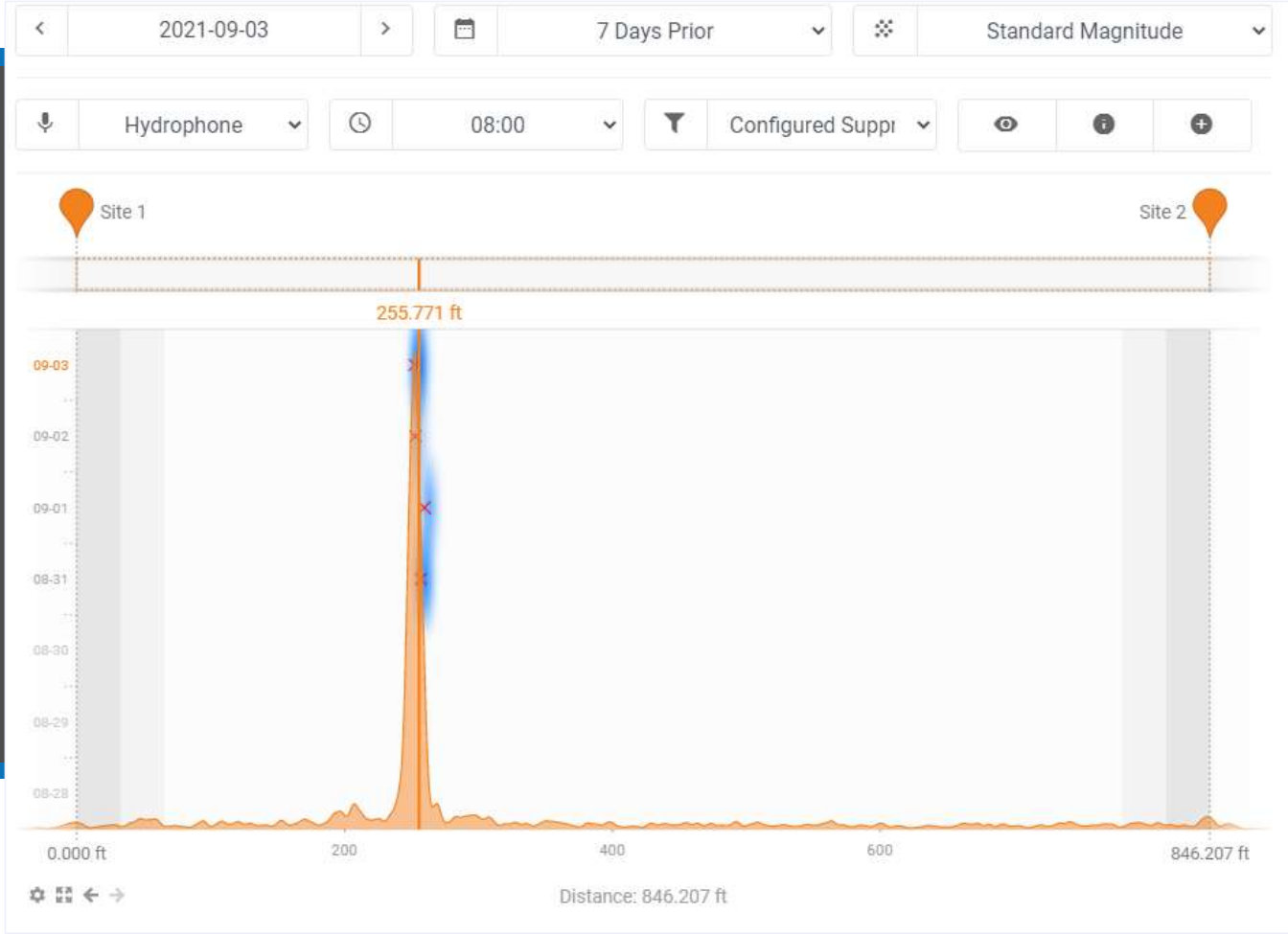
- 24” Steel Pipe on Petaluma Aqueduct
- Sensors installed at north and south end of Petaluma Aqueduct, spaced 846 ft apart
- Acoustic data collected 4x/day for 4 days
- Cathodic protection disabled during the monitoring period to reduce interference

Installation Overview

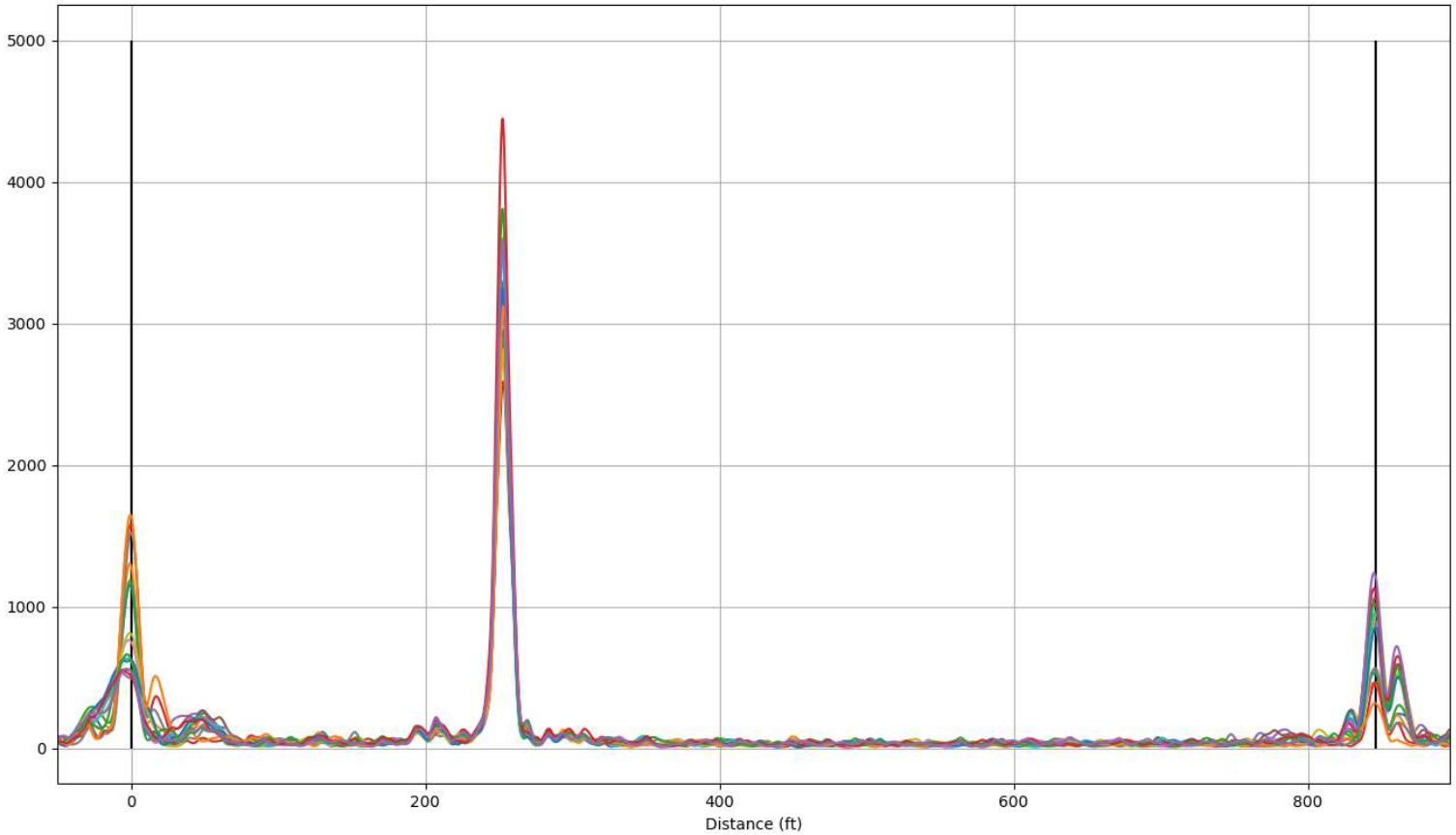
- Sonoma Water installed sensor taps
- Excavation was required
- Temporary pits were filled after monitoring
- Sonoma crew verified the exact distance between sensors
- Key advantage of this installation was no requirement to dewater the pipe

Leak Identified

Within 4 days, there was high confidence the noise signature was caused by a leak due to recurring noise peak 255 ft from sensor 1.

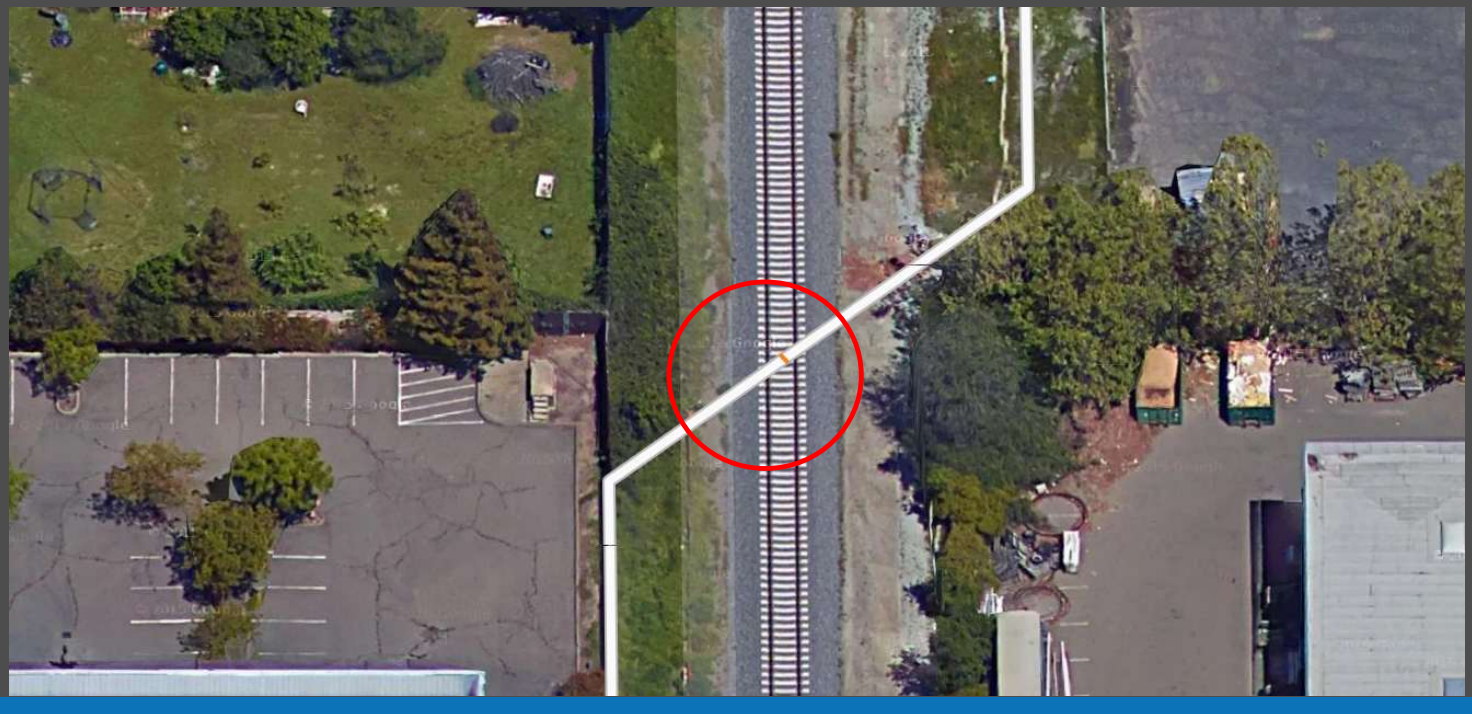


Stacked Correlations



Recurring noise correlations shown on one graph with noise peak size on the Y axis

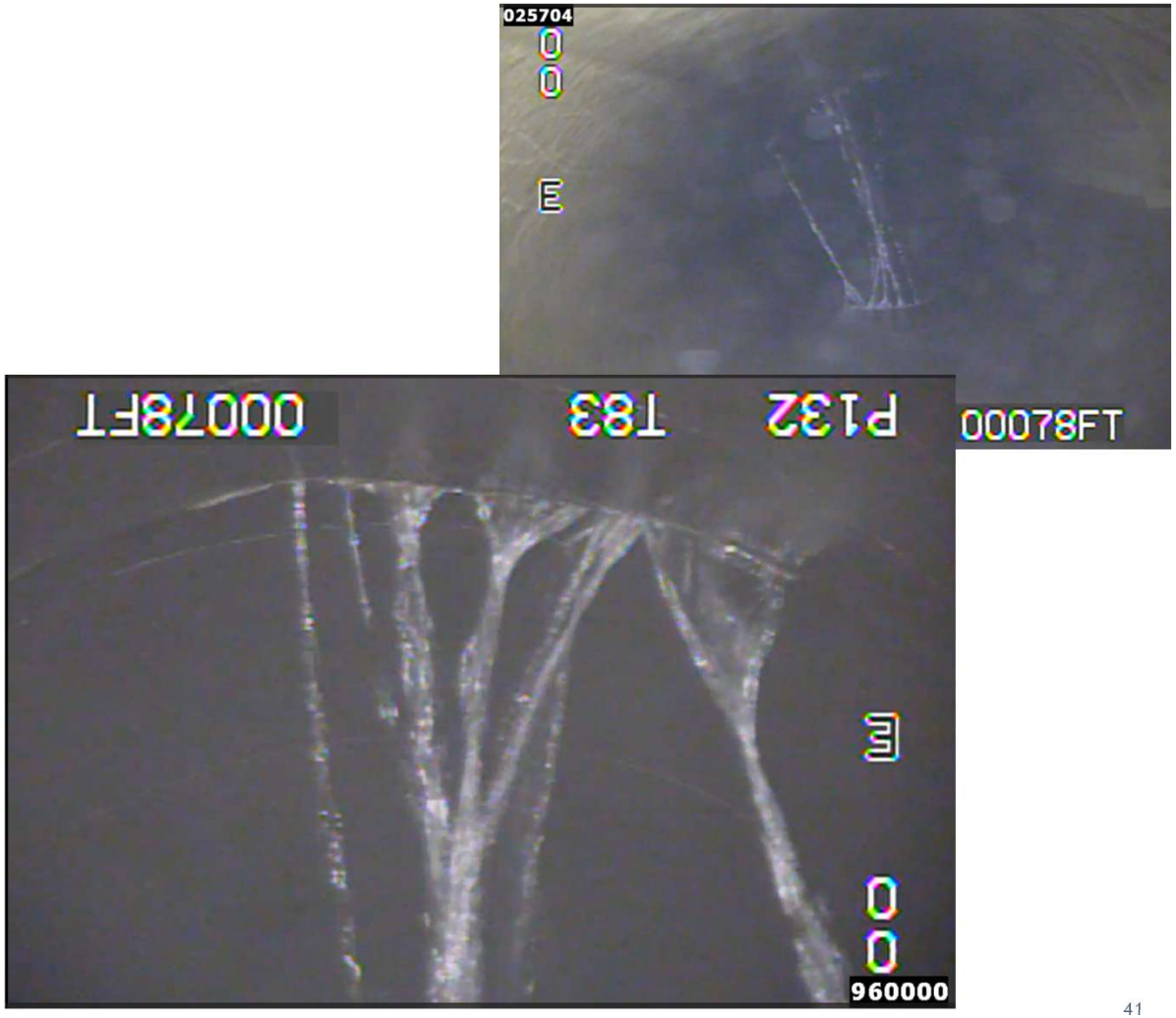
Leak Location



Position of leak is shown as orange line, directly below the railway

Verification of Results

- Video inspection confirmed the leak
- Actual leak estimated within 3’ of result
- Water was draining back into the pipe
- Leak rate estimated at 5-10 GPM
- November 2022 – repair was made
- Butt strap weld used to repair



Primary Equipment

PIPEMINDER ONE – Acoustic Sensor

High-res pressure data logging with pressure transient and burst detection alongside acoustic leak detection in all pipe materials

Installed at a 1.5” NPT connection or using an optional hydrant adapter. Installation tools included.

4 Total

Acoustic Sensor Installation Tools

T-Handle Hex Key and Hook Spanner Wrench for Sensor Installation

1 Each

Ancillary Equipment

PIPEMINDER-ONE Acoustic Sensor Battery

22Ahr Rechargeable K2 Battery

1 12V charger included

Battery design life is 100 charges.

Battery life depends on data transmission frequency, signal and event detection sensitivity.

Larger rechargeable batteries available upon request.

4 Total

Combined Cellular and GPS Lid Mounted Antenna

4G SMA Cellular Antenna

Works with a Multi-Carrier SIM Card to identify the strongest signal in a deployment area

GPS Antenna

Ensures leak locating precision.

Both antennas connect to control unit for the PIPEMINDER-ONE Acoustic sensor.

4 Total

Acoustic Sensor Hydrant Adapter (Optional)

Hydrant Adapter

Used to connect acoustic adapter to 2.5” National Hydrant Thread

Does not include security enclosure.

4 Total

Hydrant Adapter Locking Security Cover

Secure Plastic Cover

Two Locking Bars

Lock Not Provided

Fits over hydrant sensor to prevent vandalism or tampering.

4 Total

Services

Field Support Services

Onsite Installation Support

Onsite Device and Software Training

1 Day Total

Advisory Services

Software setup and data configuration

Data analytics and interpretation

2 Review Meetings

Final Presentation of Findings

6-Month Project Period

2 Day Total