

DETECTING WATER LOSS

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Leak surveys help
pinpoint & eliminate
water loss



Specialized equipment is capable of “listening” to leaky pipe.

The city of Hamilton, Ohio, decided to pursue an active leak detection program as part of an effort to reduce water loss. It also would serve to help stem the loss of overall revenue generated by the water utility. The utility did not have a regular active leak detection program, so the city decided to hire a specialized leak detection firm to provide a concentrated leak detection and location program to ferret out these losses.

When leaks occur in a pressurized water system, the water escaping the pipe creates a distinct sound that often can be detected by listening to the pipe that carries the water through the system. To perform this type of leak noise analysis, specialized equipment has been developed that can “listen” to the pipe. A specially trained leak detection technician can then “hear” this leak noise, analyze the specific sounds and trace the sound to the origin of the leak. Once located, the leak can be excavated and repaired. As simple as this seems, leak noise is not always easy to find or trace.

There are several parameters that must be met before conducting a successful leak detection program. Leak noise is a sound wave that can travel in the water and along the pipe wall for long distances. Piping materials have unique and predictable sound-carrying properties that affect the ability of the pipe to transmit the leak noise over a distance. Pipe can transmit sounds at specific velocities, but the speed of the sound wave is affected by several variables such as pipe material, pipe size, pipe joints, water pressure, soil conditions and water table in the soil. Larger pipe will transmit sound at a slower velocity than smaller pipe, and iron pipe will transmit sound at a higher velocity than plastic pipe. All of these variables need to be accounted for when attempting to listen to a water distribution system for leakage. These conditions will change from location to location within the distribution system, depending on the previously stated variables.

Leak detection used to be conducted by workers who would use probes placed directly over the water main or pushed into the ground above the main to listen for the distinct sound of water escaping the pipe. Leak detection in water systems had been performed in this manner for more than 100 years.

Today, the probes have been replaced with extremely sensitive transducer microphones that pick up the sound. The sound is amplified using a portable device so that a trained leak technician can hear it. When a potential leak has been identified, its relative location is documented.

The leak technician will return to the area a second time to listen again to determine if the noise heard was indeed a leak or if it was possibly water use by a nearby water customer service line.

Applying Technology

In Hamilton, the survey process involved listening to every mainline distributing system valve, fire hydrant and selected service connections. The listening intervals were less than 500 ft between each listening point. Technicians surveyed 339 miles of water pipe buried under the city’s streets and parkways to ensure complete leak survey coverage of the water distribution system.

When technicians located an area with a suspected leak, they used a specialized computer (leak correlator) to pinpoint the leak noise source. The correlator analyzes the sound wave from the leak. Leak noise sound waves travel in opposite directions away from the leak on each side of the leak in the pipe. The sound waves have a specific velocity (speed) and bandwidth of sound that travels along the pipe wall.

Two transducer microphones are placed on the pipe, one on each side of the suspected leak,

thus bracketing the leak. The sound is picked up by each transducer, amplified and then transmitted by radio to the leak correlator, which measures how fast the sound waves reach each transducer. One transducer will receive the sound wave more quickly than the other. The resulting difference in time indicates the position of the leak.

The leak technician will enter known information—such as pipe materials, pipe sizes and the total distance between the transducers—into the computer correlator, which has the velocities of the flight of sound waves for various pipe materials and sizes programmed into it. Once the leak is pinpointed, the leak technician will confirm its location by listening to the area directly over the location and try various combinations of positions for the transducers.

In Hamilton, the survey successfully located 102 leaks. One location identified as a leak turned out to be an almost fully closed valve that had been lost for several years. Nine mainline leaks—including previously undetected main breaks, 18 undetected customer service line leaks, 14 main line valve packing leaks on the valve stems and 61 fire hydrant leaks—were located and verified. Leak locations included areas where the water entered into sanitary and storm sewers undetected, so no water was surfacing above ground. In some cases, service line leaks did surface with wet spots.

Leak amounts are difficult to estimate because there is no accurate way to do so. It is only when the leak has been excavated and the leak orifice measured that a calculation can be made based on the operating pressure of the water system. To give a good idea of leakage amounts, a ¼-in. hole at 60 psi can leak about 9 gal per minute (gpm).

Experienced leak technicians have developed methods to estimate leak amounts. Generally, they assign leak amounts to a specific type of leak just to get an estimate of the leak size. Leak amounts are directly related to water pressure inside the pipe, so the higher the pressure, the more water will escape from that leak. The estimated leak amounts are then totaled to get an overall idea of the amount of water loss.

Once the overall amount of loss has been determined, the marginal cost of water is applied to the amount of lost water; this is the production cost and not the retail cost of water, as the water never reached the customer. This cost then is annualized to gauge potential financial loss to the utility.

The estimated loss in Hamilton’s case amounted to \$578,554 annually. The daily water loss was estimated at 452,880 gal per day or 314.5 gpm. The return on investment for Hamilton was calculated by taking the cost of the survey and applying it to the annualized loss. According to these calculations, the survey cost will be recovered by Hamilton in about five weeks. In most cases a water utility will consider a two- to three-year payoff a good investment.

It is important to note that a single leak survey may yield high returns, such as in Hamilton’s example. Once a survey has been conducted, however, it should be conducted regularly as a proactive measure to not only locate large leaks, but also to locate smaller leaks that may develop into larger leaks if left unattended. After a few surveys, the number and size of leaks will decrease, as will the overall amount of loss. **www**

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