Our Journey with Fixed Network Hydrophones

Leakage HUB

May 2024

Introduction

Who are we?

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Agenda

- AW Context
- How it all started
- How do hydrophones / Correlations work
- Developing the Analysis and Supporting Apps
- Full Demo
- Coverage Today
- Performance

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Our water company

The **largest** water and water recycling company in England by geographic area

Serving almost

7 million

customers across the East of England and Hartlepool

The driest region in the UK with

2/3

of the national average rainfall each year

One of the UK's fastest-growing regions, projected to grow by

175,000

homes by 2025

Operating

38,185km

of water mains - laid end-to-end further than a trip to Sydney and back

Employing more than

5,000

people

We are robustly regulated

defra
Department for Environment Food and Rural Affairs

- Government department responsible for water and wastewater issues including the environment.

Environment Agency

Secures, protects and improves the environment in England and Wales by influencing policy making, flood protection, protection of the environment and advice to business/agricultural bodies.

dwi
guardians of drinking water quality

Regulates public water supplies in England and Wales by assessing the quality of drinking water.

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NATURAL ENGLAND

Ensures land, flora, fauna. Freshwater and marine environments, geology and soils are protected and improved.

CCW
The voice for water consumers
Llais defnyddwyr dŵr

Independent organisation representing customers' interests.

Office for Environmental Protection

New public body created under the Environment Act 2021 to protect and improve the environment by holding government and other public bodies to account

Ofwat

Economic regulators of the water industry.
Responsible for ensuring companies carry out their functions, able to finance their operations, comply with licences, protect consumers, promote competition.

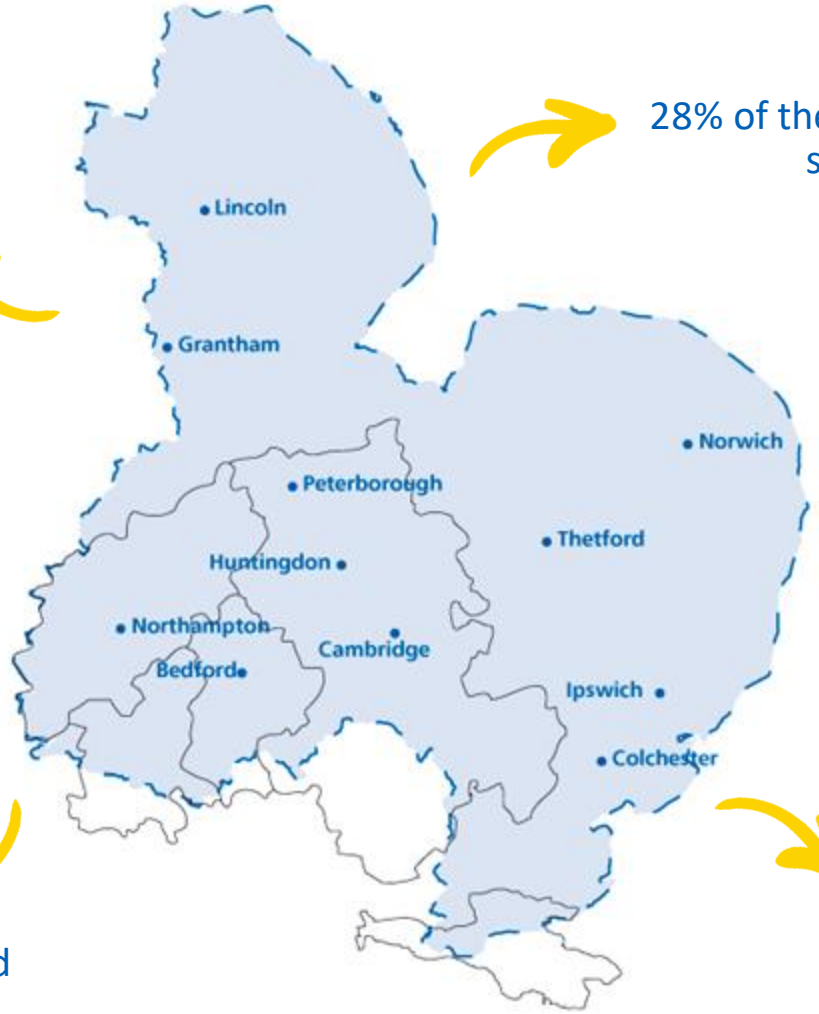
ENGLISH HERITAGE

Statutory advisor to the government on the historic environment.

Our vulnerable region

Demand for water will rise but available water won't

28% of the region is below sea level



Population is expected to rise – around 1m homes to be built in the next 25 years

As a low-lying region there is a high use of energy to pump water around the region

Climate change impacts and uncertainty

It is the driest region in the UK

How it all started

- We are heavily regulated, in the driest region and the front runners in the UK for leakage levels but need to still do much more!
- We needed a fundamentally different way of finding leakage, to do it faster and for less money than we had before across our network.
- Our region is the biggest in the UK, how can we locate faster across without increasing technician headcount exponentially? For reference our leakage team alone is over 300 people
- Our Network:
  - 38,000+ KM of water mains
  - Over 55% Plastic water mains
  - 2200+ DMAs (Discreet Zones)
  - Average Zone length of mains 19km

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How it all started

Anglian have been using Noise Logging, Sweeps (listening on fittings) and Hyq's as leak detection methods for 20+ years and as such had a good level of experience with the 3 large suppliers in the leakage environment.

HWM
Halma Water Management

GUTERMANN

OVARRO

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Results

Type	Distance between sensors	Cost to Cover average DMA	Average Sensors Per DMA	Network Suitability	Conversion Rate	Effective on Plastic	Remote Nightly Data	Multi Point correlation?
Hydrophones	750m	£33,000	25	100%	100%	Yes	Yes	Yes
Semi Permenant Correlating Accelerometers	125m	£56,000	152	45%	70%	No	Yes	Yes
Accelerometers	125m	£21,000	152	45%	50%	No	No	No

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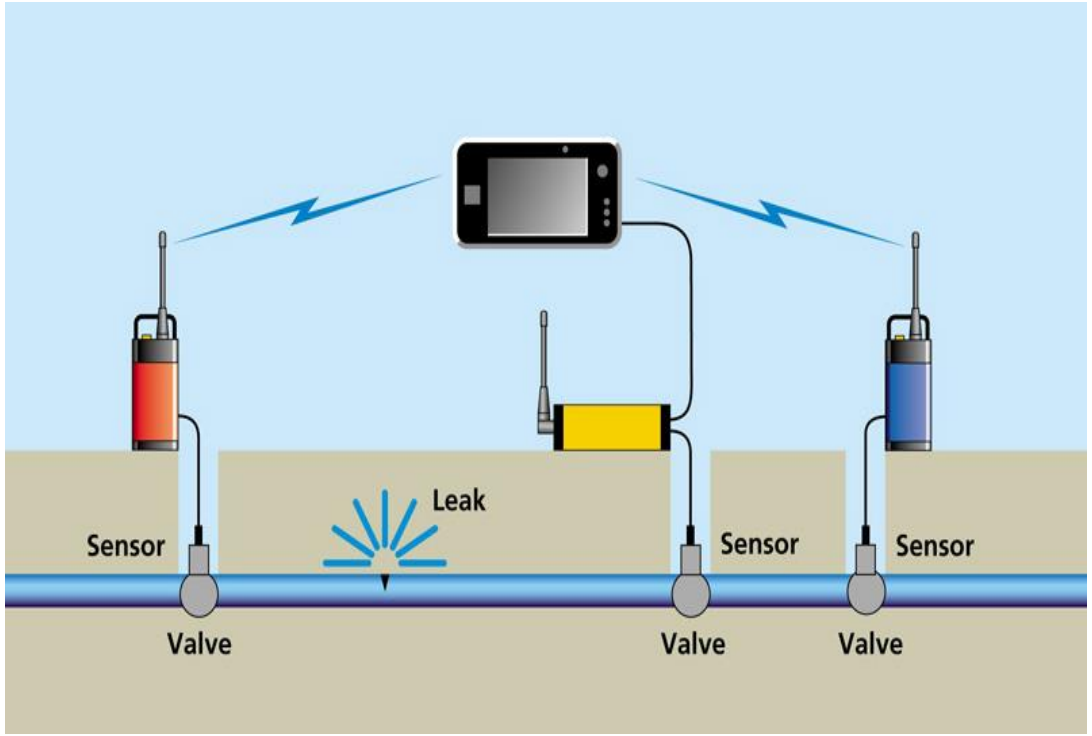
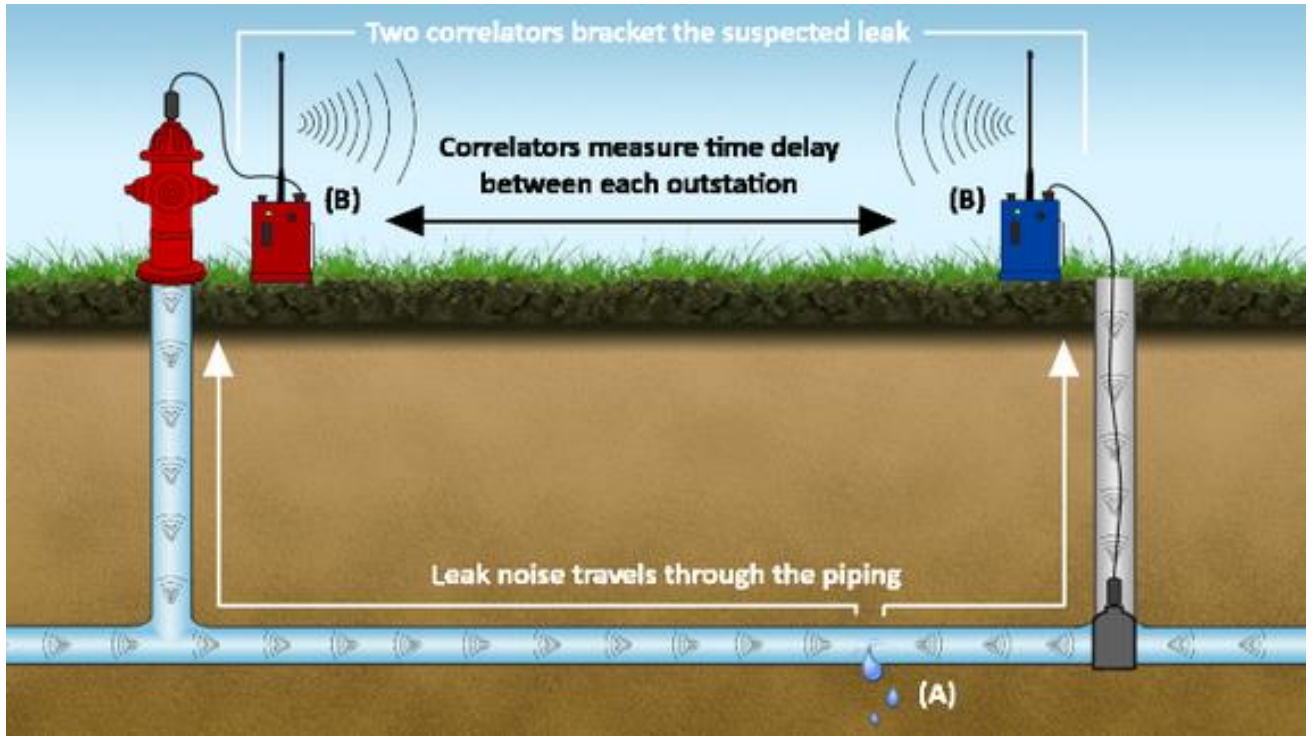
Accelerometers Vs Hydrophones





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How do Hydrophones work?

Hydrophones aren't new, they have been around for a long time, we in AW have used hydrophones well over a decade.

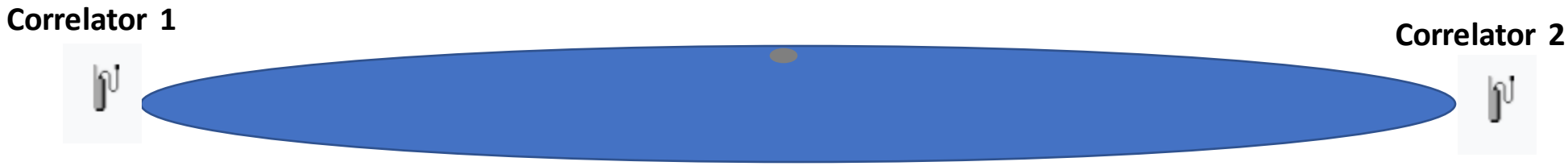
A typical hydrophone works by converting a pressure wave into an electrical voltage by detecting changes in pressure in the surrounding environment. The speed and distance at which a sound wave travels through water will be proportional to the pressure changes, which will determine the nature of the electrical output that is transmitted.

Piezoelectric material is used for making hydrophones. They can change their form and help generate an electrical potential in response to mechanical or external pressure changes. When an electrical voltage is applied to the crystalline ceramic material, the crystalline structure carries an electrical charge.

The hydrophones we use have this crystalline material; this is extremely sensitive to changes in pressure in our network caused by pressure waves.

How correlation works

Correlators work by measuring the time delay between a pressure variance or “sound” reaching each logger. When we have a leak in the network, it creates noise as the water escapes.
Basic correlation theory:



To calculate the origin of the “noise” source this equation is used:

$$\text{Distance} = \frac{\text{Length} - (\text{Velocity} \times \text{Time})}{2}$$

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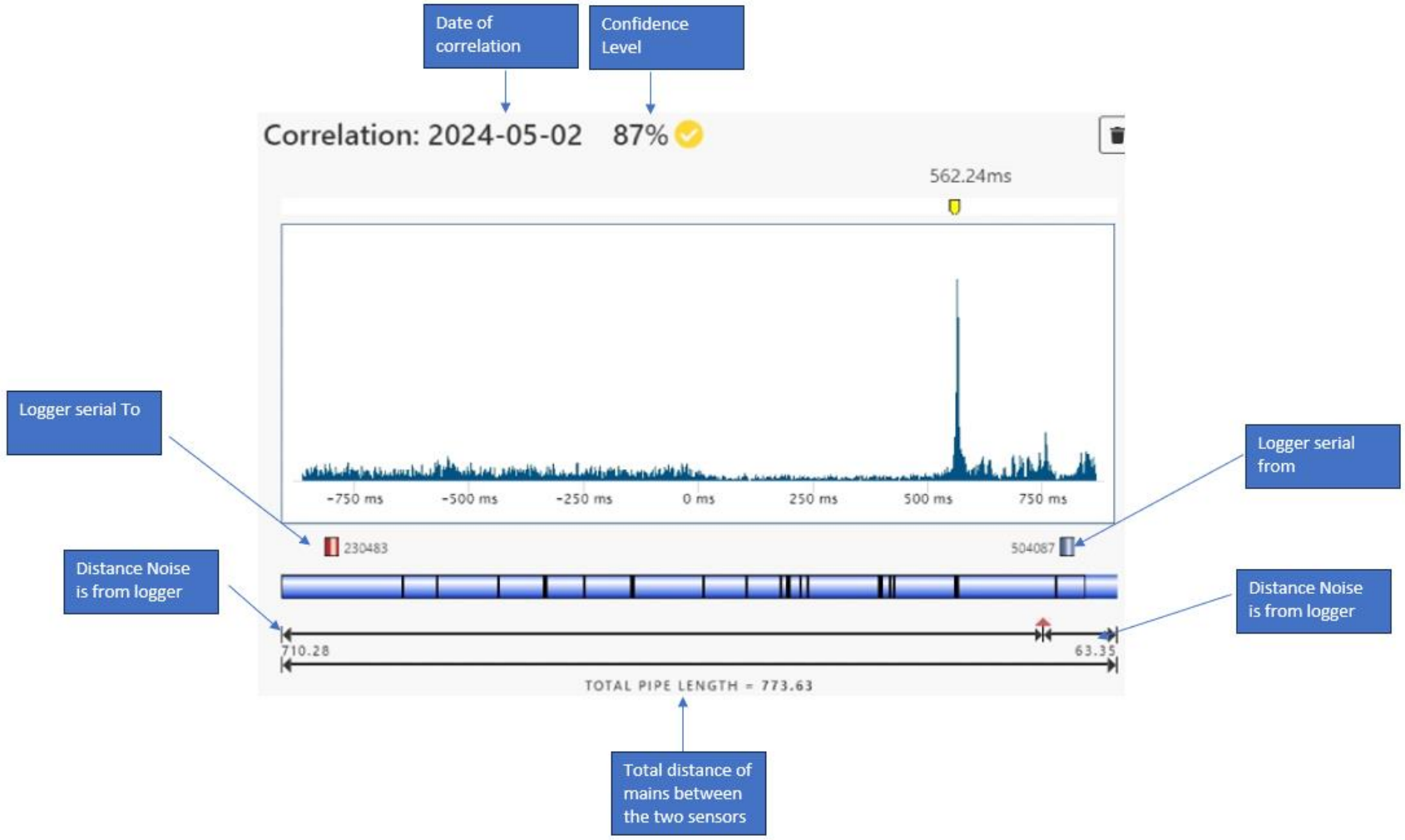
Correlations - Good



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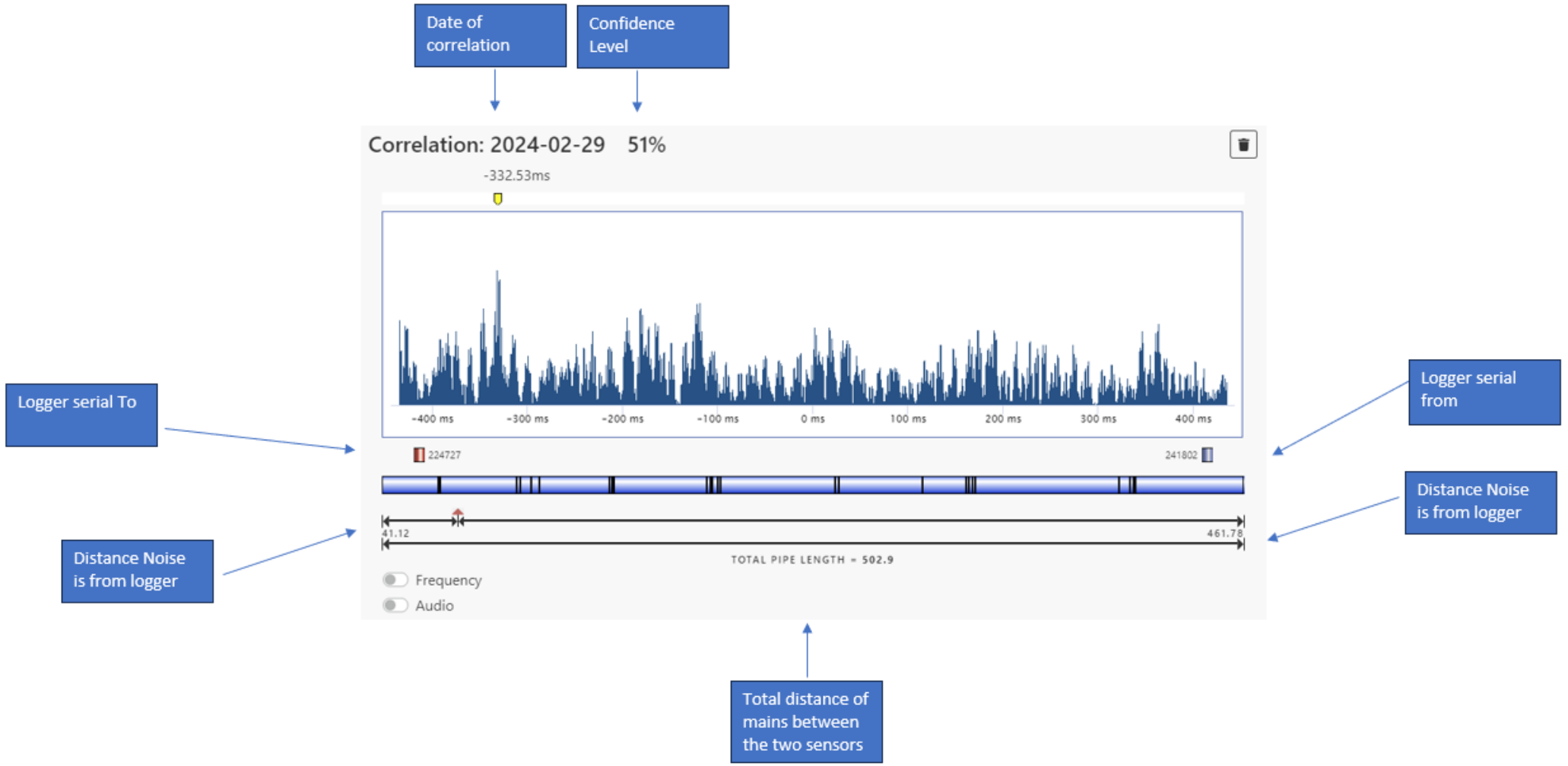
Correlations - Bad



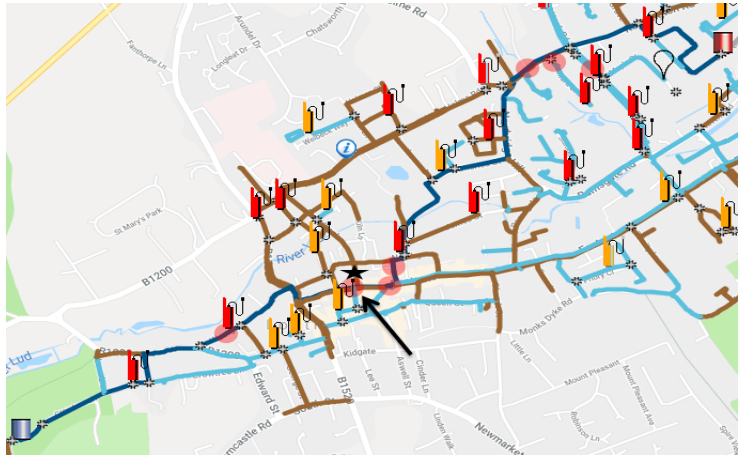
Early Case Studies

Some case studies from our initial trial of the hydrophones to test out the capabilities back in 2017.

3002m correlation to a burst main

367m of AC main	(8 mains)
1313m of CI main	(31 mains)
2m of MDPE	(1 main)
1298m of PVC main	(33 mains)
21m of HDPE main	(3 mains)

76 Different Mains materials



2826m correlation to a comm pipe leak

1899m of PVC main	(33 mains)
375m of CI main	(10 mains)
552m of HDPE main	(13 mains)

56 Different Mains Materials

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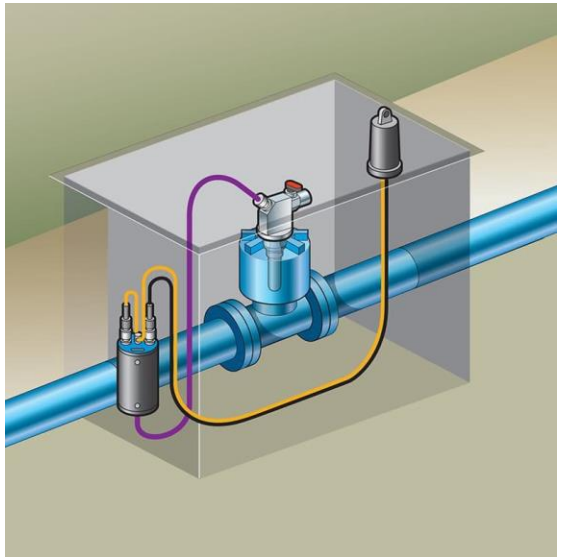
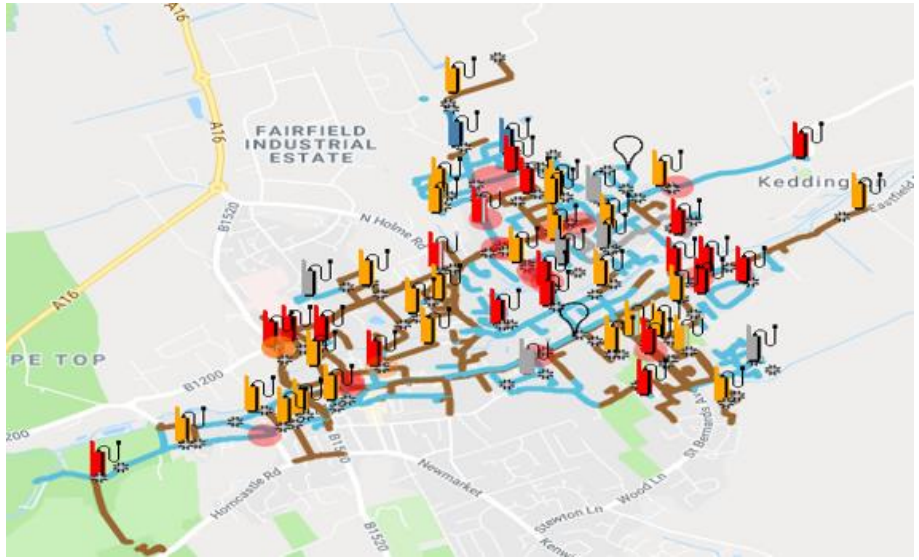
The next problems to solve



Problem 1

Hydrophones need a connection to the water column to work, almost all our assets are buried or used for other activities. If we want to use them permanently fixed in the same location, we will need to build assets to house them. Which makes things a bit more expensive!



Problem 2

Primeweb (Now Atrium) was not a scalable solution. It was incredibly intensive to analyse daily for just 40 loggers. We had to manually correlate between every logger pairing, myself and Beckie carrying out hundreds of correlations manually each day with filtering.

We can't employ 100 more analysts to do this, the software needed developing.

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Problem 1

To combat these costs, we had the idea of replacing customer stop taps for double ported assets, so our hydrophone could have the connection on a customer's supply pipe instead.

This change from tapping to replacing existing stop taps reduced each install by over half the total cost.

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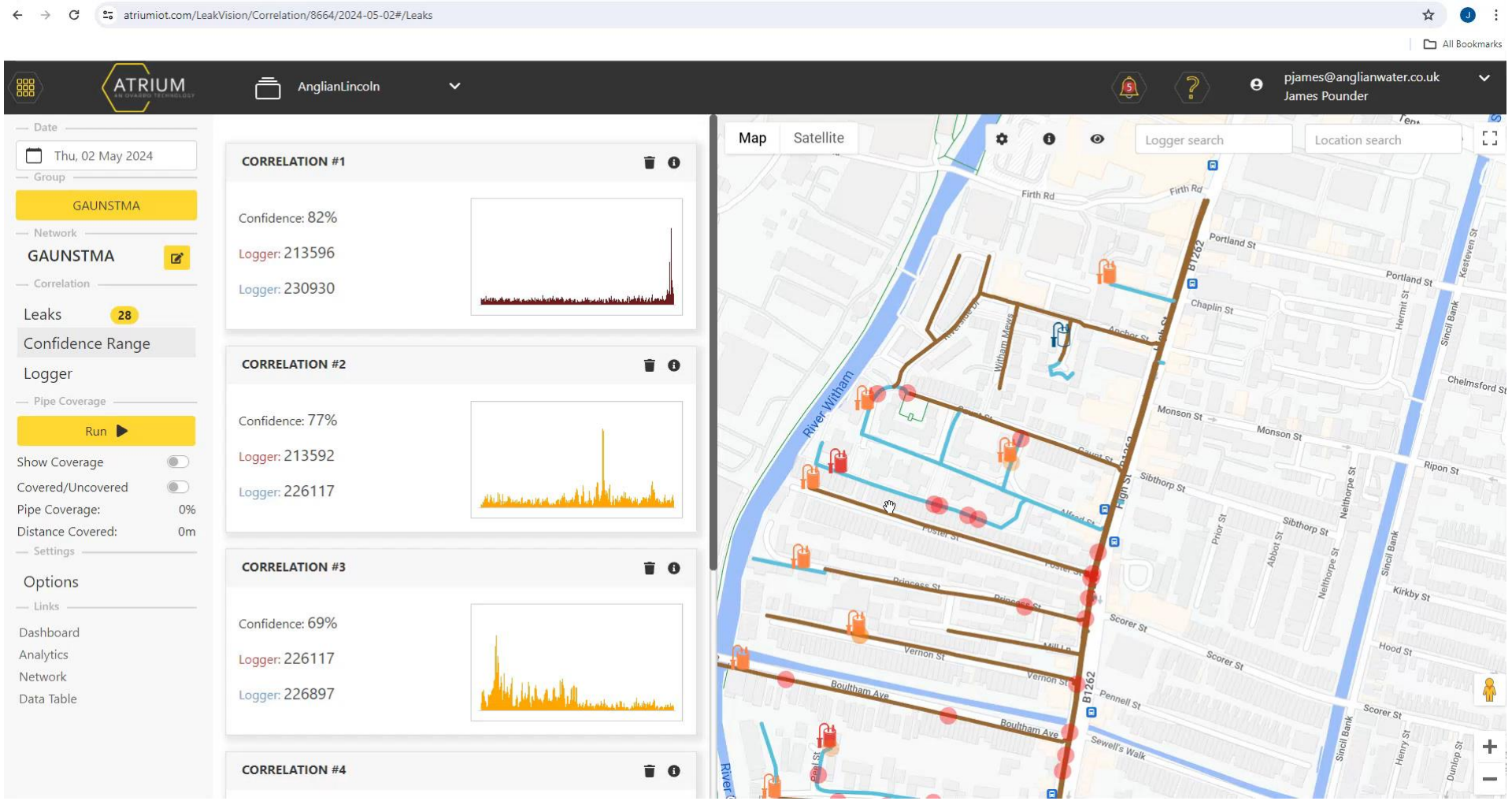
Problem 2

Upscaling Analytics - Speed of analysis

In the original version of atrium, we had to manually correlate each set of logger pairs, running through the full range of frequency narrow bands.

Material	Filter Range Hz
Default Plastics	5 - 400
Narrowband Plastics	5 - 30
Narrowband Plastics	20 - 48
Narrowband Plastics	40 - 85
Narrowband Plastics	70 - 125
Narrowband Plastics	110 - 200
Narrowband Plastics	175 - 300
Default Metallic	75 -2000



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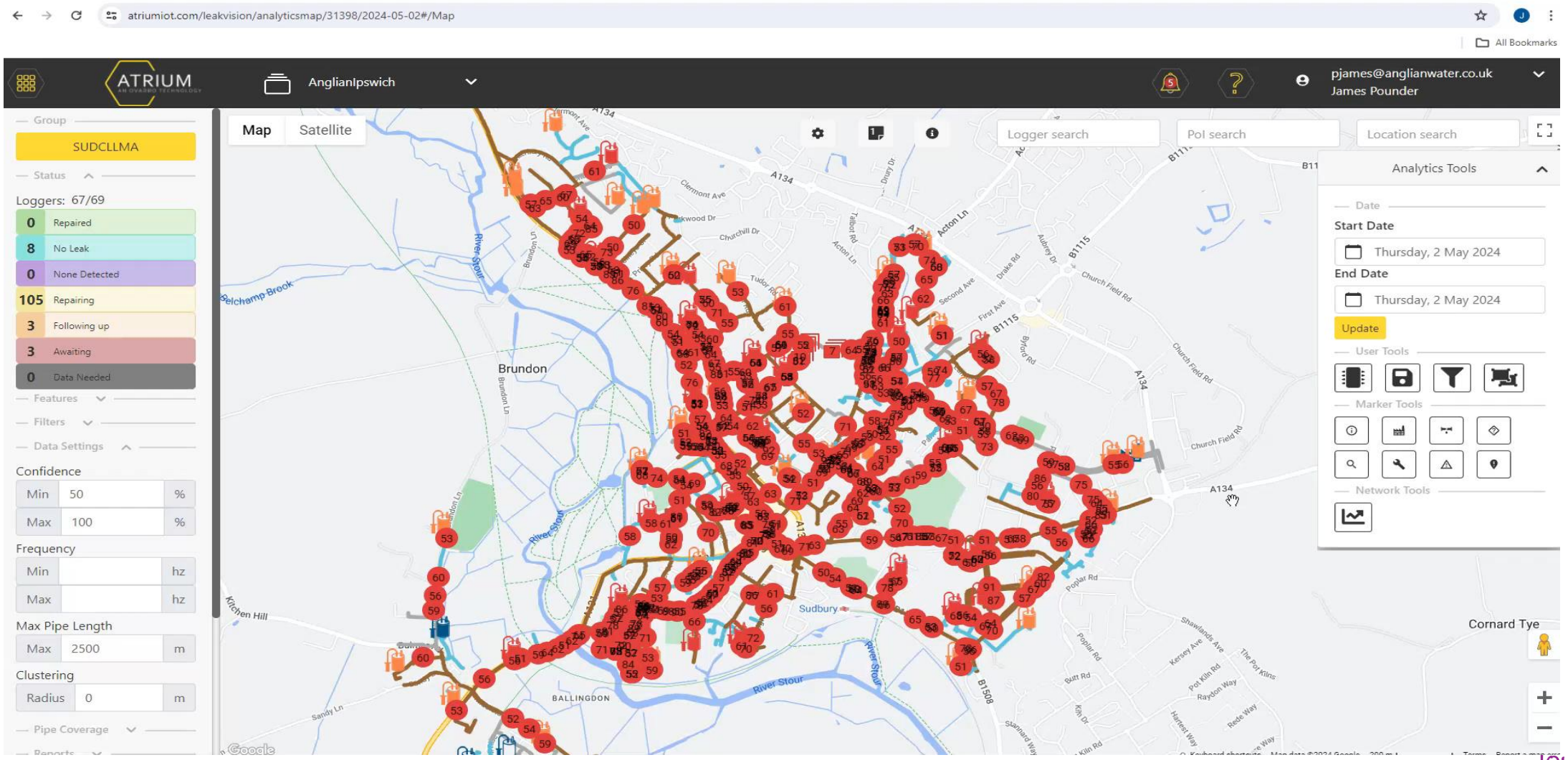
Collaborating With Ovarro

Clustering Correlations and Multi-Day Analysis

Single day - No Clustering



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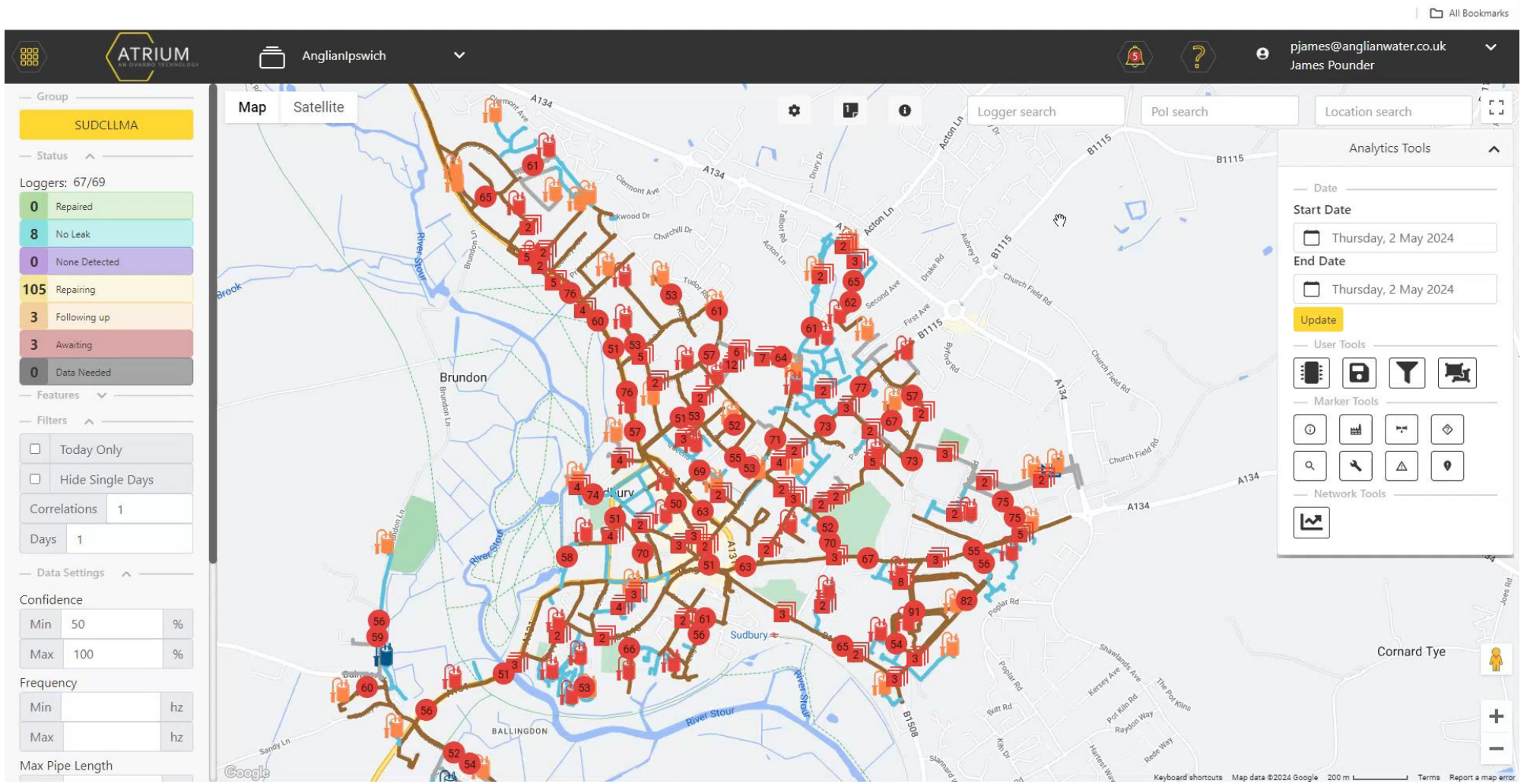
Collaborating With Ovarro

Clustering Correlations and Multi-Day Analysis

Single Day with Clustering



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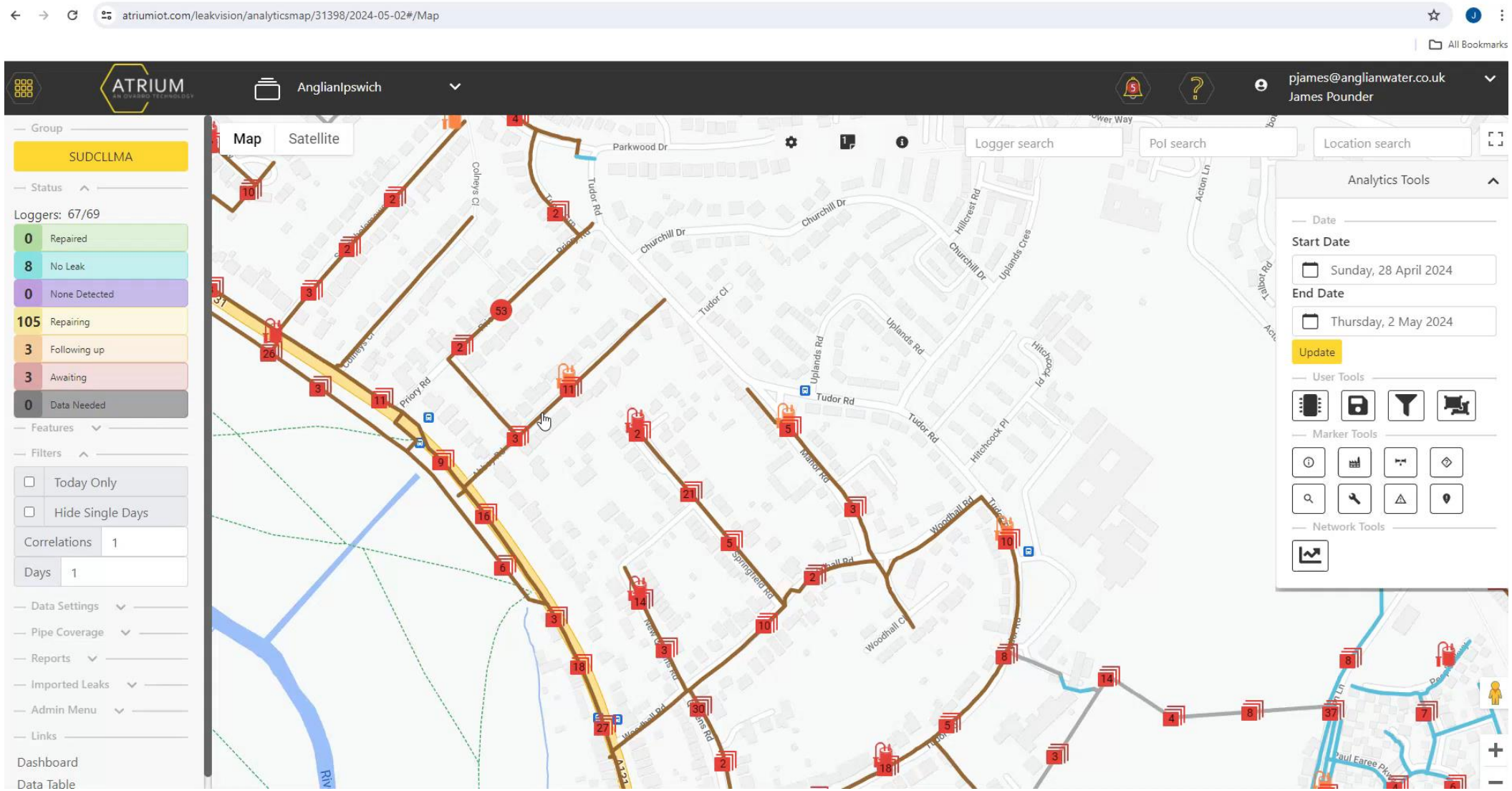
Collaborating With Ovarro

Clustering Correlations and Multi-Day Analysis

Multi Day with Clustering



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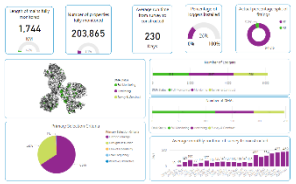
Tech development to BAU



2017 → 2020

Supply chain engagement
Collaboration team established

Product development
Hardware
3MHyQ

Product development
PrimeWeb

Feasibility testing
Live network trials

Product improvement
Hardware
3MHyQ Integrated

Product improvement
PrimePOI
PrimeDeploy

Operating parameters
Optimisation

Enhancement
Network placement model

Strategic development
Business plan
Programme delivery
Target outcomes

Performance delivery
Reporting
Tracking
Benefit realisation

Business processes
Survey standards
Investigation standards
SLA's

Employee engagement
Training
Culture
Equipment

Establishing BAU
Continuous review
Integrated workflow
Efficiency
Productivity
Structures

Product development
Hardware
3M-BB

Advanced analytics
Prioritisation
Categorisation

Collaborating With Ovarro

Deployment Mobile Application

Complete UI/UX overhaul

Data Tables

POI Cards

Workflow Management tool

Follow UP Mobile Application

Correlation Views

POI Details

POI Router

Coverage Checker

GIS Ingestion

POI Categorisations

Coverage Checker

Diagnosing Loggers

Correlation Views

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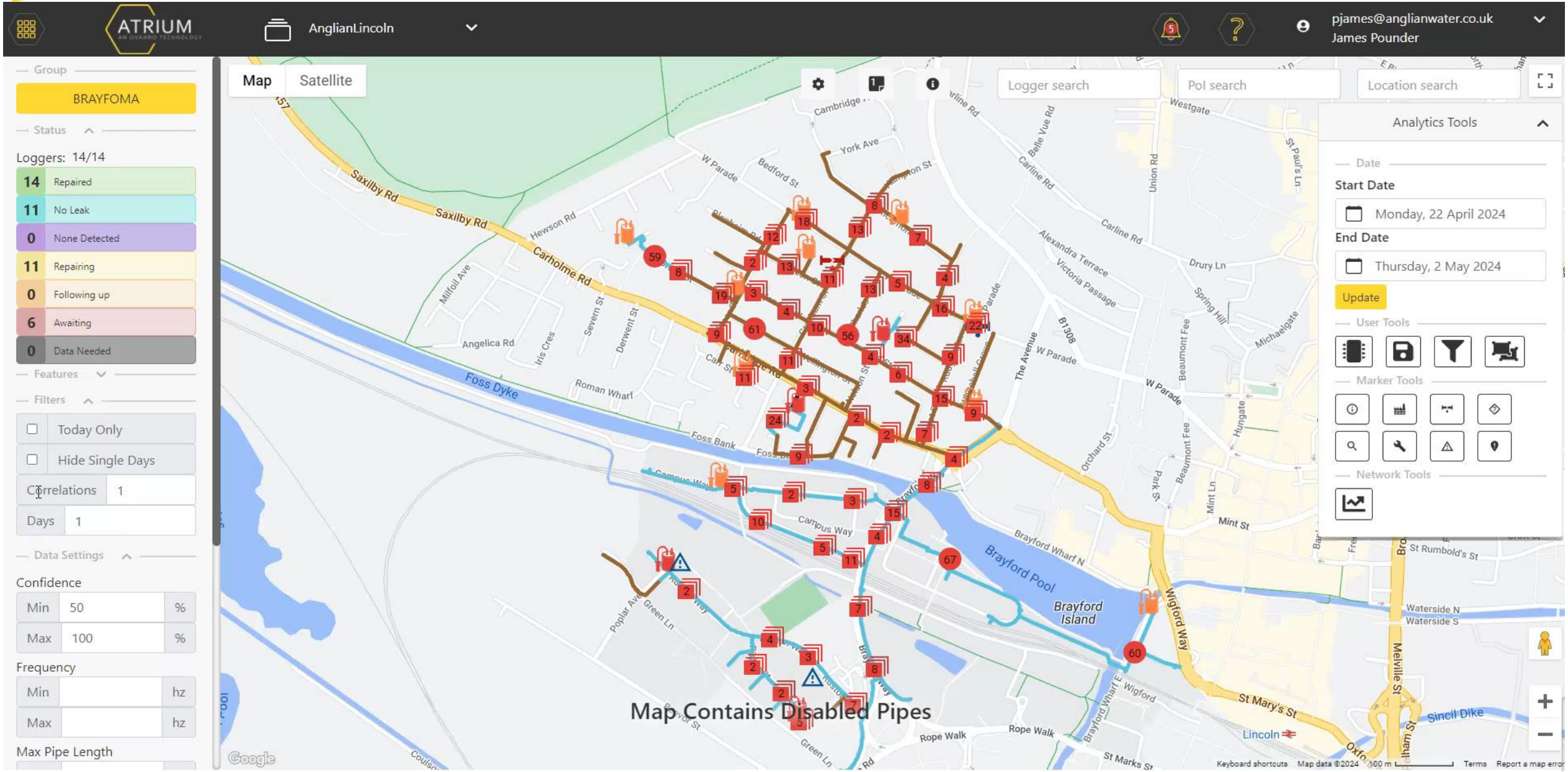
Full Process Demo



Our Hydrophone Network Today

8470

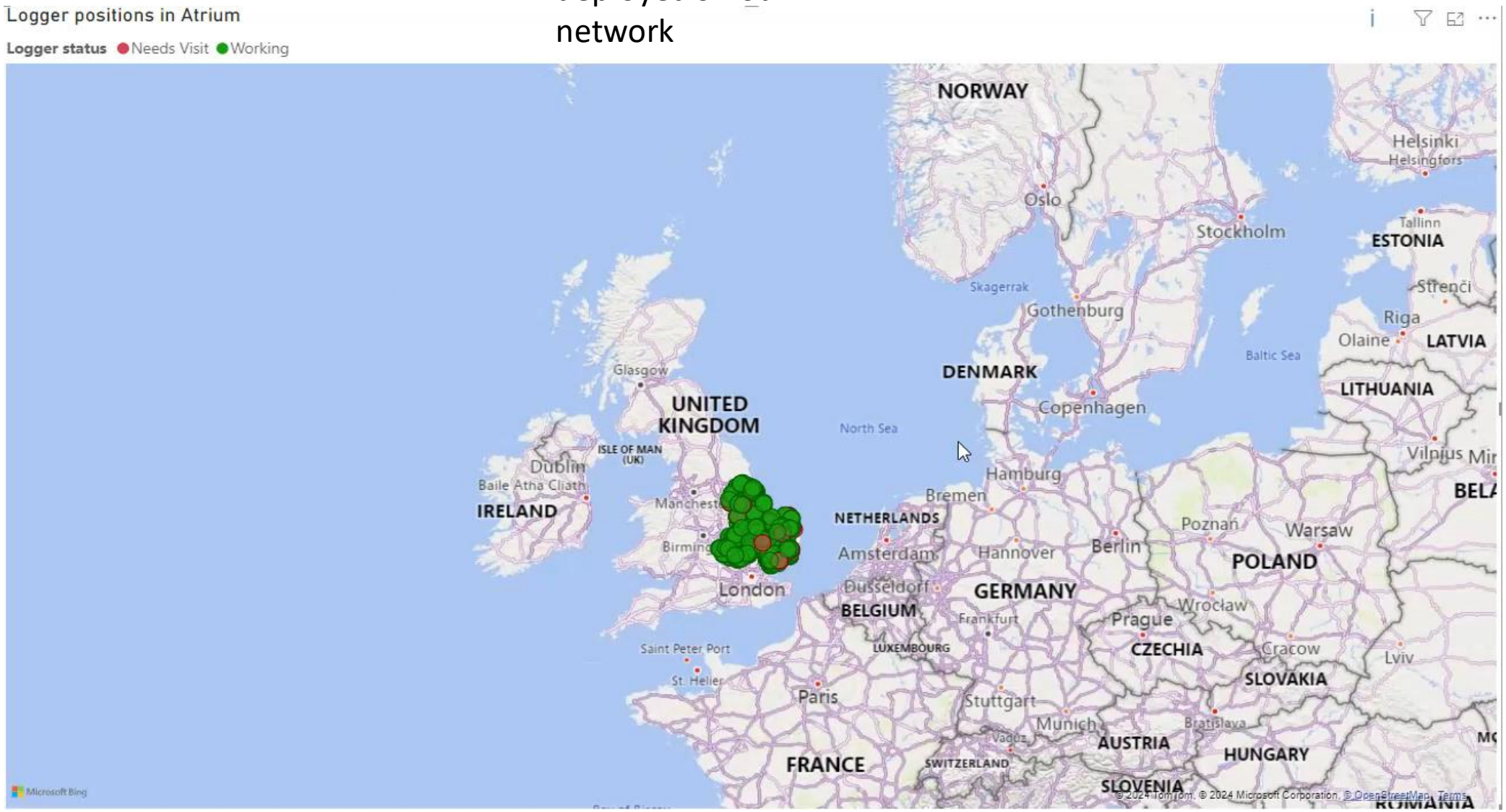
Hydrophones deployed on our network

6900km

Of mains covered

18%

Of Anglian Water's Network



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Our Hydrophone Network Today

Since 2017

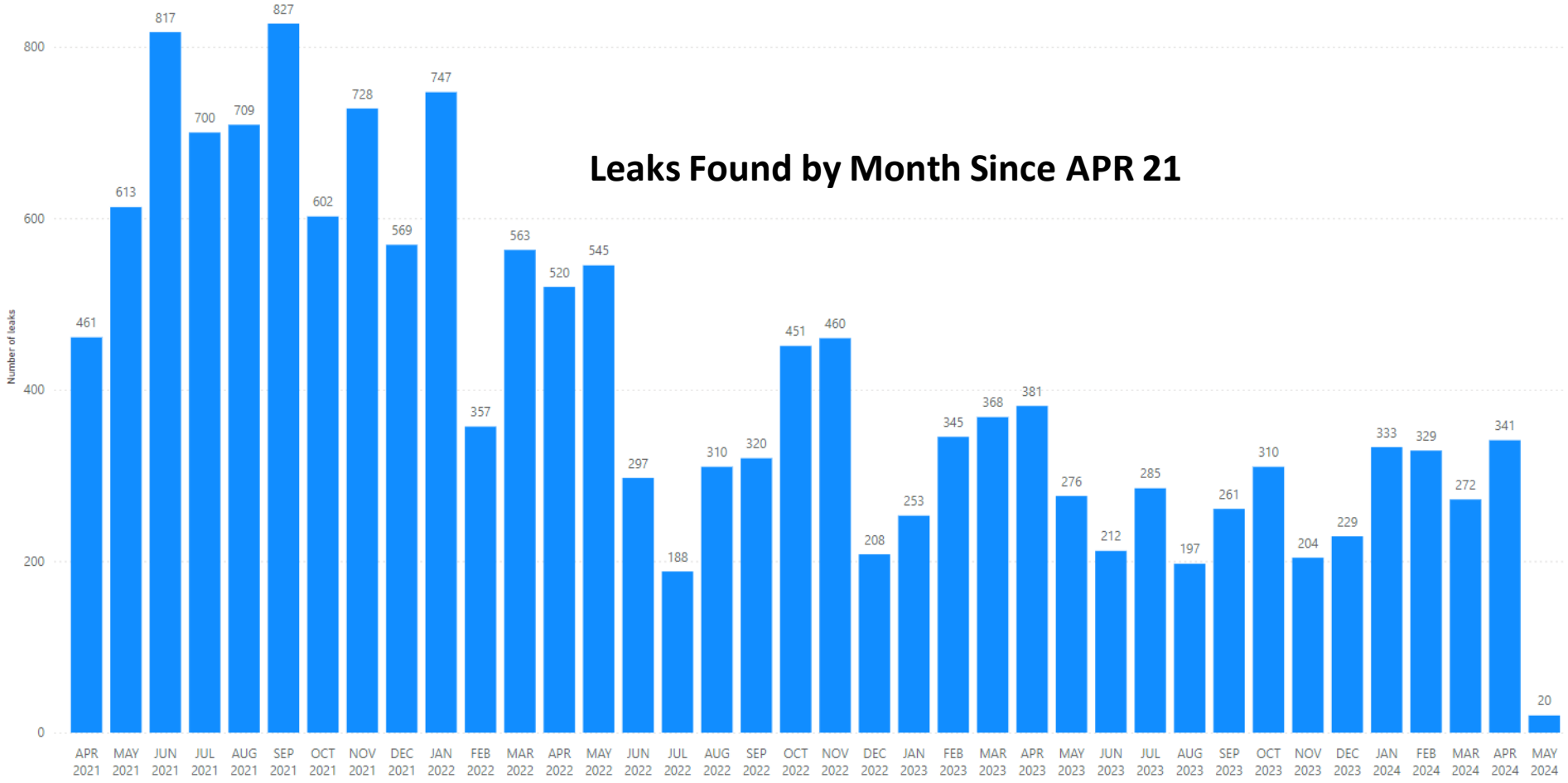
23,697

Points of Interest sent and Visited by technicians

24,160

Leaks found from the hydrophones

Leaks Found by Month Since APR 21



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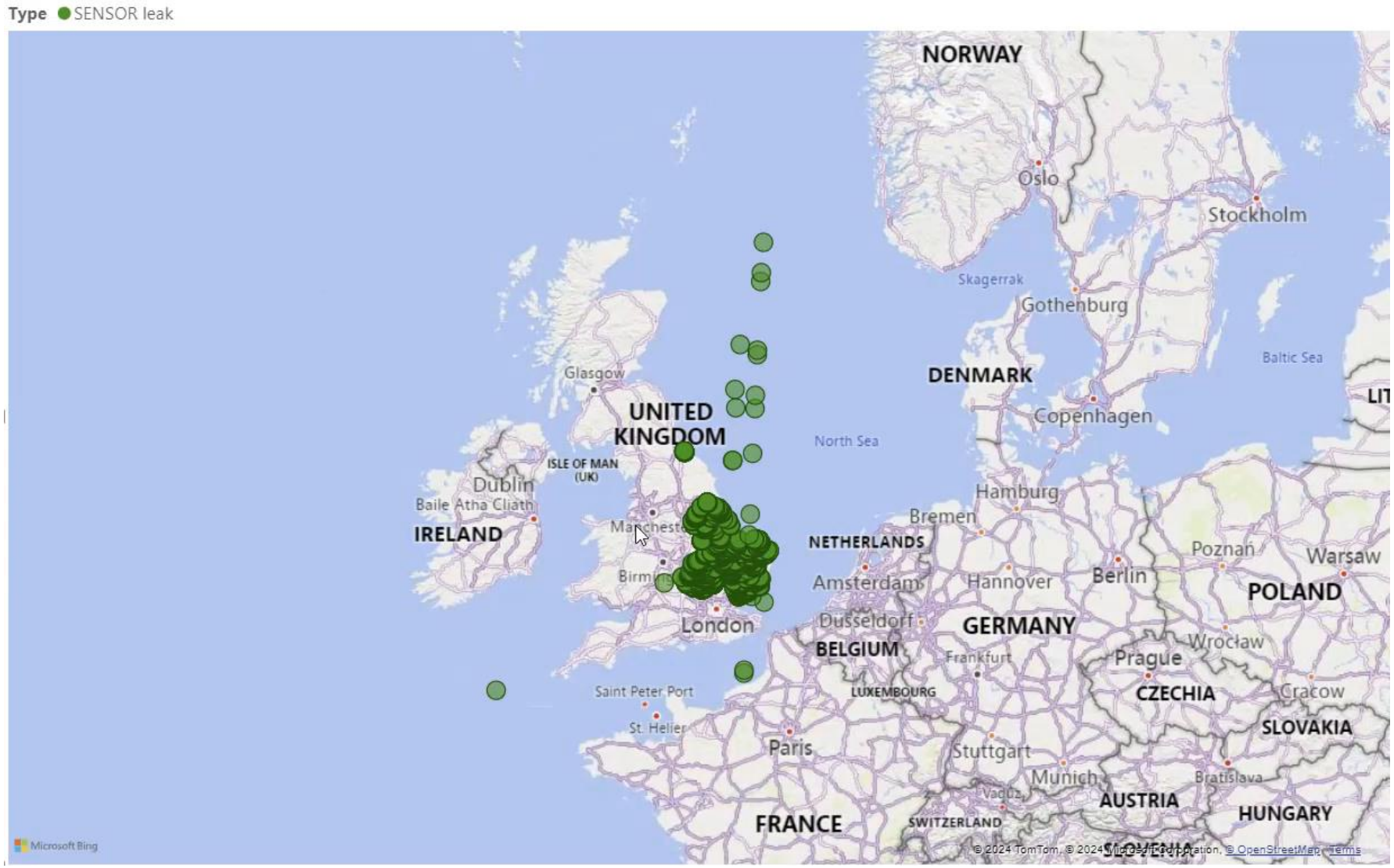
Our Hydrophone Network Today

Leak locations since 2021



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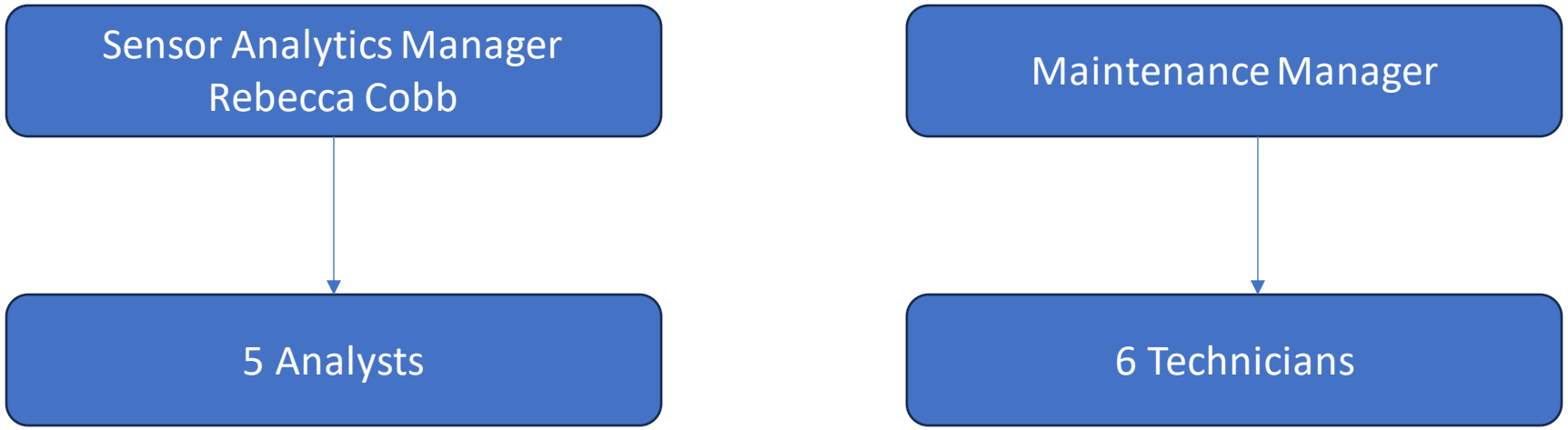
The Hydrophone Team Today



Award Wins

The team won the innovation of the year award at the Anglian Water Supplier awards

The team won initiative of the year in 2020 at the Water Industry Awards for the colloboration in building the product

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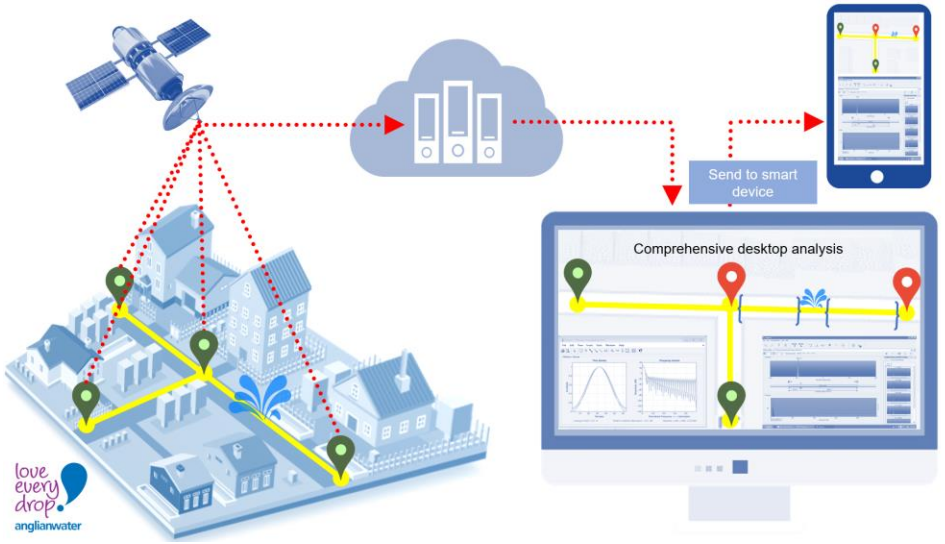
Benefits of our network in summary

- Response time to outbreaking leakage is cut dramatically, we just need to process the data that's already available!
- Targeting high leakage DMAs with hydrophones helps to reverse the reactive/proactive swing.
- Ability to drive down areas repeatedly to new lows in terms of leakage, carrying out campaign leakage in zones to bring them down!
- Find leaks that have gone previously undetected as this method is incredibly sensitive to pressure variances!
- Monitor and validate repairs – Does it still correlate after the repair? (it might not have been a very good repair!)



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Thank you for listening

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