



Cry Havoc! and Lend Me Your Ears

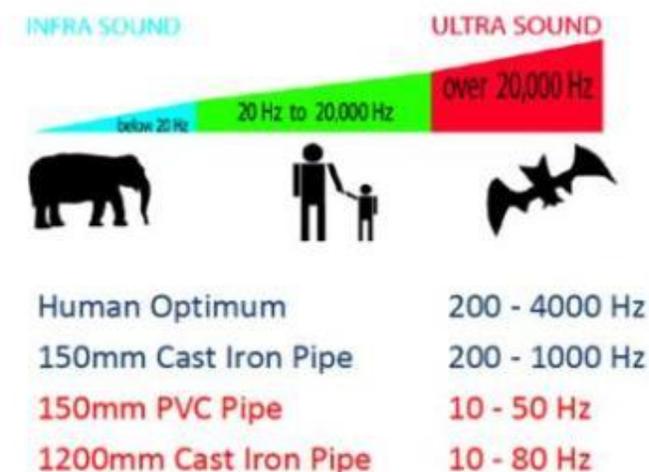
Dave Hughes, American Water

Russ Titus, New Jersey American Water

Ears to Hear Leak Noise

- Vibration occurs when water leaks from any pipe.
- Small leaks higher frequency
- Everyday vibrations (e.g., traffic, HVAC and electrical equipment) make noise make distinguishing leak
- Continuous customer water use generates similar sound.
- Humans hear from 20-20000 Hz; runs about 10-250 Hz

*“Give every man thine ear
but few thy voice”*



Monitors Deployed to Listen Daily

- Leaking water takes the path of least resistance
 - Leaks don't always surface (especially the small, constant or slowly increasing leaks)
 - May surface far away from the leak
 - Leaks may occur in places difficult to access (e.g., under a stream, highway or wetland)
- Pinpointing a leak early
 - Reduces water loss
 - Reduces damage
 - Lowers repair cost

“Better three hours too early than one minute too late”



Continuous Acoustic Monitoring Units

- First deployment with AMI 2005 at American Water
 - Finds most subsurface leaks
 - But fails to find leaks where leaks travel through different materials
 - Has issues discerning leak noise and other sounds
- Various firms work on improvements
 - Units moved from service line to mains and hydrants
 - Sensitivity to low frequency leaks improved
 - Better discrimination algorithms
 - Correlating units to pinpoint location
 - AMI options improve including cellular systems

What's past is prologue



Benefits of Continuous Acoustic Monitoring

- Saves water treatment and pumping costs by reducing lost water with early leak detection
 - Average leak goes undetected minutes to over a year
- Avoids bigger leaks and catastrophic bursts by early repair
 - Less subsurface damage
 - Less collateral damage
 - Reduces bad publicity and elevated customer dissatisfaction
- Saves repair costs by increasing planned repairs
 - Prioritizes limited capital and maintenance spending
 - Reduces emergency conditions, overtime

*Eye of newt, and toe of frog,
wool of bat, and tongue of
dog, Adder's fork, and blind-
worm's sting, lizard's leg, and
owlet's wing, for a charm of
powerful trouble, Like a hell-
broth boil and bubble.*



Echo Shore DX

- Pipe Materials:

- Designed to work on all types and sizes of distribution pipes
- Extensive testing completed on:
 - AC, Metallic pipes
 - Pipes with up to 20 feet of PVC repair or multiple PVC repairs
 - Testing on PVC pipe system in progress
 - Spacing 200 meters (100 meters for PVC)

- Pipe Sizes:

- Targets up to 12" diameter pipe
- Detects leaks off of services lines.

But for my part, it was Greek to me



Leak Noise Correlation

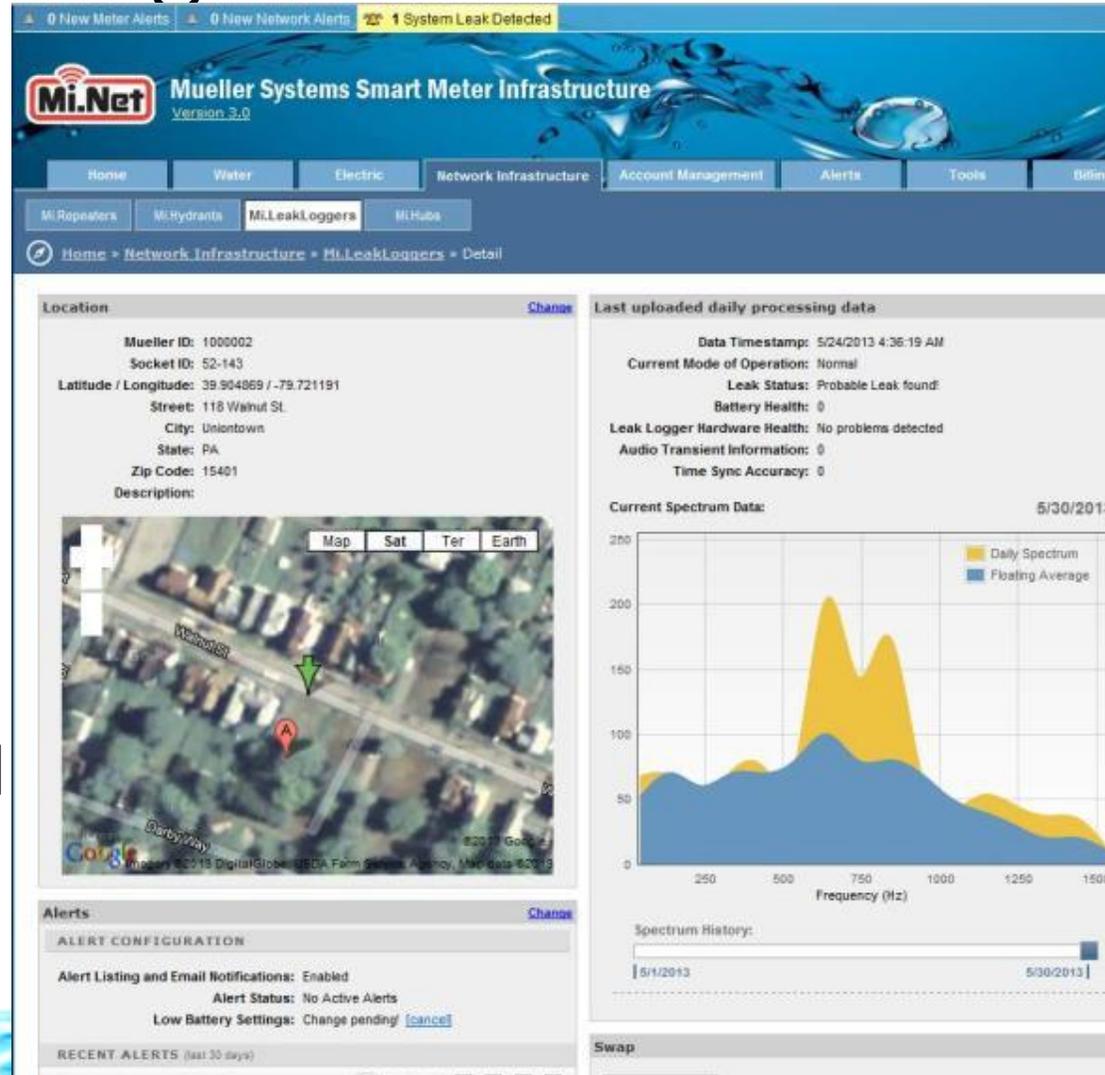
Tis neither here nor there

- Vibration travels at known speeds in pipes of specific material and size (important to know distances, diameters and materials of pipe).
- Sensors on either side of suspected leak location can bracket the sound. If a leak is not between sensors, the instrument can direct
- Sensors listen simultaneously and deliver the data to a receiving microprocessor (PC)
- PC displays a profile of the leak noise and provides a location for the leak based on distances and pipe information given to the PC.



Daily Data Gathering = Time Based Analysis

- Displays daily data collected at the logger
- Allows the user to see changes over time in a continuous manner
- Also reports health and status of each logger

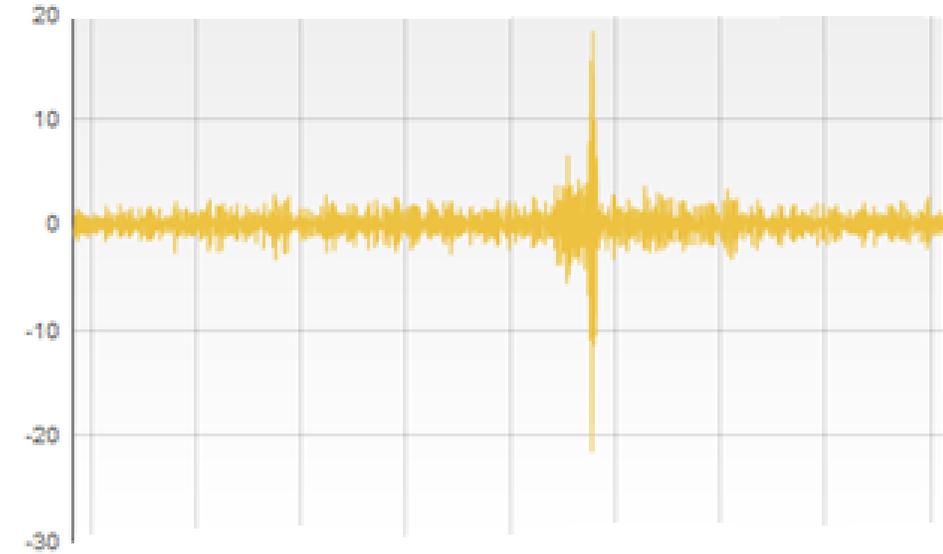


The time is out of joint—O cursed spite, that ever I was born to set it right! Nay, come, let's go together.

Beta Test Detection Suspect

True is it that we have seen better days,

- First leak detected acoustically but was already surfacing
 - Noise dissipated with repair
- Second leak detected acoustically
 - Correlated by hydrants 930 feet apart
 - Leak not surfacing, not detected initially by ground microphones
- Second leak persists and increases in volume after 3 weeks
 - Ground microphone detects increasing noise
 - Decision to excavate and correlate at excavation if necessary



Charleston, West Virginia

- Acoustic Monitoring deployed and operating
 - 386 final product units deployed in river valley area
 - Charleston has significant NRW 13.5 MGD in 2014
- First 6 months
 - Has reduced NRW about 2 MGD
 - 60 leaks that were not surfacing have been identified
 - Adding an additional 500 monitors

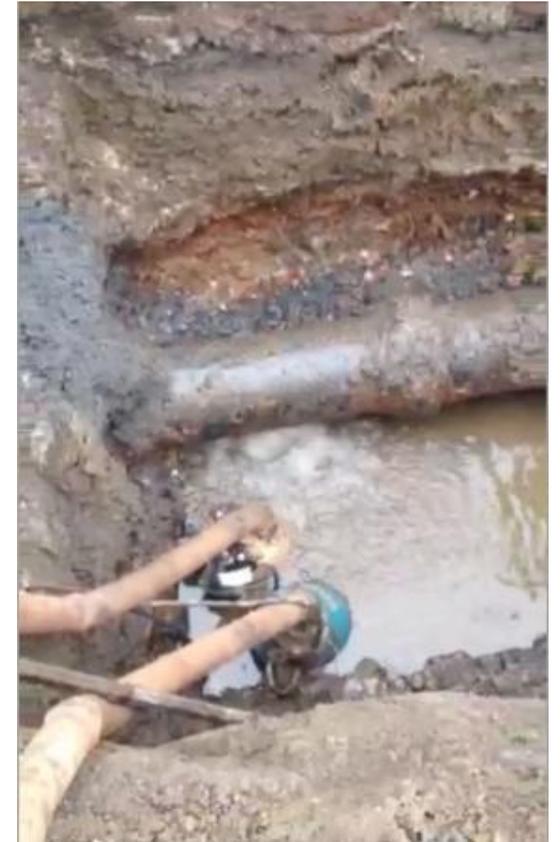
Fortune brings in some boats that are not steered



Washington NJ - April 2016

“Empty vessels make the greatest sound”

- Correlating issue with dead ends
 - Can't correlate “out of bracket” leaks
 - But can hear them
- Finding “out of bracket” leak
 - Leak heard 1900 feet from monitor
 - 80-100 gpm leak running underground
- Finding in bracket leak
 - split on bottom of 8" main
 - 80-85 GPM
 - 59' from sensor



Washington, NJ Acoustic Monitoring Summary

- March, 2016: First Point of Interest (POI) investigations in Washington district
 - Results were immediate with 5 non-surfacing leaks being located within the first month
- March, 2017:
 - 173 POI hits
 - 85 leaks repaired, 32 investigations pending
 - Estimated 1,576 gpm in leakage eliminated
 - \$807,138 in Annualized Production Avoidance
 - \$1,053,138 estimated Total Annualized Savings

*The better part of
valor is discretion*

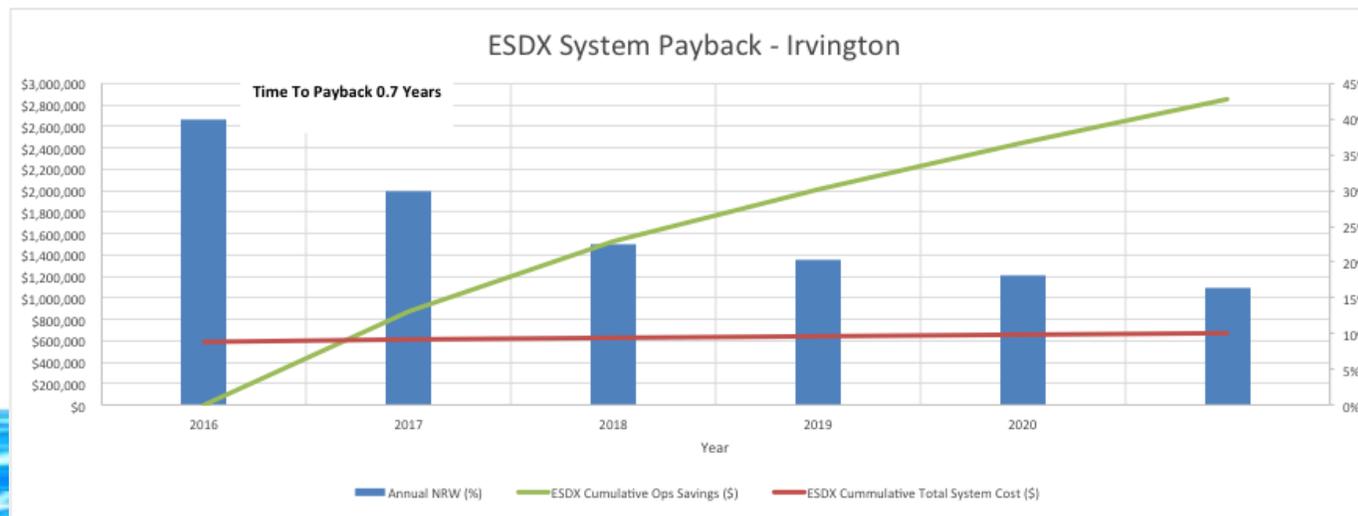
Washington and Belvidere Systems *Results*

- System was proactively surveyed previously by internal and external resources
- 15 leaks repaired
- Estimated flow of all leaks located 410 GPM
 - No leaks were surfacing at the time of location
 - Deferred capex investment value TBD
- Steady reduction in NRW %
 - 1/31/2016 – 27.7% 1/31/2017 – 23.2%
- Total VPC avoidance: \$117,014

*Though this be madness,
there is method in it*

City of Irvington System *Results and Benefits*

- No surveys performed in Irvington due to safety concerns
- April, 2016: First POI investigation
- March, 2017: 67 leaks repaired (880 gpm found)
 - Over 90% of leaks located were not surfacing at the time location
- 1/31/2016 - **27.3%** 1/31/2017 - **24.4%**



An honest tale speaks best, being plainly told

New Egypt System *Results*

- Annual Leak Surveys found no leaks
- MNF analysis indicated loss was about 36 gpm
- System found 2 leaks
- Deferred capital expenditure of \$1 million +/- for new well
- 1/31/2016 – 46.9% 2/28/2017 – 10.2%

Delays have dangerous ends

ECHO Shore Features

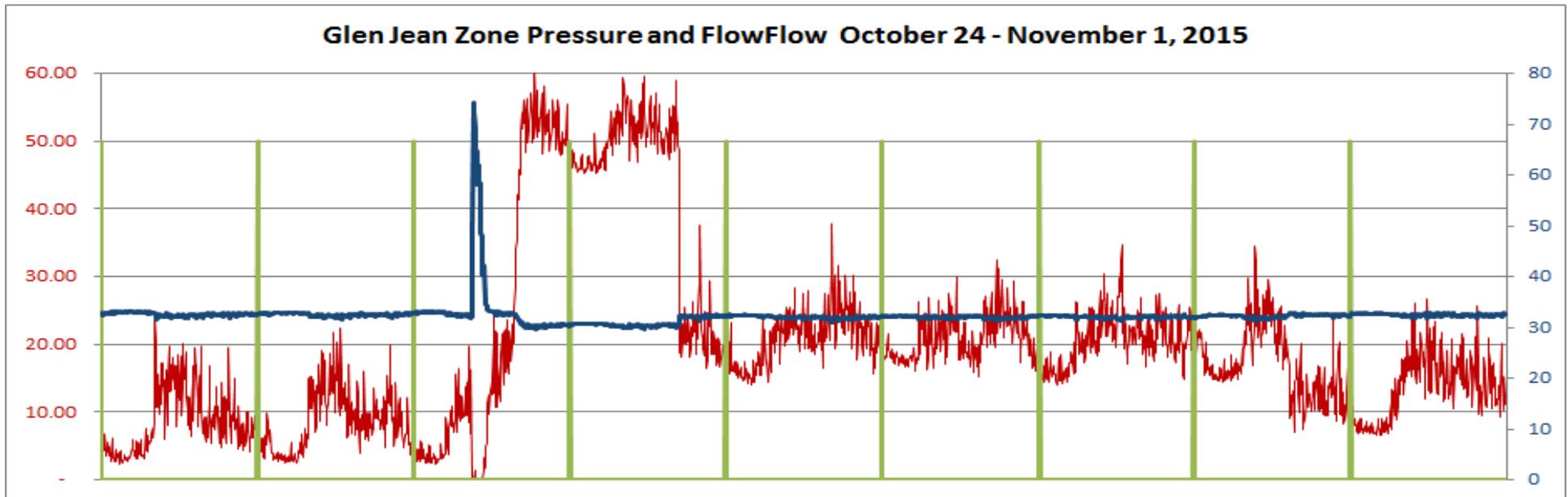
Have more than thou showest, Speak less than thou knowest

- Always on
- Less false positives (90% +)
- More data efficient than other correlating loggers
 - Battery life, transmission reliability
- Above the ground units
 - Radio reception reliability, better environment, etc.
- One company responsibility
 - Mesh network and leak detection
 - Cellular communication also available



System Metering

- Simple profiles of small zones has been effective in detecting leaks



All's well that ends well

Leak Detection from the Silence of Space

- Satellite Technology from Utilis

- Able to detect subsurface chlorinated water
- Provides one time, monthly or quarterly updates
- System verified Melbourne, EBMUD, Tennessee American 30-60% hit rate
- Fund project to test in Los Angeles systems

It is not in the stars to hold our destiny but in ourselves

