hydraulic analysis group

NWWC 2024 Conference

Managing Water Losses

Optimizing Sensor Placement for Efficient Monitoring in Water Systems

4th Nov 2024

Hydraulic Analysis Group Timeline

Half a Century in Pipelines

1973
- Hydraulic Analysis Limited (HAL) formed in Leeds, UK and starts working for water companies. It develops the first pipeline simulator (**) and pioneer's computer-based surge analysis

1980
- HAL starts working on oil systems

1982
- HAL works on its first district energy project in Denmark

1991
- HAL starts working on gas systems

1995
- HAL delivers its first LDS on the Theddlethorpe pipeline in the UK

2000
- HAL carries out its first onsite pipeline flow and transient pressure logging test using customised equipment

2005
- HAL delivers its first LDS and Training simulator on the BTC pipeline in Azerbaijan

2005
- Simulation Software Ltd (SSL) is formed to commercialise the simulator and deliver real time Pipeline Management Systems.

2006
- SSL develops its complete Pipeline Management Functionality and VariSim version 1.0 is released

2006
- SSL goes into partnership with Noval Century Technology Overseas Ltd. to deliver its software to China and East Asia

2007
- SSL delivers its first major Oil pipeline management system to Sinopec in China

2008
- First Desktop VariSim license sold to Thames water in the UK

2009
- SSL delivers its first major real time pipeline management system for the country wide gas network in Syria
- The Hydraulic Analysis Group is formed

2010
- HAL opens its office in Houston USA and Hydraulic Analysis Inc. is formed to continue supporting our many clients in North America

2010
- SSL delivers its first major UK real time LDS and pipeline management system for the Shell FLAGS/Fulmar/SEAL pipeline network in the North Sea.

2012
- HAL opens its Indonesian Office in Jakarta and PT Hydraulic Analysis Indonesia is formed to continue supporting our clients in Asia and Oceania

2015
- HAL launches the 'Pipeline Condition Monitor' for real-time monitoring of sewage rising mains and rapid burst detection

2015
- SSL delivers the largest real time water network pipeline management system to DEWA in Dubai

2016
- HAL completes its 10,000th project and now has over 1,000 clients in more than 50 countries

2018
- HAG opens an office in Abu Dhabi in the UAE

2018
- VariSim v3.0 incorporating GIS capability is released

2021
- HAL signs a partnership with Morrison Water Services in the UK and creates VariSim Delta to bring pipeline acoustic logger data into the hydraulic simulator

2022
- HAG opens an office on the Queen Elizabeth II ocean liner in Dubai

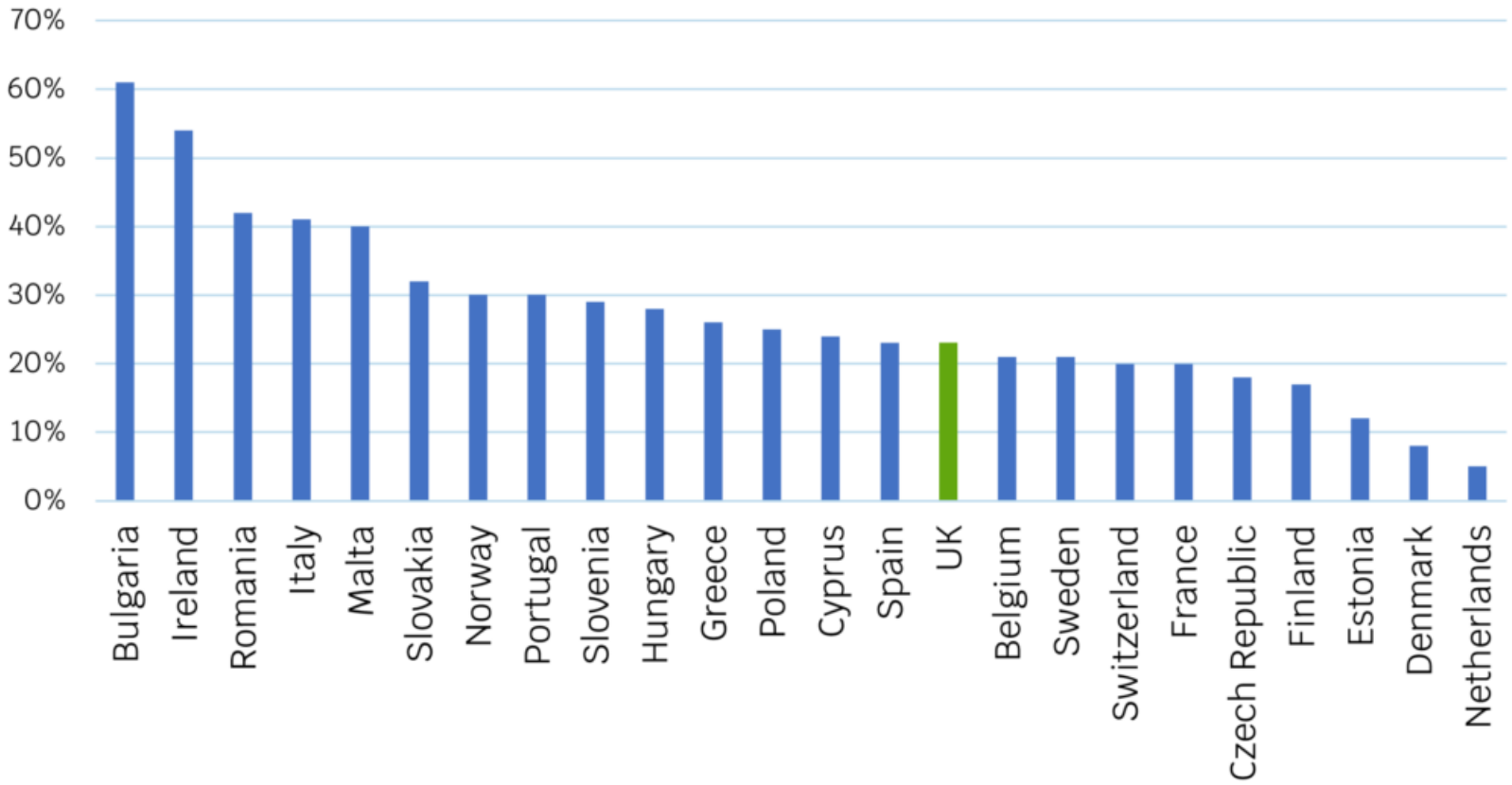
2022
- HAG delivers its first web based digital twin to Yorkshire Water in the UK

** HAL invests £125,000 ($225k) in a computer with 125K RAM to undertake its simulations

The Scale of the Problem

Environment Canada estimates that an average of 13% of water is lost in Canada

Vj g"Co gtlecp"Uqelgv{ "qh"Ekxkn"Gpi lpggtu"guvlo cvgu"vj cv"rquugu"lp"vj g"WUC"ctg"dgvy ggp"52/72'



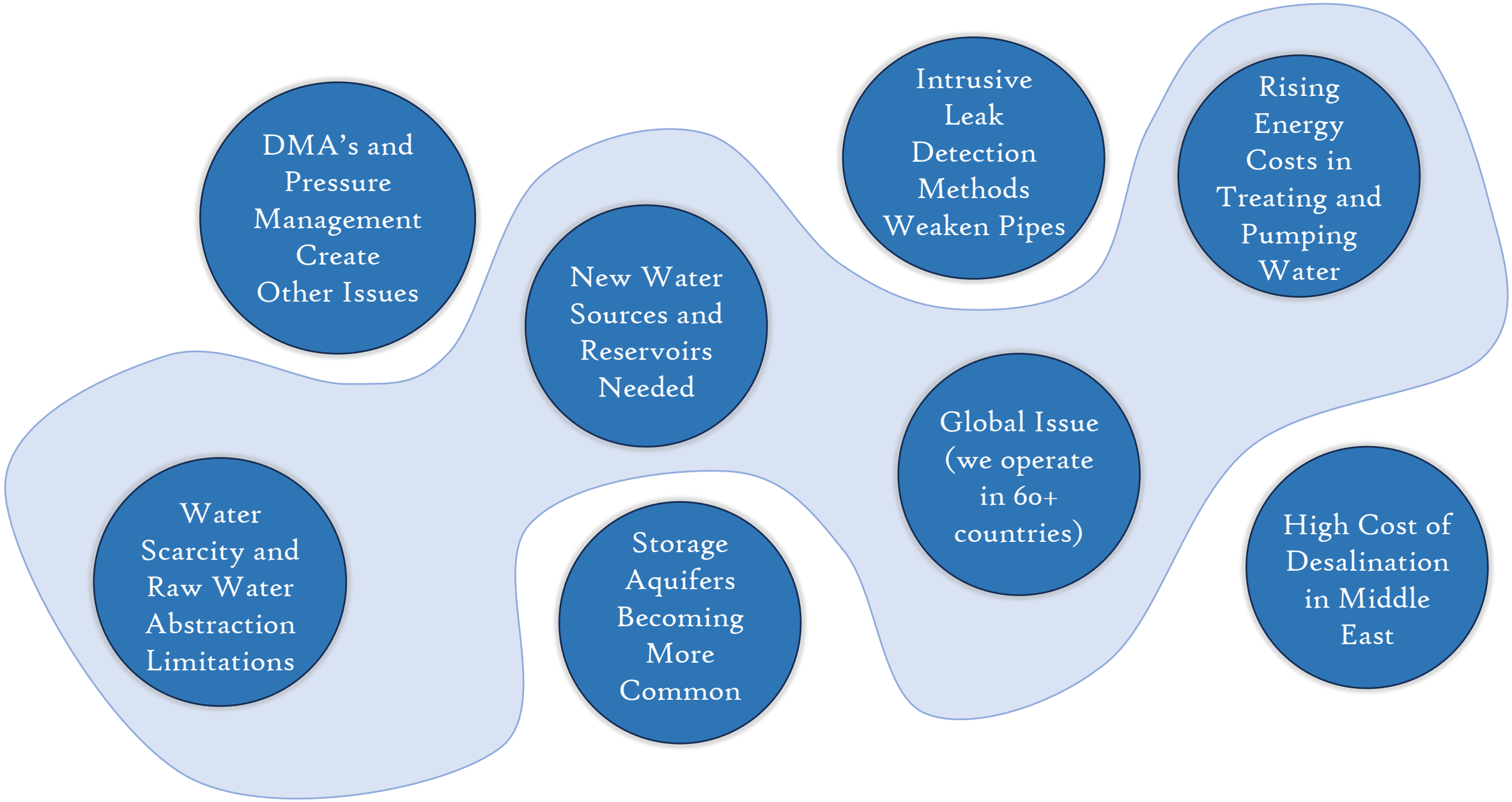
Water losses in South America are around 40%

Water losses in Saudi Arabia and Oman are around 38%

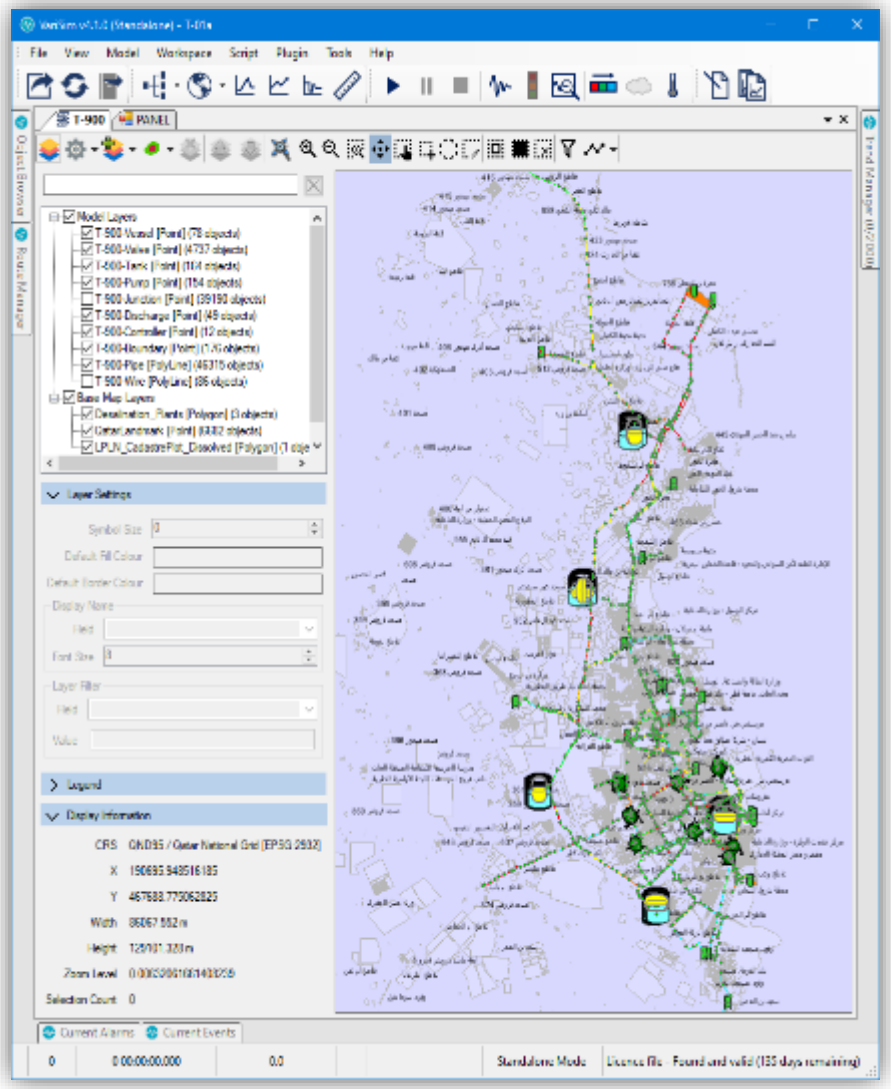
Water losses in Dubai and Singapore are between 5-6%

Leakage Levels in European countries (2018) – Source OFWAT

Leakage Implications on Water Resource Management and Energy

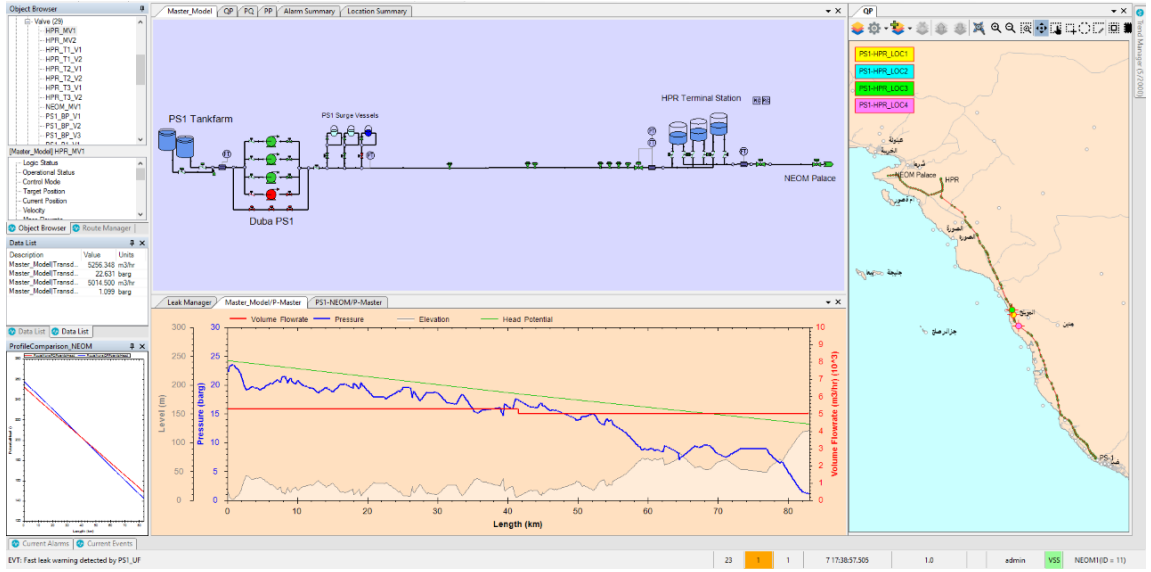


Software on a Large Scale



Scvct

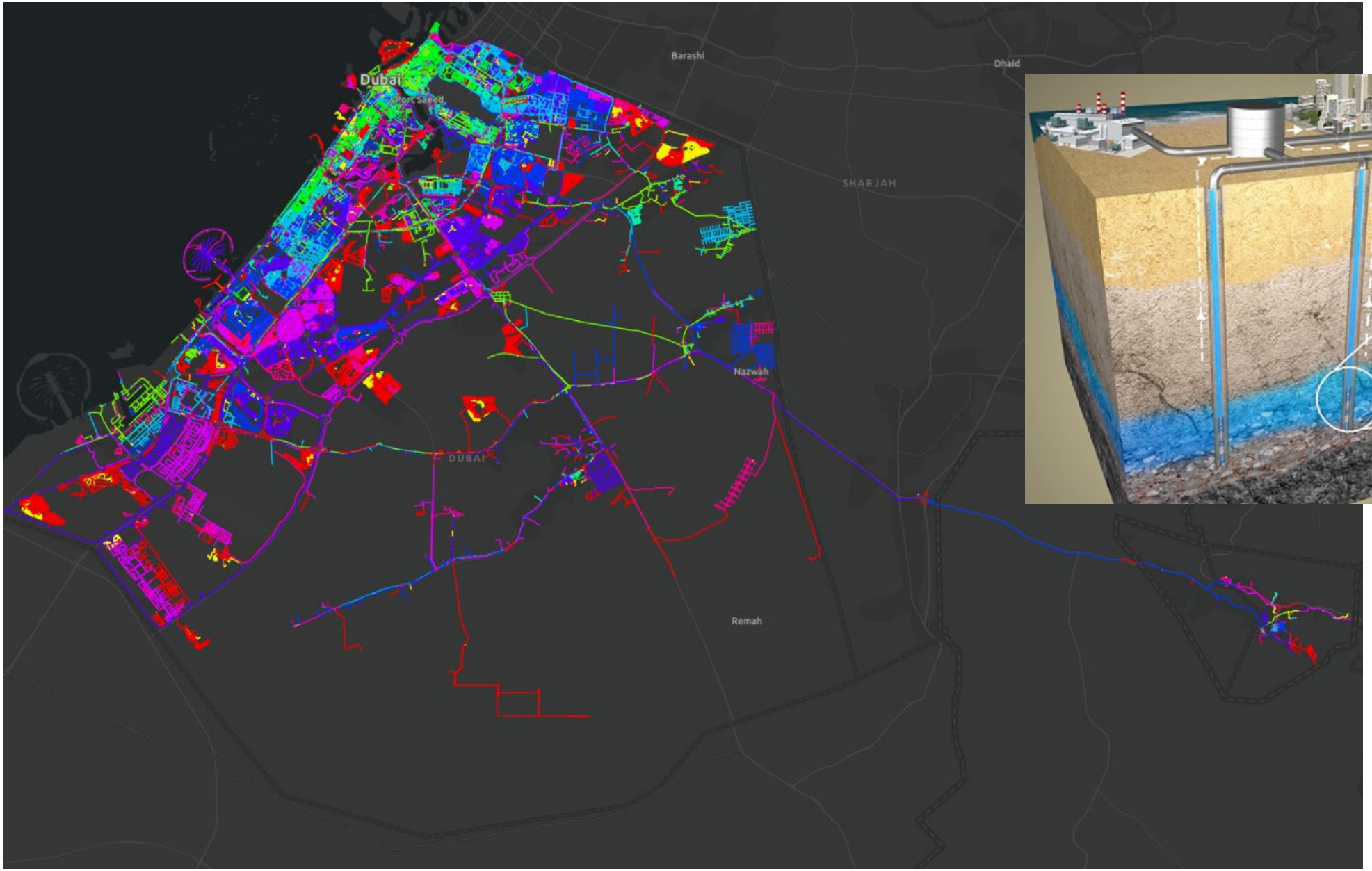
Dubai

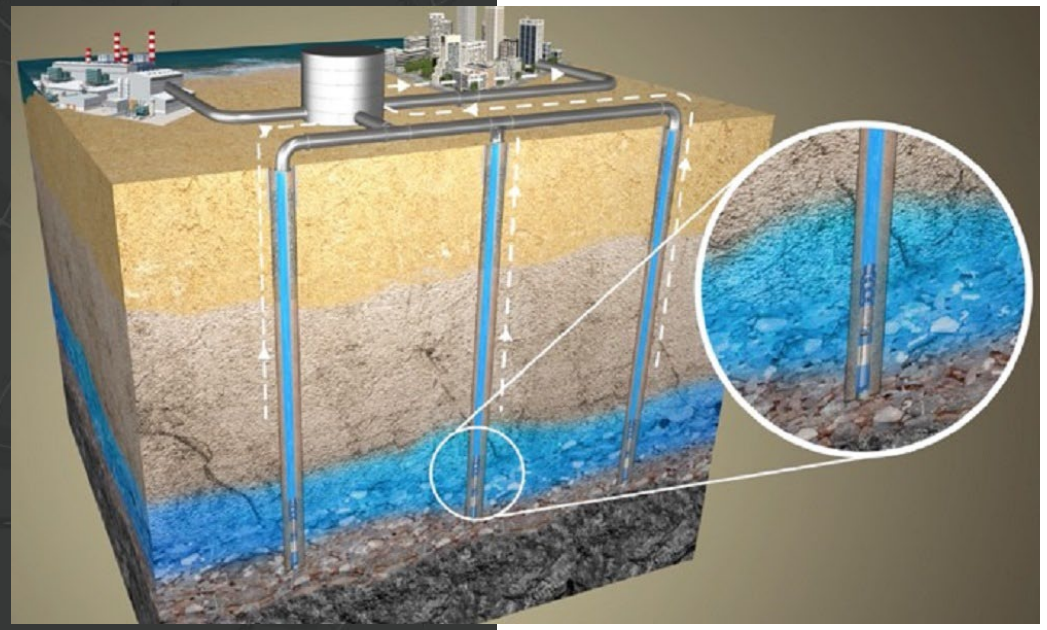


NEOM

hydraulic analysis group

hydraulic analysis group



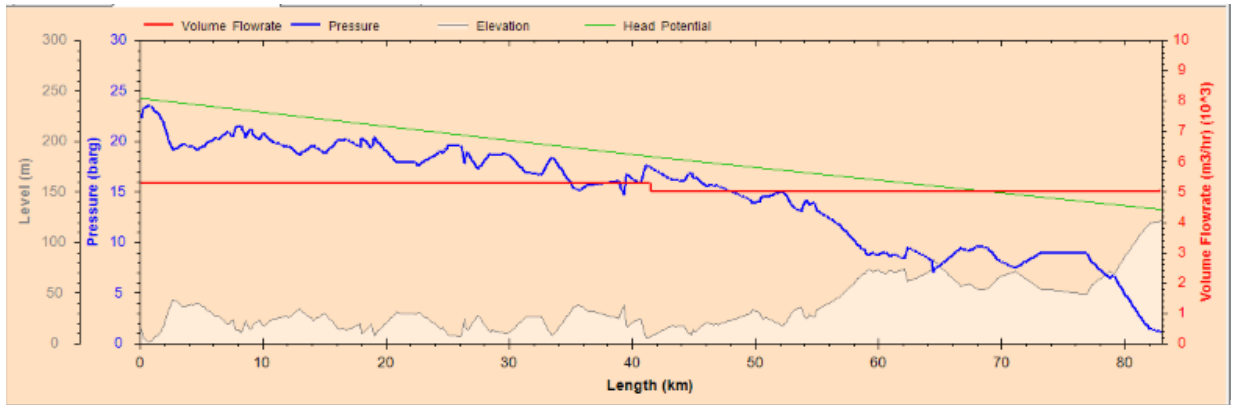


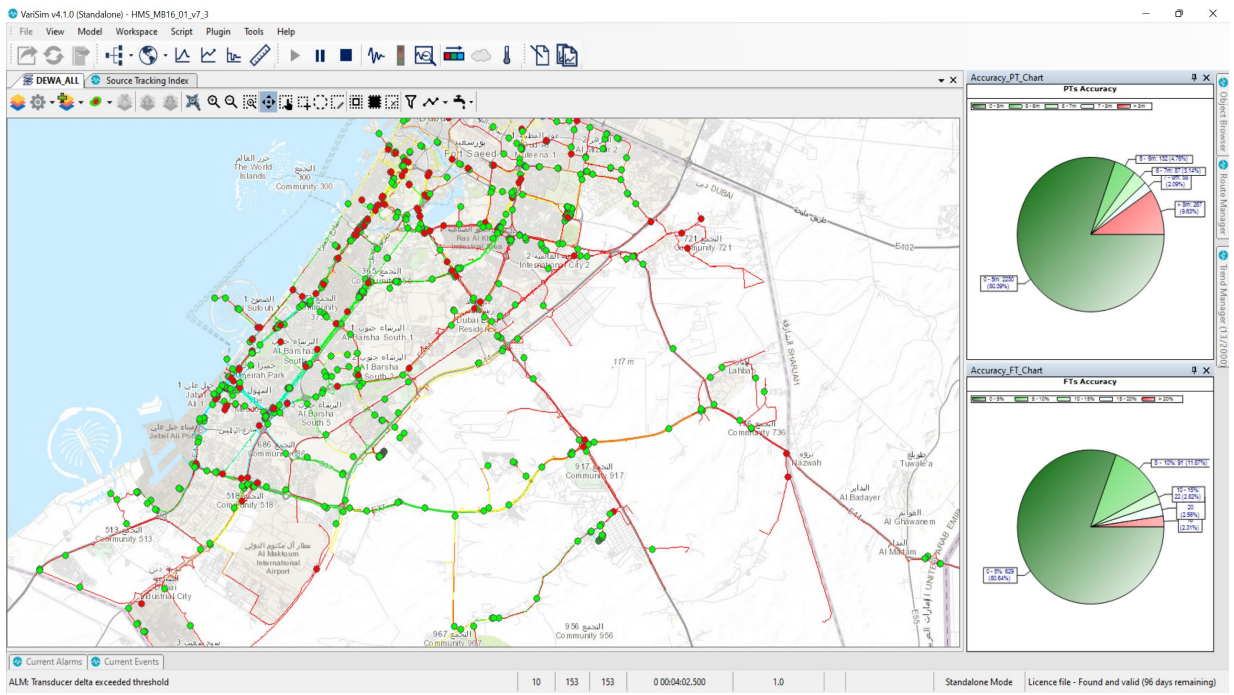
Sensor Deployment

hydraulic
analysis group

Instrumentation Requirements

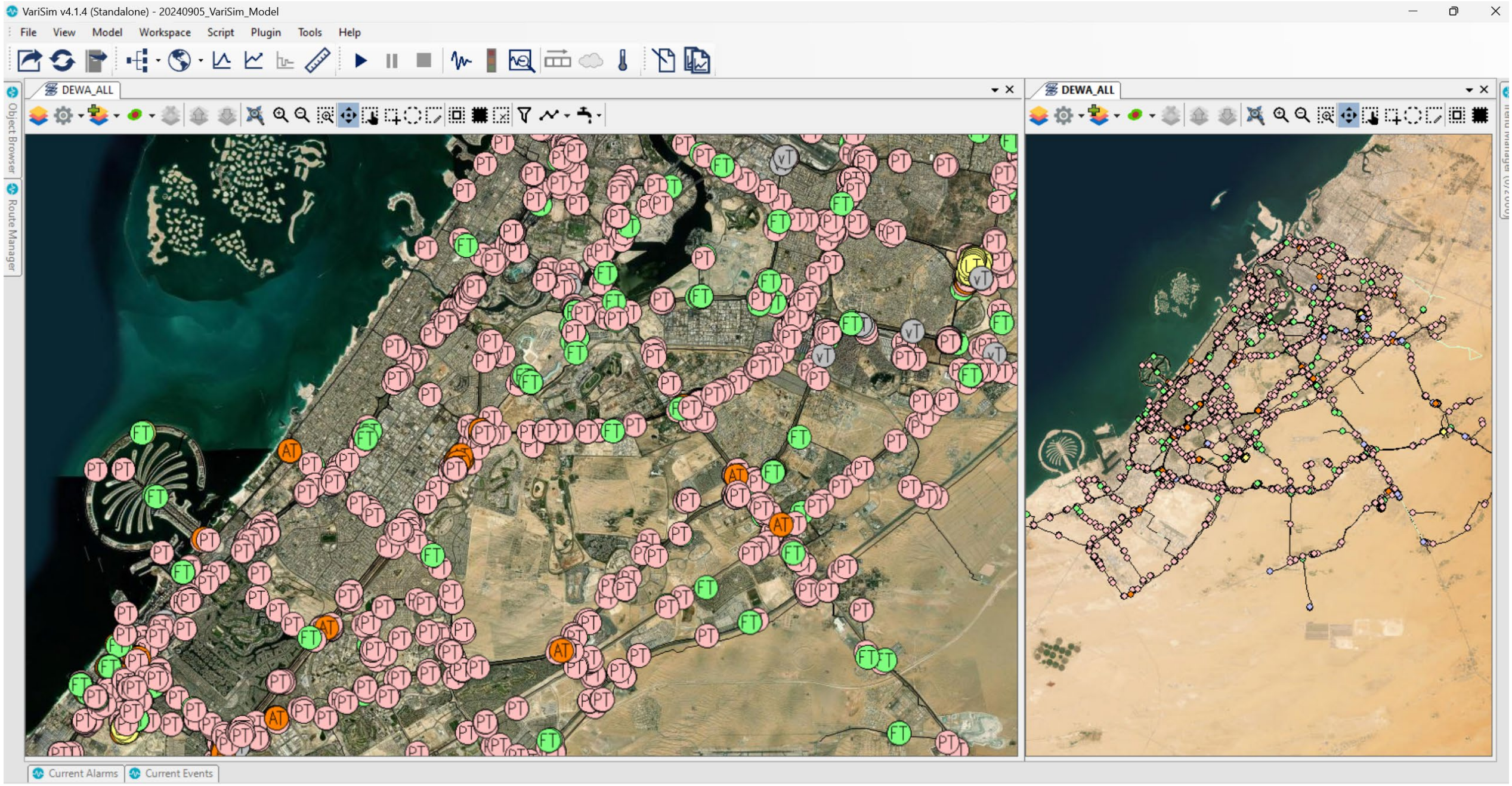
hydraulic analysis group



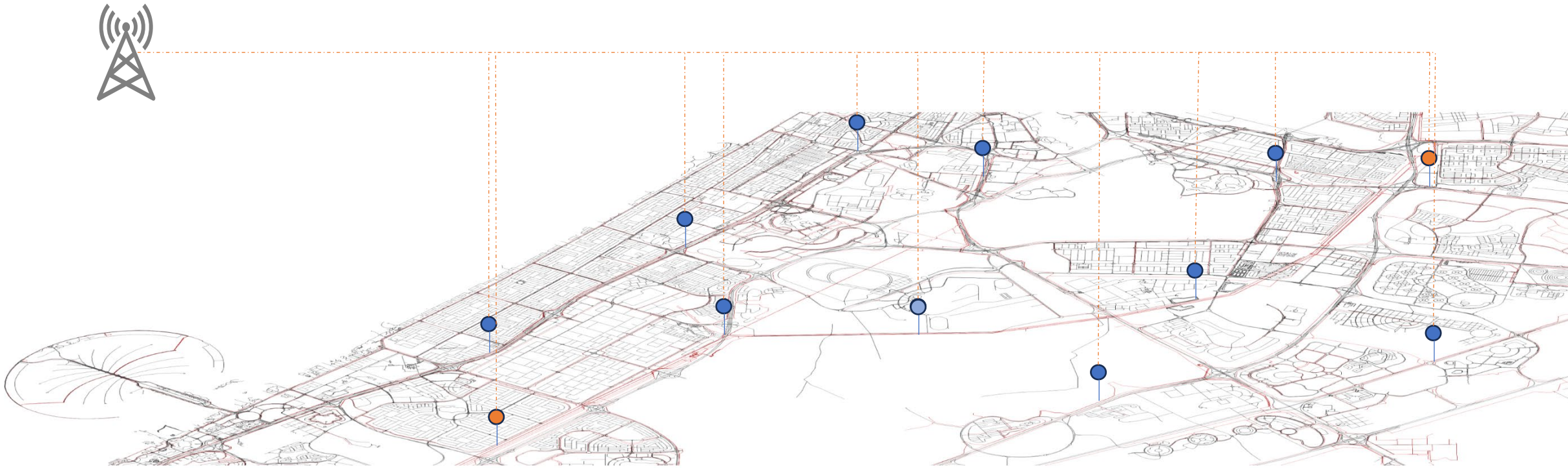


On trunk (transmission) mains, flow readings are needed at the start and end of the pipeline plus on any offtakes. Pressure readings are required every 5 miles to detect leaks of less than 1% of the pipeline flowrate.

On distribution networks, flow readings are needed at every boundary point e.g. pumping station or reservoir (level readings will also suffice). Typically one pressure logger is required every square mile to detect existing and new leaks although that depends upon the network layout, topology and hydraulics. High speed (transient) pressure data is not required.


VariSim v4.1.4 (Standalone) - 20240905_VariSim_Model
File
View
Model
Workspace
Script
Plugin
Tools
Help
DEWA_ALL
DEWA_ALL
Object Browser
Route Manager
Current Alarms
Current Events

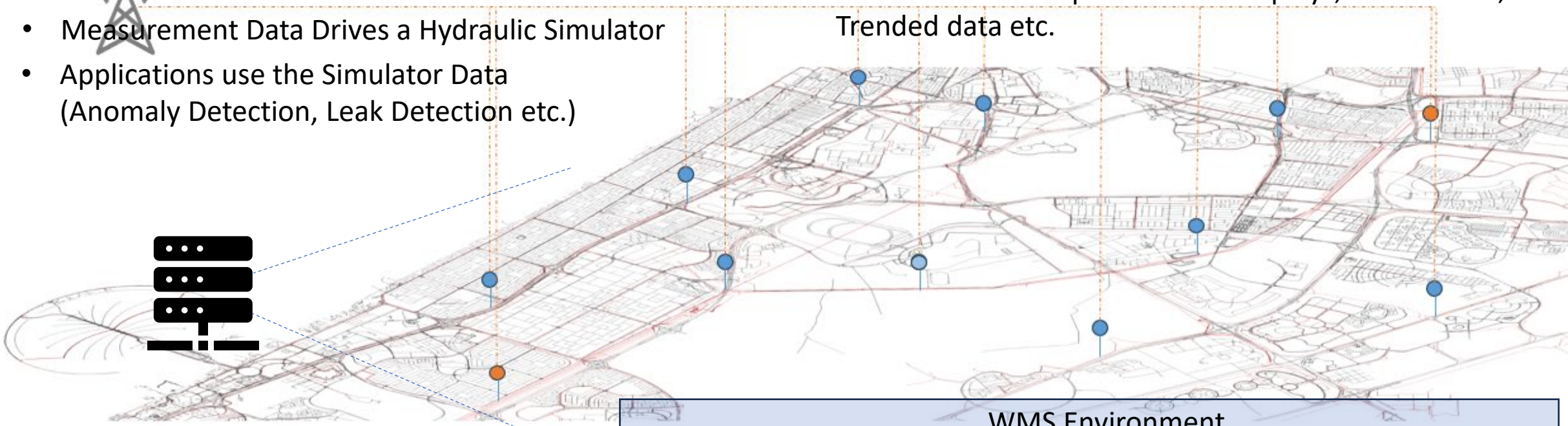
INSTRUMENTATION



WATER MANAGEMENT SYSTEM

- Telemetered data sent to measurements database
- Transfer of Measurements data to WMS database
- Measurement Data Drives a Hydraulic Simulator
- Applications use the Simulator Data (Anomaly Detection, Leak Detection etc.)

- What-IF is used for Engineering Studies
- Browser front end provides GIS displays, Dashboards, Trended data etc.

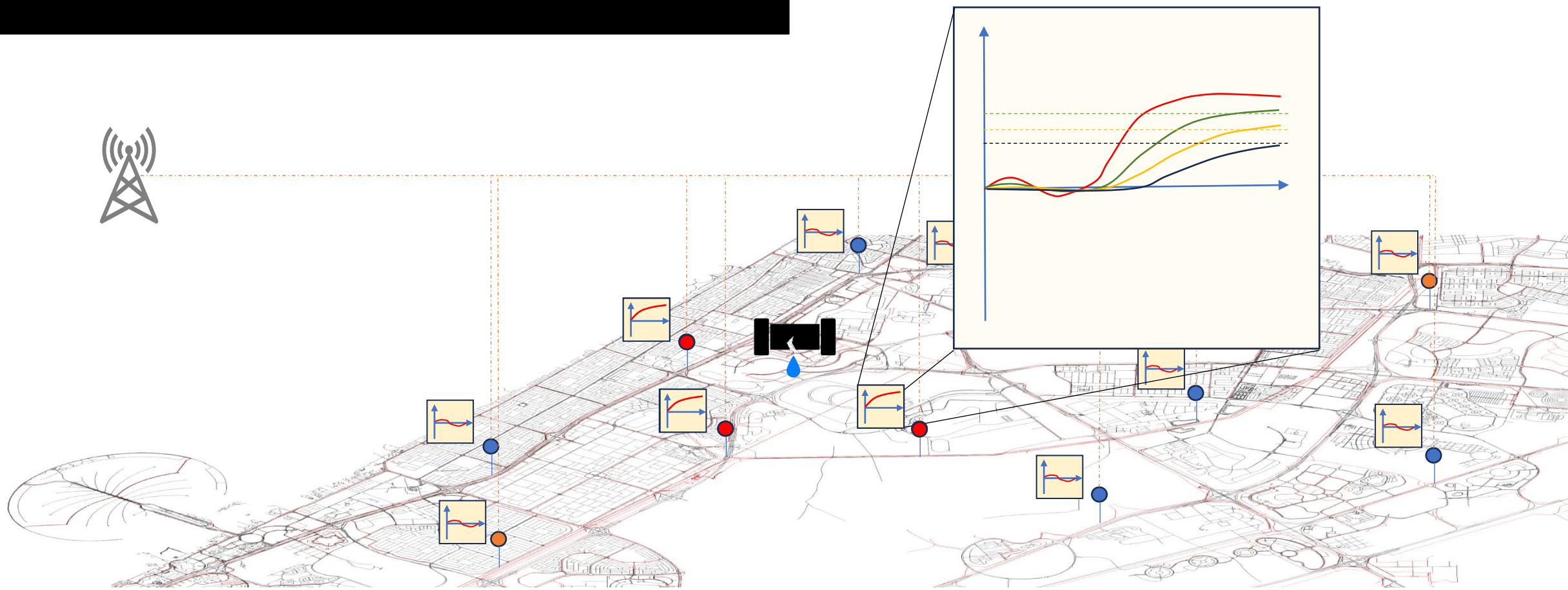


WMS Environment

VariSim™ Real Time

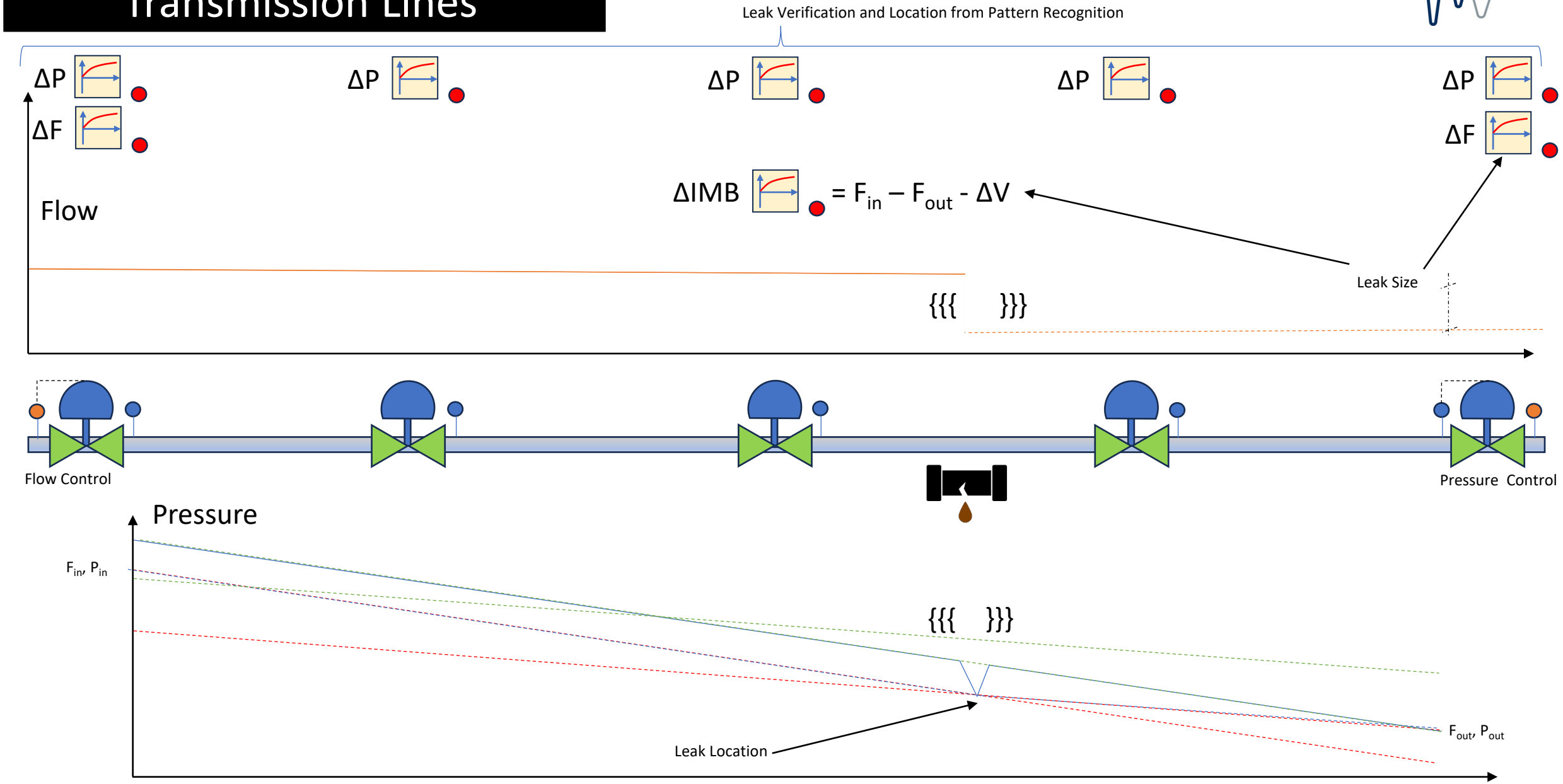
VariSim™ What-IF

ANOMALY DETECTION



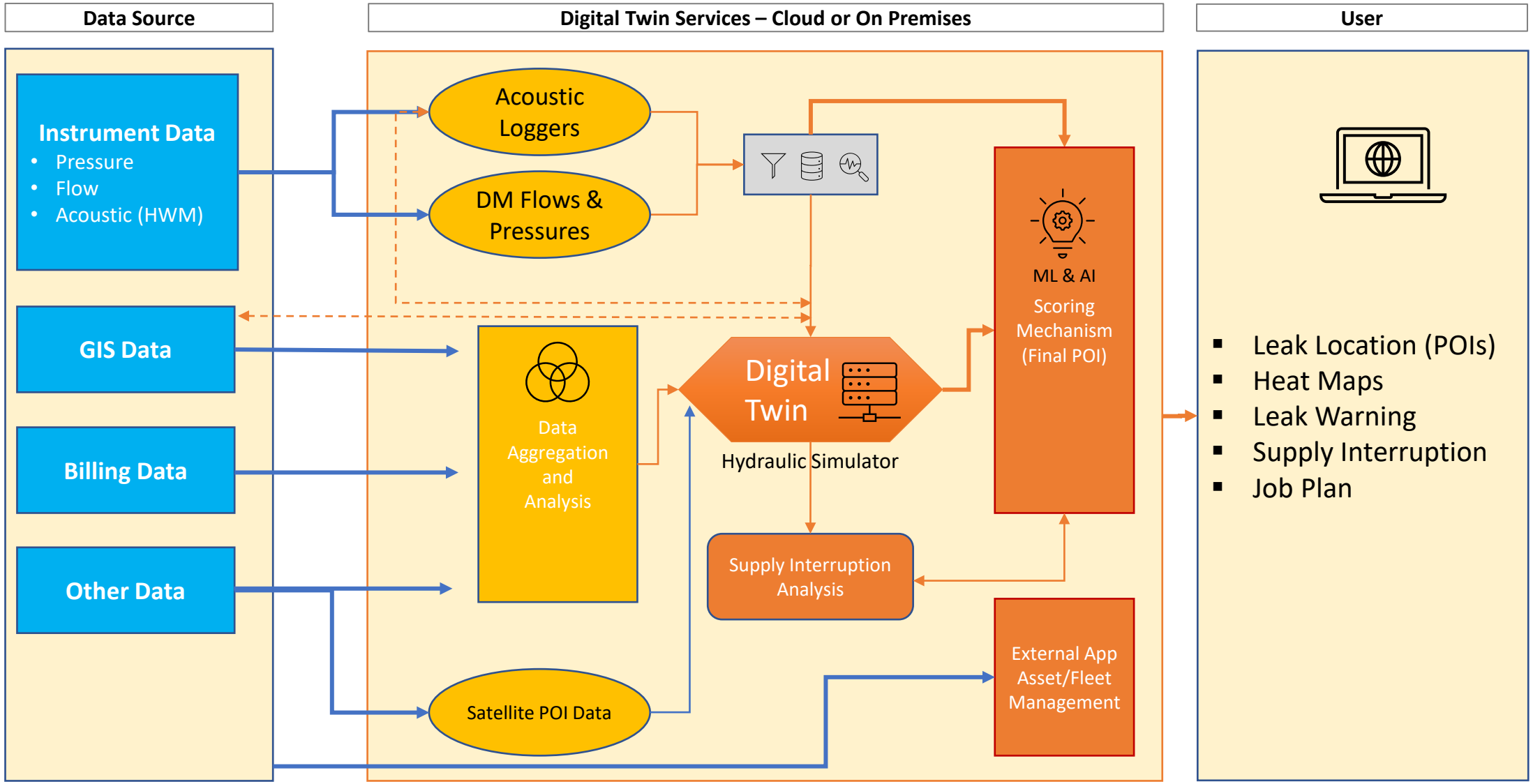
E-RTTM LEAK DETECTION
Transmission Lines

hydraulic analysis group



Live Leakage Platform

Digital Twin & Leak Management Platform Architecture
Display, Filter, Clean and Analyse Data



Hpf lpi "Gzkuvlpi "Ngcnu

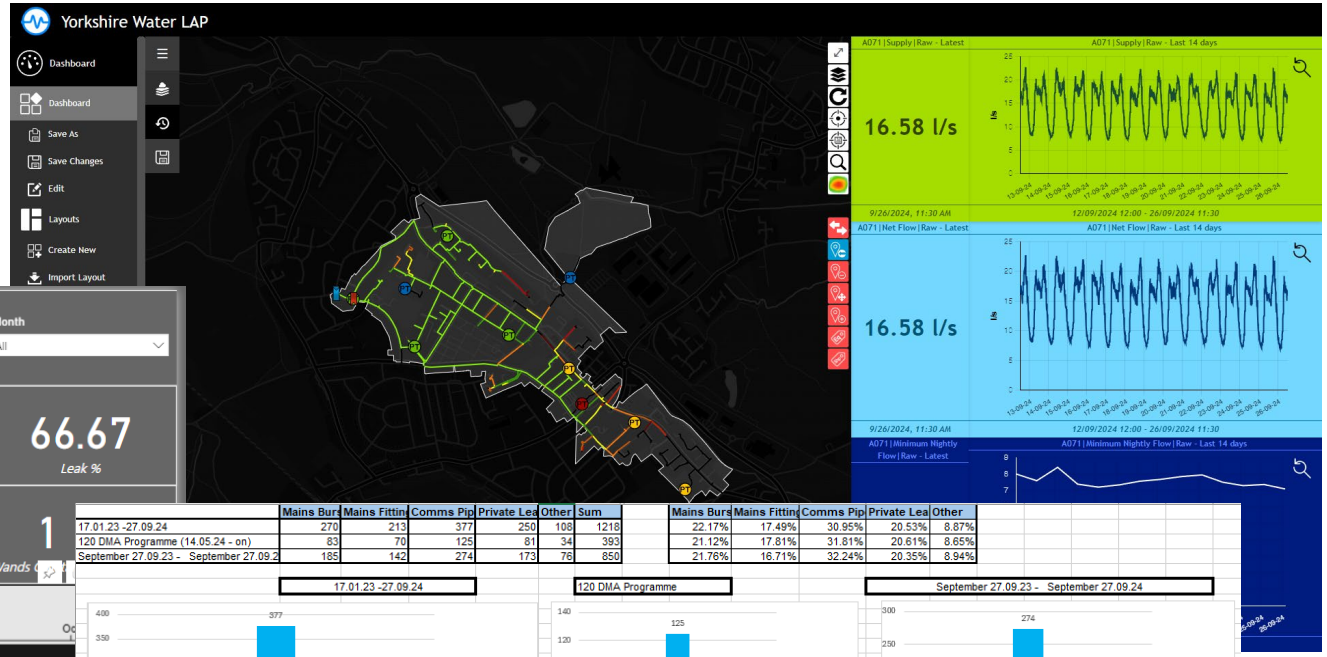
Water Network Digital Twin – Live Hydraulic Model

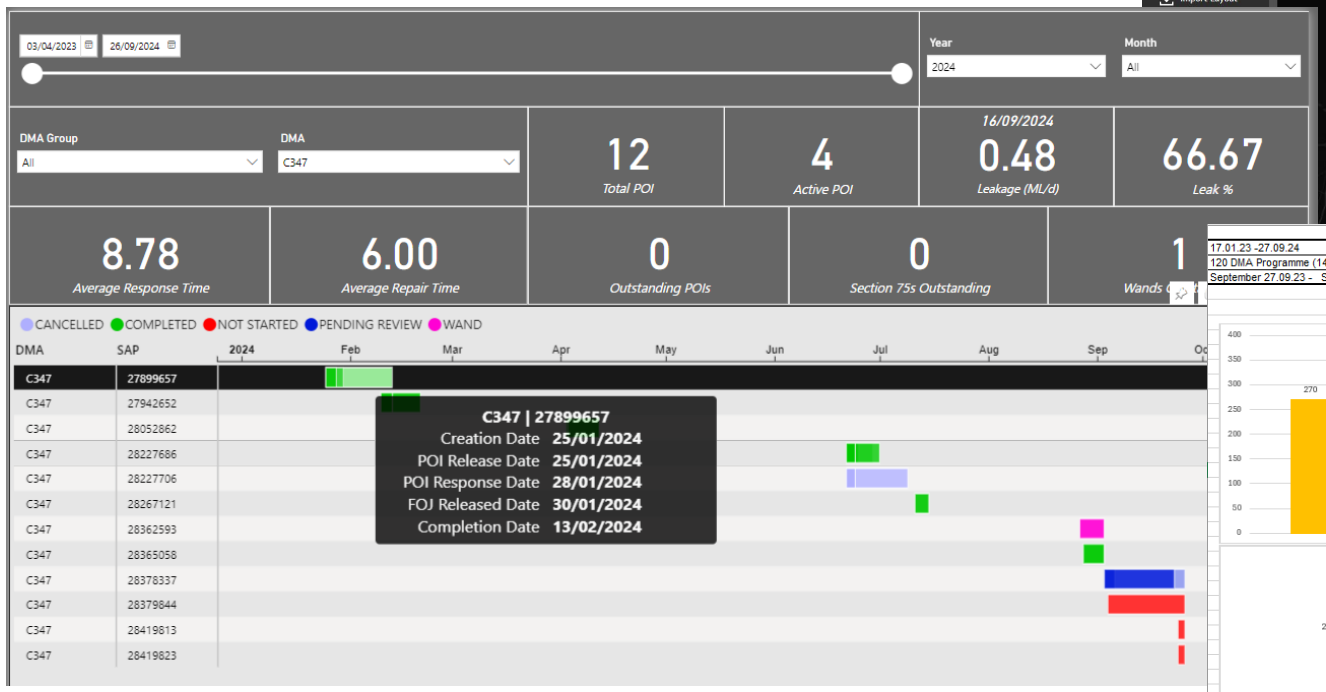
Areas of Lower Than Expected Pressure

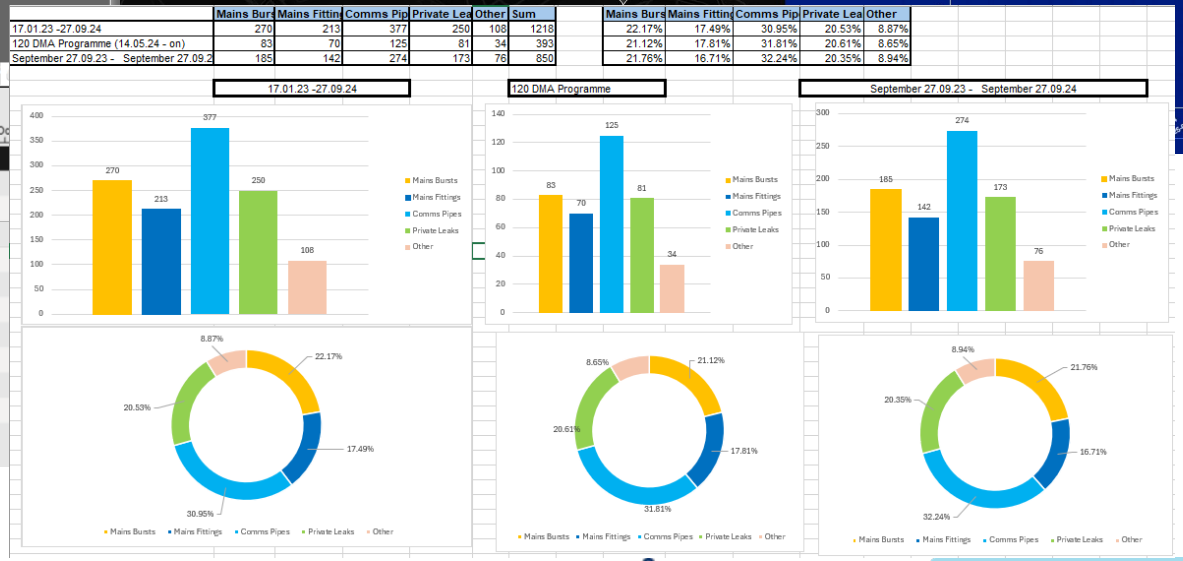
Combining Acoustic and Pressure Data

Digital Twin – Leaks Found

Significant progress with first 60 DMAs, reducing them to levels not seen before with a higher % of large leaks found, resulting in higher savings







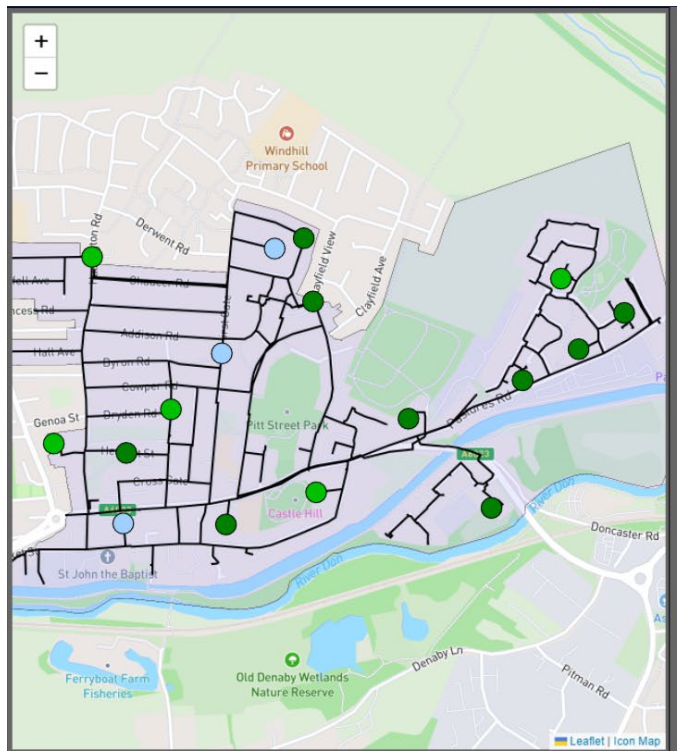
MORRISON Water Services
A part of MGroupServices

hydraulic analysis group

YorkshireWater

Burst Detection System

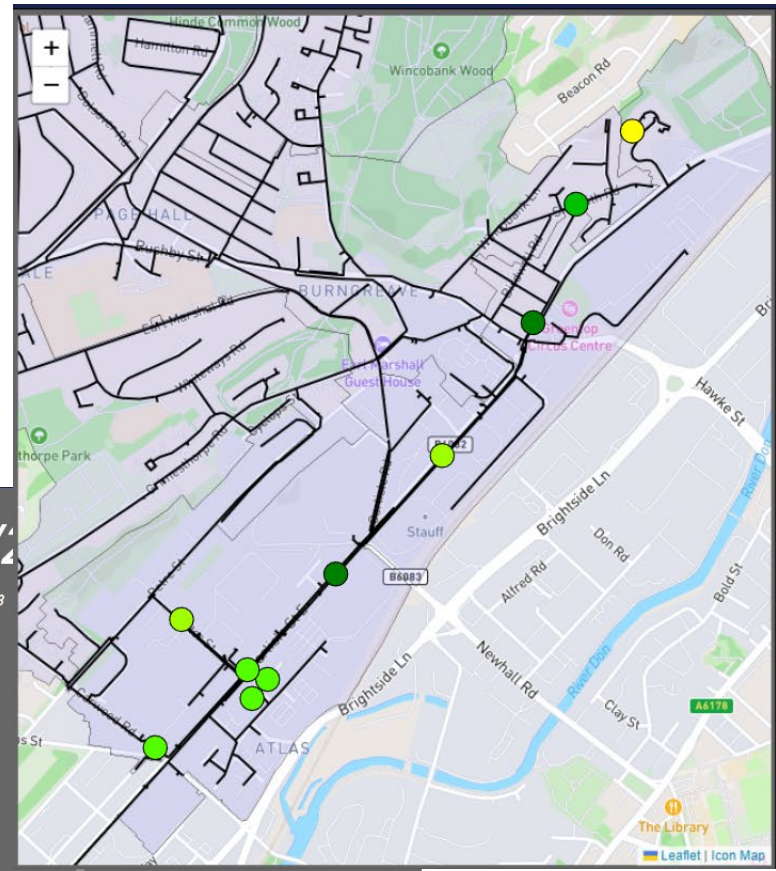
hydraulic
analysis group



26/09/2

DG3-10073005688
1
P04542001601
2
P04542001674
0
P04542001880
1
P04542003892
2
P04542003905
1
P04542004241
2
P04542004675
1
P10042007828
2
P10042016139
1

0
Flow Alarm
0
Pressure Alarm
0
A020 Alarm



26/09/2024 10:30:00

DG2-04342004463
2
P04342004002
1
P05242002490
4
P05242002500
4
P05242006569
1
P10042010671
6
P10073023129
5
P10073024037
4
P10073029412
5
PJ76210
4

Logger Not Working
No Pressure Drop
Slight Pressure Drop
Large Pressure Drop
Very Large Pressure Drop
Extreme Pressure Drop

1
4
8
12
16

2
Flow Alarm
1
Pressure Alarm
1
J762 Alarm

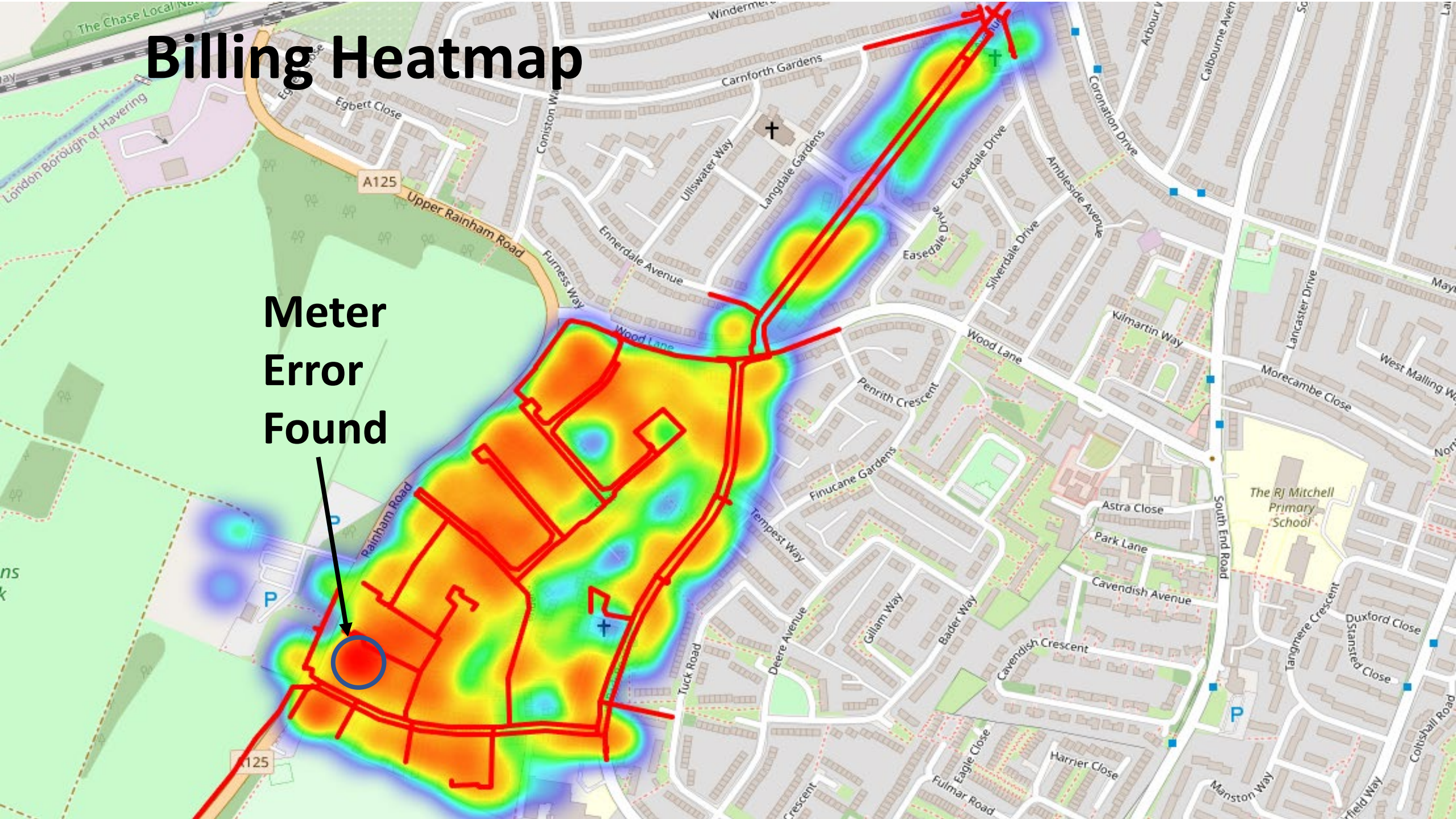
MORRISON Water Services
A part of MGroupServices

hydraulic analysis group

YorkshireWater

Customer Demands and Demand Patterns

Billing Heatmap



YorkshireWater

MORRISON Water Services
A part of MGroupServices

hydraulic analysis group

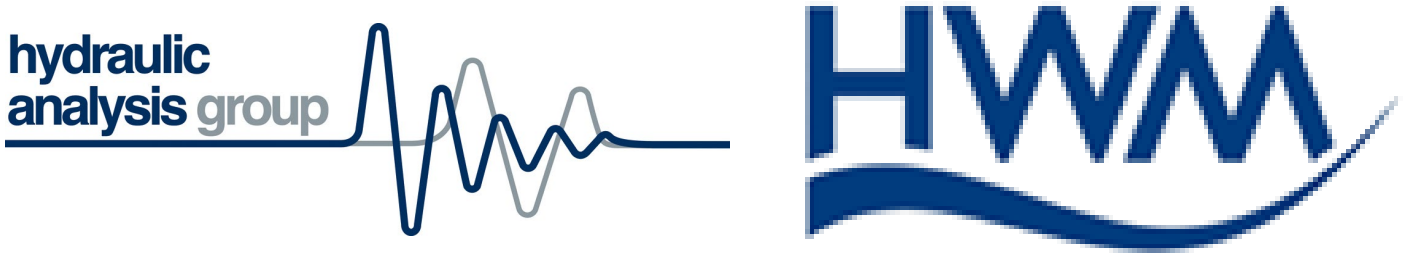
Leak Locations before SMART Meter Data

Leak Locations after SMART Meter Data

All this is achievable with GPS and NBIoT Loggers as they are reliable and provide rapid data acquisition – LoraWan is also an Option. Advanced SCADA Systems are not necessary.

hydraulic analysis group

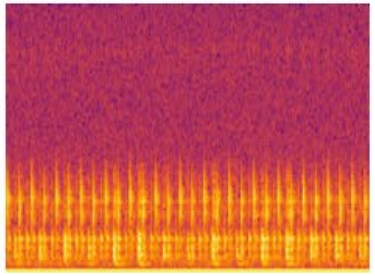
Integrating AI with Acoustic Data



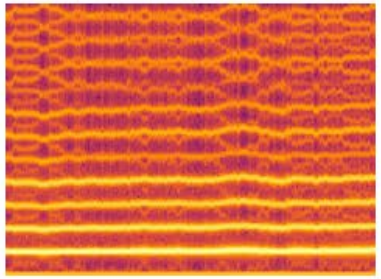
AI-Powered Spectrograms: Transforming Leak Detection with Unseen Efficiency

We Create a Spectrogram from a HWM Acoustic File. Every Spectrogram Reveals a Distinct Signature: Listening to What Our Client's Pipelines Whisper, Elevating Leak Detection Analytics and Minimising False Alarms

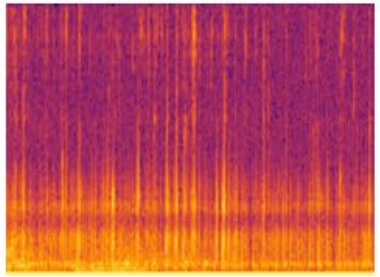
Meter Spinning Noise



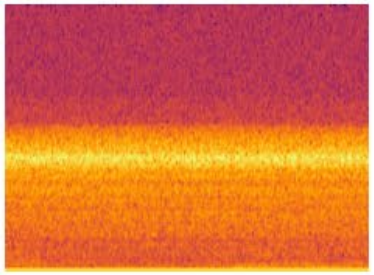
Odd Noise



Water Audio Detected

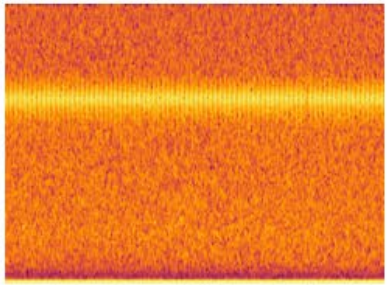


PRV Operation

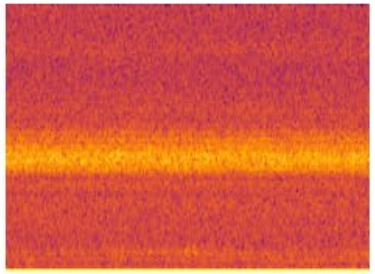


Silent Audio

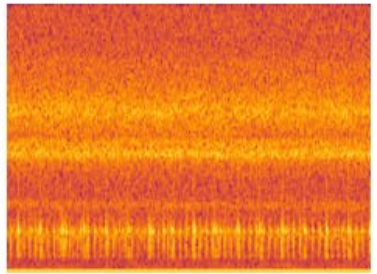
Rapid Mechanical Sound



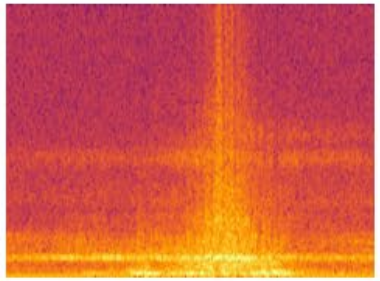
Leak



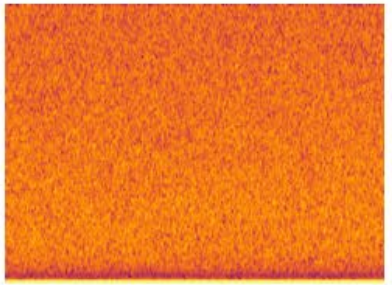
Leak with Meter Noise



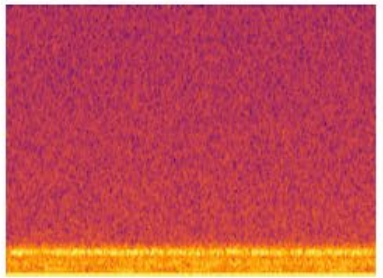
Rumbling Noise



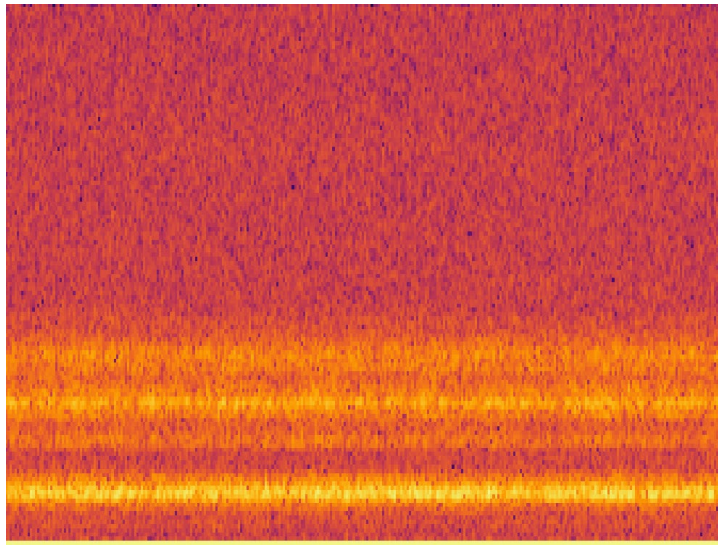
Normal Ambient Noise



Electrical/ Other Ambient Sound

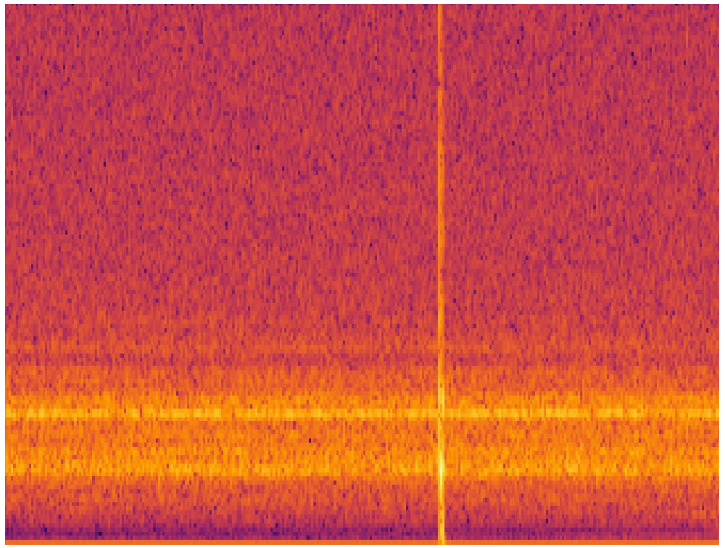


Mains Burst



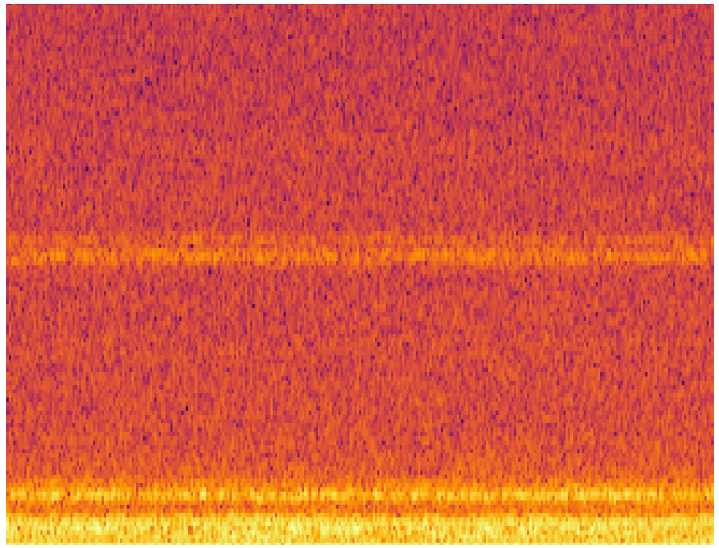
Level = 13
Spread = 3
HWM Status = No Leak
ML Leak Probability = 91%

Mains Burst



Level = 19
Spread = 8
HWM Status = No Leak
ML Leak Probability = 86%

Service Pipe Leak



Level = 10
Spread = 4
HWM Status = No Leak
ML Leak Probability = 82%

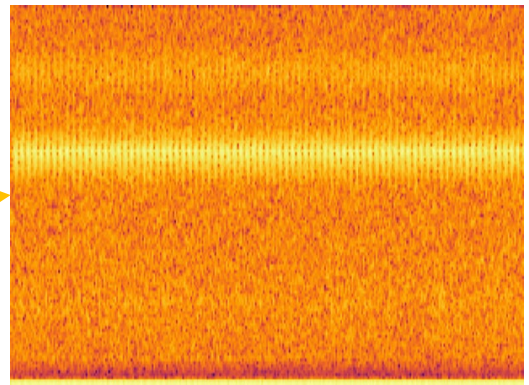
Enhanced Acoustic ML in Action – Acoustic Forced Records

1. We carried out a forced acoustic logger record on 3 DMAs which had medium level leakage to see if anything further could be found or detected via our ML process

2. The sound files were fed directly in the enhanced ML model for processing and highlighted:

- 2 mains bursts raised which, in one case, the HWM loggers were not alarming
- 1 private leak in which the HWM logger was not alarming
- 15 areas across the 3 DMAs where there were rapid spinning meter noises detected. One example as provided below was in an industrial estate which had no continuous logged meters on it. The surrounding acoustic loggers were not in alarm.

DMA	Recording Time	SiteID	Noise Type	Probability %
B607	10/04/2024 02:30:00	125007268	Metering Activity	92
B607	11/04/2024 02:30:00	125007268	Metering Activity	93
B607	10/04/2024 02:30:00	142005070	Metering Activity	98
B607	11/04/2024 02:30:00	142005070	Metering Activity	94
B607	10/04/2024 02:30:00	142005263	Metering Activity	80
B607	11/04/2024 02:30:00	142005263	Metering Activity	82



3. A usage POI was generated on the YW Analytics Platform, for the field team to further investigate these sounds with the following outcomes:

- They were verified as unusual meter spinning noises coming from non-household users
- The meter noise is due to it being 'topped out' as there is a maximum flow the meter can read and once the flow gets above this level it flatlines with this maximum flow.
- The meter is passing a lot more than it is reading and is the main contributor to the remaining leakage in the DMAs which has historically struggled to get below 0.25 ML/d
- The customers in question are not being billed for their usage due to inaccurate consumption being measured from traditional metering
- Next steps are for YW to intermittently log these users to verify usage and install a continuous logged meter if required.

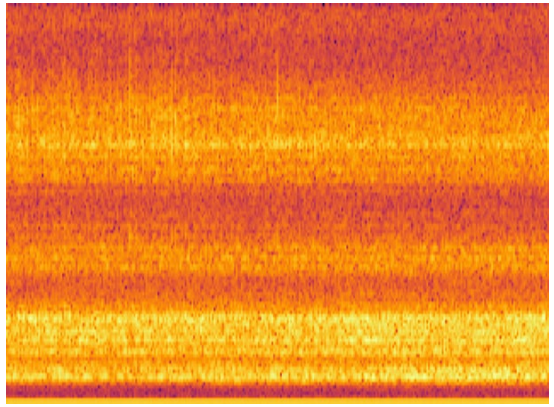
hydraulic analysis group

PRV Spectrograms vs Leak Spectrograms

Verified PRVs

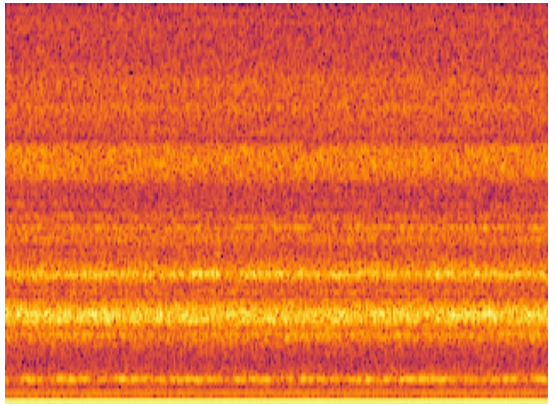
ML Output

PRV = 89% Leak = 5%
Other = 6%



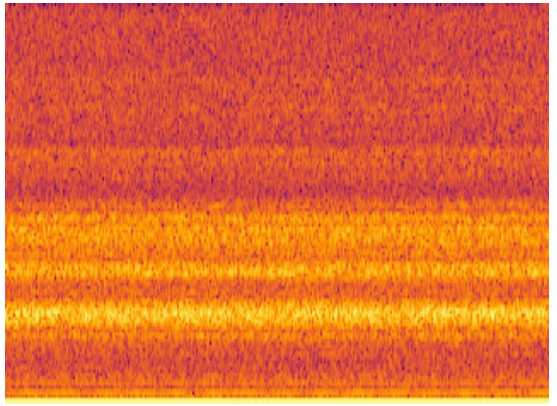
ML Output

PRV = 77% Leak = 10%
Other = 13%



ML Output

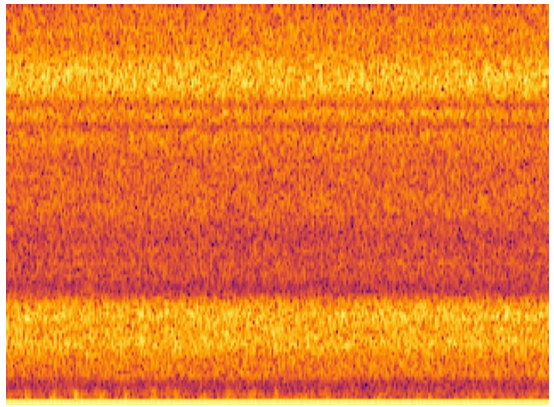
PRV = 86% Leak = 7%
Other = 7%



Verified Leaks

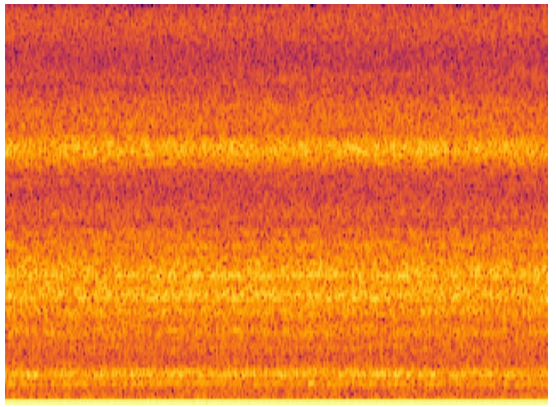
ML Output

Leak = 91% PRV = 2%
Other = 7%



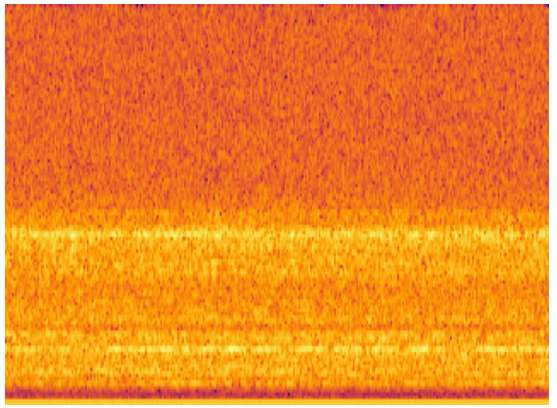
ML Output

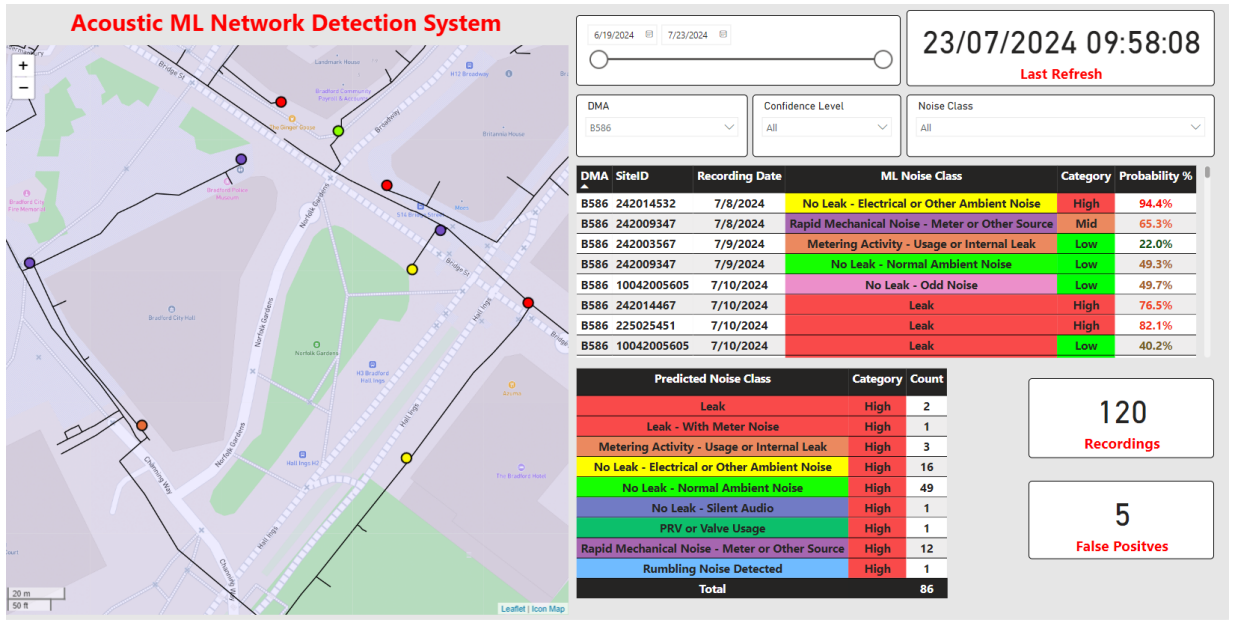
Leak = 77% PRV = 8%
Other = 15%

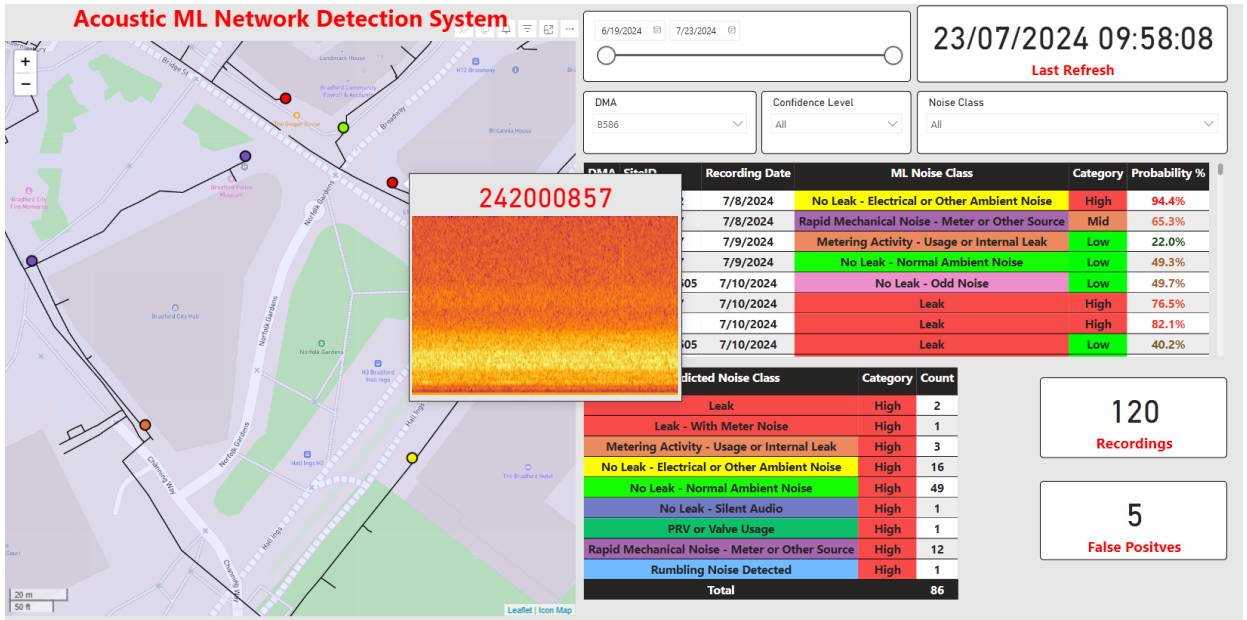


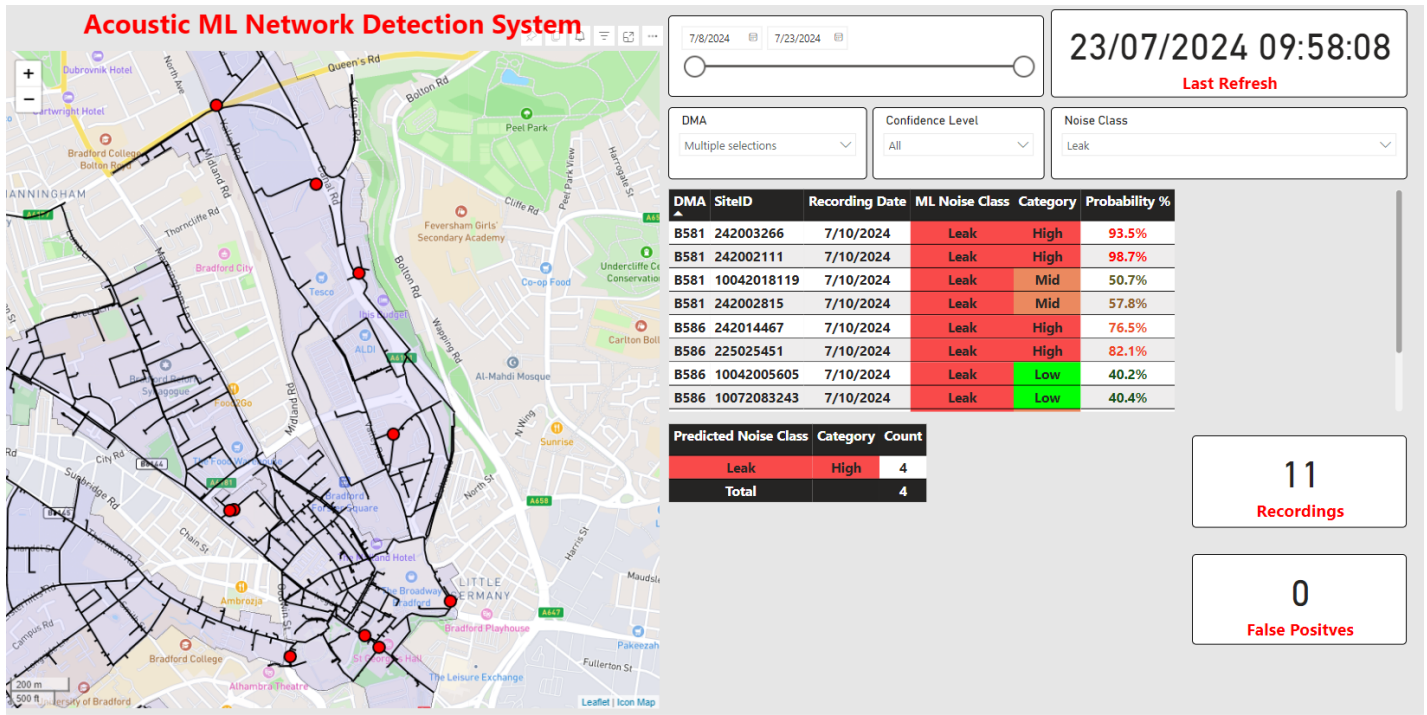
ML Output

Leak = 85% PRV = 4%
Other = 11%







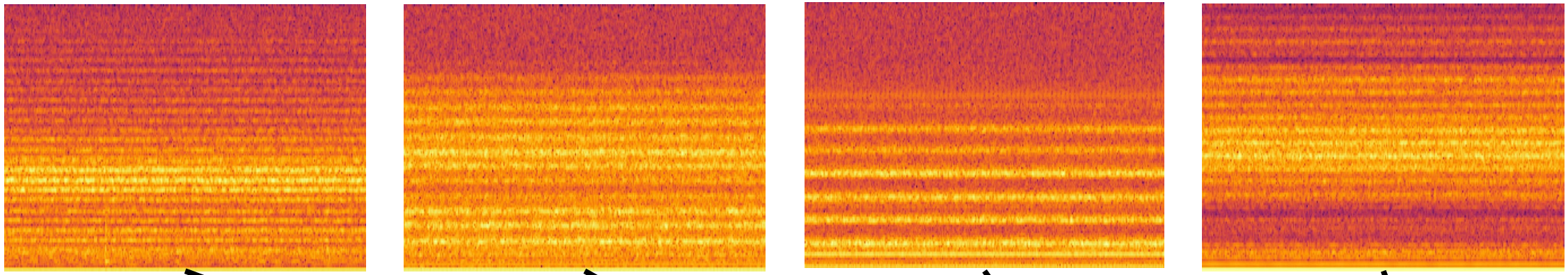


Early-Stage Dashboards

hydraulic analysis group

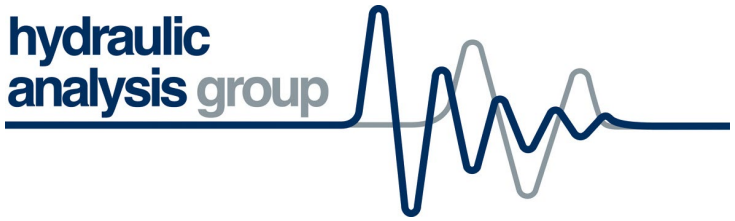
New Non-Leak Profile Observed – ML Retrained

No Leak – Electricity Meter Box Noise

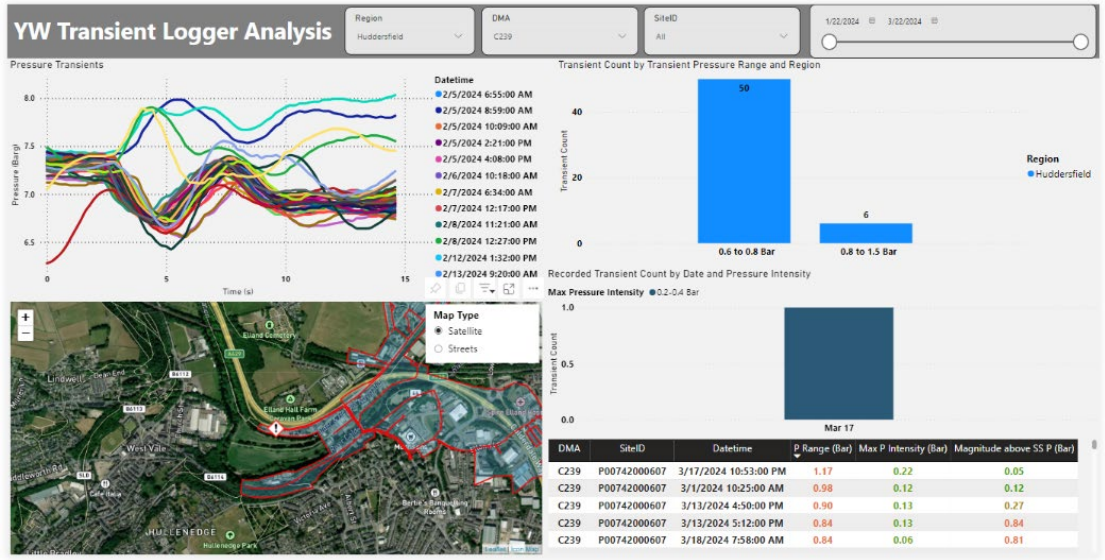


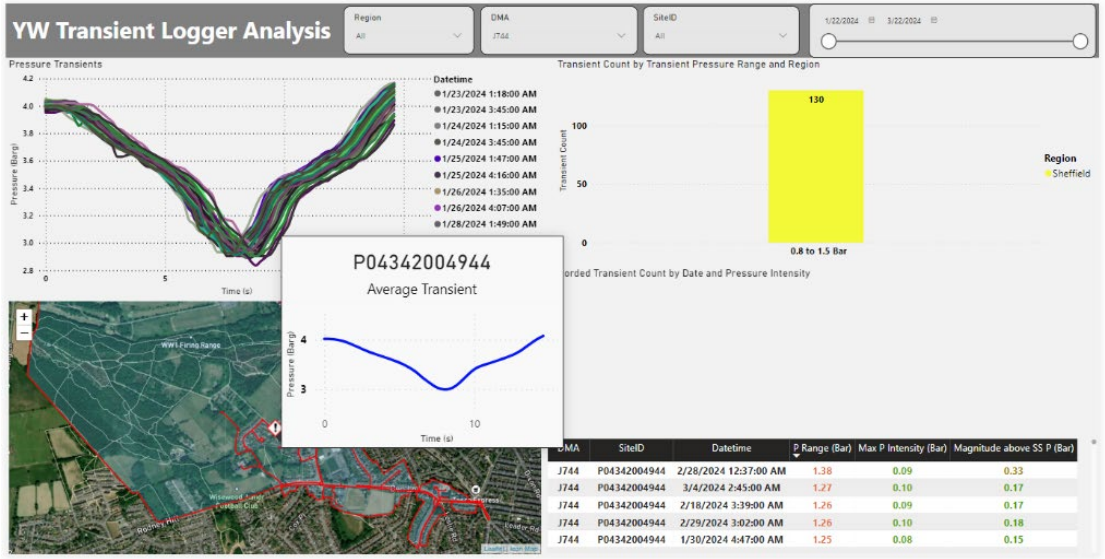
A previous leak prediction in both the ML (medium to high probability) and HWM Logger Alarm status with a specific profile resembling a leak has been verified as a no leak. The ML has been retrained to remove these type of profiles as leaks.

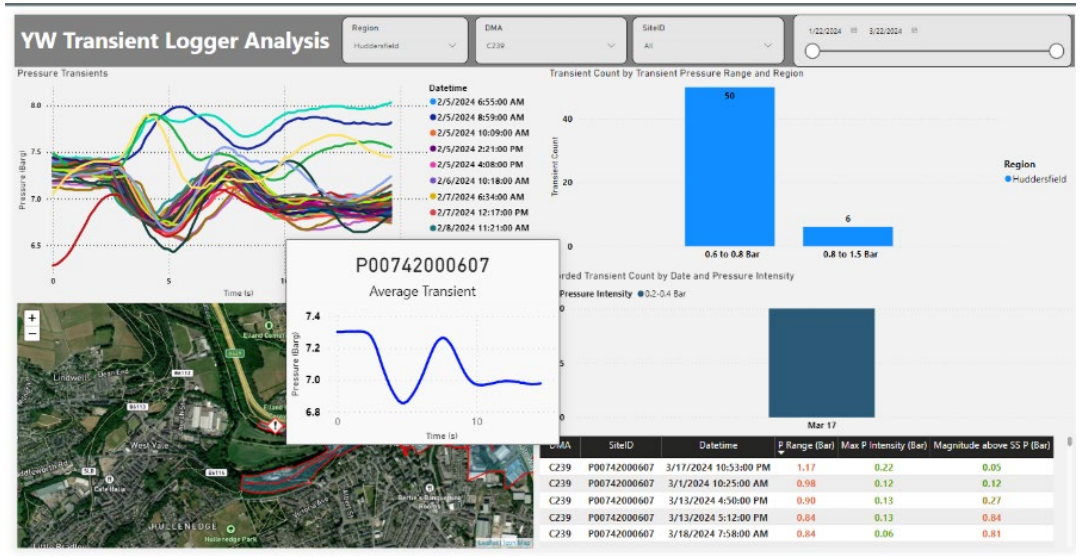
Pressure Transient Platform



Pressure Transient Monitoring and Analysis





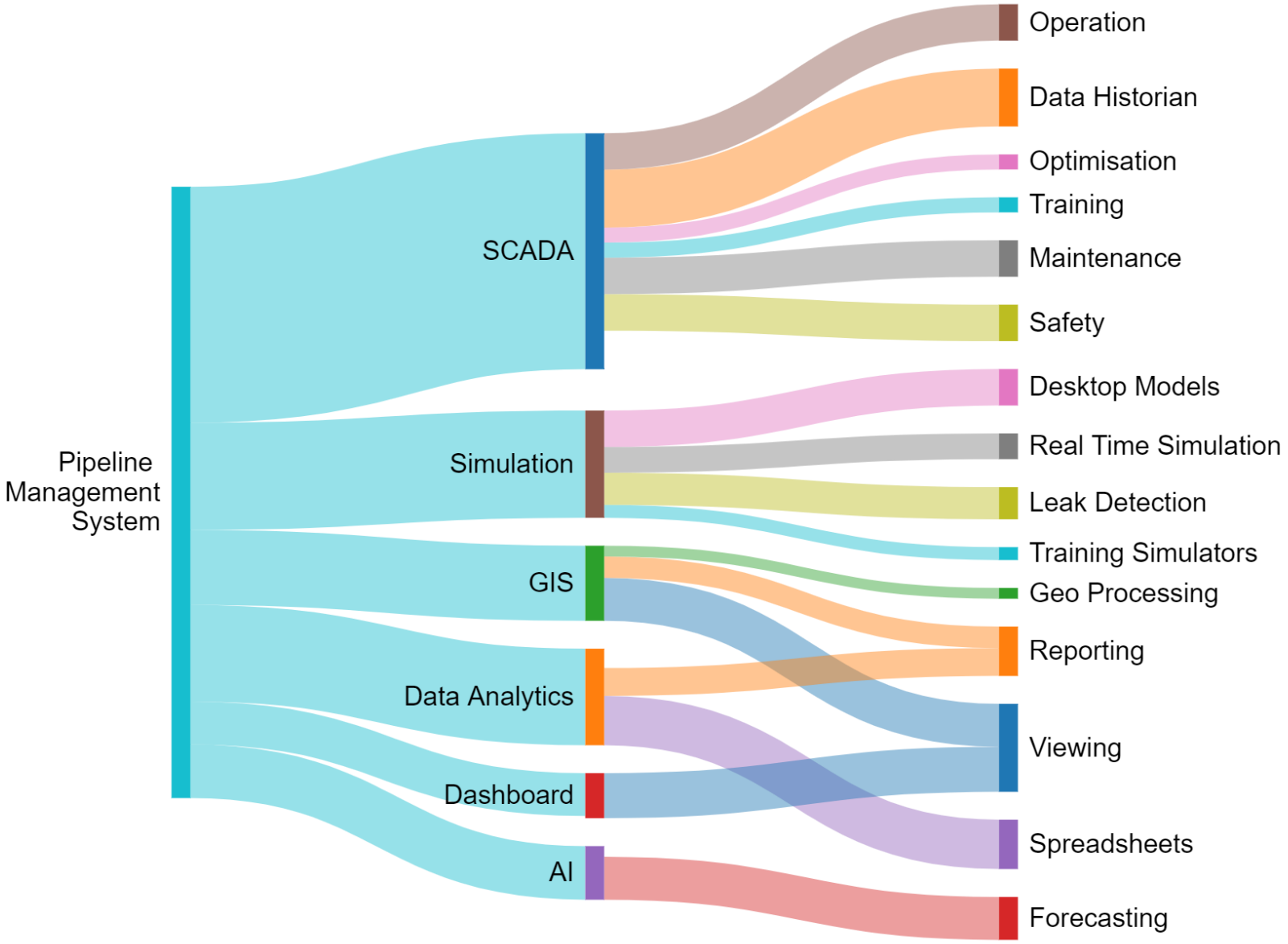


hydraulic analysis group

Implementing Effective Water Loss Management Strategies

1. Provide clear guidance on goals and be open to new strategies and technologies
2. View network sensors as an asset that provides valuable insights and understanding of network performance
3. Many new technologies are available and a lot of them have been successfully validated in other countries so there is minimum risk of failure. At the same time, every country has different strategies for operating their network and not every solution is viable – ask questions
4. GPRS / NBIoT loggers can be widely deployed now to provide effective information. Costly SCADA systems are not necessarily the best option
5. Bring all data into a centralised platform to avoid the need to continually access multiple different equipment manufacturer sites
6. Research the market for different solutions – large multinationals look attractive and produce effective marketing but ask where their systems are permanently installed and operational. Commercial models should also include an element of performance related goals, including leakage reduction
7. Foster long term relationships with suppliers and expect them to set up a local office if you are prepared to invest in their product / service. Long term collaboration is essential for success
8. Agree realistic timescales as it can take 12+ months to generate effective water loss management strategies

hydraulic analysis group



Contact:

Glyn Addicott – Operations Director

glyn.addicott@hydraulic-analysis.com

www.hydraulic-analysis.com