Aquarius Spectrum

Pipe Condition Assessment and Leak Detection based on **Continuous Acoustic Monitoring**

Company ID

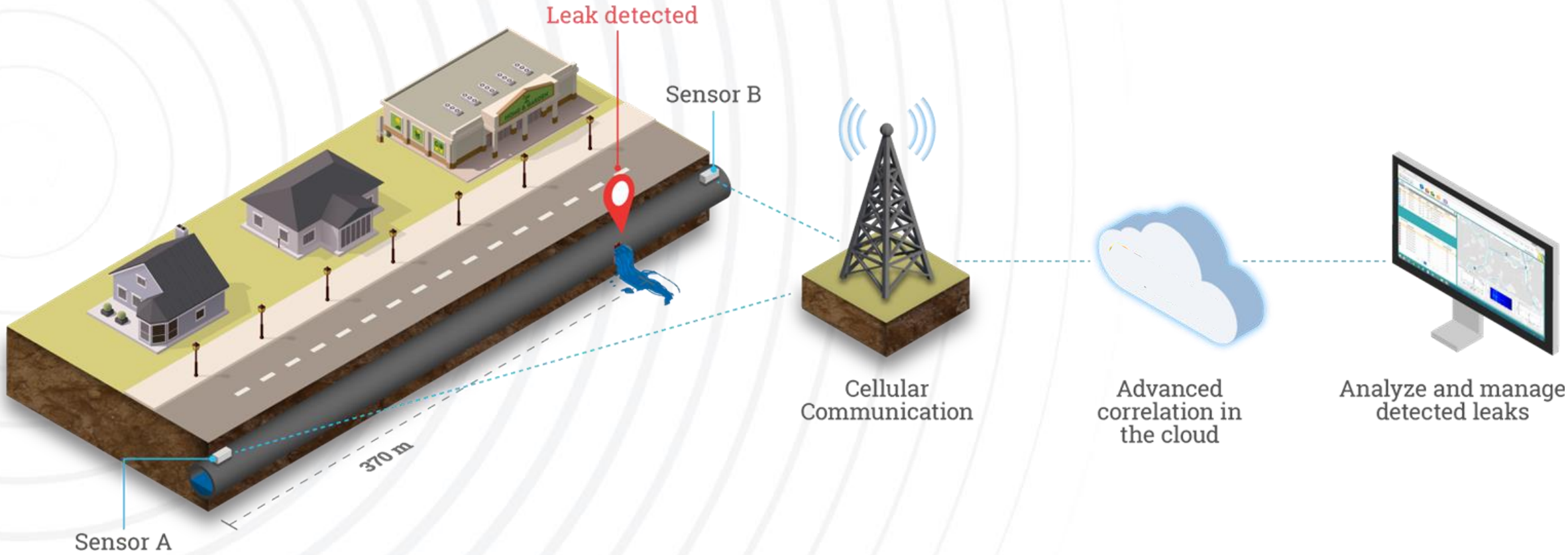
- Founded in 2009
- Thousands sensors deployed around the world
- 18 technology patents (granted and PCT)

Aquarius

Water Utility Challenges:

- Optimize pipe replacement
- Reduce Non Revenue Water
- Prevent water pipe bursts

Fixed Detection by Correlation (How it Works)



AQS-SYS UI

Aquarius Spectrum

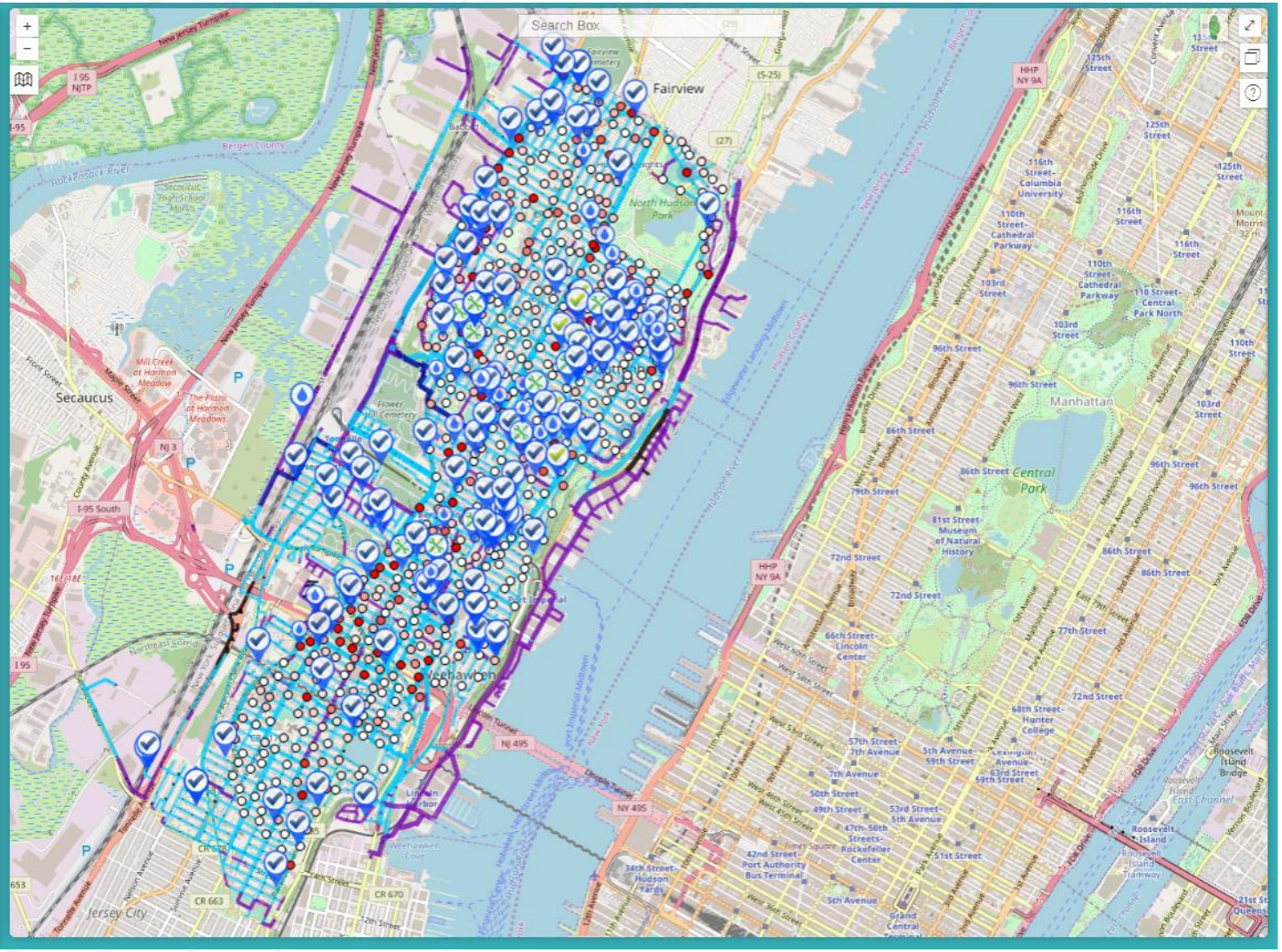
Alerts

Search Alert

Filters: Status Type

	ID	Detected	Type	Status	Address	Comment
A	37945	2016-02-11	Leak	Fixed	304 50th St, West New Yor...	MAIN BREAK LESS THAN ...
B	36503	2019-06-25	Leak	To Be Located	556 55th St	Need a VB RTG to finish thi...
B	36139	2019-05-07	Leak	Fixed	70th Street 301	Disc leak assigned to insp. ...
B	37906	2019-09-23	Leak	To be Fixed	6237 Durham Ave	Pinpointed leak on 63rd St ...
B	37835	2019-09-18	Leak	To be Fixed	304 43rd St	Leak has already been pinp...
B	37636	2019-09-05	Leak	To be Fixed	505 41st St	OSL at 511 41st located in ...
B	38014	2019-09-26	Leak	To Be Located	JFK Blvd at 31ST St	See WO # 1582256
B	35077	2019-03-01	Leak	Fixed	132 69th St, Guttenberg, N...	Sensor 23500 had noise w...
B	37713	2016-12-16	Leak	Fixed	5709 Palisade Ave, West N...	MAIN BREAK LESS THAN ...
B	36041	2019-05-18	Leak	Fixed	Westover Place 121	Per planning, waiting on pe...
B	36044	2019-05-19	Leak	Located	310 58th St	Located an ISL at 311 58th ...
B	36111	2019-05-26	Leak	Fixed	312A 67th St	OSL located at 431 67th St
B	37708	2018-11-15	Leak	Fixed	5600 Broadway, West New...	Improvement service leaking
B	37706	2018-01-26	Leak	Fixed	3800 Park Ave, Weehawke...	Improvement service leaking
B	35507	2019-04-12	Leak	Located	568 61st St	Found inside service leak a...
B	35464	2019-04-11	Leak	Fixed	John F. Kennedy Boulevar...	See WO # 1483515.
B	35612	2019-04-18	Leak	Fixed	Palisade Avenue 211	Located an outside service ...
B	37703	2005-08-07	Leak	Fixed	153 71st St, Guttenberg, N...	MAIN BREAK LESS THAN ...
B	36400	2019-06-14	Leak	Fixed	6031 Fillmore Pl	See WO # 1582257
B	34836	2019-02-18	Leak	Fixed	65th Street 119	Determined leak on 6" main.
B	36378	2019-06-10	Leak	Fixed	John F. Kennedy Boulevar...	See WO # 1458645.
B	38224	2019-10-17	Leak	To Be Located	604 79th St	See WO # 1589288
B	37406	2019-08-16	Leak	Located	414 78th St	ISL located at 414 78th St.
B	38191	2019-10-13	Leak	Located	560-578 60th St	Inside service leak
B	38140	2019-10-06	Leak	To be Fixed	7011 Hudson Ave	
B	35740	2019-04-27	Leak	To be Fixed	6134 Jefferson St	Contractor will be...
B	38189	2019-10-12	Leak	To Be Located	204 60th St	See WO # 1589074
C	38335	2019-10-25	Leak	To Be Located	400 60th St	See WO # 1594145
C	38077	2019-10-02	Leak	To be Fixed	308 57th St	WO's created for 2 dig and ...
C	38046	2019-09-29	Leak	To be Fixed	6402 Smith Ave	There is already a job in 1...

Selected: 0. Total: 152



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B	36503	2019-06-25	Leak	To Be Locate	556 55th St	Need a VB RT...
B	38014	2019-09-26	Leak	To Be Locate	JFK Blvd at 3...	See WO # 15...
B	38761	2019-11-17	Leak	To Be Locate	332 70th St	See WO # 15...
B	39064	2019-11-30	Leak	To Be Locate	8211 Grand Ave	Source might ...
B	36044	2019-05-19	Leak	Located	310 58th St	Located an IS...
B	37406	2019-08-16	Leak	Located	414 78th St	ISL located at

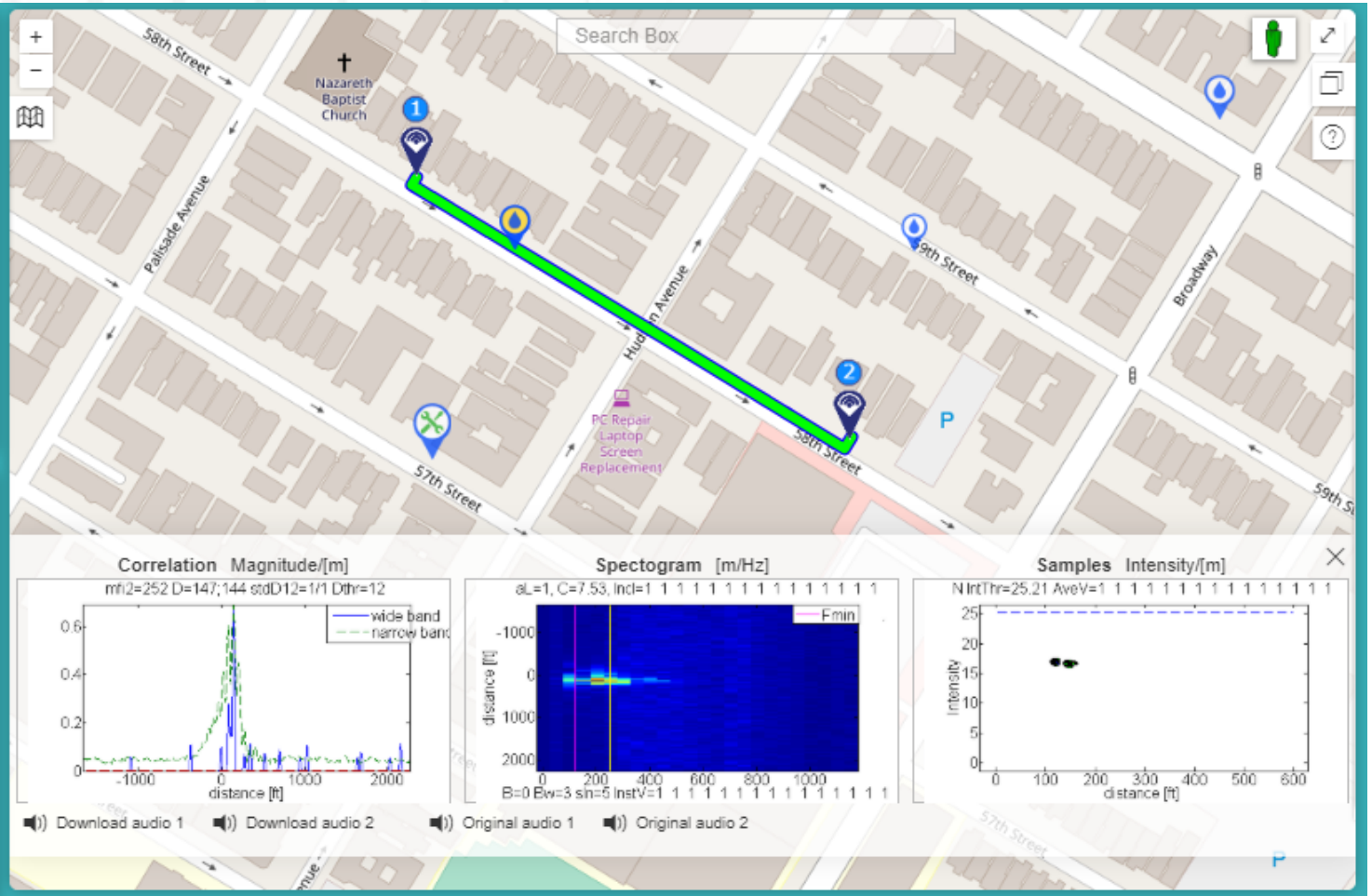
Selected: 5. Total: 26

Alert 36044

DETAILS HISTORY FILES SAMPLES LEAKGROWTH

	Sample Time	Weighted Distance	Weighted Intensity
B	2019-12-06, 08:00	144	16
B	2019-12-05, 08:00	144	16
B	2019-12-04, 08:00	144	16
B	2019-12-03, 08:00	118	16
B	2019-12-01, 08:00	118	16
B	2019-11-30, 08:00	118	16

first prev 1 2 3 next last



Technology – IoT Sensors

- **Easy installation** up to 30 aboveground units per day per technician
- **3G/4G communication** with advanced time synchronization
- **Vibration sensors** for up to 24” pipes - installation on aboveground and belowground hydrants (Iron & AC pipes)

  900-1500 ft./ 300-500 m. between sensors
- **Hydrophone sensors** for PVC, HD-PE and Large Diameter pipes (above 24”) - installation on underground hydrants/valves,

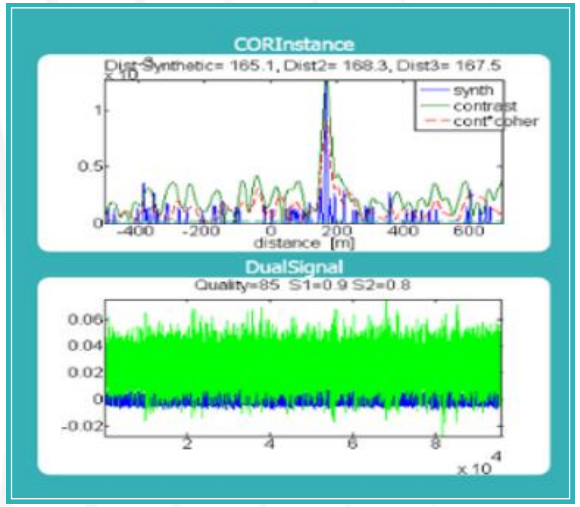
  900-4,000 ft. / 300-1,300 m. between sensors
- **Multi-sensors** for Water Transient and Pressure monitoring
- **5 Years battery life**
- **Secure cloud** infrastructure and communication

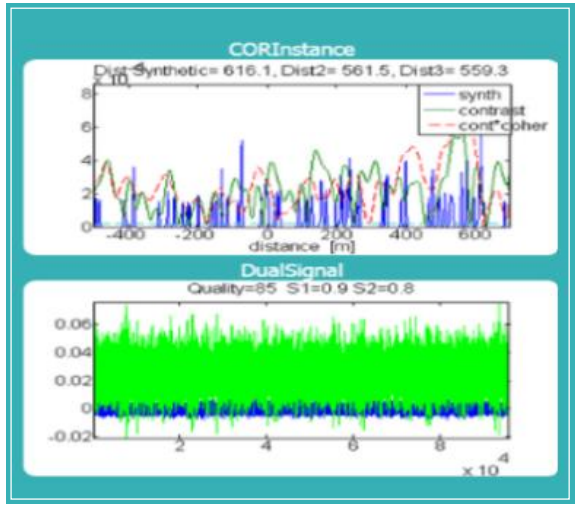
Detection by Multi Spectral Correlation

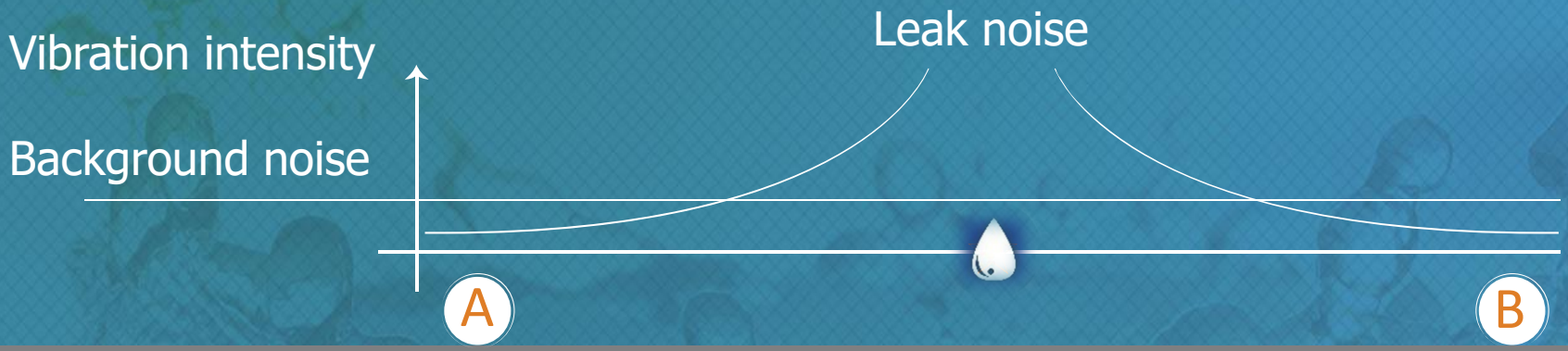
Correlation is based on pattern matching

Benefits

- Highly sensitive
- Accurate leak location – pinpointing leaks
- Intensity estimation
- Leak classification







Correlating Sensors vs. Noise Loggers

Aquarius Spectrum – Correlating Sensors	Parameters	Noise Loggers
• Requires time synchronization of all the sensors • Requires transmitting the vibration recording for analysis on the server	**Technology**	Very simple technology
Automatically records and sends 20 seconds of wave file to the server for analysis. The sound file can be downloaded and listened to.	**High Quality Sample**	Requires a few seconds of compressed data – the outcome is mostly one number (the level of noise).
<u>Multi Spectral Correlation (Low false positive rate):</u> • 3-15 correlations are needed before alerting. • Capable of detecting small leaks (below background noise).	**Detection Method**	<u>Detection by Noise (High false positive rate):</u> • Only one noise sample is needed before alerting. • Capable of detecting only high noises which are above the background noise.
Large distance between sensors (1,000 ft / 330 m)	**Spacing**	Shorter distance between loggers (500 ft /150 m)
Up to 10 ft / 3 m deviation	**Leak Location**	Provides a wide radius that requires a field team with mobile correlators for pinpointing
Multiple choice: Aboveground and belowground	**Installation**	Only one method
No limitation	**Material**	Does not support PE pipes, limited range with PVC pipes
No limitation (ACC up to 24” and hydrophones above 24”)	**Diameter**	Up to 12” pipes
Good estimation. Supports 0.5 mm leaks	**Size of Leak**	No estimation
Seamless integration	**Integration with Mobile sensors**	No integration

Pipe Condition Assessment

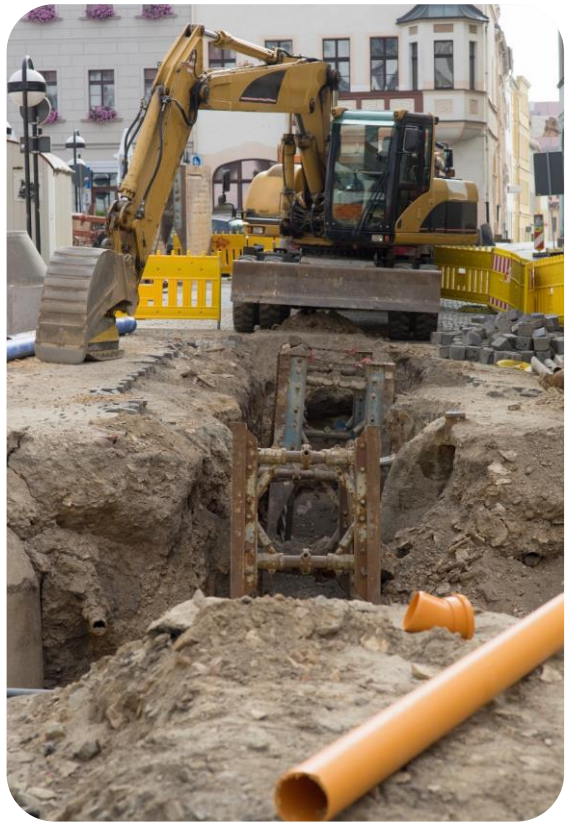
Integrating Big Data with Smart Dynamics Surveys

Pipe replacement cost $1M per 1 km

- Big Data analytics of history & current pipe repairs
- Replacement prioritization by condition rather than age
- Saving millions by extending the life of existing assets and by optimizing replacement decisions

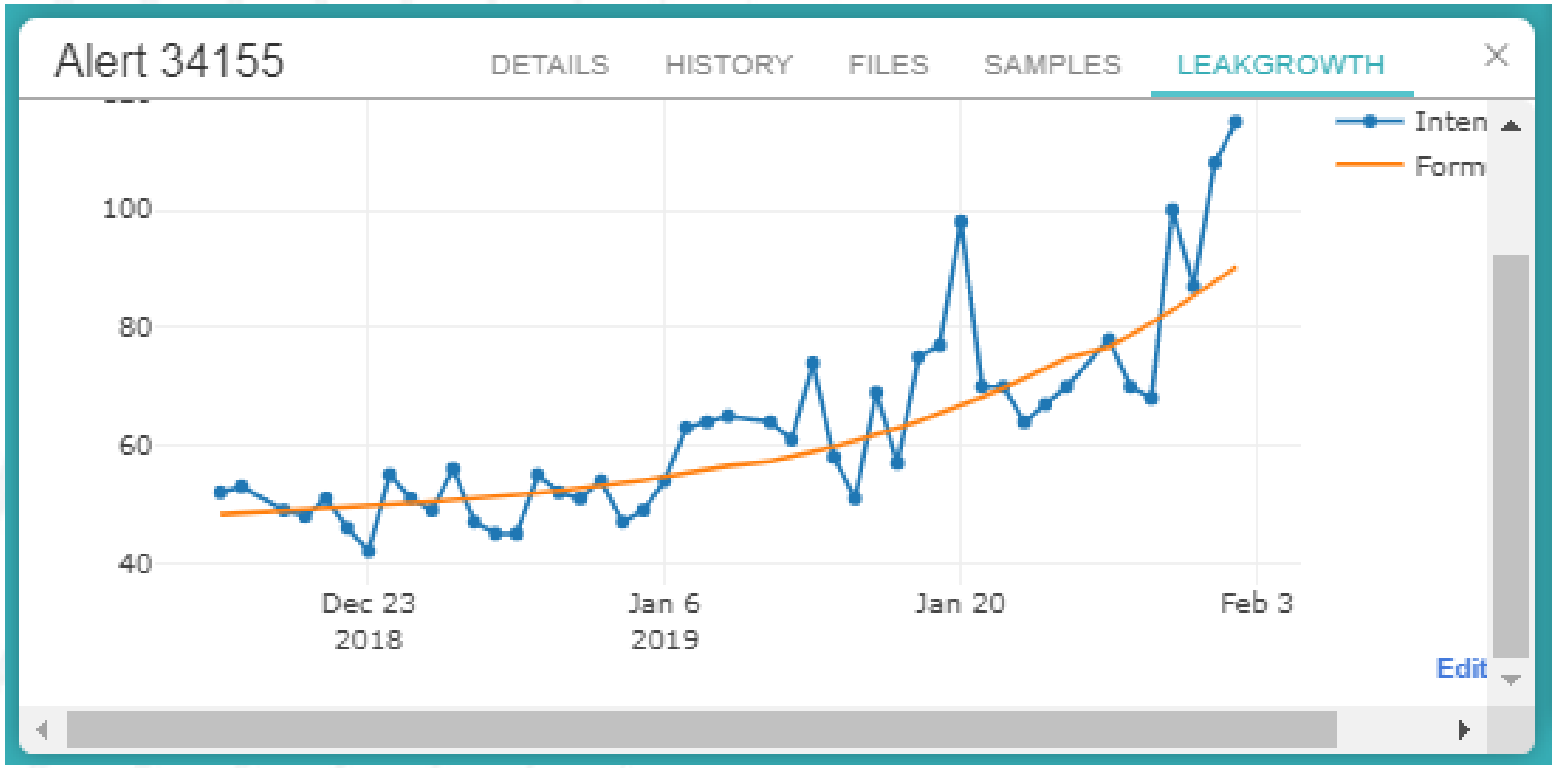
Assessment methods

1. Historical repairs
2. AQS background leaks
3. Leaks evolutions



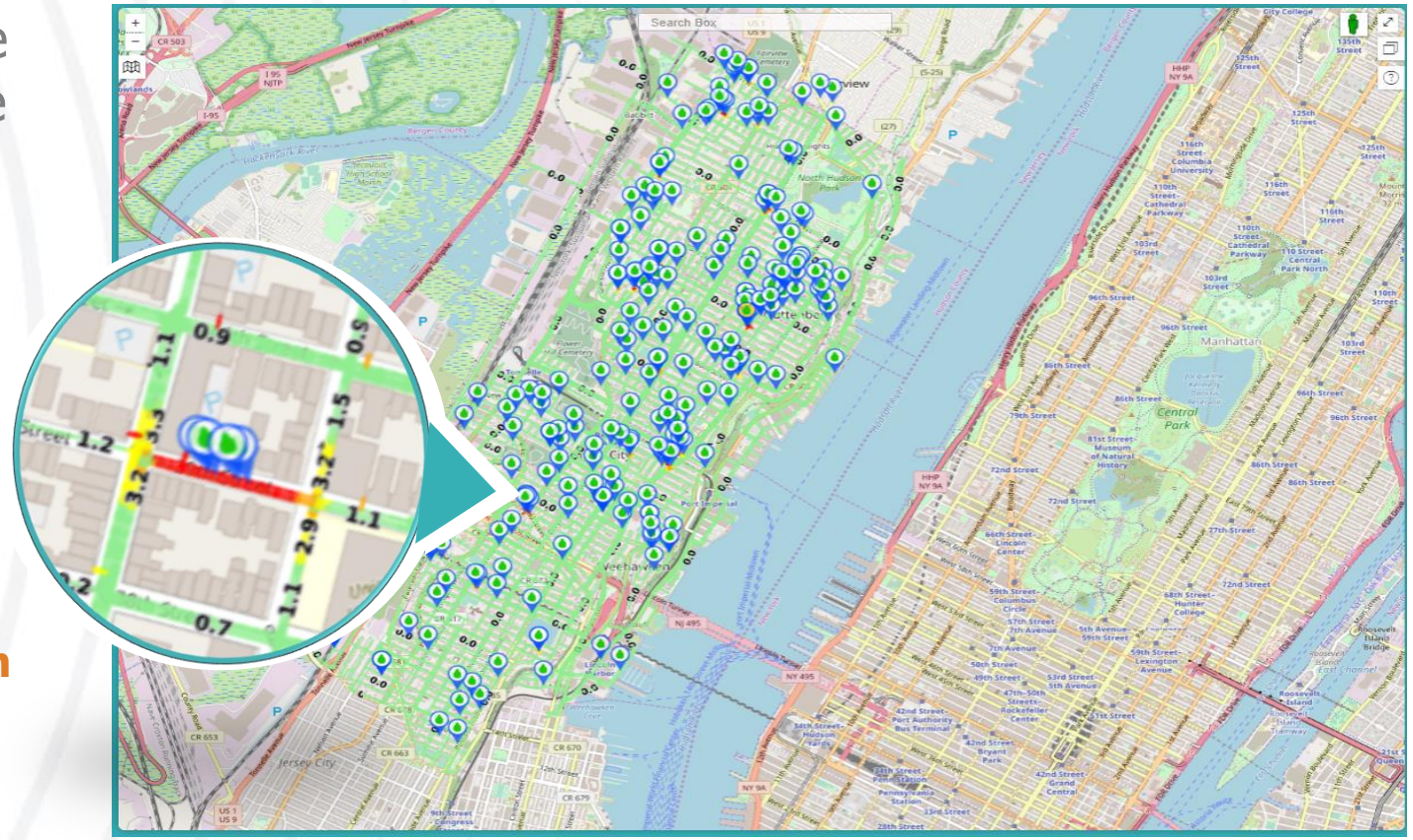
Pipe Condition Assessment Leak Evolution

We look for sections with fast growing leaks.
If the leak grows fast the pipe is in poor condition



Pipe Condition Assessment Historical repairs & background leaks

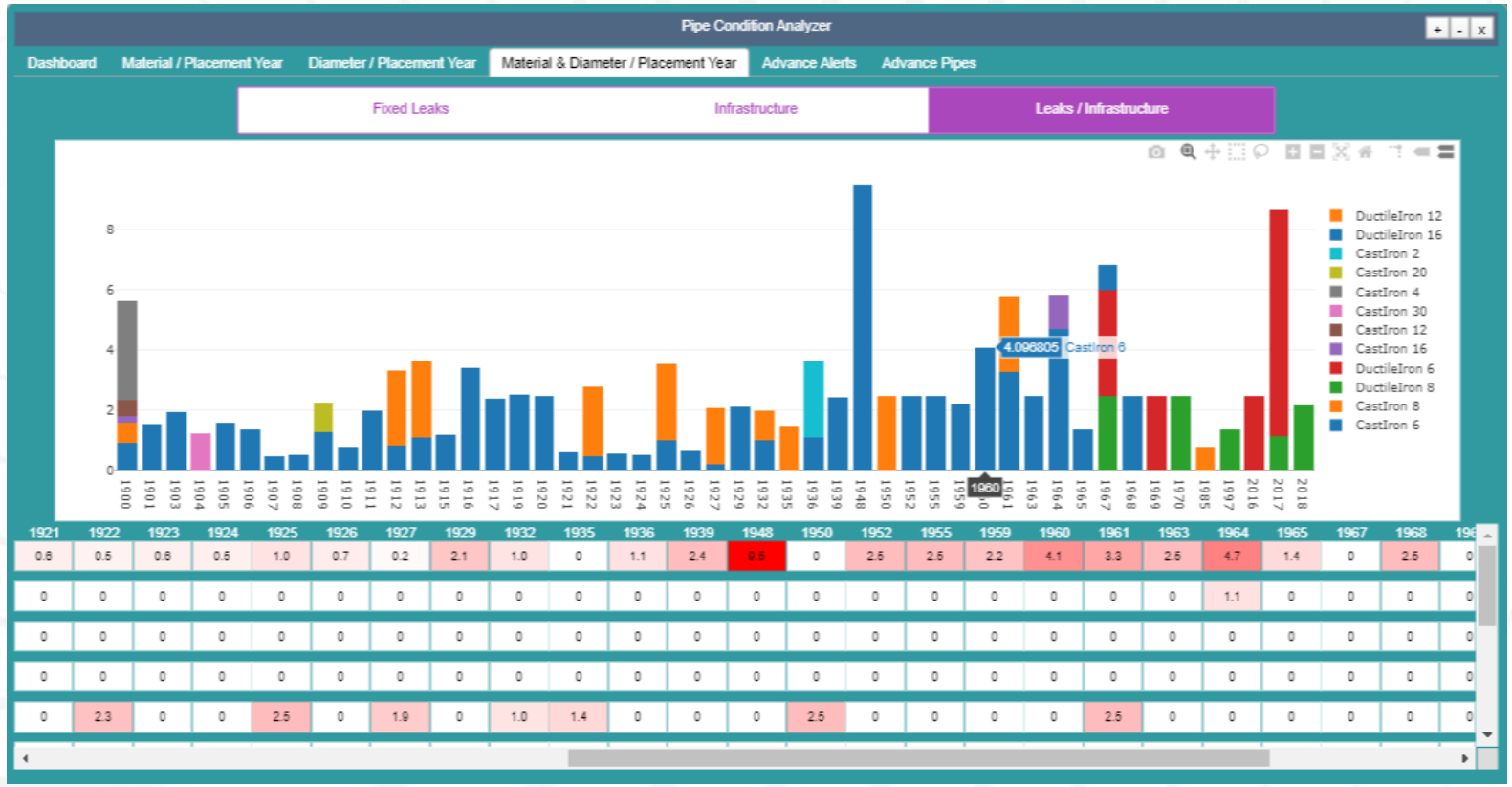
Big Data analytics of history & current pipe repairs. We look for sections with high rate of leaks per mile.



5 leaks on a 8” steel pipe in 15 ft / 5 m section over a period of 18 months

Pipe Condition Assessment Big Data Analytics Dashboard

1. We highlight the magnitude of the problems (how many miles of pipes need to be replaced)
2. We highlight the problematic sections in terms of material, size and placement year



Pipes High Severity analysis:

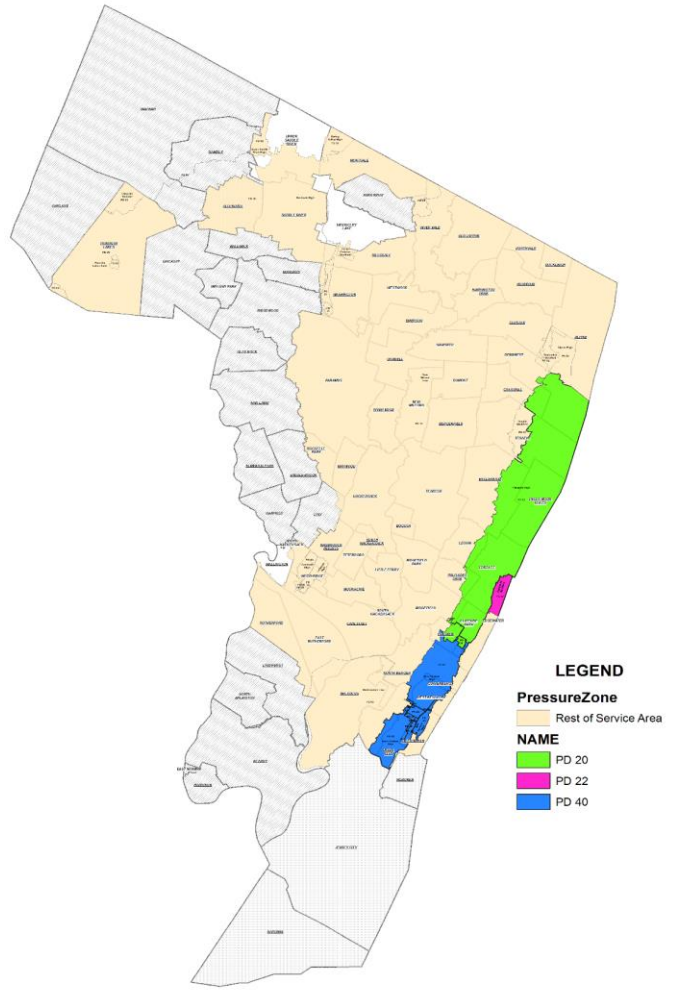
Placement Year	Material	Pipe Diameter	Pipe Length	Leaks
1900	CastIron	6	1271 ft	12
1900	CastIron	4	76 ft	5
1901	CastIron	6	461 ft	4
1948	CastIron	6	230 ft	4
2017	DuctileIron	6	317 ft	3
1921	CastIron	6	104 ft	2
1939	CastIron	6	177 ft	2

Most Problematic Pipes Based on Leaks per mile

Placement Year	Material	Pipe Diameter	Pipe Length	Leak per mile
1948	CastIron	6	1386 ft	8.0
1900	CastIron	4	1 mile	6.1
2017	DuctileIron	6	693 ft	6.0

Case Study – SUEZ New Jersey

- Production Sources
  - Haworth Water Treatment Plant
  - Serving over 800,000 customers in Hudson and Bergen Counties
  - 2,200 miles of transmission and distribution pipes.
- **2,000** sensors monitoring **500** miles of pipes
- **120** Leaks found and repaired in the first 2 years
- High Draft Monthly Average MGD dropped dramatically:
  - New Durham (PD40) 21.40 → 18.11 (-15%)
  - Palisades (PD20) 15.18 → 10.17 (-33%)
  - Palisades (PD22) 0.82 → 0.31 (-62%)



iQuarius Mobile Solution

Aquarius Spectrum

3 products in 1 – A highly sensitive mobile sensor for:

Listening **Survey** **Correlation**

- Android application
- Data is recorded and presented locally and analyzed on the server
- Anyone can use it, not only experts
- Map-based data presentation (GIS)
- Field team supervision

INDUSTRY GAME CHANGER!

Detection of major leak with the iQuarius

Web Application

Aquarius Spectrum

Aquarius Spectrum
Version : 1.7.5

Alerts Sensors Couples iQuarius Management

Hello guy | Help | Settings | Reports | Logout

ThamesWater

Tasks

Filters:

	ID	Task Name	Creation Date	Samples
☐	3916	train	4/10/2018	11
☑	2668	ZSTHFL05	11/13/2017	2020
☐	2664	ZSURB3005	11/11/2017	2
☐	2647	64 grantham road sw9 9dj	11/9/2017	1
☐	2644	10 Dillwyn close se26 4dd	11/9/2017	1
☐	2636	38 albert road br5 4af	11/9/2017	1
☐	2631	3 oakfield road cr0 2ud	11/8/2017	2
☐	2626	opp 46 okeburn road	11/8/2017	1
☐	2625	road	11/8/2017	0

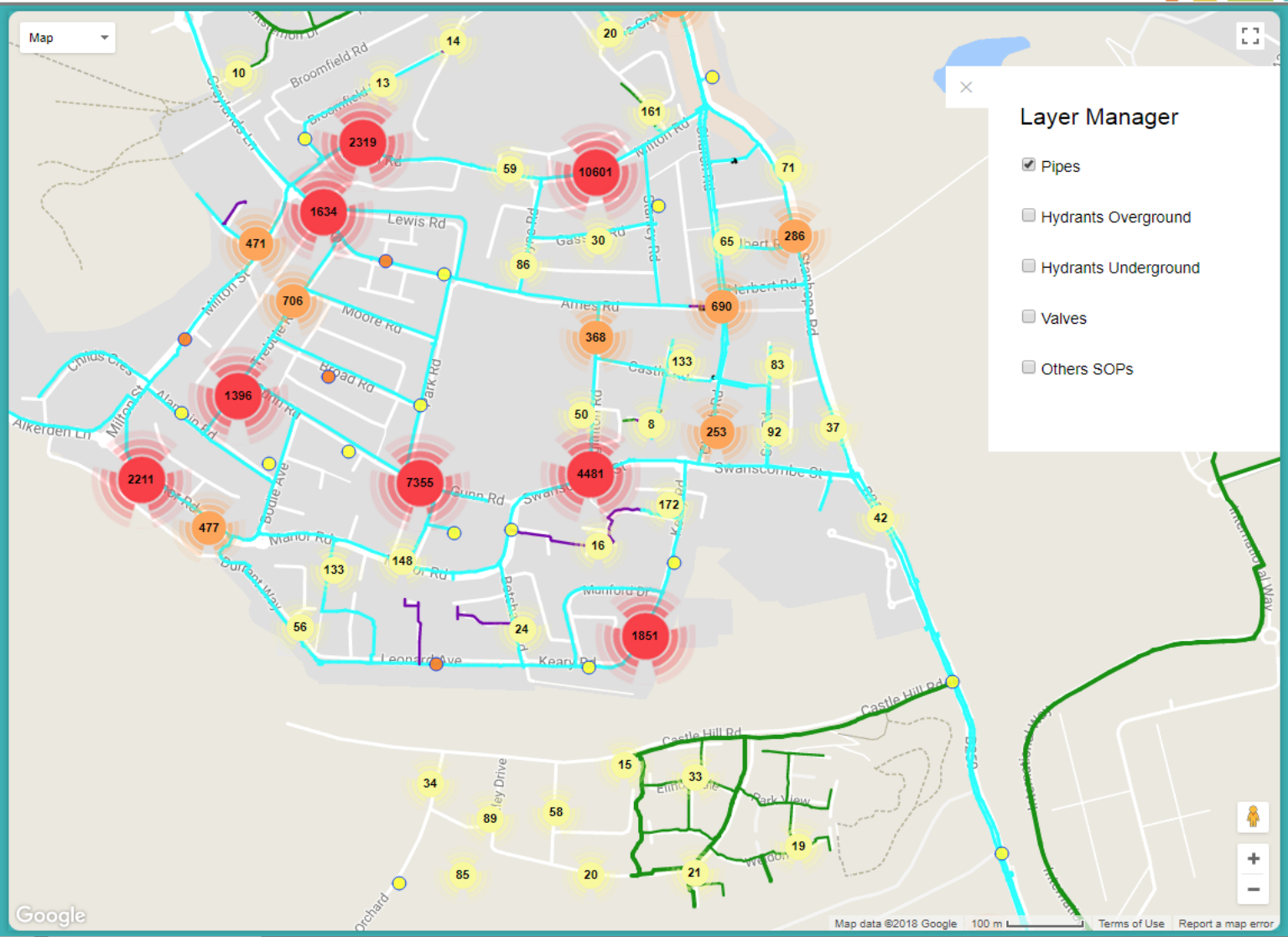
Search | Filter by users: | Filter dates

Samples

☑ Valid Quality ☑ Valid Clarity | Export Samples

	Sample Time	Status	Intensity	Quality	Clarity	Dist			Work Order
●	22-11-17 13:03		10,600.7	69.9	97.5				☐
●	23-11-17 13:15		7,354.8	83.1	100.0				☐
●	23-11-17 13:11		6,035.9	63.9	98.8				☐
●	22-11-17 15:19		4,481.0	66.9	87.5				☐
●	23-11-17 13:19		4,470.5	85.5	98.8				☐
●	23-11-17 13:16		4,361.8	83.4	100.0				☐
●	22-11-17 15:09		3,014.4	84.7	100.0				☐
●	21-11-17 13:28		2,318.9	80.7	100.0				☐

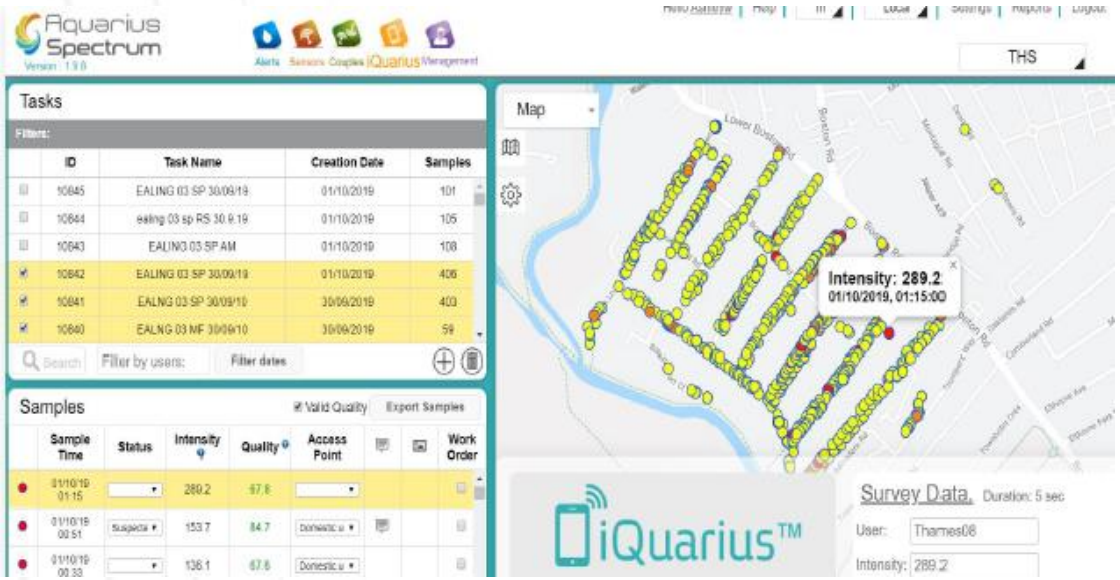
Distance: 111,878.8[m] | Status Filter | Users Filter: thames1 | Min Intensity: 0 | Apply



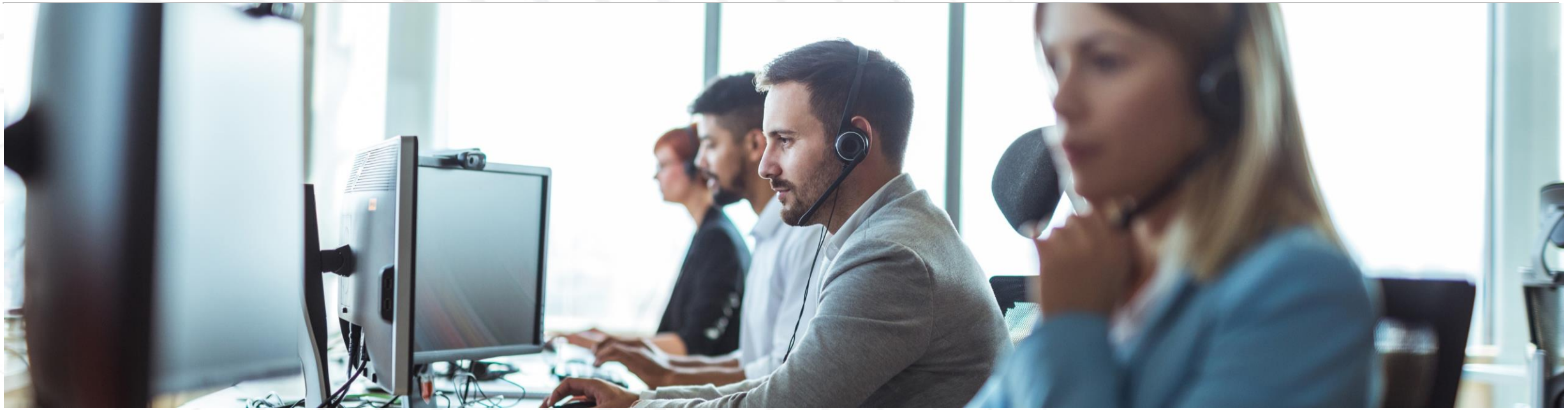
Introduction | Fixed System | Mobile System | Bench marketing & Reference | Best way forward

Case Study Thames Water

Sampling	Total samples taken >374,401 Total POI's 14,227 Per resource 62,400 3.8% samples converted into points of
Leaks	Total leaks raised 2,730 Main side 1,481 Customer side 1,249 Conversion rate of 19.1% POI's to leaks.
Averages	Average samples per person >300 per shift Teams raise 52.5 leaks per week 21.25 leaks per leakage engineer
Savings	>18.22 mega litres per day (MLD) 9.11 MLD per leakage engineer 2.27 MLD per resource.



Professional Services & Support

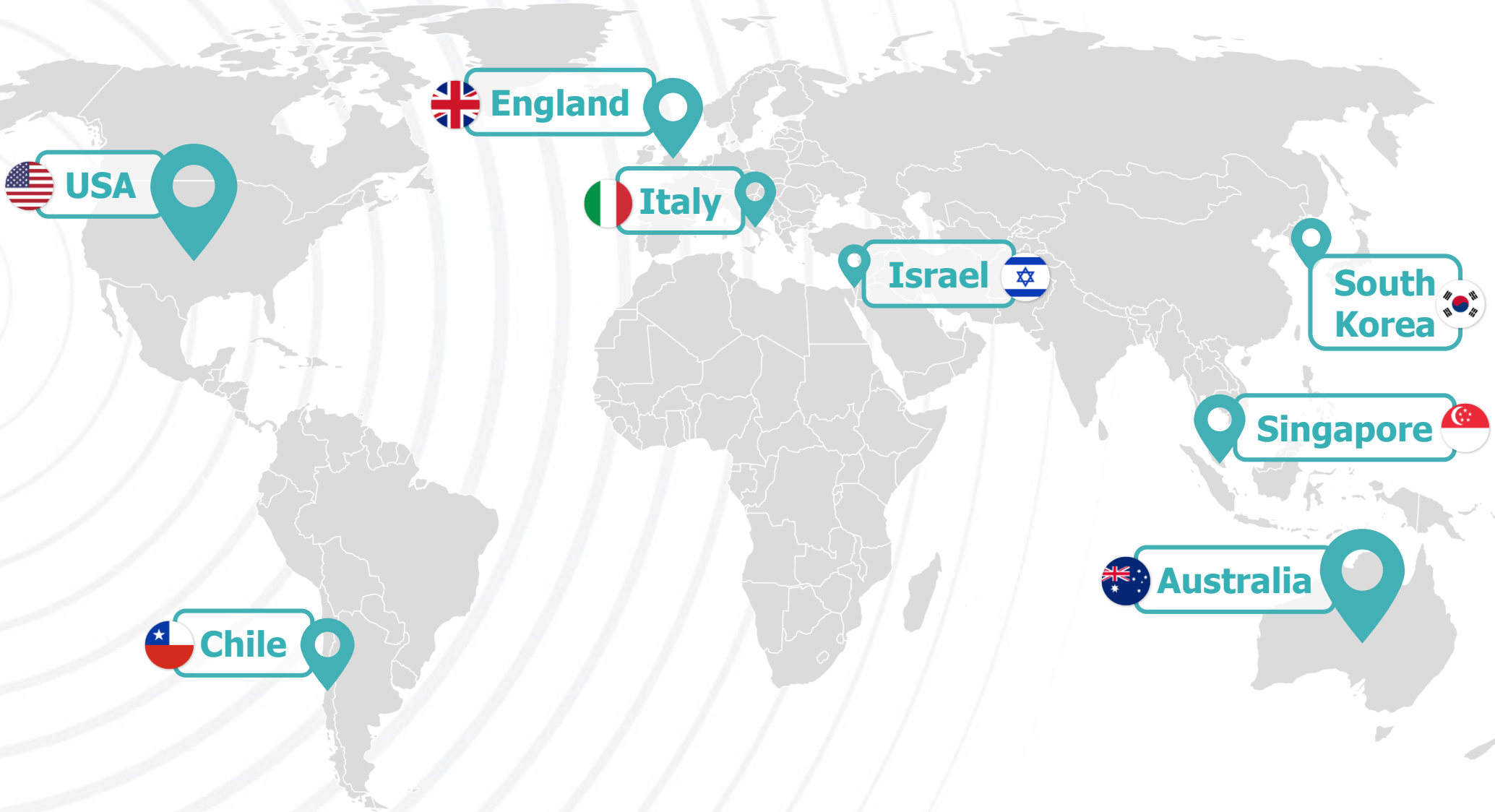


An experienced team is available to serve customers from installation to ongoing usage of the system.

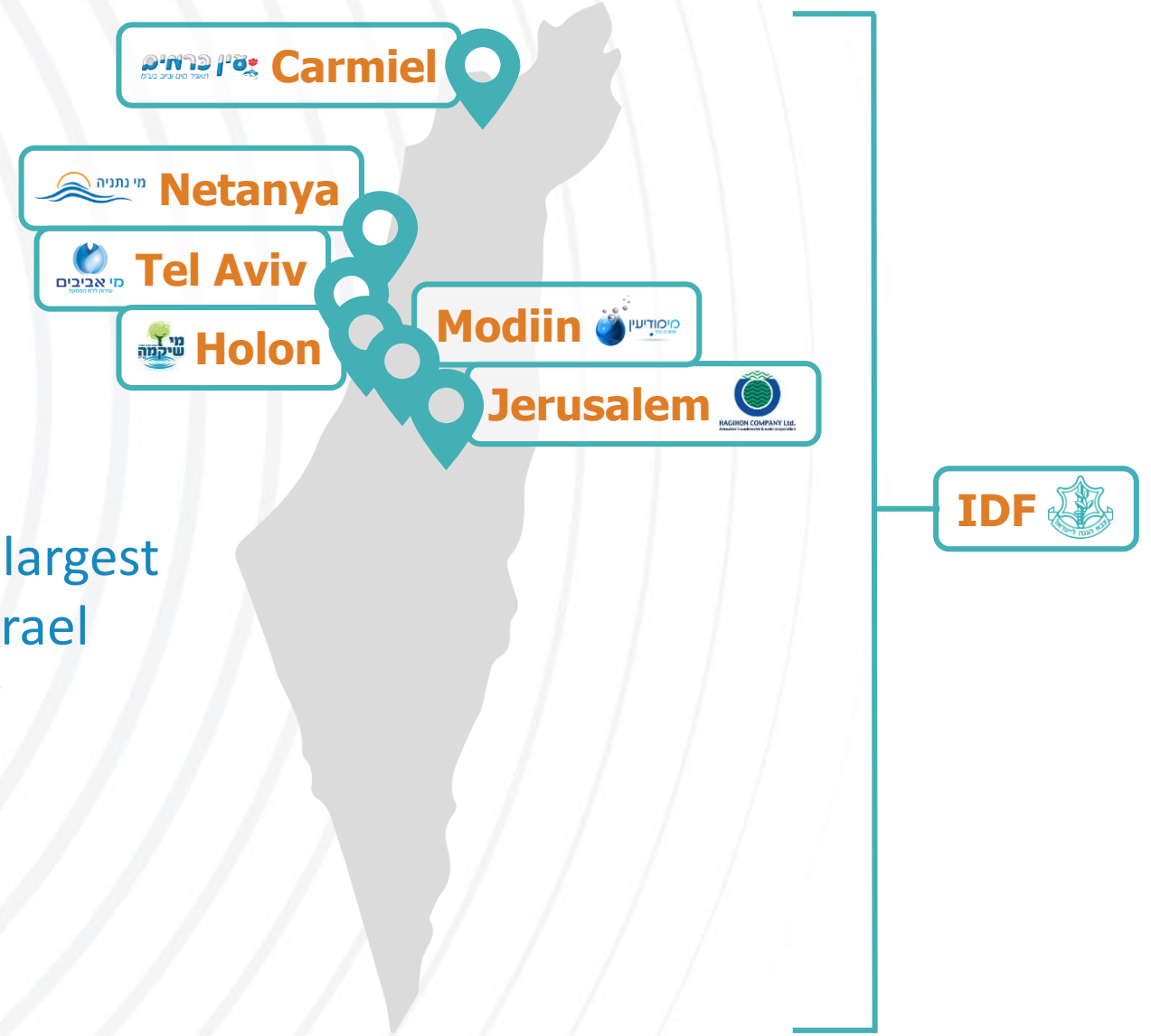
The analysis team will analyze the data and the health of the sensors on daily basis and will hold weekly calls with every customer in order to direct him to the best looking POIs.

Based on the health checks predictive maintenance tours will be scheduled to make sure the system is in mint conditions.

Global Activity



Aquarius in Israel



We work with the largest water utilities in Israel and with the army

Aquarius in the USA

Duluth
Successful pilots conducted

SUEZ PA
purchased 500 sensors following a successful pilot at Harrisburg.

SUEZ NJ
installed 2,000 sensors. The system identified dozens of leaks and helped the utility save a Billion gallons of water by now.

American Water
installed 130 sensors in West Virginia.

SUEZ DA
purchased 100 sensors

LAWP
Successful pilots conducted

Greenville
Successful pilots conducted

San Diego
Successful pilots conducted

Arlington TX
has the system up and running for 4 years now.

Florida Keys
Successful pilots conducted

Miami
Successful pilots conducted

Best way forward – Conduct a pilot

Prerequisites

- Choose an area with known leaks and good Cellular coverage and let us know which pipes to monitor – up to 5 mile.
- Complete GIS info (in English) in SHP format including: Pipe material, diameter, locations of hydrants, manholes.

Planning

Based on the information received we plan the installation points, determine which sensors to use and will ask to survey the installation points and provide pictures.

Sign a pilot agreement and schedule the trial

Trial

We will send a technical engineer with 20 fixed sensors + 1 mobile kit for a week:

Day 1-2 installation of sensors

Day 3-4 verifying the POI with iQuarius mobile. Simulation in case of no POIs from the system.

Day 5 summarizing the pilot

Get the sensors & mobile kit for 30 days

after which the customer can have the option to buy the equipment and enlarge the quantities.

Key Advantages and Differentiators

- Accurate Leak Location
- Large distance between sensors
- Low false positive rate
- Pipe Condition Assessment
- Powerful, yet User-friendly interface
- Superb service and support
- Seamless integration between sensors and mobile app
- Integrated pressure monitoring

Aquarius Spectrum

WATER LEAK DETECTION AND PIPE CONDITION ASSESSMENT

THANK YOU.