Find Leaks Before They Find You:

Using Acoustic Technology to Transform Leak Detection Programmes from Reactive to Proactive

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Leak Detection Programs

Alert

- General observation
- Customer complaints
- Pressure drops
- Utilizing technology for early detection

Respond

- General observation
- Physical digging
- Utilizing technology to pinpoint leaks

Manage

- Utilizing Technology for
  - Recording, classifying & prioritizing leaks
  - AI advancements
  - Asset management

Leak Detection Technology

Thermal Imaging	Camera Inspection	Satellite
Work Order Applications	Ground Penetrating Radar	Acoustic Leak Detection
In-line Inspection	Electromagnetic Inspection	Customer Feedback Applications

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More Than Just NRW

Risk Mitigation

Sustainability

Reduction of Environmental Impact

Operational Efficiencies

Regulatory Compliance

Customer Service

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Acoustic Leak Detection

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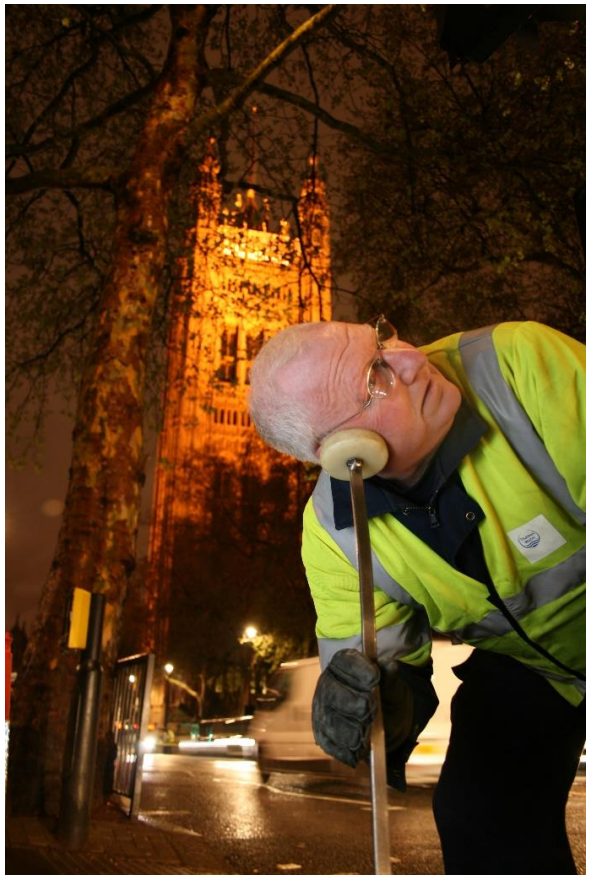
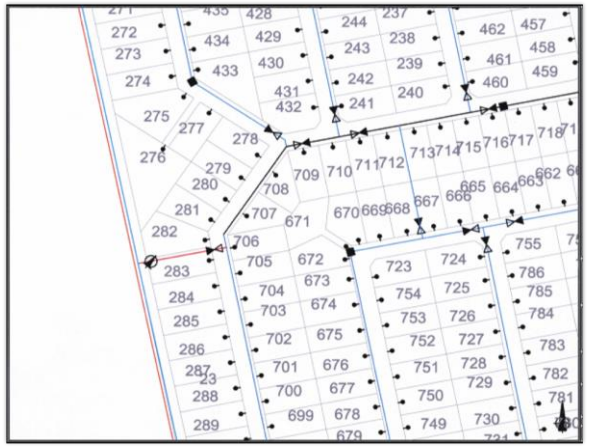
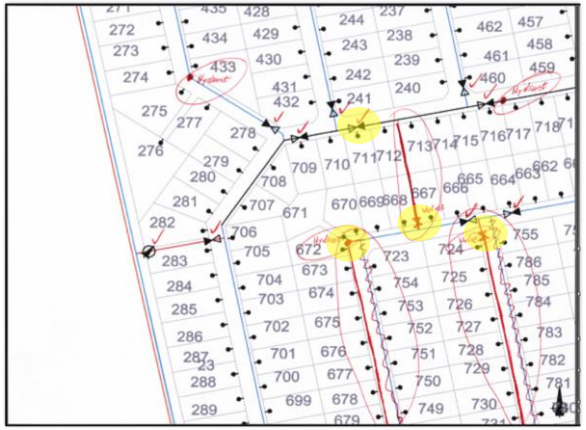
Acoustic Listening in Field Surveys



- Listen at fittings along the pipe network
- Highlight fittings with louder sound
- Circle back to investigate highlighted areas





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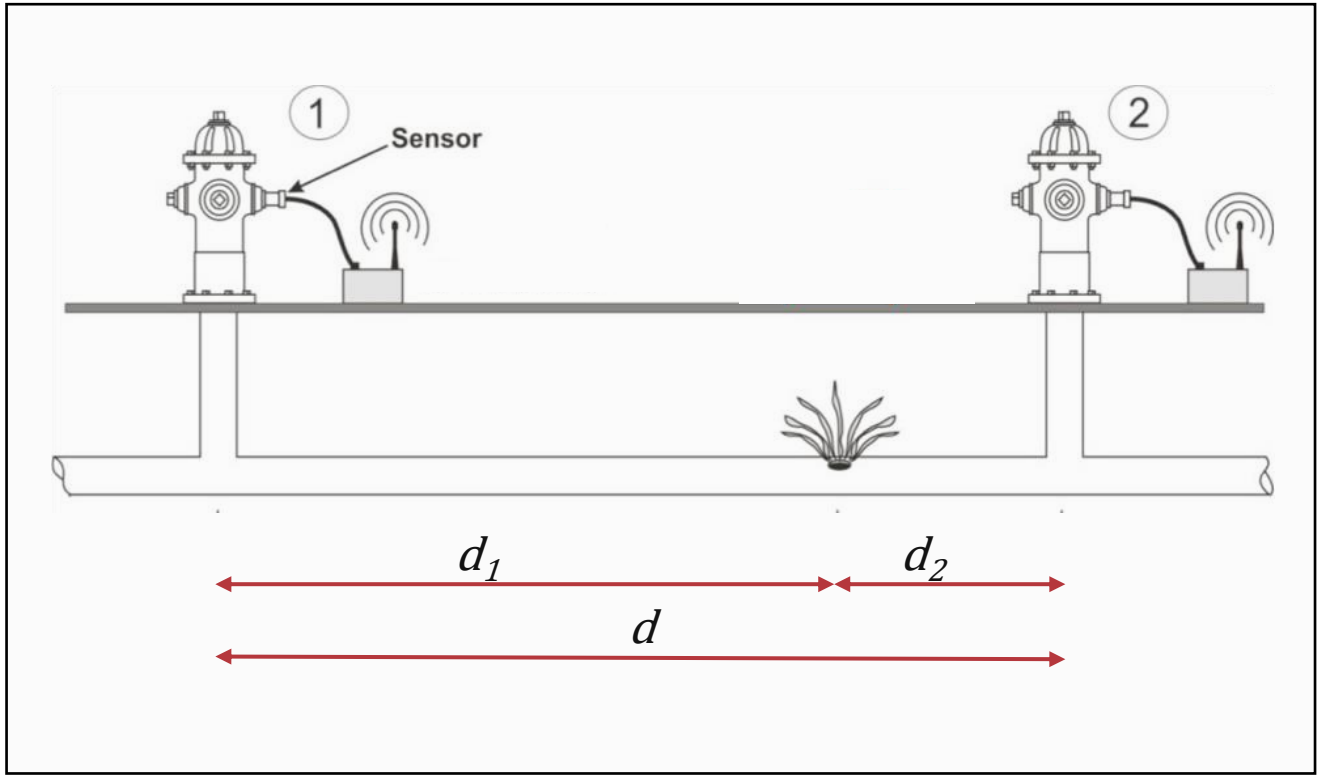
Acoustic Correlation for Leak Detection



$$d_1 = \frac{d - ct_d}{2}$$

$d_1 = distance\ to\ leak$

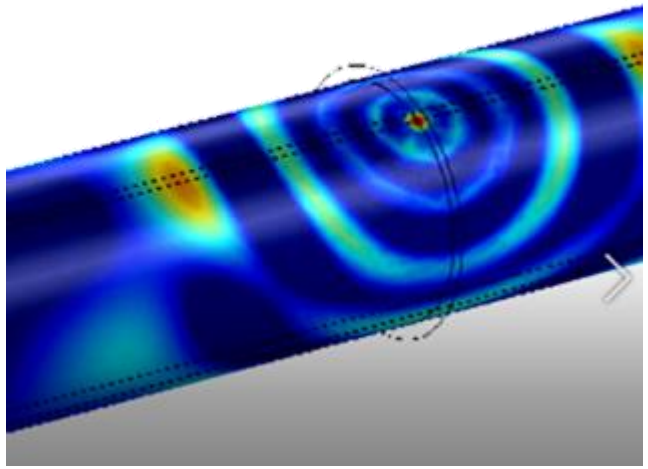
$d = distance\ between\ sensors$

$c = pipe\ wavespeed$

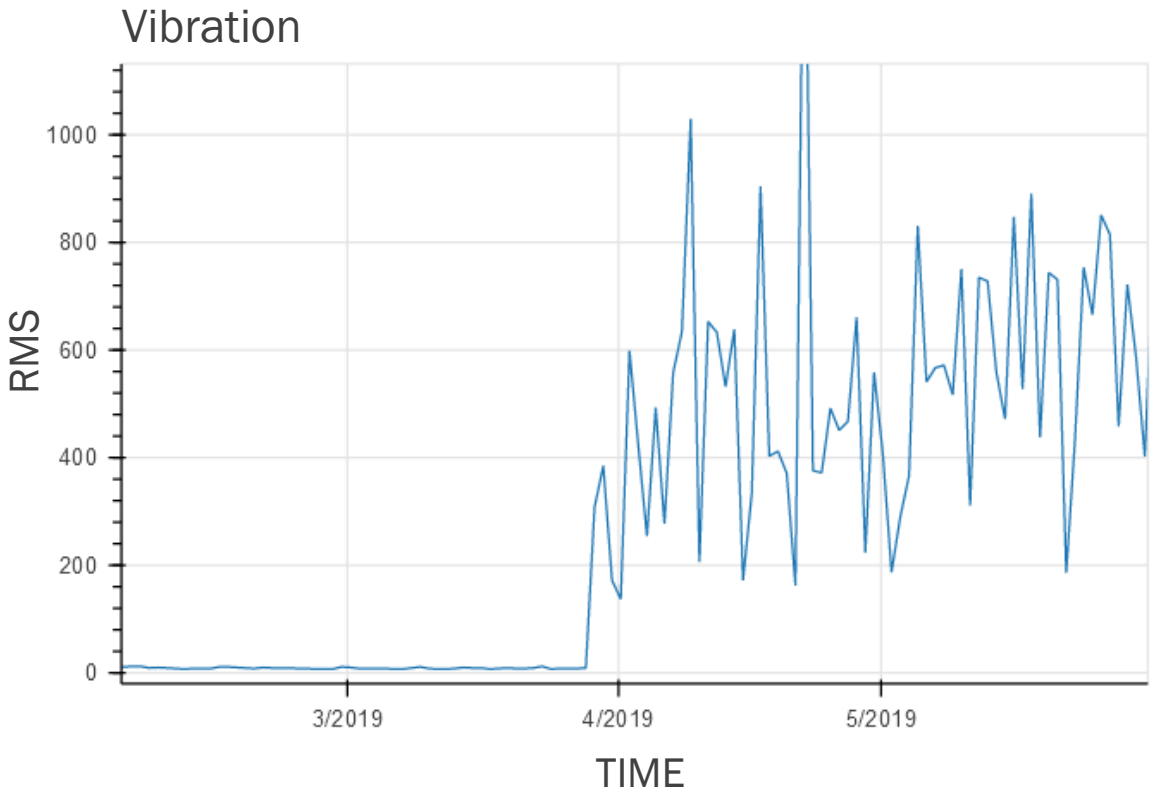
$t_d = time\ delay$

Leak Detection Principles

- Leaks generate acoustic noise
- Pipes are good acoustic wave guides. Acoustic waves can propagate over a long distance
- Acoustic waves can be detected using hydrophones (sound pressure) or accelerometers (vibration)



Change in Sound Pressure



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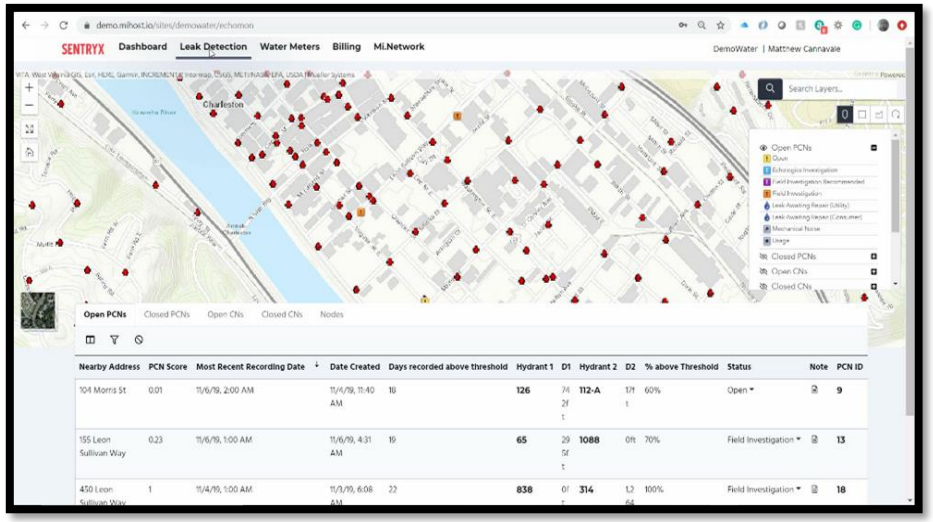
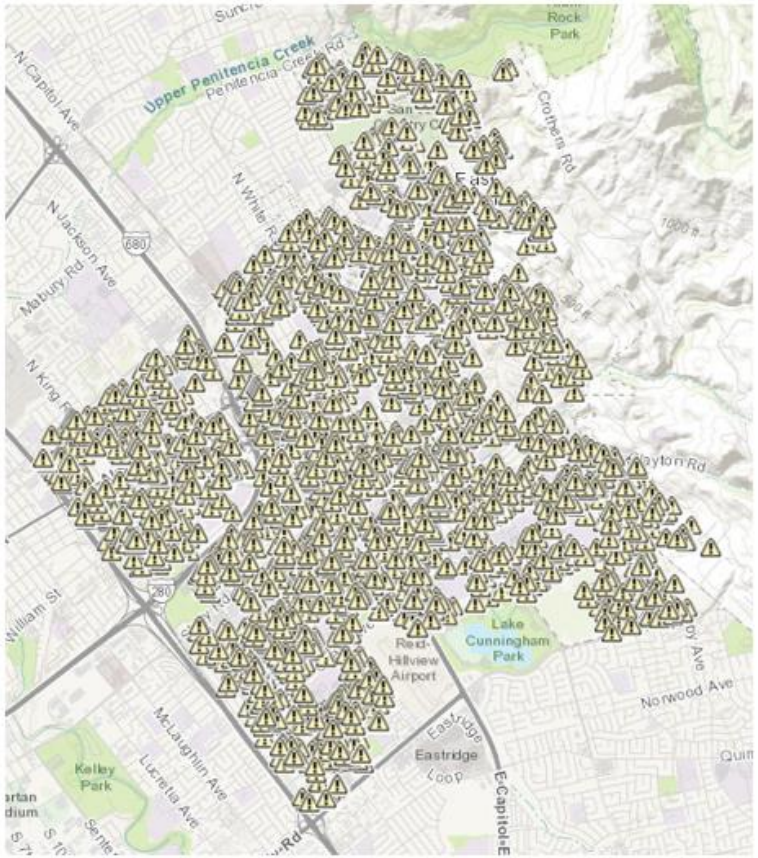
Permanent Acoustic Leak Monitoring System

- Devices installed at access points throughout the network
- Scheduled data capture and upload



- Backend data analytics
- Managed monitoring and leak reporting
- Leak investigation support

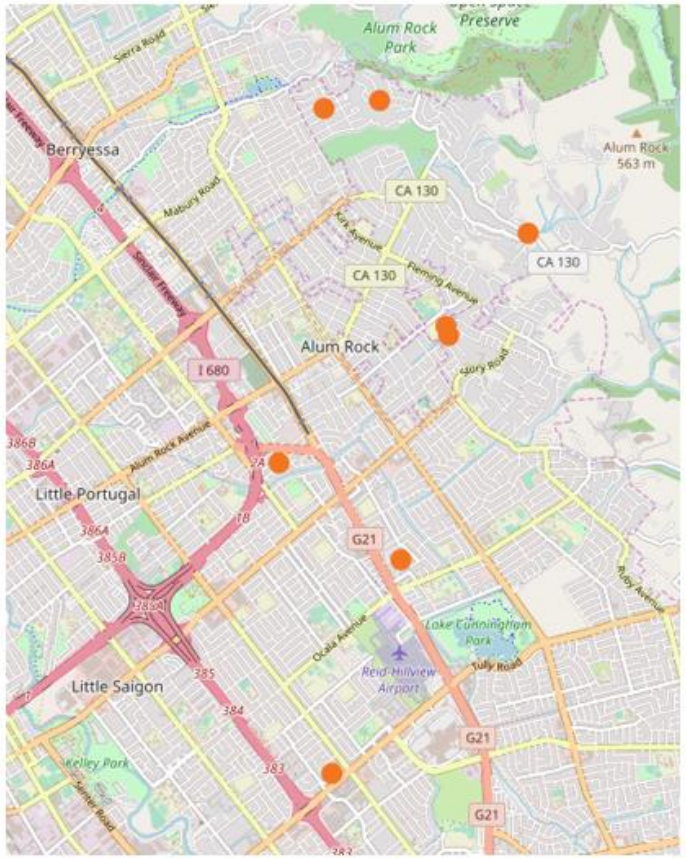
Data Flood Problem in Acoustic Leak Detection



29,297 network noises

Leaks are not the only noise sources

- Ambient noise: weather, traffic and construction equipment
- Usage create noise too
- One leak detected at multiple locations by multiple sensors



8 investigations recommended

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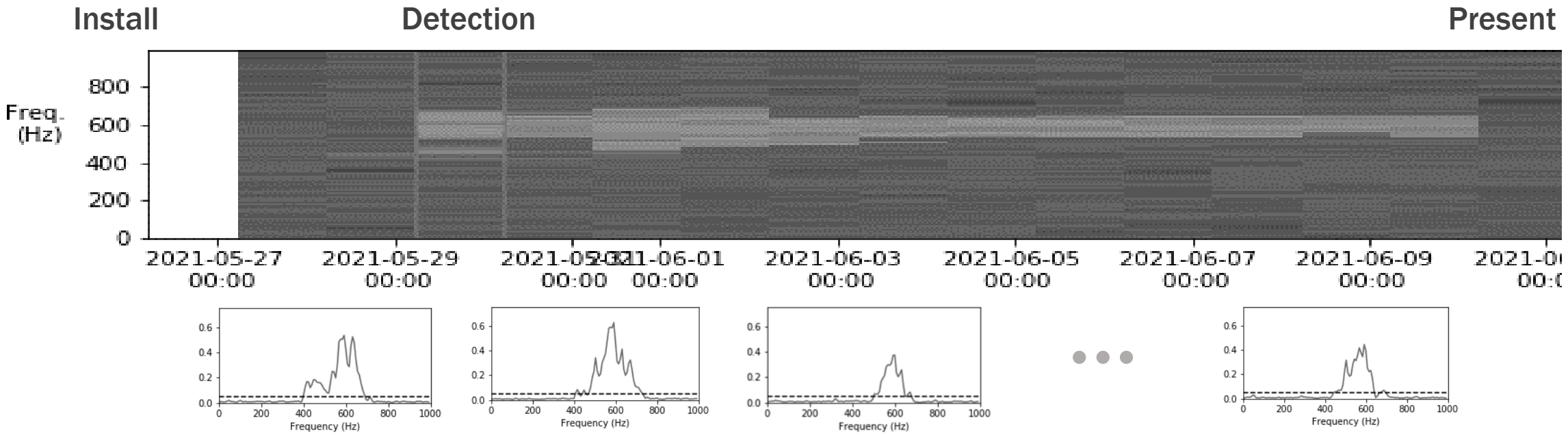
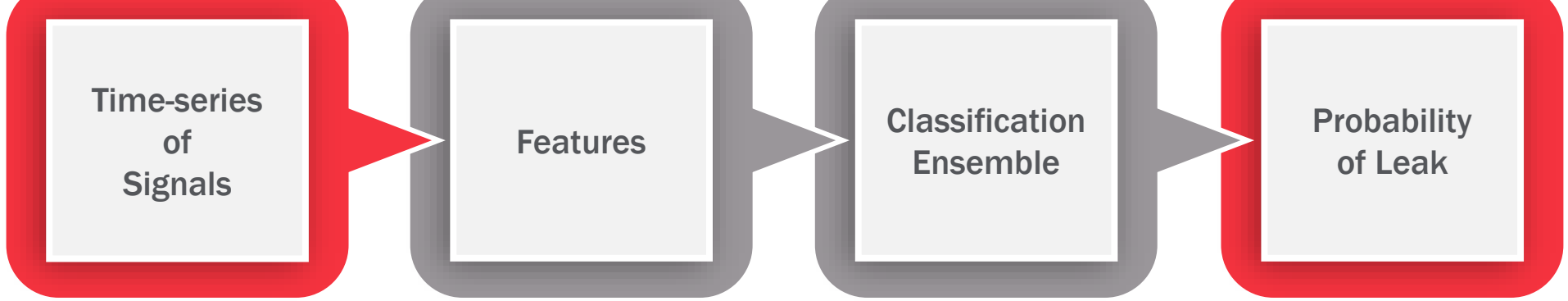
Leak Classification framework





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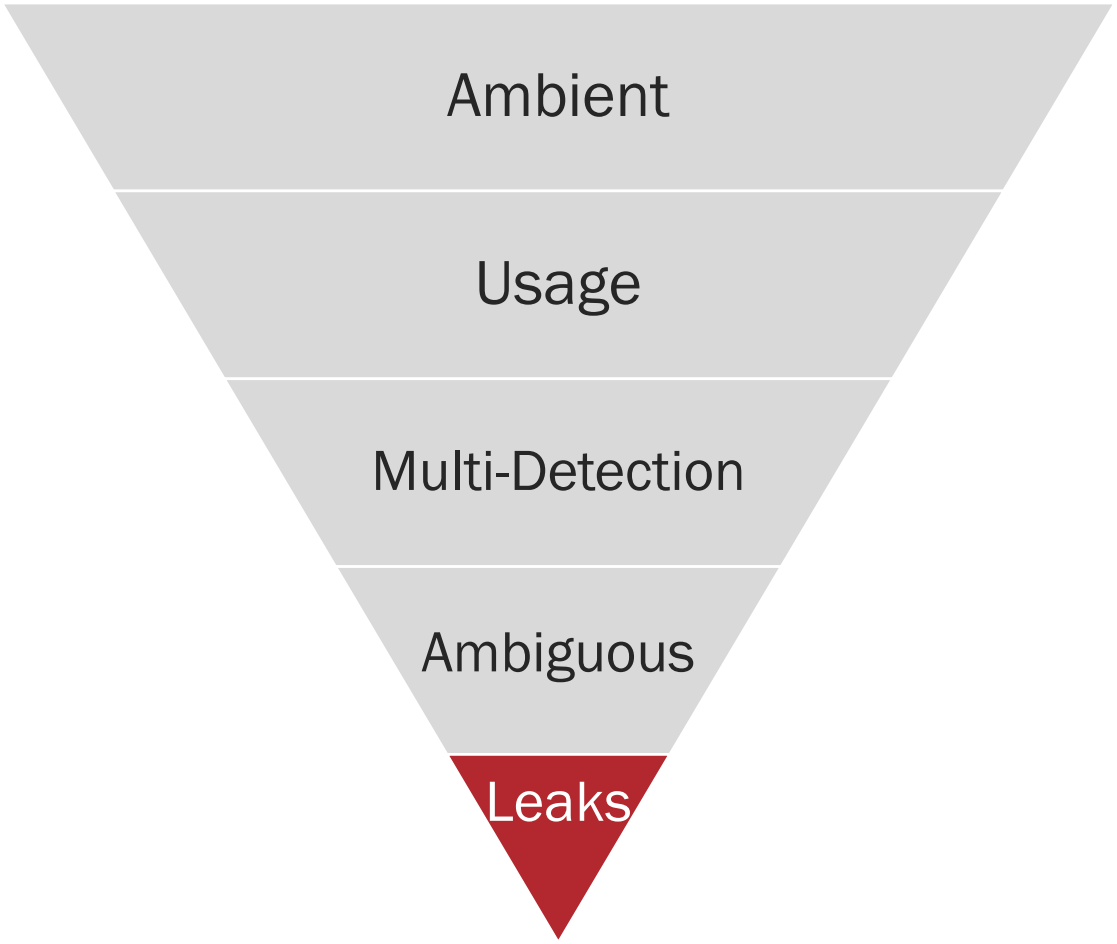
Leak Detection - Events Classification



- Correlation reduces false detection caused by weather, traffic and construction equipment.
- Heuristic filter identifies usage.
- Unsupervised Clustering groups multiple events caused by the same source. Accurate leak localization.
- Advanced Time-series ML algorithm resolves ambiguous intermittent sources

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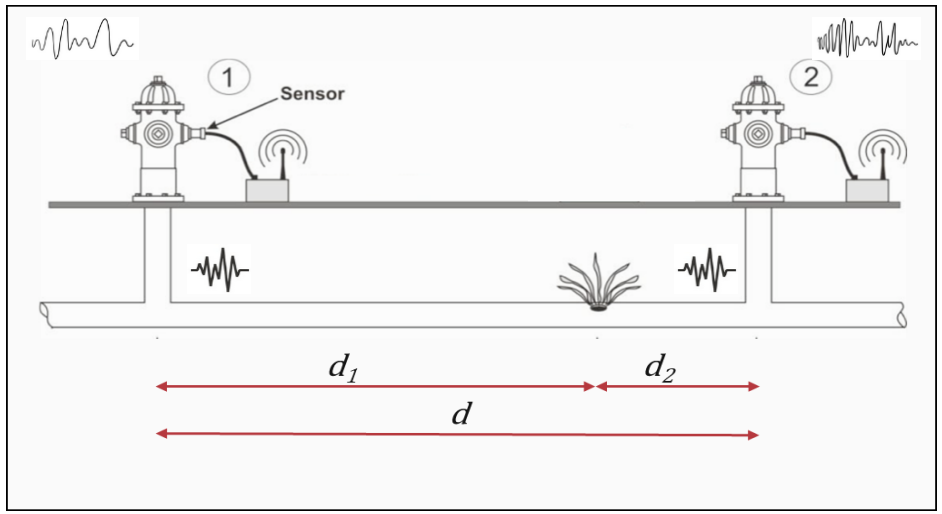
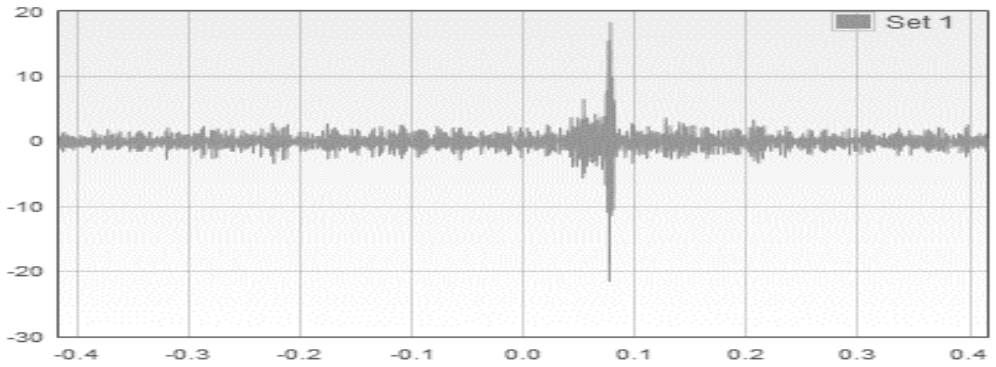
Correlation Leak Detection





Event Classification

- Ambient
- Usage
- Multi-Detection
- Ambiguous
- Leaks

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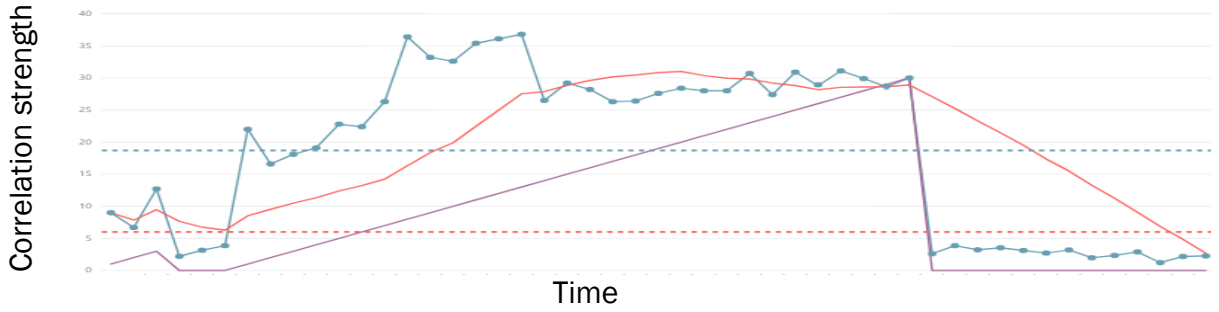
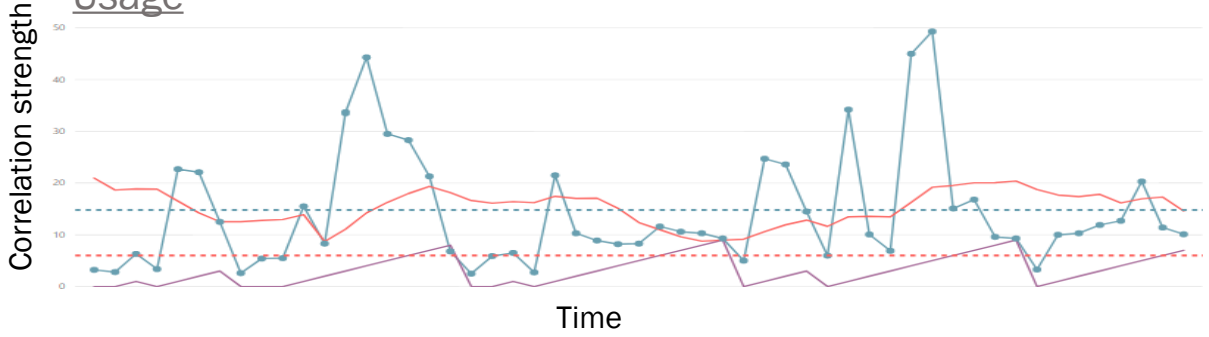
Persistency Test

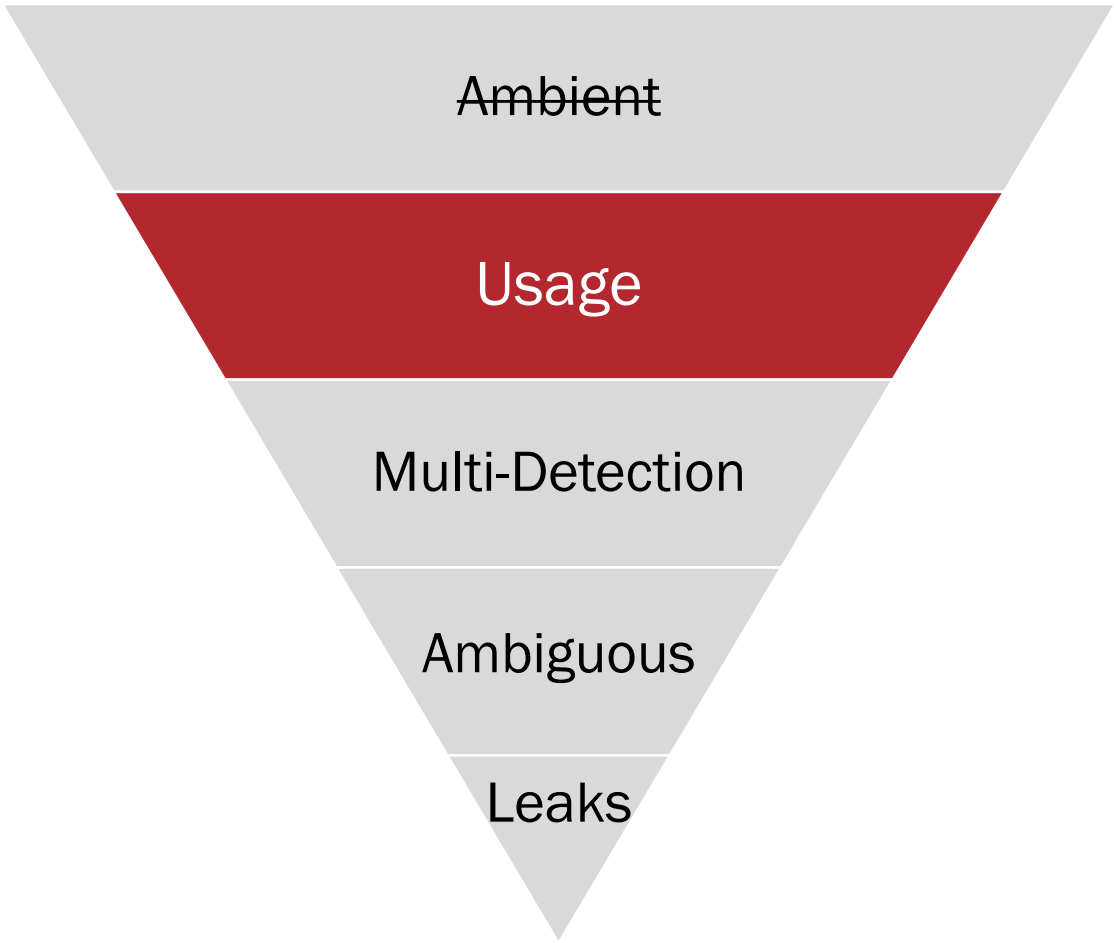
Main Leak



Usage



Event Classification



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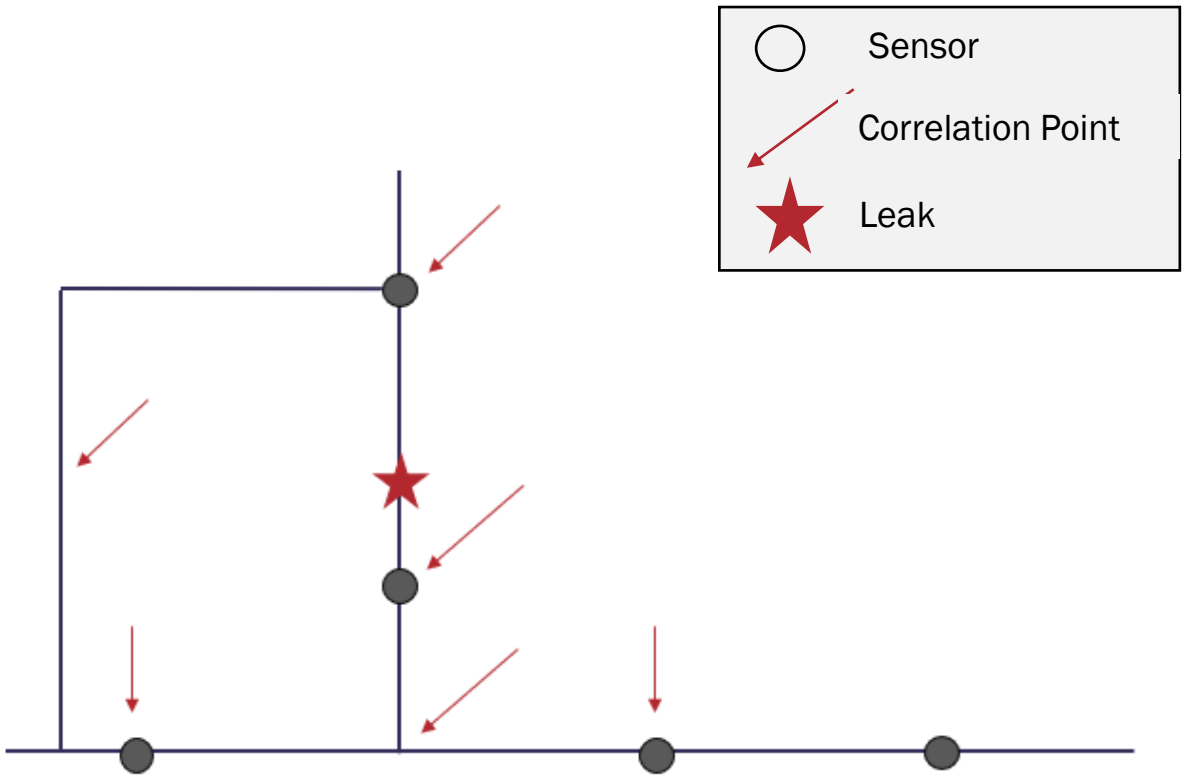
Event Clustering



Event Classification

~~Ambient~~

~~Usage~~

Multi-Detection

Ambiguous

Leaks

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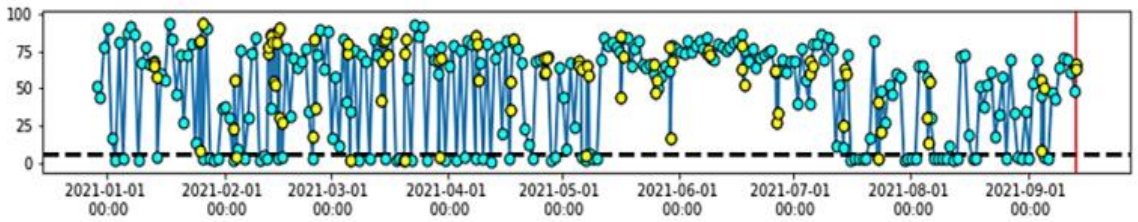
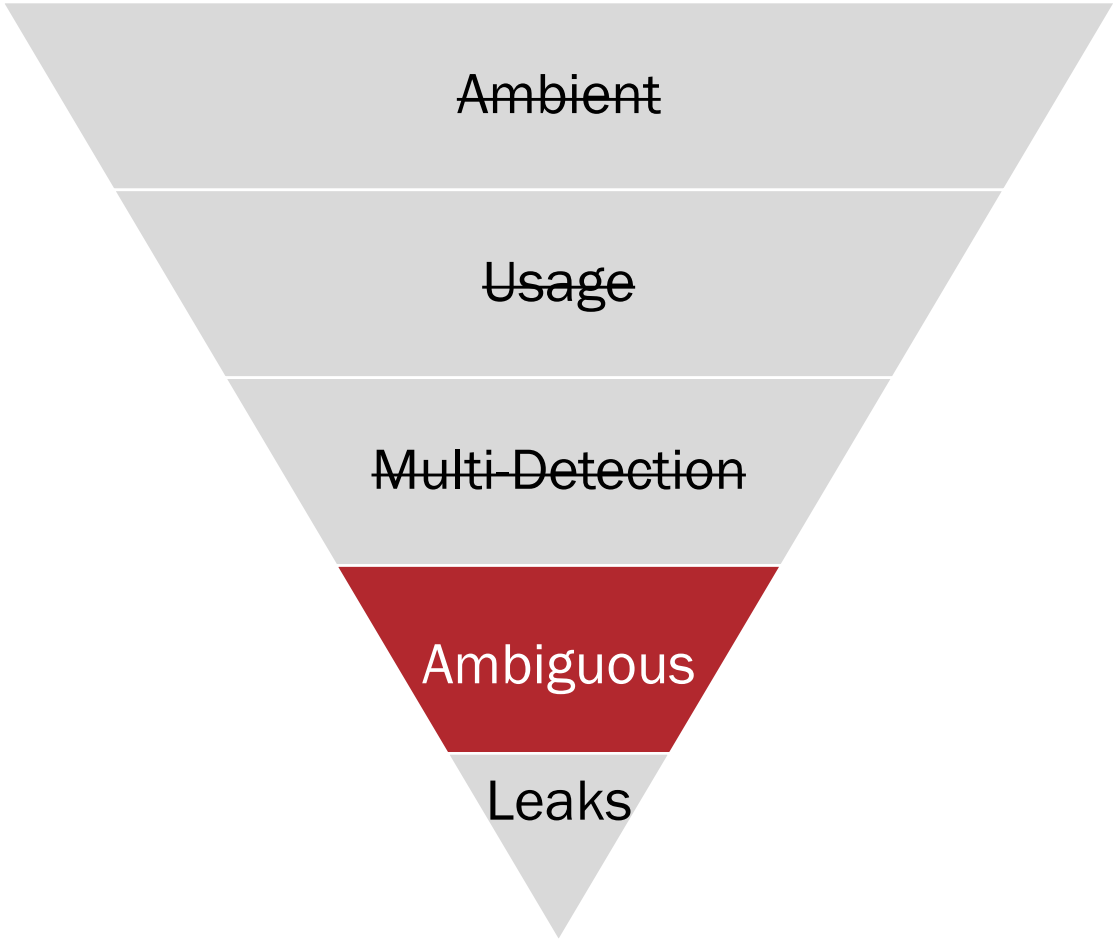
Ambiguous Noise Sources

- Leaks with intermittent sound due to pressure variation
- Non-flow sources that present similar characteristics (i.e. pressure regulators)



Hypothesis: time-series statistics is different for different event classes

Event Classification



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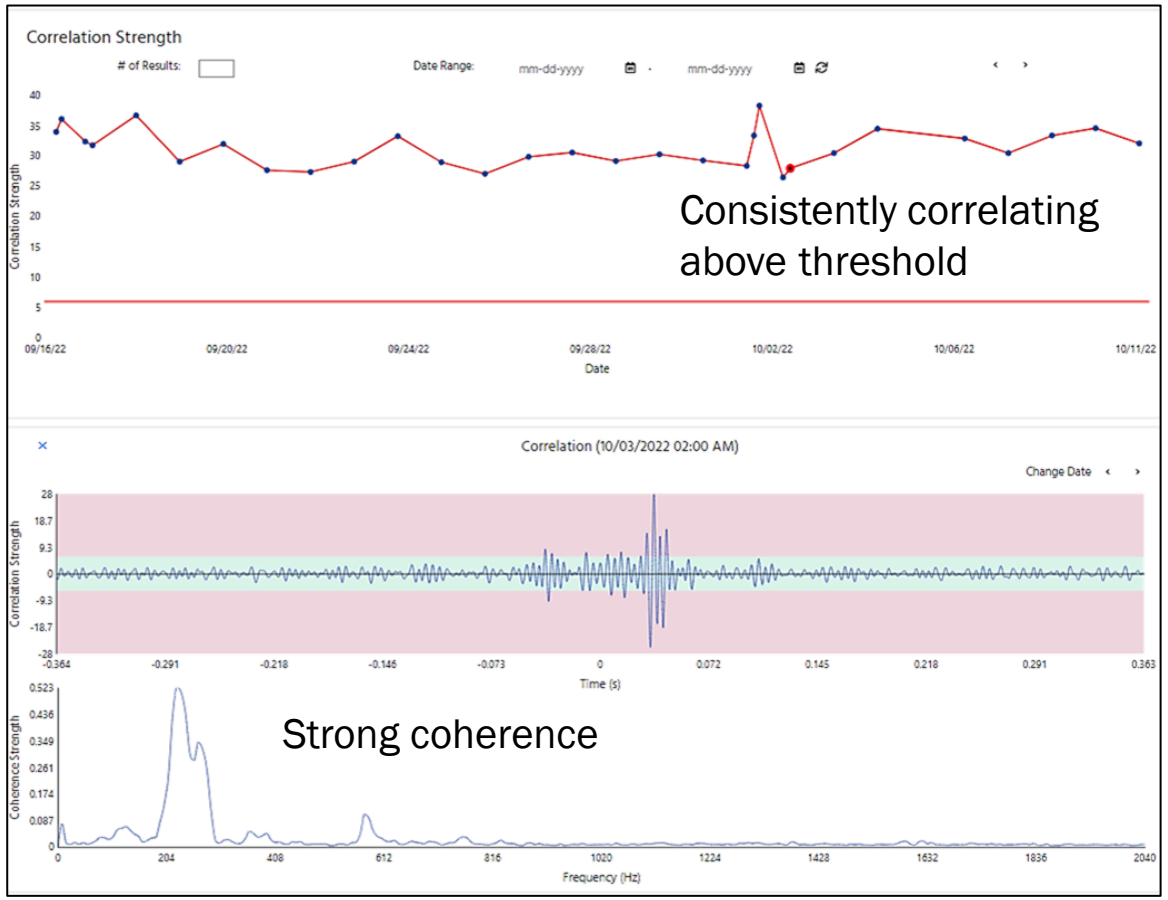
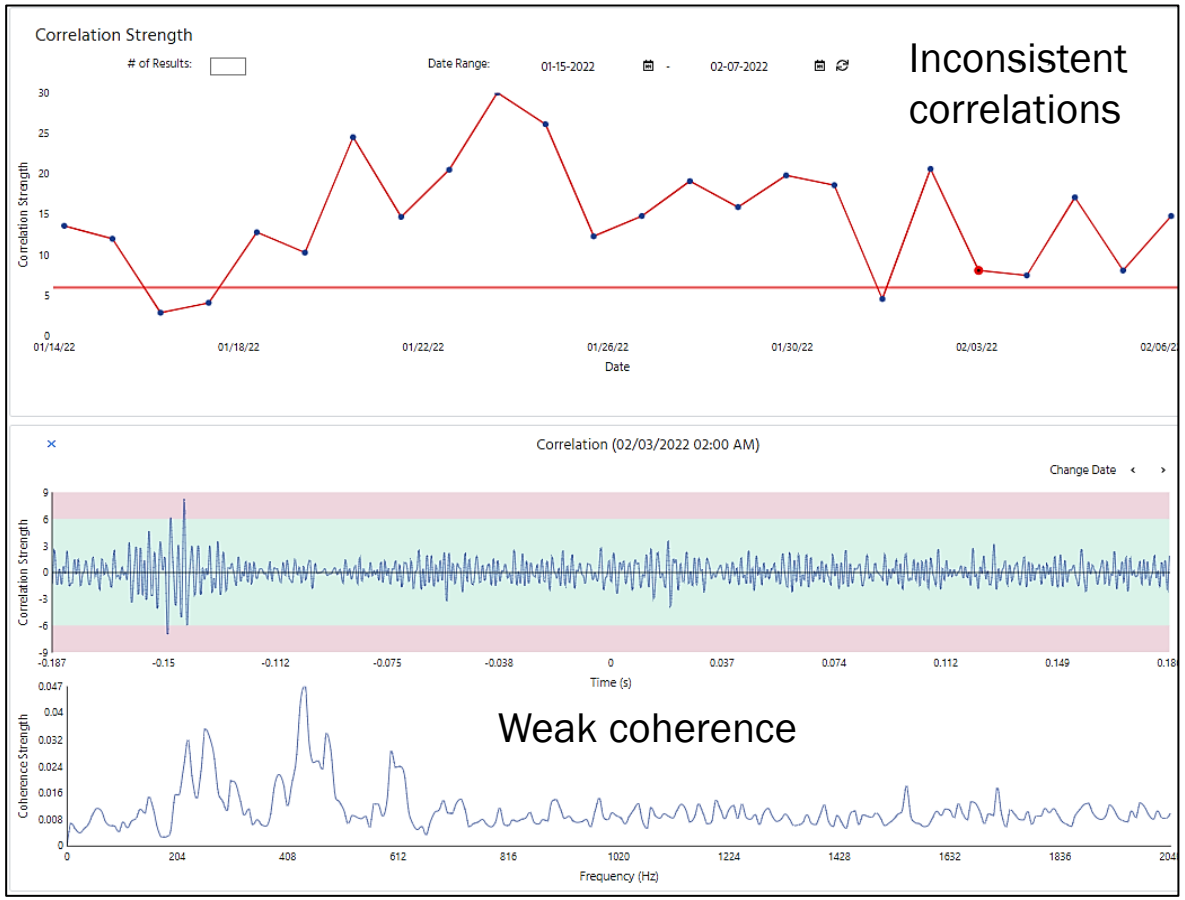
Identifying leaks





No leak
AI Score = 6%

Leak
AI Score = 77%

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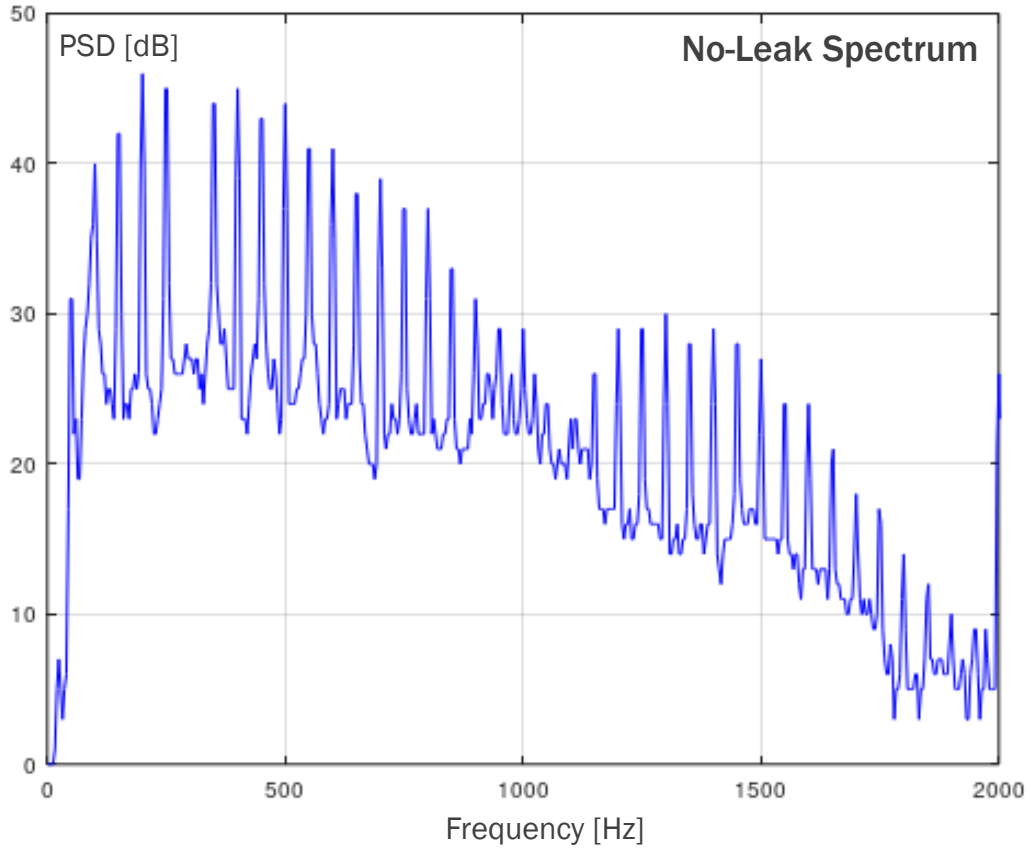
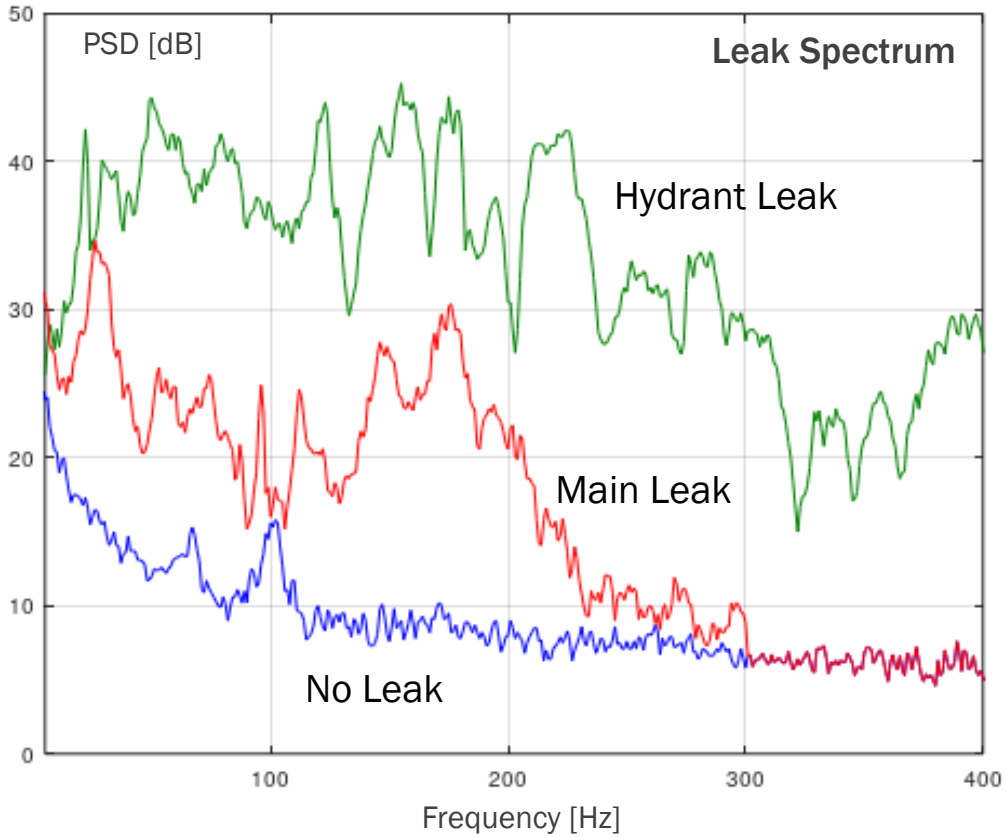
Spectrum Patterns

Spectrum includes information about the nature of the source





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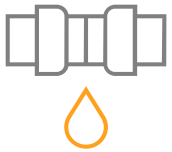
Key Takeaways

Technology added to a LD programme can increase the ability to be proactive



Acoustic leak monitoring systems are effective at finding leaks on water pipe networks

The challenges of technology (and related solutions) can lead to more valuable insight for your LD programme

Machine learning algorithms reduce significantly (x 100) the number of qualifiable acoustic events

The benefits of investing in a proactive leak detection program extend far beyond NRA.

Any Questions?

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