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American Water Works Association
Pacific Northwest Section

City of

SANDY OREGON

Water Distribution Management Systems:

Quantifying an Innovative Approach to Improve Water Loss and Carbon Footprint

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Belgrade, MT

406-223-2192

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Who is Mueller?



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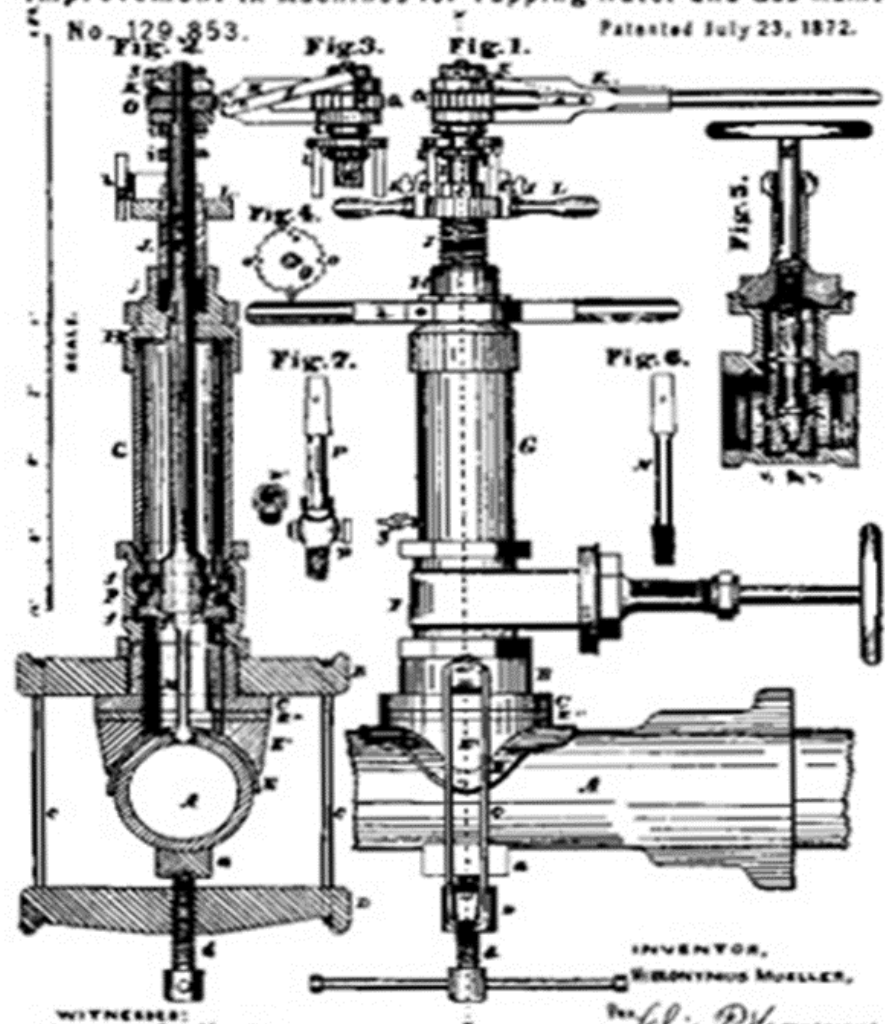
MUELLER

H. MUELLER.

Improvement in Machines for Tapping Water and Gas Mains

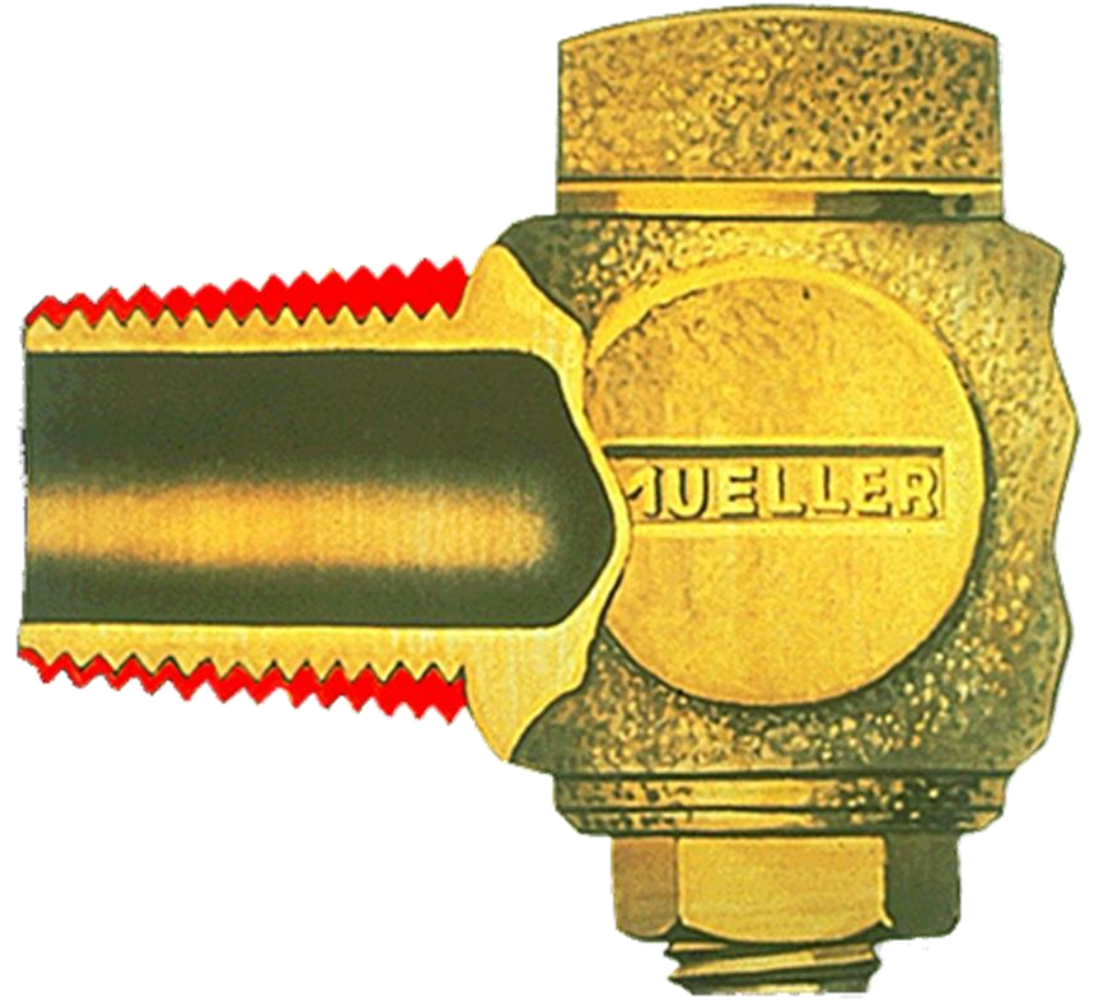
No. 129,853.

Patented July 23, 1872.

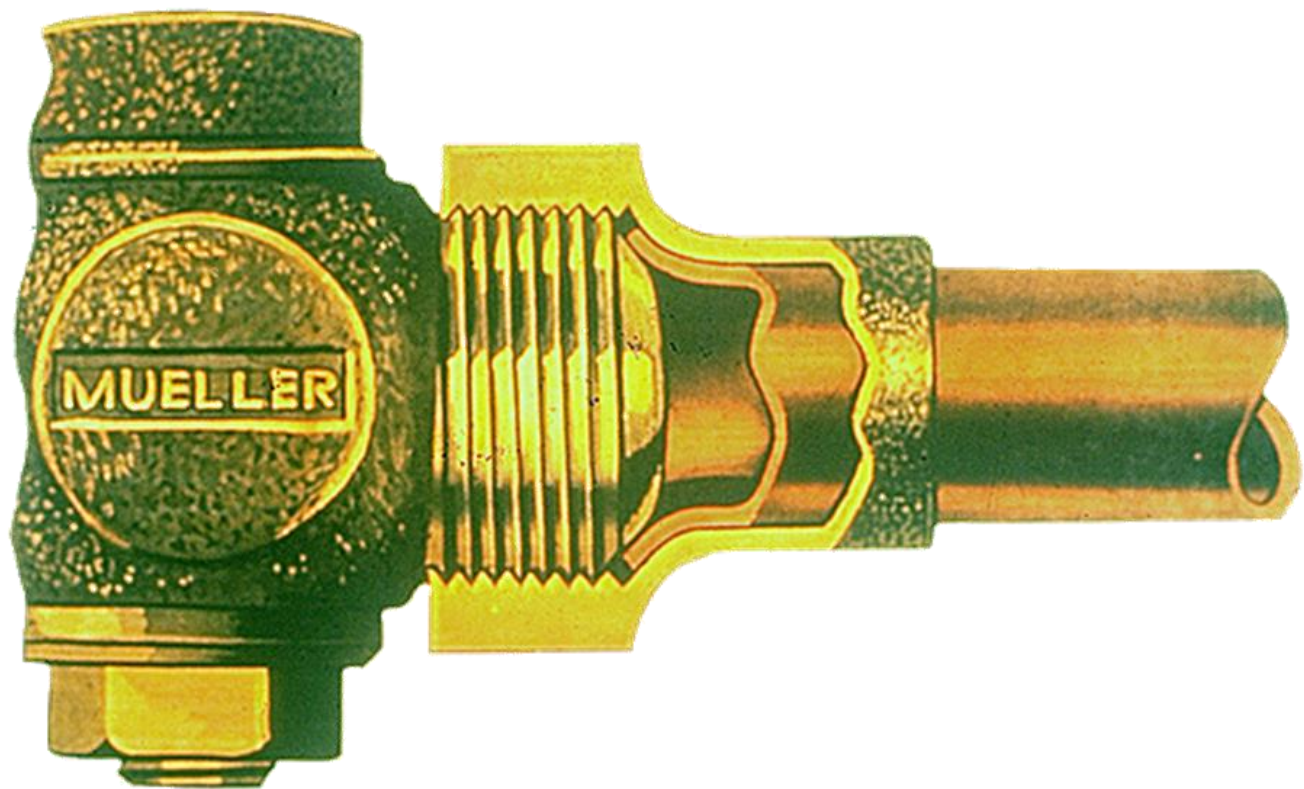
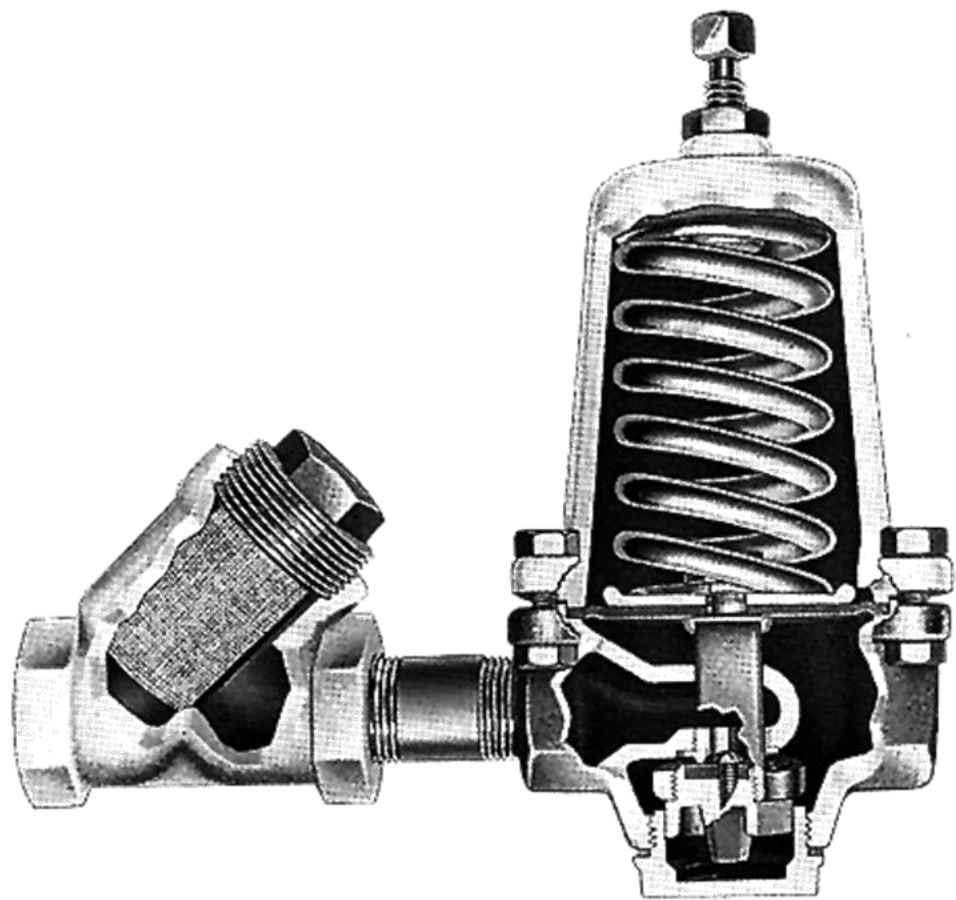


WITNESSES:
David S. Miffill
Edward G. Howe.

INVENTOR,
HEDONINUS MUELLER,
By *Chas. P. Morrison*
ATTORNEY.



MUELLER



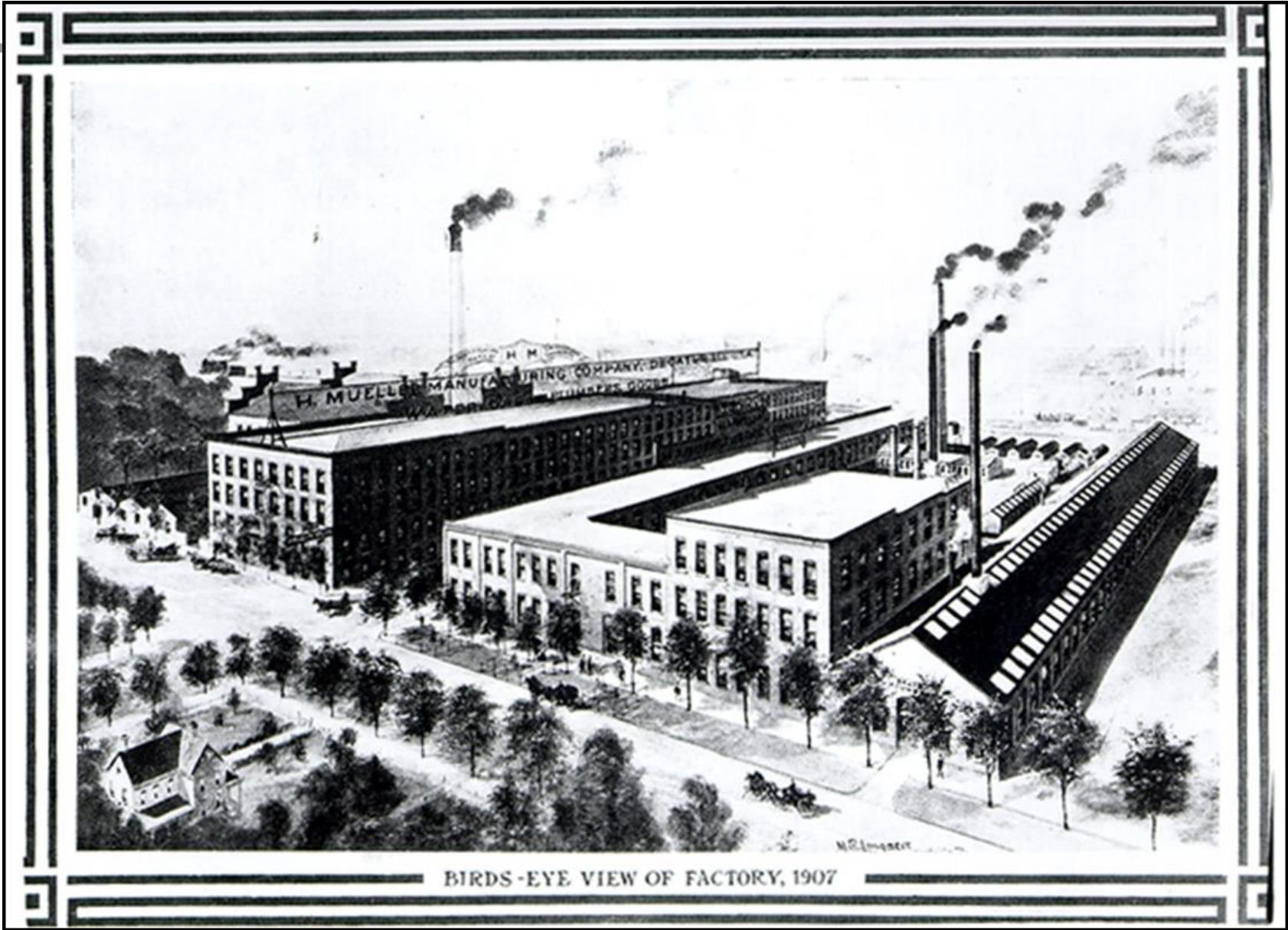
PICNIC BEER FAUCET COMPLETE



H-1459

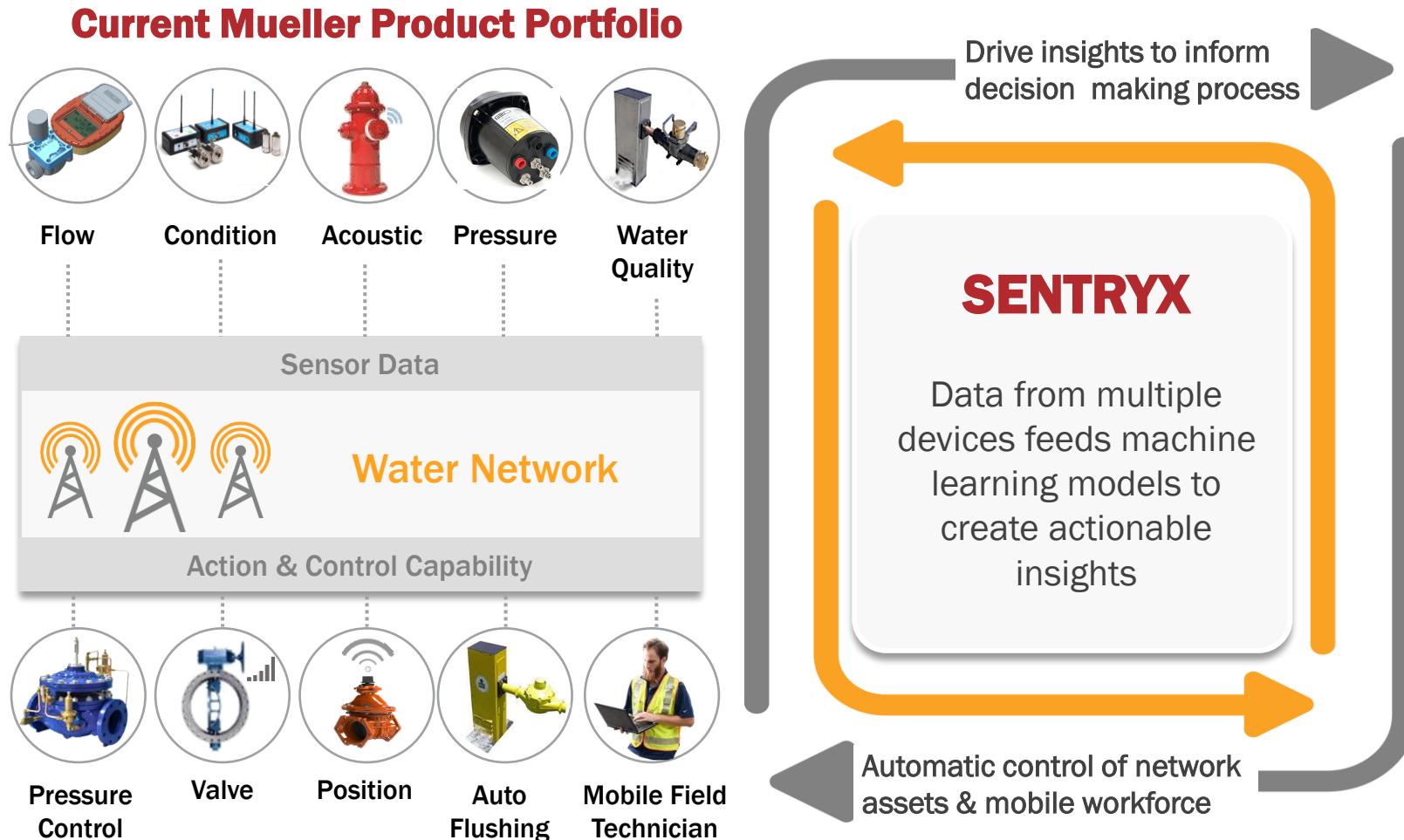
Mueller H-1459 Cr. P. Picnic Faucet complete with
Mueller Tap and 32" rod, Beer faucet and air pump.

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The Mueller Vision for Sentryx – Intelligent Software Platform



Water Network Administrators

Utilize Sentryx insights & visualization tools to:



Asset Managers

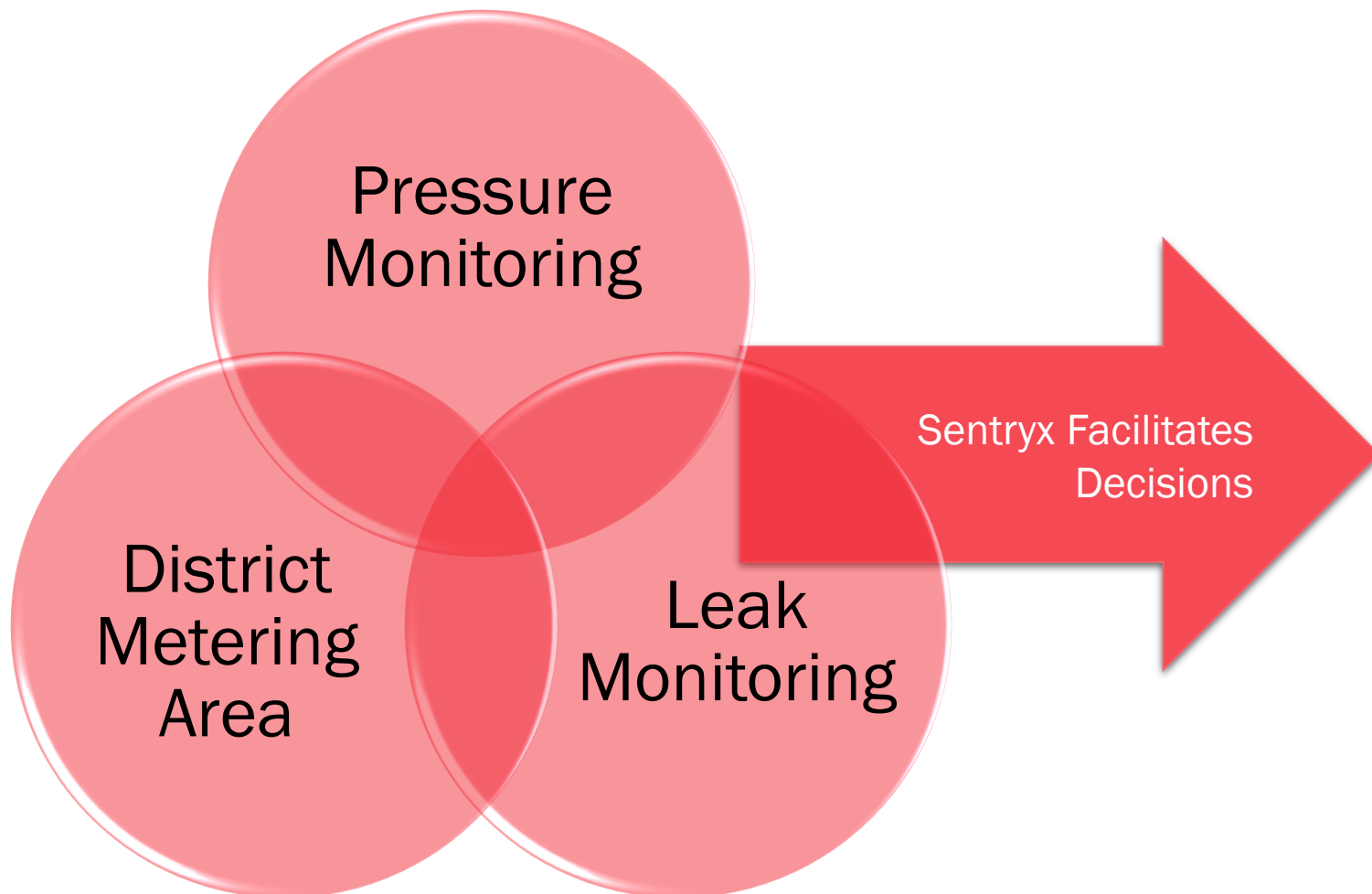
- Extend Asset Life
- Optimize and Prioritize Expenditures



Field Supervisors

- Produce Digital Workflows
- Plan Maintenance & Inspections

The Power at the Intersection of Multiple Sources of Data



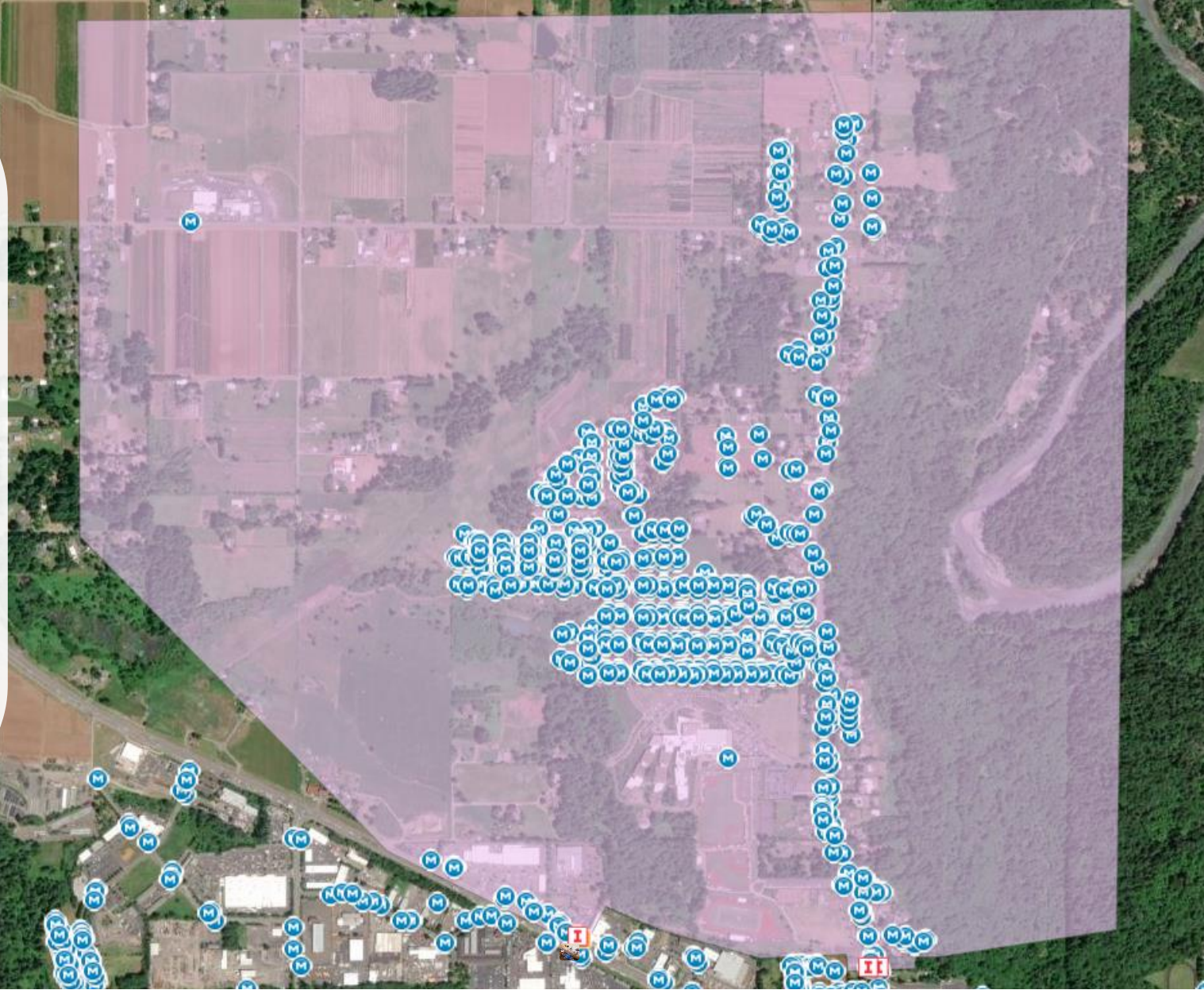
- DMA shows water imbalance
 - An older area in town needs focus to reduce non-revenue water loss, but where exactly?
- Leak Monitoring proactively shows multiple locations with potential leaks
 - Repair team starts to address
 - Which ones are the highest priority
- Pressure drop is detected and noise from one leak location stops
 - Text / email alerts sent immediately, and team jumps into action on high priority repair



Introduction

Sandy, Oregon

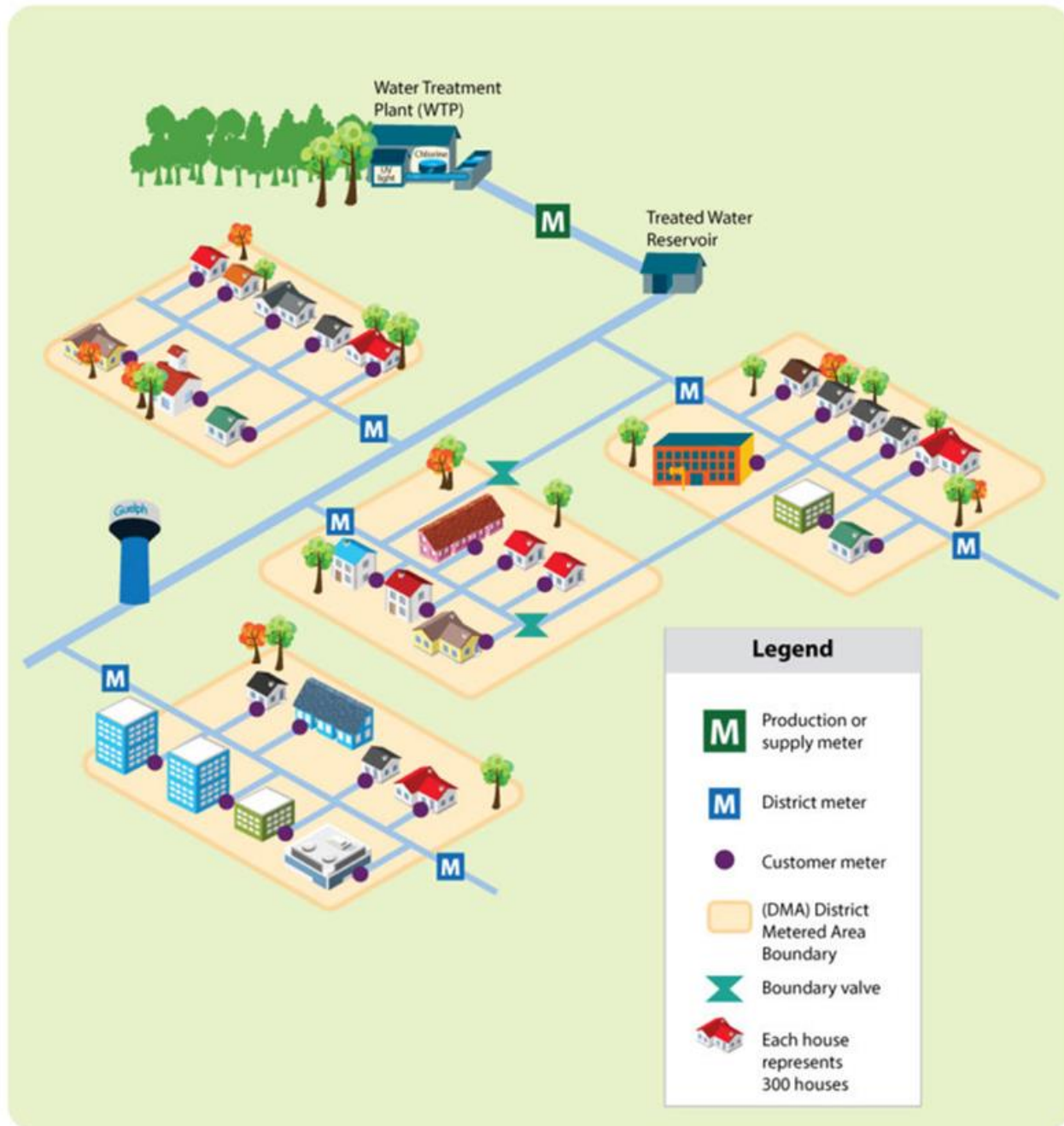
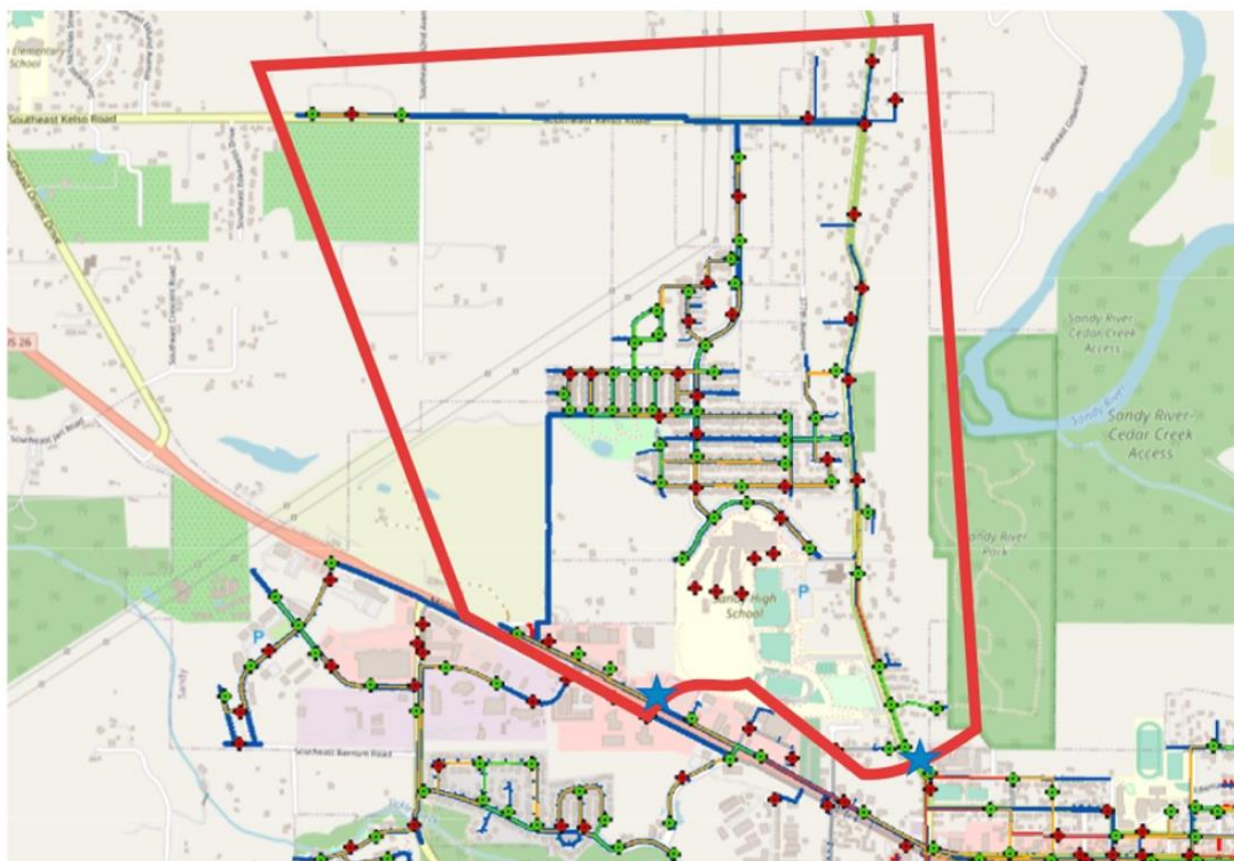
- Zone 4 in their network of District Metered Areas
- Contains High School, Commercial District, Residential Development and Industrial Fruit Processing Facilities
- Two existing input locations
 - Starbucks Vault
 - 3" and 10" Pressure Reducing Valves
 - Bluff Road Vault
 - 2" and 6" Pressure Reducing Valves



Existing Zone 4 DMA in Sandy was selected as it had two points of input and no outputs, existing AMI meters already deployed and an estimated overall water loss of 20% for the Utility



What is a DMA?



Sandy DPW - The Setup to Collect Data

Create a unique DMA Network

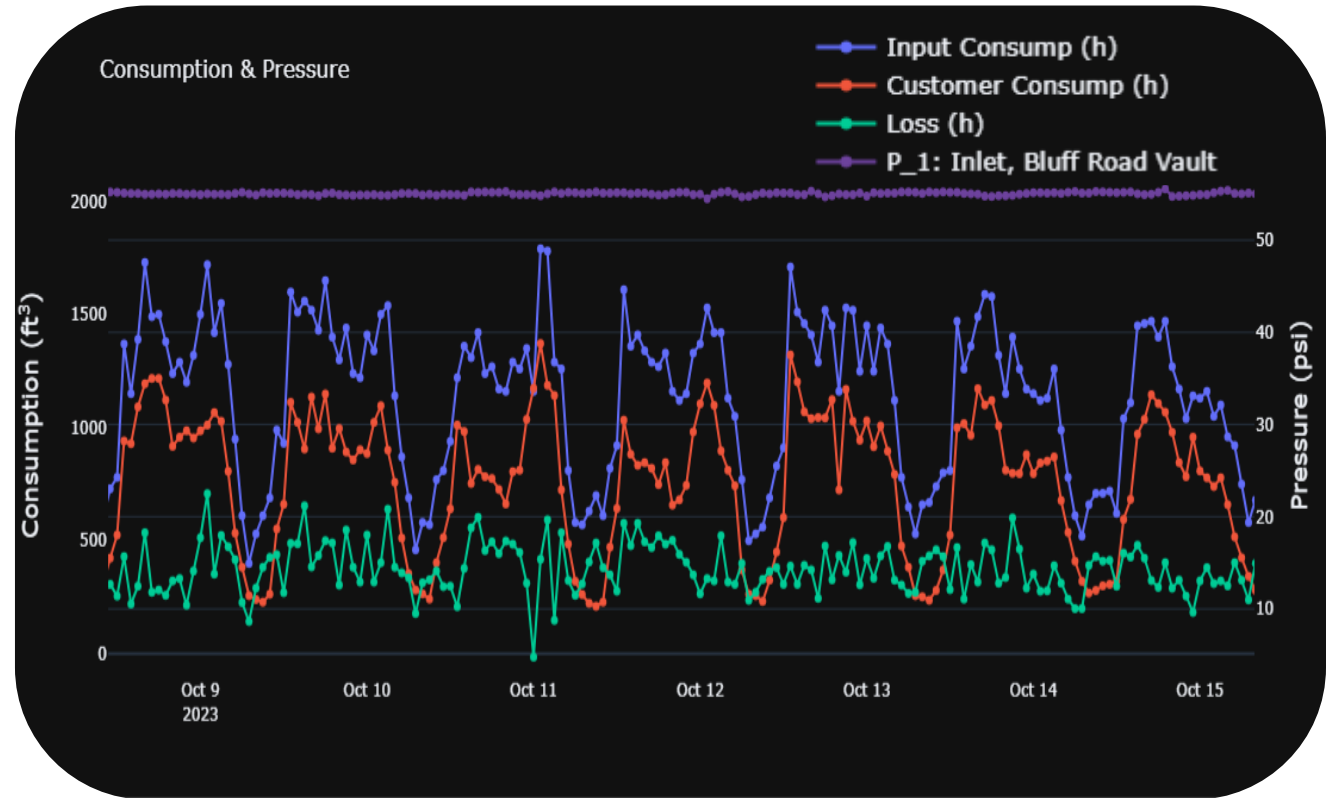
- 💧 District Metering Area with two points of input
- 💧 688 existing AMI Meters deployed
- 💧 Singer Pressure Reducing Valves integrated with McCrometer Insertion Flow Meters
- 💧 Mueller Systems Consumption Meters with Hymax Grip Flanges
- 💧 i2O 3-port Pressure Loggers & Automatic Pilot Valves



Sandy DPW – The Data

Quantify inputs and outputs

- Historic data for the DMA Customer Consumption shows cyclical usage with high draws in the summer for irrigation.
- Input Consumption is consistent with the Customer Consumption
- Average Water Loss was calculated to be 33%, or 47 gallons per minute



	9-Oct	10-Oct	11-Oct	12-Oct	13-Oct	14-Oct	15-Oct
Input Consumption	28,510	26,850	27,310	27,890	26,300	25,030	26,360
Customer Consumption	18,548	17,831	17,267	19,265	17,525	16,586	17,835
Water Loss	9,962	9,019	10,043	8,625	8,775	8,444	8,525

Leak Monitoring





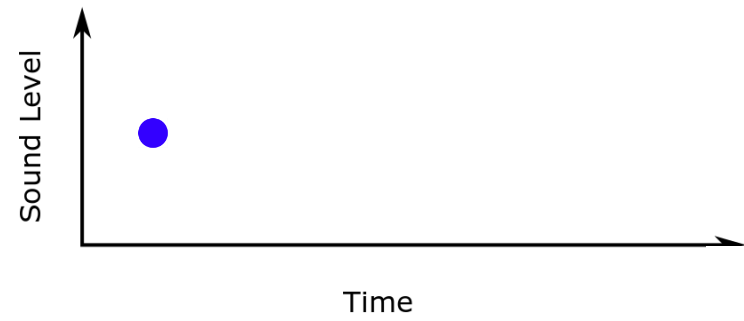
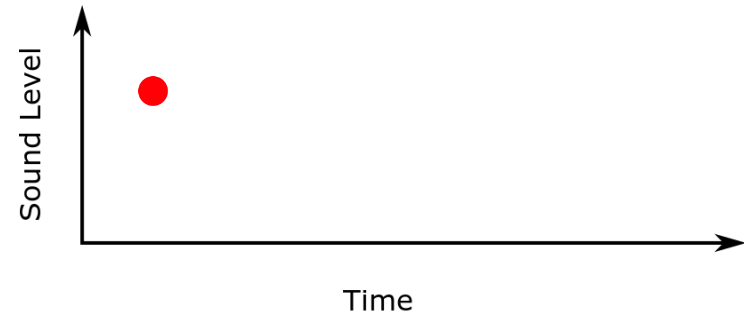
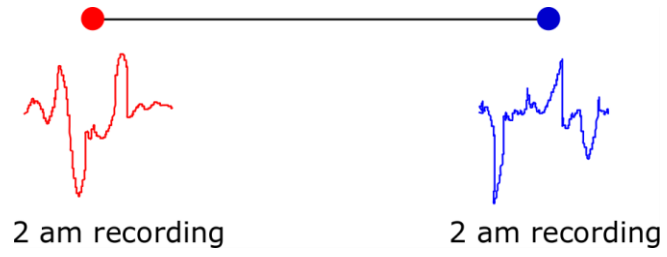
The Early Days...

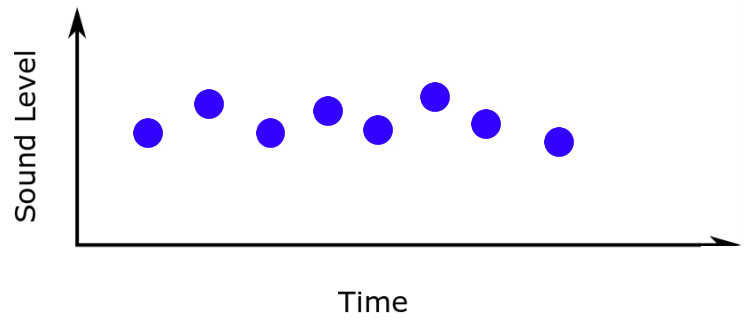
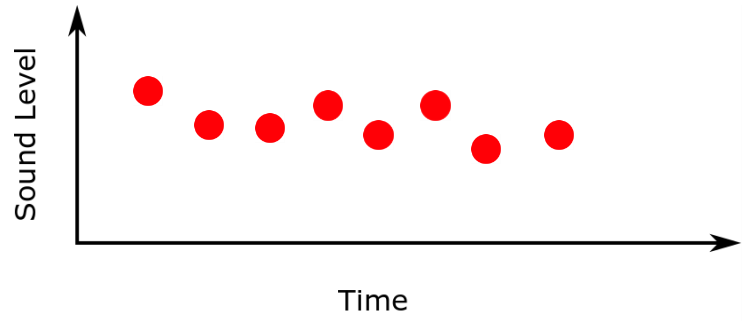


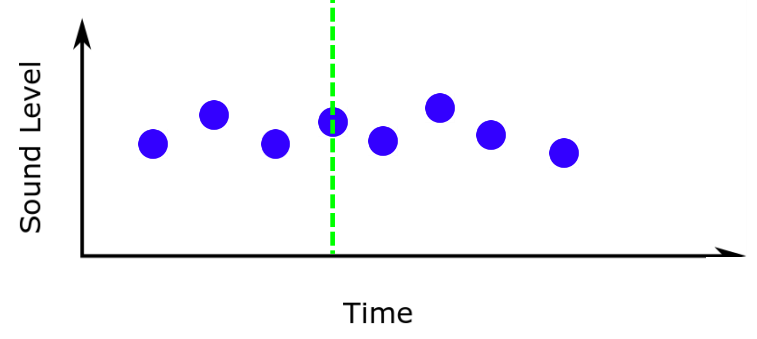
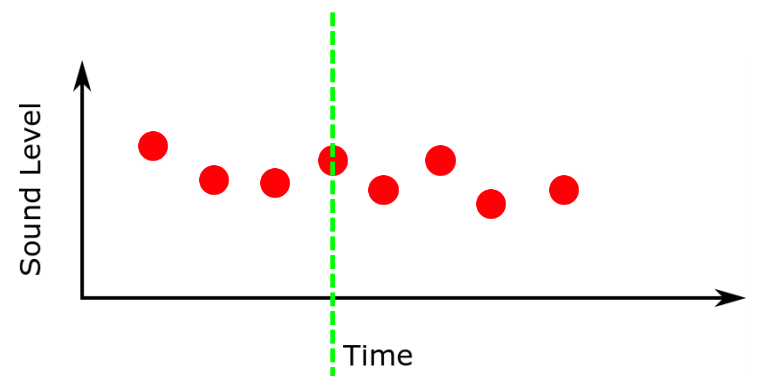
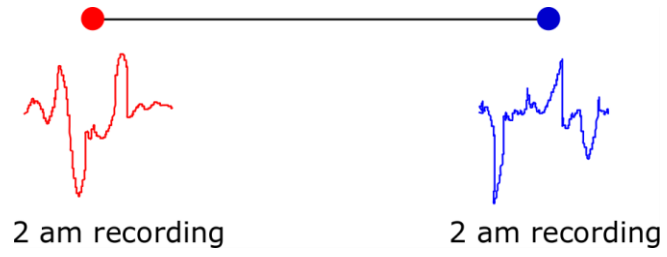


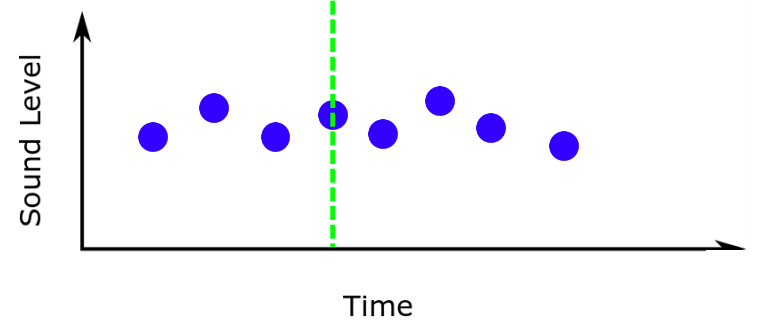
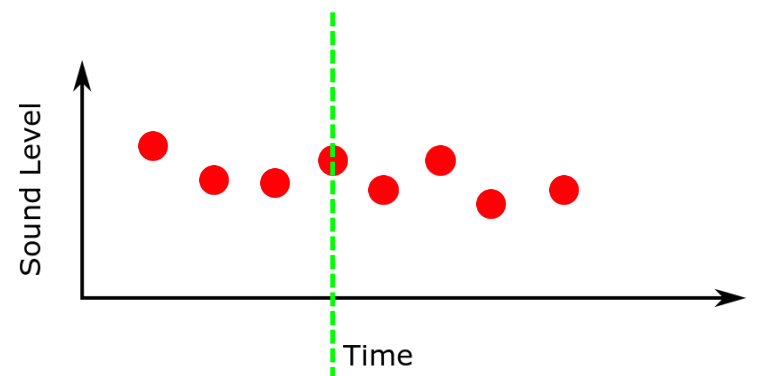
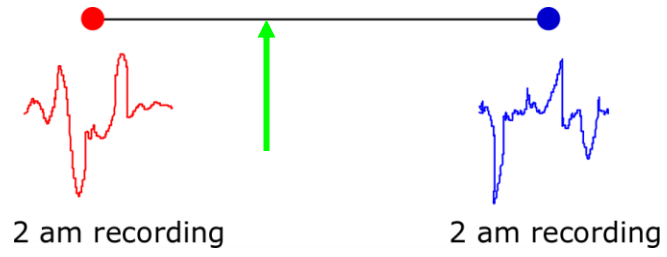
How it works





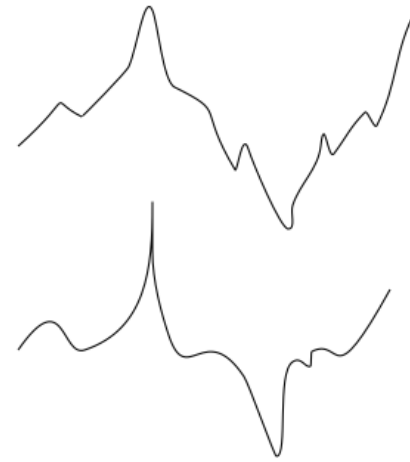








low correlation



high correlation

The magic tricks of correlation



1 ... 2 ... 3 ... 2 ... 1



Time



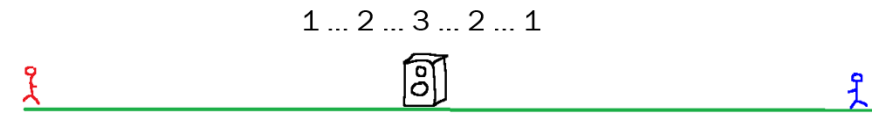
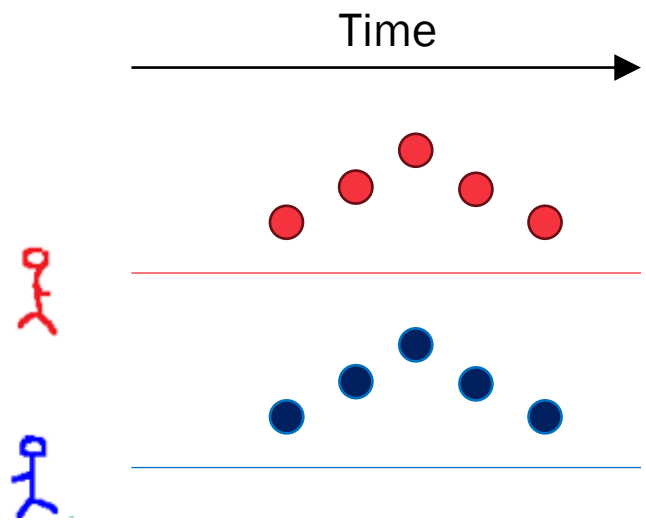
1 2 3 2 1

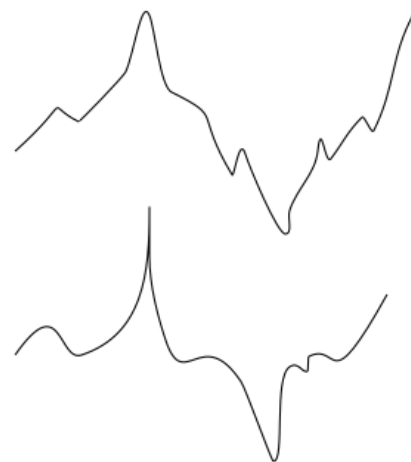
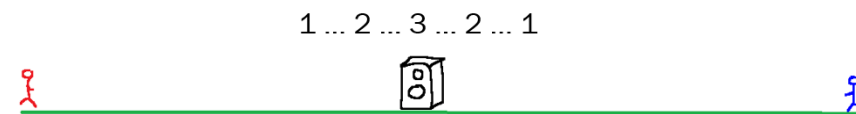
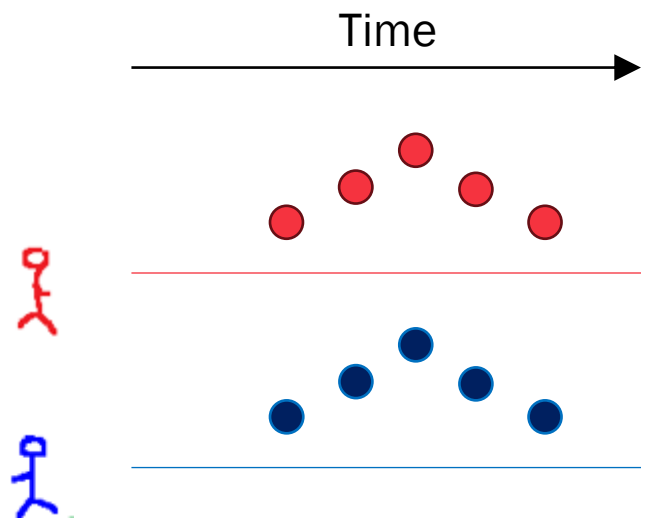


1 2 3 2 1

1 ... 2 ... 3 ... 2 ... 1







high correlation

Time



1 ... 2 ... 3 ... 2 ... 1



Time



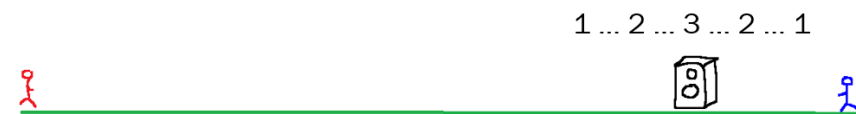
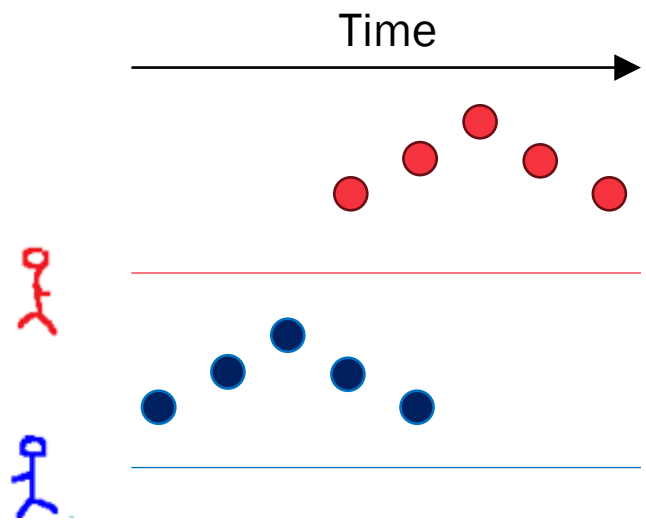
1 2 3 2 1



1 2 3 2 1

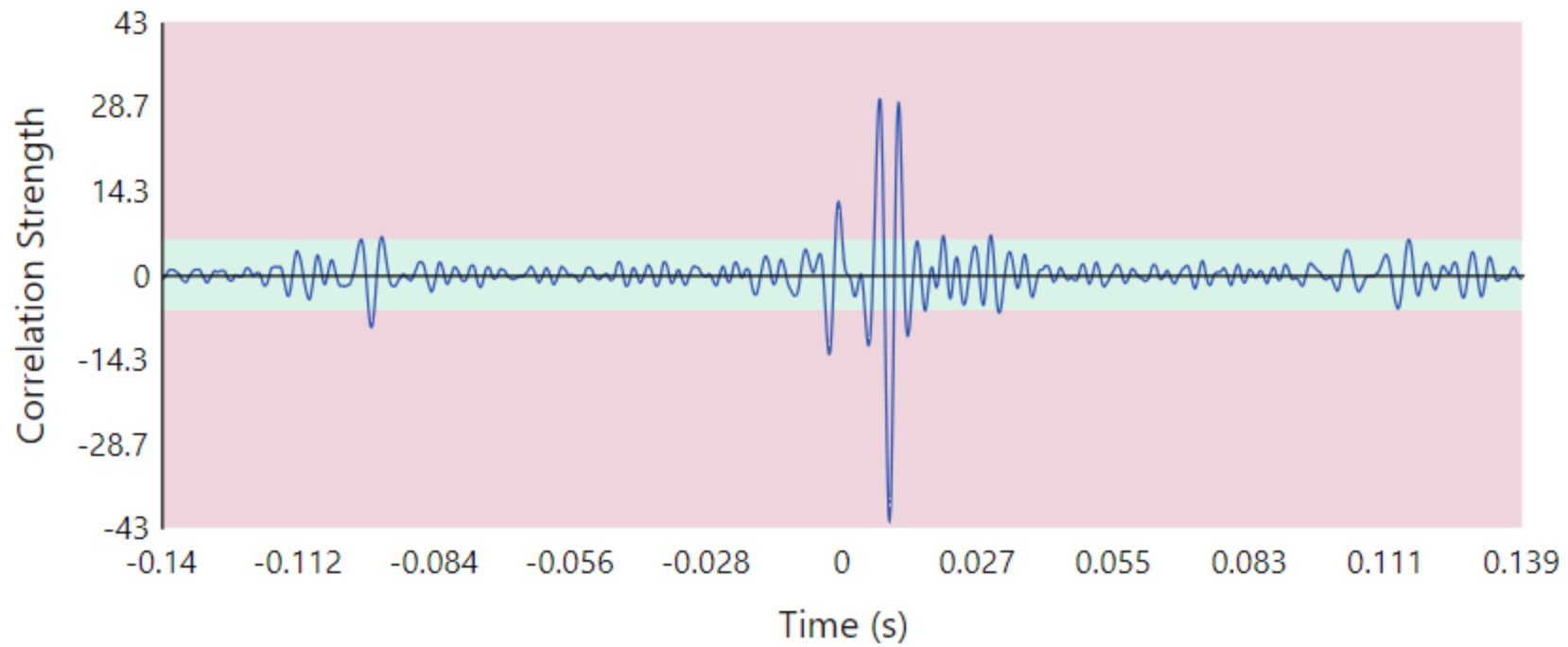
1 ... 2 ... 3 ... 2 ... 1

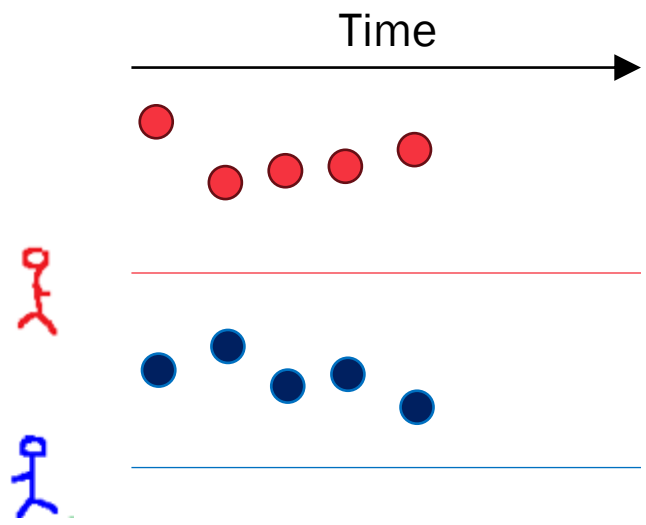




Correlation (02/17/2024 05:00 AM)

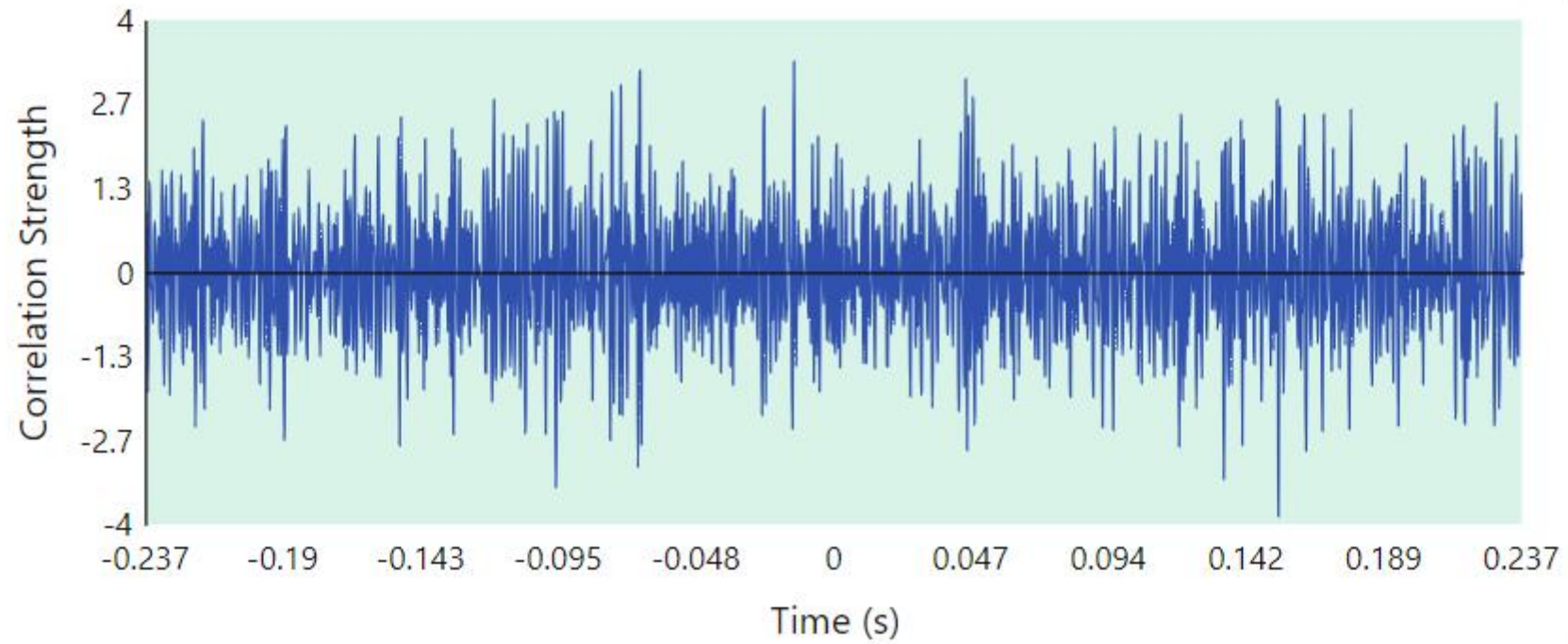
Change Date < >





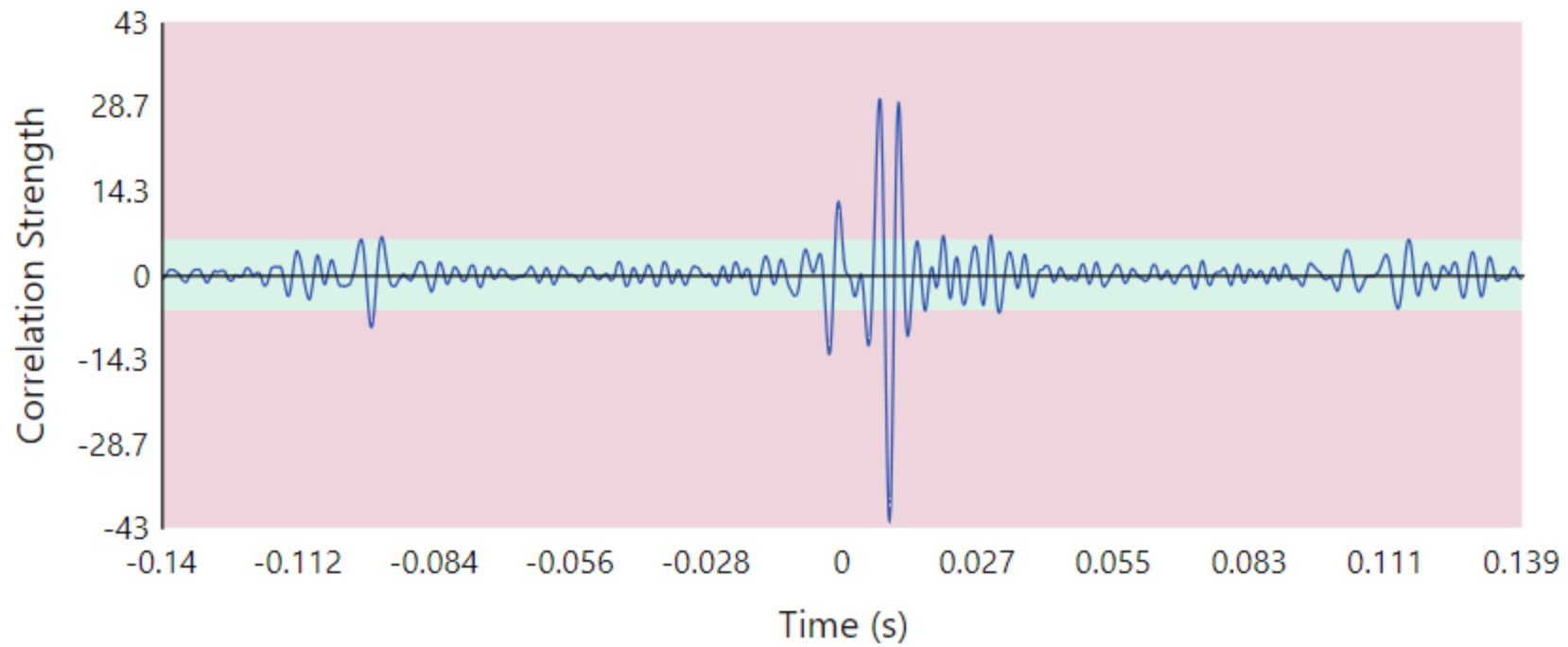
Correlation (06/11/2022 05:00 AM)

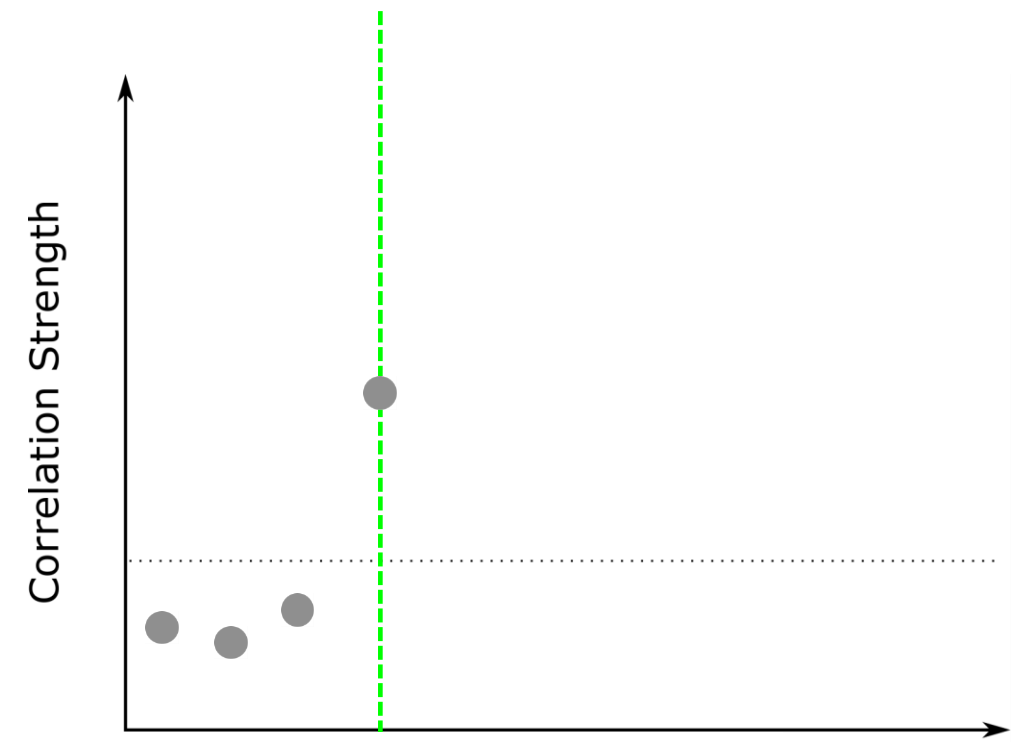
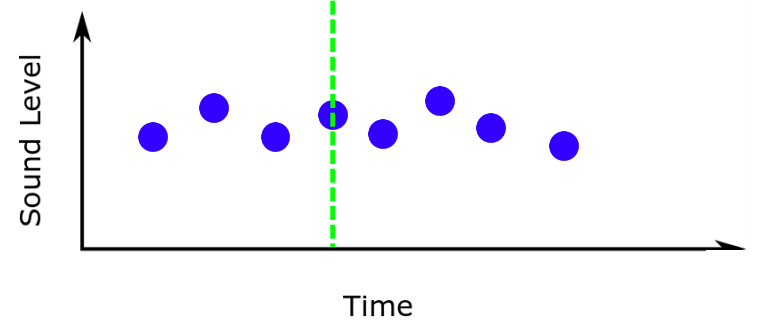
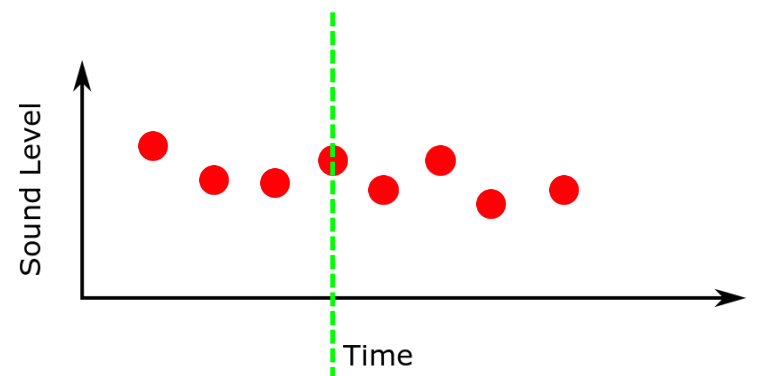
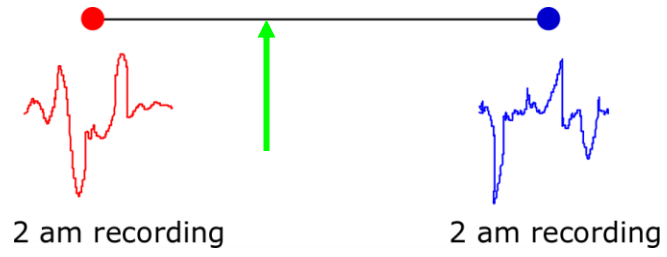
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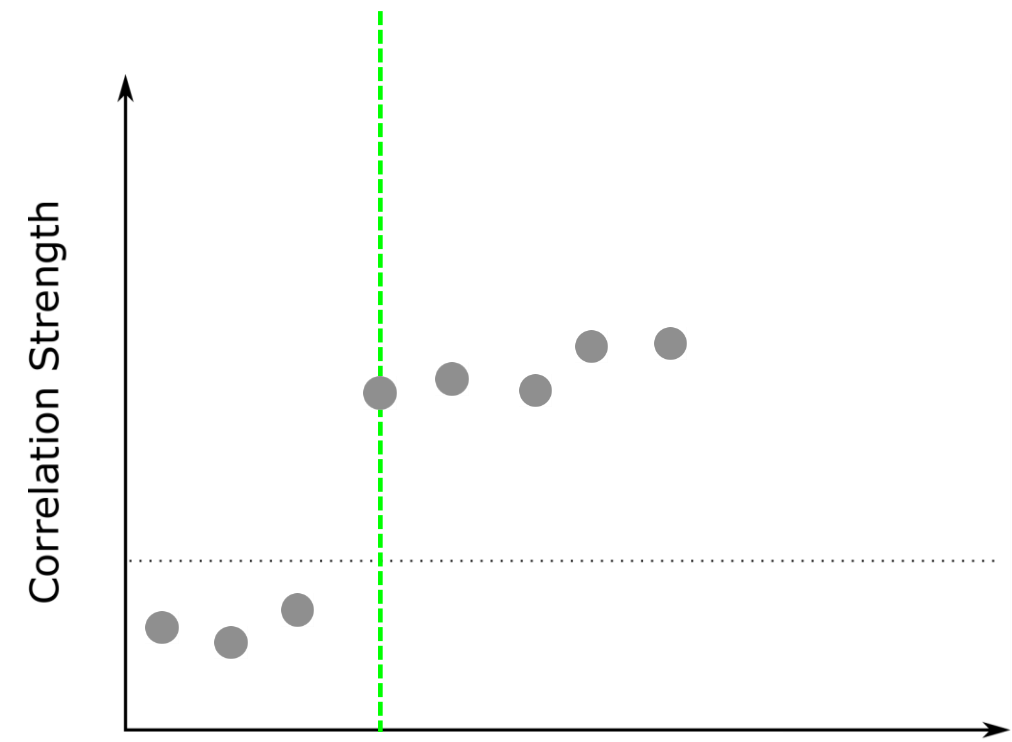
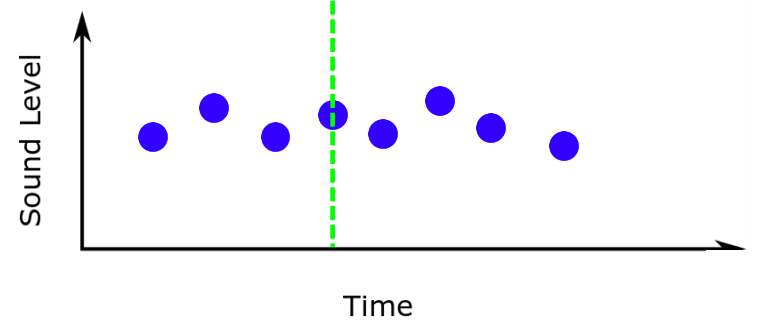
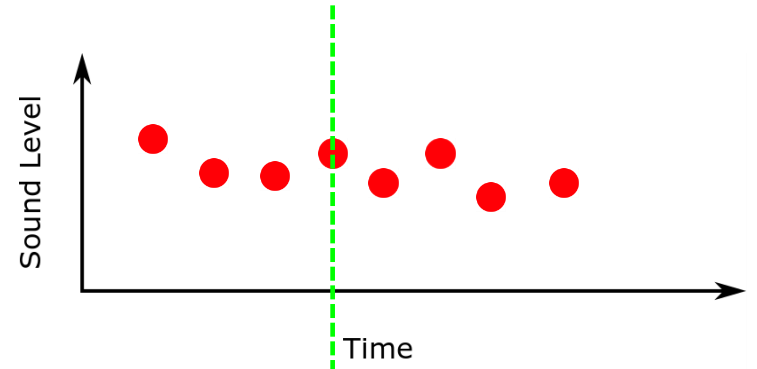
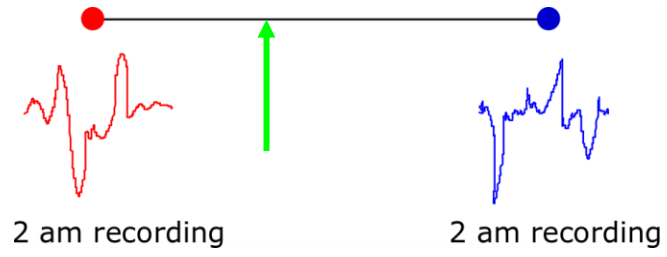


Correlation (02/17/2024 05:00 AM)

Change Date < >







Sandy DPW – Leak Detection



Deploy Echoshore DX Permanent Leak Detection Sensors

1



Test the sensitivity of the system

2

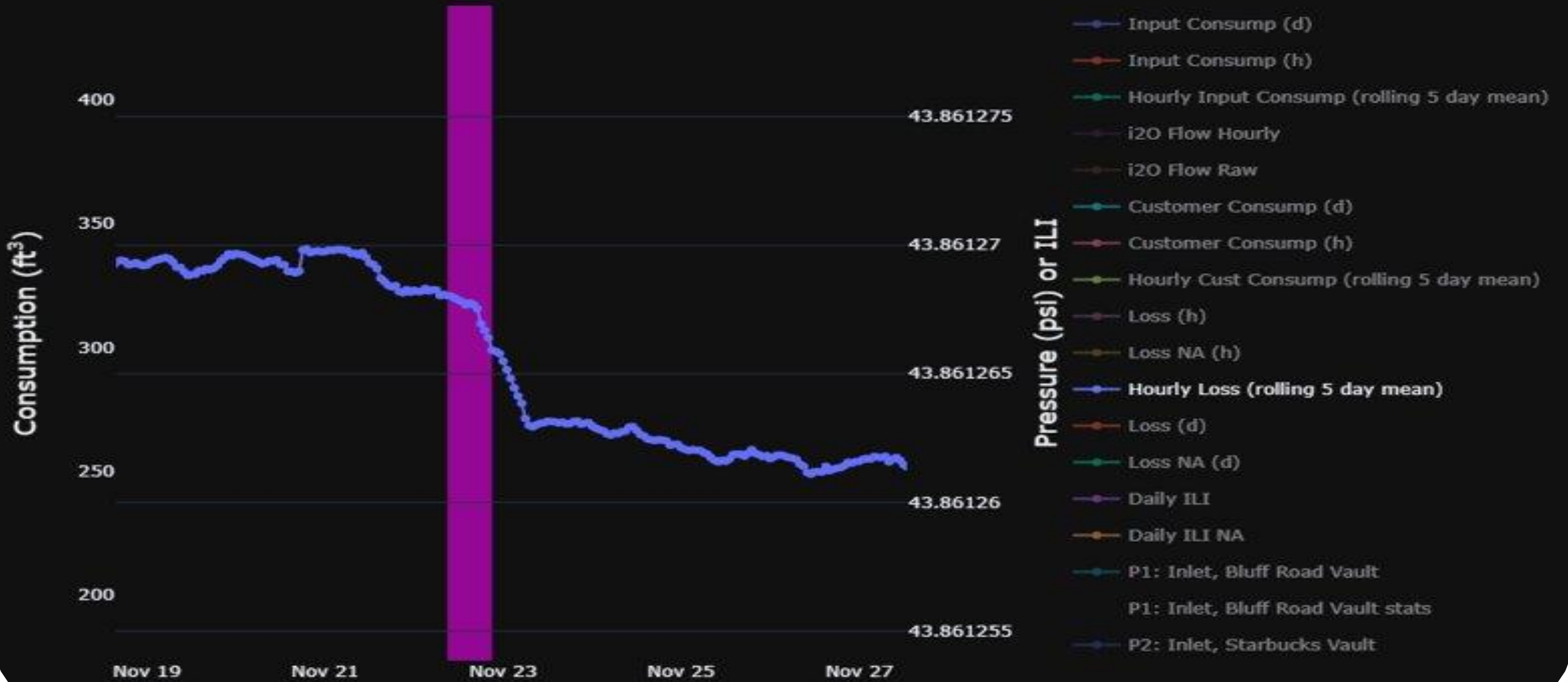


Identify and repair the leak(s)

3

Finding the Leaks

Consumption & Pressure



Fixing the Leaks



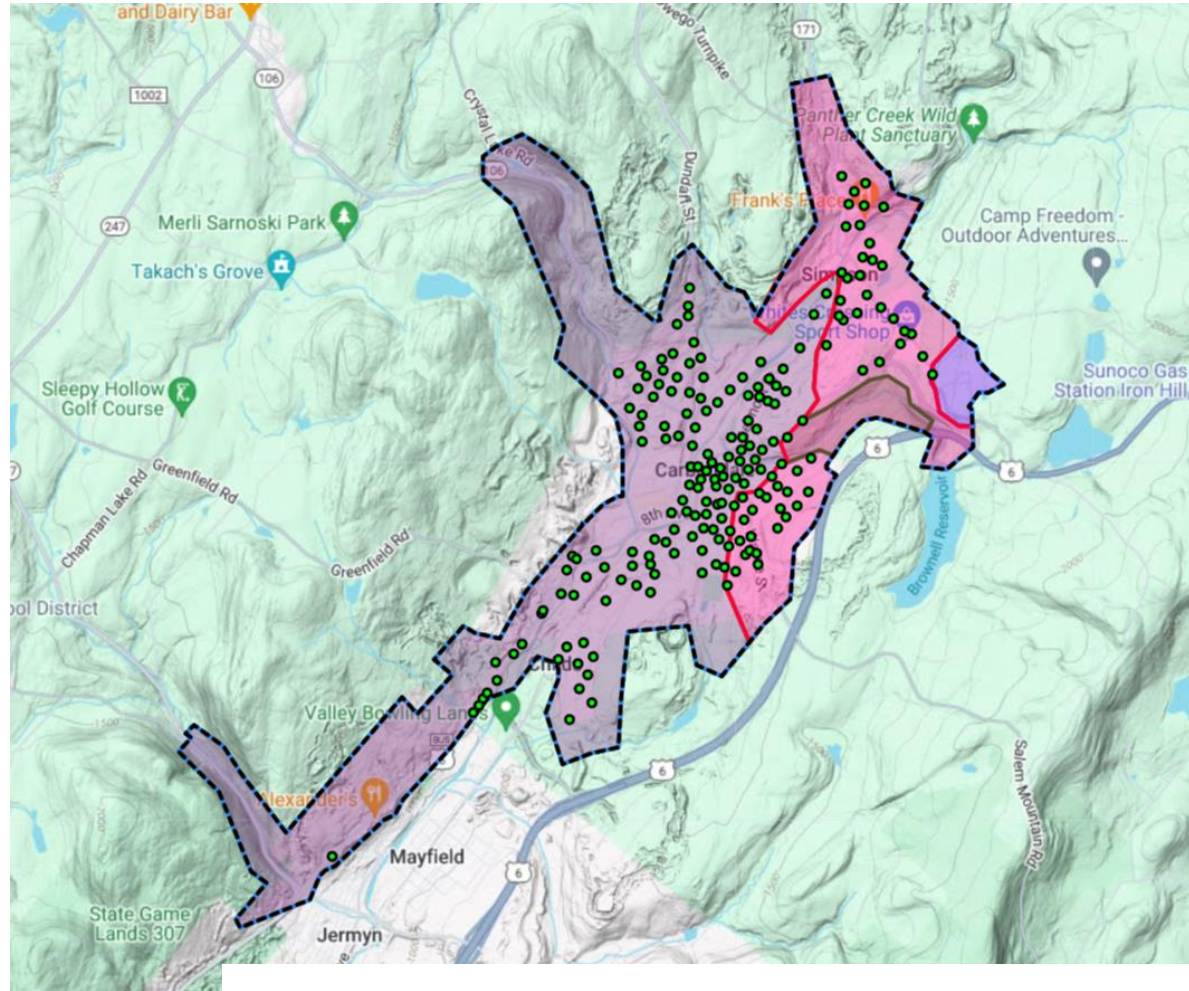
- Estimated in the field to be a 7gpm leak
 - Calculated to be a 7.85GPM leak based on the loss data

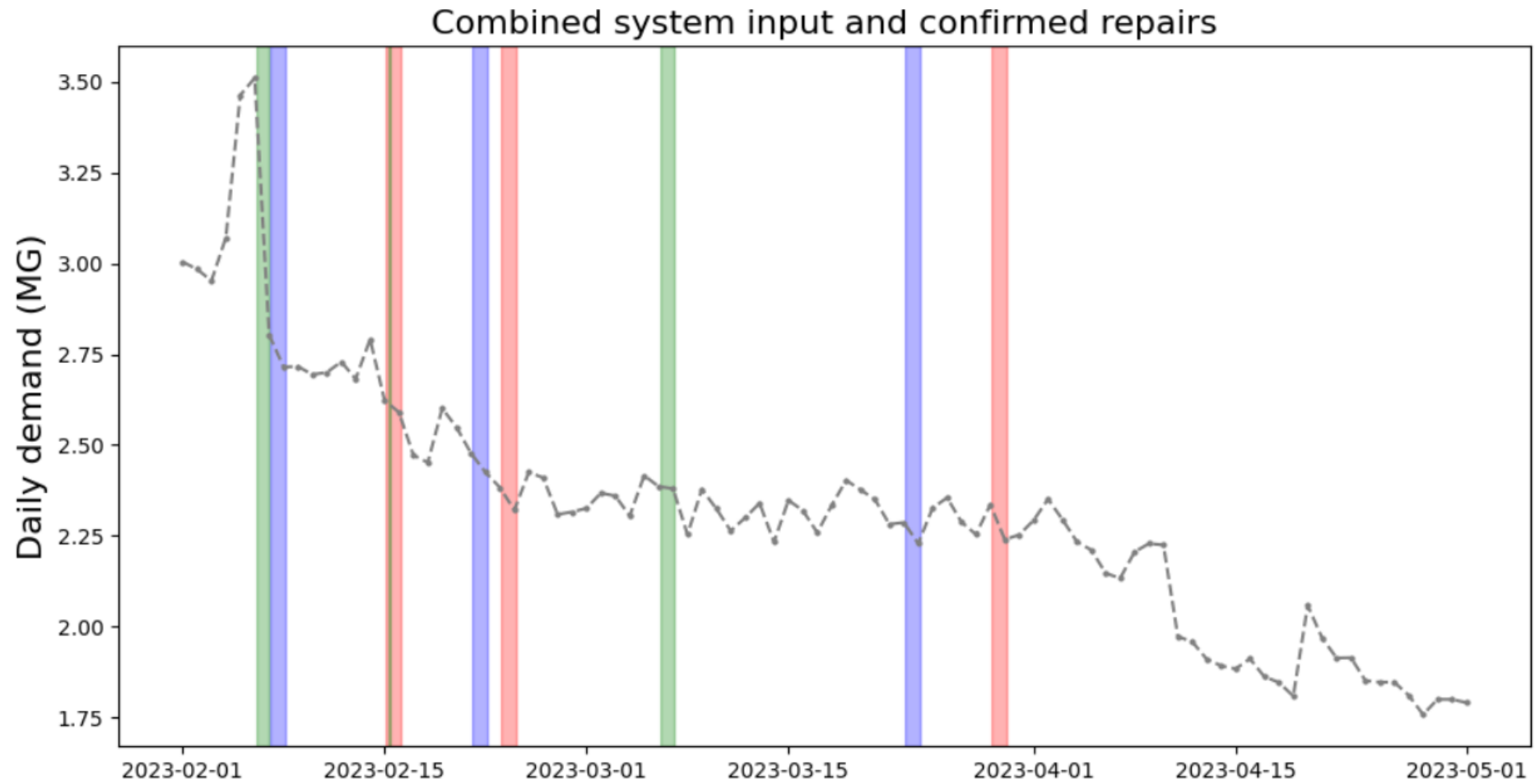
Estimated Annual Savings from 1 repair:

- 4.13 Million Gallons of water saved per year
- 9,250 kWh reduction in energy consumption
 - \$1,400 in electrical savings @ \$0.15/kWh
- Revenue lost in Unbilled Potable Water: \$24,400 per year
- Savings from early intervention (difficult to quantify)



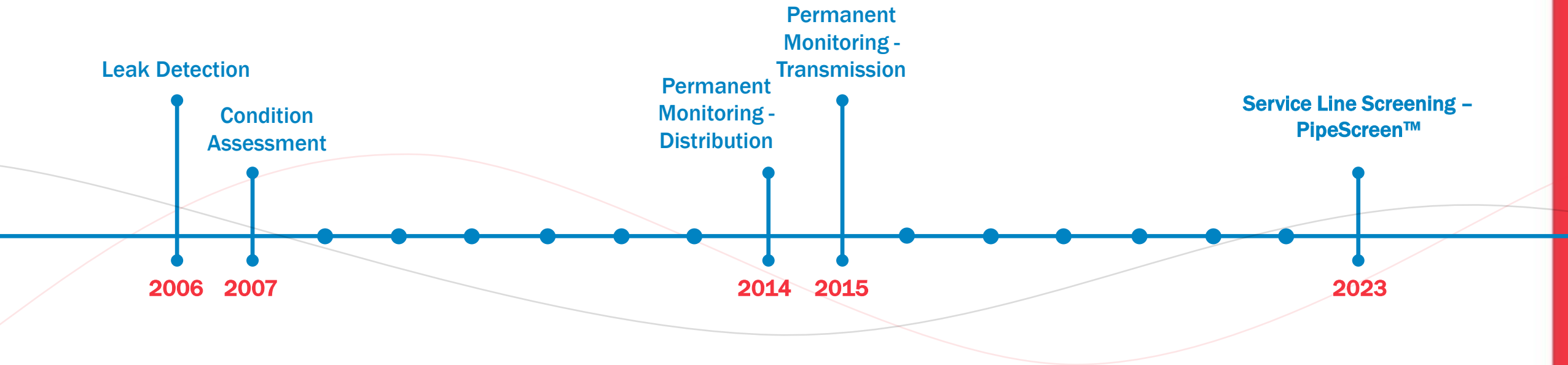
On a Larger Scale...





Echoshore

A long lineage in acoustic technology



Mueller Fixed Leak Detection Products

ECHOSHORE DX PERMANENT DISTRIBUTION MONITORING



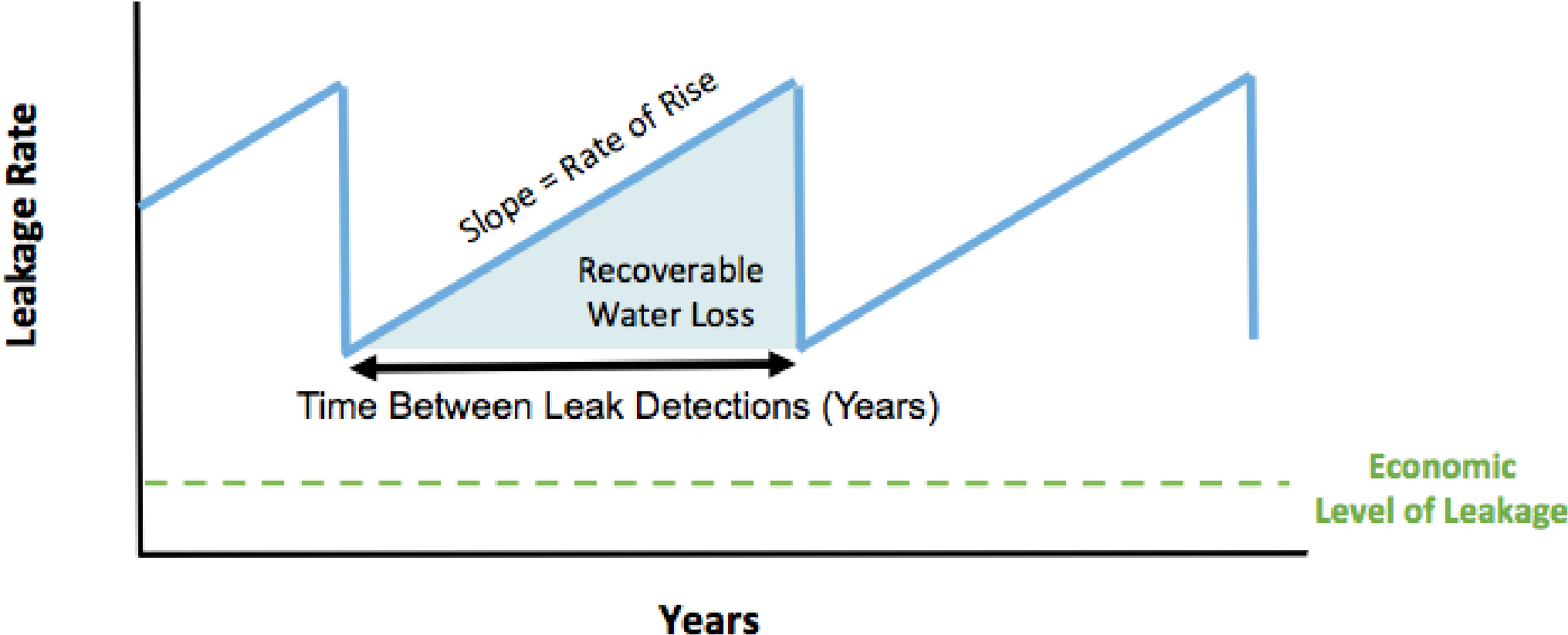
- Utilize existing utility hydrant and valve assets to monitor for leaks
 - Identify leaks early
 - Monitor leak progression
 - Prioritize field crew schedules
 - Significantly reduce pipe repair costs
 - Achieve non-revenue water loss targets
 - Extend pipe asset life

ECHOSHORE TX PERMANENT TRANSMISSION MAIN MONITORING

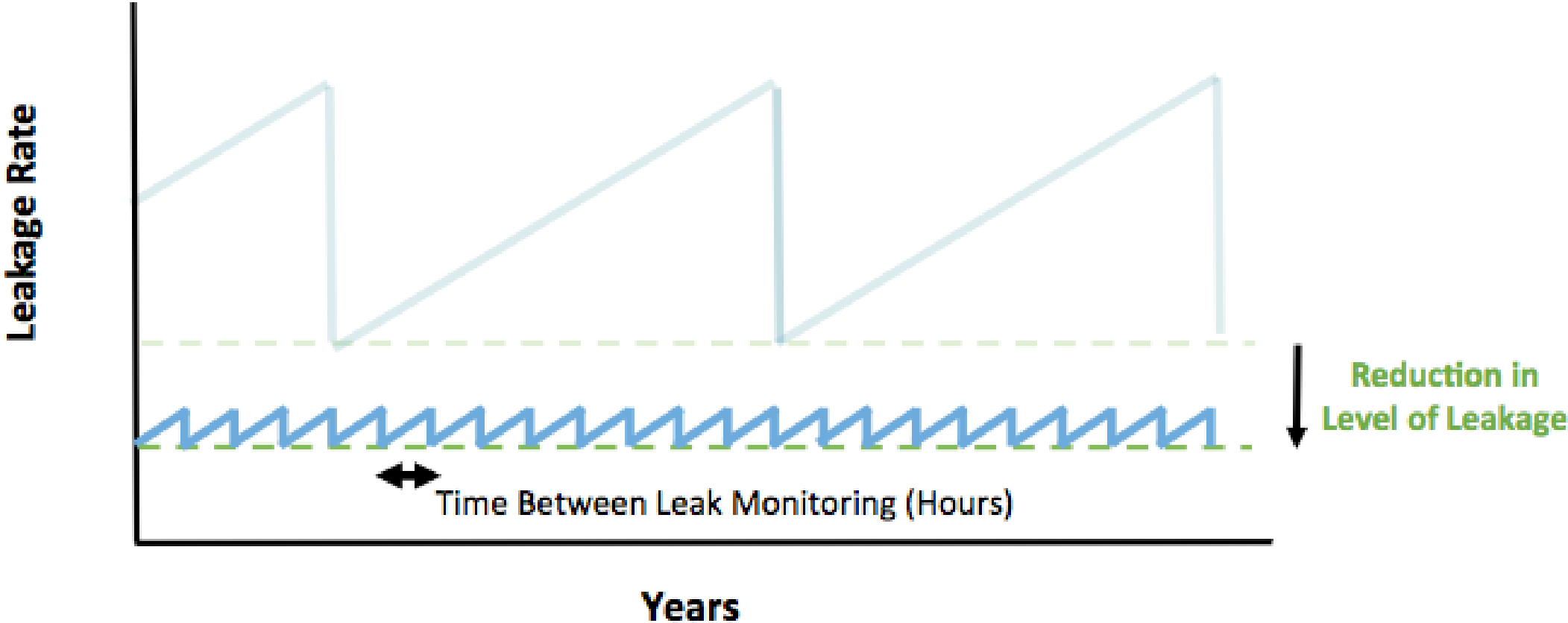


- Dedicated monitoring of the largest, most critical supply lines without service disruption
 - Bridges and river crossings
 - Major roadways and transport links
 - Mains without redundancy
 - Critical feeder mains
 - Mains with a history of rupture or leakage
 - Industrial supply lines
 - Construction zone monitoring

Active Leakage Control



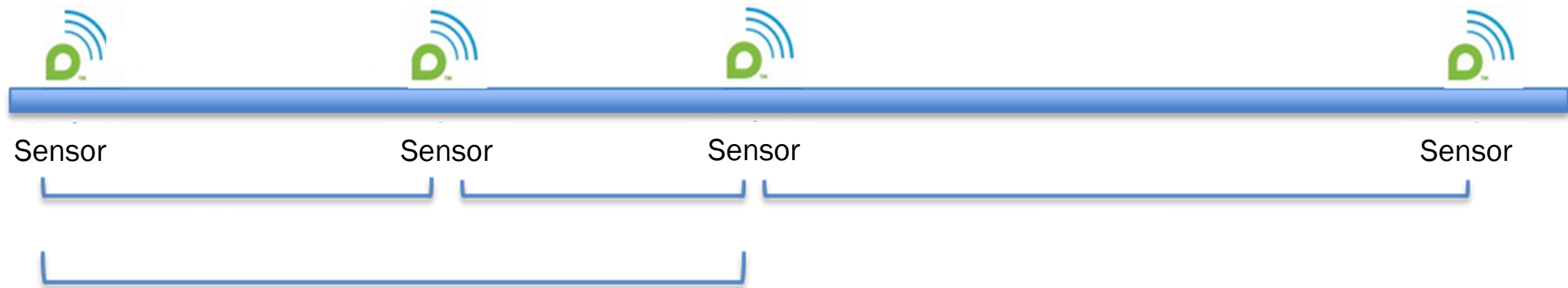
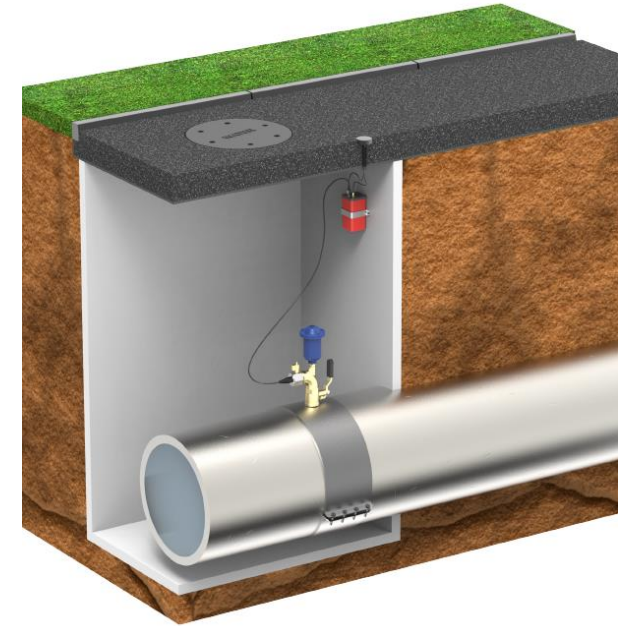
Fixed Leak Monitoring



What is EchoShore®-TX?

EchoShore®-TX is a permanent monitoring leak detection solution for transmission water mains

- Captures acoustic data using sensitive acoustic hydrophones sensors installed along a transmission pipe
- Acoustic data from these sensors is reviewed to find leaks



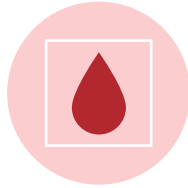
EchoShore-TX: Technical Qualification



GIS SOURCE DATA



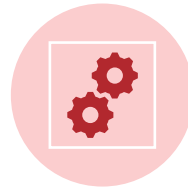
PRESSURIZED
CONNECTIONS OR
WILLINGNESS TO TAP



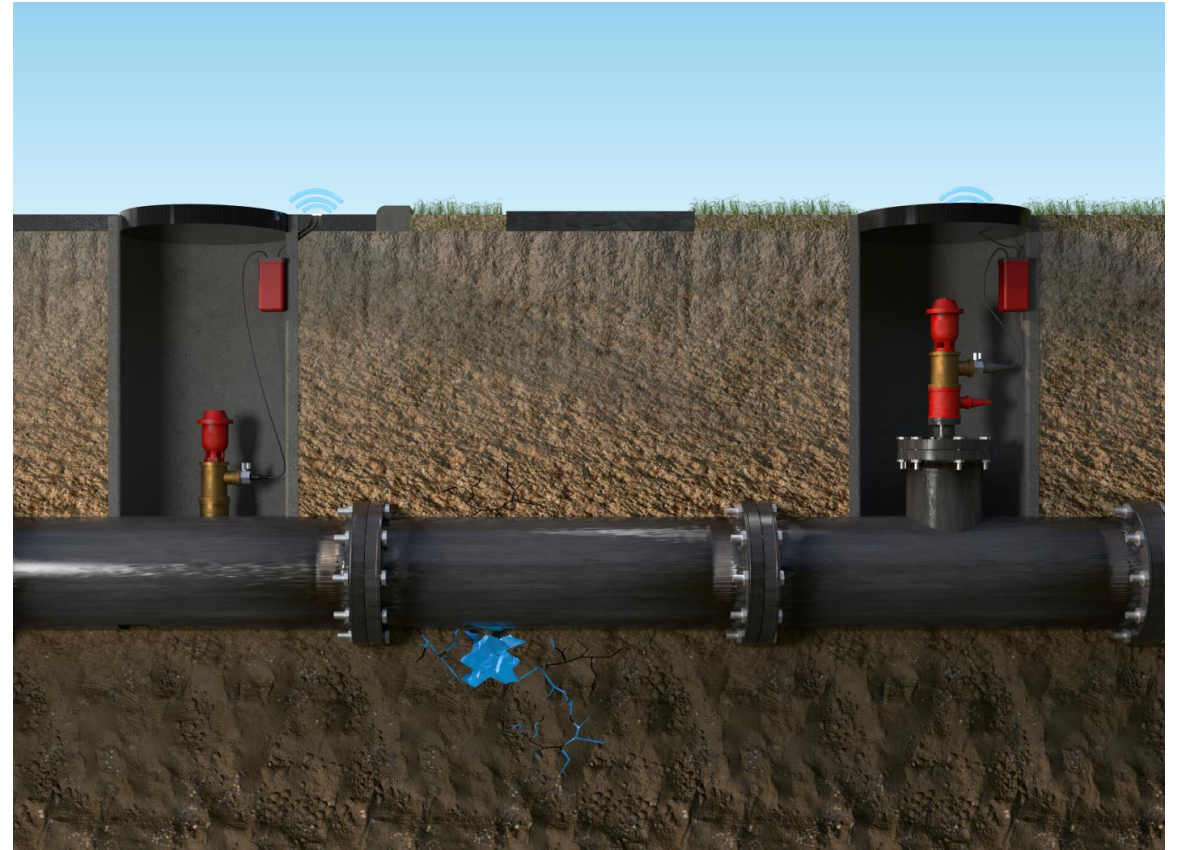
PRESSURIZED PIPES



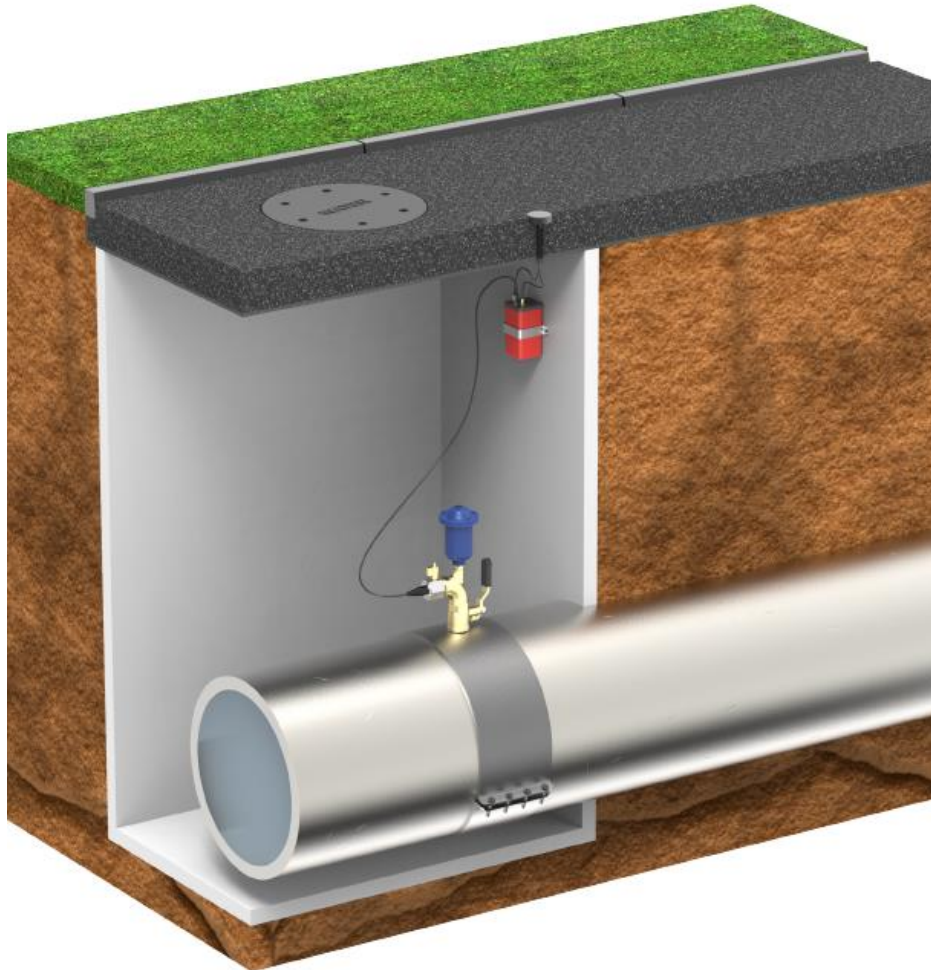
CELLULAR SERVICE



SIMULATION
SUPPORT



EchoShore®-TX Hardware Components



Antenna

For cell and GPS connection



Electronic Module

Houses battery and processor



Hydrophone Sensor

Collects acoustic data

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Antenna Options for EchoShore-TX GEN3

Side Mounted – Road Rated Antenna



- In traffic ✓
- Small ✓

Centre Mounted Antenna



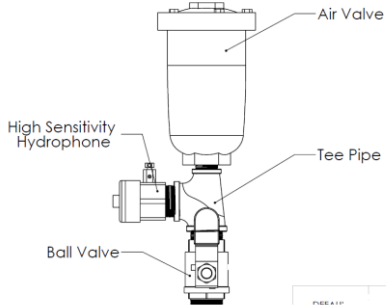
- In traffic ✗
- Small ✓



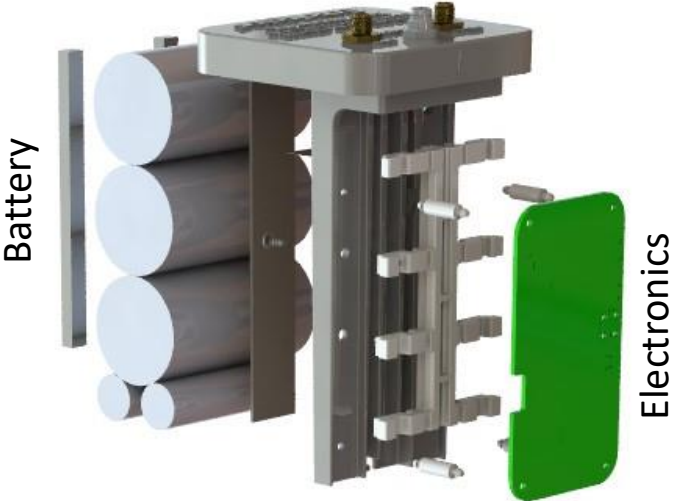
Hydrophone Sensor for EchoShore-TX GEN3



1.5in NPT Thread



Electronic Module for EchoShore-TX GEN3



Electronic module fully assembled



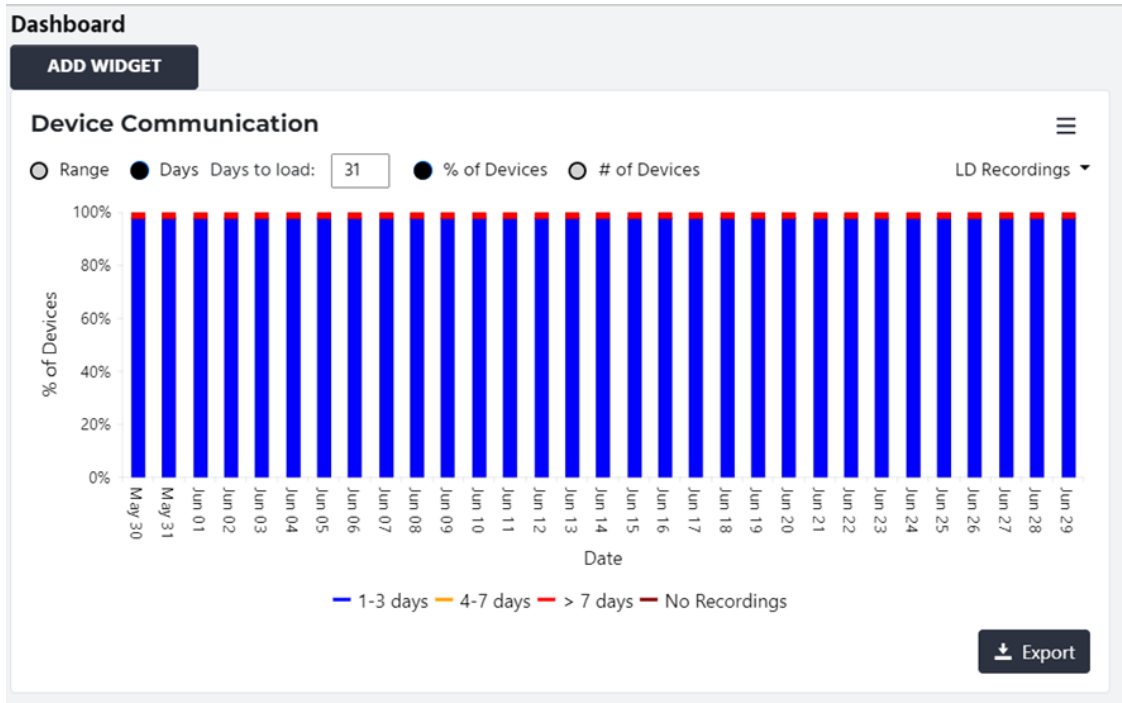
Electronic module typically mounted to the side of the chamber

EchoShore-TX GEN3 Installation Photos



Sentryx™ System Health Support

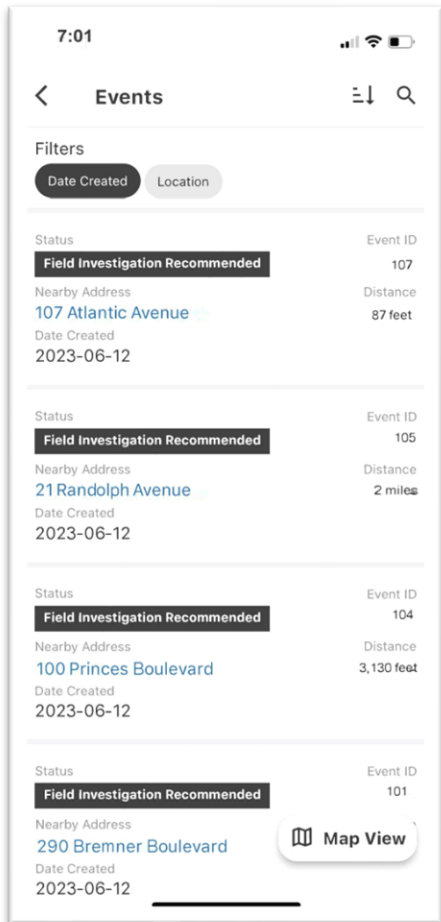
KPI Dashboards



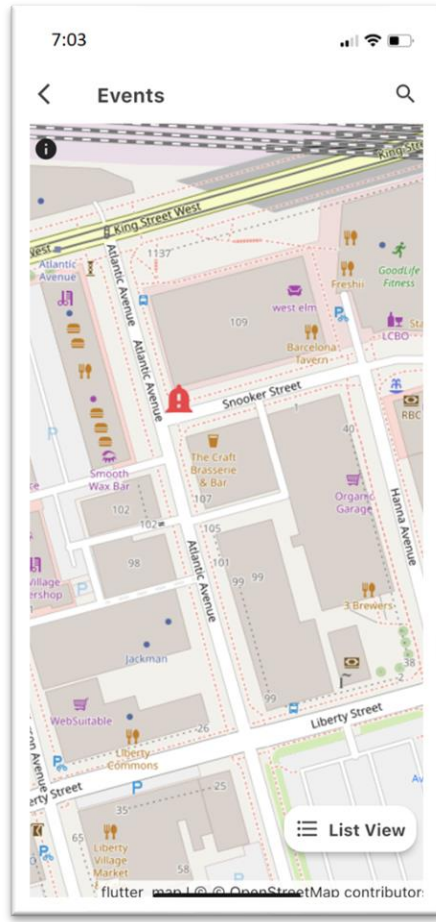
Sensor Status Indications

Sensor ID	Days Since Last Recording ↑	Socket ID	Sensor Status	Battery Status	Note
110151600	1	HSU-94	OK	OK	
110608400	1	HSU-176	OK	OK	
110637600	1	HSU-403	OK	OK	
110570200	1	HSU-379	OK	OK	
110541100	1	HSU-483	OK	OK	
110646100	1	HSU-482	OK	OK	

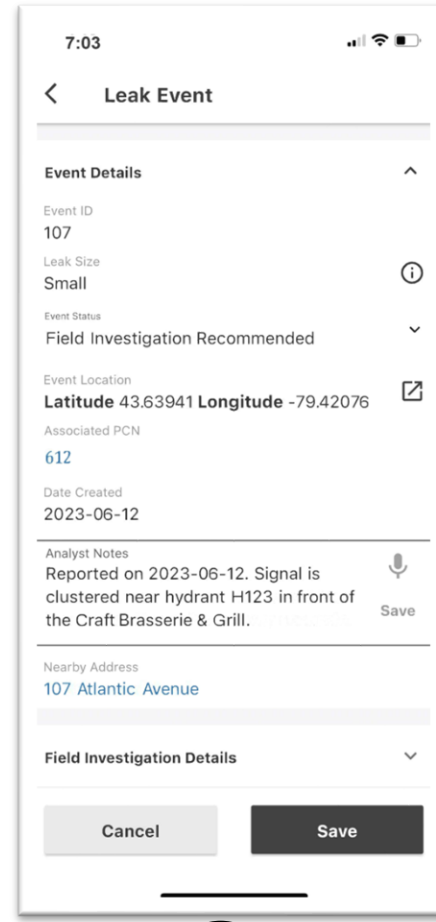
Sentryx™ Mobile App - Access to Information



1



2

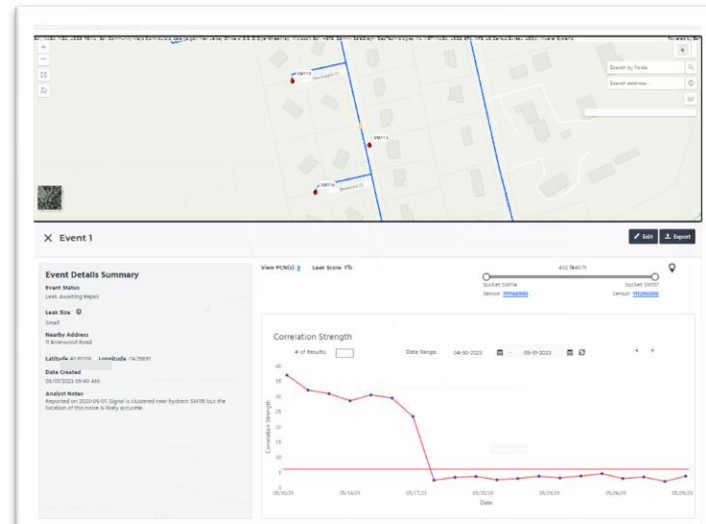


3

Reports your leak

- 1 Presence of a leak
- 2 Location
- 3 Leak event details

Sentryx™ Mobile App - Feedback



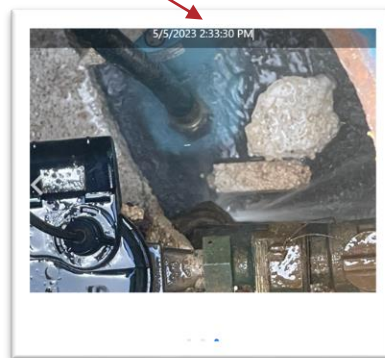
Feedback available on Sentryx™ web interface

Event Information

Related Events

History of Changes

Event Photos

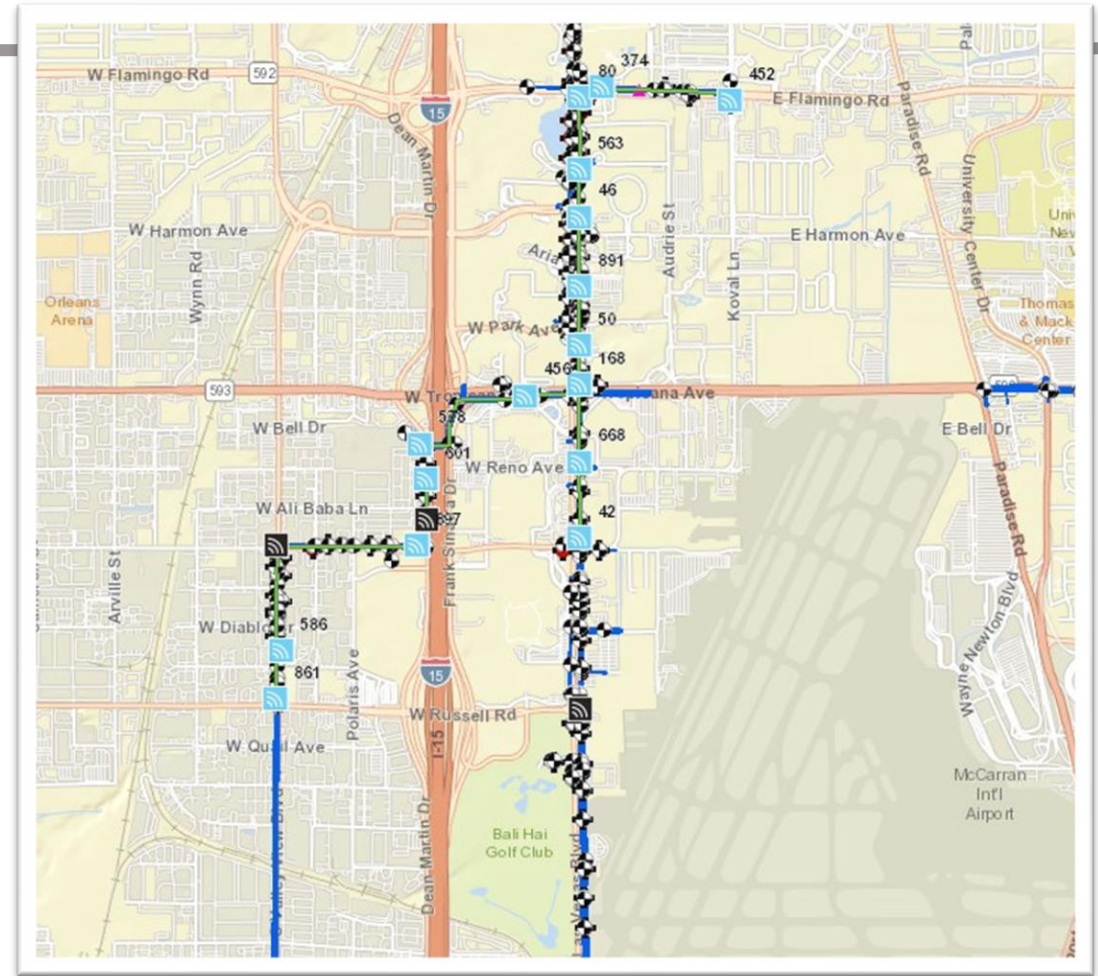
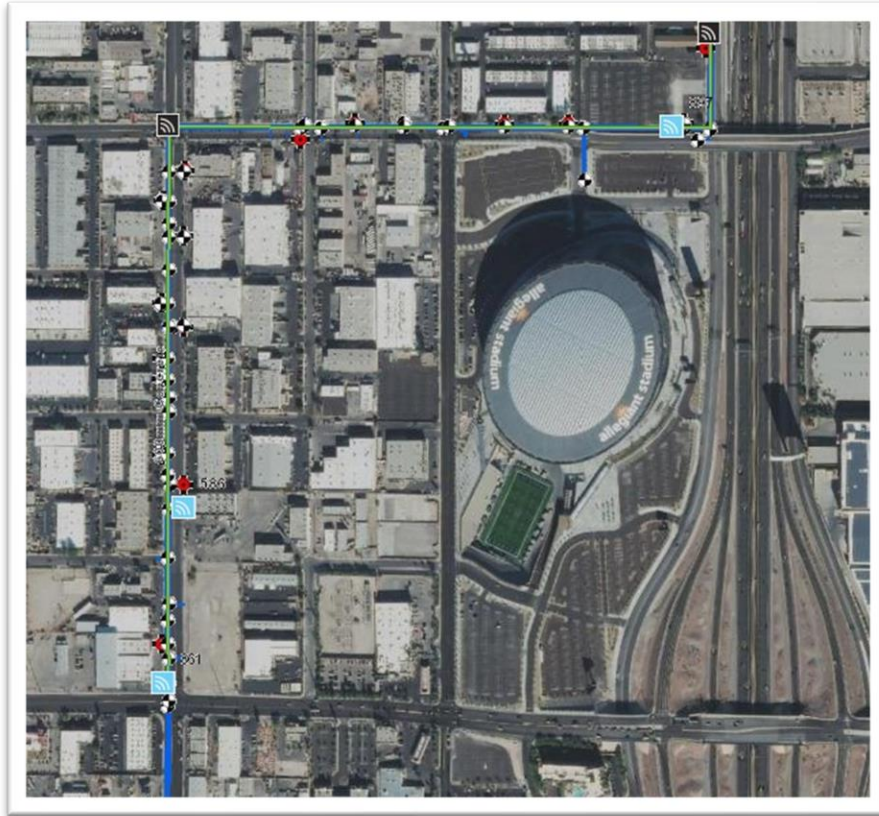


Event Information						
Field Investigation Details						
Date Investigated	Noise Source Type	Sound Evaluation	Field Correlation Result	Work Order #	Date For Review	Notes
05/05/2023 12:00 AM		Positive	Positive			
Leak Information						
Actual Address	Date Repaired	Leak Type	Event Cause	Flow Rate		
		Service (Customer)	Unknown			
Estimated Duration (Days)	Defect Type	Defect Size (Area)	Pipe Pressure	Surfacing?		
	Lateral/Service		118.0 psi	No		
Pipe Information						
Pipe Material	Pipe Size	Wall Thickness	Repair Material	Pipe Coating	Pipe Age (Years)	
Copper	1 in					

Update investigation results and upload photos from the field



Las Vegas Strip



- Monitoring critical 36inch PCCP mains that service: Allegiant Stadium, Mandalay Bay, Luxor, Tropicana, MGM Grand, Aria, Planet Hollywood, Bellagio etc.
- ~4.5 miles covered by 19 nodes

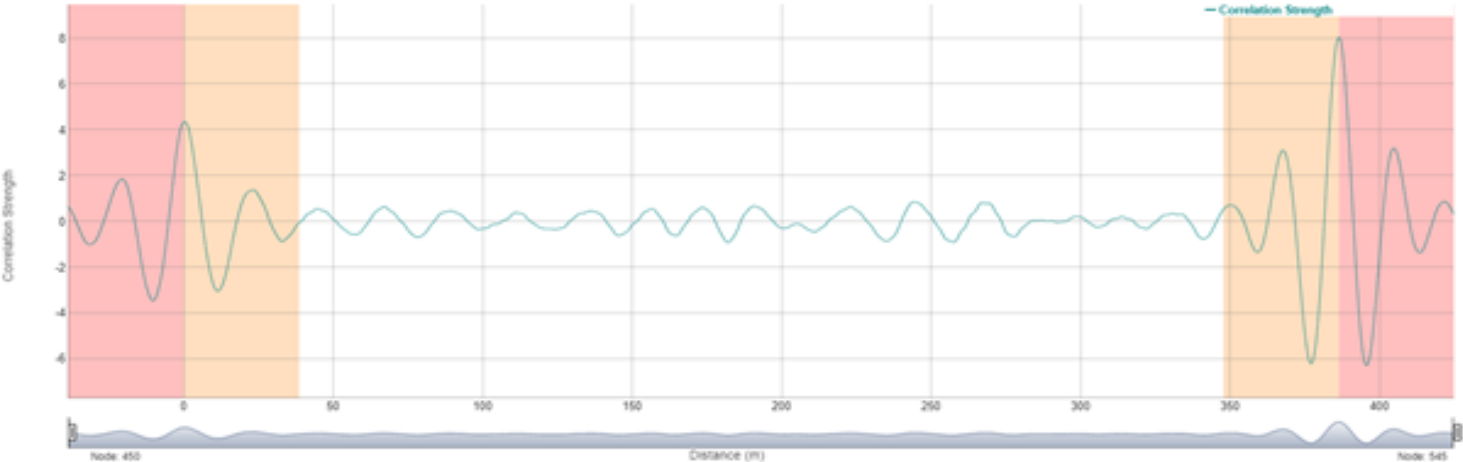
Major Airport Water Supply



Airfield

Significant Acoustic Signal Detected Day Over Day

June 18th



No noises detected within the pipe segment

June 19th



Strong noise detected within the pipe segment

Confirmed Leak Location: At First Few Signs of Leakage



June 19th



June 30th

Pinhole Leak Near Invert of Pipe – 20 GPM



Pin-hole leak



Leak Plugged with Wood Splint
Smaller than Finger

Echoshore-DX

Seamless Integration



10-year product + battery life

Hidden in plain sight

Patented Technology

Works for both wet and dry barrel hydrants

Works over 4G LTE-M cellular network

Pumper Nozzles or Side Caps – Adaptable!



Integrated Sensors Built and Tested Mueller Tough



Node plastic enclosure is constructed of impact resistant polycarbonate materials

Painted for added UV protection

Tested to the IEC 62262 standard for impact survival

Node withstood torque of 797 ft-lb. Stopped at 797 ft-lb as fire hydrant nozzle failed at that torque

System Advantages



Design Flexibility

- Detects Leaks on cast iron, ductile iron, steel, asbestos cement, and concrete pipe materials.
- Works on Pipe Diameters up to 18" diameter.
- Utilize existing or new fire hydrants of any manufacture

Automatic Acoustic Analysis

- Leaks automatically correlated by multiple sensors
- Leak Location identified within a few feet

Low Maintenance

- Above Ground Installation
- 10-year design life
- System Diagnostic Capabilities



What if there are no hydrants?

EchoShore-DXe

- Versatile and rugged design
- Fill gaps between hydrants
- Extra-long (verified) 10-year battery life

Implement EchoShore-DXe on:

- Valves
- Below-ground hydrants
- Release valves

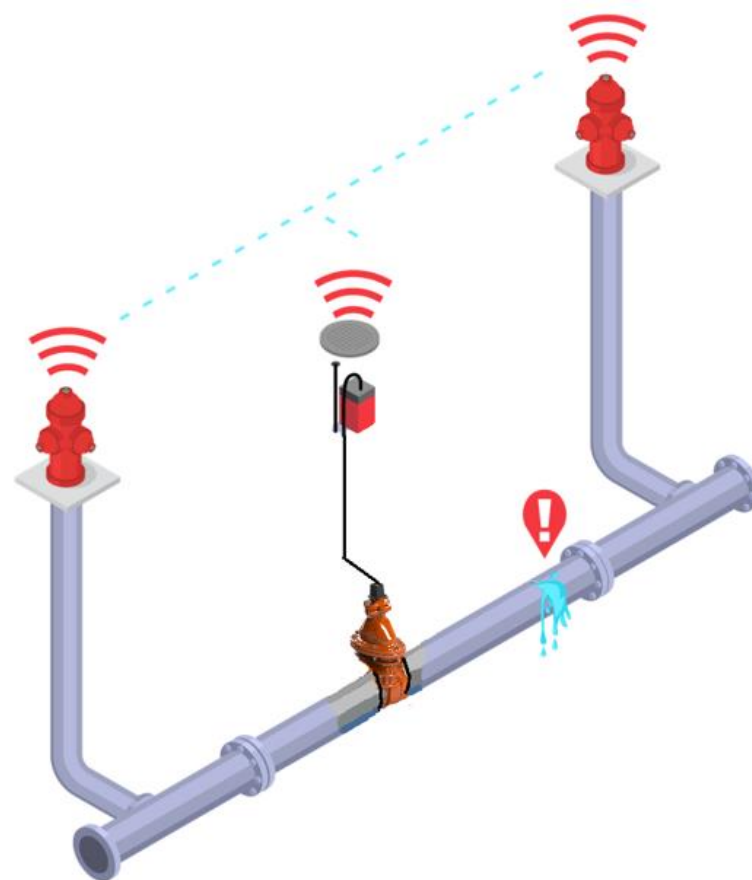


Installation Photos



Install and Forget

EchoShore-DX system uses sound and vibration monitoring to positively detect and locate leak acoustic patterns, preventing false alarms.



EchoShore-DX: How it Works



DESIGN



DETECT



ANALYZE



ALERT

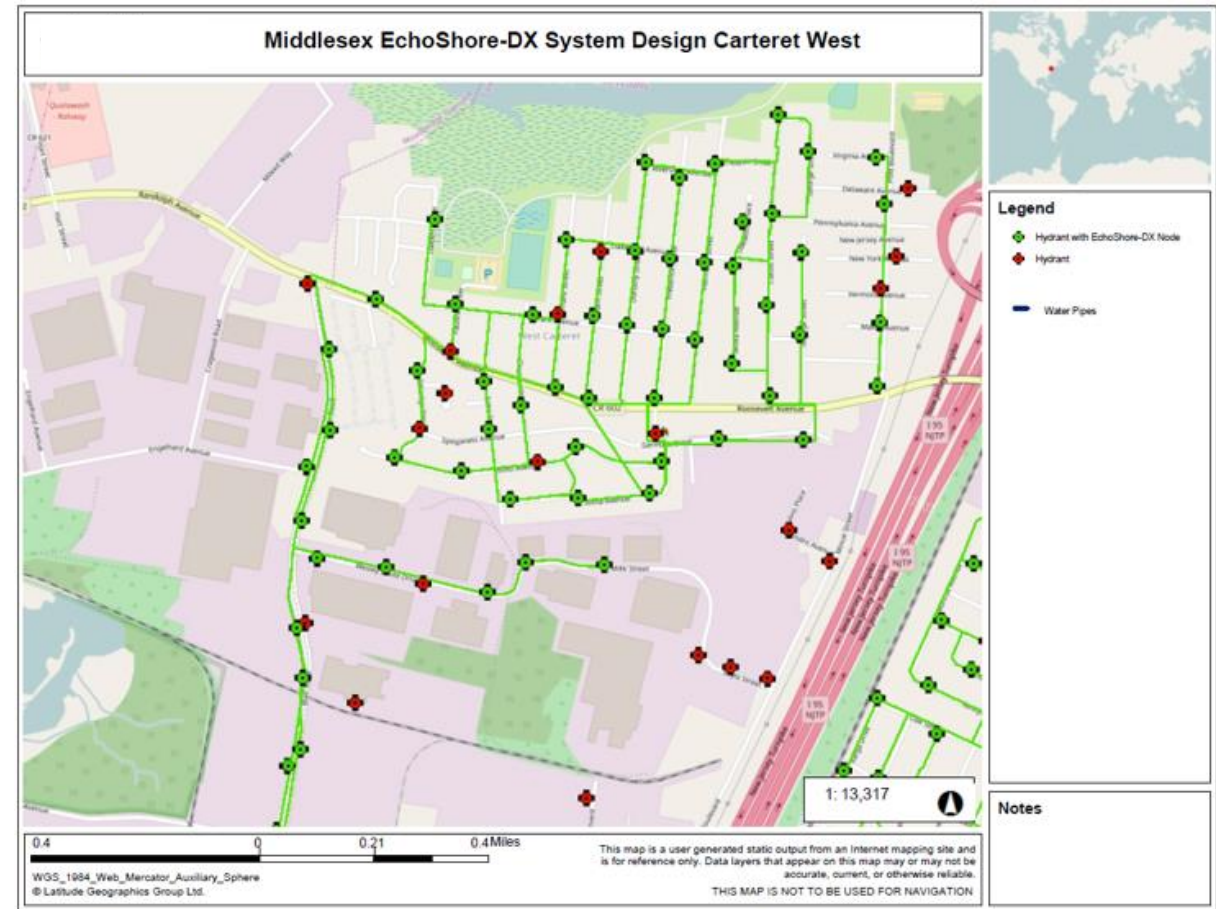


MONITOR

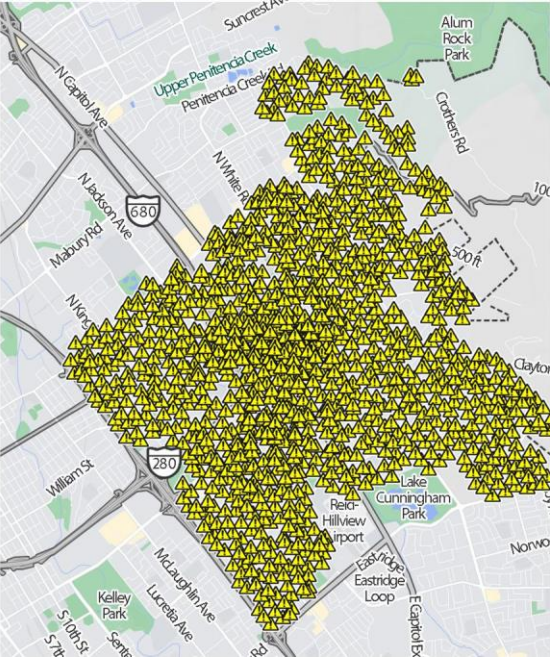
Sophisticated planning architecture

Our planners work with you to optimize EchoShore-DX by:

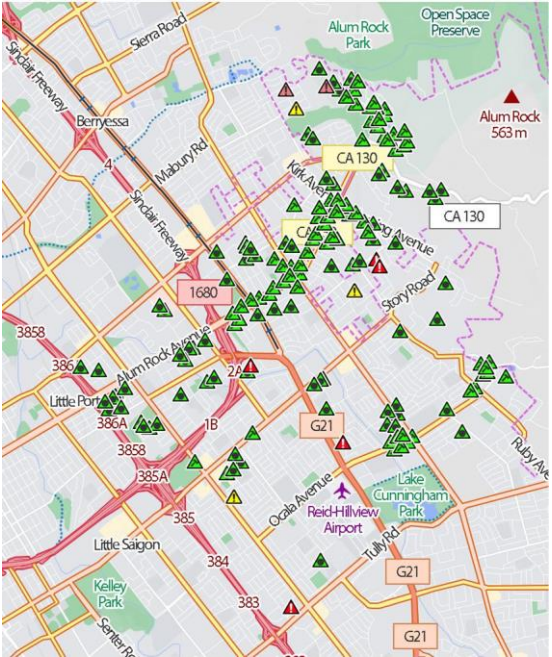
- Strategically placing sensors to greatest effect
- Minimizing cost, maximizing impact



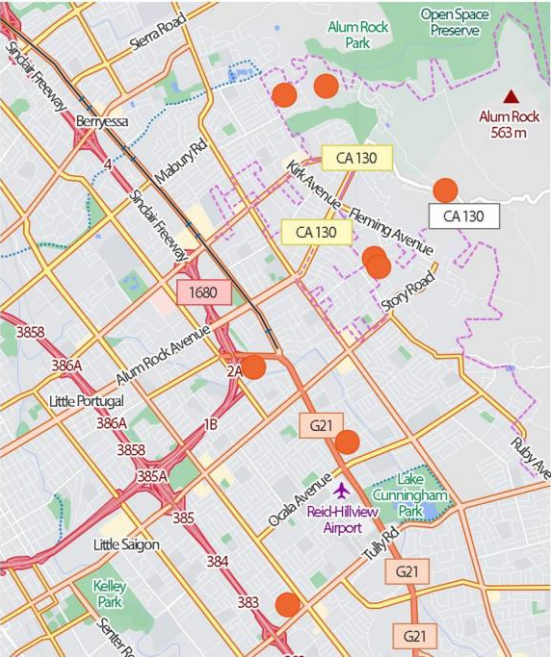
Cut through the noise



Data: 29,297 Network Noises



Information: 555 Persistent Noises



Insights: 8 Investigations Recommended

Leak Sizes – A Predictive Model

Leak Size:

- Predicts the potential size of a reported leak event
- Backed by Machine Learning and model trained and validated on over 1,500 reported leaks
- Provides a prediction of a small, medium or large leak



Small Flow Rate: Less than 5 Gallons Per Minute (GPM)



Medium Flow Rate: Between 5 GPM and 30 GPM



Large Flow Rate: Larger than 30 GPM

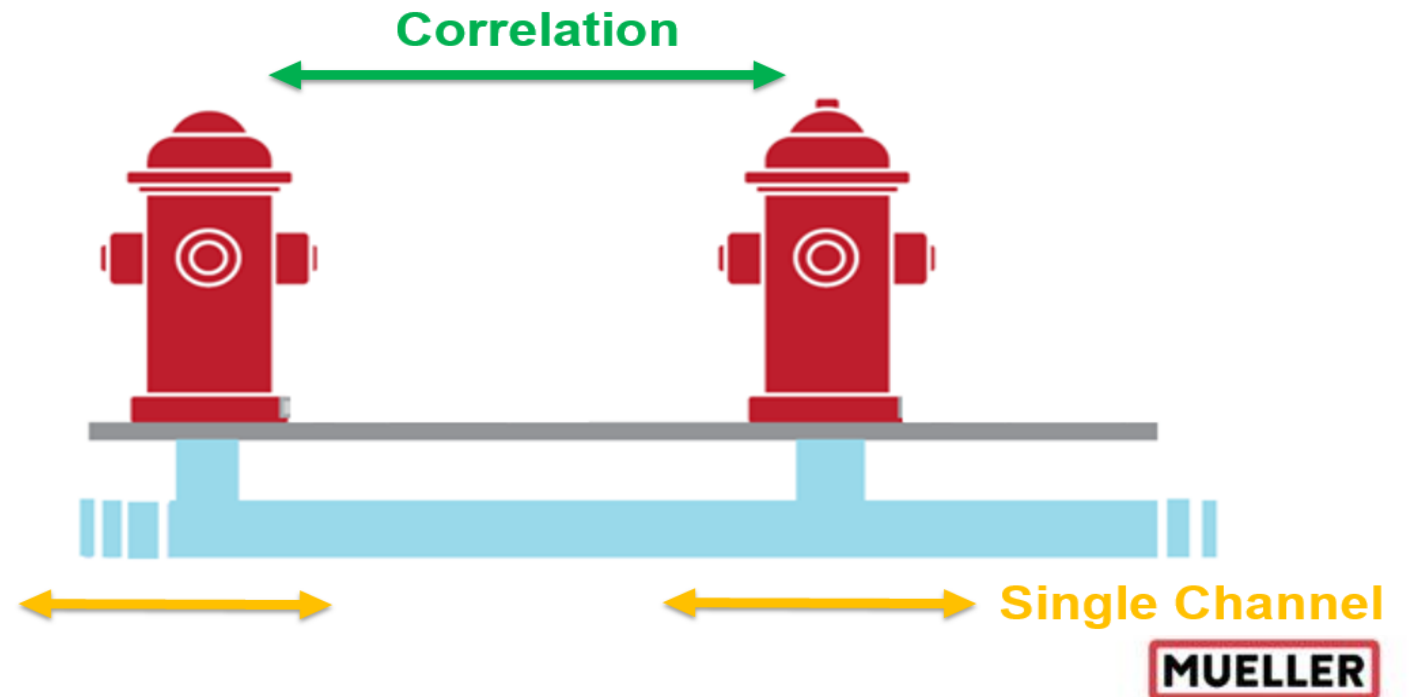
Single Channel Leak Detection

Overview:

- Single Channel leak detection monitors for changes in sound that indicate an emerging leak
- Leak notifications are generated from data from a single sensor and signal leakage at or nearby an EchoShore-DX sensor

Benefit:

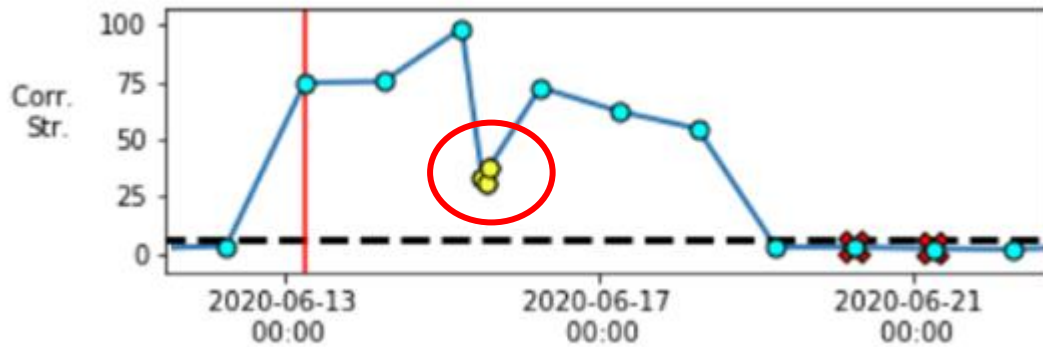
- Detects leaks that are located directly at or nearby EchoShore-DX sensors to improve correlated leak monitoring capabilities



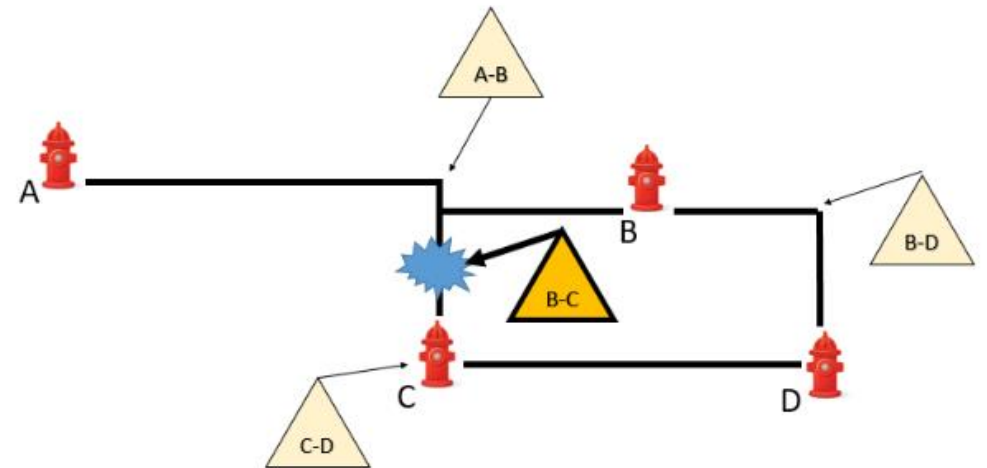
Machine Learning

*Both algorithms are automatic and result in a higher likelihood of an alert being a leak

- Recordings scheduled outside of standard time



- Group of signals reporting from same source



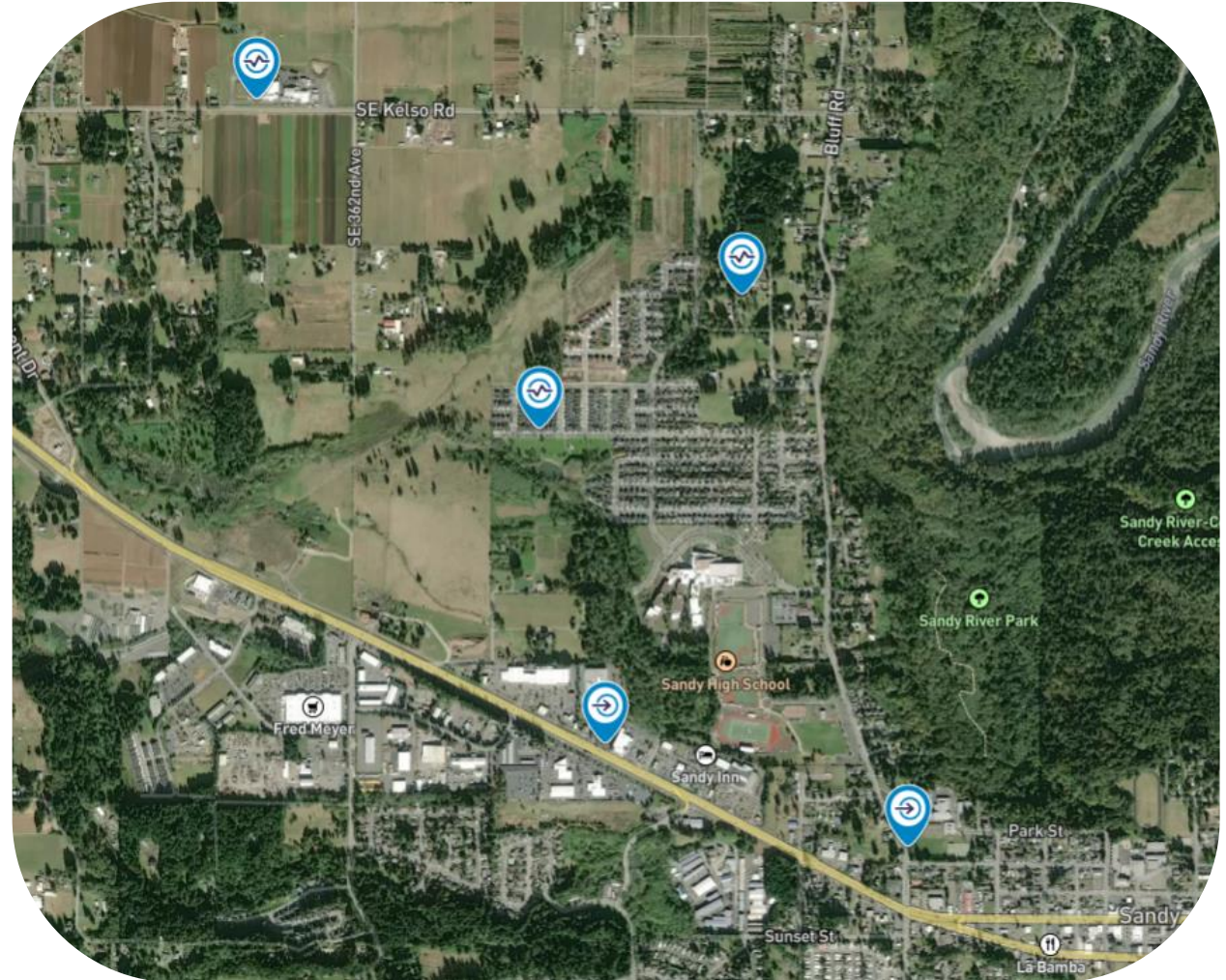
Pressure Monitoring



Pressure Monitoring and Management

Monitoring Changes in Pressure

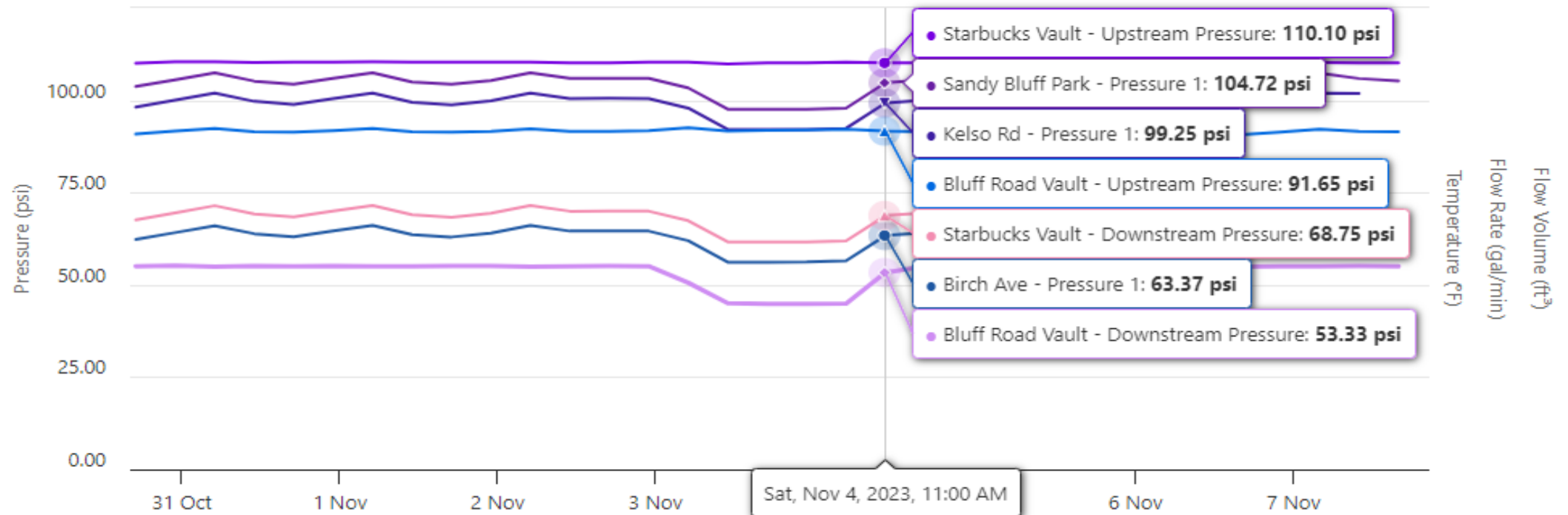
- Five (5) i2O Pressure Loggers were installed throughout the DMA
- Determine Critical Point Logger Location
- See pressure reduction effects at various elevations throughout the DMA



Pressure Monitoring and Management

Monitoring Changes in Pressure

- See pressure reduction effects at various elevations throughout the DMA



In June 2021, Mueller acquired i20 Water whose pressure monitoring and control solutions are used by more than 150 water companies in more than 50 countries around the world



i20 PRV monitoring and control systems offer more accurate, stable, and smooth control of network pressures

PRV



Monitored PRV



+



Control
Logger

Remotely controlled PRV



+



Advanced pilot valve (APV)

Automatically optimised PRV*



+

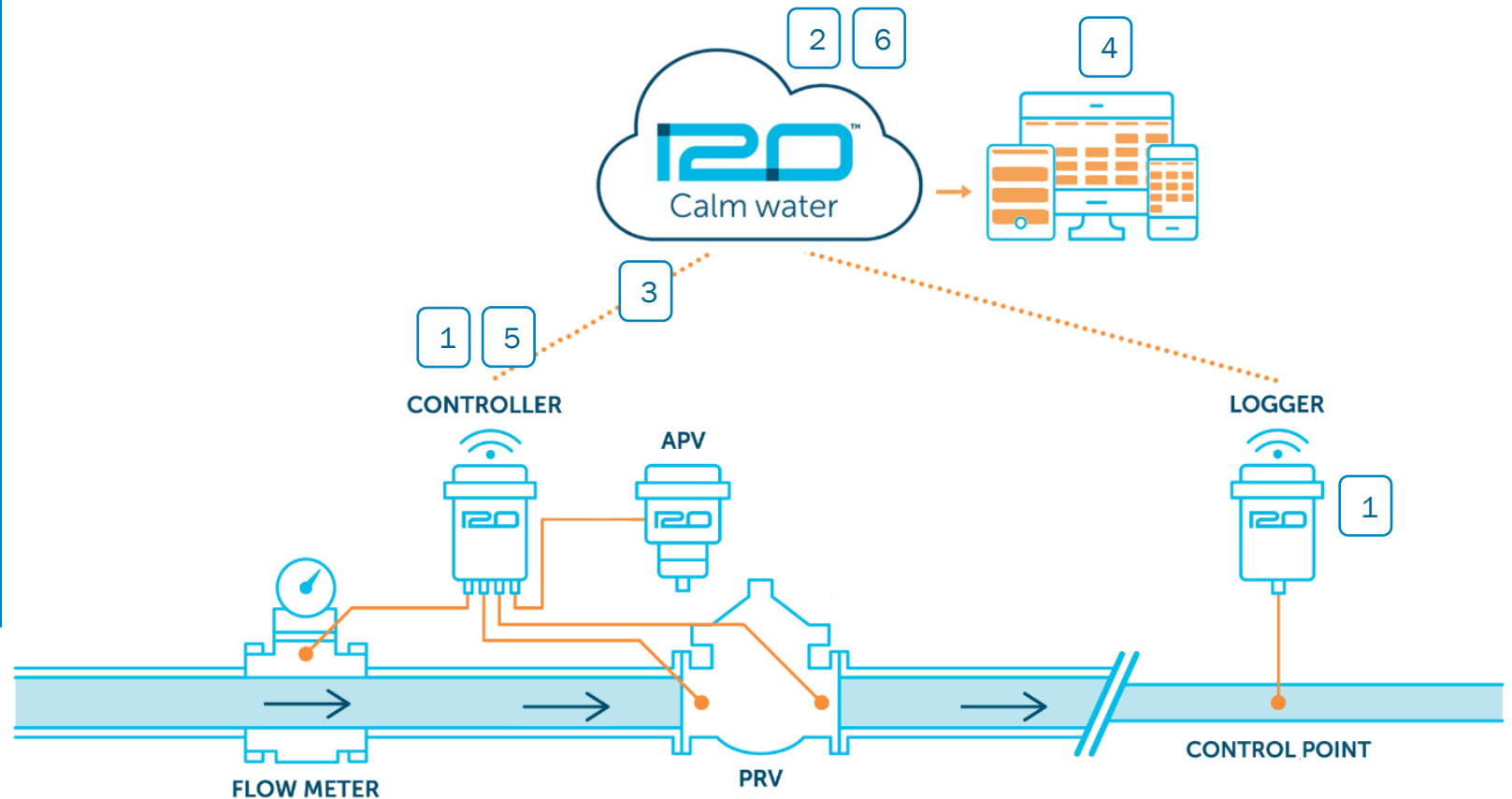


Control
point logger



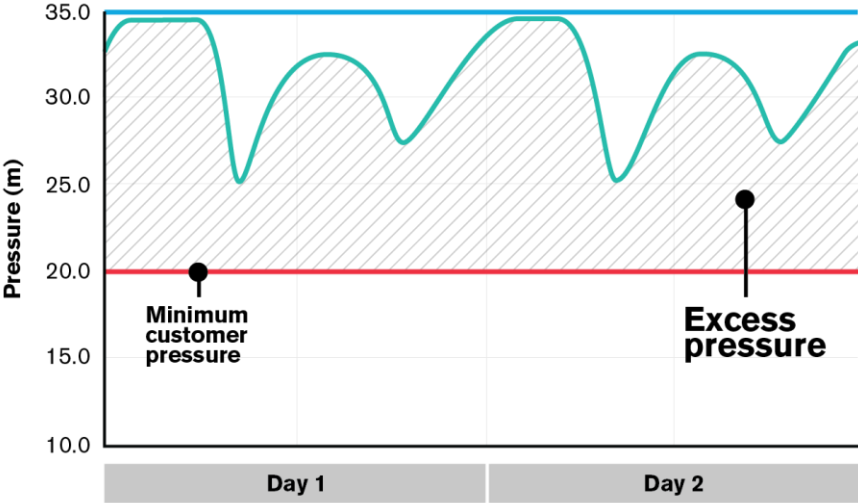
How i20 Advanced Pressure Management works

1. Flow and pressure data is recorded and sent to Sentryx cloud platform
2. Flow-related head-loss curve created using algorithm
3. Head-loss curve sent to PRV controller
4. Client sets target pressure for critical point
5. Controller reads flow in real-time and instructs the Advanced Pilot Valve what outlet pressure is required
6. Pressure and flow data re-analysed each day and head-loss curve updated if necessary

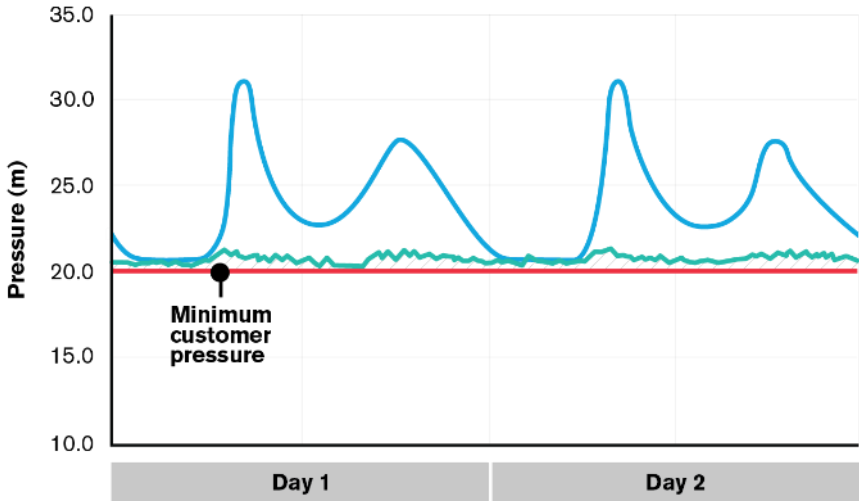


i20 Advanced Pressure Management is used to reduce over-pressure which in turn reduces leakage, bursts and open-tap demand. It delivers fixed pressure at the control point by varying the PRV outlet pressure.

BEFORE: fixed outlet pressure at the PRV with over-pressure in the network



WITH i20: varying outlet pressure with minimal viable pressure for customers

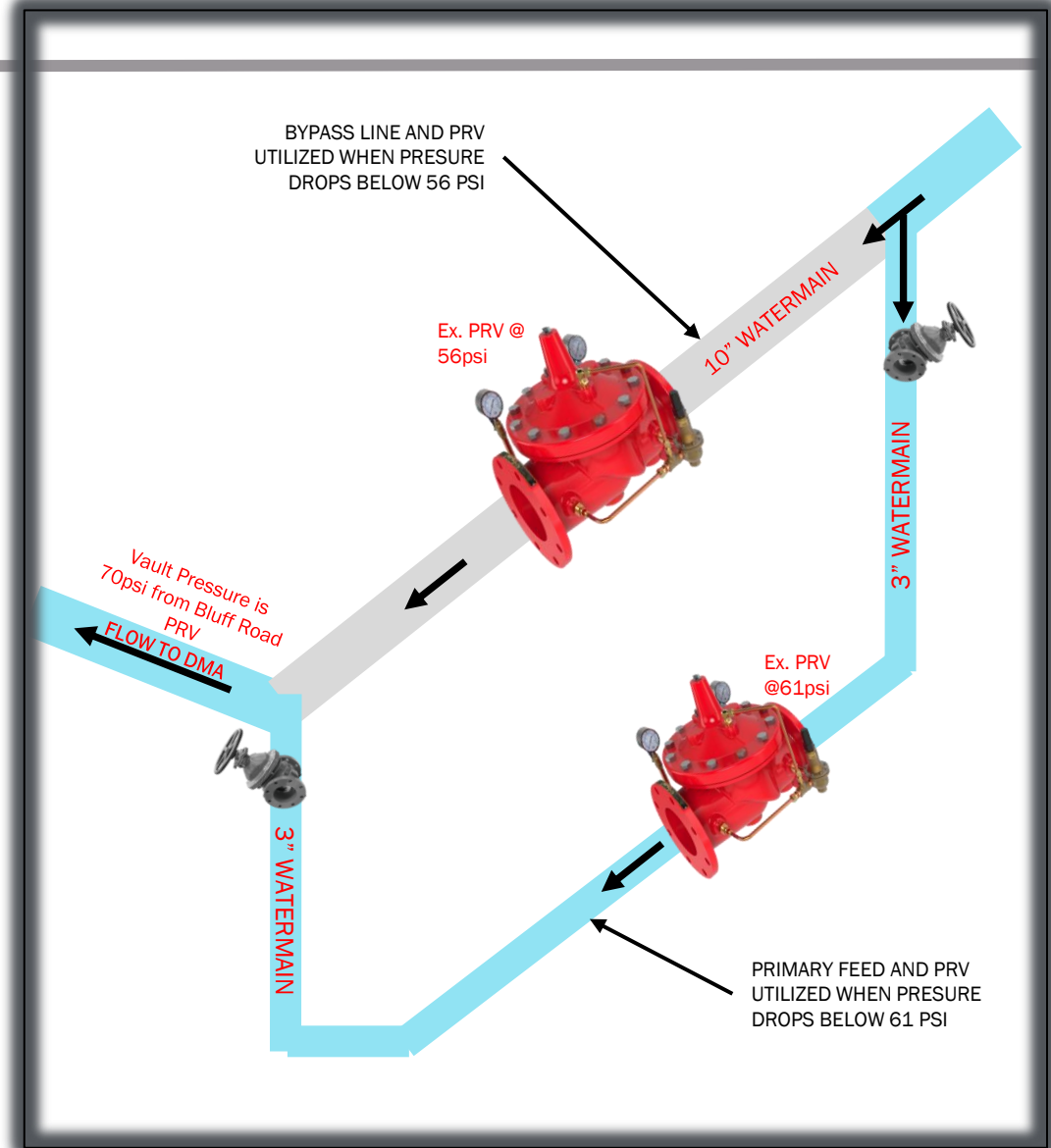


- PRV outlet pressure
- Control point pressure
- Minimum viable pressure

Sandy DMA

- Existing Layout
 - Existing PRV on smaller main is utilized to control pressure in the DMA.
 - Existing PRV on larger main is utilized should there be a large pressure drop in the DMA. This is utilized as a bypass line.
- Proposed Scope:
 - Small Valve to be utilized to control pressure in the DMA:
 - Mueller Consumption Meter for flow measurement via Mi.Node to Sentryx
 - i20 APV and Control Logger to regulate pressure
 - Large Valve to be utilized during low pressure scenarios in the DMA:
 - i20 APV and Control Logger to regulate pressure
 - McCrometer Insertion Meter and ProComm Go to compute volume and flow rates

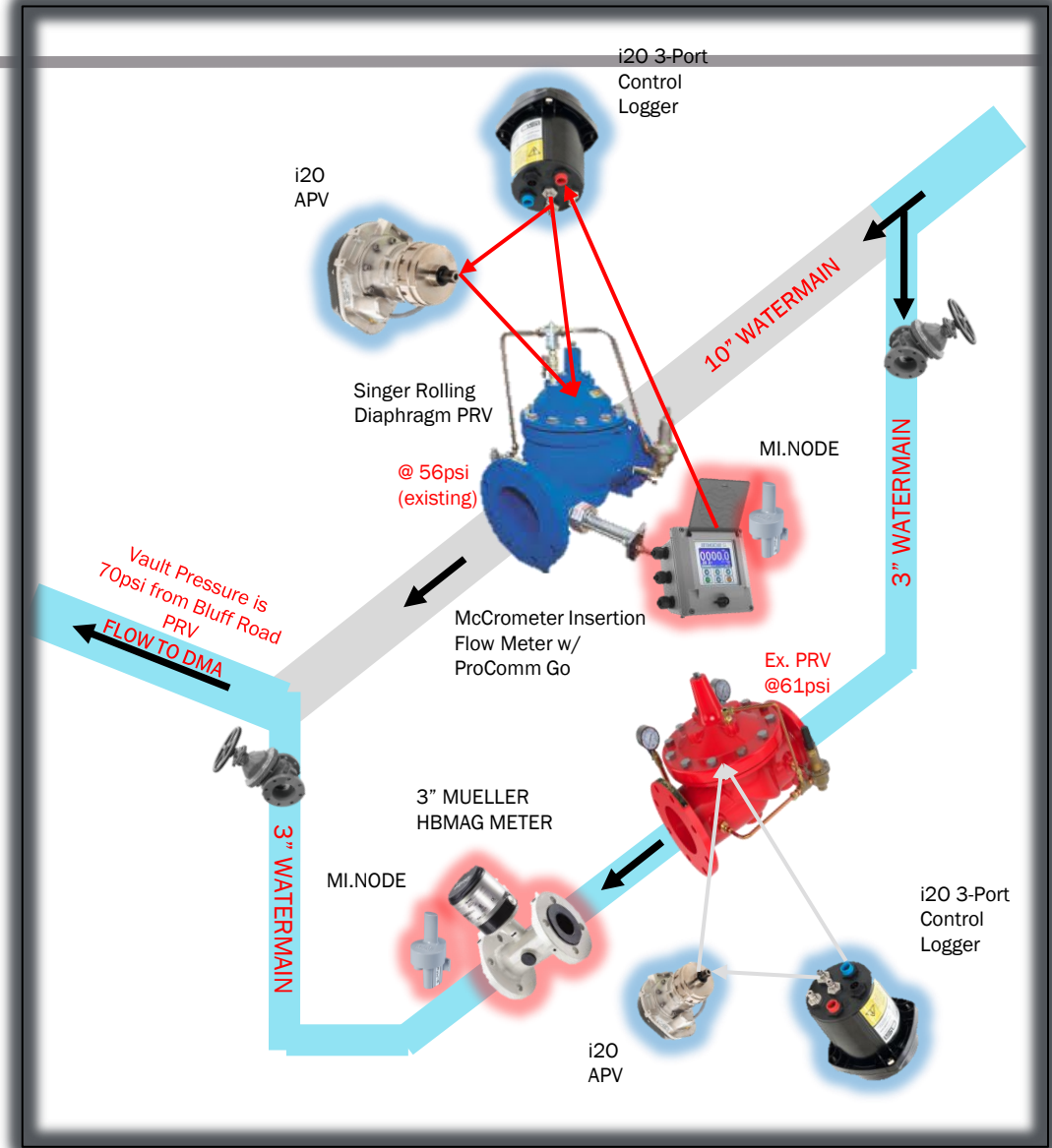
EXISTING LAYOUT OF STARBUCKS VAULT



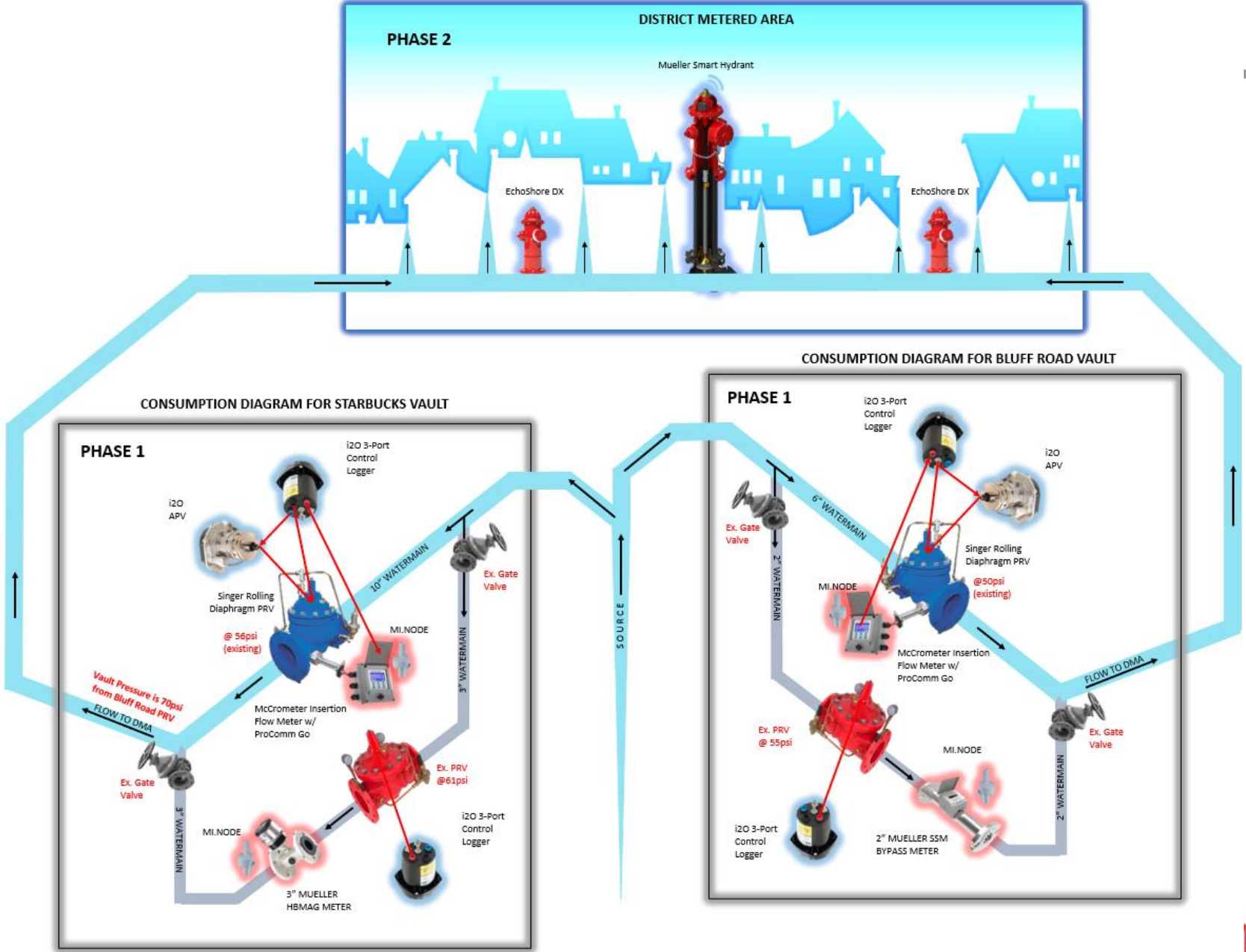
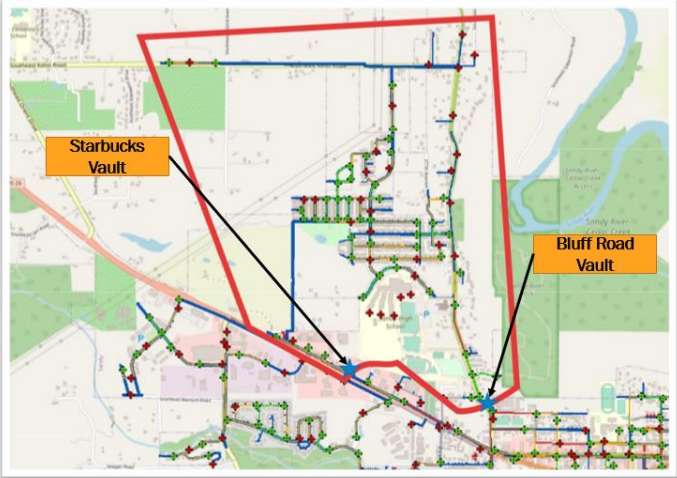
Sandy DMA

- Existing Layout
 - Existing PRV on smaller main is utilized to control pressure in the DMA.
 - Existing PRV on larger main is utilized should there be a large pressure drop in the DMA. This is utilized as a bypass line.
- Proposed Scope:
 - Small Valve to be utilized to control pressure in the DMA:
 - Mueller Consumption Meter for flow measurement via Mi.Node to Sentryx
 - i20 APV and Control Logger to regulate pressure
 - Large Valve to be utilized during low pressure scenarios in the DMA:
 - i20 APV and Control Logger to regulate pressure
 - McCrometer Insertion Meter and ProComm Go to compute volume and flow rates

































CONSUMPTION DIAGRAM FOR STARBUCKS VAULT



System Diagram



How do we achieve desired outcomes?

Utility Value	Acoustic Monitoring	Pressure Monitoring	Flow Monitoring	Pressure Control
Find slow growing leaks				
Find bursts				
Find Household leaks				
Decrease break rate				
Improve Speed / Quality of Repair*				
Decrease Real Losses				
Decrease Unavoidable Losses				
Extend asset life				

<https://www.sentryx.io/login>



MUELLER

Thank you for your
interest and time.

Q & A



ePulse Condition Assessment

Why Perform Condition Assessment Inspections?

Condition Assessment is the collection of pipe data to determine:

- What's occurring in the system today?
- What's the probability of a failure?
- What's the best solution to prevent a failure?
- How much time do I have to implement the solution?



The Problem of Pipe Replacement & Failure

- All pipe will degrade and fail over time but at varying rates
 - Consequences = water loss and catastrophic breaks
- Pipe is hidden underground
 - No visual way to determine good versus bad pipe
- Reliance on pipe failure history and age can be ineffective
 - 60% to 70% of mains being replaced are still in good condition
- Replacing and rehabilitating pipe is expensive
 - Pipe replacement costs of \$1,000,000 or more per mile
- Because of price and selection error, wrong pipes are targeted
 - Increasing water loss and likelihood of catastrophic breaks



Prioritizing Pipeline Renewal Based on Condition

Pipeline 1	Pipeline 2
Installed 1860	Installed 1860
Brown sandy soil	Brown sandy soil
Moderate soil corrosivity	Moderate soil corrosivity
6" Cast Iron Pipe	6" Cast Iron Pipe



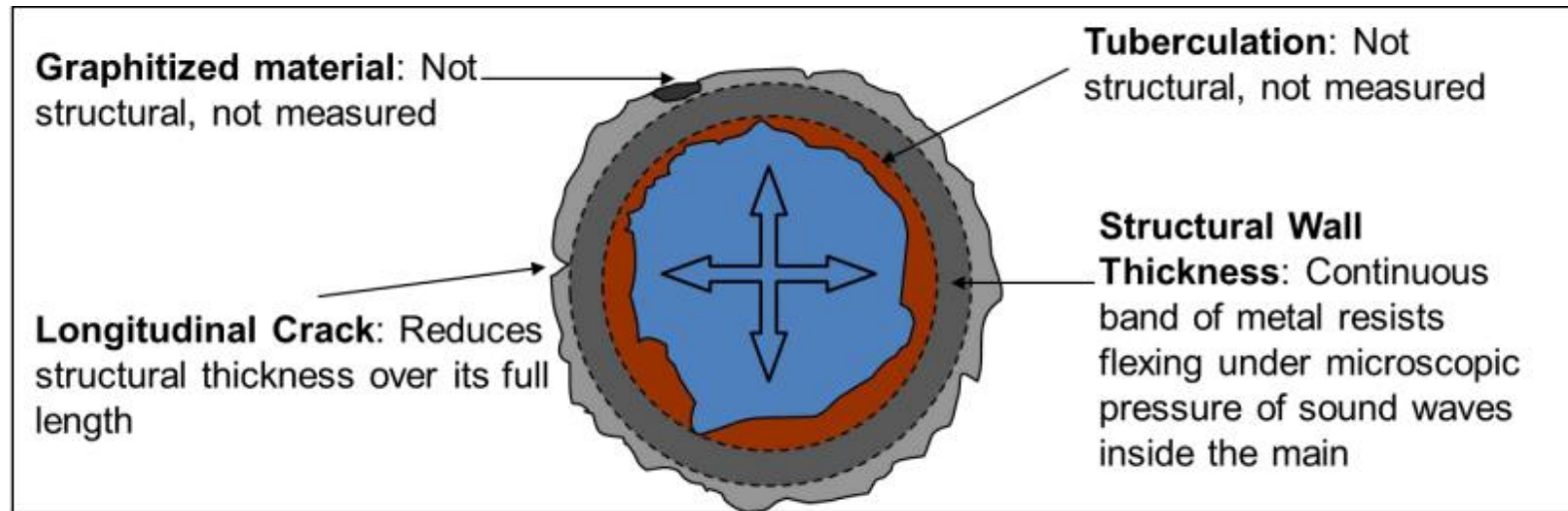
31% Thickness Loss



1% Thickness Loss

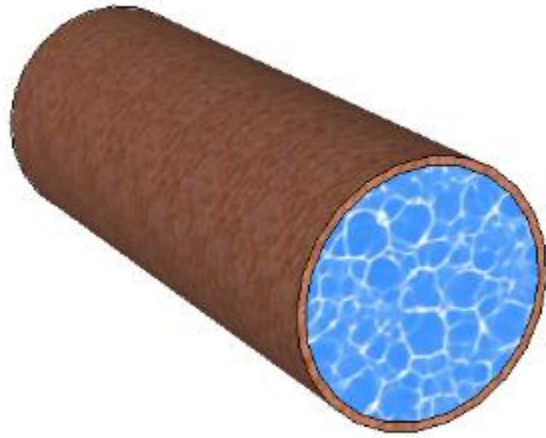
ePulse – Acoustic Pipe Wall Condition Assessment

The ePulse Measures the average minimum remaining pipe wall thickness over a length of pipe between two sensors

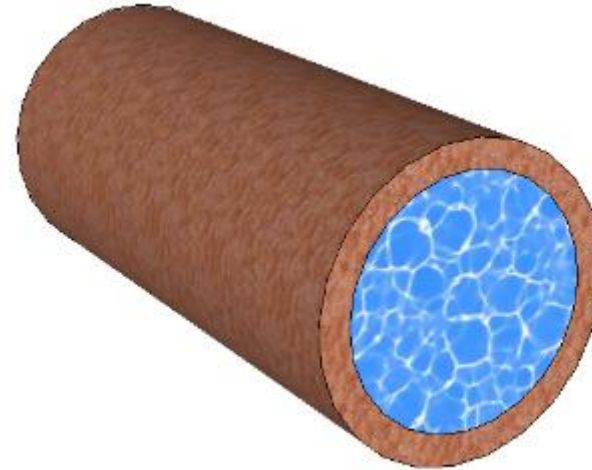


Added Value: Detect Leaks while measuring average minimum remaining pipe wall thickness

ePulse – Acoustic Wave Speed Principle

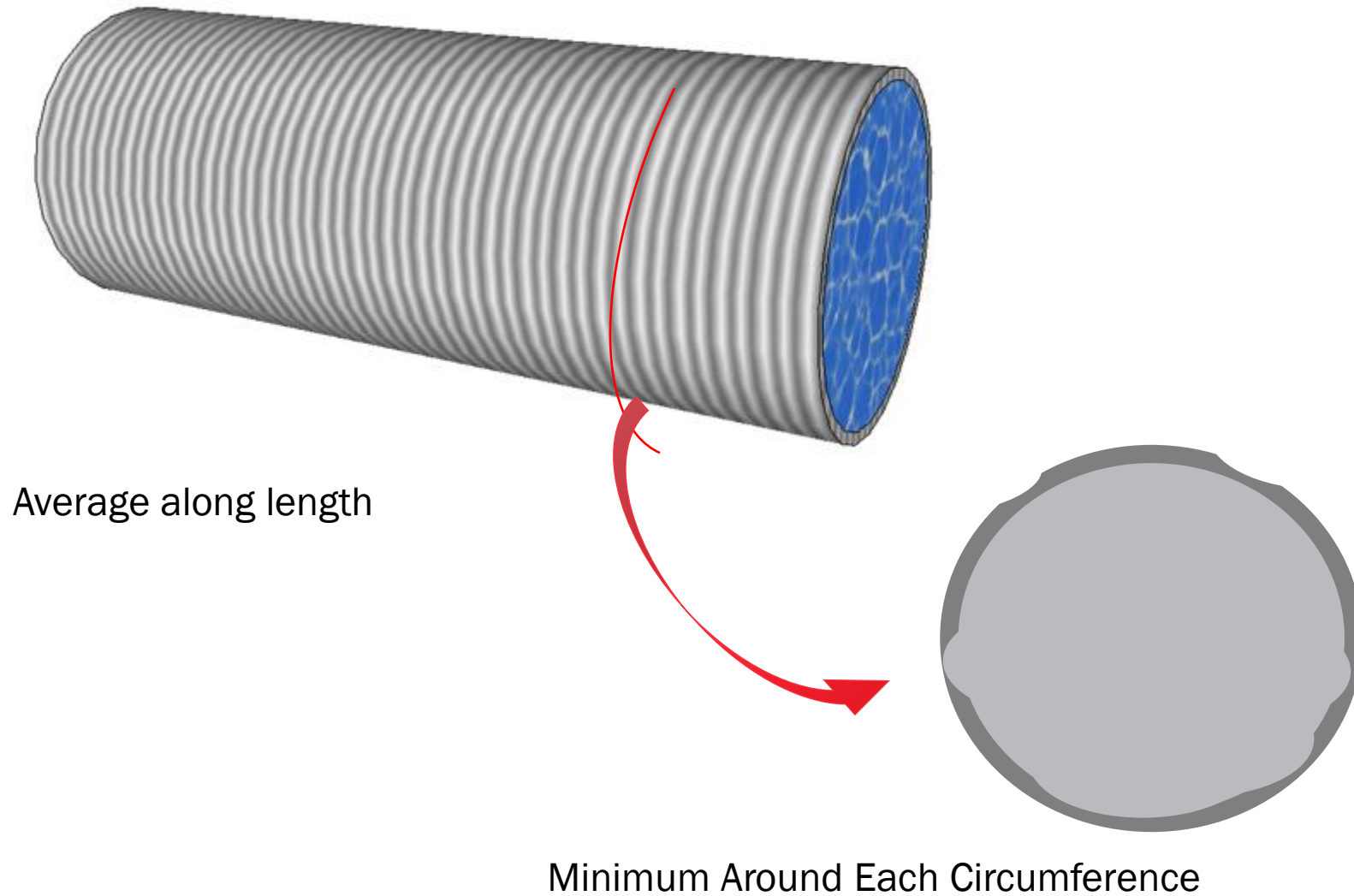


Slower

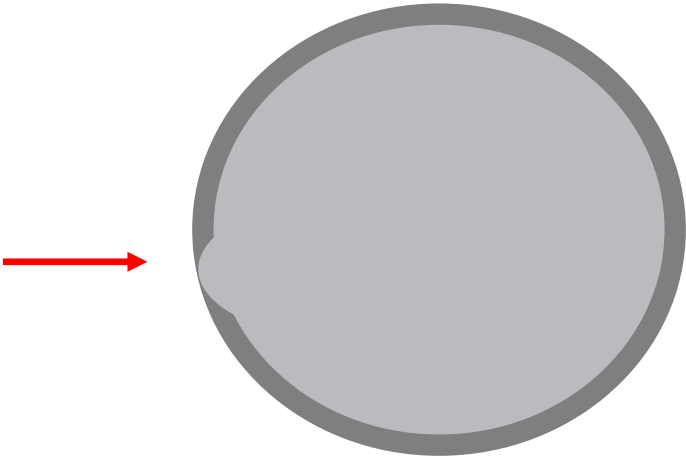
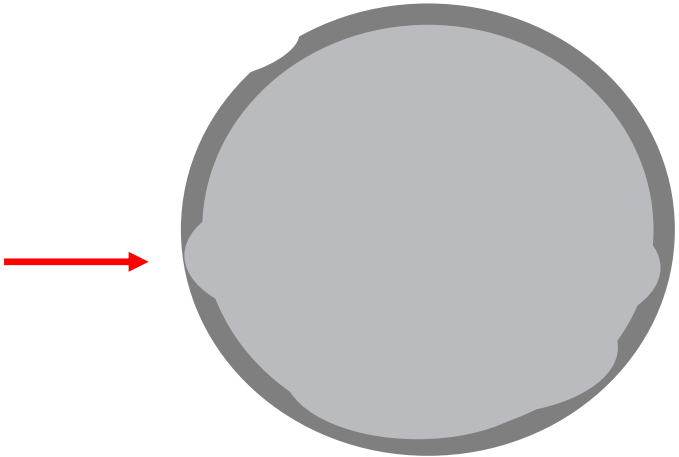


Faster

ePulse Measured Thickness



Measure Minimum Around the Circumference

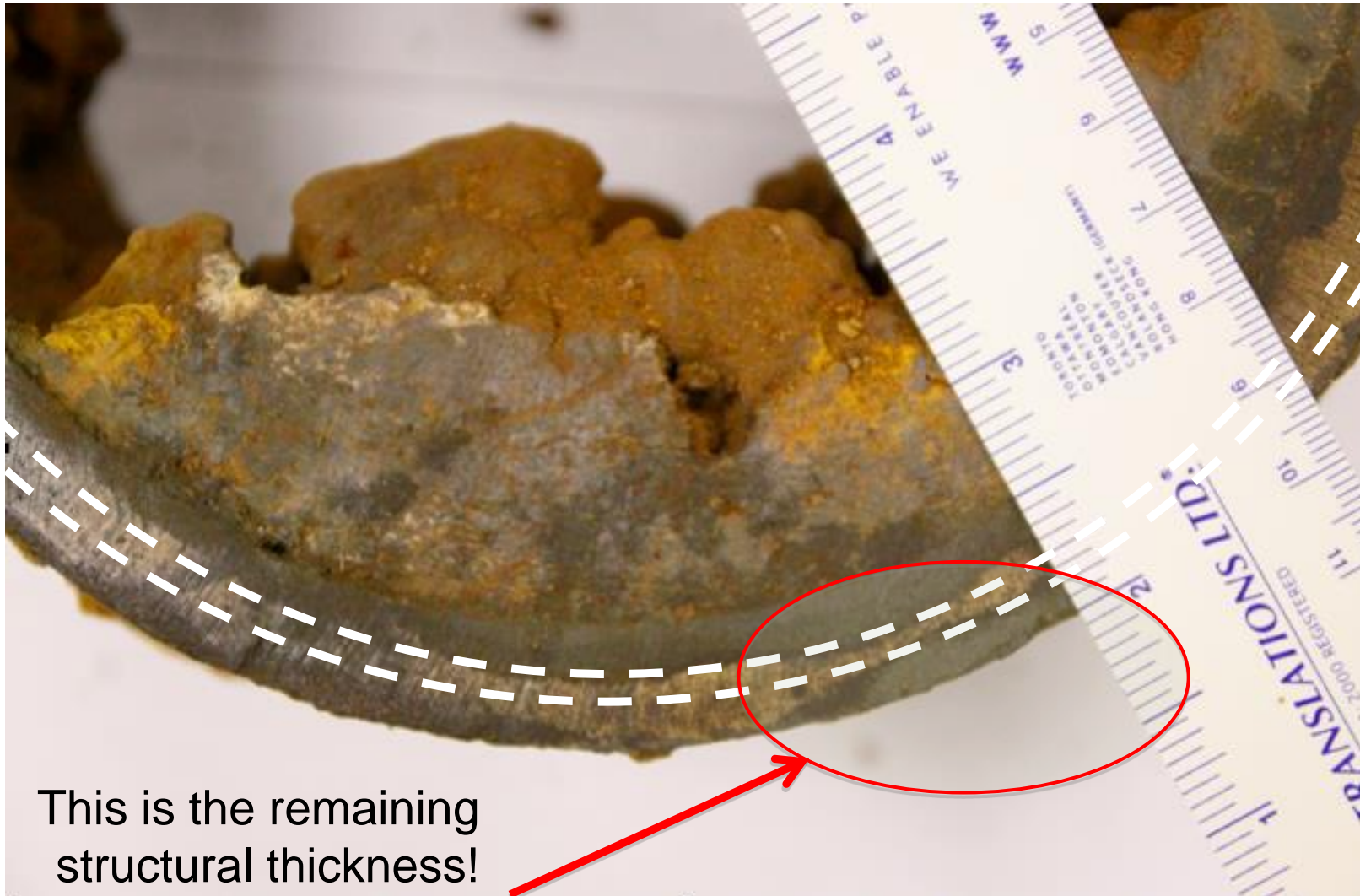


Minimum Wall Thickness	0.13	Minimum Wall Thickness	0.13
------------------------	------	------------------------	------

Average Wall Thickness	0.18
------------------------	------

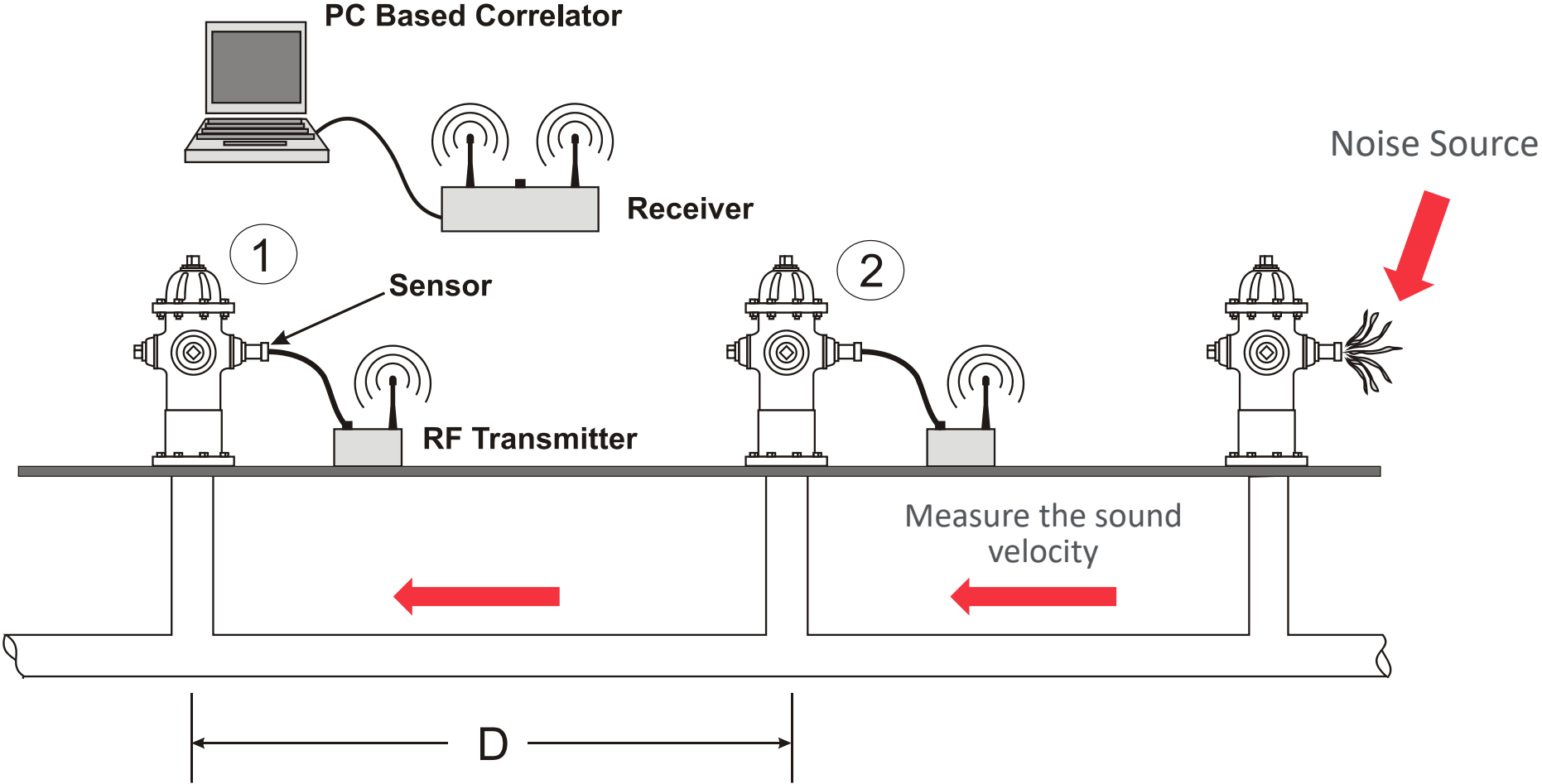
Average Wall Thickness	0.27
------------------------	------

The Pipe can be Deceiving



This is the remaining structural thickness!

ePulse – How it works



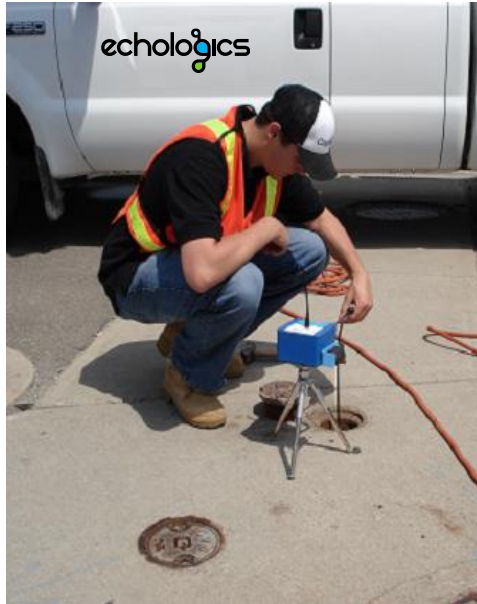
Wave propagation velocity (v) = $D/\Delta T$, where ΔT is time delay between signals 1 and 2

ePulse – Typical Field Setup for distribution mains



How it Works – In the Field

1-Connect
Sensors



2-Measure
Distance



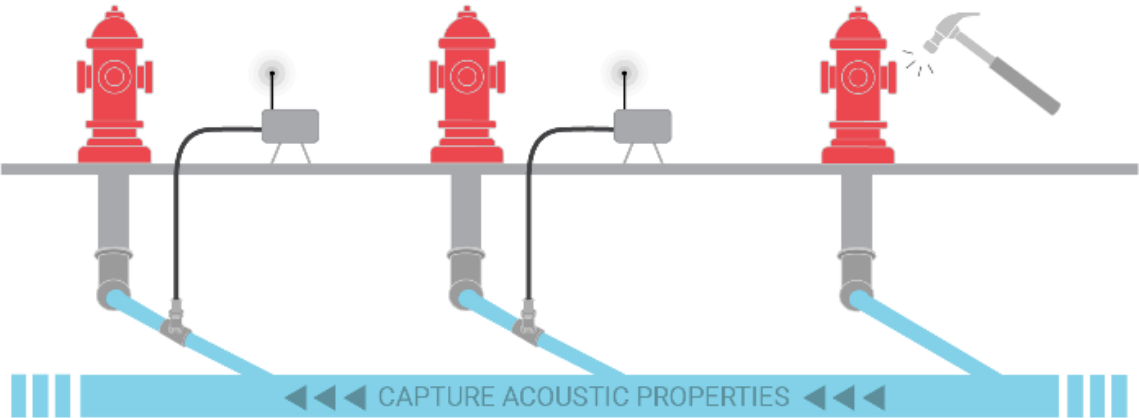
3-Create
Noise



4-Measure
Velocity



ePulse Discovery



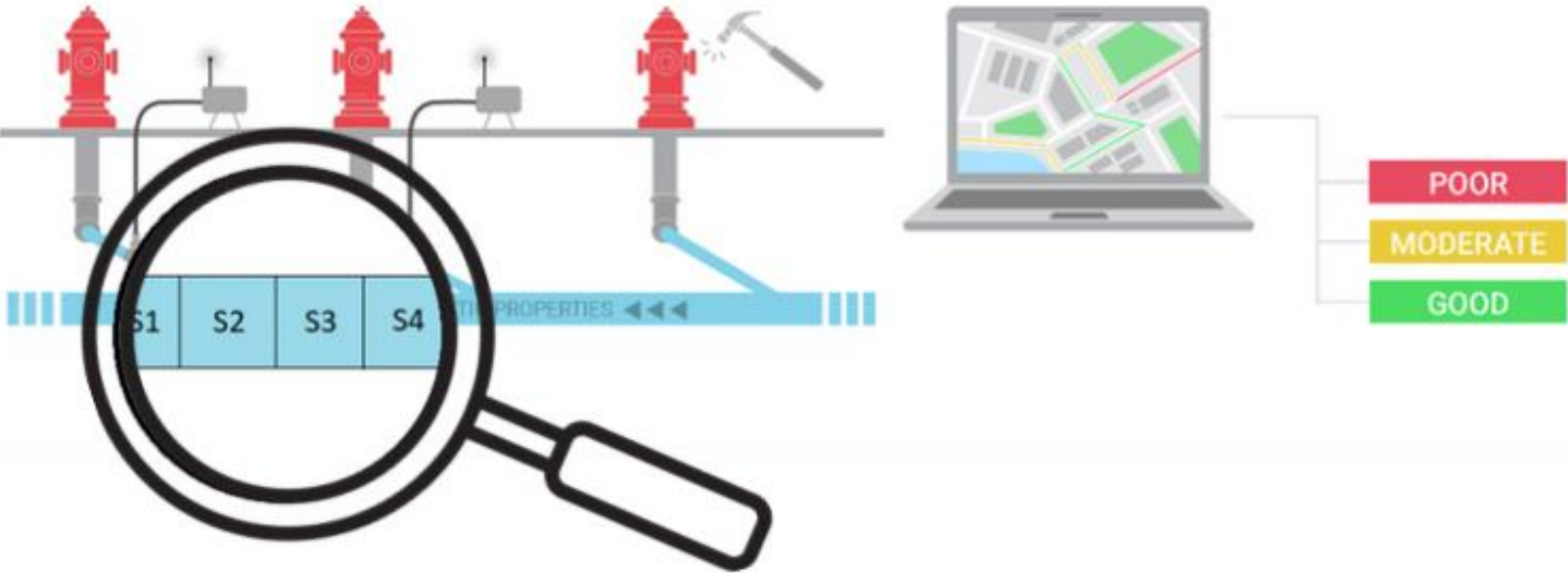
- POOR
- MODERATE
- GOOD

ePulse® Optimize

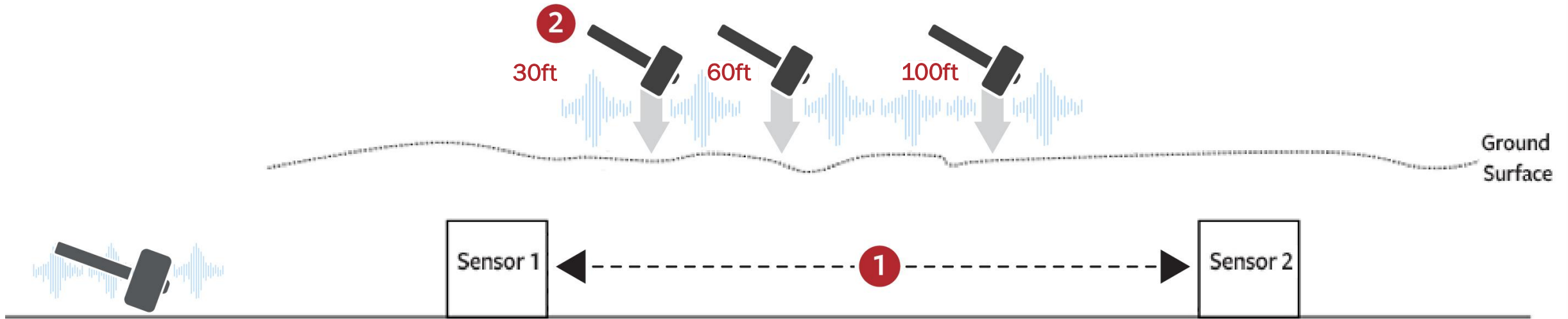
- Provides pipe ranking of poor, moderate, or good

- Analyzes sections of pipe as low as 30ft

- Provides simultaneous leak detection



ePulse® Optimize - How it Works?



- 1 Carry out standard ePulse including distance measurement between sensors and "out of bracket" excitation recordings.
- 2 Divide out desired sections within the segment and generate "in-bracket" excitation recordings for each section.

- 3 Recordings are sent to Echologics data science team for analysis. A report is provided with pipe condition and location of any leak(s) identified during survey.

ePulse: Technical Qualification

1. The Right Pipes

Pipe Material	Pipe Diameter
Metallic or Asbestos	Up to 108"

2. Maps (GIS Preferred)

3. Access to outside of pipe (~every 700')

NOTE: May require potholing

4. Known Pipe Material & Diameter

5. Pressurized Pipes (20+ psi)



Often GIS maps is all you need to develop an ePulse proposal

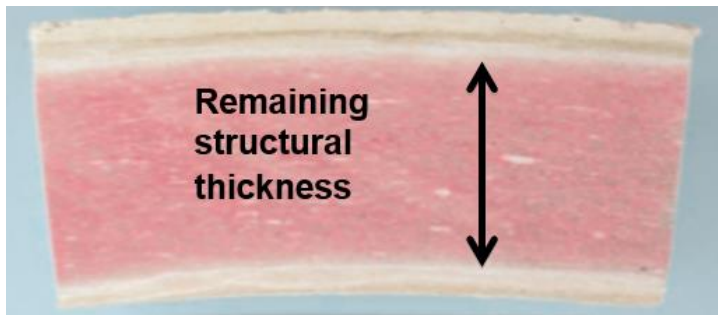
ePulse Survey Results

ePulse Data

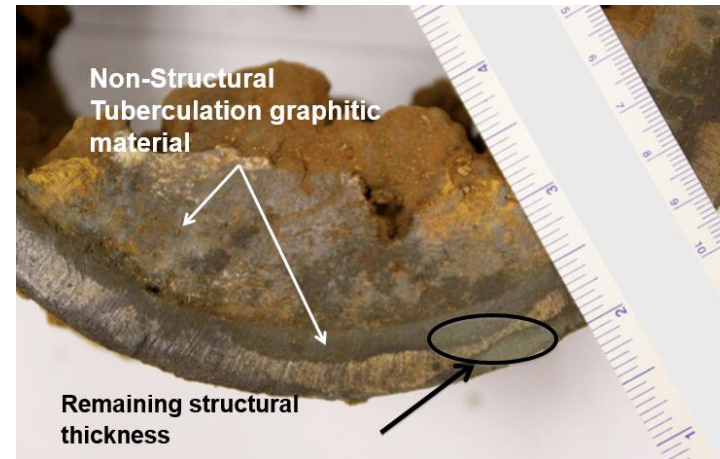
- Remaining Structural Wall Thickness
- % Loss from Original Thickness
- Qualitative Pipe Grade
- Presence and Location of Any Leaks

Section	Diameter (In)	Length (Ft)	Material	Pressure Class	Nominal Thickness	Measured Thickness	Loss
Unit	In	Ft	-	-	In	In	%
1	16	546	DI	350	0.38	0.31	20%
2	16	251	DI	350	0.38	0.23	40%
3	16	252	DI	350	0.38	0.34	11%
4	16	428	DI	350	0.38	0.35	7%
5	16	427	DI	350	0.38	0.37	4%
6	16	516	DI	350	0.38	0.41	0%
						0.32	17%

Pipe Samples



Asbestos Cement

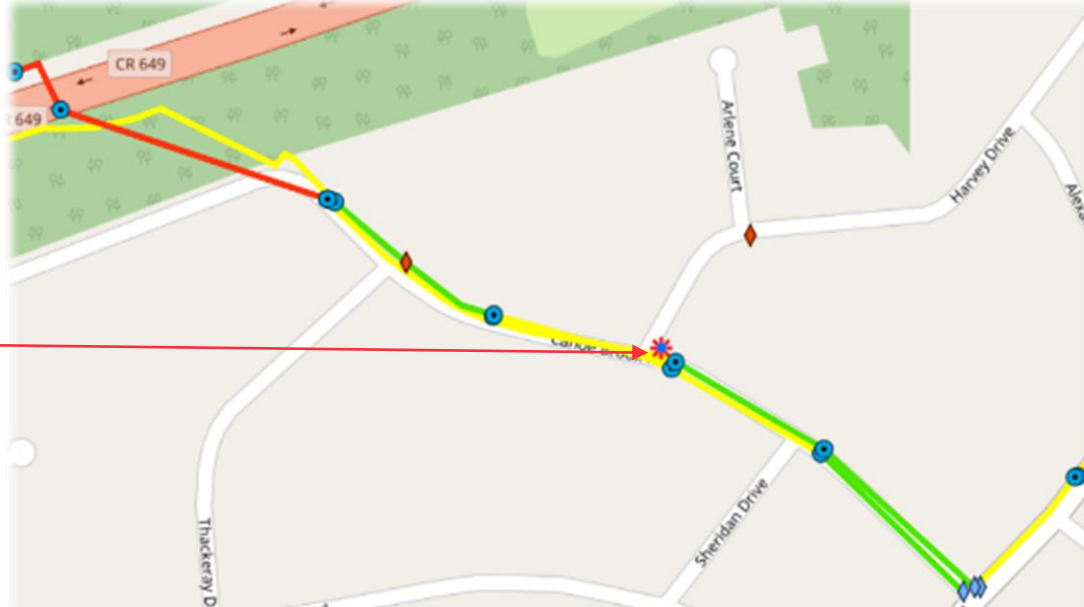


Ferrous



ePulse – Typical Results

Leak

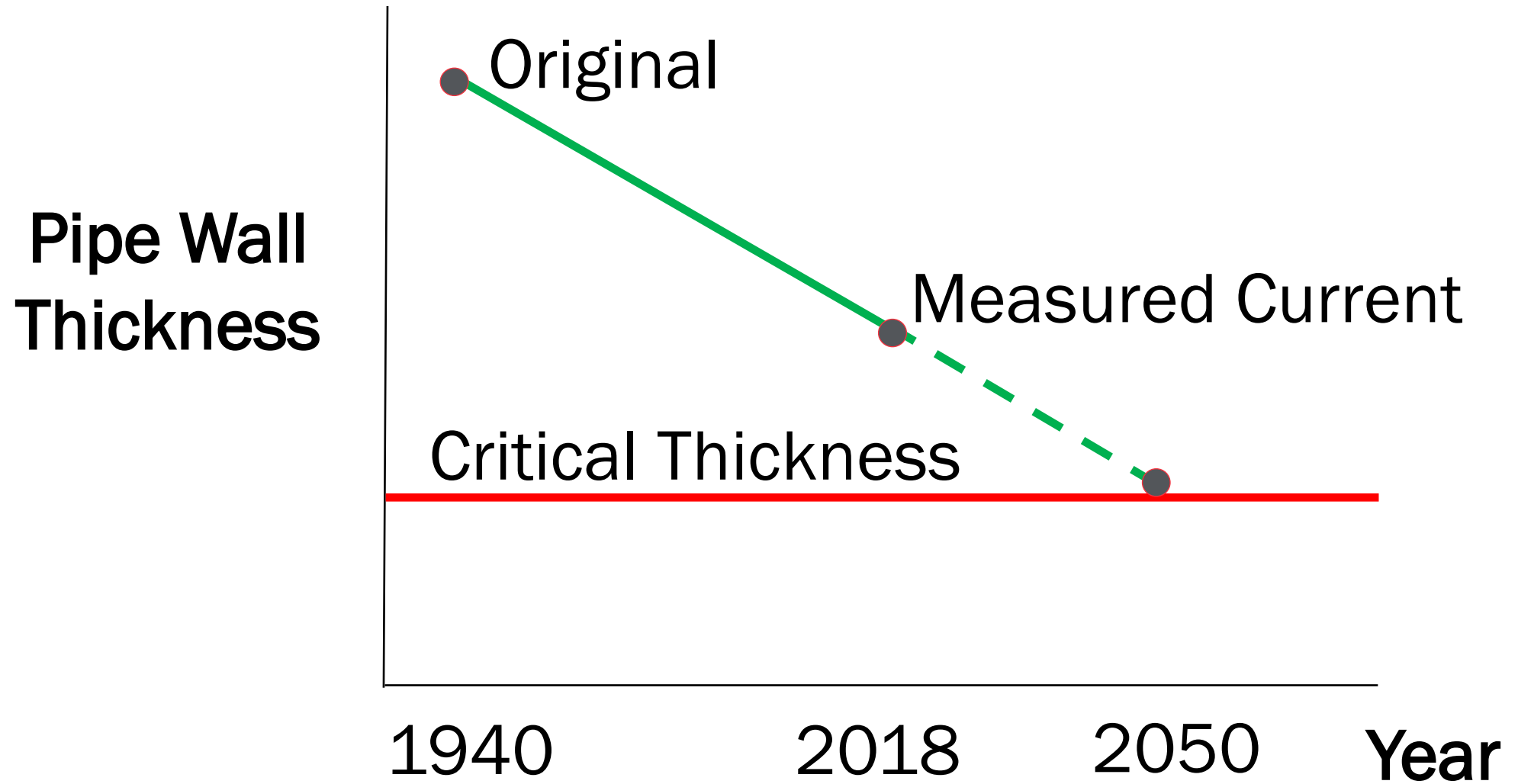


Applications

- Pipe Types: CI, DI, AC, BWP
- Segment Distances:
 - Minimum = 150 lf
 - Maximum = 750 lf
 - Preferred = 500 lf

Segment	Street	Distance (ft)	Pipe Material	Internal Diameter (in)	Nominal Thickness (in)	Remaining Thickness (in)	Change from Nominal %
1	West Vine St.	413	Asbestos Cement	6	0.66	0.31	53%
2	West Vine St.	338	Asbestos Cement	6	0.66	0.43	35%
3	West Vine St.	323	Asbestos Cement	6	0.66	0.41	38%
4	Cottage St.	381	Ductile Iron	8	0.33	0.28	15%
5	Cottage St.	425	Ductile Iron	8	0.33	0.30	9%

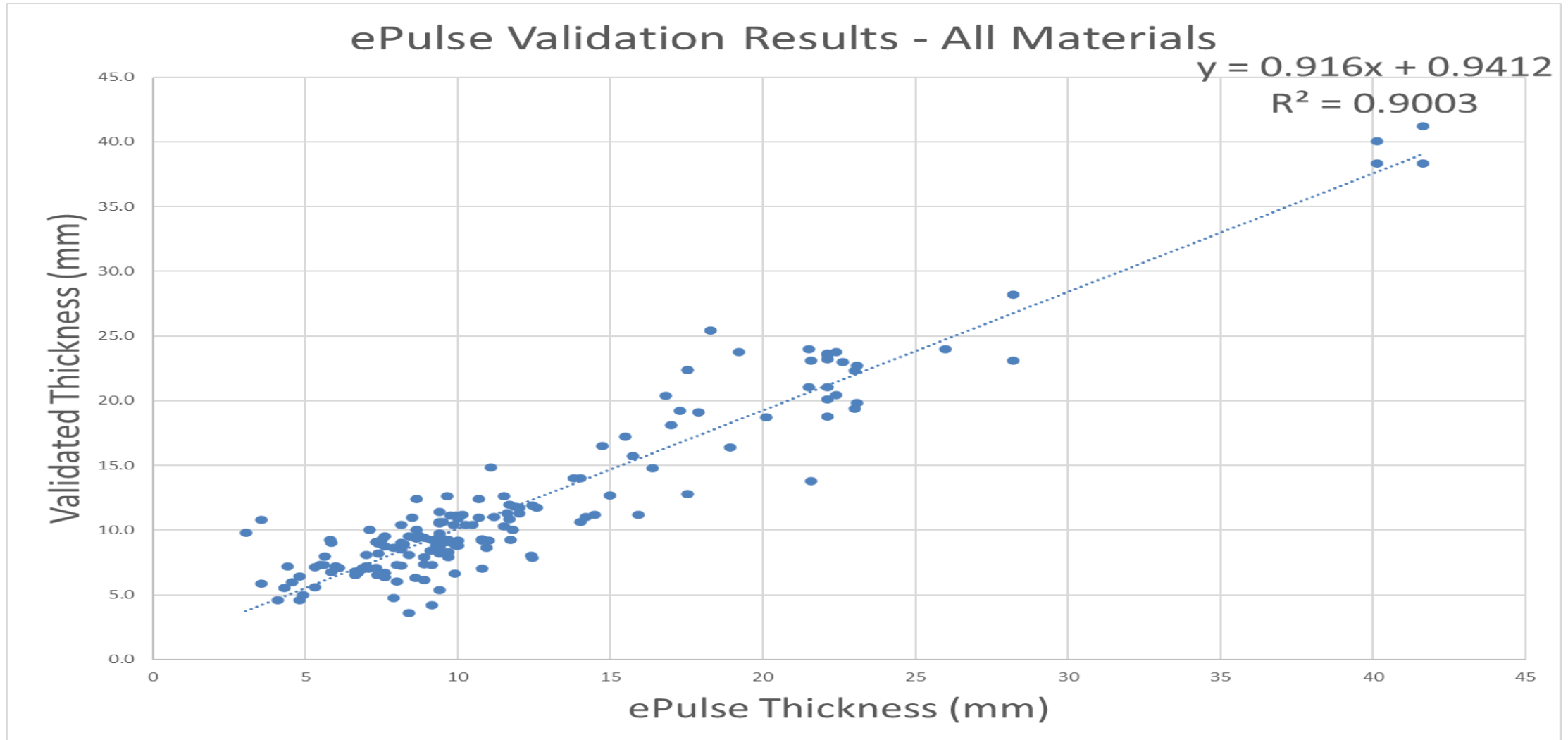
Remaining Service Life Calculation



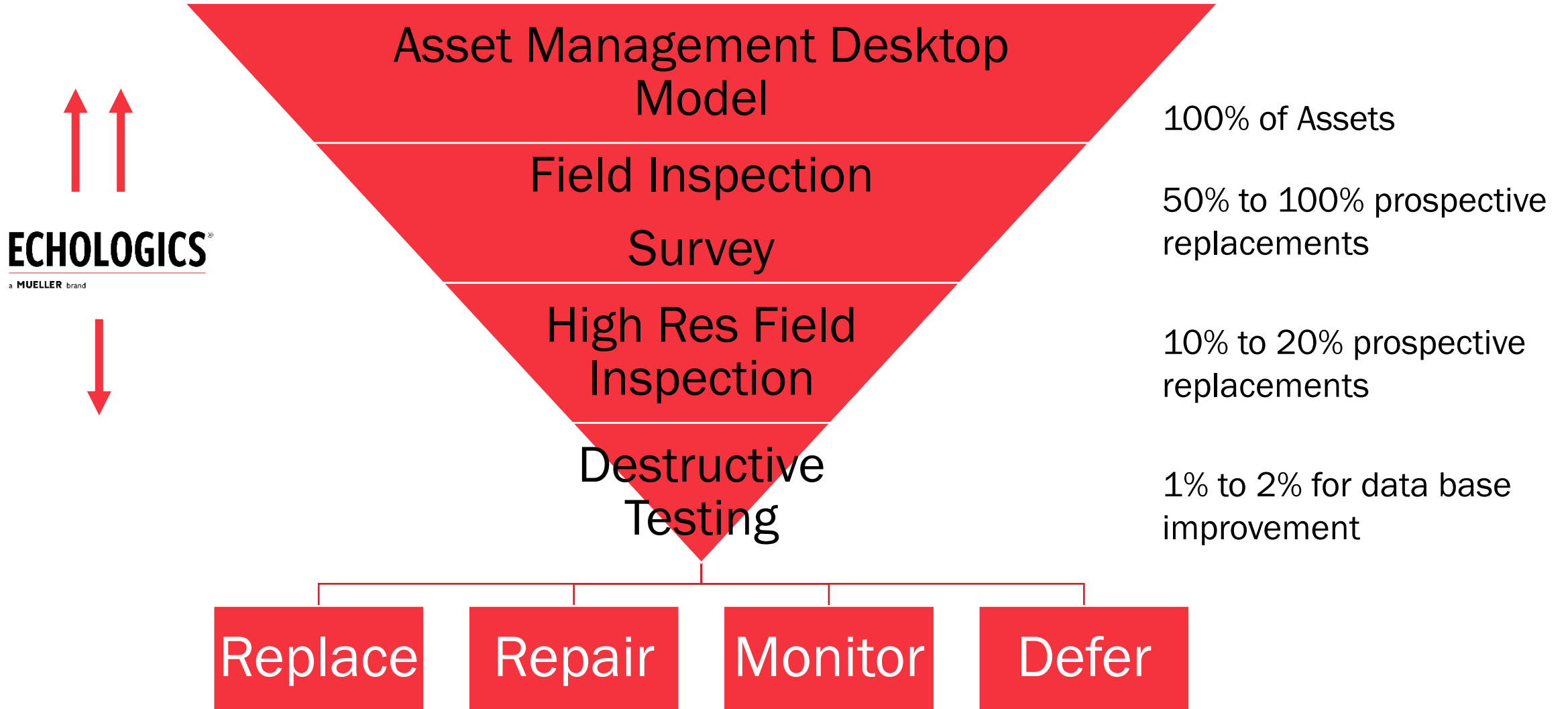
Remaining Service Life Calculation with ePulse

Pipe Segment	Street Name	Length	Nominal Thickness ₁	ePulse® Measured Thickness	Pressure	Temp	Installation Year	% Change from Nominal	Remaining Service Life (years)	Predicted Breakage Rate	Probability of Failure Per Segment Length
#		(m)	(mm)	(mm)	(PSI)	(°C)				(brks/km/yr)	(this year)
1	Hennebury Pl	185.9	10.9	9.1	85	11	1940	-17%	50+	0.01	<1%
2	McNeil St	152.4	10.9	4.4	70	11.3	1940	-60%	Exceeded RSL	1.02	3%
3	Howley Ave	175.9	11.7	10.2	70	11.3	1940	-13%	50+	0.00	<1%
4	Summer St	132.6	10.9	3.1	70	11.3	1940	-72%	Exceeded RSL	1.71	4%
5	Merrymeeting Rd	168.2	14.7	9.9	85	11.6	1940	-33%	Exceeded RSL	0.16	1%
6	Merrymeeting Rd	133.8	14.7	11.0	85	11.6	1940	-25%	20 to 29	0.05	<1%
7	Merrymeeting Rd	149.7	14.7	10.9	85	11.6	1940	-26%	20 to 29	0.05	<1%
8	Winchester St	114.3	10.9	8.2	85	11.6	1940	-25%	30 to 39	0.04	<1%
9	Monchy St	152.7	10.9	7.8	75	11.6	1940	-28%	10 to 19	0.07	<1%
10	Monchy St	99.4	10.9	8.5	75	11.3	1940	-22%	40 to 49	0.02	<1%
11	Hamel St	147.8	10.9	3.4	95	11.3	1940	-69%	Exceeded RSL	4.21	39%

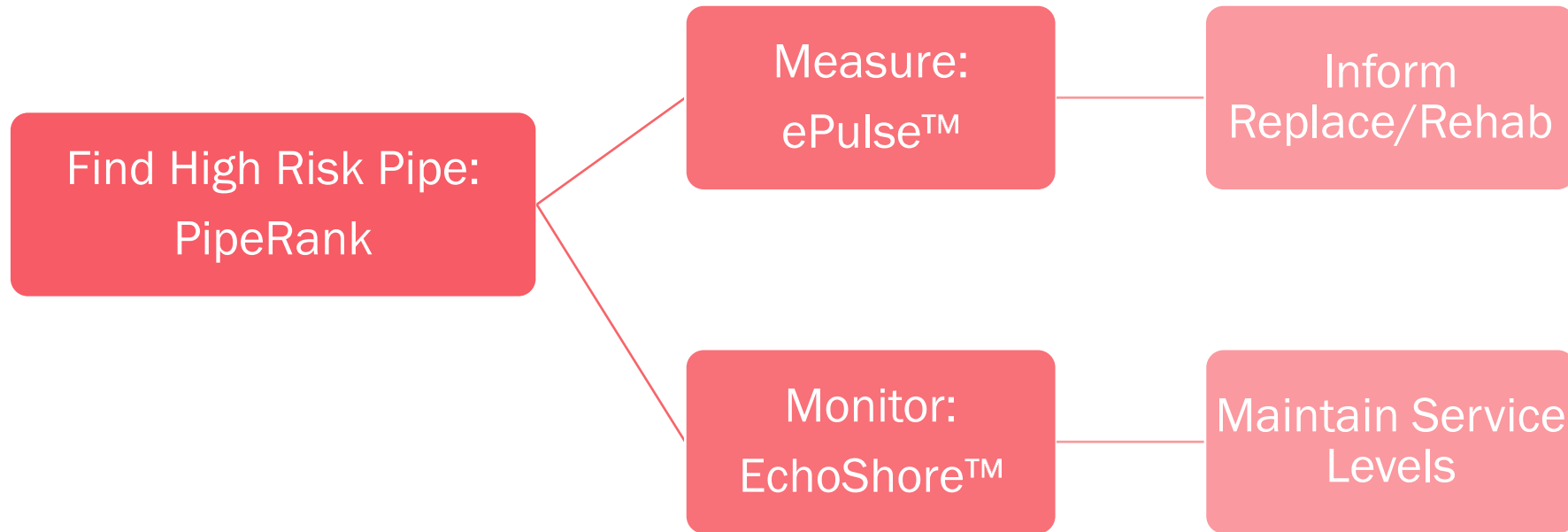
ePulse – Validations



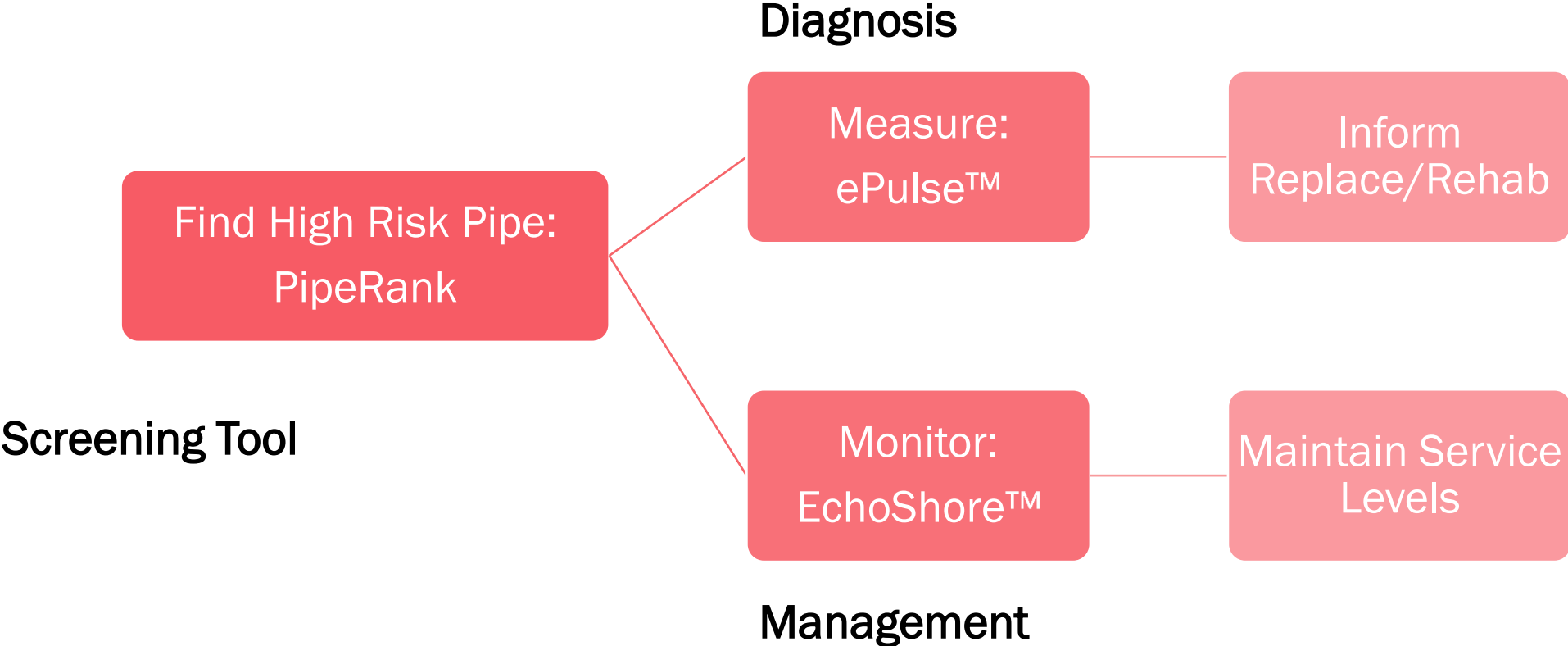
Inform Capital Investments



A New Process is Possible

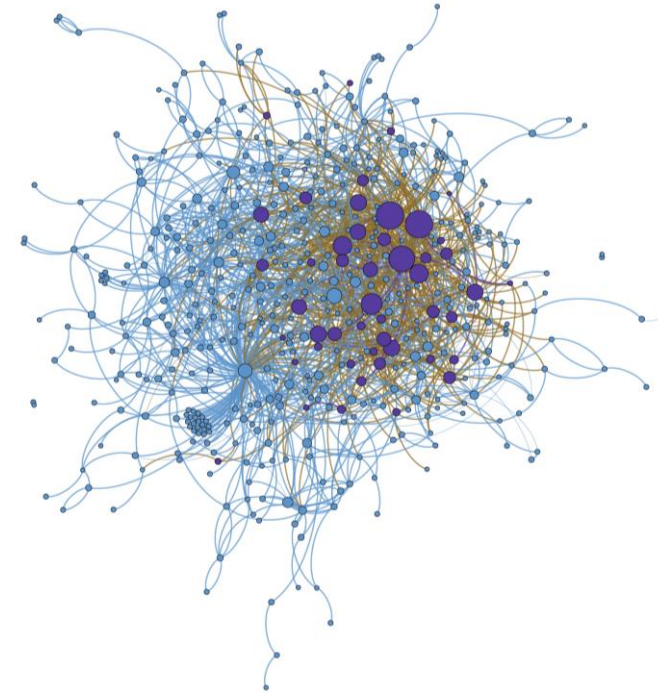
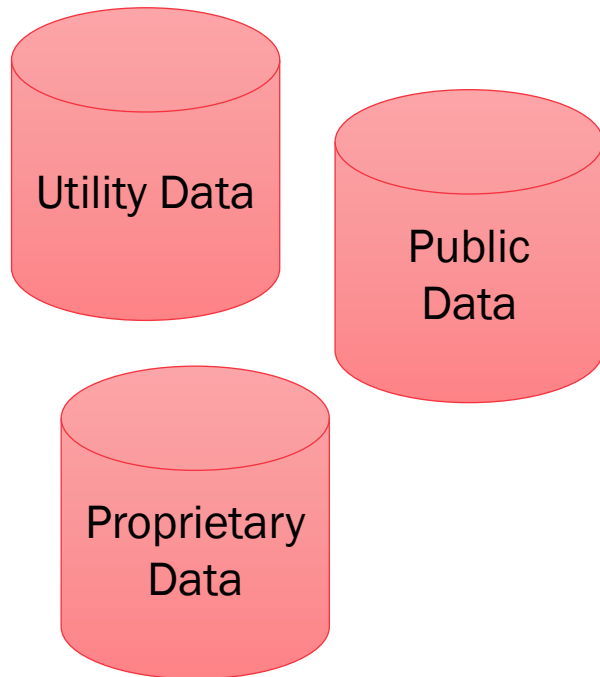


A New Process is Possible



What is Pipe Rank?

How Does PipeRank generate results?



Top 3% of pipes ranked by LoF

Pipes Being Displayed: 1 - 308

> Pipe ID: 5877	100%	1
> Pipe ID: 1184	100%	2
> Pipe ID: 16888	100%	3
> Pipe ID: 22628	100%	4
> Pipe ID: 17797	100%	5
> Pipe ID: 7291	100%	6
> Pipe ID: 3728	100%	7
> Pipe ID: 6659	100%	8
> Pipe ID: 1782	100%	9
> Pipe ID: 2889	100%	10
> Pipe ID: 1453	100%	11
> Pipe ID: 6436	100%	12
> Pipe ID: 18278	100%	13
> Pipe ID: 7918	100%	14

Data collection
and clean up

PipeRank finds patterns
and relationships

Asset Analysis

Case Study 1

Public utility with 260,000 pipe segments (~5,000 miles)

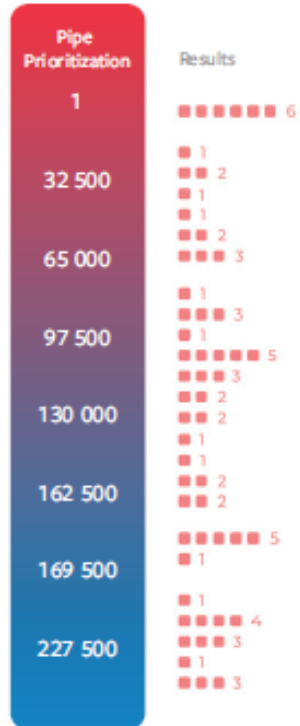
PipeRank predicted 2018:

- In top 1% of ranking, PipeRank caught 50% of all system breaks
- 86% of those pipes had no prior failure

Case Study 1: PipeRank Accurately Predicted Failures

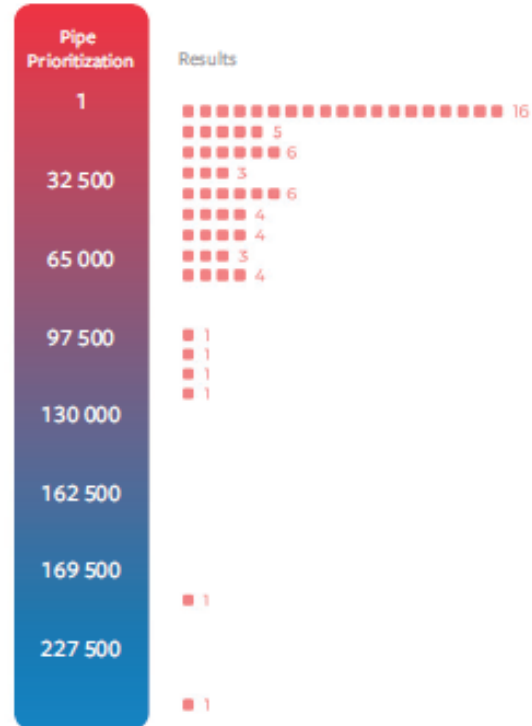
Prior Breaks

16% of failures
in top 5%



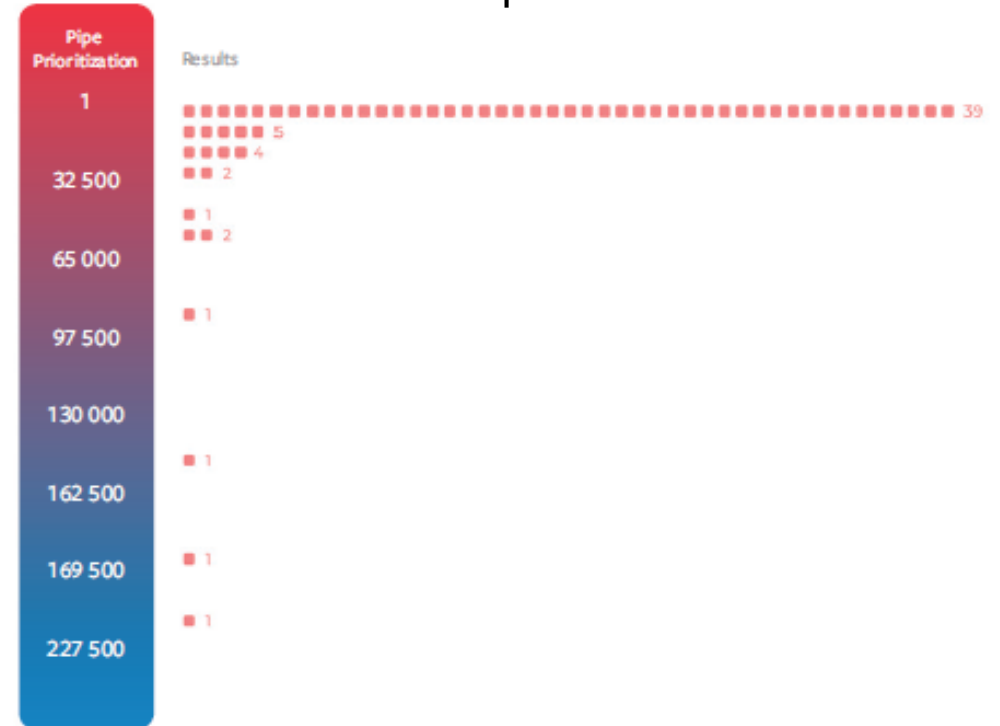
Age

44% of failures
in top 5%



PipeRank

77% of failures
in top 5%



LOF Ranking Vs Actual Failures in 2018

Case Study 2: Pipe Insights accurately predicted breaks

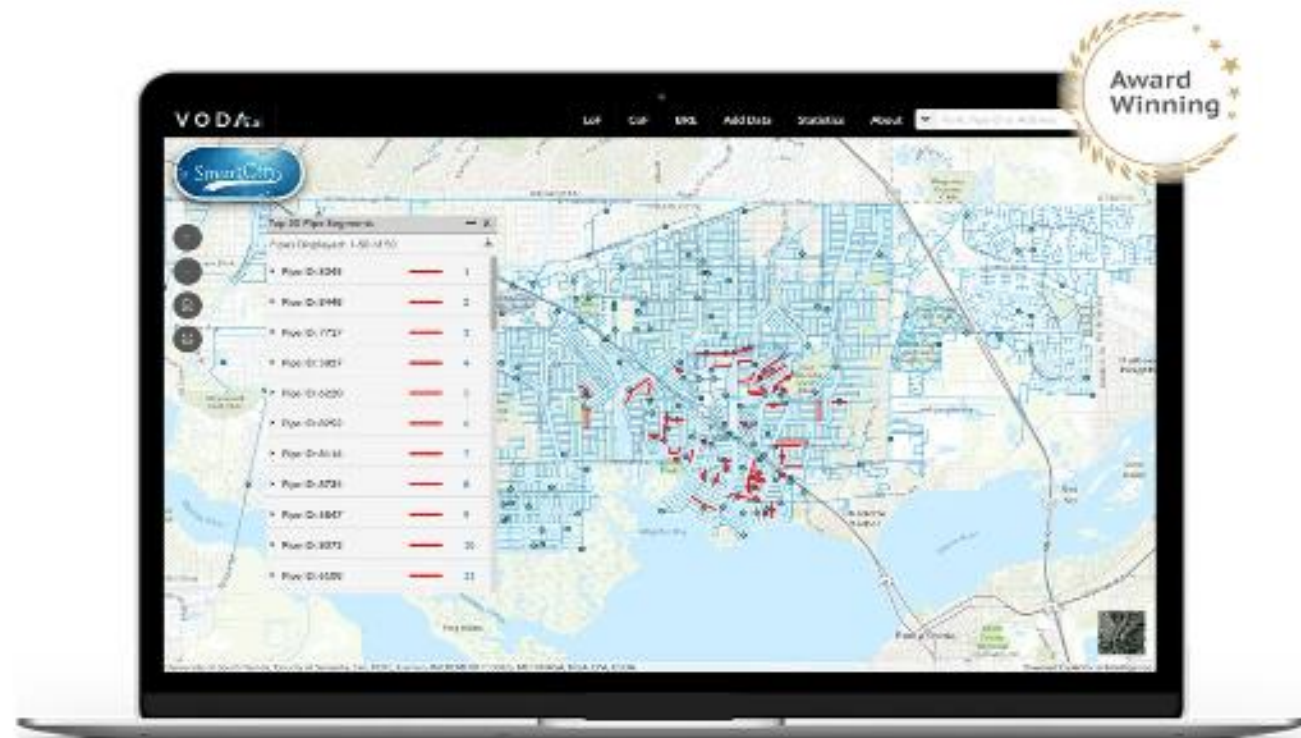
Public utility with 7,400 miles used Pipe Insights to rank probabilities of failure in 2018

- 17 of the top 18 pipes ranked likely to fail - failed
- Pipe #1 failed 2 months later

“We are seeing a new way of doing our business.”

Utility Director

PipeRank Demo



Acoustic Service Line Screening

Lead Service Line Risk: Lead Exposure

- Dangers of lead consumed with drinking water
 - Cognitive impairment (memory loss, lack of concentration, irritability, depression)
 - Reproductive system issues
 - In children, slowed development and damage to the brain and nervous system
- Switching from Leaching Protection to Replacement
 - To better protect children and elementary schools and daycare centers
 - Empower communities with better information on sources and solutions to reduce lead in drinking water



“Nothing in the world worth having comes easy” ~ Theodore Roosevelt

Water professionals seek options to confidently deploy at scale

MANY DATA COLLECTION TECHNIQUES

Data collection considerations

Accuracy & coverage

.....

Overall time

.....

Cost

.....

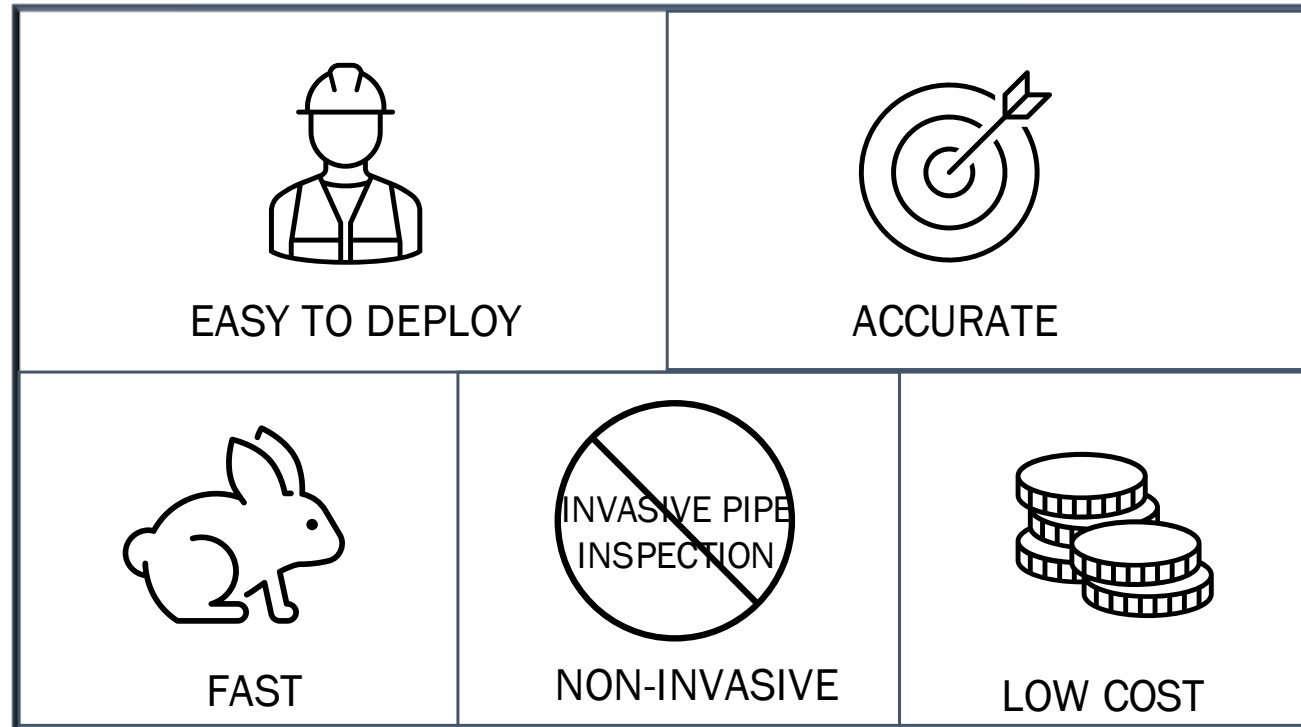
Skill (labor, technical interpretation)

.....

Property owner/tenant disruption (water service interruption, property damage, participation)

.....

Disturbance (service line, traffic flow)



Mueller's PipeScreen Service Line Analyzer

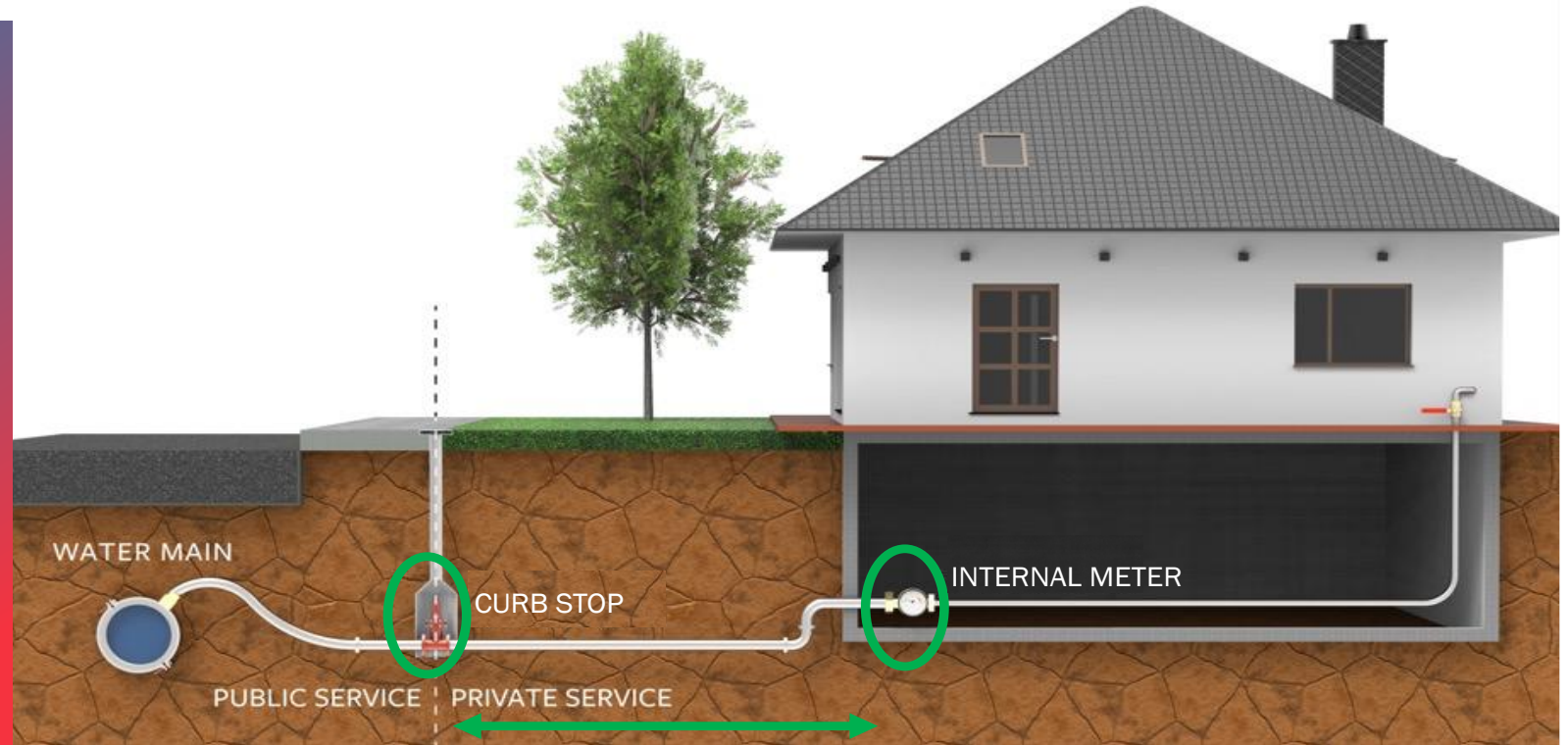
TM

BENEFITS

- No digging
- Non-invasive
- Fast & simple

FEATURES

- Robust signal processing
- Digital data management
- Validated dataset
- Scalable license-model²
- Self-service or partner-delivered



FIELD OPERATIONS TEAM PLACES SENSORS



LSL INSPECTION RESULTS

Note¹ - LSL Screening Method will not identify lead joints, solder, or other lead components along a pipeline. Sentryx results describe dominant pipe material type, not reporting classification.

Note² - Minimal purchase criteria must be met by utility

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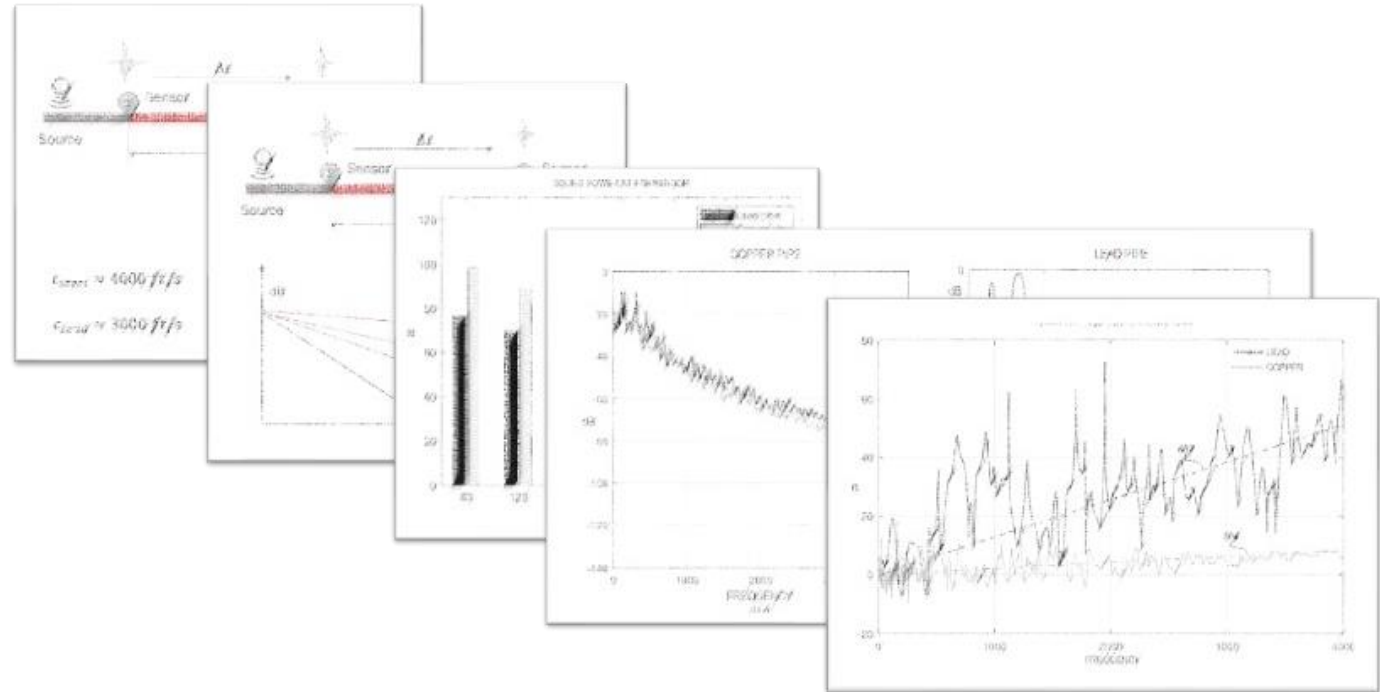
How it works

Applied scientific approach

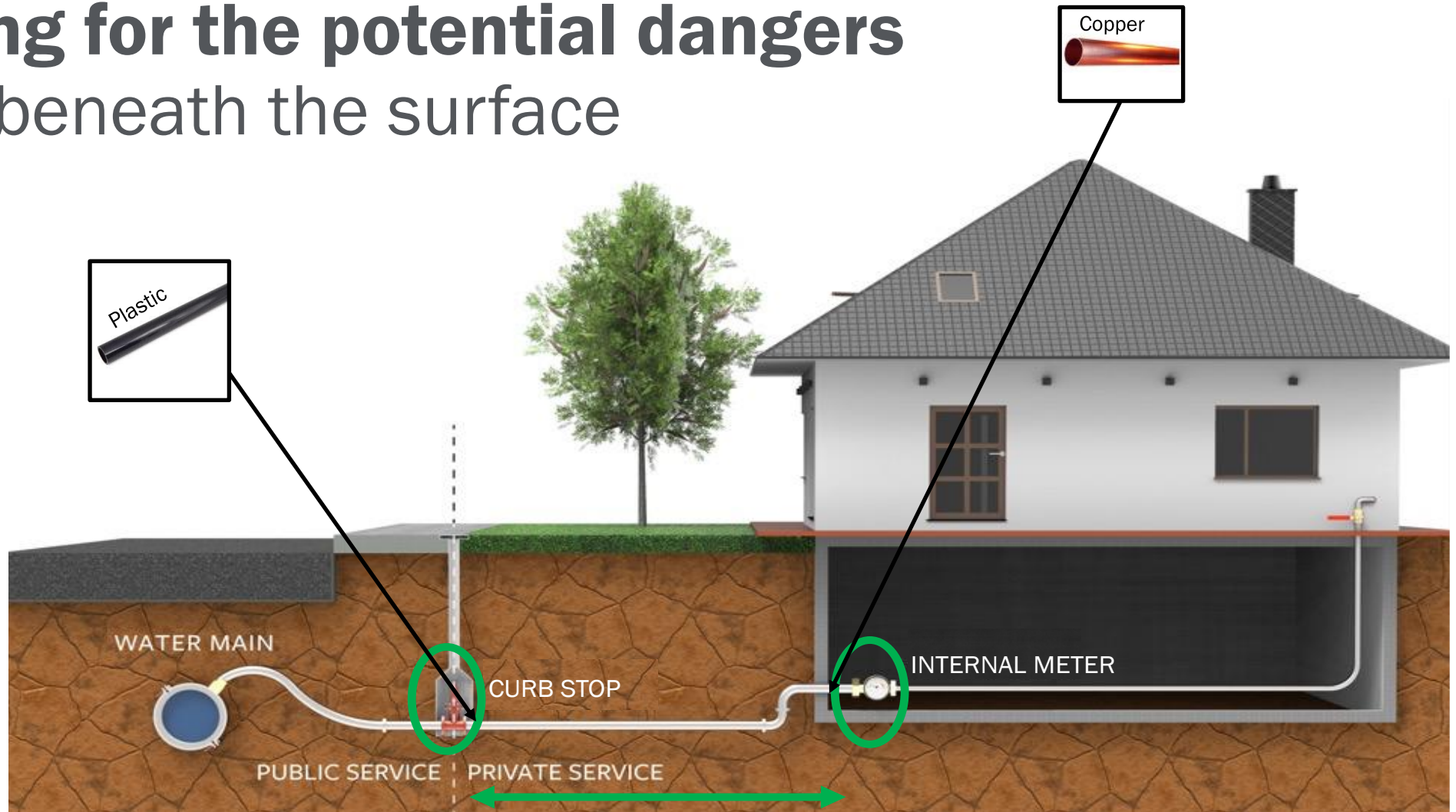
Extract features from sampled sound profile

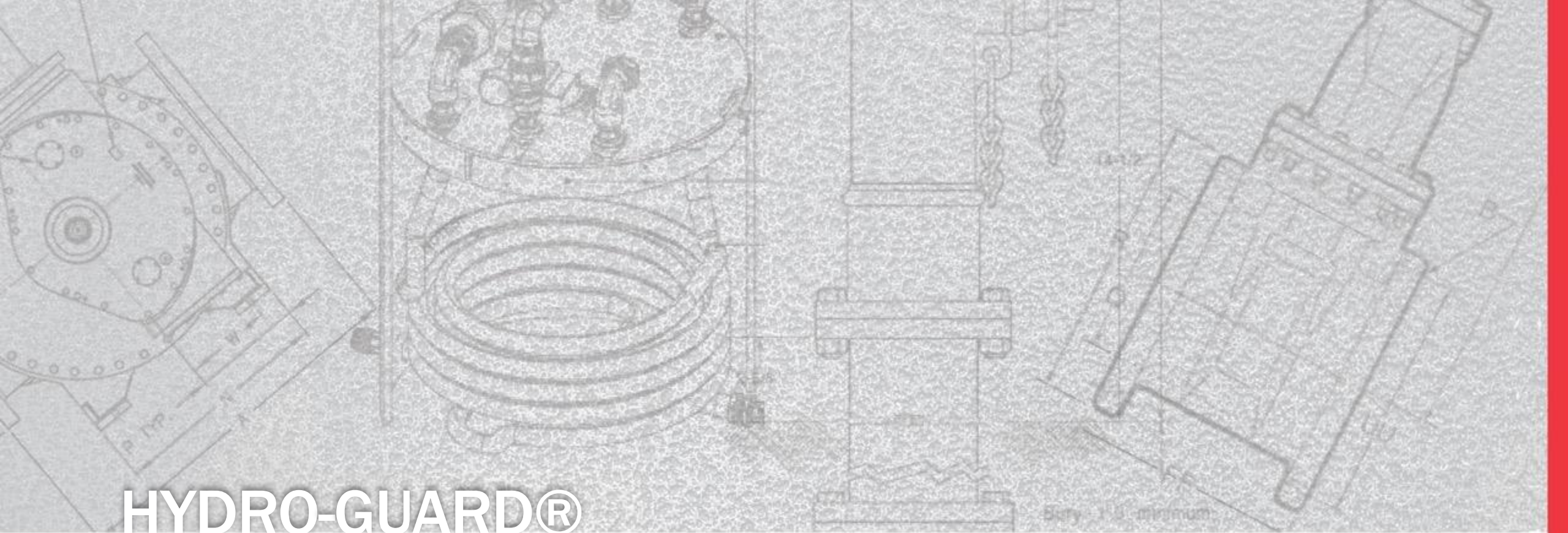
Evaluate each feature and assign a material classification

Compare multiple classifications to reinforce or reject findings



Listening for the potential dangers that lie beneath the surface





HYDRO-GUARD®

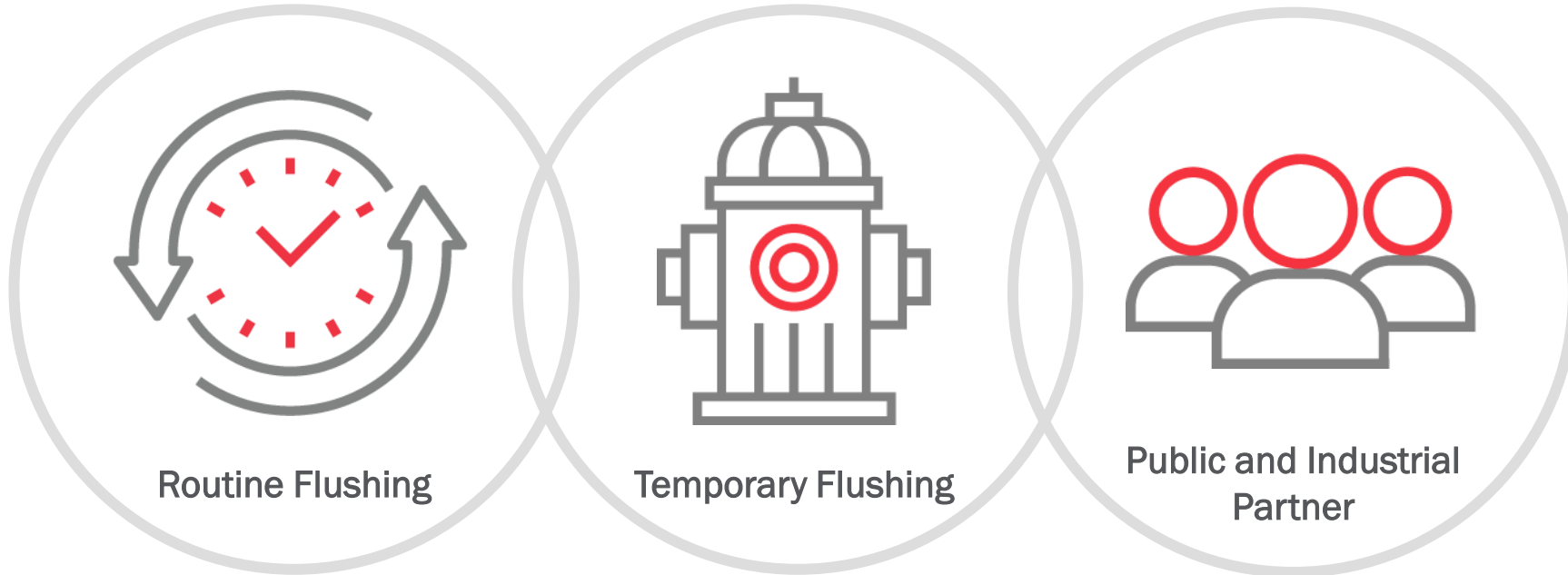
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Why Not Rely on a Hydrant to Flush a Water Line?

- Impossible to correct conditions and maintain quality control
 - Crews cannot attend to a hydrant enough to solve a significant water quality condition by use of a hydrant
- Inefficient
 - Crews often over flush from a hydrant
 - Results in higher volumes than necessary being used and lost revenue
 - Wastes crew time and impacts the bottom line...costs associated with crew time
- Damage to hydrant
 - Overuse, or misuse, of hydrant can lead to damage to nozzles and other components of the hydrant



Identifying Your Flushing Needs



Routine Flushing

Temporary Flushing

Public and Industrial
Partner

Why are you flushing?

- Where are the sites in your system that costs you the most crew time?
- Are you flushing to reduce water age?
- Are you flushing to maintain quality standards, or to remove sediment?
- Are you concerned about quality at key industrial, educational, research, military, or health care customer locations?

Common Automated Flushing Deployments



Residential Dead-Ends/
Rural Communities



Seasonal/Oversized Lines



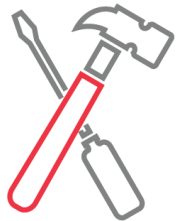
Remote/Restricted Areas



Industrial Parks

Finding the Right Device – Semi-Permanent Automatic Flushing

Select the Right Product for the Right Location so that it can operate at the Right Time in the Right Way.



Installation Site Considerations



Community Concerns



Physical and Data Security

Installation Site & Community Requirements

Where does your utility needs fall on the spectrum?

Discharge to Ground

- Secure, stable and critter resistant
- Simple programming

Direct Discharge

- Water conservation limited visibility to general public
- Erosion concerns
- Surface water freezing hazards

Below Ground

- Above grade is not viable (snowplows, etc.)
- Non-intrusive structure/ Community sensitivity
- Security concealment

LOW

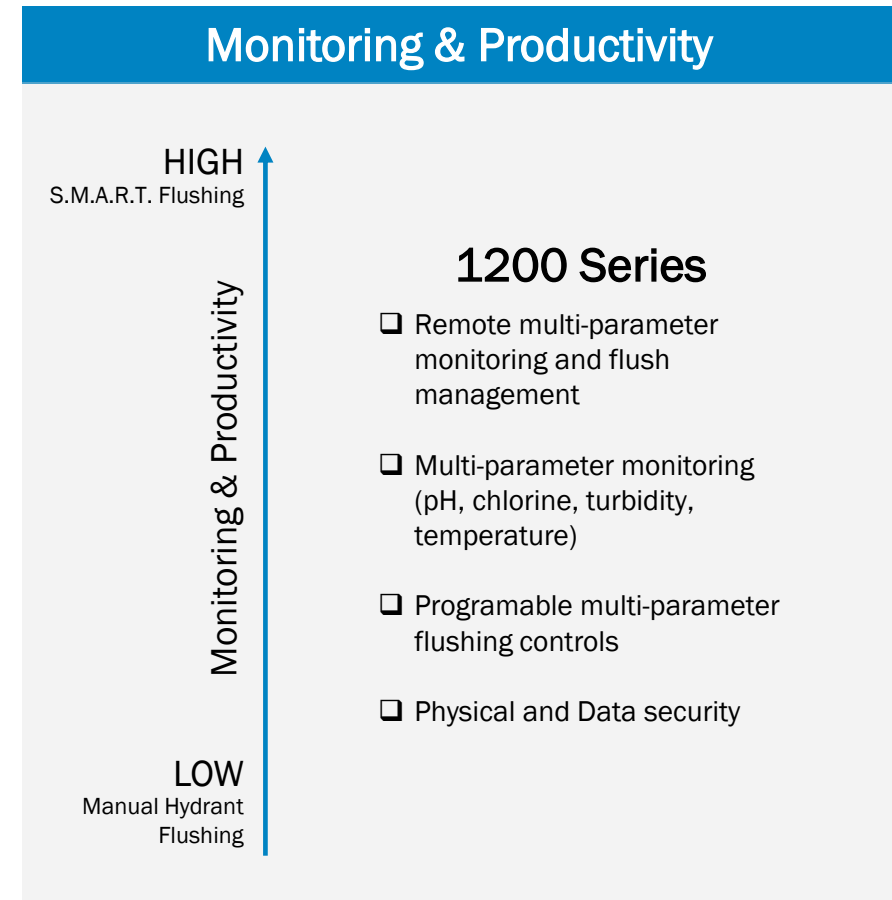
Installation Site & Community Requirements

HIGH

Finding the Right Device – S.M.A.R.T. Automatic Flushing

Get S.M.A.R.T. when standard automatic flushing does not address your most problematic areas.

- Ideal for most challenging points in water distribution network
- Typical installation site:
 - Consecutive and supply partners
 - High water demand variations
 - Long distribution runs
 - Limited access locations
- Event-based and time-based flushing
- Secure remote monitoring is desirable
 - Verizon and AT&T Cellular retrofit kits available
 - Hydro-Guard Flushing Application for easy configuration
 - SCADA compatibility for advanced integrations

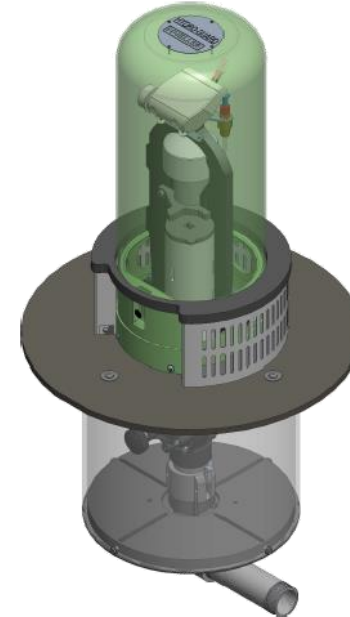


100 Series

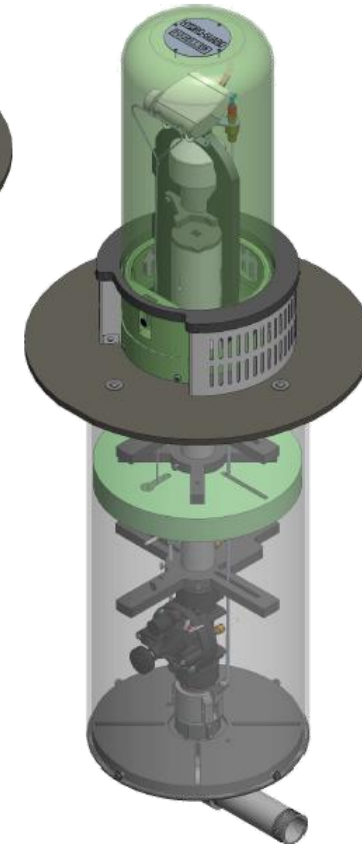
Ideal for areas in the distribution network where it is difficult to maintain water quality, disinfectant residual, and where customer complaints are numerous.

FEATURES

- 100 Series Warm Climate
 - Available Bury Depth: 18-inches
 - CamLock release for ease of maintenance and accessibility
- 100 Series Cold Climate
 - Available Bury Depths: 18-inches, 36-inches, 60-inches, 84-inches, and 108-inches
 - Removable internal assembly for ease of maintenance; patented CamLock release system with insulation to hold ground heat
 - Integrated freeze protection system allows all water in service piping to drain from device to prevent freezing
- Above ground design with below-grade base for stability
- Schedule 80 PVC piping with option for no-lead Brass piping
- Flush up to 24 times per day with durations of one (1) minute to six (6) hours per event
- Bluetooth controller (managed by free app) or NODE onsite programming
- OEM-installed Dichlorination System
- OEM-installed Sampling System
- Diffusing vents dissipate energy while enhancing the system's stability
- Splash plate minimizes erosion from the flushed water being discharged
- 2-inch glass reinforced Nylon composite valve with flow adjustment, full port, and single piece EPDM diaphragm
- Air Gap backflow prevention
- Low profile, lockable, pedestal enclosure



100 Series Warm



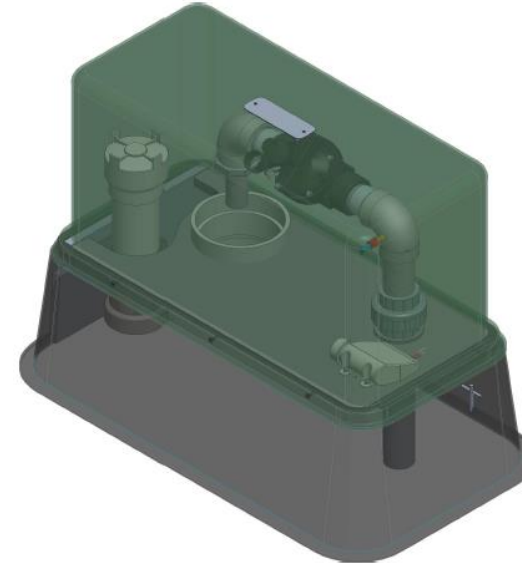
100 Series Cold

200 Series

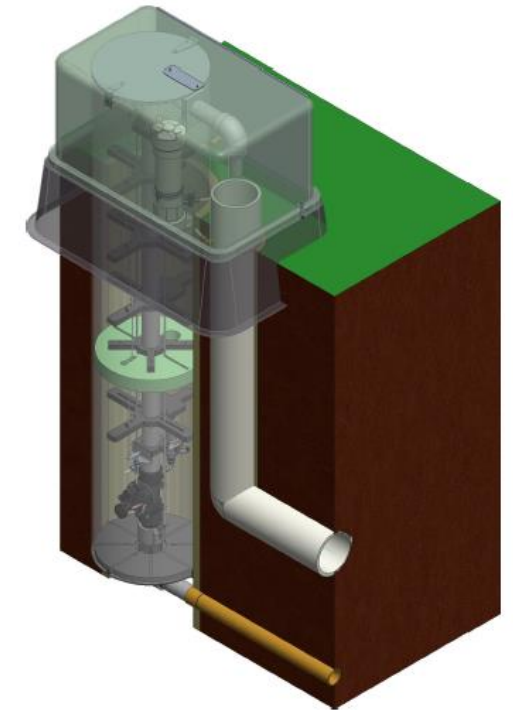
Ideal for clients who prefer to direct their discharged water to a storm sewer or retention facility. With this design, the utility can conduct essential water quality flushing and testing without the visibility of having water flushing to the ground.

FEATURES

- 200 Series Warm Climate
 - Available Bury Depth: 18-inches
 - Standard Air Gap backflow prevention. Optional Reduced Pressure Zone (RPZ) or Double Check Valve (DC) for warm climate models.
 - Low-profile or high-profile design. High-profile design is ideal for flood prone areas.
 - Thermal Control Valve (TCV) freeze protection is optional for moderate climates
- 200 Series Cold Climate
 - Available Bury Depths: 36-inches, 60-inches, 84-inches, and 108-inches
 - Removable internal assembly for ease of maintenance; patented CamLock Release with insulation to hold ground heat
 - Integrated freeze protection system allows water in service piping to drain from device
 - Air Gap backflow prevention
- Optional Pressure Monitoring for the measurement and reporting of critical pressures
- Schedule 80 PVC piping with option for no-lead Brass piping
- Flush up to 24 times per day with durations of one (1) minute to six (6) hours per event
- Bluetooth controller (managed by free app) or NODE onsite programming
- OEM-installed Dichlorination System
- OEM-installed Sampling System
- Accessible from above ground and housed in HDPE quality, lockable, low-profile enclosure



200 Series Warm



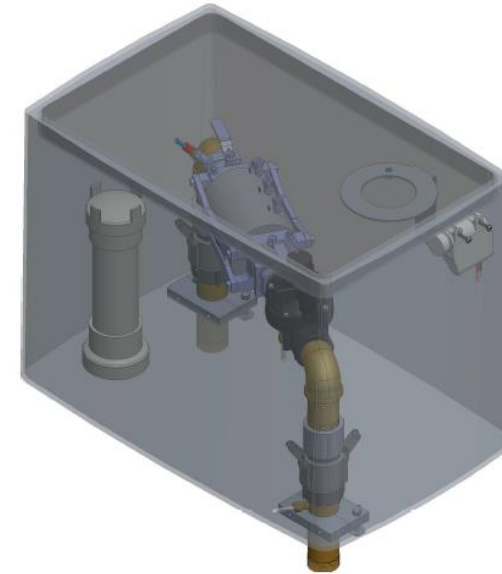
200 Series Cold

300 Series

Ideal for distribution systems with problematic disinfectant residuals or where taste, color or odor issues lead to customer complaints. The below ground design reduces the potential for freeze damage while allowing utilities to enhance water quality by flushing, collecting quality samples from the flushing system, and conducting flushing operations when water quality conditions warrant.

FEATURES

- 300 Series Warm Climate
 - Available Bury Depth: 24-inches
 - 2-inch internal piping assembly with no lead brass
 - Durable DFW meter vault, lockable
 - Wilkins-Zurn DC valve backflow prevention
- 300 Series Cold Climate
 - Available Bury Depths: 48-inches, 60-inches, 84-inches, and 108-inches
 - 1-inch Mueller Thermal Coil Meter Vault no kink coil technology allows all flushing components to rest below frost depths for protection against frost damage.
 - Wilkins-Zurn DC valve backflow prevention
 - Includes a 2-inch-thick insulation pad to help maintain ground heat inside of the vault
- Optional Pressure Monitoring for the measurement and reporting of critical pressures
- Available with choice of 22.75-inch composite or cast lid
- Standard no-lead brass piping
- Flush up to 24 times per day with durations of one (1) minute to six (6) hours per event
- Bluetooth controller (managed by free app) or NODE onsite programming
- Glass reinforced Nylon composite valve with flow adjustment, full port, and single piece EPDM diaphragm
- OEM-installed Dichlorination
- OEM installed Sample Station



300 Series Warm



300 Series Cold

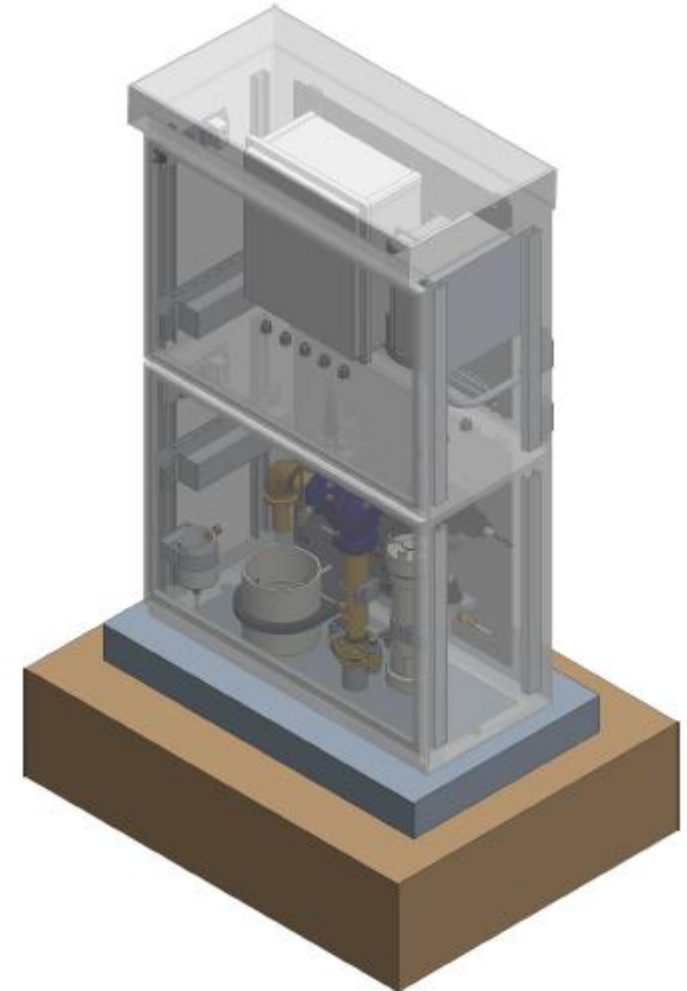
1200 S.M.A.R.T. Flushing

Ideal for the most remote or troublesome points in the distribution network. The 1200 Series S.M.A.R.T. system's advanced technology allows it to monitor conditions, and react to them, to mitigate a condition that is outside of the utility's acceptable range for chlorine (total, free or combined), temperature, pH, turbidity, flow, or pressure.

The 1200 Series S.M.A.R.T. system captures water quality condition data and transmits it back to operators and managers in near-time so that water quality and distribution network maintenance decisions can be made more effectively and efficiently.

FEATURES

- Real-time water quality data management log
- Weather-proof, climate controlled, and lockable protective enclosure, mounting system and weather-proof fittings; multiple access doors for ease of use and maintenance
- Internal piping assembly is comprised of no lead brass piping and a piloted 2" Singer Control Valve with speed control and flow adjustments¹
- Monitoring - Simultaneous monitoring of multiple water quality conditions
- Mitigation - User-defined setting for flushing parameters to mitigate water quality issues
- Data Logging - Data logged incrementally for analysis and trend mapping
- Data transfers by way of cellular networks. Cellular remote upgrade packages optional.
- 120-volt AC power and alternative power compatible
- SCADA Compatible (ModBus-TCP)



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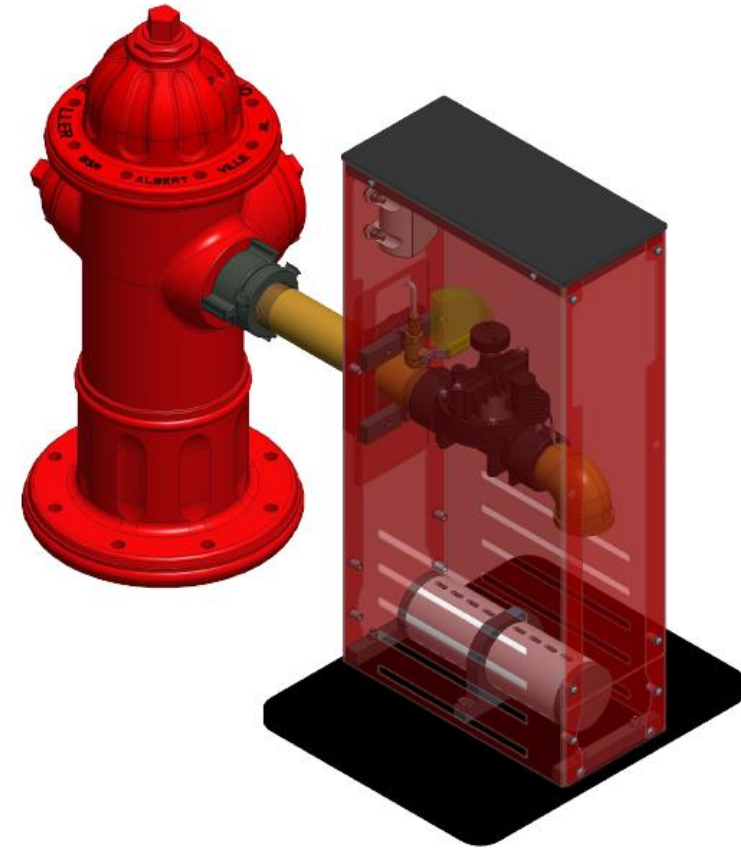
¹ In the event that flow monitoring is requested, a cast valve with an integrated digital flow meter will be utilized.

600 Series

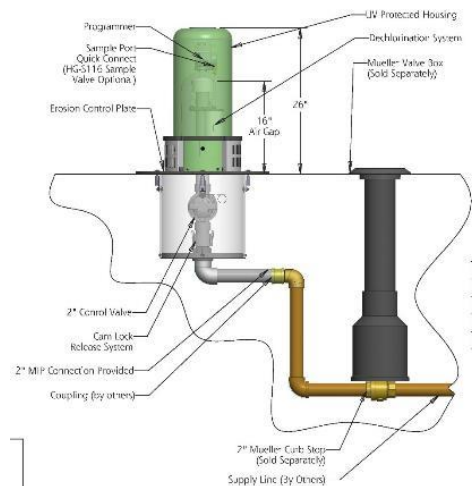
Take automatic and programmable flushing capabilities anywhere in the water distribution system where a fire hydrant is available. The 600 Series system is portable, supports its own weight, and offers height adjustment so it can be connected to the hose nozzle of any brand of fire hydrant and is the perfect solution for temporary or emergency flushing needs.

FEATURES

- Durable, heavy-gauge Stainless Steel construction
 - 2-inch glass reinforced Nylon composite valve with flow adjustment, full port, and single piece EPDM diaphragm
- Sampling Valve (operational with unit on or off)
- Bluetooth controller for flush scheduling
- Flush several times per day with durations of one (1) minute to six (6) hours per event
- 2.5" NTP hydrant swivel adapter
- Security kit
- Air Gap for backflow prevention
- OEM-installed Dechlorination System
- Venting and splash plate minimize the potential for ground erosion
- Unit weight – 60 lbs.



Typical Requirements of Ownership



Installation:

- With a tapping saddle and corporation stop, install a 2-inch tap in the distribution main.
- Install an isolation valve / curb stop and meter if desired.
- Using the 2-inch NPT thread on the inlet side of the Hydro-Guard[®] product, couple the Hydro-Guard product to the service line.

Maintenance:

- 9-volt Battery – change once per year
- Fill Decoloration System with 3-inch Ascorbic Acid / Vitamin C tablets; every 84,000 gallons flushed

Devices to Address Your Flushing Needs

Reduce fuel cost, time and money with Automatic Flushing and S.M.A.R.T. flushing devices in your distribution network.

- Unique designs for cold and warm climate application
- NSF/ANSI 372 Certified – USEPA SWDA Lead Free
- Dechlorination tablet dosing system for environmentally safe discharge
- Easy to program schedules (multi-times per day, multi-day, up to 24-hr flushing time)
- Up to 120 PSI
- Battery powered and convenient Bluetooth smartphone control for Hydro-Guard 100, 200, and 300 Series Automatic Flushers

Are you flushing high-pressure water lines (>120PSI)?

No Problem.

Install Singer PRV upstream of flushing unit

Do you have a trouble point that you flush more than 1x per month?