Using Data Analytics to Make Informed Water Infrastructure Maintenance Decisions

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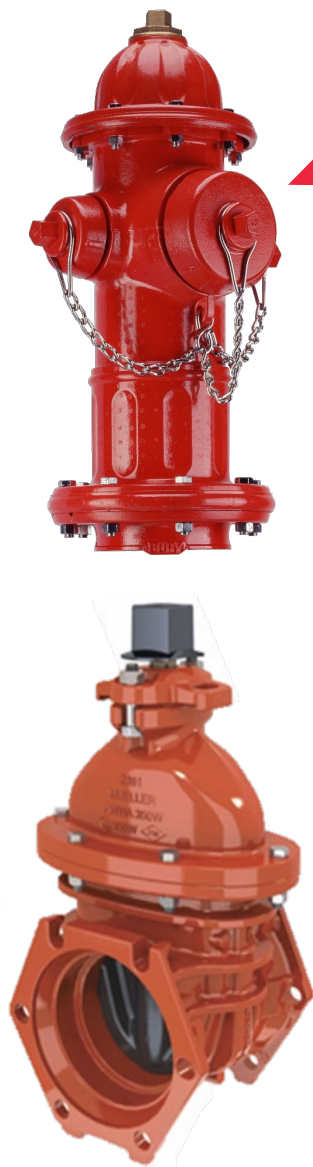(406) 223-2192

muthe@muellerwp.com

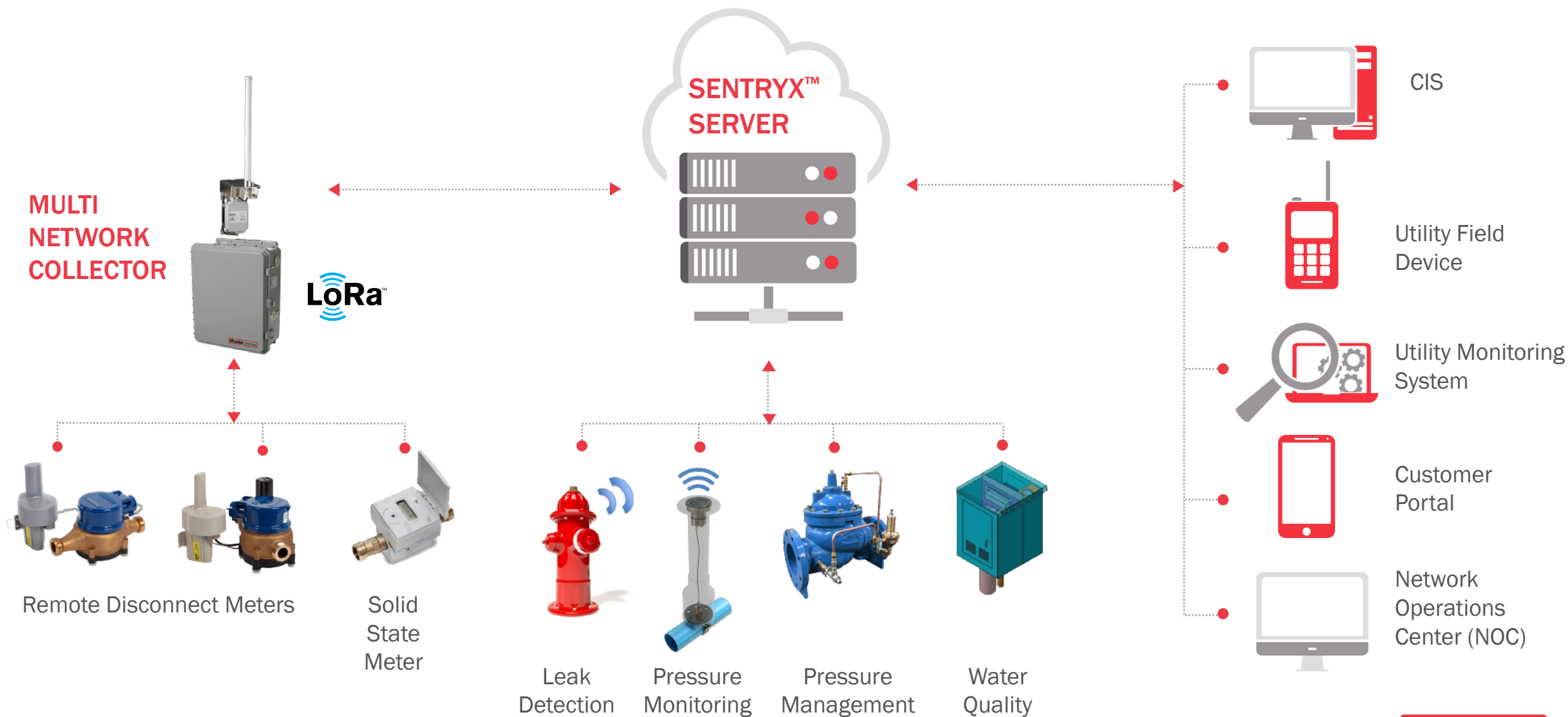# Future State: Imagine Your Assets... Smarter

Sentryx Software

- The utility's single platform for monitoring the health of their distribution system
  - Leak detection
  - Pressure management
  - Water quality
  - Remote disconnect
  - Metering data
- Graphical and intuitive web-based interface
- System health monitored by the Network Operations Center

Mueller® Smart Water Infrastructure Network

SENTRYX™ SERVER

MULTI NETWORK COLLECTOR

LoRa™

Remote Disconnect Meters

Solid State Meter

Leak Detection

Pressure Monitoring

Pressure Management

Water Quality

CIS

Utility Field Device

Utility Monitoring System

Customer Portal

Network Operations Center (NOC)

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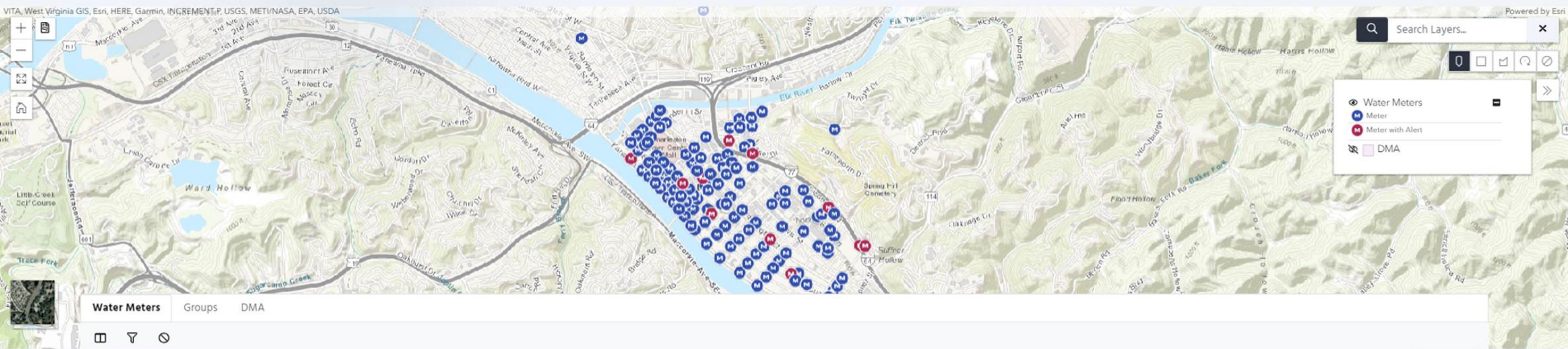# NOC Managed Services with Sentryx Platform

Network Operations Center

- Secure, safe, redundant storage
- 24/7 network and intrusion monitoring
- Time and cost savings
- Quick and reliable access to data
- No need for in-house servers and infrastructure
- No worries about upgrades

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ADVANCED METERING INFRASTRUCTURE (AMI)

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Water Meters   Groups   DMA

0 Nodes Selected   On Demand Read ▾   ⬇ Export

	Account ID	Last Read	Last Read Date ↓	Alerts	Route Number	Service Address	City	State	Device ID
☐	**1053**	97,847	10/23/2019 00:00	N	0002	651 Upland St.	Charleston	WV	410003700
☐	**1054**	156,747	10/23/2019 00:00	N	0003	141 Shade Ln.	Charleston	WV	410003800
☐	**1055**	112,756	10/23/2019 00:00	N	0003	640 Morningside St.	Charleston	WV	410003900
☐	**1056**	37,088	10/23/2019 00:00	N	0003	237 Woodbury St.	Charleston	WV	410004000
☐	**1057**	115,563	10/23/2019 00:00	N	0003	8217 Highgate St.	Charleston	WV	410004100
☐	**1058**	192,721	10/23/2019 00:00	N	0003	5213 Woodledge St.	Charleston	WV	410004200
☐	**1059**	191,937	10/23/2019 00:00	N	0003	231 Woodridge St.	Charleston	WV	410004300
☐	**1060**	190,039	10/23/2019 00:00	N	0003	6091 Hillcrest St.	Charleston	WV	410004400
☐	**1061**	108,998	10/23/2019 00:00	N	0003	571 1st St.	Charleston	WV	410004500
☐	**1062**	124,800	10/23/2019 00:00	N	0003	9182 2nd St.	Charleston	WV	410004600

Security Features

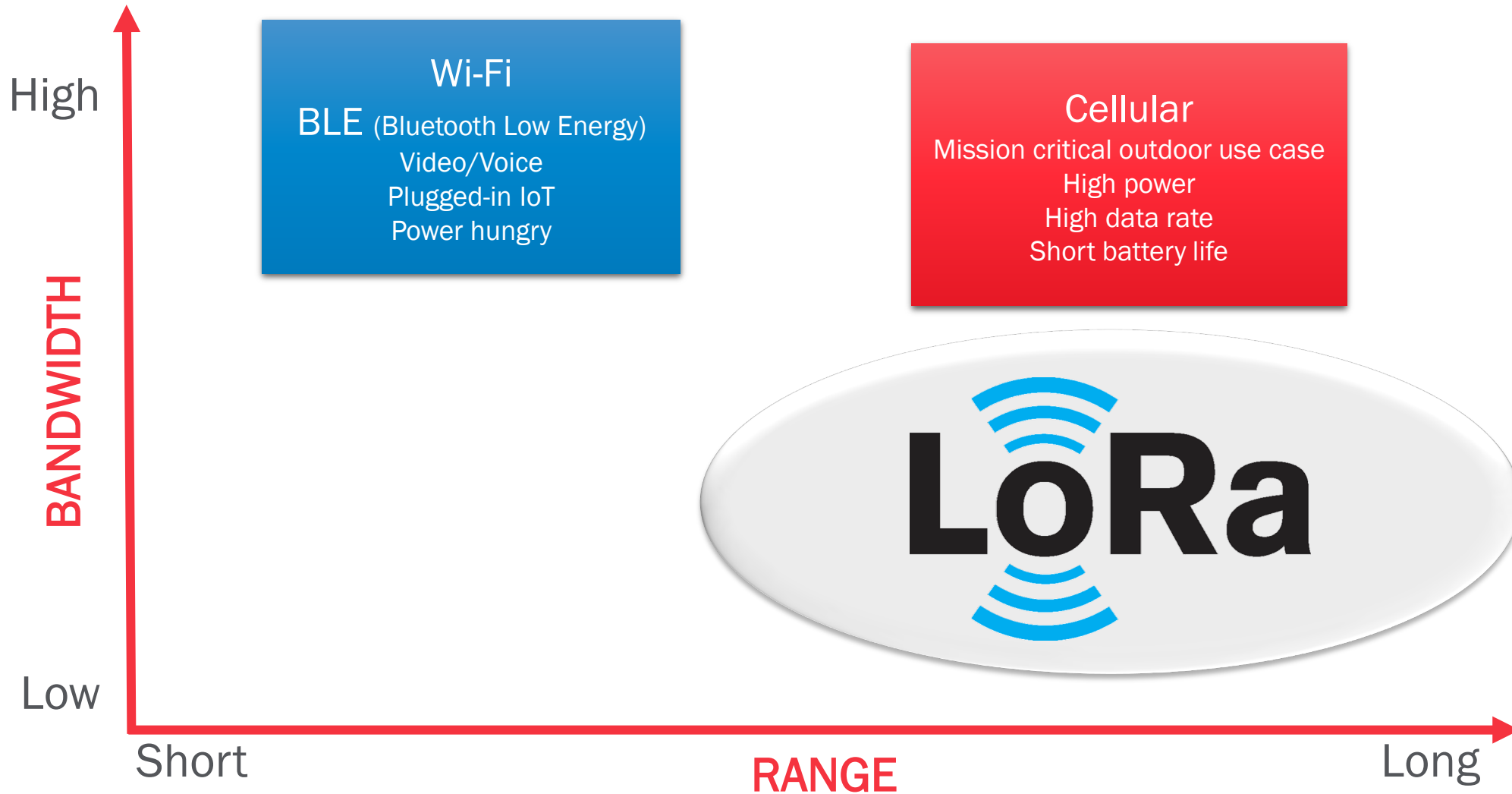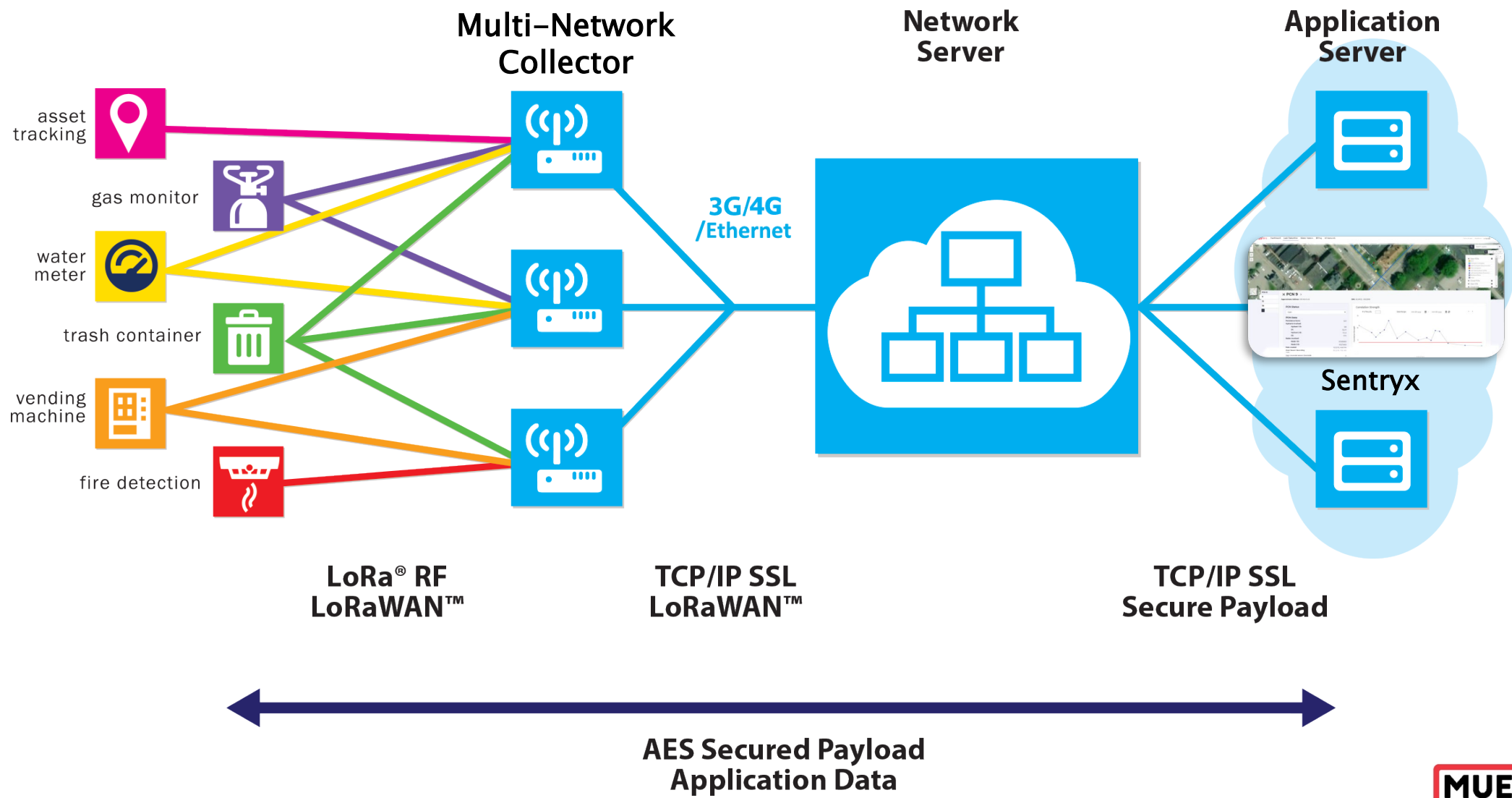|	
All system communications are encrypted	Prevents tampering with, or intercepting, meter data
Unique encryption keys for each Node	Hacking one Node does not permit access to any other Nodes
Each remote disconnect message is re-authenticated	Cannot copy a command to issue disconnect messages to other Nodes
Firmware upgrades are digitally signed	Attackers cannot deploy malicious firmware on Nodes

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Modulation

Smart City Diagram

Multi-Network Collector

Network Server

Application Server

asset tracking

gas monitor

water meter

trash container

vending machine

fire detection

3G/4G /Ethernet

Sentryx

LoRa® RF
LoRaWAN™

TCP/IP SSL
LoRaWAN™

TCP/IP SSL
Secure Payload

AES Secured Payload
Application Data

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Remote Disconnect

- Turn off/on a Remote Disconnect Valve in 15-30 seconds (phone call window)

- Exponentially improves ROI for AMI

- Compassionate scheduling

- Over 4 million field actuations since 2013

Mueller's 420 RDM

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High Speed Patented "Wake-on-Demand" Technology

- Every 3 seconds the Mi.Net node looks for a 2-way request

- The Mi.Hub sends multiple requests on different channels to ensure the node hears the on-demand request

- This guarantees a valve activation or on-demand read within seconds

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WATER QUALITY MONITORING

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Device Data

Status:

Device State: Active

Power Mode: Off

Commission Date: 07/29/2016

Pressure

Status: Normal
Last Reading: 98.4 psi
Reading Time: 10/23/2019 02:00
Alarm Log Type: AvgMinMax

Pressure

— min — trn — max — avg — critical — warning

10/16/2019 🗓 - 10/23/2019 🗓
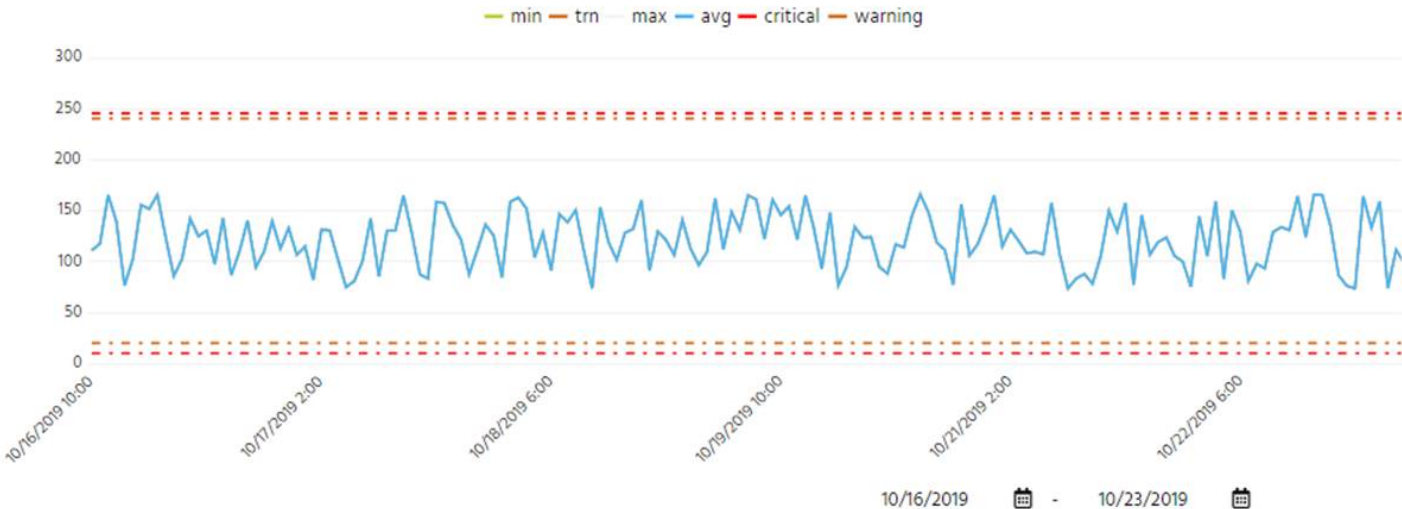
Water Quality

Chlorine

Status: Normal
Last Reading: 1.5 ppm
Reading Time: 06/04/2019 16:48
Alarm Log Type: AvgMinMax

Temperature

Status: Normal
Last Reading: 48.0 °F
Reading Time: 06/04/2019 16:48
Alarm Log Type: AvgMinMax

Turbidity

Status: Normal
Last Reading: 0.5 ntu
Reading Time: 06/04/2019 16:48
Alarm Log Type: AvgMinMax

pH

**Status:** Normal
Last Reading: 8.0 pH
Reading Time: 06/04/2019 16:48
Alarm Log Type: AvgMinMax
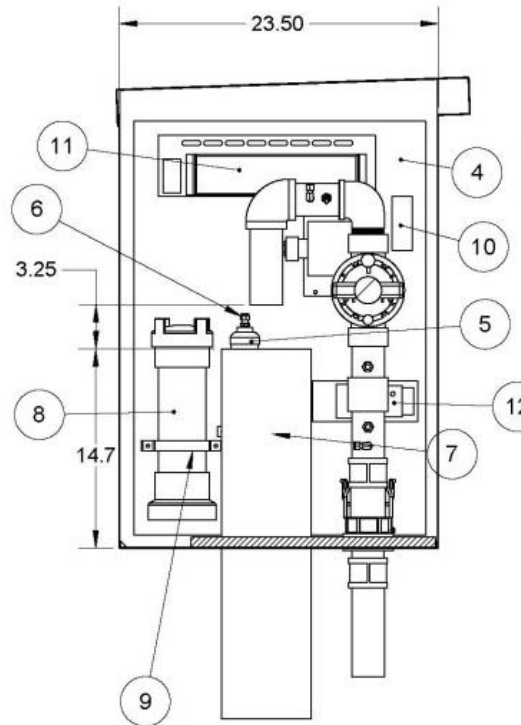
S.M.A.R.T. Flushing Systems

- Capable of Monitoring a Wide Range of Water Quality Conditions…
  - Chlorine (Free or Total)
  - Temperature
  - pH
  - Turbidity
  - Flow
  - Pressure
  - Total Organic Compounds
- Automatically Initiates a Flush Event to Mitigate Poor Water Quality Conditions
- Allows for Two Way Communication
- SCADA Compatible
- Capable of Sending Event Notifications
- Ideal for Remote Locations or Trouble Points in a Distribution System

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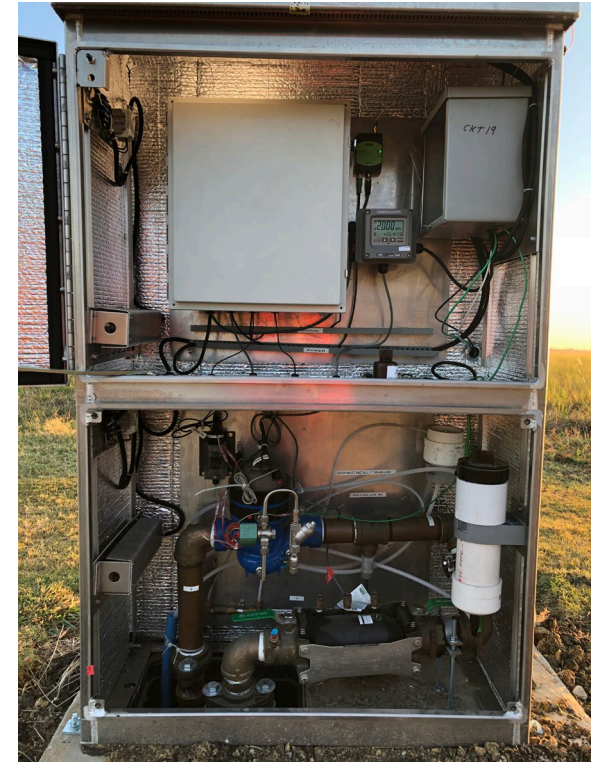
SMART Flushing

SMART

- 10-Flush Events
- Duration: 1 min. to 24 hours / event
- Programming interface remains in flushing system
- Monitors water quality 24/7
- MAX runtime management
- MIN off-time management
- Flexible communication platform

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Operations

Manual Flush

Man | Auto

Flush Solenoid

Time Flushing Progam(s)

Program	Enabled	Active
Program #1	✓	
Program #2	✓	
Program #3	✓	
Program #4	✓	
Program #5	✓	
Program #6	✓	
Program #7	✓	
Program #8	✓	
Program #9	✓	
Program #10	✓	

Sensor Flush Elapsed Time

0   Minutes

Hardware Flush Elapsed Time

0   Minutes

Flushing Off Elapsed Time

0

Flow Meter Totalizer (Gallons)

0

Flow Rate (GPM)

0
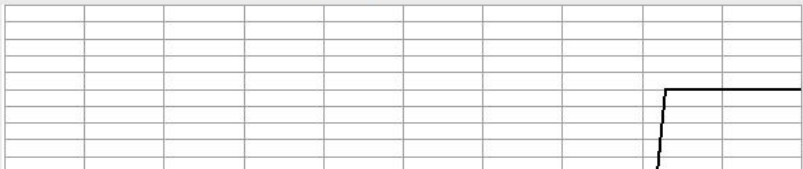
Electrolyte Monitor Elapsed Days

24

Membrane Monitor Elapsed Days

24

Current Date and Time: 2017-04-25 14:07:23

Flush Solenoid Trend

| 2:06:06 PM | 2:06:26 PM | 2:06:46 PM | 2:07:06 PM | 2:07:26 PM | 2:07:46 PM |
| 04/25/2017 | 04/25/2017 | 04/25/2017 | 04/25/2017 | 04/25/2017 | 04/25/2017 |

Manual   Zoom Out   << scroll   < scroll   scroll >   scroll >>   Zoom In

Flush Solenoid

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Configuration

	Analog Input 1	Analog Input 2	Analog Input 3	Analog Input 4
Type	Chlorine Analyzer (Free) - Report Only	Temperature - Report Only	pH Analyzer - Report Only	Turbidity Analyzer - Report Only
Scale Min	0	0	0	15
Scale Max	3	100	14	45
Units	ppm	° C	pH	NTU
Deadband				
Control				

	Digital Input 1	Digital Input 2	Digital Input 3	Digital Input 4
Type	Tamper Switch	No Sensor Connected	Flow Meter	Hardware Manual Flush

Flow Meter Configured	Scada Control
3 Gallons Per Pulse	Disabled

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Monitor

Chlorine Analyzer (Free) - Flush Driving

Scaled Min	0
Scaled Max	3
Units	ppm
Actual	2.9503
Setpoint	2.4

Temperature - Report Only

Scaled Min	0
Scaled Max	100
Units	° C
Actual	18.24

pH Analyzer - Report Only

Scaled Min	0
Scaled Max	14
Units	pH
Actual	8.2316

Turbidity Analyzer - Report Only

Scaled Min	15
Scaled Max	45
Units	NTU
Actual	0.9587

Max Hardware Flush Time
60 Minutes

Max Auto Flush Time
01 Minutes

Flush Off Minimum Time
05 Minutes

Reset Flow Meter Totalizer

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DISTRIBUTION LEAK MONITORING

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Commonwealth of Virginia, Microsoft | Mueller Systems   Powered by Esri

Search Layers...

Open PCNs
⚠ Open
ℹ Echologics Investigation
■ Field Investigation Recommended
⚠ Field Investigation
💧 Leak Awaiting Repair (Utility)
💧 Leak Awaiting Repair (Consumer)
◪ Mechanical Noise
▪ Usage
Closed PCNs
Open CNs
Closed CNs
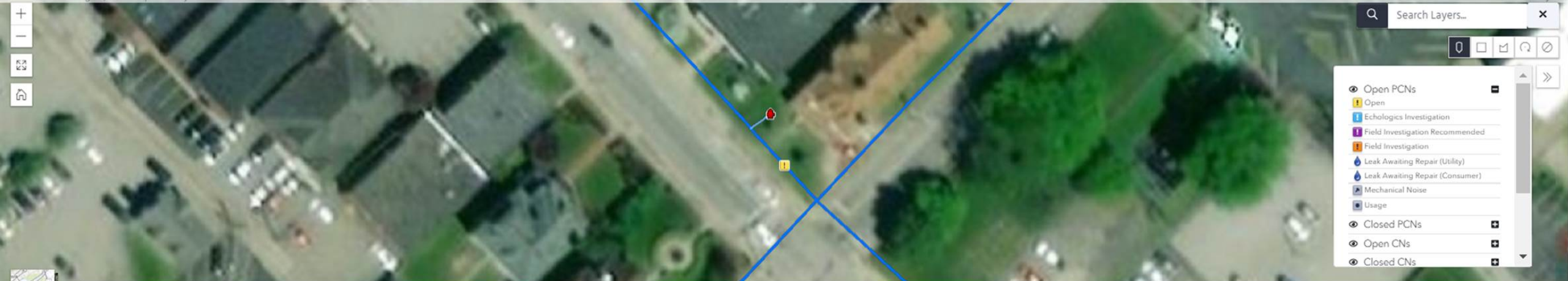
PCN ID
9
13
18

1

✕ PCN 9 ›

Approximate Address: 104 Morris St   **GPS:** 38.34433, -81.62948

PCN Status

Open ▾

PCN Data

Persistence Score:	0.01
Hydrants Involved:	
Hydrant 1 ID:	126
D1:	742 ft
Hydrant 2 ID:	112-A
D2:	17 ft
Nodes Involved:	
Node 1 ID:	101295900
Node 2 ID:	101273400
Date created:	10/21/19, 4:40 PM
Most Recent Recording Date:	10/23/19, 7:00 AM
Days recorded above threshold:	18

Correlation Strength

of Results: [   ]   Date Range: mm-dd-yyyy 📅 - mm-dd-yyyy 📅 🔄   ‹ ›

Pipeline Monitoring – What are we looking for?

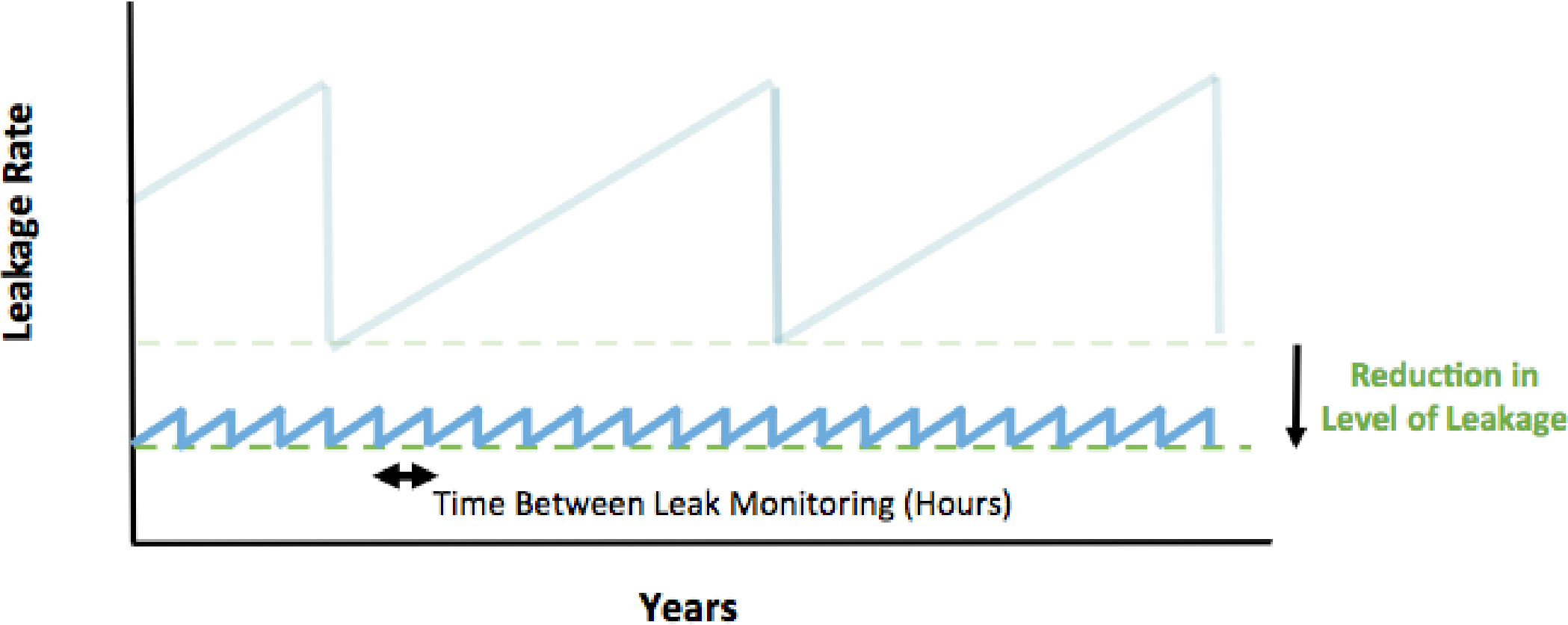Know when this starts.

To avoid having this happen!

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Active Leakage Control
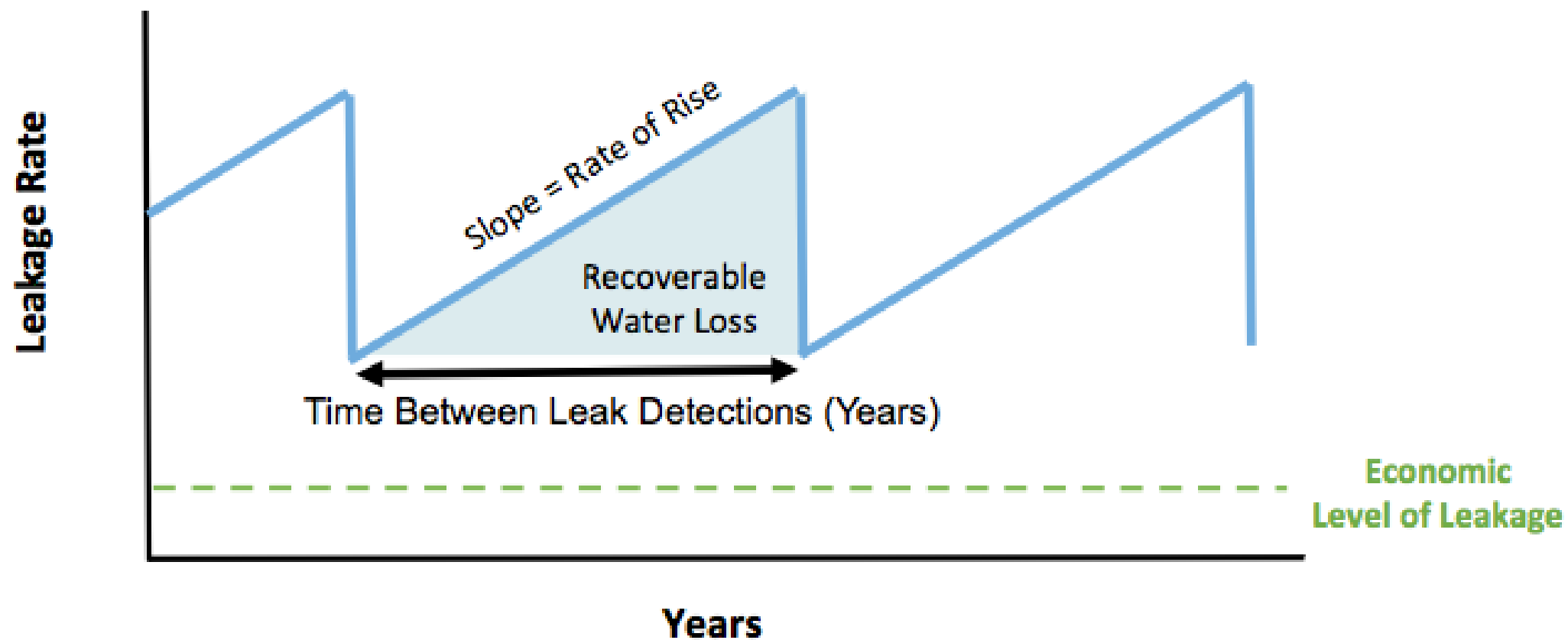
Fixed Leak Monitoring

System Advantages

Design Flexibility
- Detects Leaks on cast iron, ductile iron, steel, asbestos cement and concrete pipe materials.
- Works on Pipe Diameters up to 16" diameter.
- Utilize existing or new fire hydrants of any manufacture

Professional Design & Installation Process
- Installation and Optimal Spacing of Nodes by Echologics.

Automatic Acoustic Analysis
- Leaks automatically correlated by multiple nodes
- Leak Location identified within 6 feet
- Spectral Analysis Range between 50Hz to 1000Hz finds small leaks.
- Reduces False Positives
- Daily Reports – Email or Text

Low Maintenance
- Above Ground Installation
- 5 year Average Battery Life
- 10-year design life
- System Diagnostic Capabilities

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Primary Leak Detection at Hydrant Level

Single Channel Leak Detection:

1. Node collects data over a 2-hr period
2. Node processes the data
3. Nodes determines leak likelihood

Once/day data packet is transmitted to EAM:

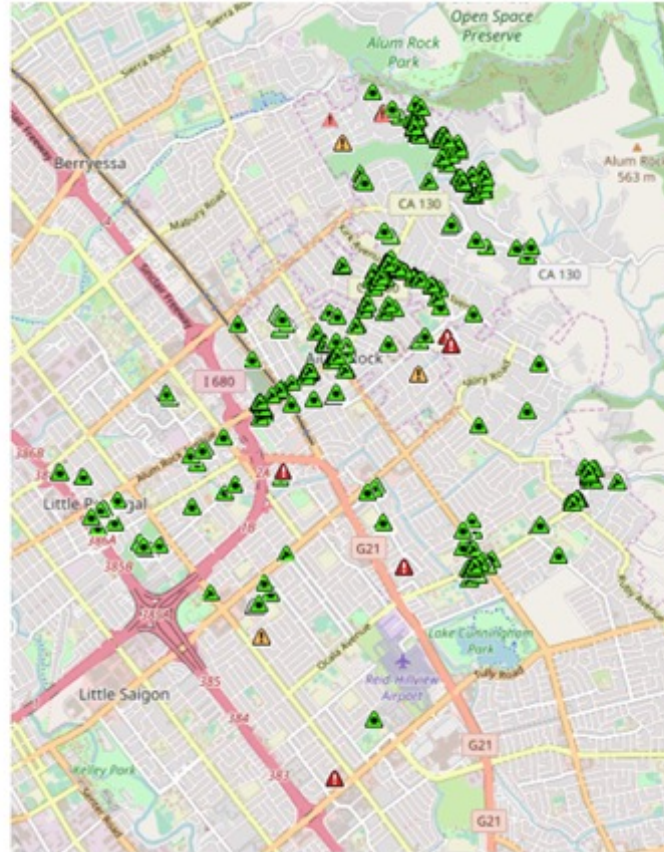- Leak likelihood score
- Node vitals

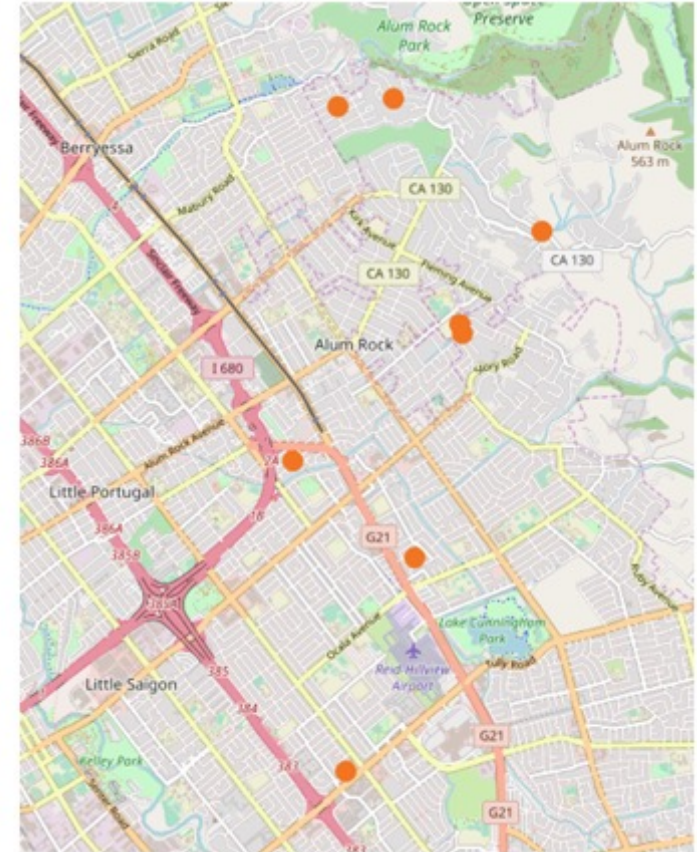Node-level intelligence reduces false positive rate and extends battery life

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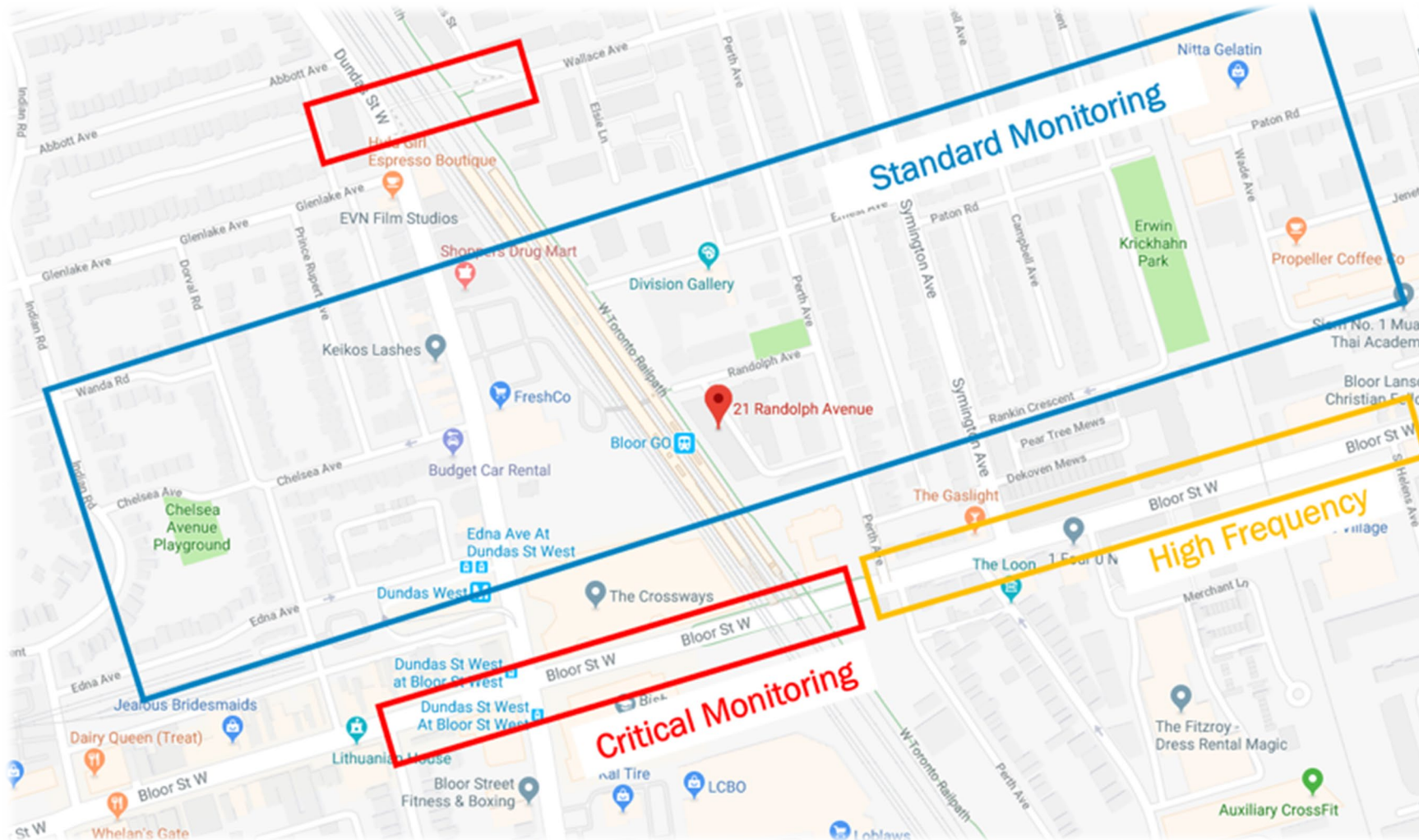# Workforce Efficiency: Delivering Better Insights
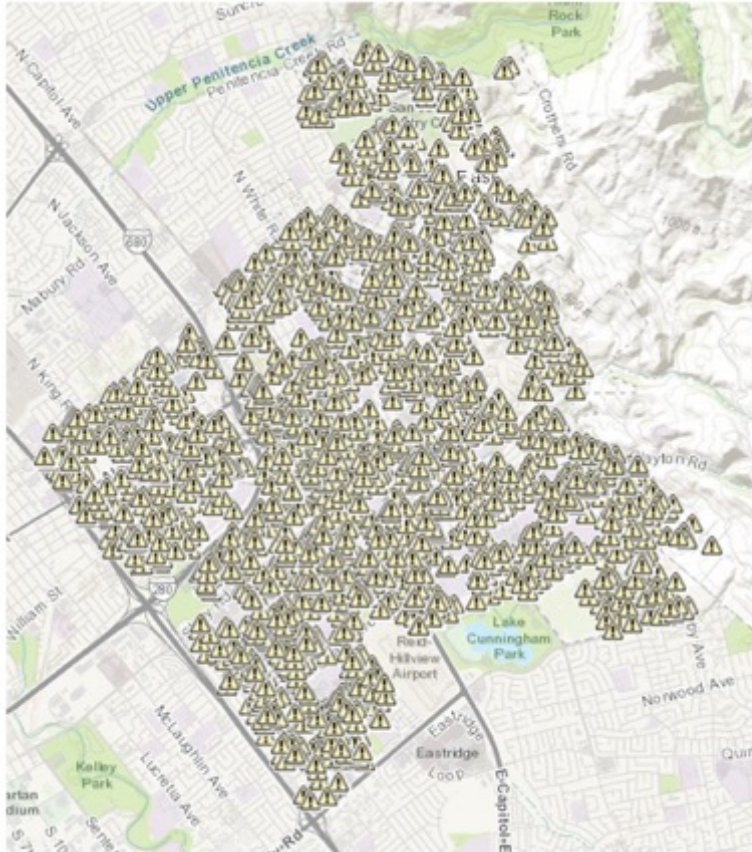
Data
29, 297 Network Noises

Information
555 Persistent Noises

Insight
8 Investigations Recommended

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Short Hills: Actual ROI & Project
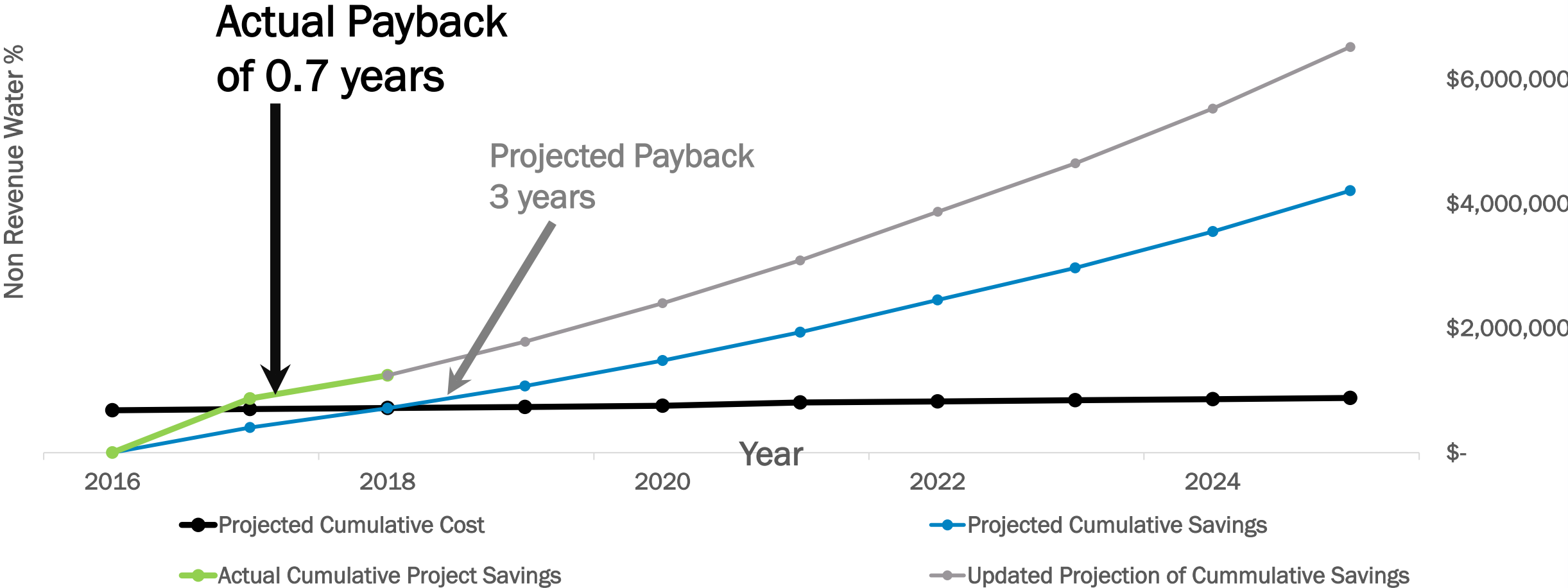
Pumper Nozzles or Side Caps – Adaptable!

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POLL QUESTION 1

PRESSURE MONITORING

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VITA, West Virginia GIS, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA | Mueller Systems | Powered by Esri

Search Layers...

Water Quality
- Remote Pressure Monitor
- Hydro-Guard®

Open PCNs
- Open
- Echologics Investigation
- Field Investigation Recommended
- Field Investigation
- Leak Awaiting Repair (Utility)
- Leak Awaiting Repair (Consumer)
- Mechanical Noise
- Usage

Pressure and Quality | LD-Nodes

Export ▼

Device ID	GPS	Device Type	Description	Status
1156	38.34924, -81.62398	Hydro-Guard®	RTU 29	
1018	38.34575, -81.63346	Remote Pressure Monitor	Valley/Diamond	
1155	38.34861, -81.6175	Remote Pressure Monitor	Demo RTU(Ken)	
1033	38.34957, -81.63462	Remote Pressure Monitor	Harper/Randall	
56	38.34679, -81.62471	Remote Pressure Monitor	East Side Utilities	
1020	38.34307, -81.61539	Remote Pressure Monitor	RTU 11	
1027	38.34117, -81.62604	Remote Pressure Monitor	RTU 10	
1028	38.34361, -81.62792	Remote Pressure Monitor	RTU 9	
1	38.3431, -81.62638	Hydro-Guard®	device 6	Cl pH
1030	38.34477, -81.62943	Remote Pressure Monitor	Crags/Berkeley	

|◄ ◄ ► ►| 10 ▼ items per page   0 - 0 of 0 items

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Sentryx™ Software Enabled Super Centurion® Hydrant

The communications hub for your water distribution system.

The Sentryx software enabled Super Centurion hydrant brings together the infrastructure platform you trust with the data intelligence to make informed, actionable decisions. Leveraging Industrial IoT, powerful mapping and data visualizations as well as advanced analytics, you'll be able to understand the performance of your distribution system like never before.

SENTRYX Software Enabled SUPER CENTURION Hydrant
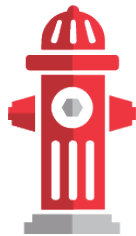
Super Centurion®
The most sold hydrant in North America, trusted and proven, now has become the communication hub and physical architecture, housing advanced sensors.

EchoShore-DX®
EchoShore-DX provides visibility to the presence and location of emerging leaks at key locations in a water network.

Hydro-Guard®
The Hydro-Guard Pressure Monitoring System Sensor is protected, enshrouded within the lower stem, and through porting is able to capture pressure data (while the main valve is closed) from the water in the hydrant shoe and network.

Cellular Communications to Sentryx Software
Gathered sensor data, along with insights are displayed on the Sentryx Water Intelligence Platform.

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Overview – Super Centurion and Sentryx

- Sentryx software enabled Super Centurion Hydrant is configured based on customer specification with EchoShore-DX technology and/or Hydro-Guard solution

- Hydro-Guard Pressure Sensor provides network pressure monitoring with the Main Valve CLOSED, avoiding the Charged hydrant

- Innovative wireless design and engineered components make hydrant installation, operation, repair and maintenance easy

- Available as a new, fire hydrant or as a retrofittable kit

- Retrofit kit supports Mueller 5-1/4" Centurion fire hydrants with bury depths 3'-6" thru 6'-0", manufactured since 1975

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Sentryx Software Enabled Super Centurion Hydrant

Cellular

Bluetooth
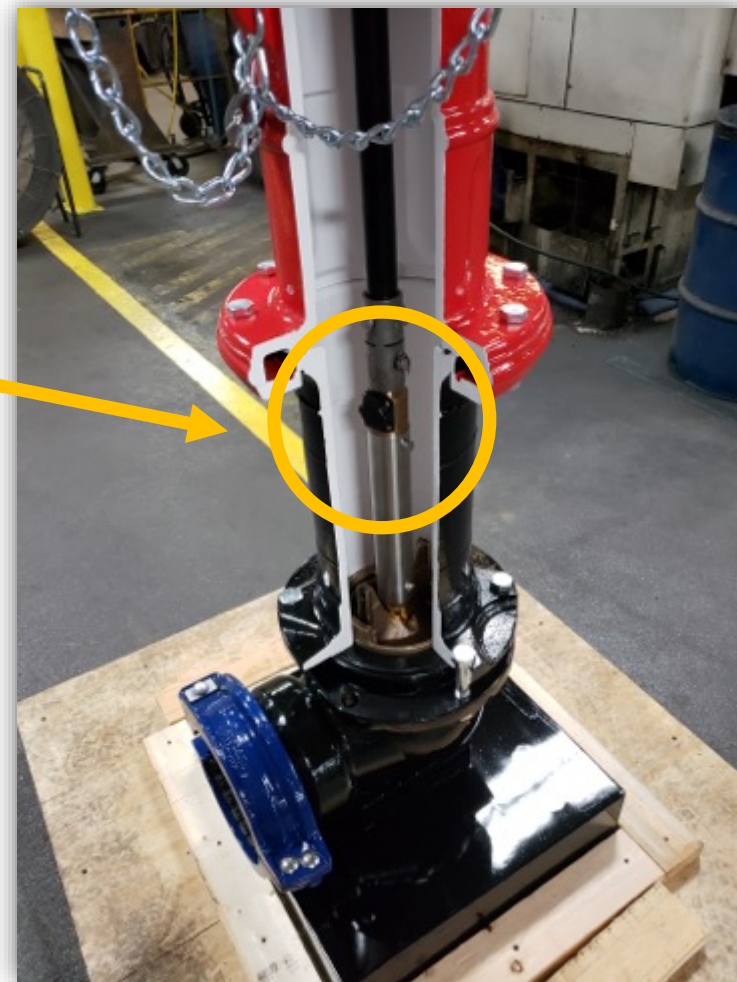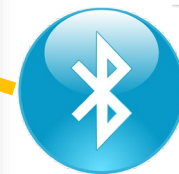
Familiar Centurion:
(Few Unique Parts)

- Bonnet Assembly
- Lower Stem Assembly
- Valve Nut
- Pumper Cap

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Sentryx Software Enabled Super Centurion Hydrant

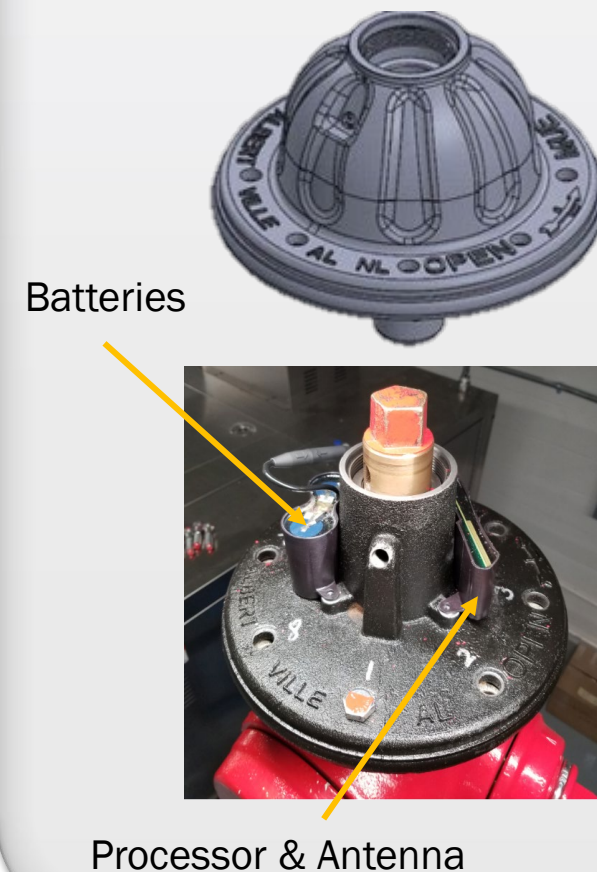## EchoShore-DX Cap
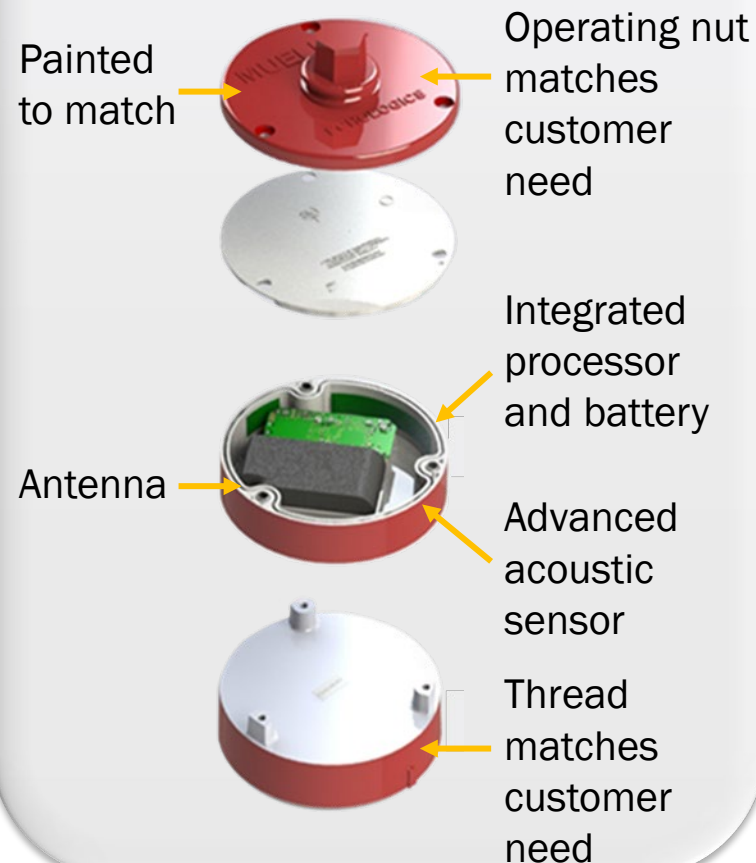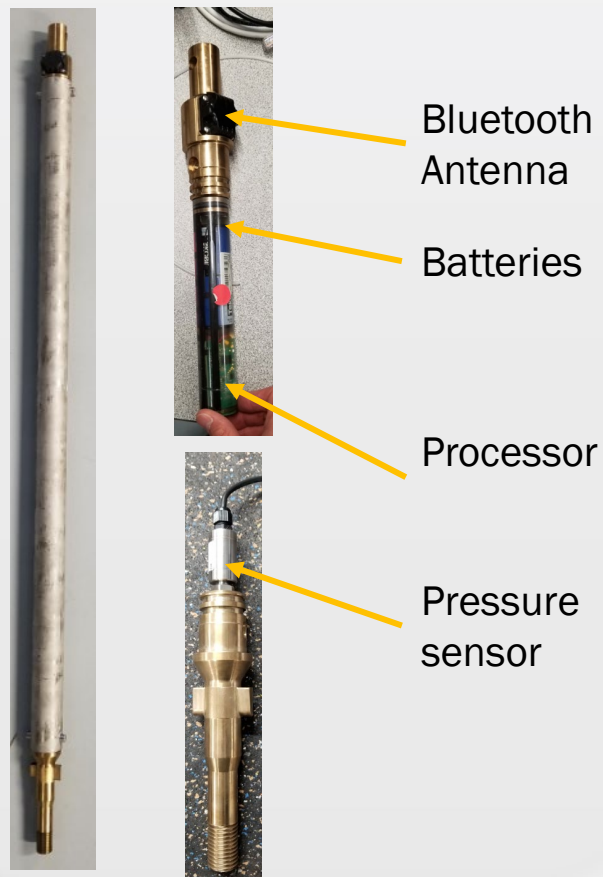
Painted to match

Operating nut matches customer need

Integrated processor and battery

Antenna

Advanced acoustic sensor

Thread matches customer need

Smart Stem

Bluetooth Antenna

Batteries

Processor

Pressure sensor

Smart Bonnet

Batteries

Processor & Antenna

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Pressure Monitoring Systems

Flexible Installation Options:

- Vault – PRV, etc.
- At the Water Tanks
- Air Release Valves
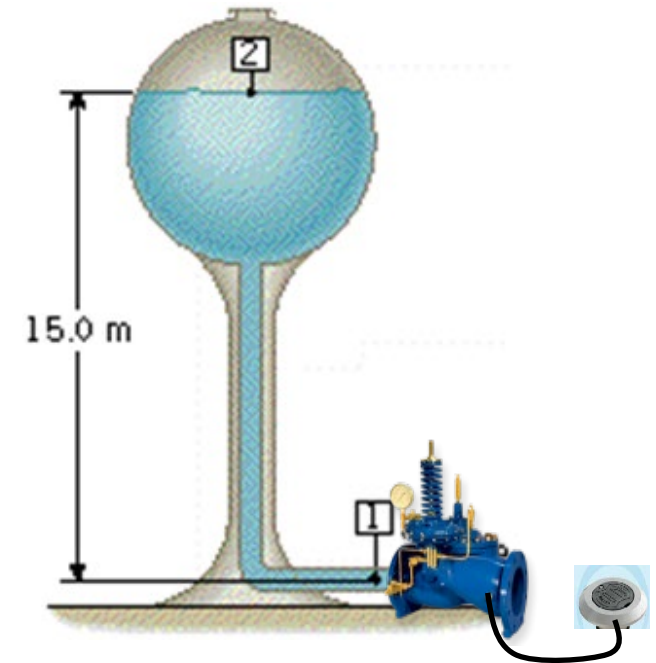
Cellular pressure transmitter installed on a fire reserve tank fill control valve to monitor fire reserve tank level
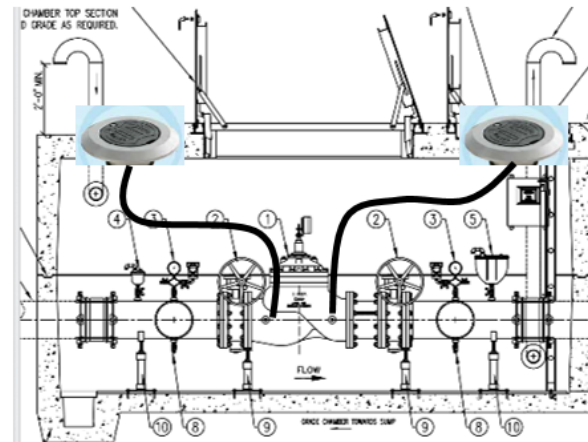
Cellular pressure transmitter installed in top cap of a control valve vault monitor upstream & downstream system pressure

15.0 m

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Pressure Monitoring...**How?** When? Where? **What?** Why?

How can Intelligent Water Technology™ benefit your distribution network?

- Continuous verification of system pressure data anywhere in the distribution network

- Remote data logging and performance analytics

- Near-time condition alerts

- Powered by long-life Lithium battery (~5 years)

- User friendly web interface
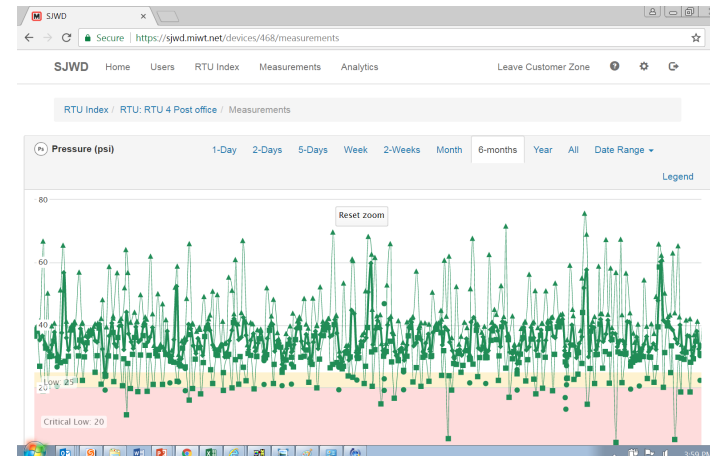
- SCADA compatible with OPC Client protocol

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Pressure Monitoring...How? When? Where? What? Why?

How frequently can Mueller's pressure monitoring system sample pressure?

- Multiple reading options in a "steady state" mode

- In a "transient state" mode the device will sample at rate of 4, 32, or 256 readings per second.

- Observance Mode...Know when pressure differentials are beyond your set points
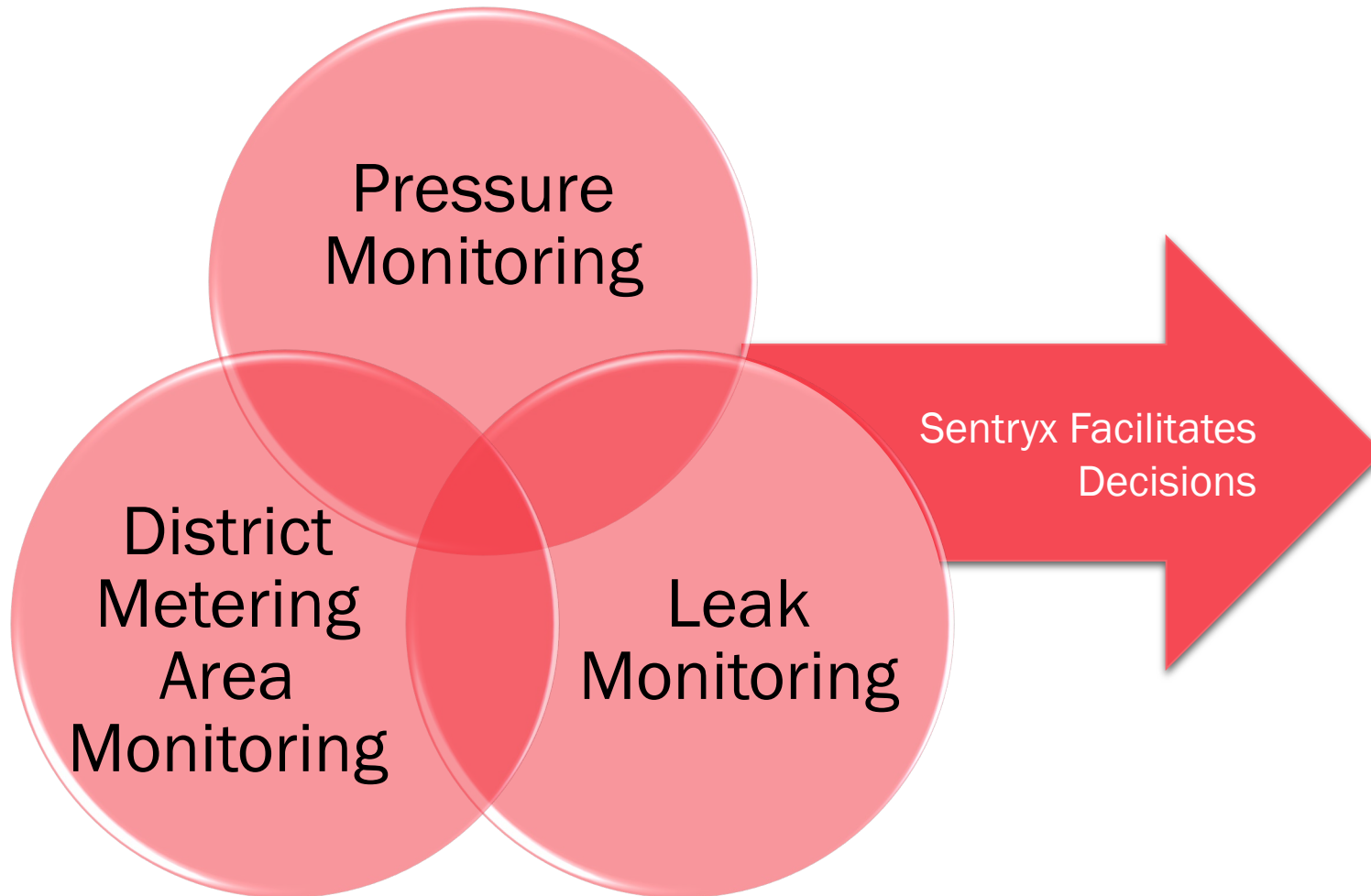
- Sampling Mode...Raw data for hydraulic modeling
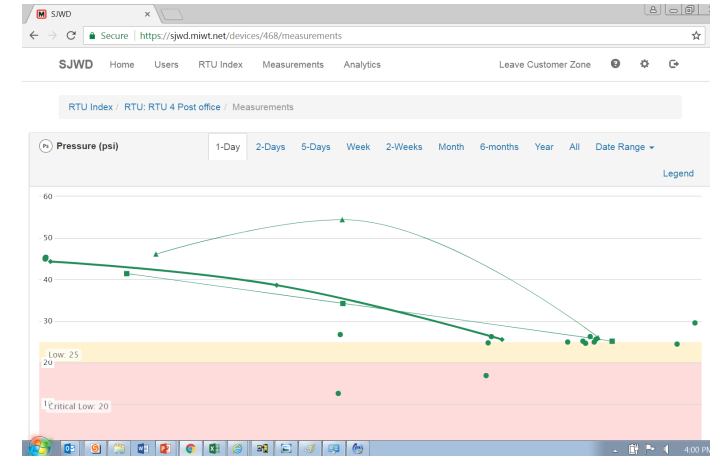
Steady State

Transient State

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The Power at the Intersection of Multiple Sources of Data

Pressure Monitoring

District Metering Area Monitoring

Leak Monitoring

Sentryx Facilitates Decisions

- 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

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POWER CONSUMPTION

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Renewable Energy!

KEY BENEFITS

An end-to-end solution that accurately controls pressure, reduces operating costs and creates a new source of revenue by producing electricity that can be used onsite or sold to electric utilities (net metering and wheeling).

Low cost source of energy

- High utilization/capacity factor;
- Space efficient;
- Easy installation;
- Low maintenance costs.
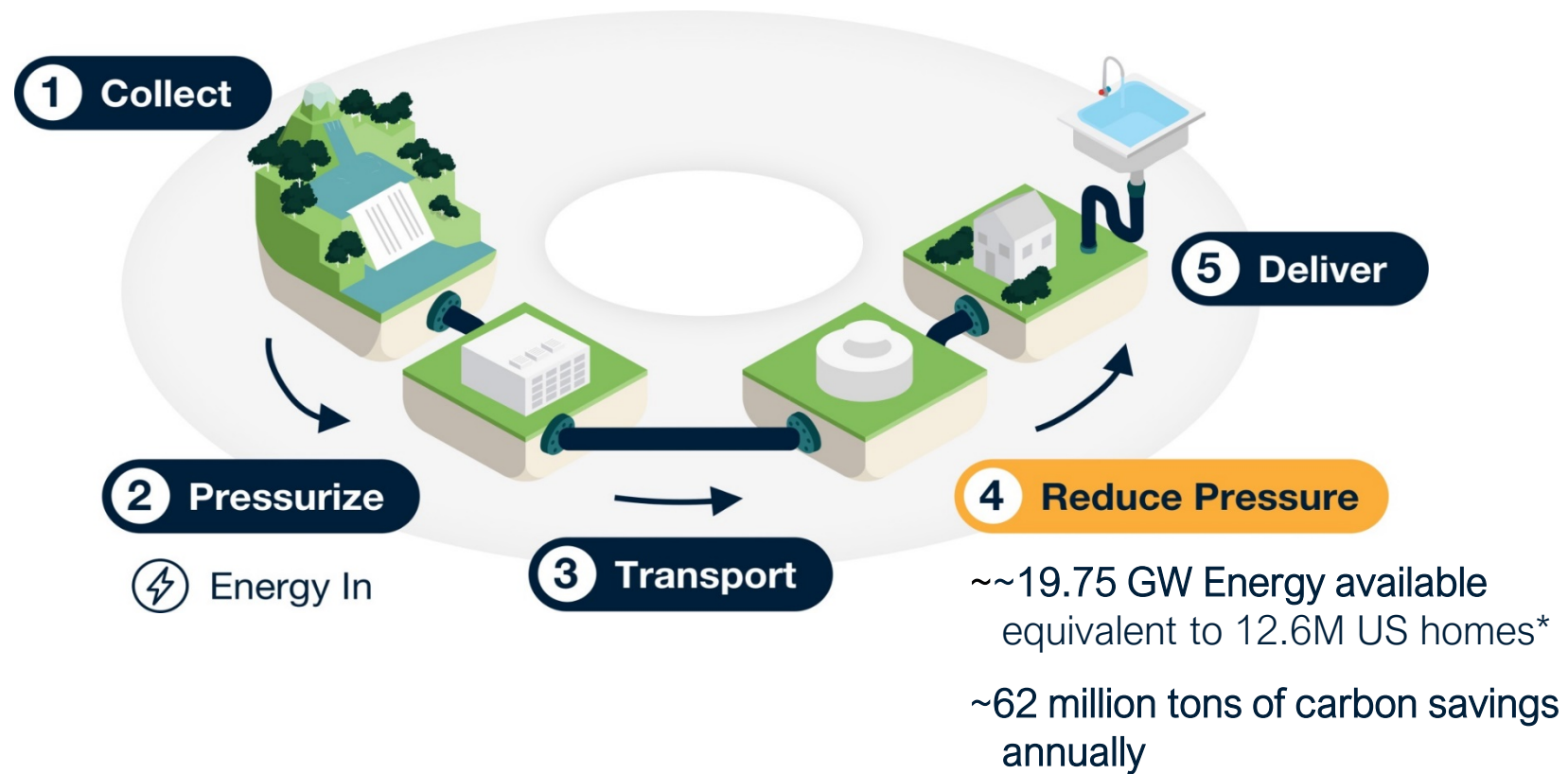
Low operating risk
- Uses proven components.

Long operating life (>30 years).

In-PRV PRODUCT

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Tapping into the way things work

~~19.75 GW Energy available
equivalent to 12.6M US homes*

~62 million tons of carbon savings annually

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Mueller has a new, low-cost source of carbon-free energy

The In-PRV™ produces renewable energy and accurately controls pressure

- Turn-key, software and sensor-based, modular solution, installs efficiently onto water pipelines and electric grid
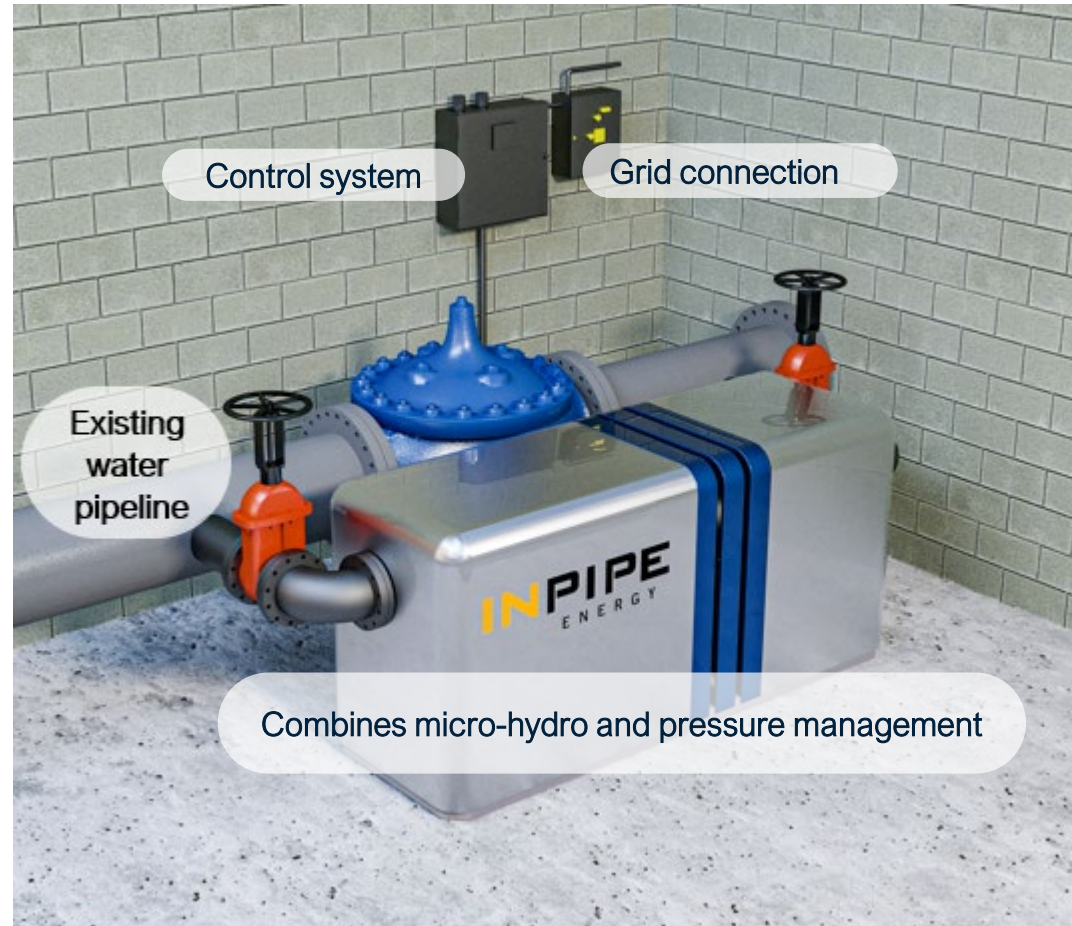
- Offsets carbon emissions otherwise lost with wasted energy

- Digitally-enabled, providing mission critical data and control

- Lowest cost-of-energy for a distributed renewable energy source: 3-5 cents/kWh

Control system

Grid connection

Existing water pipeline

INPIPE ENERGY

Combines micro-hydro and pressure management

Patents pending

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Ideal conditions

Site

- Existing PRV/Flow, sleeve valve or control valve

- Behind-the-meter or grid connection nearby

- Gravity-fed, outflow, effluent or excess pressure Pipeline

Hydraulics

- Typical pipe diameters of 12 – 42 inches

- Ideal flow ranges:1.6 – 27 MGD (3 CFS - 50 CFS)

- Net pressure: 35+ PSI (80 Ft of Head)

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Water energy nexus

Annual Energy Production is based on Flow and Pressure

Available Pressure (Ft) * Flow Rate (CFS) * System Efficiency * Uptime (Hrs/yr)

Differential Pressure (PSI)	Head (Feet)	Flow Rate (CFS)	Flow Rate (MGD)	Power (KW)	Energy Production per year (KWH)
20	46	20.00	12.93	59	463,735
40	92	20.00	12.93	118	927,471
60	138	20.00	12.93	176	1,391,206
80	185	20.00	12.93	235	1,854,941
100	231	20.00	12.93	294	2,318,676
120	277	20.00	12.93	353	2,782,412
140	323	20.00	12.93	412	3,246,147

Two Installations Up and Running

Project site

Original *PRV* site

w/ In-PRV

HILLSBORO IN-PIPE HYDRO-ELECTRIC PROJECT

Hillsboro

SMART WATER

CLEAN ENERGY

BETTER WORLD

EnergyTrust
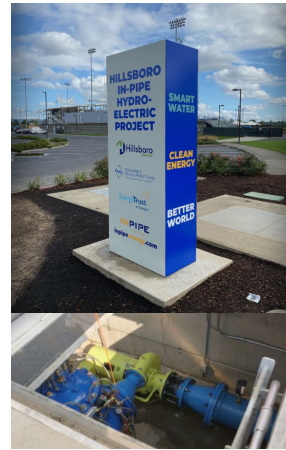
IN PIPE

Consistent energy profile

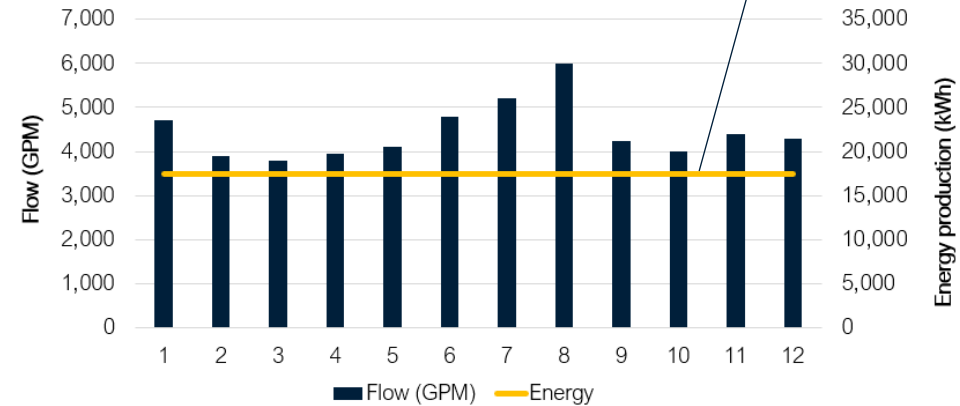Hydraulics enable consistent energy recovery

- Location
  - Pressure control vault in a City of Hillsboro (OR) water distribution pipeline
  - Co-located in recreational complex housing minor league baseball stadium
- In-PRV Energy savings: 200,000 kWh/yr.
- CO_2 emissions offset: 2,427 tons over project life (30 years)
- Funding: Municipality funded with support from electric utility programs
- Status: up and running September, 2020
- Precise replication of the existing pressure reducing valve (PRV) functionality to control downstream pressure.
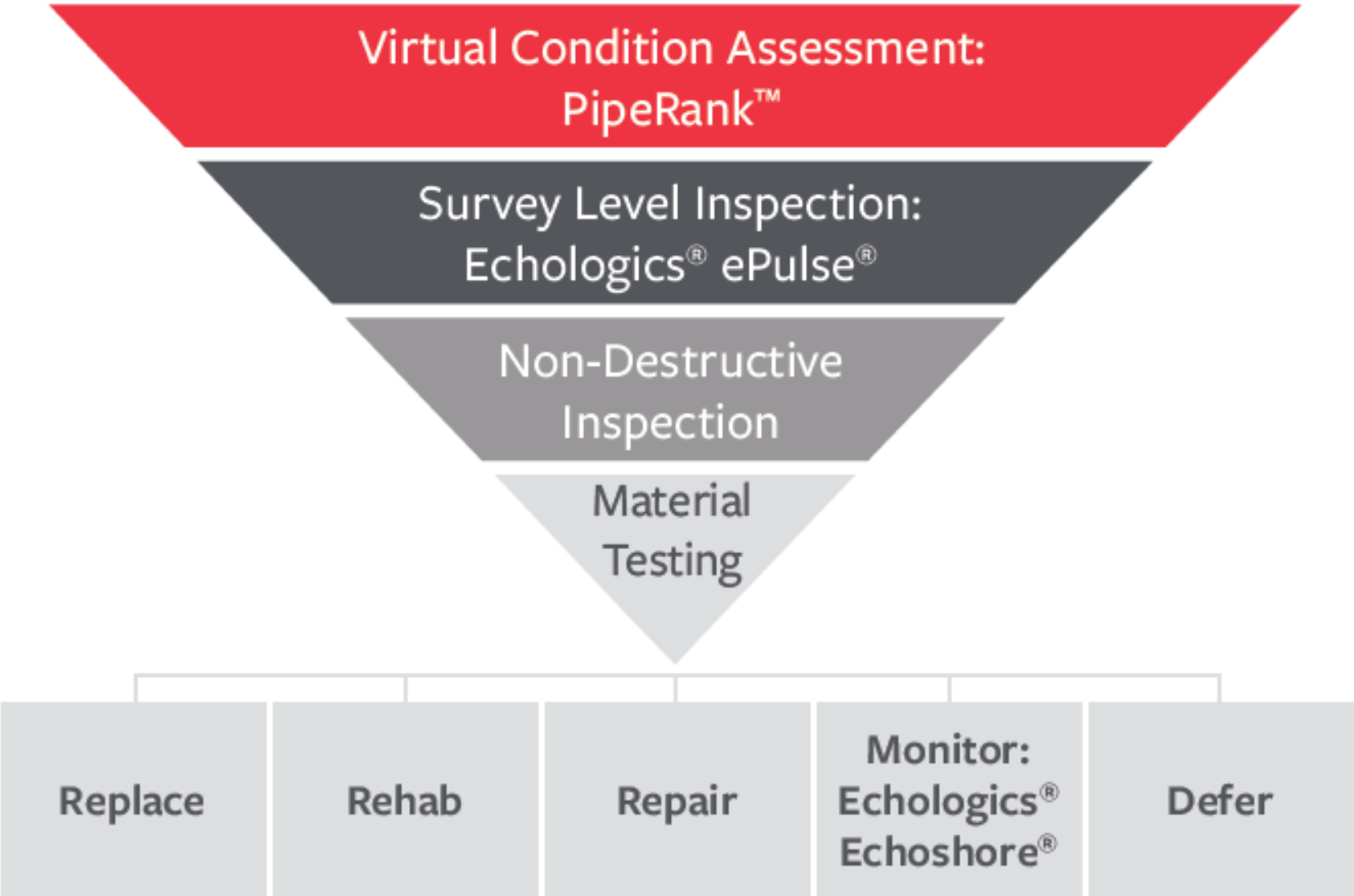 - ☑ Efficient conversion of water flow to electricity.
  Assumes: 0.9884 CO_2 per kwh, 30 yr. project life, Portland General Electric Schedule 38 – Large Nonresidential service, 2% inflation

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MANAGING RISK

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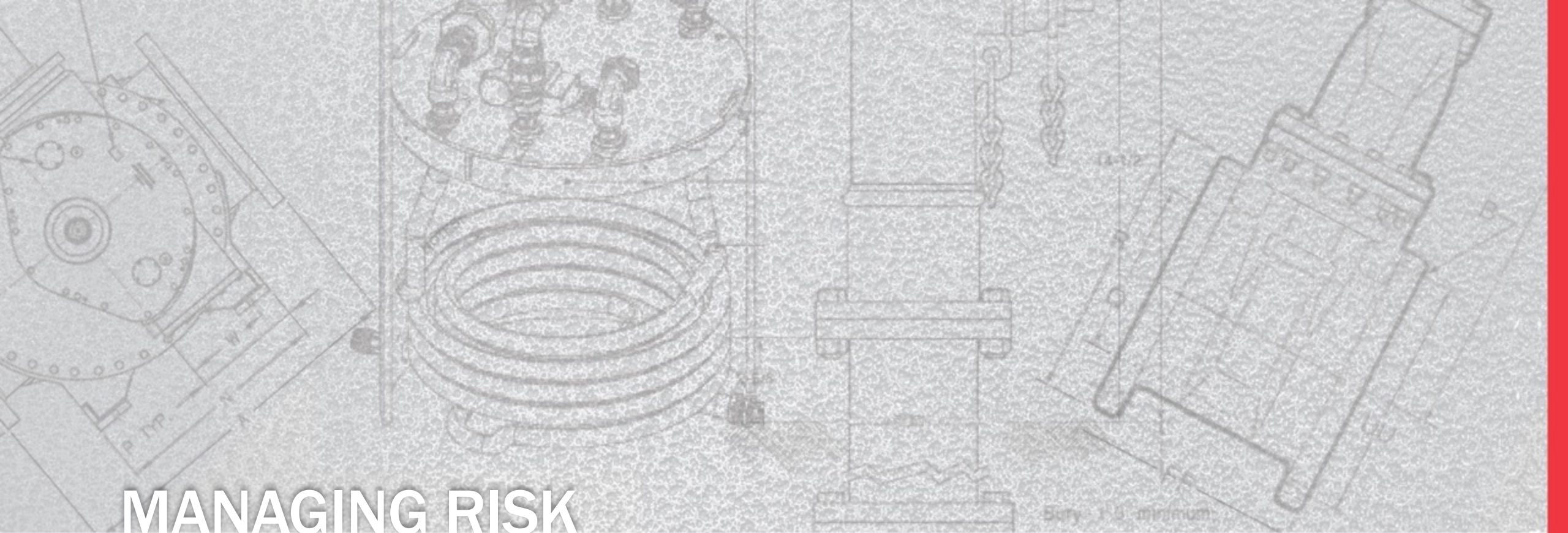
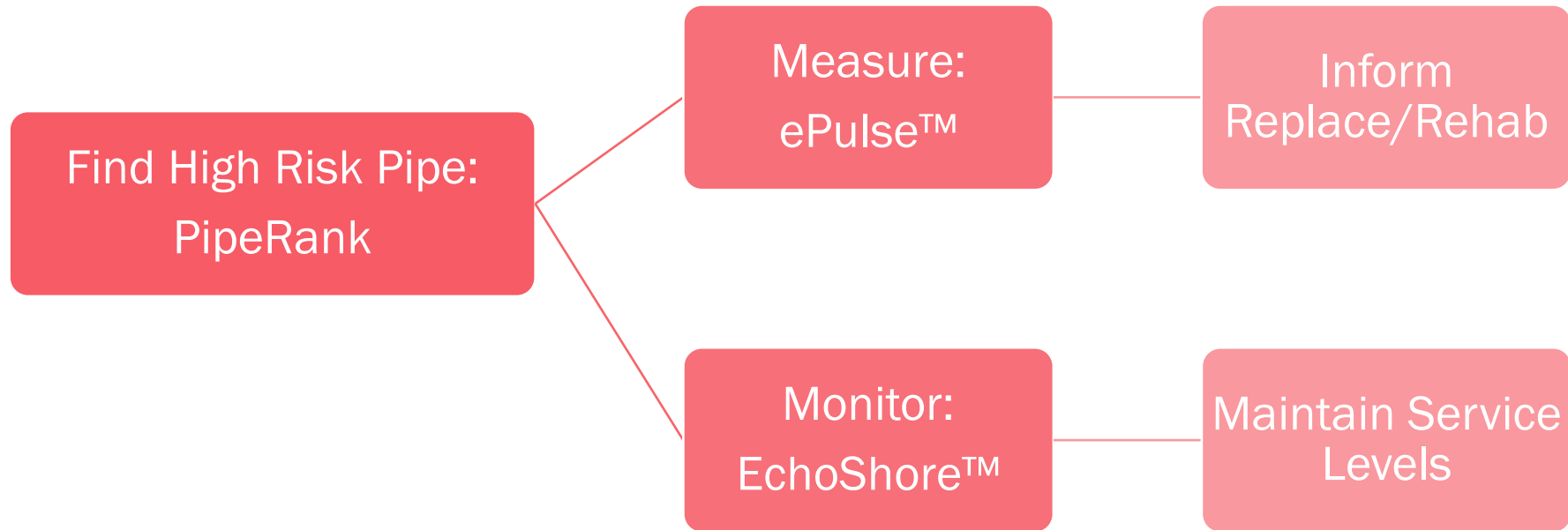# Progressive condition assessment enhances capital investment

If you knew what pipes were about to break next year....
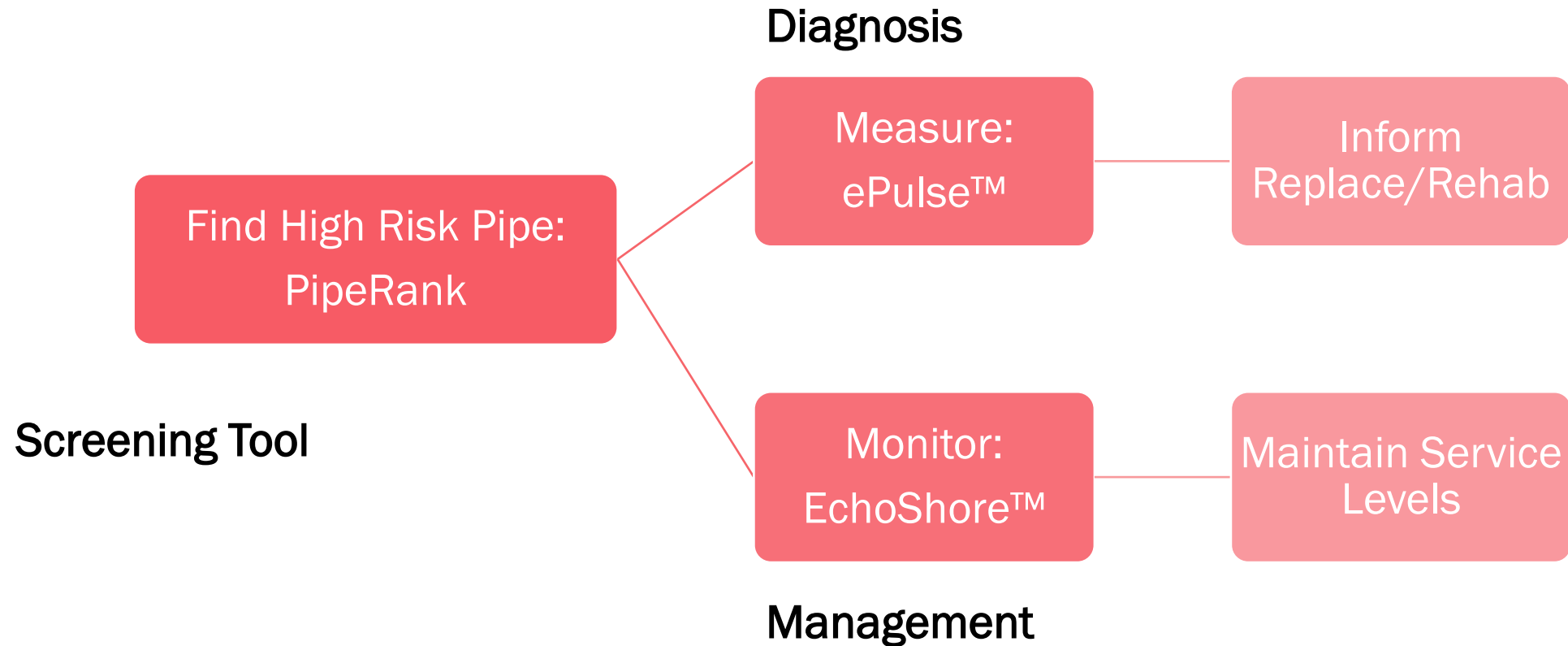
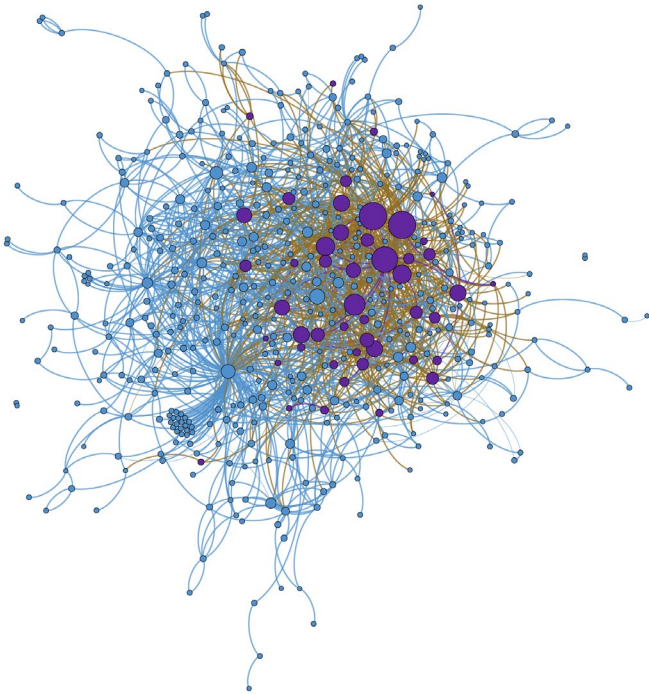**what would you do about it?**

A New Process is Possible

A New Process is Possible
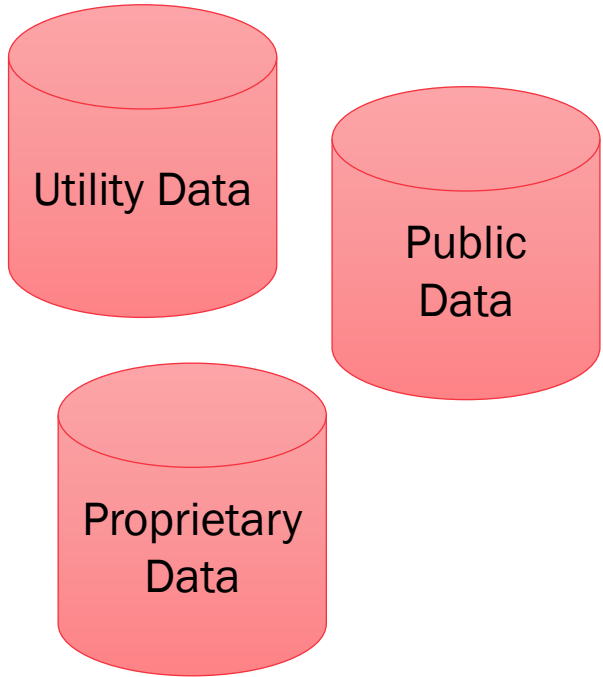

Diagnosis

Find High Risk Pipe: PipeRank

Measure: ePulse™

Inform Replace/Rehab

Screening Tool

Monitor: EchoShore™

Maintain Service Levels

Management

How Does PipeRank generate results?

Top 3% of pipes ranked by LoF

Pipes Being Displayed: 1 - 308

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

Utility Data

Public Data

Proprietary Data

Data collection and clean up → **PipeRank finds patterns and relationships** → **Asset Analysis**
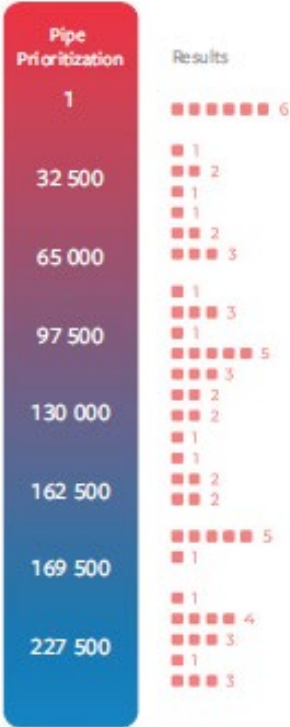
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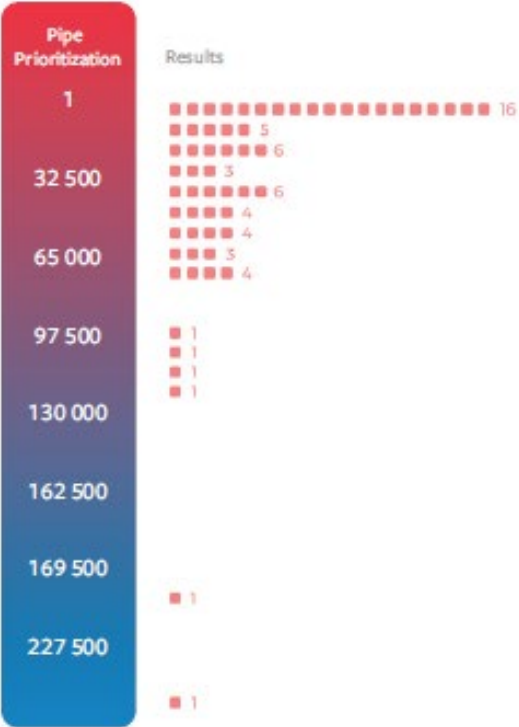Public utility with 260,000 pipe segments (~5,000 miles)
PipeRank predicted 2018:

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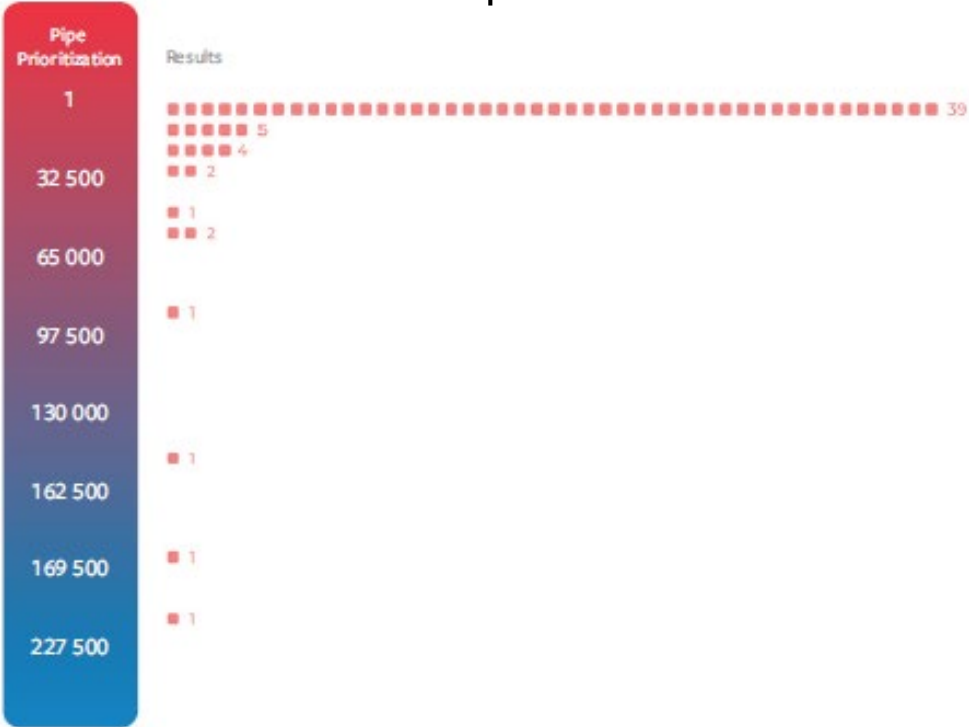
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Prior Breaks

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

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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

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