





**CASE
STUDY**

Putting Nautilus™ to the Test in Phoenix, AZ



Characteristics of the sections inspected:

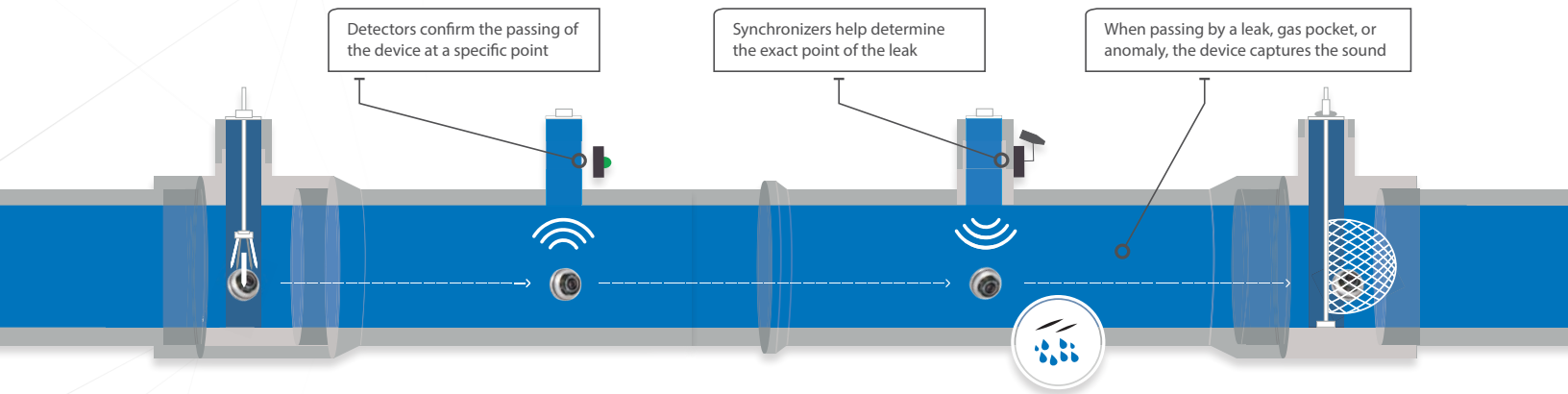
-  **Location**
Phoenix, Arizona
-  **Pipeline Diameters**
20-inch & 24-inch
-  **Lengths**
2.47 miles & 1.62 miles
-  **Material**
Bar-Wrapped Pipe
AWWA C303 (BWP)

Overview

As the 5th largest city in the U.S.A., The City of Phoenix, Arizona provides clean drinking water to over 1.5 million people, while operating a system comprised of over 7,000 miles of water mains, 50,000 hydrants and 119,000 valves. The City of Phoenix has long been a proponent of critical infrastructure leak and condition assessment, deploying various technologies over the years to better understand the current state of the city's aging pipelines. In 2019, as part of a broader infrastructure planning effort, The City of Phoenix partnered with HDR Engineering and WaCo Contracting to perform a head to head comparison between Pure Technologies' SmartBall®, a well-established inline leak assessment tool, and the Nautilus System, a newly introduced technology to the US marketplace. One of the primary goals was to identify an accurate and cost-effective internal leak assessment tool for a long-term asset management program.

The Technology

Originally developed in Spain in 2015 by Aganova, the Nautilus System has recently been introduced in the US market by Hydromax USA. The Nautilus System consists of a small, neutrally buoyant sphere that is inserted into the network where it travels freely, driven by the flow of water in the pipe. Sounds generated by a leak, gas pocket or anomaly have unique characteristics. The device captures the sound of these from inside the pipeline. Once the device is extracted, software processes the compiled information using a mathematical algorithm to determine the location of leaks, gas pockets and anomalies encountered.



Project Details

HDR Engineering, WaCo Contracting and the City of Phoenix identified two separate pipelines to manage the direct comparison between Hydromax USA's Nautilus System and Pure Technologies' SmartBall®. For consistency, new insertion and extraction points were installed on both pipelines. Pipeline A covered 2.47 miles of 24-inch Bar-Wrapped Pipe watermain with a flow rate of approximately 1.03 ft/s. Pipeline B consisted of 1.62 miles of 24-inch & 20-inch Bar-Wrapped Pipe watermain with an approximate flow rate of 1.02 ft/s.

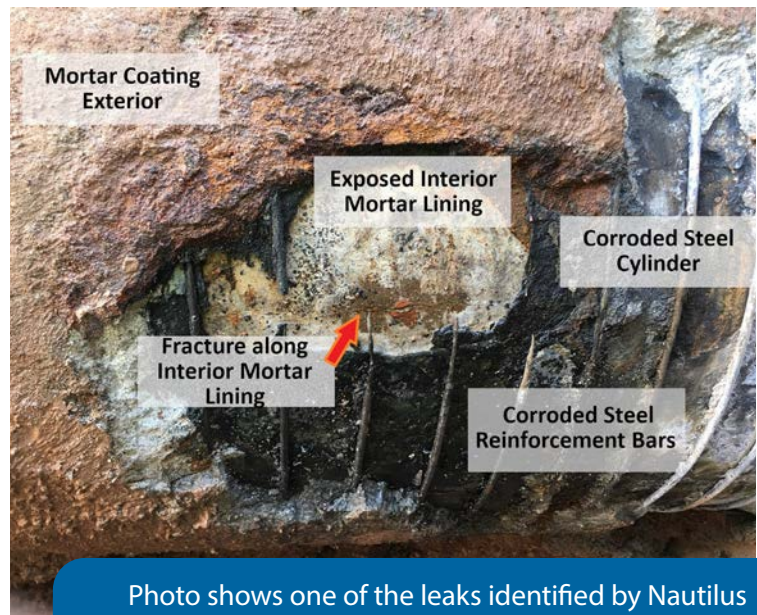


Photo illustrates the distance between the leak located by Nautilus and the dry hole identified by SmartBall.



The Validation

Having successfully navigated each pipeline both Hydromax USA and Pure Technologies delivered their findings to HDR and WaCo. Pure Technologies identified one leak along Pipeline A and no findings along Pipeline B. Hydromax USA identified three leaks and one air pocket along Pipeline A and no findings along Pipeline B. To verify each leak, WaCo Contracting excavated each leak location along Pipeline A. The noted air pocket was not included as part of the validation study. The locations of each leak were wheeled off from known assets to establish the most accurate dig location.

At the first site, both technologies identified leaks in the same stretch of pipe, approximately 34 feet apart. Removing the asphalt roadway and exposing the pipe fully at the location identified by Pure, the hole was found to be dry. WaCo then moved to the Nautilus identified site 34 feet away and a positive leak confirmation was established. The leak consisted of a longitudinal crack at approximately the 1 o'clock position on the pipe. The exterior mortar, bar wrap and steel cylinder were all heavily corroded resulting in flaking once exposed.

While SmartBall identified no additional findings, Nautilus identified the location of a second leak further down the pipeline. Crews from WaCo contracting started excavating the site but quickly encountered a network of other utilities. These included a gas line running perpendicular to the project pipeline as well as a smaller Asbestos Cement waterline that was in close proximity to the assessed pipeline. As a result, the pipe could not be fully exposed in the location identified by the Nautilus System and the validation was abandoned due to concern for safety.

The last and final validation location was again identified by Nautilus but missed by the SmartBall. WaCo Contracting excavated the

Hydromax USA identified location, exposing the pipe fully. Once exposed an 18-inch concrete pipeline was encountered running just above and perpendicular to the test pipeline. A leak was identified on this adjacent pipeline at the 5-6 o'clock position – and the water was flowing down onto the assessed pipeline. Nautilus was able to capture the sound of the water running down onto the pipe and identify the leak on the adjacent pipeline.

Conclusion

In a direct head-to-head comparison with Pure Technologies' SmartBall, Hydromax USA's Nautilus System proved to be the more effective technology and provided significant savings. Nautilus identified three leak locations and one air pocket. SmartBall only identified one leak location of which the "dig here" location was nearly 34 feet away from the actual location of the leak. Additionally, the Nautilus assessment is nearly half the cost of the competition, allowing utilities to test more pipeline with their available budget.

The Nautilus System: Pre-Launch, Insertion, Navigaton and Extraction

PRE-LAUNCH ASSEMBLY

Prior to inserting the Nautilus System, the Hydromax USA team places synchronizers at intermediate locations along the pipeline using existing accessible features such as hydrants, valves, etc. The synchronizer devices serve as reference points for the Nautilus sphere as it traverses the pipeline and help to optimize the accuracy of the results.



INSERTION AND NAVIGATION

Hydromax USA team launches Nautilus, typically via insertion at a vertical valve, and the sphere is released into the flow of the water. Nautilus creates an audio recording as it moves with the flow of water.

Neutral buoyancy provides Nautilus the most optimal means of traversing the pipeline. Traveling in the center of the pipe allows Nautilus to avoid many obstacles including sediment build up and more easily navigate butterfly valves. Additionally, traveling in the center of the pipe allows Nautilus to utilize the most efficient velocity provided by the pipeline.

EXTRACTION

Encompassing the full internal diameter of the pipeline, the Nautilus System catch net is installed prior to any insertion. The proper placement and alignment of the net is verified using a built-in camera system allowing real time verification for field crews. Once Nautilus has reached the end of the test, the team is alerted via camera and an alert system. It is captured in the net and safely removed from the pipeline.



Measurable Results

Once the sphere is extracted, the recorded sounds are processed and analyzed using the Nautilus Systems' proprietary algorithms. (The data contains different spurious noises that are filtered by several processing techniques.) The final inspection report provides for each identified leak, gas pocket, and anomaly a range of observations, including but not limited to:

- Acoustic recording supported by visual plot (Colorimetry) of the identified discrepancy.
- Prioritization level for each identified leak.
- GPS /GIS deliverable of all findings and all project appurtenances in ESRI compliant format.