Utility Technologies, LLC

Technology Solutions for Efficient Utilities

A Comprehensive Guide to Water Loss Management Solutions

Mark Beatty, Principal Owner/CEO

OTCO Water Distribution Systems Workshop

Underground Leak Locating

Old School leak Detection

Methods of Leak Detection and Water Loss Management

- **Acoustic Methods**
  - Acoustic Leak
  - Leak Noise Correlators
  - Leak Loggers (Temporary and Permanent)
  - Leak Monitors
  - Hydrophones, Microphones, and Sensors
- **Non-Acoustic**
  - Tracer Gas
  - Pipeline Assessment
    - Video Inspection
    - Ultrasonic Assessment
    - Vibration monitors
  - Pressure Monitors

Underground Water Leak Locating

- Leak Locator – Detects and locates a leak based on leak noise (acoustics)

Underground Water Leak Locating

- Leak Locator – Features to look for
  - Digital or Analog Processing & listening?
  - Sound processing & filtering
    - Frequency ranges & limits
    - Sound volume limitation (hearing protection)
  - Sensors & Adapters (magnets, rods, tripods, wind microphones, etc.)
  - Wired or wireless (Mic, receiver, headphones)
  - Software /Firmware upgradable
  - Export or database interface

Underground Water Leak Locating

- Acoustic leak detecting is a mix of:
  - Science/Physics
    - Sound limitations, pipe materials, leak type, leak place
  - Technology
    - Quality of locator, locator features, locator attachments
  - Experience, Learned Skills and formal training
  - Environment
    - Soil type, background noise, available assets, depth
  - Luck

Underground Water Leak Locating

- Reasons for failure to detect or locate:
  - Not actually a leak
    - Intermittent usage, Wind noise, meter noise
  - Wrong location
    - Wrong line, underground locations incorrect, off the line
    - You should locate pipe before locating the leak
  - Low noise output
    - Rubber gaskets, depth, soil cover, plastic pipe
  - Excessive background noise (masking)
    - High road traffic, electric transformers, high usage in area

Underground Water Leak Locating

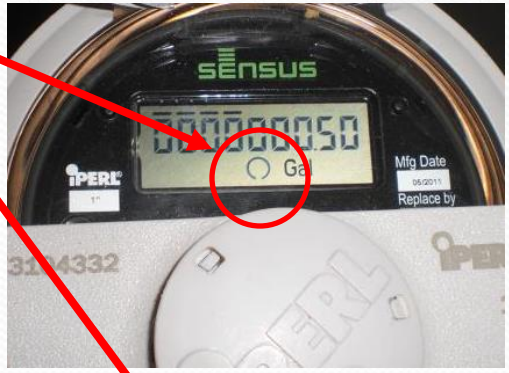
- Reasons for false positive detection or locating:
  - Noise not from water leak
    - Electrical Transformer noise (filtering)
    - Wind (filtering and special microphones)
    - Gas leak
  - Underground assets unknown or incorrect
    - GIGO with correlations
  - Sound Echo from Tees
  - Usage rather than leak (check water meters)

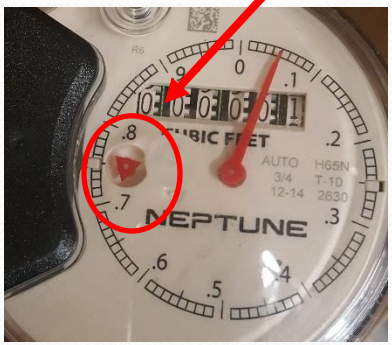
Underground Water Leak Locating

- Checking for metered usage, look for the leak detector on the meter face.

Digital Meter – flashing/animated icon

Analog Meter – Rotating wheel





Basic Leak Locators

- Price Range $1000 - $2500

Underground Leak Locating

Sewerin Stethophon 04 Example

- Simple, Low Cost
- Compact & Portable
- Versatile
- Simple Noise Filters/Volume Limiter

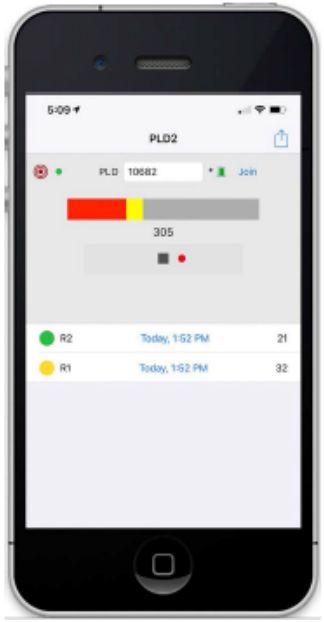
Mid Range Leak Locators

- Price Range $2,500 - $4,000

Underground Leak Locating

Example WaterPoint PLD

- Digital Accelerometer Leak Sensor
- Wireless
- Magnetic base or ground resonator
- Software is an IOS app
  - Updatable software
  - Runs on iPod, iPhone, or iPad
  - Simple to use
  - Filters out non-leak frequencies
  - Can interface with GIS mapping



case

Underground Leak Locating

Example Sewerin Aquatest T10

- Test Rod based device
- Survey and Pre-locate
- Electro-acoustic
- Wireless or Wired Headset
- Multiple Band Filters
- Touchpad on/off
- Probes, wind mic, or tripod use options

Mid Range Leak Locators

- Price Range $2,500 - $4,000

- Common Features:
  - Higher quality microphones
  - Wireless Headphones
  - More advanced and granular sound filtering
  - More user controls
  - More specialty microphone types
    - Wind, Soft Soil, Magnetic, test tips, etc.
  - Versatility for different Situations

Advanced Leak Locators

- Price Range $4,000 – $10,000

Underground Leak Locating

Example Sewerin AquaPhon A200

- High Feature Sound Processor
  - View frequency graphs and filters
  - Save/replay recordings
- Completely Wireless
- Color Touch Screen
- Multiple Sensors
  - 1 to 4 Specialized microphones
- Acoustic Pipe Locating Feature
- Charging in case

Advanced Leak Locators

- Price Range $4,000 – $10,000

- Common Features:
  - Hard Carry Cases
  - High end headphones & Wireless
  - Advance frequency analysis
  - Ability to save or download audio recordings
  - Software upgradeable
  - Typically for the more advanced leak locating staff or leak locate specialist
  - GIS Software and Data Integrations

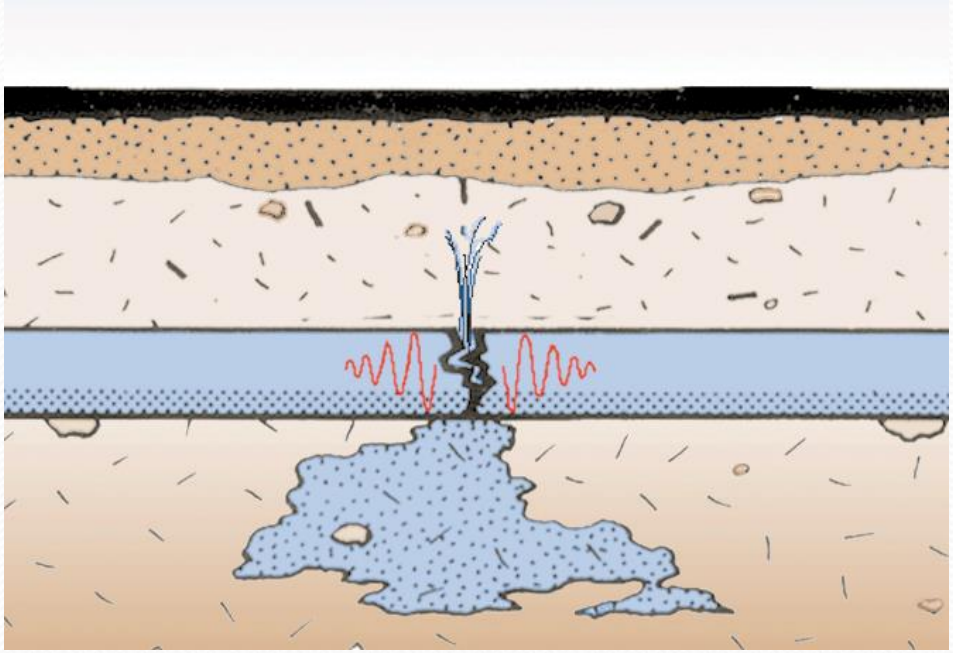
Underground Leak Correlator

- **Leak Noise Correlator** – Detects and locates a leak based the time delay of leak noise reaching two or more sensors.
- Three Things needed for Calculation
  - Pipe Diameter(s)
  - Pipe Material(s)
  - Linear Distance between Sensors

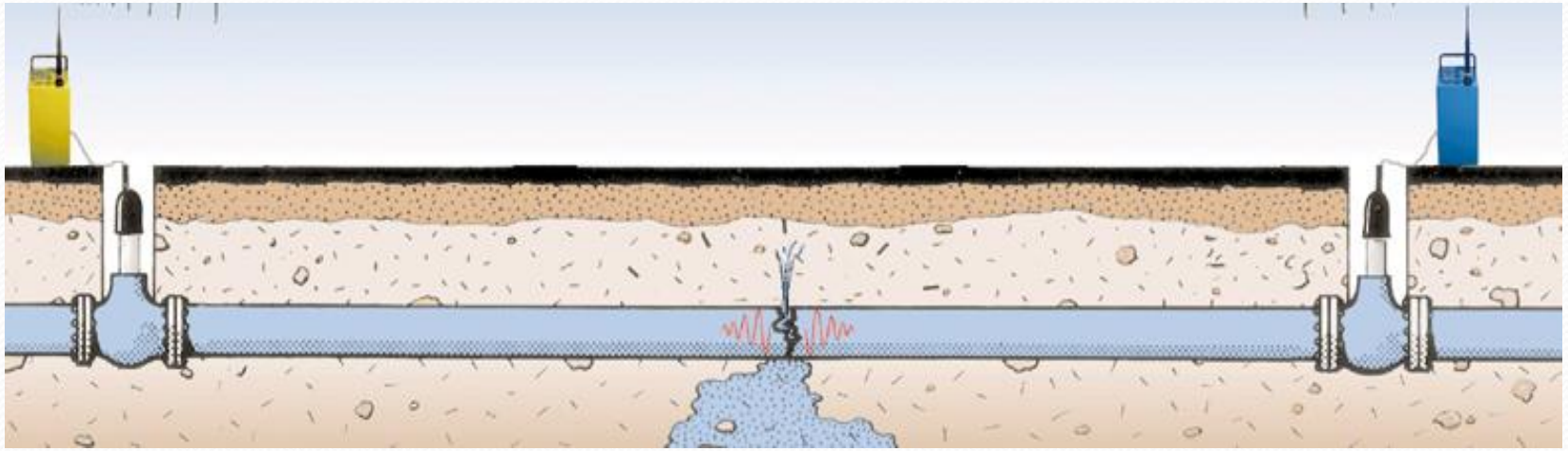
$$(f \star g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f^*(\tau)\ g(t+\tau)\, d\tau,$$

Principals of Correlation Technology

- Vibration energy (sound) is emitted when a leak occurs.
- The leak sound travels away from the leak site through the fluid and pipe wall.



Principals of Correlation Technology (cont'd.)



Acoustic vibrations are sensed in two ways:

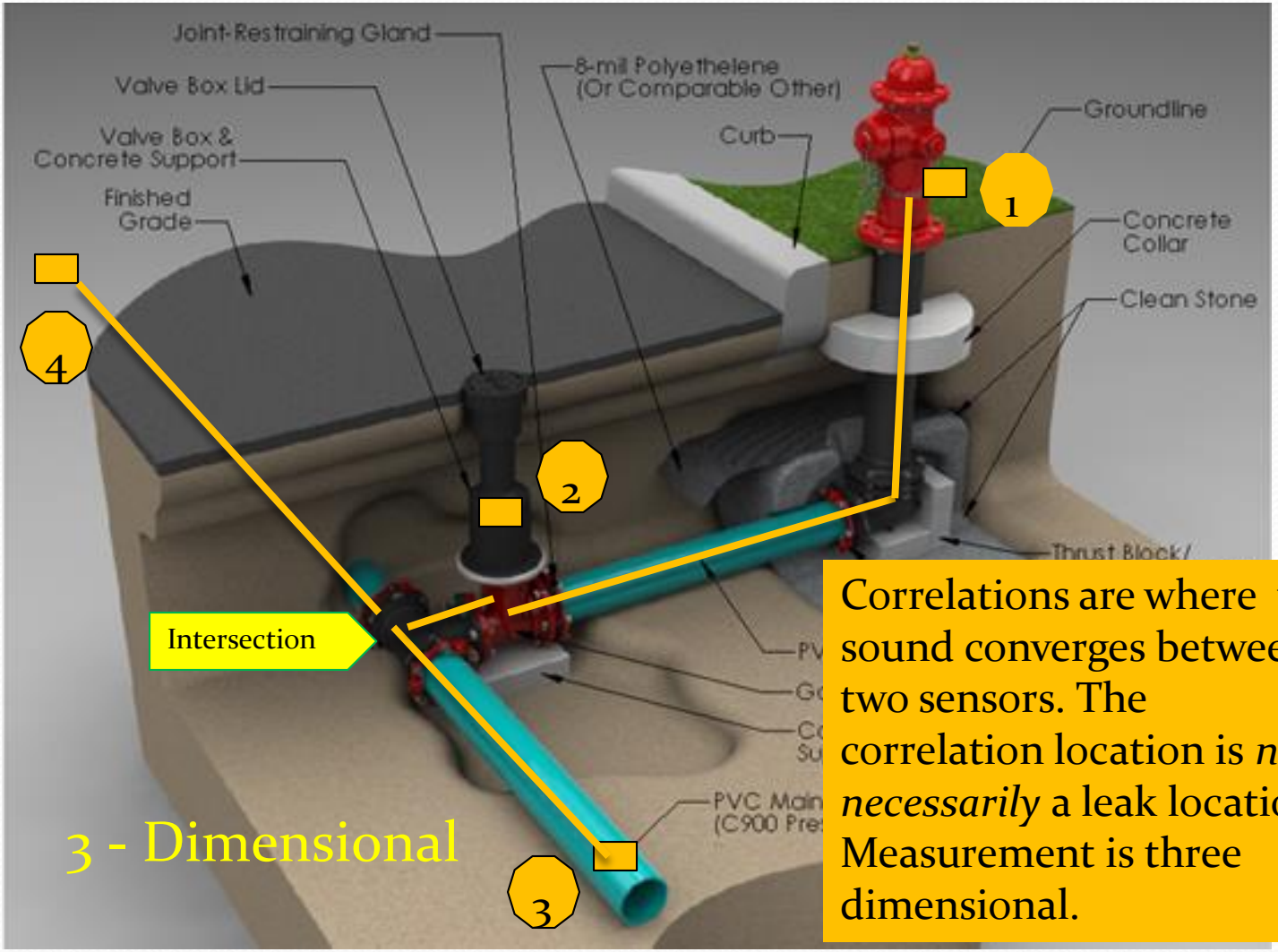
- Outside of pipe using *accelerometers or microphones*; and
- Within the flow using *hydrophones*.

Principals of Correlation Technology

Correlation Facts:

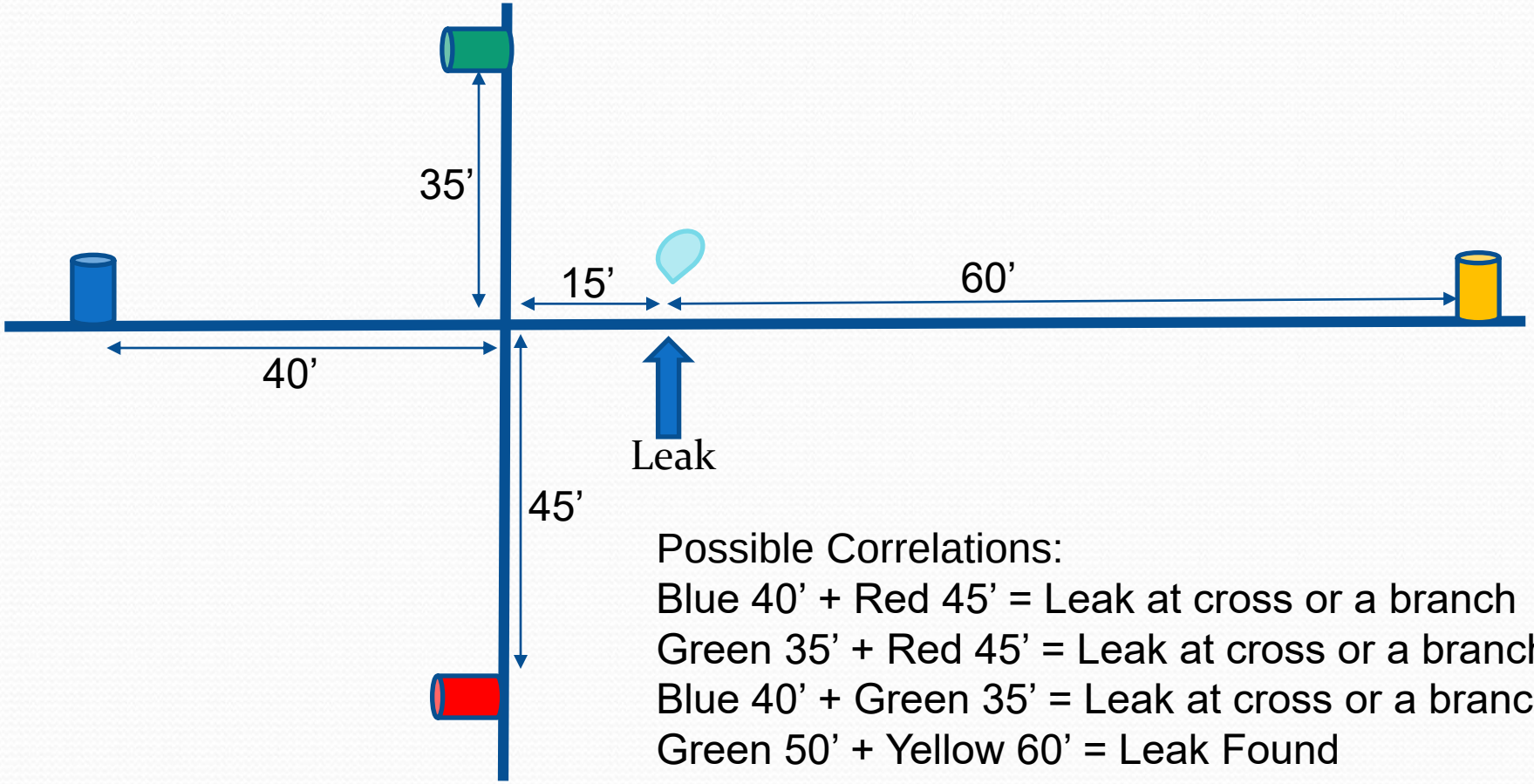
- We need three things to correlate:
  - Distance between Sensors
  - Pipe Material(s)
  - Pipe Diameter(s)
- Multiple Sections can be calculated
- Speed of Sound through known materials is generally known data
- Microphone distance limited by sound carrying characteristics
  - Iron Pipe – up to 1800’ (800-1200 typical)
  - AC Pipe – up to 700’ (500-600’ typical)
  - Plastic Pipe – up to 250’ (150-200’ typical)
- Hydrophone distance longer, but variable

Correlating Pipe Intersections



Correlations are where the sound converges between two sensors. The correlation location is *not necessarily* a leak location. Measurement is three dimensional.

Correlating Pipe Intersections



Possible Correlations:
Blue 40’ + Red 45’ = Leak at cross or a branch
Green 35’ + Red 45’ = Leak at cross or a branch
Blue 40’ + Green 35’ = Leak at cross or a branch
Green 50’ + Yellow 60’ = Leak Found
Blue 55’ + Yellow 60’ = Leak Found
Red 60’ + Yellow 60’ = Leak Found

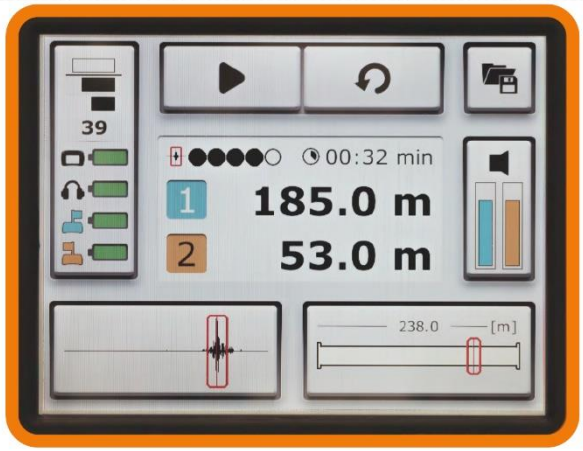
Correlator Types

- Analog or Digital
- Microphone or Hydrophones
- Live Radio, Docking, Close Range Radio, Permanent
- Two Sensor – Three or more sensors
- Live RF or Unattended & Night Logging
- Laptop, Tablet, Smartphone, Self Contained Handheld
- Correlator Only or Combo Units
- Live audio processing only, or post processing possible
- GIS integration

Leak Correlating

Sewerin Secorr C200

- Main Processor – Enter up to 5 sections of pipe
- 2 Sensors communicate via live RF Signal
- Optional Hydrophones for Plastic
- Quick instant radio communication
- Enter Pipe data into Processor
- Pauses for temporary sound
- Easy to run multiple analysis
- Data can be saved into memory
- Easy to use and learn

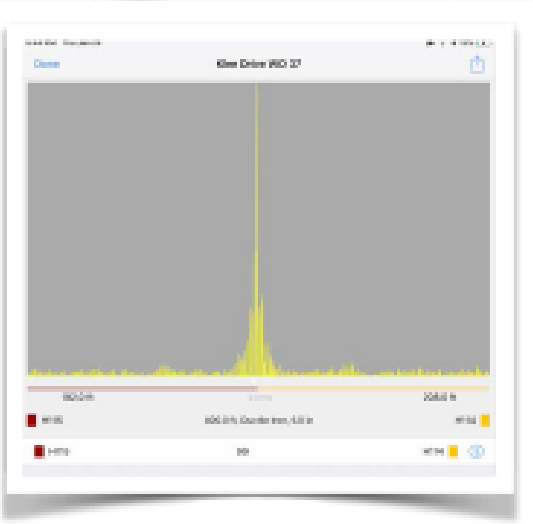


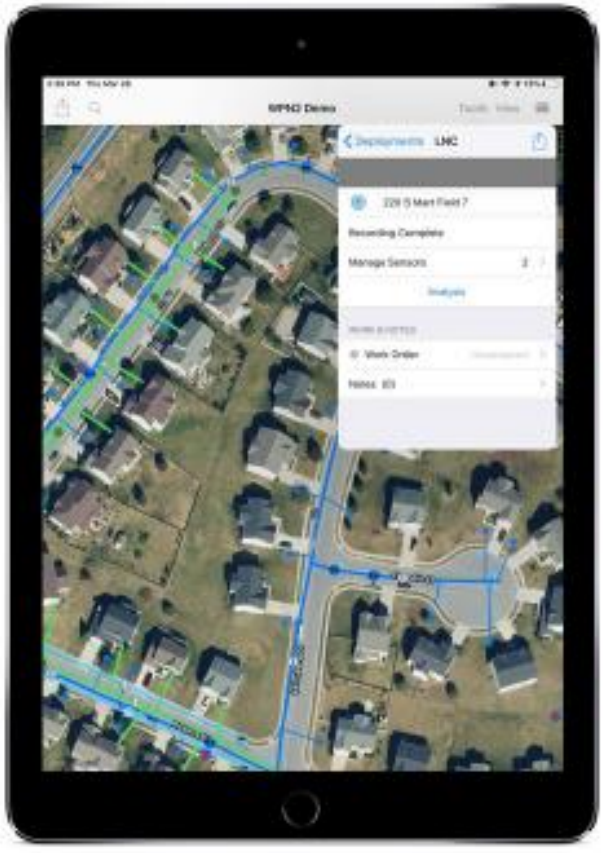
Underground Leak Locating

- Hydrophones for correlation (Non-metallic Pipe)
- Listed to leaks in the water column rather than pipe wall
- Allows more distant correlation on Plastic

Leak Correlating

- 64 Seconds LNC

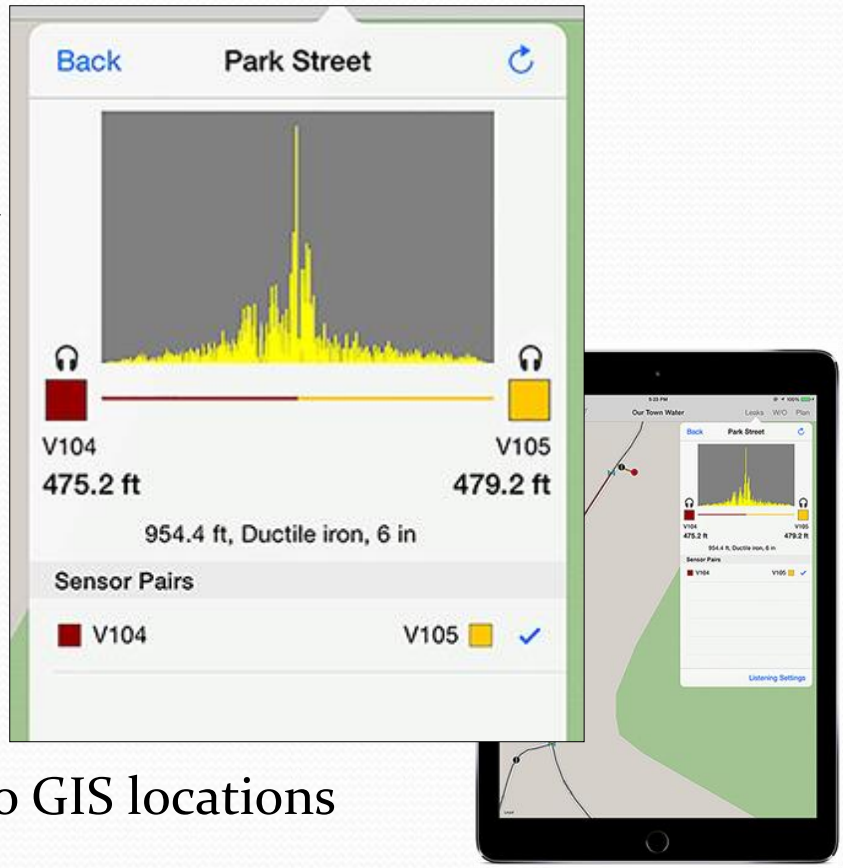




Leak Correlating

64 Seconds LNC – Multi Logger Example

- Leak Noise Correlator
- Wireless communications
- Use 2-4 Sensors
- Delayed Deployment - Logging
- Software is an iPad App
- Can use Existing GIS data:
  - Locations & lengths
  - Pipe Sizes & Materials
  - Enter data via GPS
  - Calculate Multiple Paths
  - Can save audio and analysis data to GIS locations

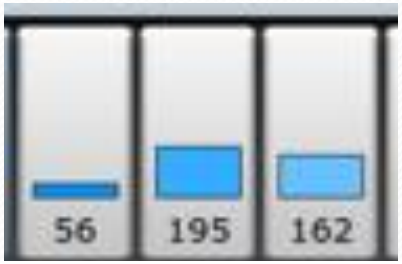


Multi-Function Devices

- Leak Detector and Correlator
- Leak Detector, Acoustic Pipe Locator
- Leak Logger and Correlator
- Leak Monitor and Correlator

Acoustic Pipe Locating

Locate Non-Metallic Pipe without Tracer wire



Acoustic Pipe Locating

Mobile Apps

Underground Leak Locating

- Leak Loggers
  - Log leak sounds unattended at preset time or times
  - May also be correlators
  - Overnight leak detection advantages
    - Less background noise from use or traffic
    - Higher Pressures at night
  - Permanent Logging
    - Develop history of sound to find new leaks
    - Proactive leak detection plan – finds leaks early
  - Temporary Leak Logging
    - Leak Surveys with fewer loggers

Underground Leak Locating

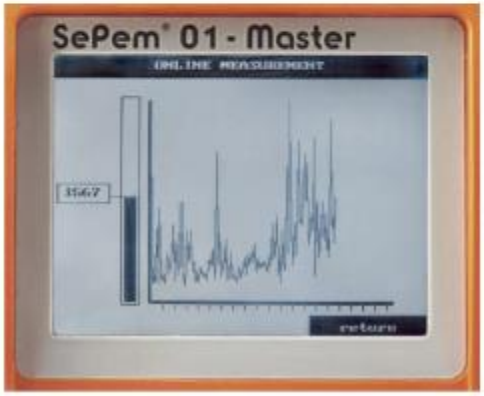
- Leak Loggers Examples
  - WaterPoint LNC
    - Can be left for a single timed leak recording up to 24 hour delay.
    - Can also Correlate the any leaks found
  - SePem 155 Radio Loggers
    - Drive-by or Walk-by Radio Solution
    - Radio loggers installed in valve boxes
    - Up to 400 loggers managed per Master Reader
    - Can be deployed Permanently to find leaks as they start and develop
  - SePem 305
    - Permanent Cellular Network Leak Loggers

Leak Logging Systems

SePem 155

Temporary or Permanent Leak Logging

This table lists the data from each ***SePem® 01*** in succession as the vehicle passes the measuring points.



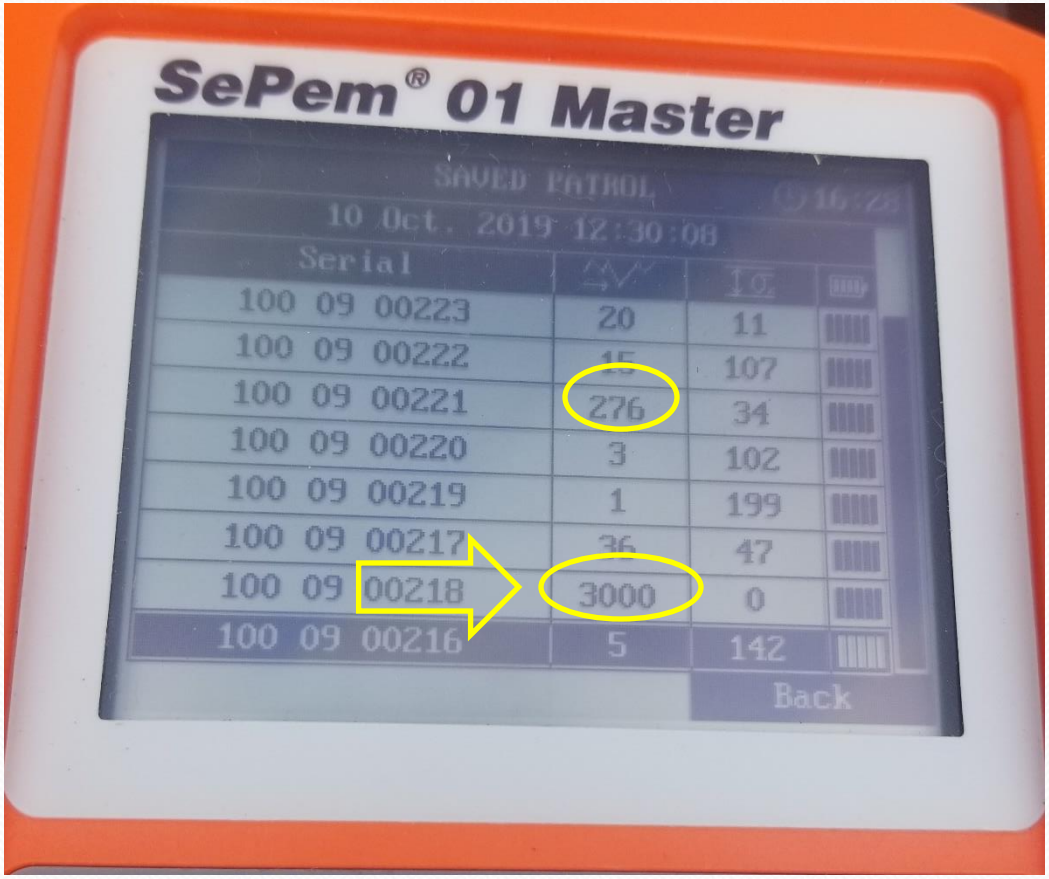
Online measure-ment, as illustrated here, allows you to determine prior to installation if a "zero measure-ment" might even be possible during the day.

Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

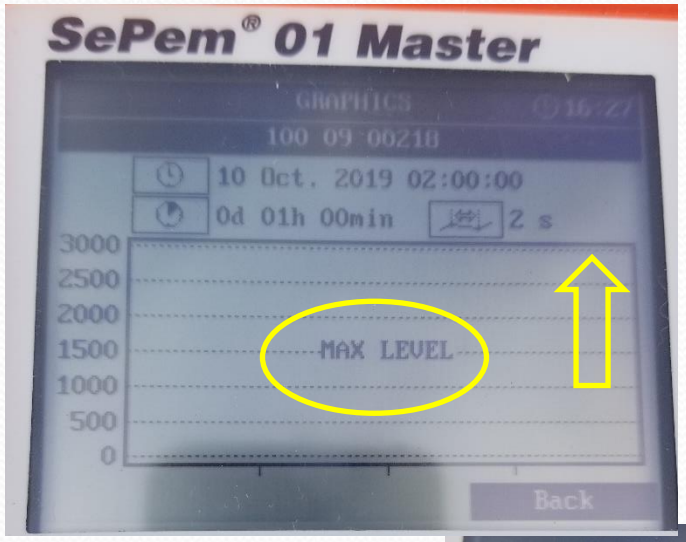
Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

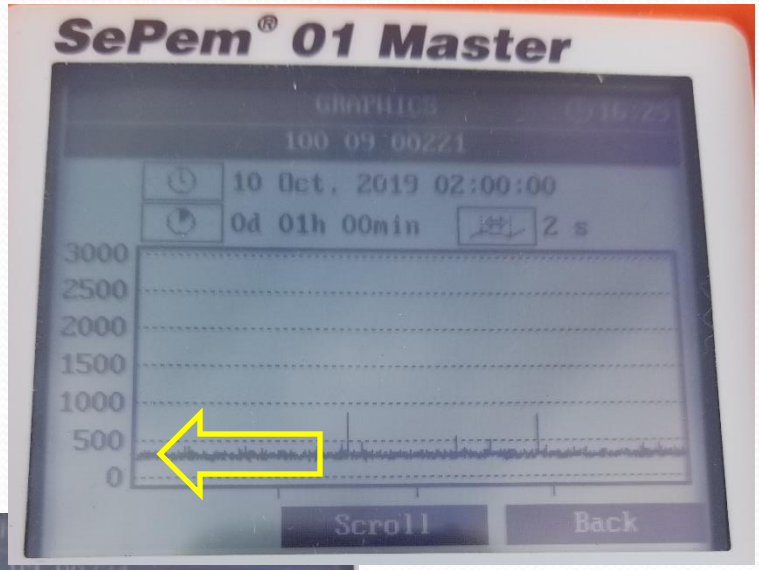


Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

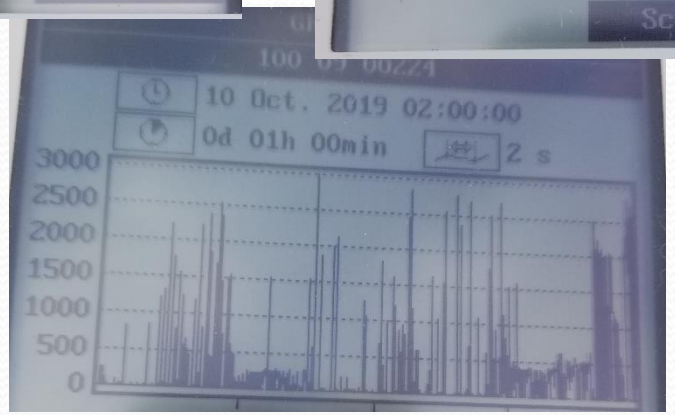


Definite Leak



Possible Leak

One Hour
Recordings
2:00 am to 3:00 am



Noisy, but no leak
since it goes to zero

Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

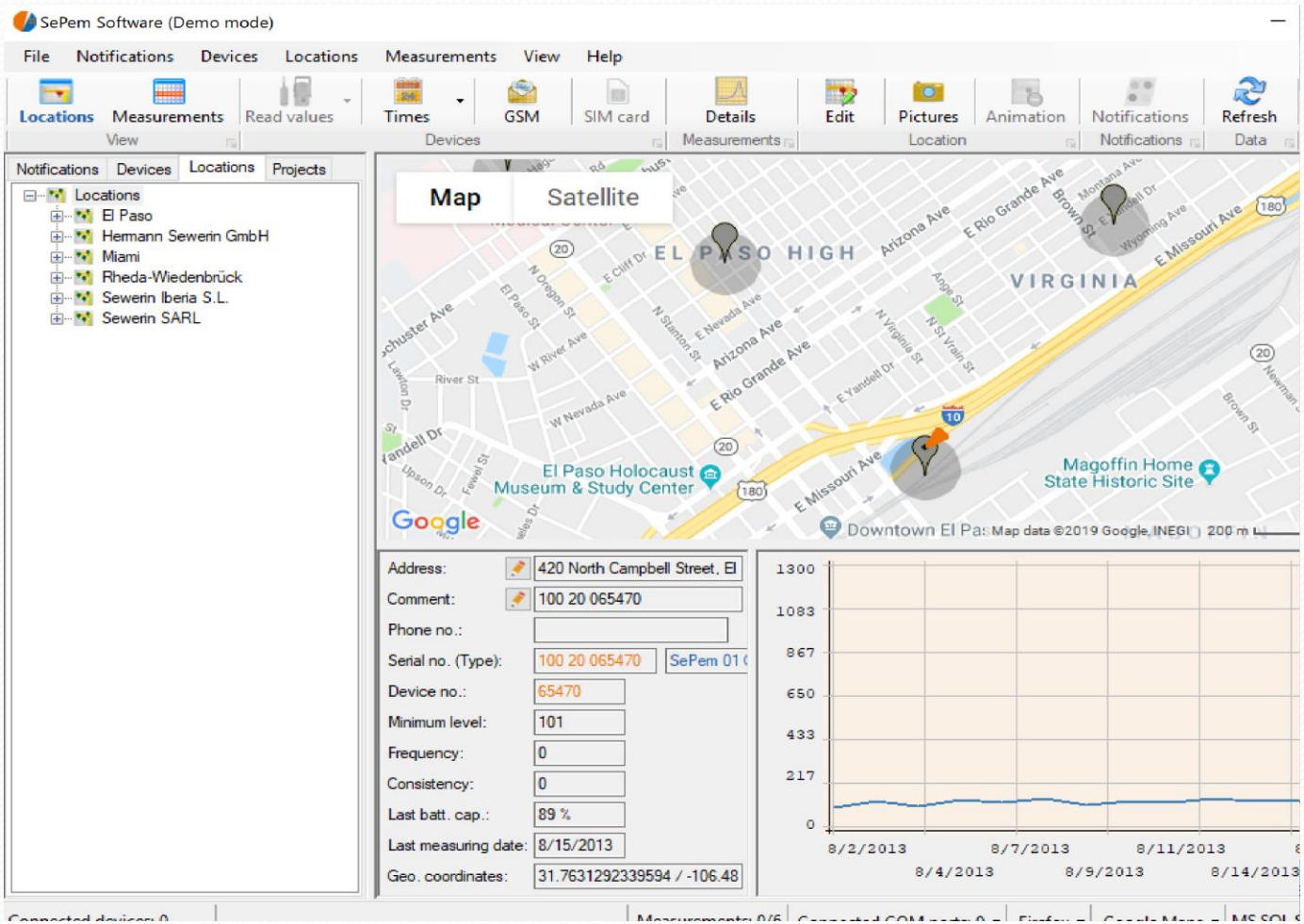
Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

Leak Logging Systems

Sewerin SePem 155 – Leak Logger Example

Leak Logging Systems



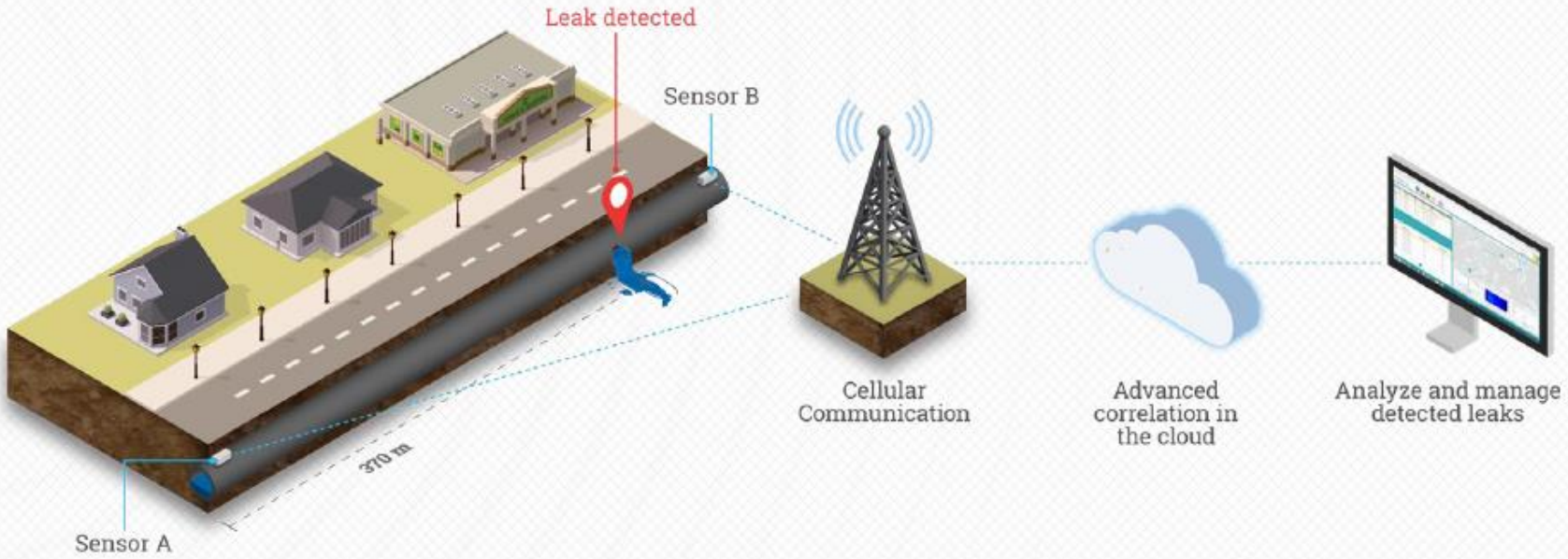
Continuous Leak Monitoring

Fixed Sensors
Continuous Monitoring

AQS-SYS

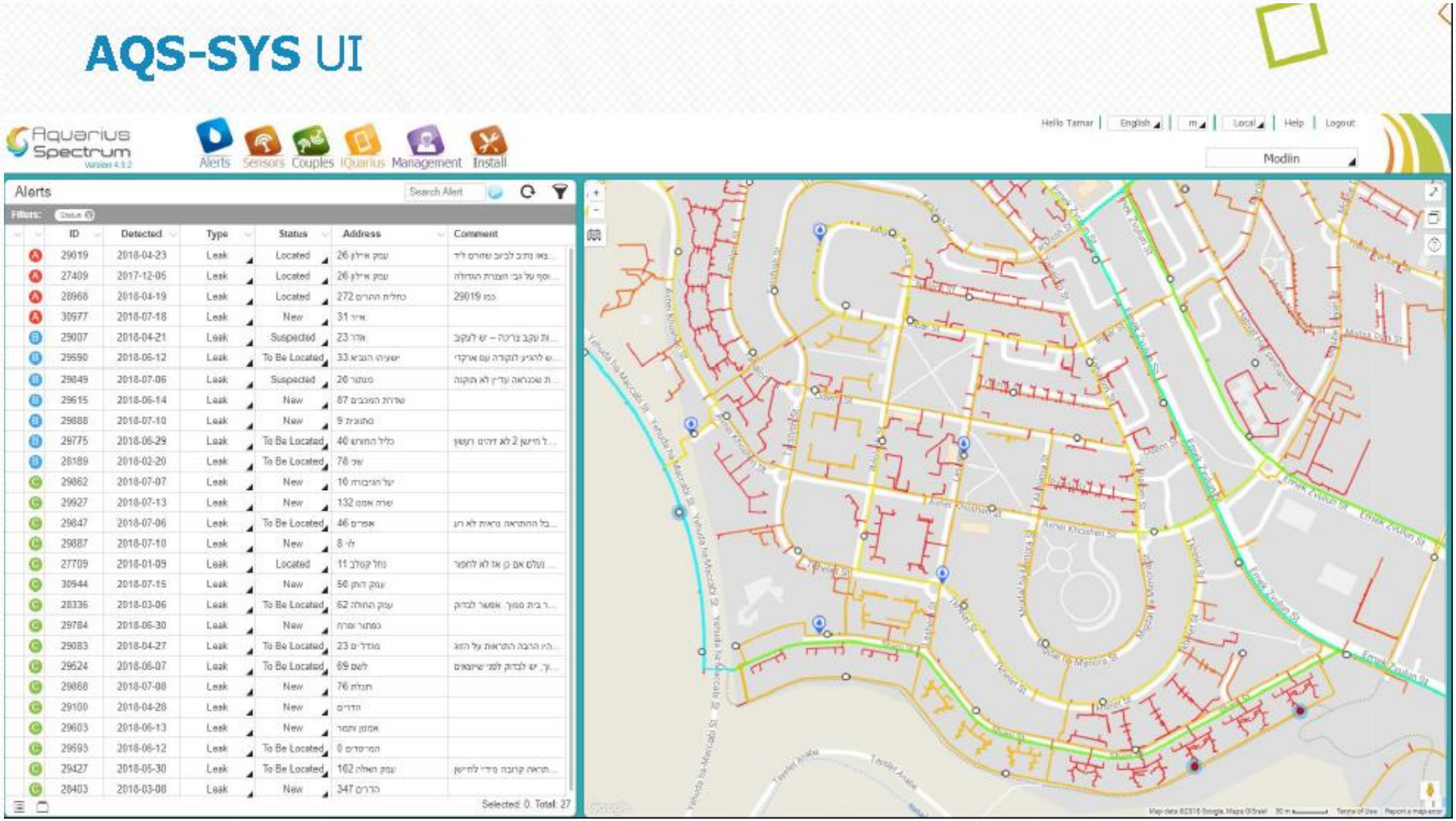
Continuous Leak Monitoring

Fixed Detection by Correlation (How it Works)



Aquarius Spectrum

Continuous Leak Monitoring



Continuous Leak Monitoring

Technology – IoT Sensors

Patented fixed sensors for network monitoring, automatic leak detection and location by continuous correlation between all sensor couples.

- **Plug and play technology** for easy installation
- **3G/4G communication** with advanced time synchronization
- **Vibration sensors** for installation on aboveground and belowground hydrants (Iron, AC & PVC pipes) 900-1500 ft between sensors
- **Hydrophonic sensors** for installation on underground hydrants for HD-PE pipes, 800 ft between sensors
- **Large diameter pipes** are monitored by hydrophones with an optional pressure sensor for transients

Aquarius Spectrum

Continuous Leak Monitoring

Aquarius in the USA

Projects:

- **SUEZ NJ** installed 300 Underground sensors in 2017 and 300 aboveground sensors in 2018. The system identified dozens of leaks and helped the utility reduce its NRW by hundreds of millions of gallons of water by now.
- **SUEZ PA** purchased 330 sensors following a successful pilot at Harrisburg.
- Last week we installed 130 sensors in one of the largest water utilities in the US.
- **Arlington TX** has the system up and running for 3 years now.
- Successful pilots conducted at **LAWP, San Diego, Miami, Florida Keys, Duluth, RWA** and more.

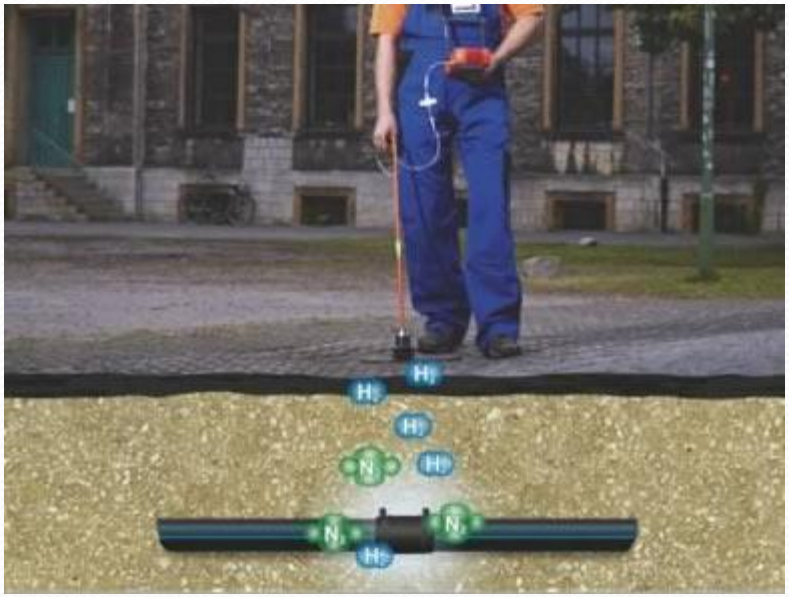
Aquarius Spectrum

Non-Acoustic Leak Locating

- Locate Leaks with Gas Tracing
  - Gas Molecules Smaller than Water
    - Air - High pressure, Not traceable at surface
    - Helium - Expensive, non-renewable, empty pipe
    - Hydrogen/Nitrogen mix - Correct mix required, can dissolve in water, non-flammable
  - Gas will always rise, water may not
  - Can Penetrate hard surfaces (asphalt, concrete)
  - Best done with empty pipe
  - Takes time, setup

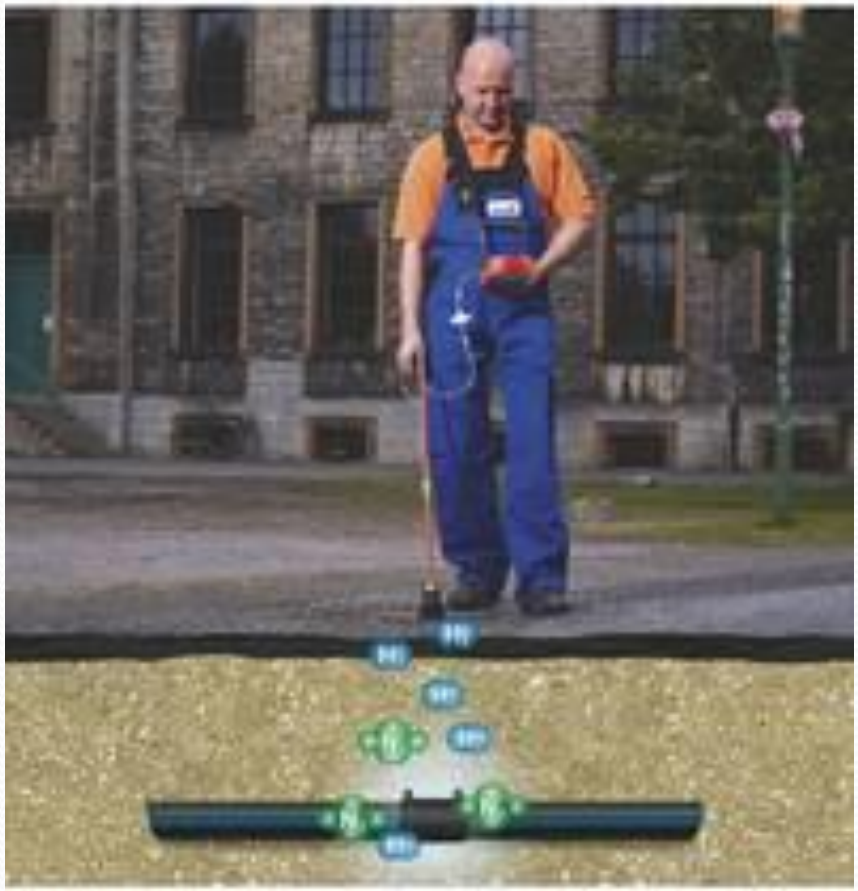
Underground Leak Locating

Tracer Gas
Setup
Examples



Underground Leak Locating

- Tracer Gas Example
  - Empty Pipe
  - H2 (cheaper than Helium)
  - NSF-61 approved
  - Safe 5% H2 (balance N2)

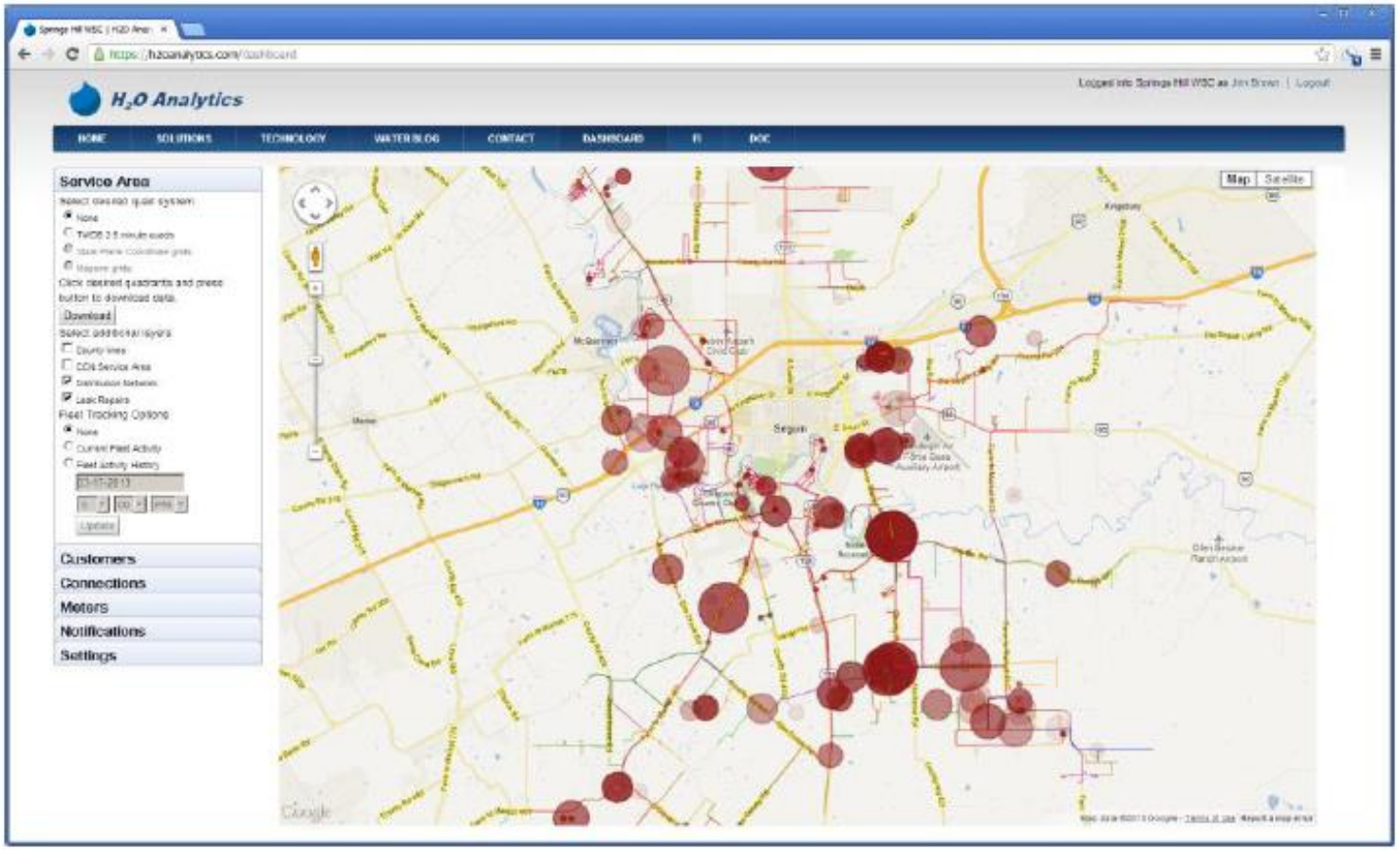


Methods of Leak Detection and Water Loss Management

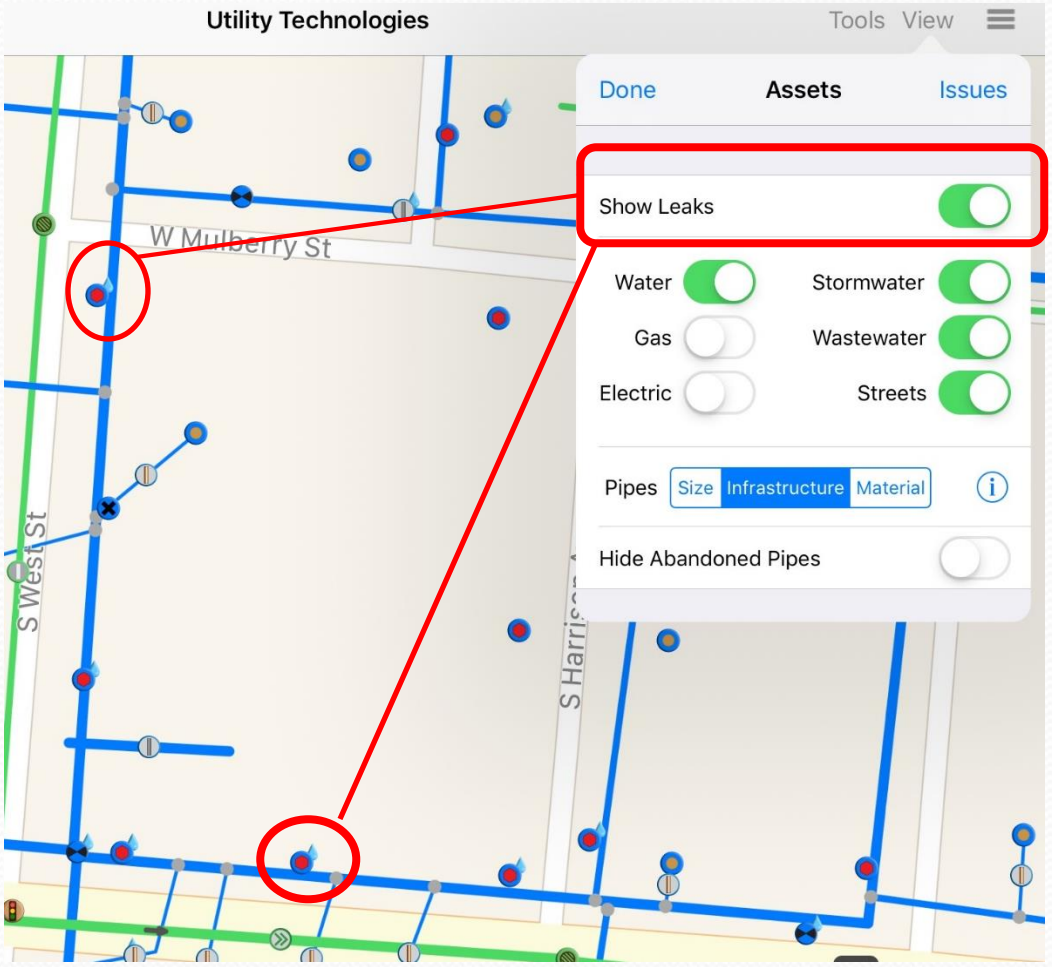
- GIS and Other Data Integrations
  - GIS Integration with Correlations
  - GIS Leak Mapping
  - Leak Detections and Repair Work Order Integrations
  - AMR and AMI System Integrations
  - Analytics Software Integrations
    - CIS System, GIS, AMR/AMI, SCADA

Underground Leak Mapping

LEAK VISUALIZATION DASHBOARD



Underground Leak Mapping



Methods of Leak Detection and Water Loss Management

- **Metering**
  - End-point Meter Flow Monitoring (AMR/AMI)
  - End-point Meter Acoustic Detection (AMR/AMI)
  - Pipeline Assessment
    - Video Inspection
    - Ultrasonic Assessment
    - Vibration monitors
  - District Metering Areas
    - Permanent and Temporary Meters

AMR/AMI Meter Leak Detection

Leak Detection based on low flow

Meter Acoustic Leak Detection

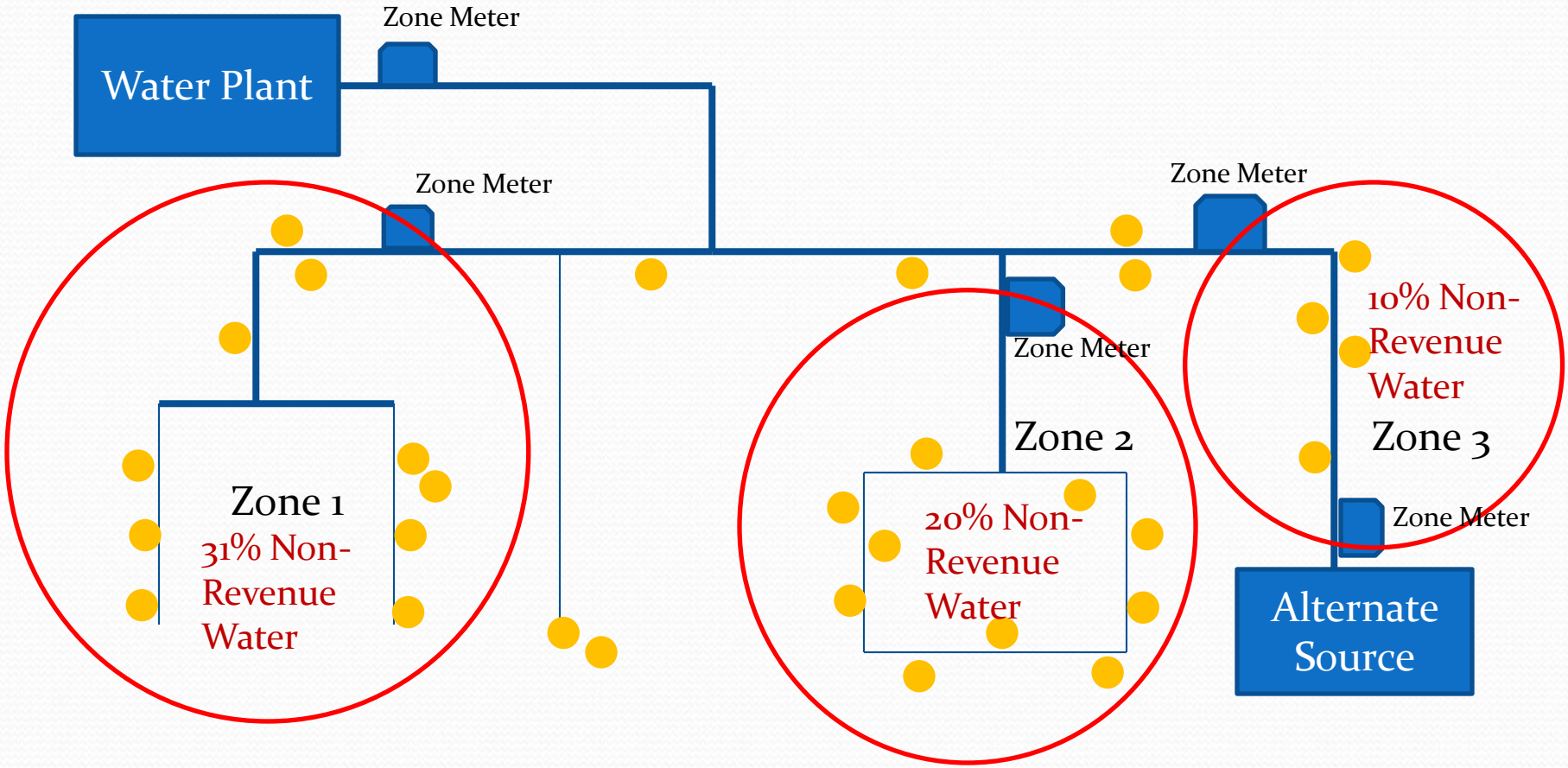
District Metering Zone Leak Detection

AMI Pressure Monitors

District Metering Zones

- Overall System Leak Detection with DMZ (DMA)
  - District Metering Zone (or Area)
- Meter all sources
- Meter all end users
- Synchronize Meter readings as much as possible
  - AMI daily reads is more accurate than monthly
  - AMR Read by zone
  - Time of day reads if possible
- Install Zone meters for sections of the system

District Metering Zones



Clamp-on Ultrasonic Meters

Temporary Portables

- Flexible fit to any size line ¾” to 79”
- Data logging for flow total and flow rates
- Short term or long term deployments

Clamp-on Ultrasonic Meters

Permanent Installations

- Install on live lines in minutes
- Can tie-in to SCADA or AMR/AMI systems
- Bi-directional flow on looped lines
- No line cut-ins, strainers, or check valves

In Pipe Hydrophone Camera

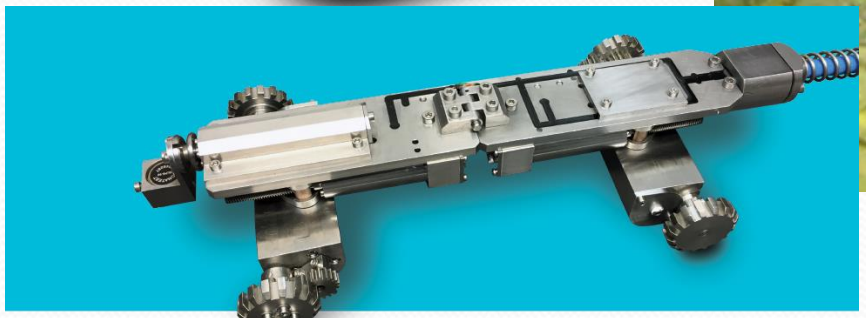
AQUAM

PIPE DIAGNOSTICS

Live Water Main Diagnostics

- Video Inspection
- Hydrophone Leak Detection
- Pipe Locating Sonde

In Pipe Hydrophone Camera

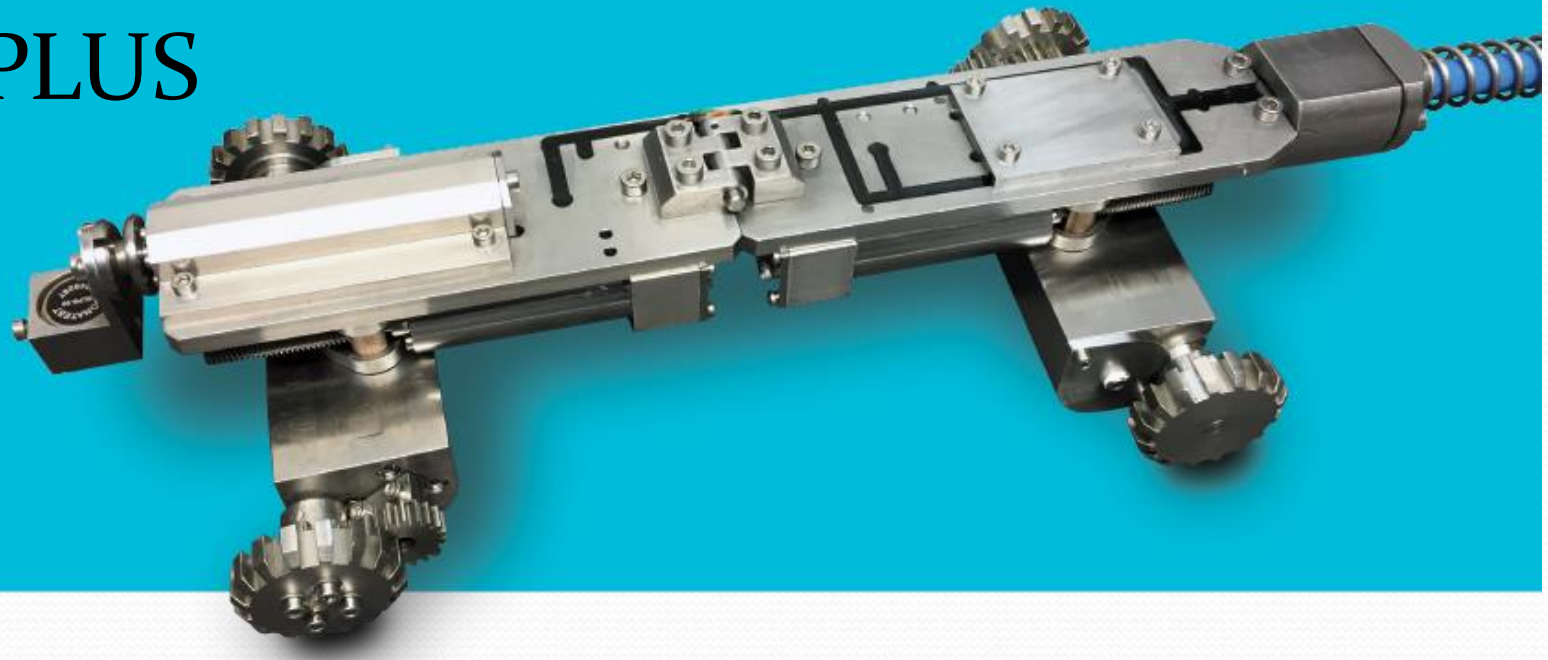


Hydrophone/Camera/Sonde

Hydrophone/Camera/Sonde

AQUAM
PIPE DIAGNOSTICS

AMPLUS

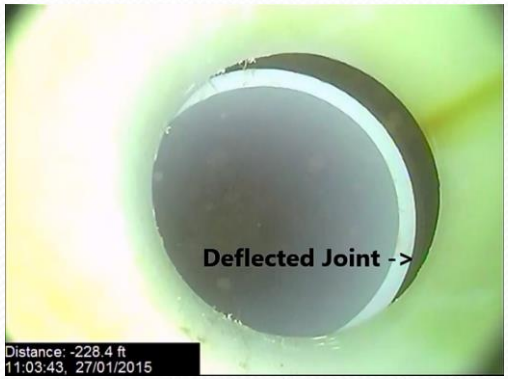


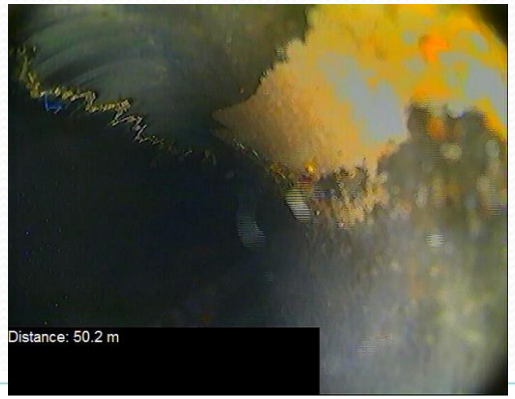
Hydrophone/Camera/Sonde

Hydrophone/Camera/Sonde

Pipe Diagnostics
Visual Inspection

AQUAM
PIPE DIAGNOSTICS





- Obstructions
- Deflected Joints
- Fractures
- Tuberculation
- Air Pockets
- Sedimentation

Continuous Pipe Monitoring

Key Features

- Condition Monitoring
- Legionella Condition Alerts
- Leakage Alerts
- Flow Events and Alerts
- Vibration Monitoring
- Pressure Monitoring
- Freeze Alarms
- Predictive Maintenance Alerts

Continuous Pipe Monitoring

Key features:

- Fire Hydrant Monitoring
- Usage And Tamper Alerts
- Leakage Alerts
- Temperature Efficiency Monitoring
- Flow Events And Alerts
- Vibration And Seismic Monitoring

Continuous Pipe Monitoring

Key features:

- Condition Monitoring
- Predictive Maintenance Alerts
- Leakage Alerts
- Pressure Drop Alerts
- Freeze Alarms
- Flow Event Monitoring
- Vibration Alerts
- Seismic Alerts

Replace Detector Check or Fire Line Meters without anything in in-line flow!

A Comprehensive Guide to Water Loss Management Solutions

Questions ??

Utility Technologies, LLC

Technology Solutions for Efficient Utilities

A Comprehensive Guide to Water Loss Management Solutions

Mark Beatty, Principal Owner/CEO

Sales@utility.biz | 513-488-1940