Advanced Metering Infrastructure

April 11, 2024

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Providing effective energy strategies for buildings and communities

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE

Who We Are

We assist buildings and communities in achieving energy efficiency, saving money, and becoming more sustainable.

We are an applied research program at University of Illinois.

Our goal: Reduce the energy footprint of Illinois and beyond.

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ISTC Mission

To encourage and assist citizens, businesses and government to prevent pollution, to conserve natural resources, and to reduce waste to protect human health and the environment in Illinois and beyond.

Upcoming Field Day

May 15, 2024

Field Day Announcement!

Tour of Algaewheel Process: Distributed treatment system for Bookwalter Woods MHP near Gardner, IL

Algal Treatment Processes Workshop: Location TBD

- Applications at distributed and central WWTPs
- Benefits for nutrient removal and energy consumption
- Side-stream income opportunities

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About the IEPA PWI Energy Efficiency Program

The Illinois EPA Public Water Infrastructure Energy Assessment Program helps municipalities reduce the cost of water and wastewater treatment.

- NO-COST energy assessments and technical assistance
  - Limited number of slots remaining!
- Comprehensive report listing:
  - Cost of upgrades
  - Estimated payback period
  - Any applicable incentives or funding opportunities
- Operator continuing education events

Funding provided in whole or in part by the Illinois EPA Office of Energy. This program is in partnership with the U.S. Dept. of Energy Sustainable Wastewater Infrastructure of the Future (SWIFT) Accelerator for energy efficiency in wastewater treatment.

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U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Why Complete an Energy Assessment?

Older Existing System or No Previous Assessments?

Identify missed opportunities

Plan for capital improvements

Uncover what is possible

3rd party support for personnel's ideas

New or Recently Upgraded?

Always more to improve

Plan for future opportunities outside the scope of recent projects

New technologies and processes always in development

Identify opportunities for repairs or upgrades and associated funding!

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Apply for an Energy Assessment!

Step 1: Initial Application – Pre-Qualification

- Apply at www.smartenergy.illinois.edu/water
  - Be located in Illinois and be publicly-owned
  - Allow SEDAC/ISTC to visit site – remote visit is an option!
  - Be willing to share facility information
  - Share final assessment report with Illinois EPA Energy Office

Step 2: Data Collection

- Facility information –Process flow diagram, types of processes, etc…
- 2 years of utility bills and MORs
- We're here to assist!

Step 3: Site Visit Scheduled

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Guest Speakers

Dave Wills

Manager of Technical Solutions

Sensus, a Xylem Brand

David.Wills@xylem.com

Graham Mattison

Solution Manager

Kamstrup Water Metering, LLC

grmn@kamstrup.com

xylem
Let's Solve Water

The Smart Water Utility With AMI

Presented by David Wills – Sensus a Xylem Brand

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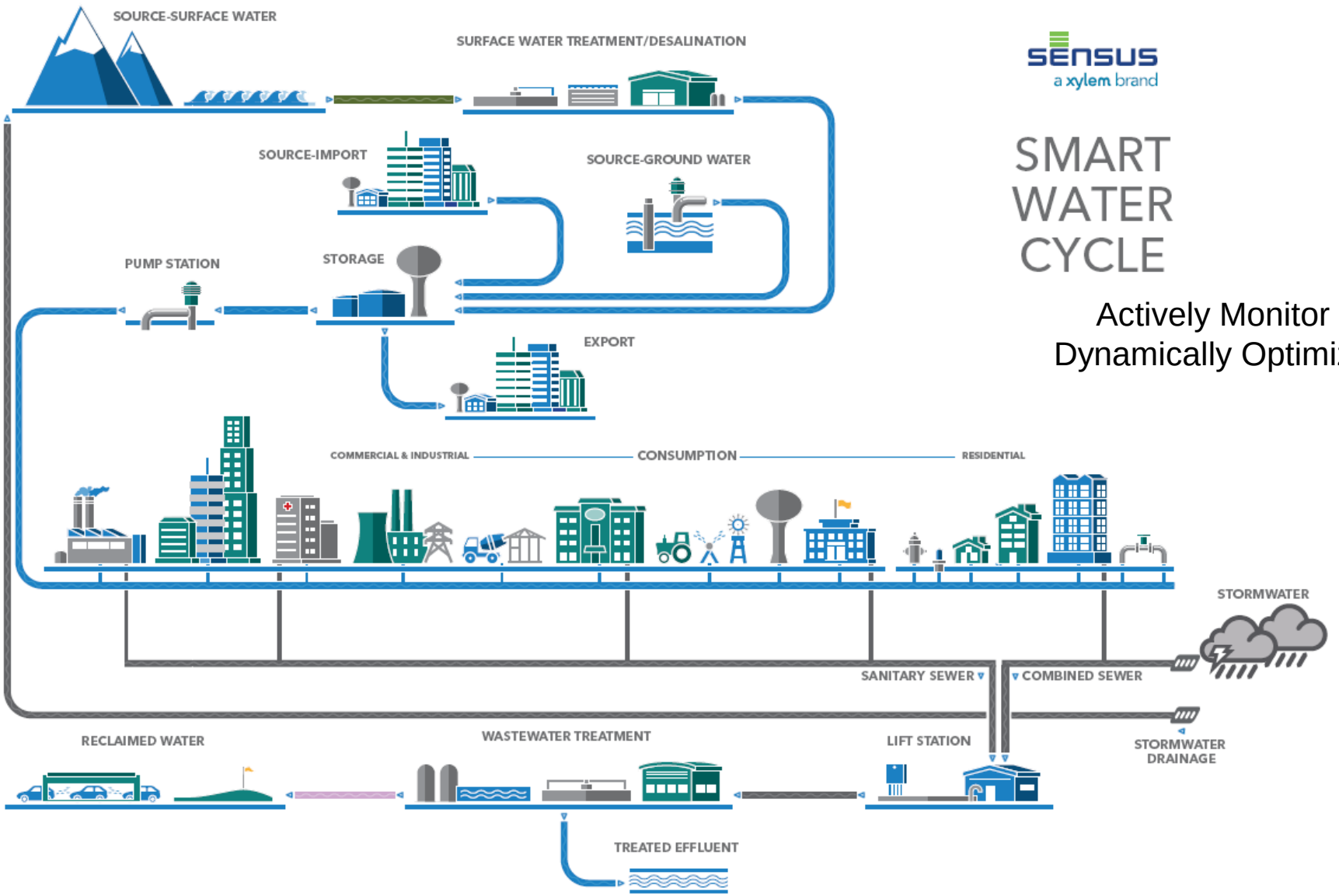
Agenda

- Overview of metering history to AMI.
- AMI grows beyond just a meter read.
  - Case Study - customer information.
  - Metering and Sensors.
  - Pressure Planning.
  - Real case scenarios.
  - Pressure management and leaks.
- Summary.

The Entire Water Cycle



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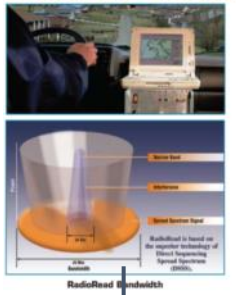
SMART WATER CYCLE

Actively Monitor
Dynamically Optimize

The Smart Utility Network

TouchRead

RadioRead



1870s

Municipal water **meters invented** and gain widespread adoption

1870s – 1984

Metering technology advances; data processes still based on **Manual Reads**

1984

Walk-By technology improves the speed and accuracy of meter reading

1993

Drive-By solution further improves the speed and accuracy to form Automatic Meter Reading **(AMR)**

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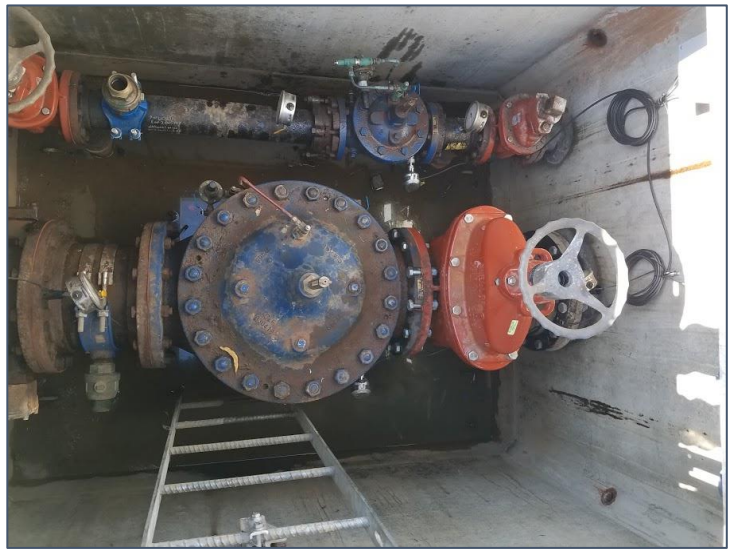
The Smart Utility Network

Today, the Smart Utility Network is unlocking increasing value…

- Pressure & temperature monitoring at the service connection
- Remote control of meter services (for customer service activation, de-activation, flow throttling)

- Smart monitoring across the network, including pressure, temperature, level, and more.



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Let's Solve Water

Walla Walla, WA

Pressure Management Case Study

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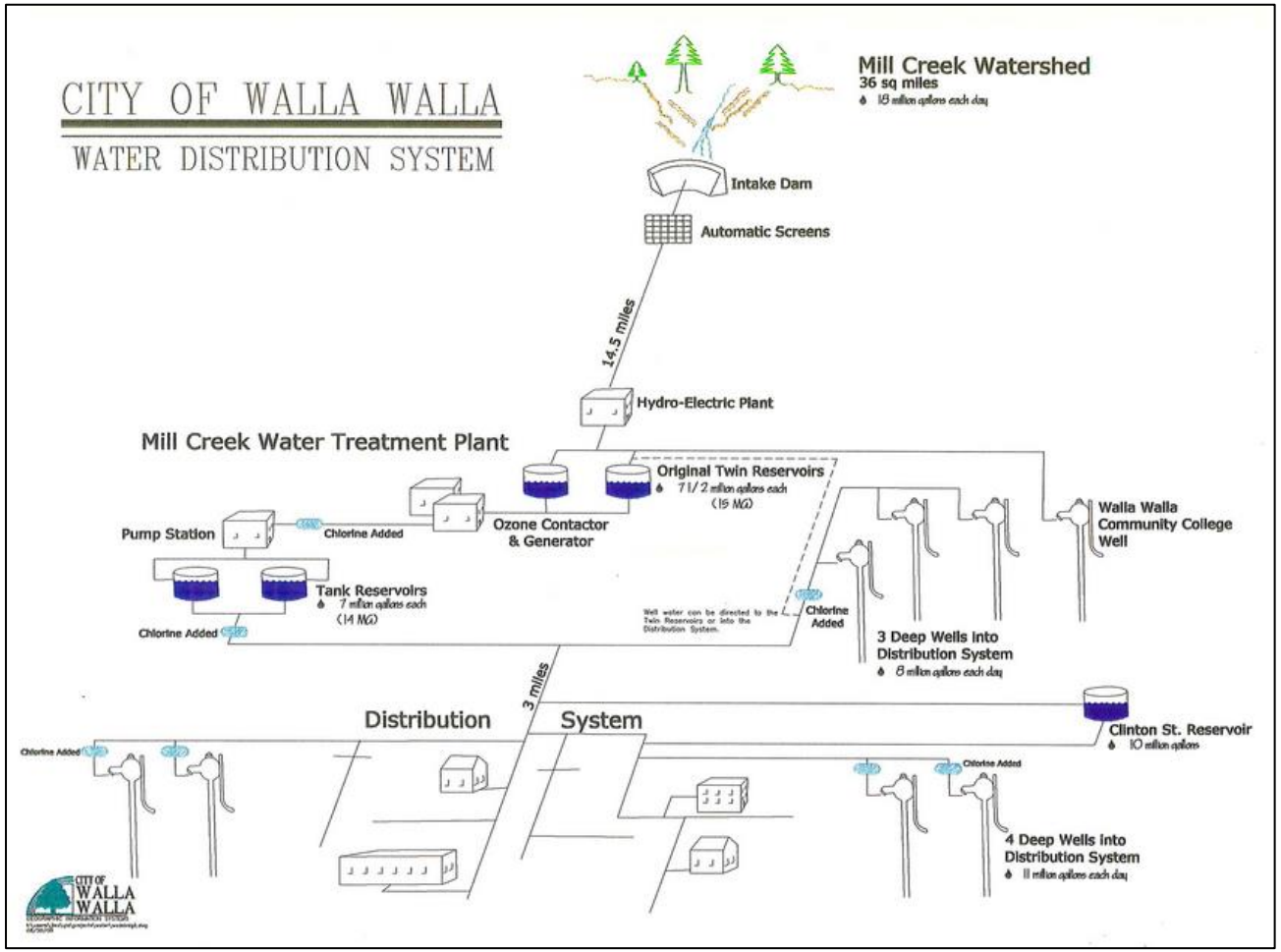
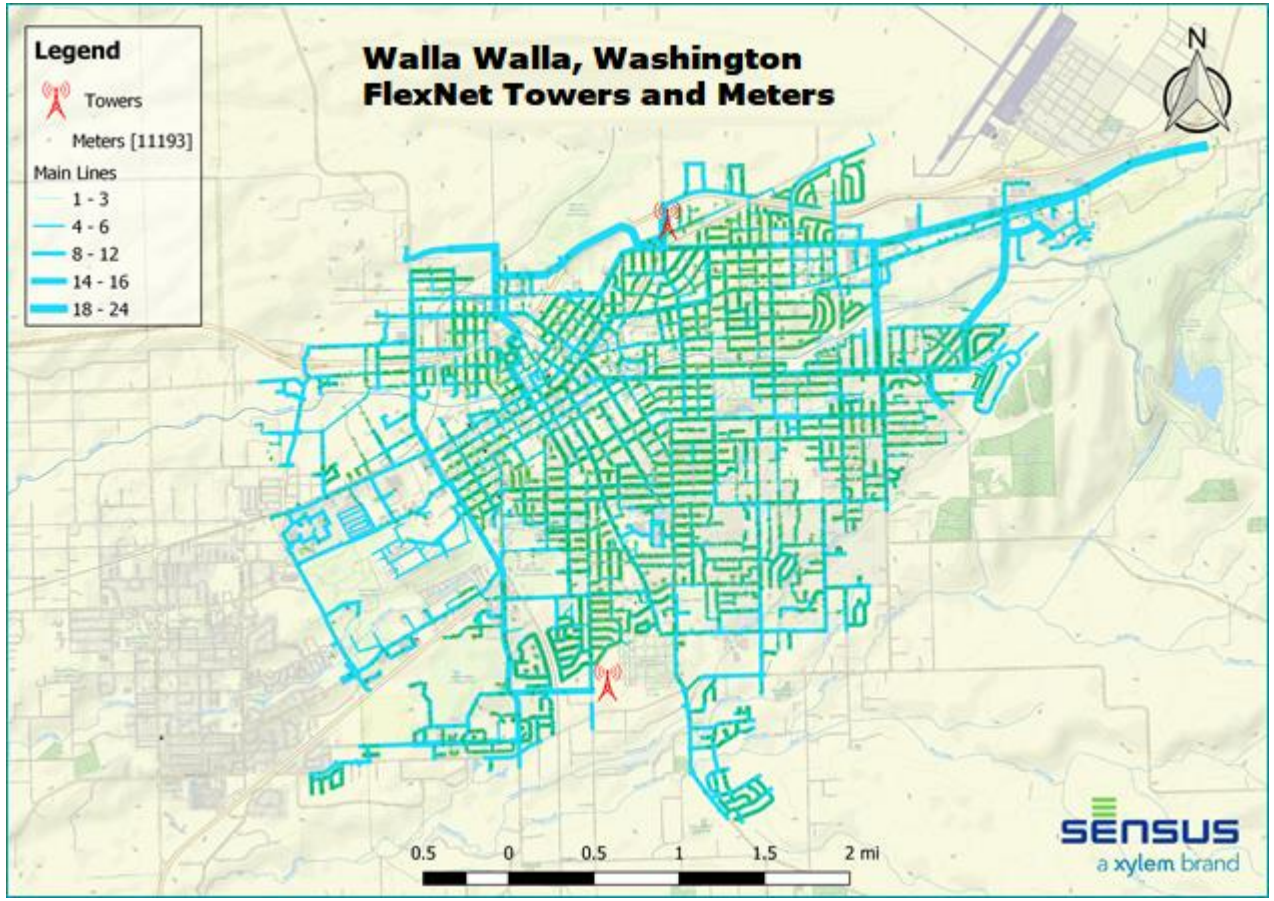
Utility Background

- Population = 33,000 (11,000 svcs)
- Resilient supply (24 MGD capacity)
  - 90% Surface Water
  - 10% Groundwater
  - Aquifer Storage and Recovery (ASR) for peak demands and emergencies
- Aging water distribution system
- Large elevation change across system
  - 4 pressure zones, 29 PRVs



Advanced Metering Infrastructure

- AMI deployment completed in 2018
- All 11,000 service connections changed out to smart meters
- 99.6% system read success
- Immediate Outcomes
  - Customer-side leak detection
  - Reduced winter estimates
  - Increased accuracy



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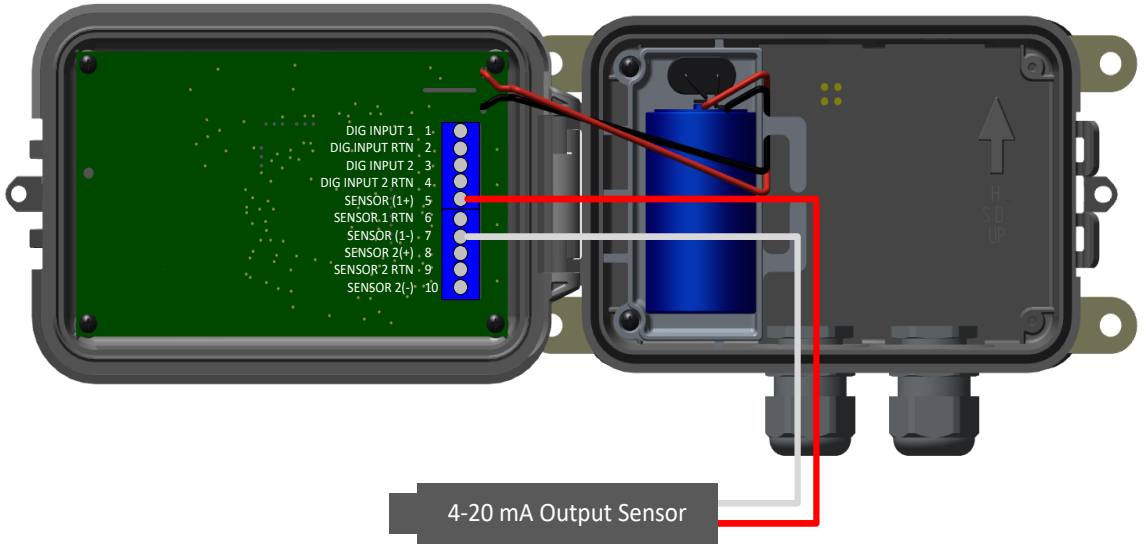
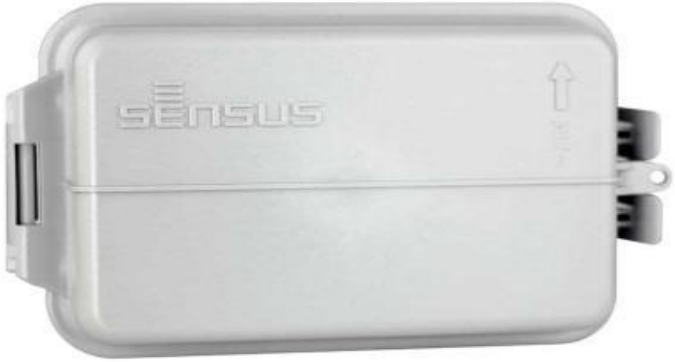
Technology Utilized: Smart Water Meter

- Monitoring Parameters
  - Pressure
  - Temperature
  - Consumption
- Remote Valve Functionality
  - Open
  - Closed
  - Reduced

Technology Utilized: Smart Gateway Sensor Interface

- Two analog inputs (4-20 mA)
- Two digital inputs (form A/B contact)
- Battery Powered
- Intrinsically Safe Class I Div. 2
- IP66 packaging for outdoor applications





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Sensors

Water Quality

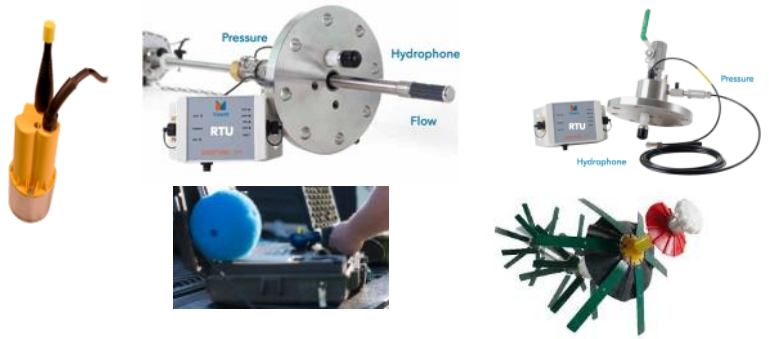
- pH / ORP
- Chlorine
- Turbidity
- Temperature

Movement of Water

- Pressure
- Flow
- Tank level
- Well level
- Sewer level

Leaks

- Acoustic
- Hydrophone
- Transients
- In-Situ



Sensors

Other

- Position
- Wind
- Noise
- Air quality
- Chem feed
- Cathodic protection

Wastewater / Stormwater

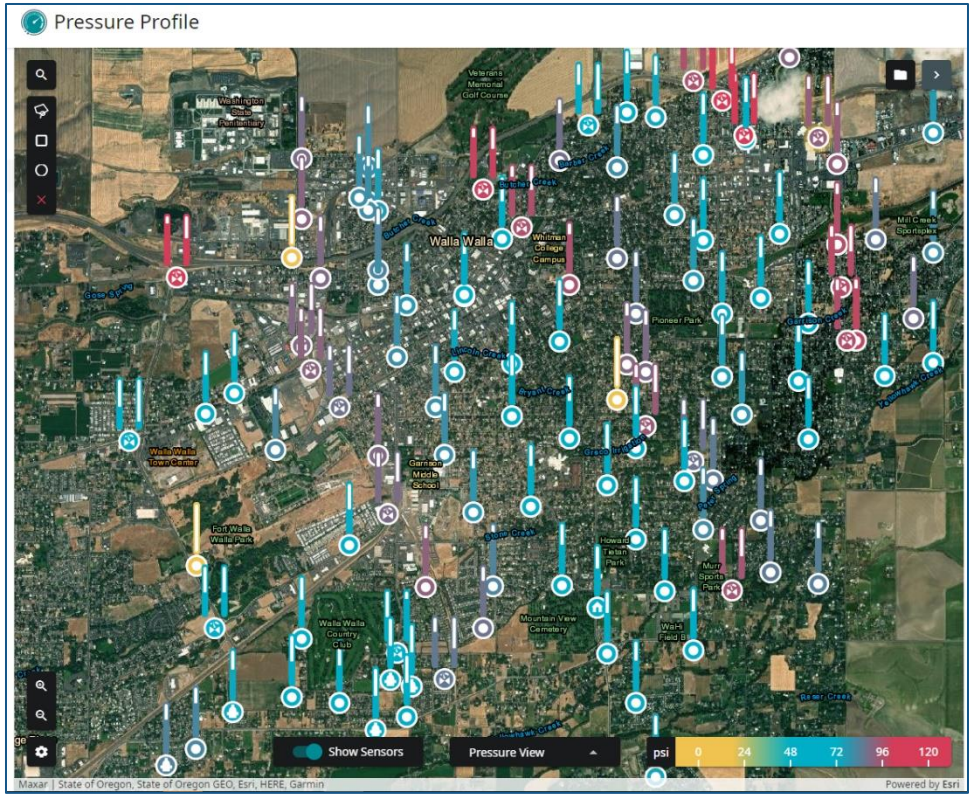
- Dissolved oxygen
- Hydrogen sulfide
- Level
- Grinder pump
- Vacuum valves
- Flow

Pressure Monitoring Plan

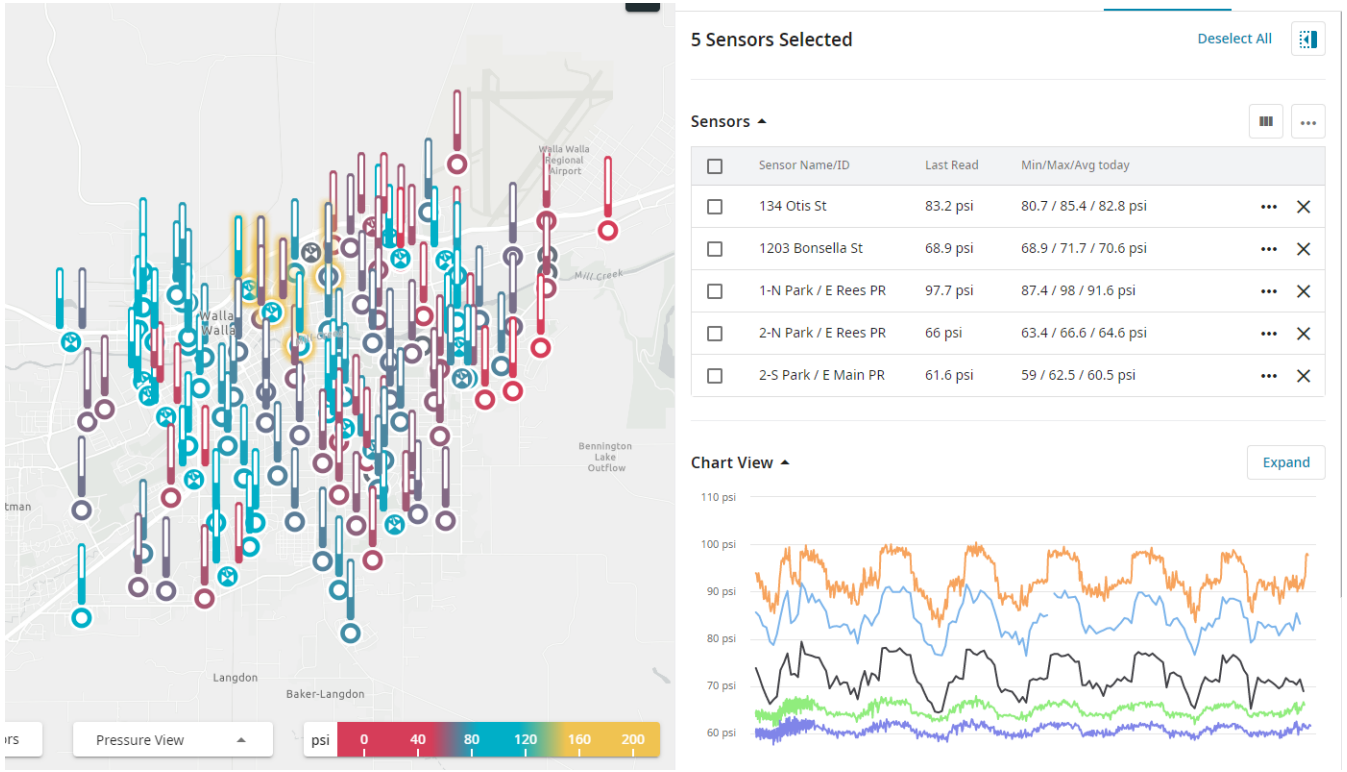
1. Assessed and mapped all available monitoring locations

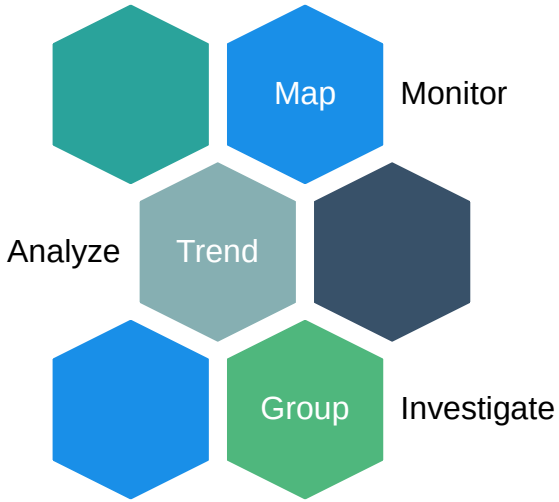
2. Placed pressure sensors at…
   - Highest and lowest elevation in each zone
   - All 6” and larger services
   - Upstream / downstream of each PRV, PSV, booster pump station

3. Continued to add additional sensors to achieve…
   - Desired vertical spacing (i.e. elevation resolution)
   - Desired horizontal spacing (i.e. water network miles)



Visualizing & Digesting the Data – Pressure Profile





Increase system visibility to achieve more proactive distribution system management.

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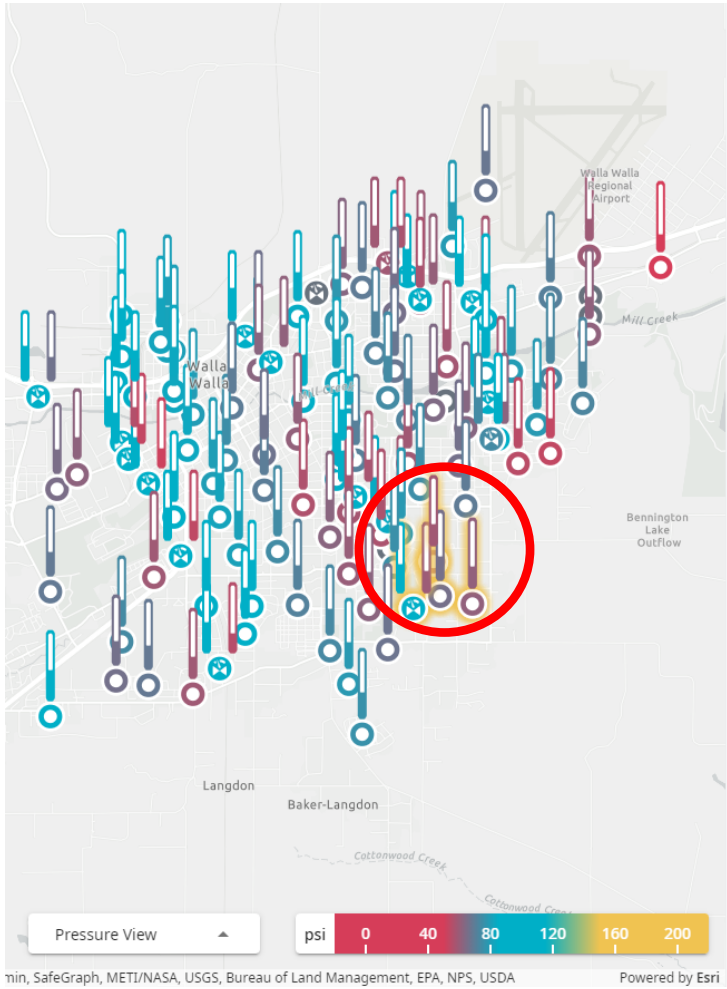
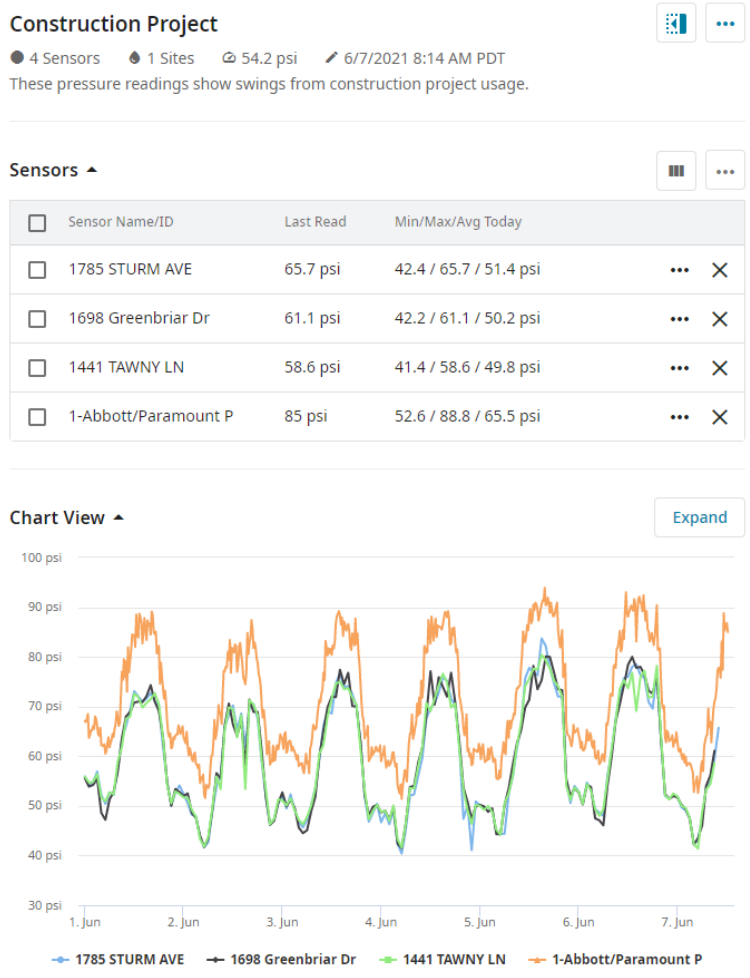
Assessing the Impact of a Construction Project

- Large water main replacement
- Temporary bypass line installed
- Wanted to ensure pressure in area was adequate during construction project
- Meters and sensors were already deployed
- Enabled device grouping in software interface to monitor





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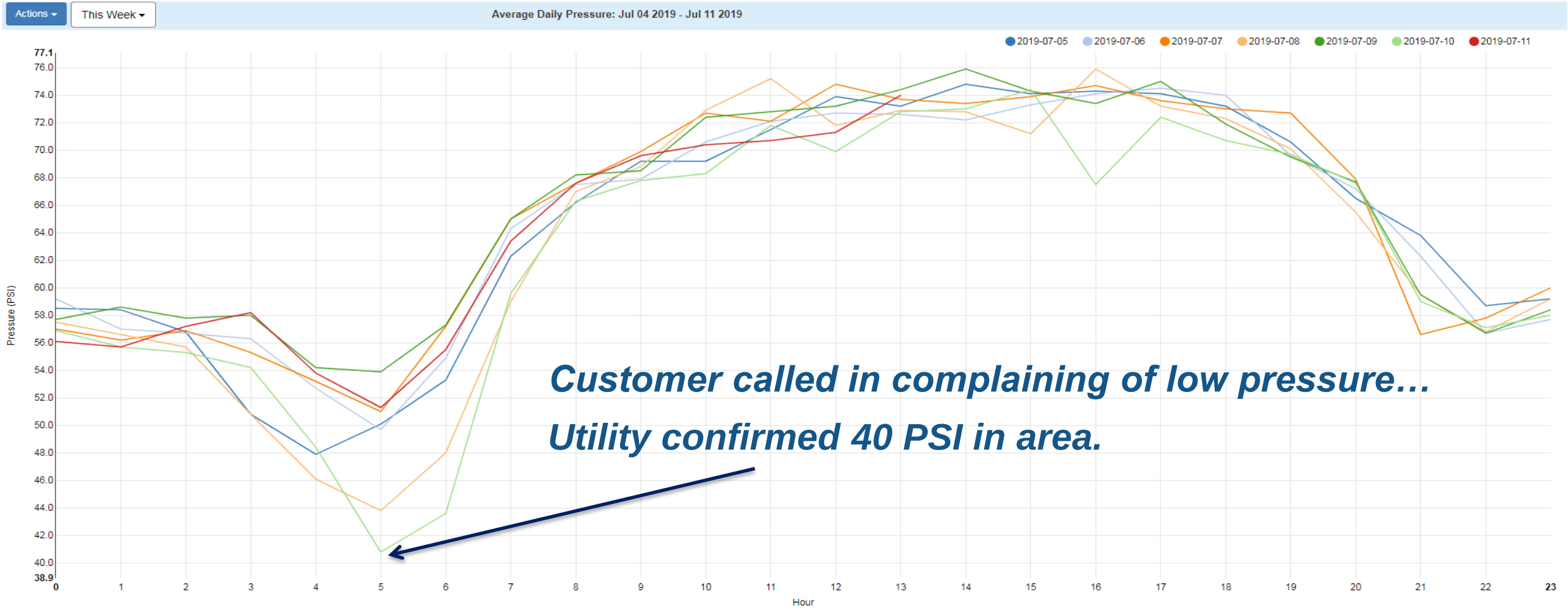
Customer Service: Low Pressure Area



To mitigate, Walla Walla 1) worked with customers in the area who were irrigating during morning hours to adjust schedules and 2) adjusted a pressure sustaining valve controlling area pressure to keep levels > 45 PSI.

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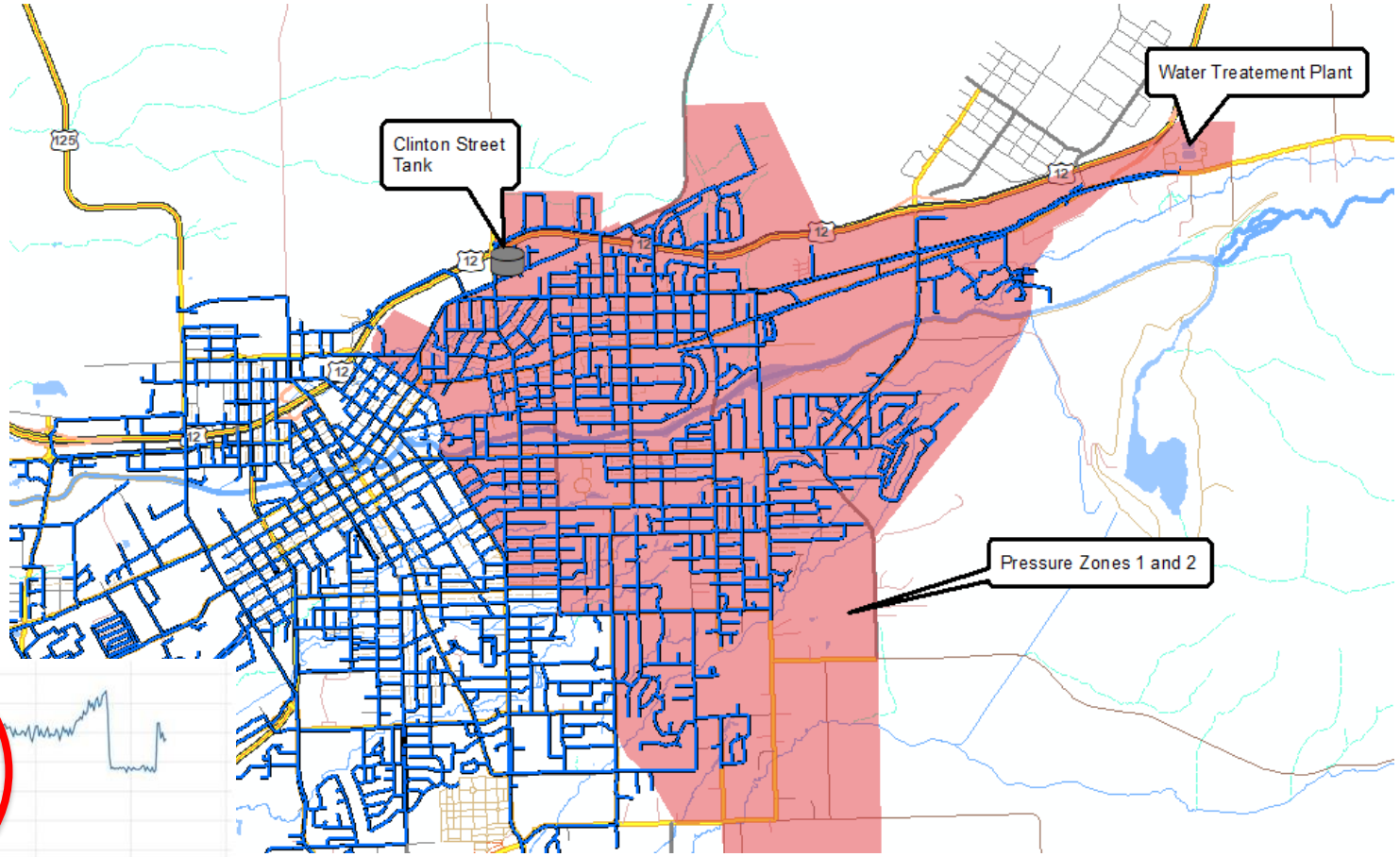
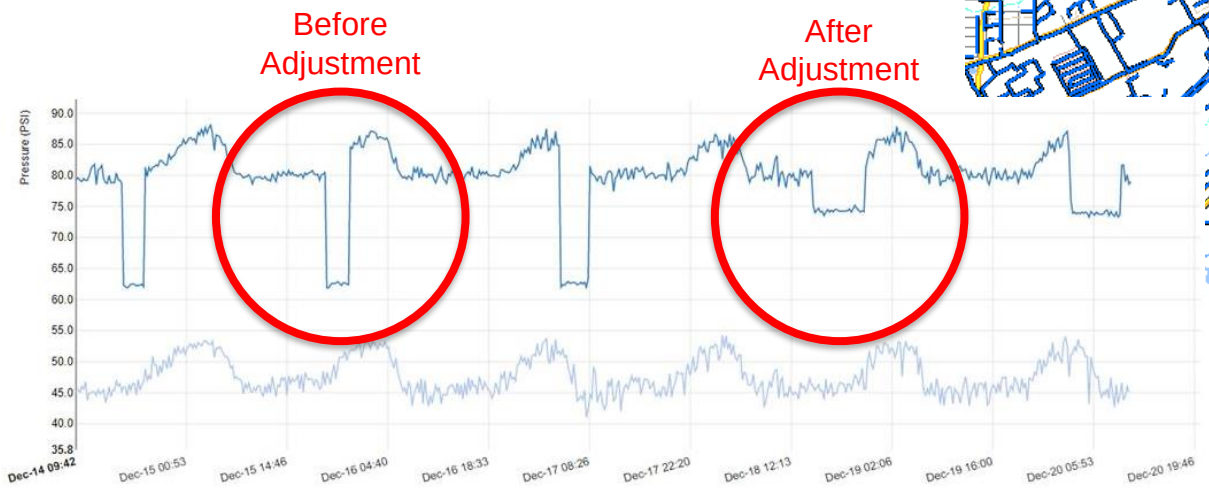
Operational Insights: Reservoir Filling Impact

- 10 MG reservoir feed with a 16” main





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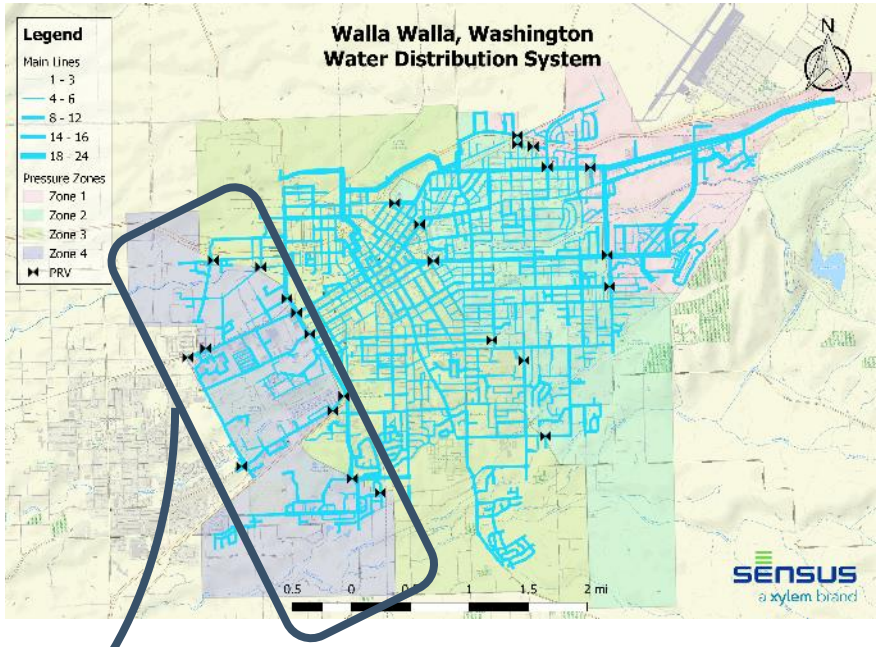
Pressure Management – Leak Control



- ✓Stabilize pressure
- ✓Reduce pressure
- ✓Validation

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Pressure Management – Leak Control

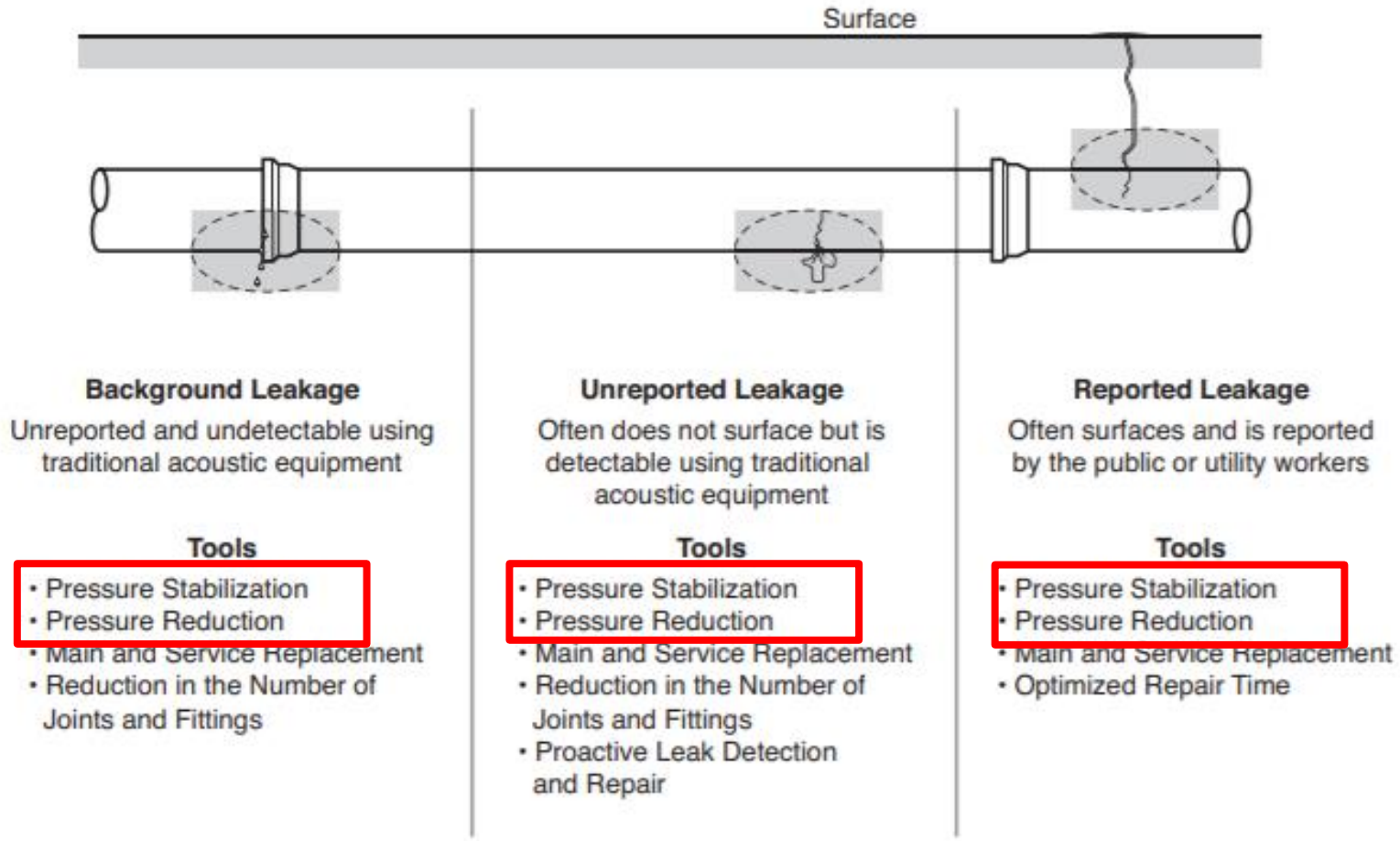

Figure 5-2 Components of leakage and appropriate intervention tools[3]

Source: AWWA M36, 3rd ed.

Pressure Management – Leak Control

- Real losses as a function of pressure:
  - 0.79 gallons per service connection per day per PSI (avg)
    - *Source: EPA/WRF Water Audits in the US: A review of Water Losses and Data Validity*

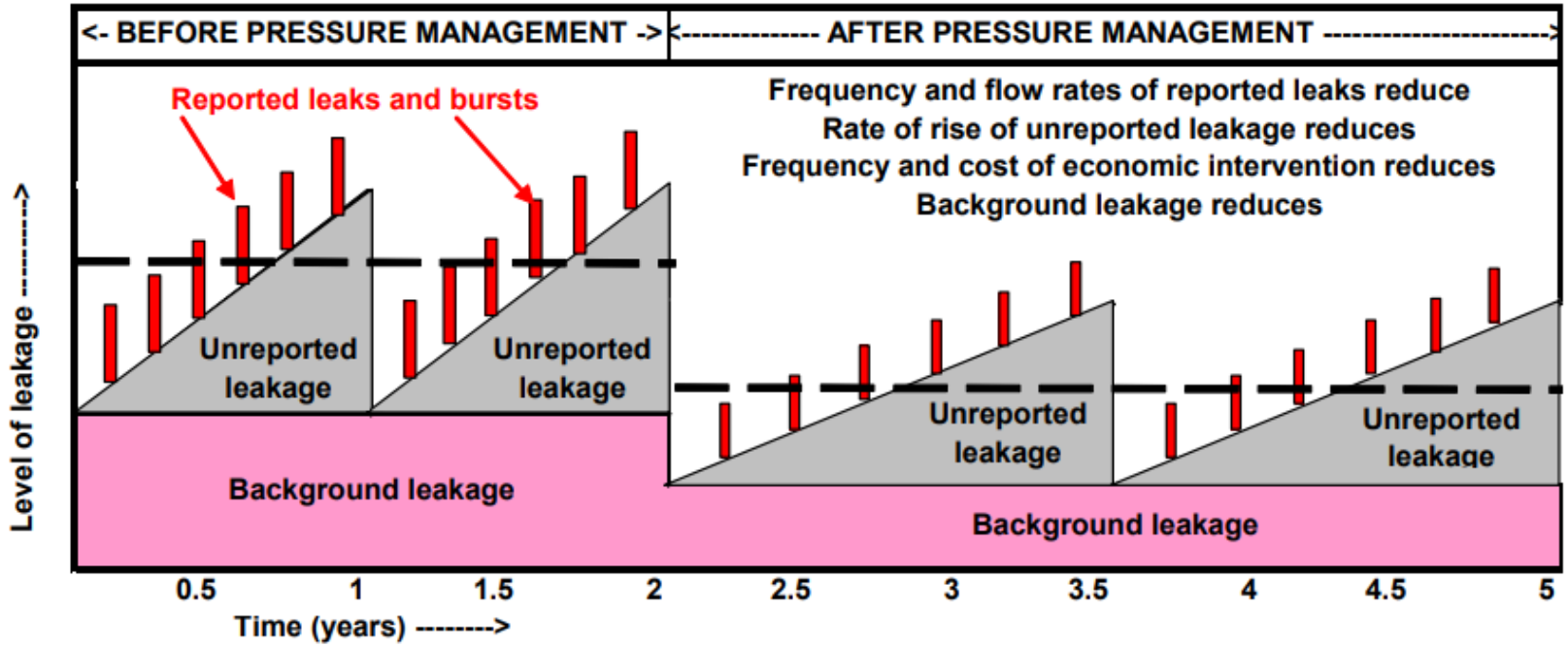

Figure 1: Influence of pressure management on BABE components of Real Losses
Source: Fantozzi & Lambert (2007)

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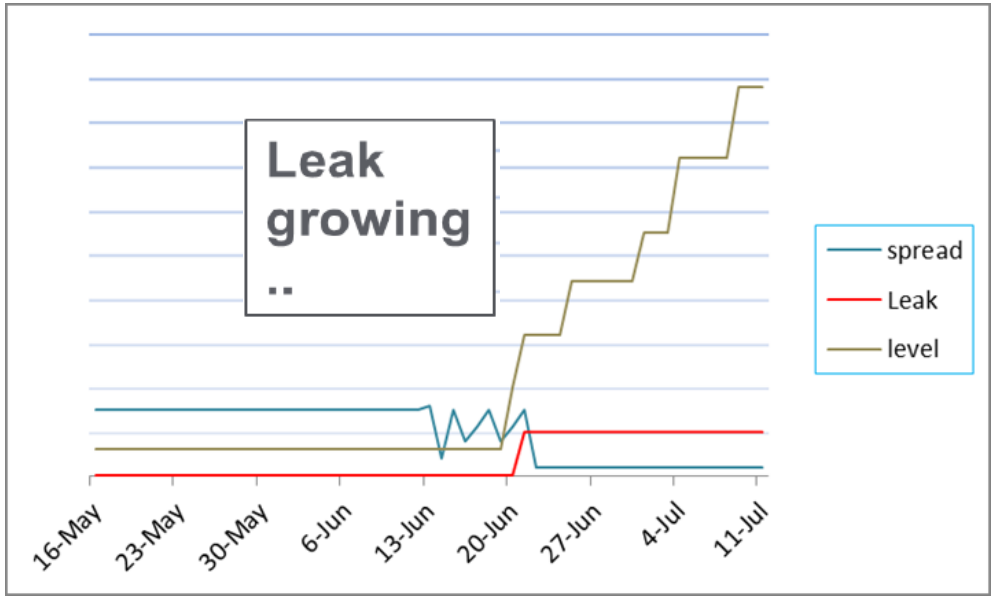
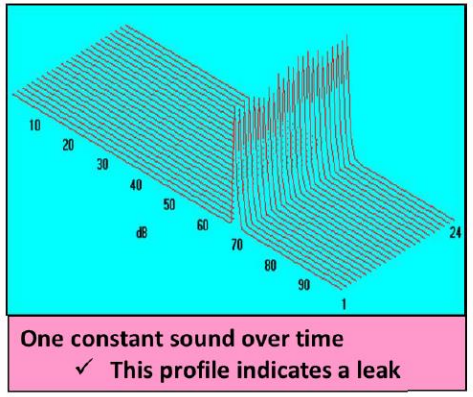
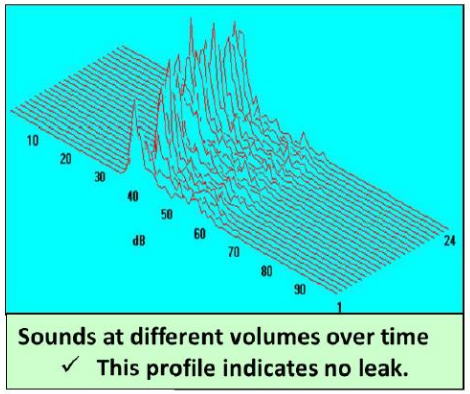
Acoustic Monitoring

Interpreting a logger data trends



- Level
  - How loud is the leak
  - How close is the leak
- Spread
  - This is the delta between the samples
- Low spread, higher confidence it is a leak
- Leak
  - Combining both level and spread data provides direction of “leak/non leak” situation





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The Smart Utility Network Summary

- Expanding Traditional AMI networks to other applications provides added value to utilities

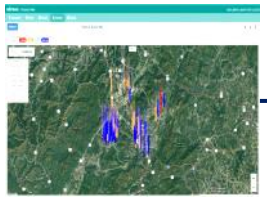
Smart Residential Meters and SmartPoints

Commercial & Industrial Meters and SmartPoints

Smart Gateways with 3rd Party Sensors

Base Station

Network Management Software



Smart Applications & Data Analytics

Customer Portal

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Let's Solve Water

Thank You for Keeping the Water Flowing!

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PRESENTING TODAY

Graham Mattison

Solution Manager - Kamstrup

16+ years in the Water Industry

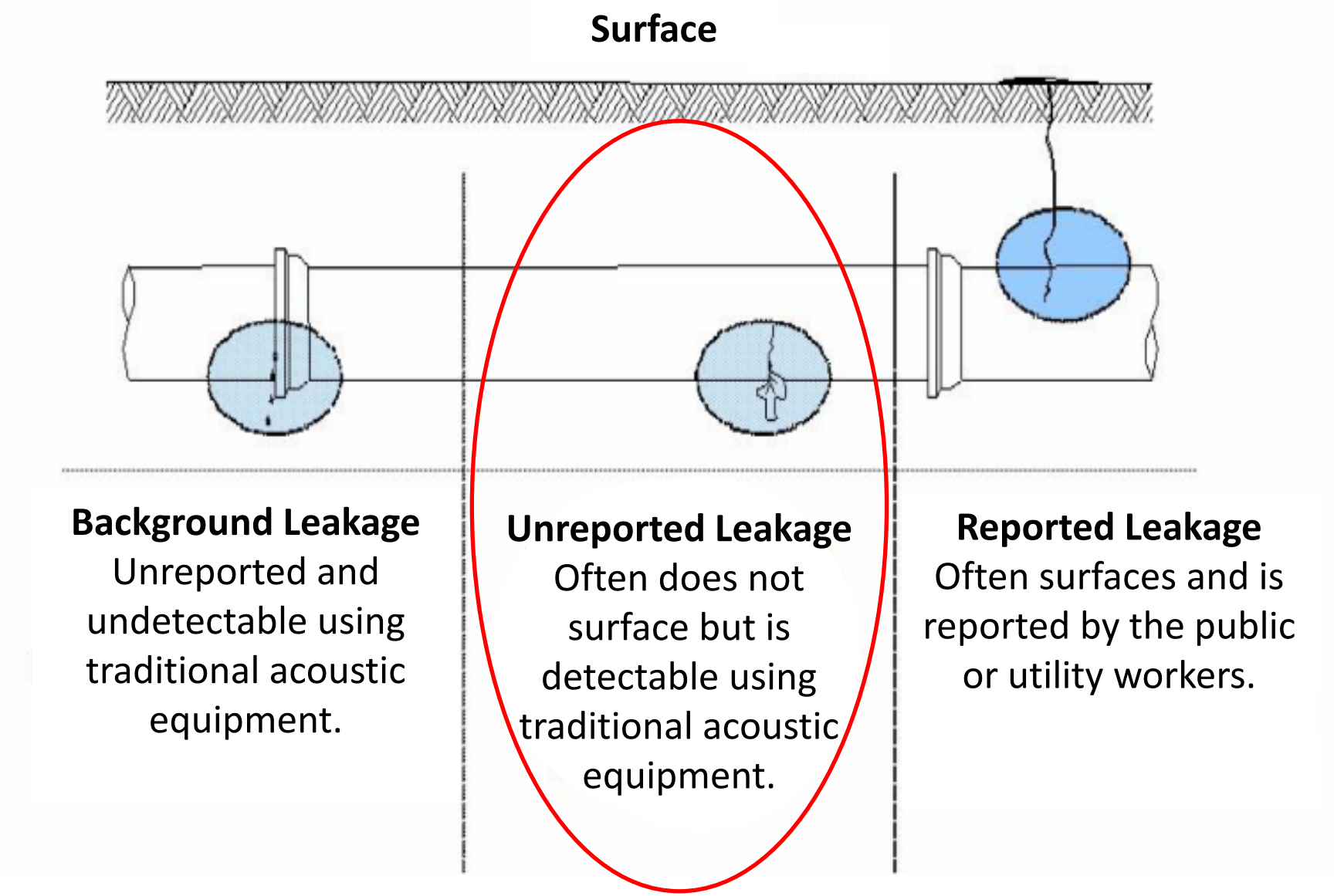
More than a decade in Acoustic Leak Detection

Has helped utilities across North America eliminate more than a billion gallons a year in water loss / non-revenue water

What Types Of Water Main Leaks Are We Trying To Identify?

(Hint: It’s Not This One)

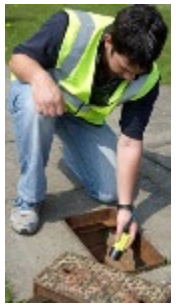
Different Types of Leaks



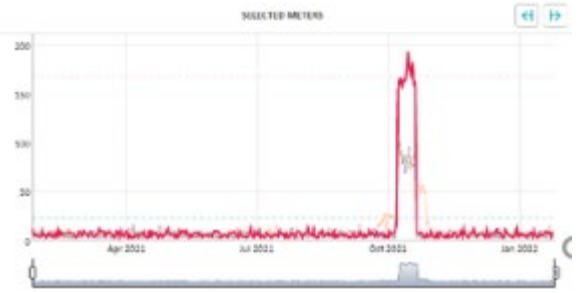
Leak Detection Strategy

Repair / Report

System Assessment



Localize



Investigate

Confirm / Pinpoint

Acoustic Leak Detection – Survey Technologies

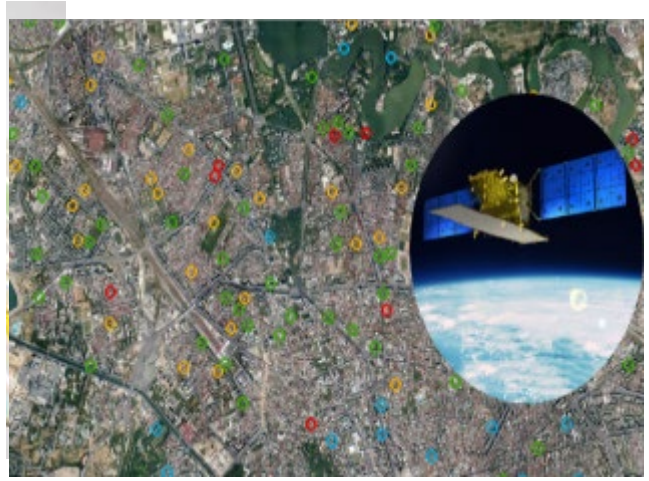
Ground Mic /
Listening Stick

Lift-&-Shift Noise Loggers

In-Pipe Surveys

Correlators

Fixed-Base Noise Loggers



Satellite Leak Detection

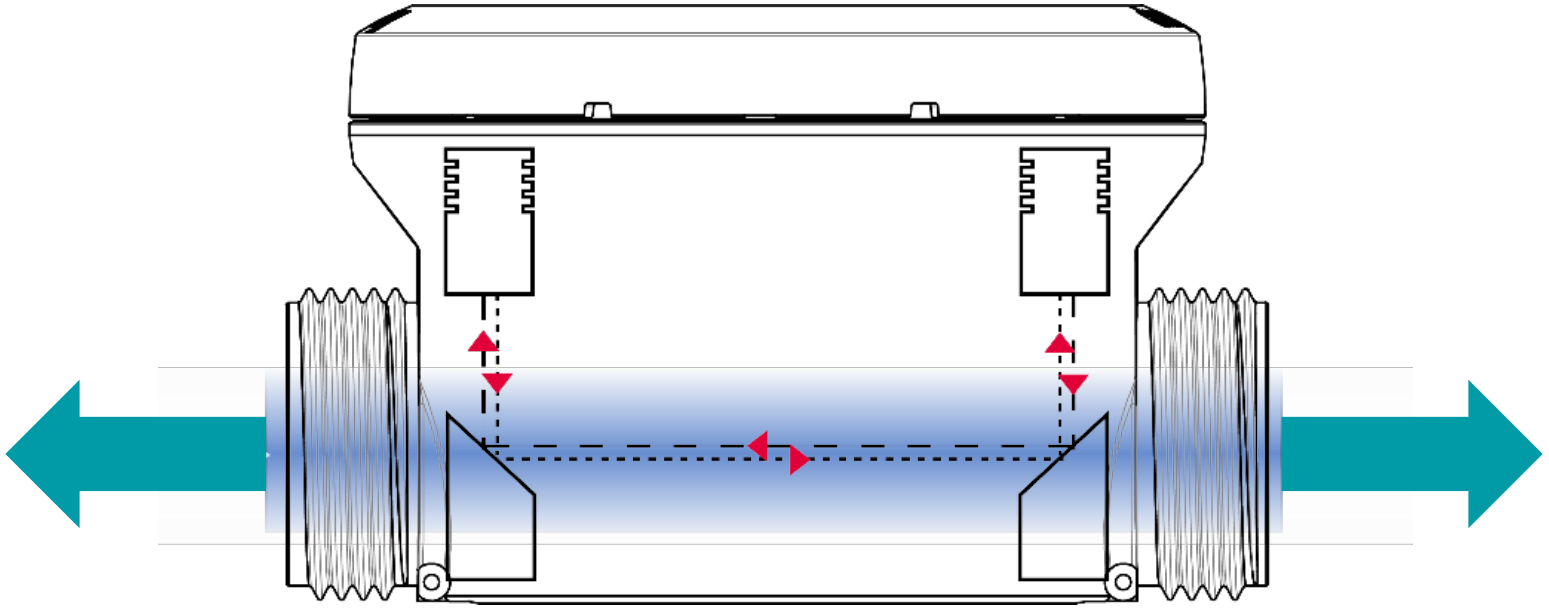
Acoustic Leak Detection – Survey Technologies

One-Time Leak Survey Tools

Survey Tool	Primary Use
Electronic Listening Tools “Sticks” Ground Microphones	Surveying systems; sounding fittings; confirming leaks
RF/Other Local Communication Acoustic Noise Data Loggers	Identify main leaks and adjacent service line leaks where possible using lift & shift methodology
Leak Noise Correlator	Pinpointing leaks within 3 ft (available in both real and non-rea time systems)
Satellite Leak Detection	One-time survey of large areas to identify potable water within 300 ft radius (282,743 sq. ft. area of interest)
In-Pipe Leak Detection Survey	Surveying large mains (16”+) or to confirm accuracy of leak on smaller pipe
In-Meter Pressure Monitoring	Quickly Identify catastrophic leaks. Great for verifying a hydraulic model. Zero–Point drifts continuously, can’t be re-zeroed in-service.

What Is “Built-In” Acoustic Leak Detection?

Acoustic Sensors With The Ultrasonic Measuring Principle



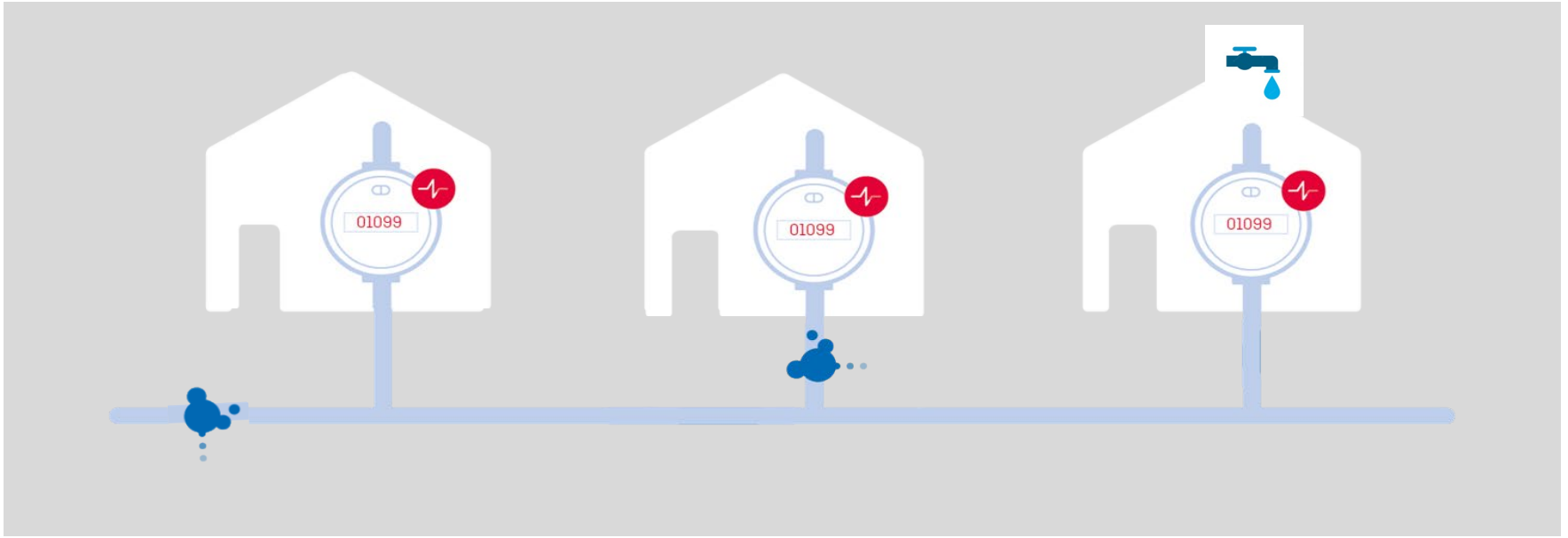
With the integral acoustic sensor, it is possible to measure noise in both direction of the pipe.

The acoustic sensor does not influence the flow measurements at any time.

Listening to Different Types of Leaks – with a Water Meter?

How does it work?

- It is well known that a leak will generate energy in the form of noise / sound.
- The built-in acoustic sensor allows the meters to measure acoustic noise within the distribution network upstream from the meter.
- Provide additional “info codes” (alarms) for any unusual customer side usage (continuous consumption/customer-side leaks).



Why(?) Use “Built-In” Acoustic Leak Detection?

FYI - Quick Reference for Leak Noise transmission distance thru pipe wall based on pipe size and material:

How Do Leak Sounds Travel on Pipes?

Metal pipes, particularly iron mains between 6 inches and 12 inches, copper services, and steel pipes transmit the sounds of water leaks for hundreds of feet in every direction. Asbestos-cement pipe and PVC pipe do not transmit the sounds nearly as far.

Distances transmitted for the "Hiss" or "Whoosh" sounds of water leaks are a function of the pipe diameter as well as the pipe material:

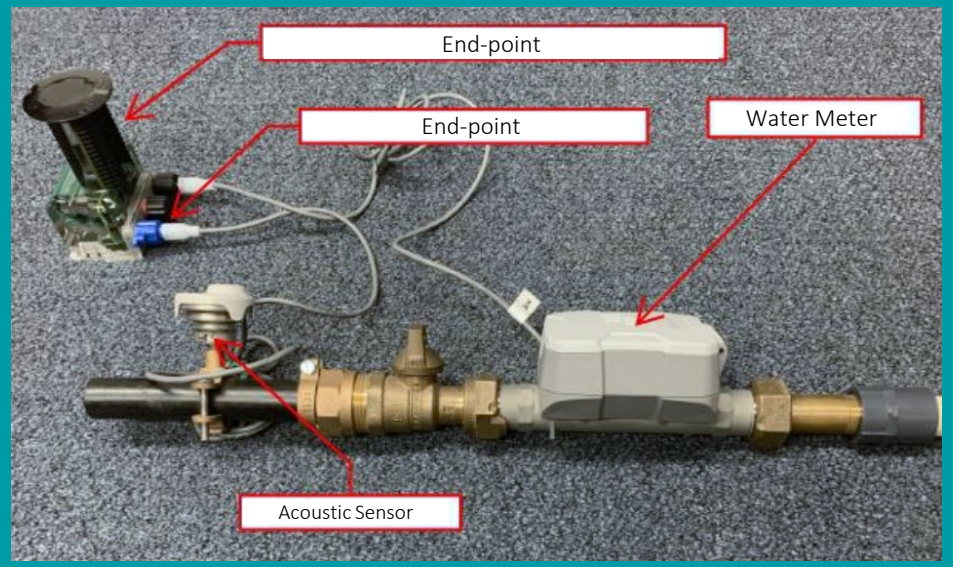
Pipe Material and Diameter	Distance Sounds Travel for 2 GPM Leak at 60 PSI
6 inch Cast Iron Pipe	600 to 1000 feet
12 inch Cast Iron Pipe	400 to 800 feet
24 inch Cast Iron Pipe	200 to 400 feet
6 inch AC Pipe	400 to 800 feet
12 inch AC Pipe	300 to 500 feet
24 inch AC Pipe	100 to 300 feet
6 inch PVC Pipe	200 to 300 feet
12 inch PVC Pipe	100 to 200 feet
24 inch PVC Pipe	50 to 100 feet

Material	Diameter (mm)	Velocity (m/s)
Polyvinyl Chloride (PVC)	40	565
	80	540
	150	530
Cast-Iron	150	1220
	250	1160
	350	1120
Steel	25	1375
	40	1350
	60	1330
	90	1286
	150	1200
	250	1150

Temperature - t - (°C)	Speed of Sound - c - (m/s)
	Water
0	1403
5	1427
10	1447
20	1481
30	1507
40	1526
50	1541
60	1552
70	1555
80	1555
90	1550

Leak noise travels faster and farther through the water column than it does along the pipe wall.

Reduced Complexity to Deliver the Future, Today



Legacy Non-Revenue Water Solutions

Meter Cost + Radio Cost + Leak Sensor Cost

Meter installation + Radio installation + Leak Sensor installation

2 Wires

3 Hardware Components to Manage / Troubleshoot

3 Different Warranties

Unlikely 100% Distribution Coverage

flowIQ® 2200 with Embedded Acoustic Leak Detection Built-in

Just The Meter Cost

Just The Meter Installation

No Wires

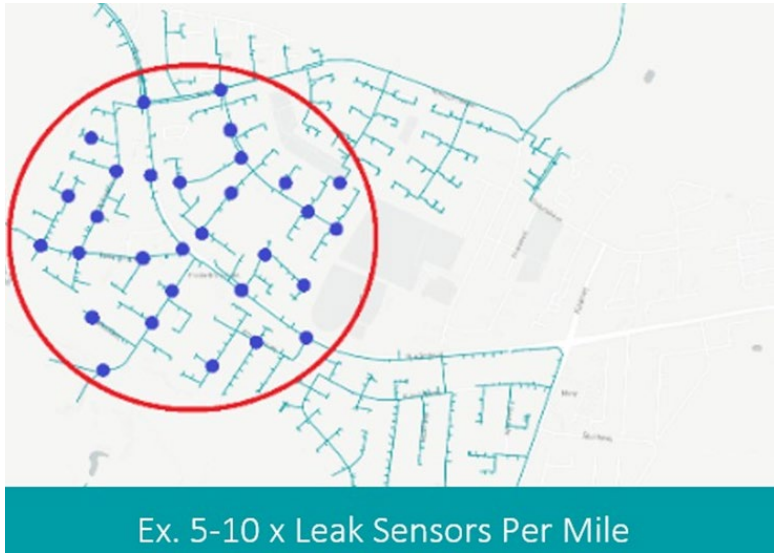
1 Hardware Component to Manage / Troubleshoot

1 Warranty

100% Distribution Coverage

Minimum Viable Survey Deployment vs Complete System Coverage

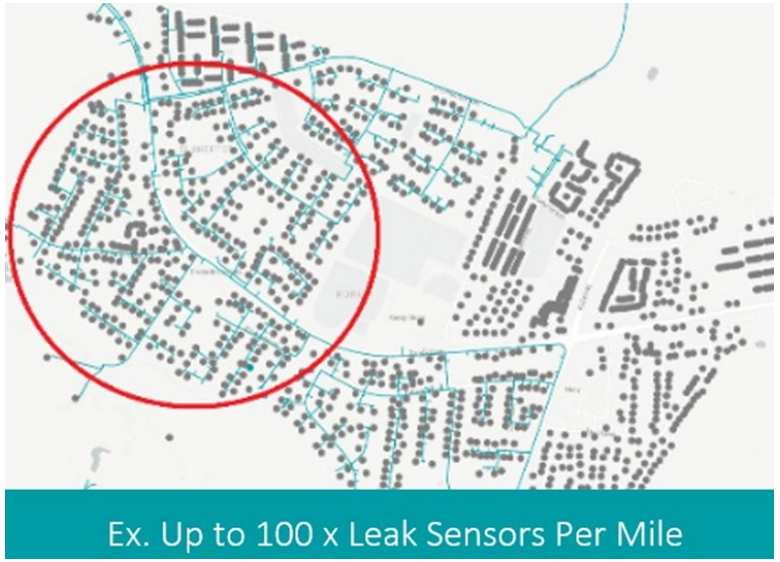
Main Line Coverage Only



Other Solutions

50%+ Of All Distribution System Leaks Occur At Or Near Service Connections.

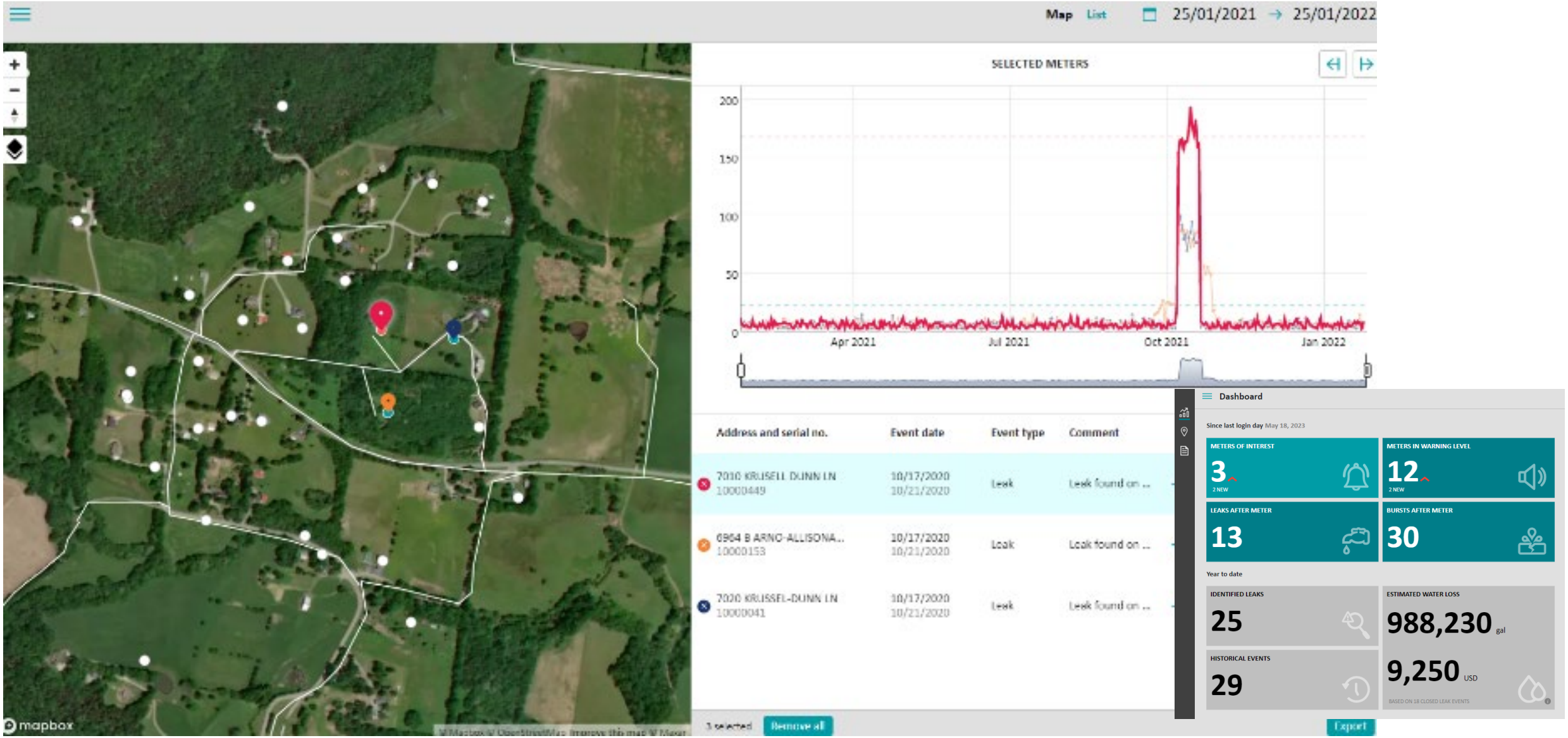
Service & Main Line Coverage



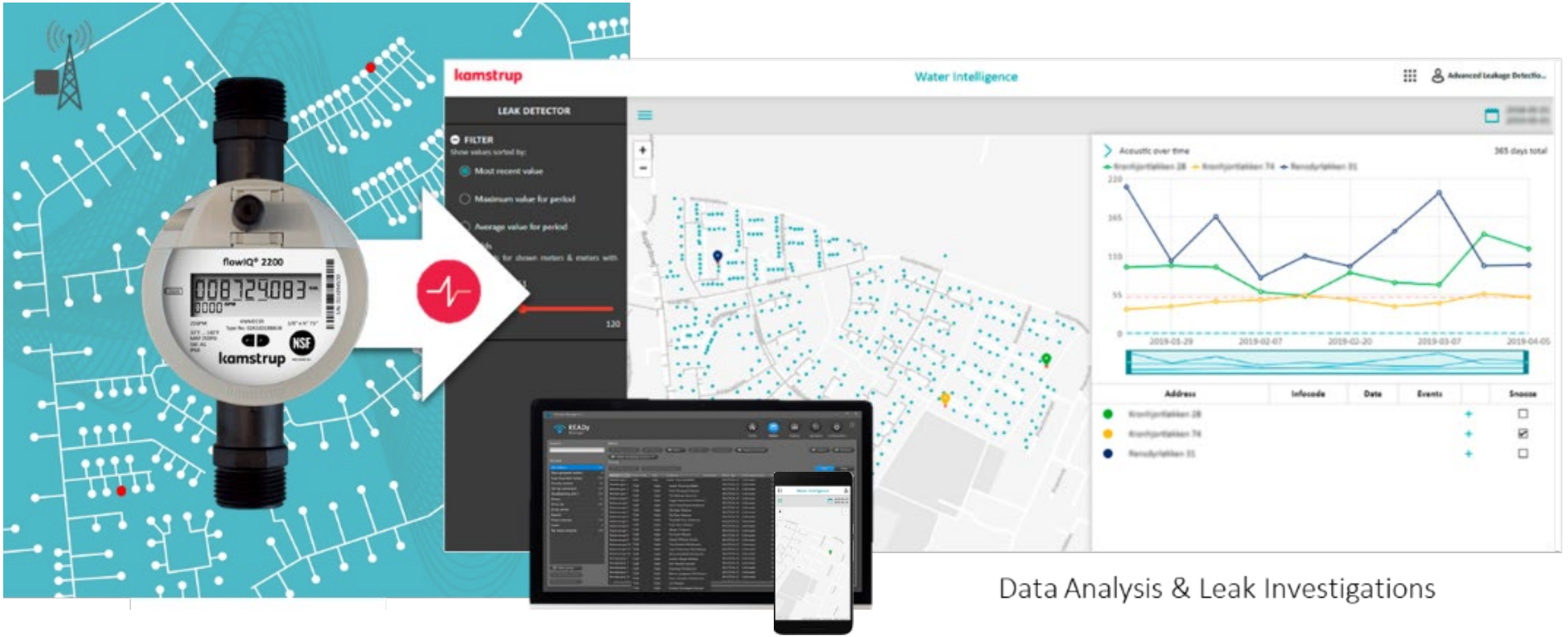
Kamstrup ALD

With 10x As Many Sensors Per Mile Compared To Acoustic Leak Monitoring Solutions Installed On Valves And Hydrants - It's Almost Impossible For Leaks To Hide

Acoustic Leak Detection Software



Built-In Acoustic Monitoring



Data Analysis & Leak Investigations

A Built-In Acoustic Advantage

Acoustic Leak Detection

Across Your Entire Water Distribution Network.

7,300

Distribution-Wide Acoustic Leak Surveys

Over **20** Years

No Additional:

Hardware, Infrastructure

Or

Manpower Required.

Focus & Prioritize

Leak Investigations

Get Closer.

10x More Leak Monitoring Points Per Survey

(Compared To Other Fixed-Base Leak Monitoring Technologies)

More Actionable Data With Less Wasted Effort

Proactively

Monitor For New Distribution Leaks

Every

55

Minutes!

26/7

365 Days A Year

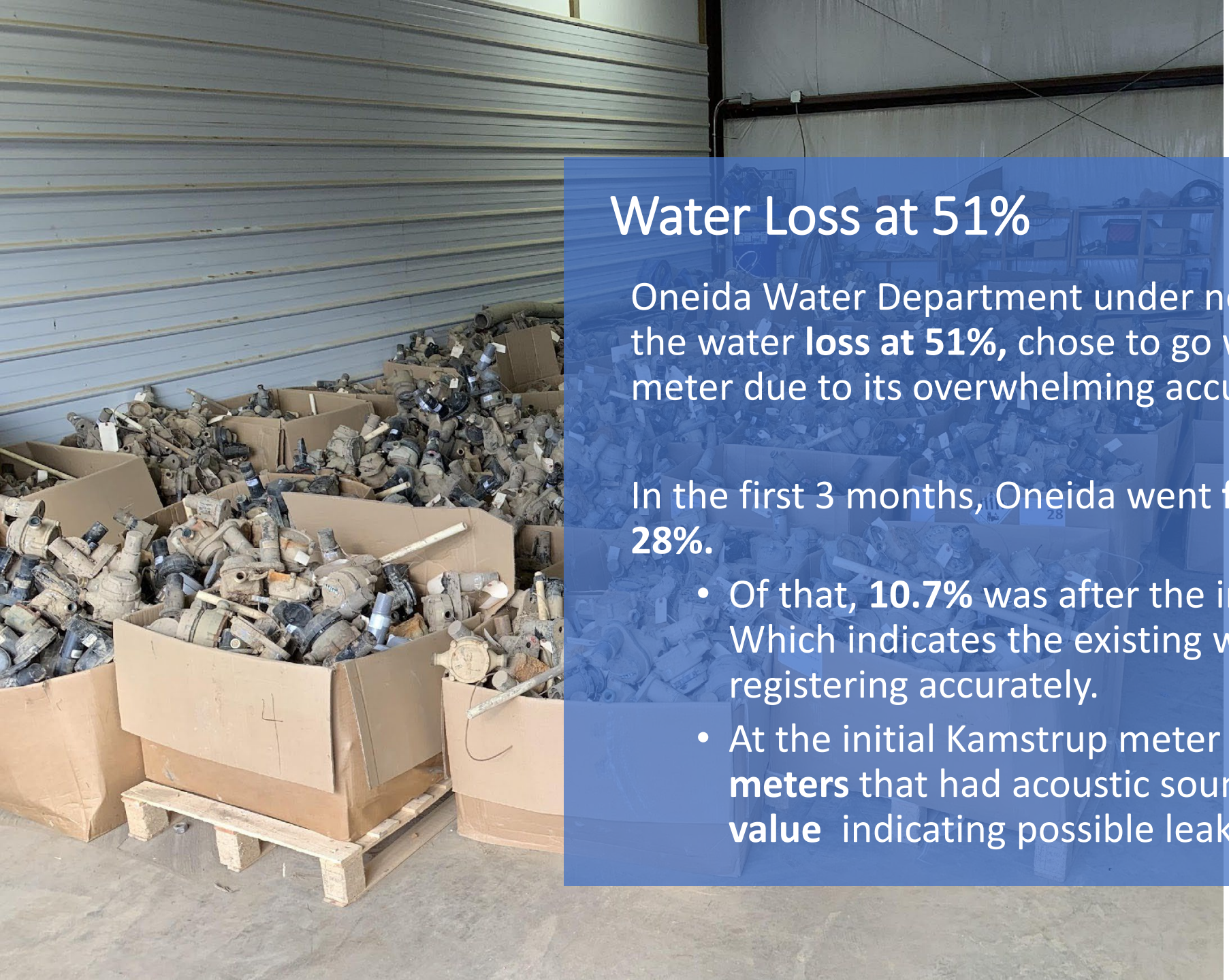
For **20** Years!

Case Studies & Testimonials

Town of Oneida, TN

- **4,620 AMI / ALD Meters**
- **15** Data Collectors
- **118** Square Miles
- **322** Miles of Mainline Pipe
- 6 Month Deployment

Oneida Changed out 4,620 Mechanical AMR Meters in 6 months



Water Loss at 51%

Oneida Water Department under new management seeing the water **loss at 51%,** chose to go with the new AMI/ALD meter due to its overwhelming accuracy and reliability.

In the first 3 months, Oneida went **from 51% water loss to 28%.**

- Of that, **10.7%** was after the initial total changeout. Which indicates the existing water meters were not registering accurately.
- At the initial Kamstrup meter startup Oneida had **77 meters** that had acoustic sound levels over **100 noise value** indicating possible leaks.

Water Loss Recovery

Initiated an aggressive water loss recovery program:

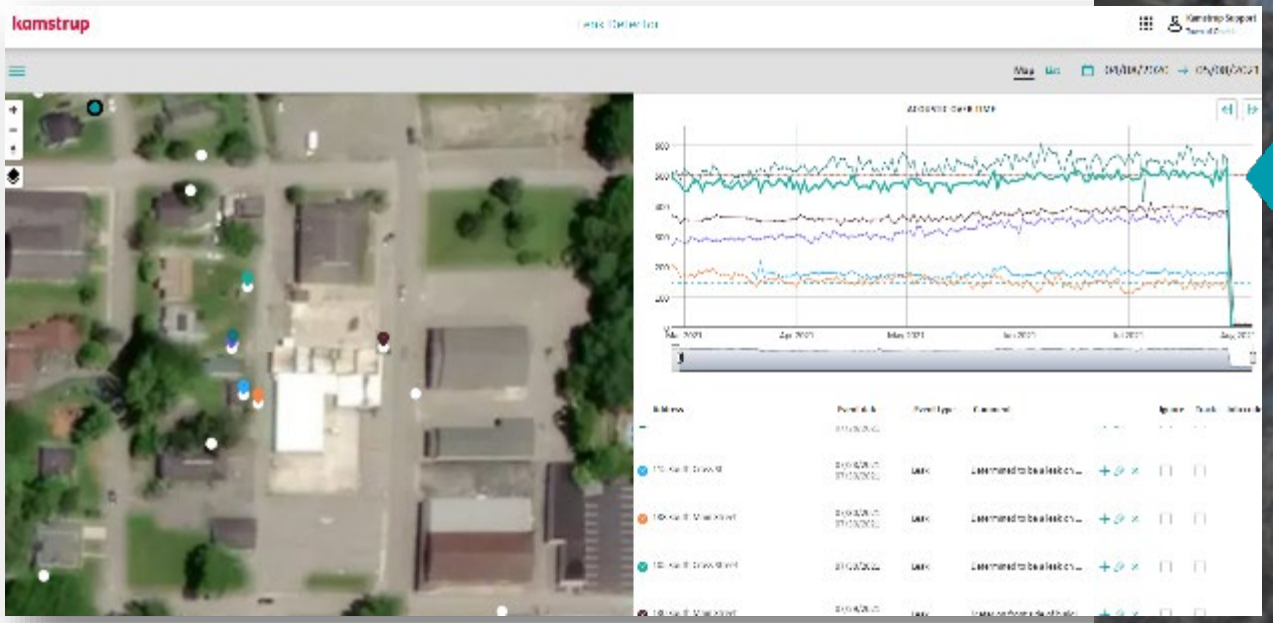
- Placing **2 full time employees** with leak detection equipment.
- Using ALD, **70+ leaks** were located and/or repaired by the Distribution repair crew. (2022)

Currently:

- **Expect to** be at or below **15% water loss in 2024** which will save approximately **$140,000** in lost revenue and **gained 36** working days not having to read meters to spend more time finding water leaks.

Oneida, TN

- High noise detected on several meters
- Service line leak had been running a minimum of 5 months



Leak Repaired

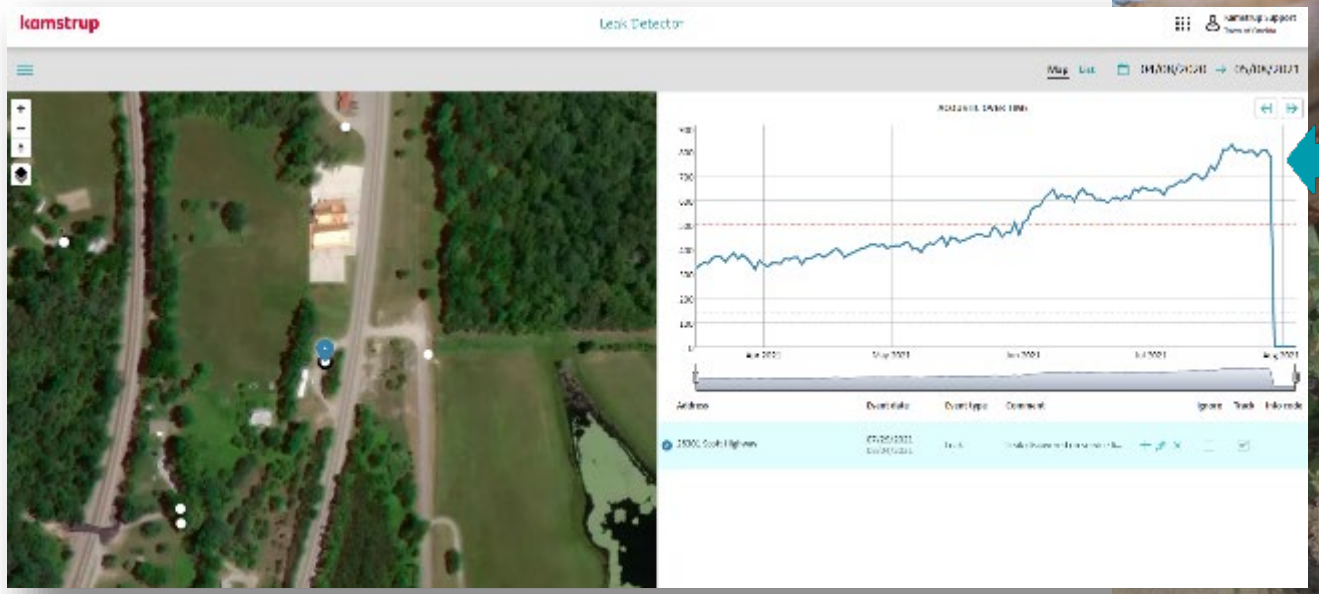
Leak estimated at 2 GPM and had been running for at least 5 months

Utility Service Line made from ductile iron

Distance to leak was approximately 30 feet to 150 ft

Oneida, TN

- High noise detected on single meter
- Service line leak had been running a minimum of 4.5 months
- The total NRW would account to $21,000 in 12 months*



Leak Repaired

Leak estimated at 4 GPM and had been running for at least 4 months
777,600 for 135 days

Utility Service Line made of PVC

Distance to leak was approximately 50 ft

*based on TN American Water base rate

Cost Savings

During the initial changeout, Oneida's water treatment plant was operating on average around **15 hours** per day and is now down to **11 hours per day** resulting in even more dramatic **OPEX Savings** in Electricity, Treatment Chemicals, and Man Hours.

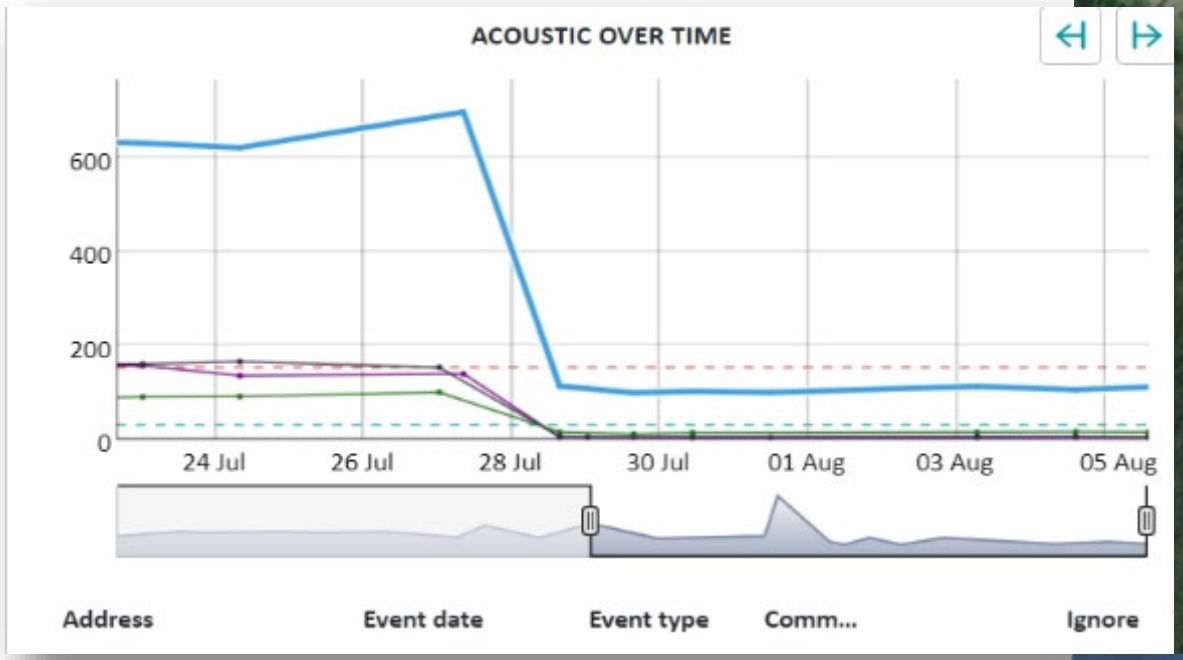
Fun Fact:
A 4 hour per day reduction in water treatment plant runtime equals 2 months less runtime 60 WTP Operating Days Saved in just one year!

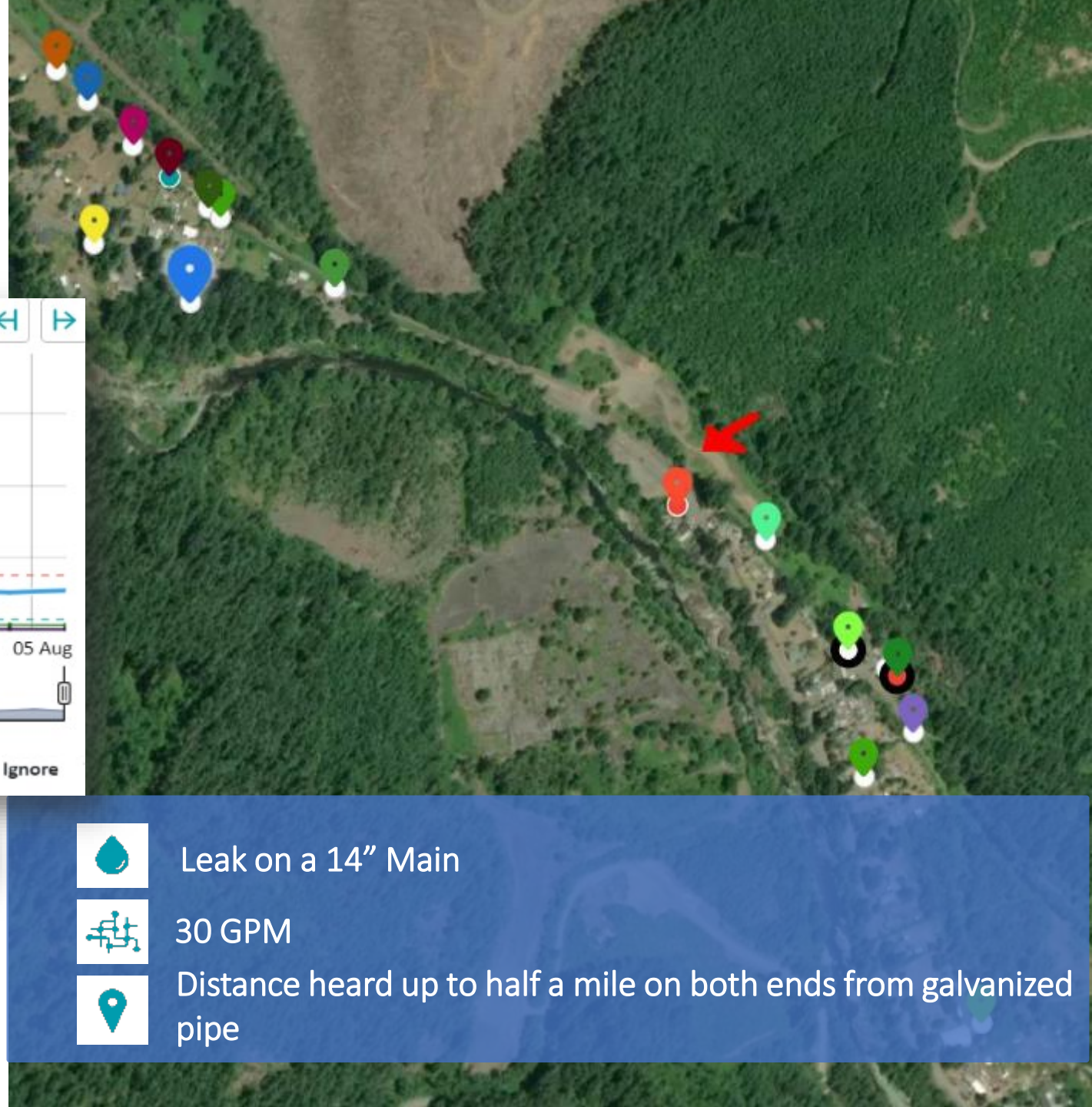
Mapleton Water District, OR

- 180 gpm leak detected, found, and repaired
- 6” AC Main – furthest meter was >1500 ft away
- Possible new leak now being investigated

Row River Valley, OR

- Main line leak found by meters up to <u>0.5 mi away</u>





Leak on a 14” Main

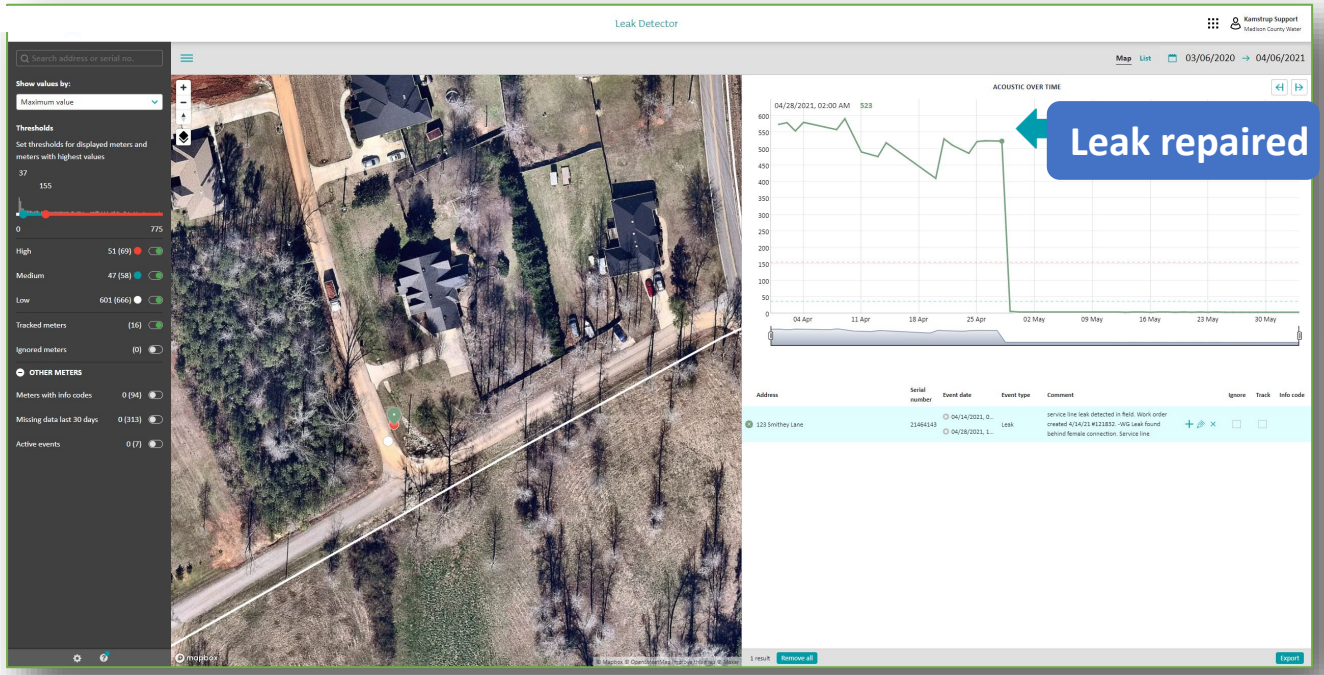
30 GPM

Distance heard up to half a mile on both ends from galvanized pipe

Madison County, AL

- Water leak never reached the surface (nearby creek absorbed it)
- Leak had been running for approximately 2 months
- Total water lost accounted to 432,000 gallons

- *If the leak had been running for 12 months:* 2,628,000 gallons



Leak Detector

Site visit with Madison County, TN

Leak was estimated around 5 GPM and had been running for at least 2 months

Utility service line made from polyethylene

Distance to leak was approximately 6 feet

Ephrata, PA

- Main line leak found before water surfaced or worse

"Something that we wouldn't have found until it got much worse."
- Ephrata JAA

Leak on 12" Main

Leaking from stainless steel clamp

55 ft from copper service line

Questions?

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