Inexpensive Leak Detection for Small Waterworks

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Office of Drinking Water
Safe Drinking Water for a Healthy Virginia

The methods in this brochure are targeted at small community water systems with less than 100 connections. Many of these methods will work for larger systems but may not be as time and cost efficient as commercially available computerized leak detection equipment.

At the end of this session…
you will be able to determine whether or not you may have a leak based upon meter readings from your source and customers, use a hand held pressure gauge to locate which section of your distribution system may have a leak, and understand several inexpensive low-technology methods for locating leaks in your water system.

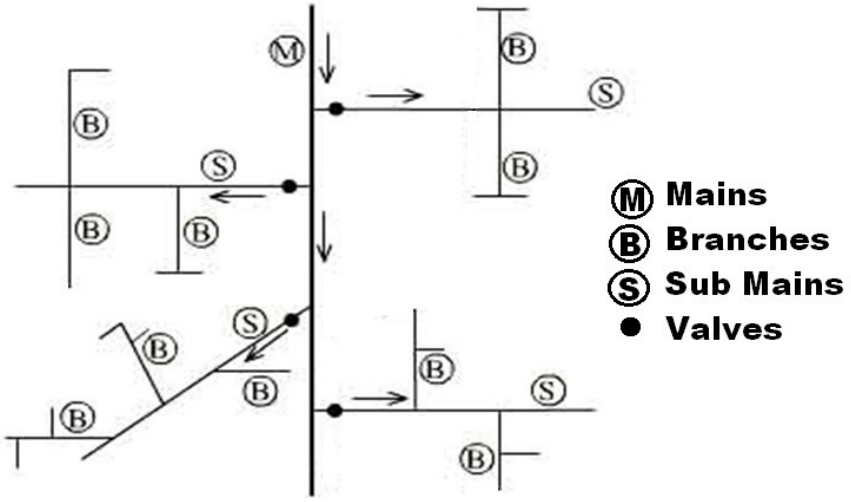
Account for all of your water
Good record keeping of your water use and production is very important to determine if you have any leaks. If your water source(s) and all of your connections are metered, you can add up the use at all of the connections and subtract it from the source production to determine the water loss in your system. Some of this loss may be due to old meters that do not record all of the water that passes through them. If you have large differences between your production and use, you should first try to find out if there are unmetered connections or if there are specific meters that may need to be replaced. After making sure you have included all connections and replaced all faulty meters, you will have a good idea of how much water you are losing to leaks. We will discuss how to locate those leaks later.

> **Useful tip:** A meter for a factory that reports less water use than a typical residential connection may be a good example of a meter that needs to be replaced.

My connections are not metered
If you don't have meters on the individual connections you should still have a meter on your source(s). If you record the meter reading in the late evening and early morning to determine the water use during the middle of the night, when little water use is expected, you should be able to determine if a major leak is present. A major leak will show up as a large amount of water use during a period of time when very little water use is expected.

Prepare for, and prevent leaks
The following is a list of things you can do to prevent or prepare for leaks.

- Always account for all of your water
- Replace or repair faulty meters on a routine basis
- Install run time meters on all of your pumps that tell you how many hours the pump has been running
- Install meters on all of your sources, as well as all connections to different pressure zones
- If your distribution system is very large consider installing meters on main branches supplying large areas
- Exercise shut off valves so they will work when you need to use them to locate a leak
- Install new shut off valves in locations that will help you determine which section of the distribution system a leak is in, before you actually have a leak
- Maintain maps of the system that detail where valves, meters, and pressure reducing valves are located, global position system (GPS) devices can aid in the creation of this map.
- Include map information such as pipe sizes, pipe material, and which customers will lose water if a shut off valve is closed.



Use a metal digging bar or geophone "coconuts" type listening device as a listening device to help narrow down the approximate location of the leak. Allow one end of a metal digging bar or the coconuts part of a geophone type listening device to rest on a valve or hydrant in the section of pipe where the suspected leak exists. (Geophones can be used directly on ground surface, but you will get a better result if you place it on a pipe, fire hydrant, or a valve.) Place the other end to your ear. You should be able to distinguish the noise created by the flow of water through the pipes. When you get close to a leak, the noise will be different or louder. You can rest your listening device on valves, or hydrants along the leaking section of piping at equal distances. Example: if you have narrowed your leaking section of piping down to a two mile section of the distribution system, you can listen to hydrants or the pipe itself at one half mile intervals to help determine where the noise from the pipe is the loudest. Then listen to more locations in that section to determine if you can find the exact loudest location on that section of piping. This should be the closest valve or location to the location of the leak. You may want to do some exploratory digging in this area to try to locate the leak. If you do not locate the leak immediately, you can always install a new shut off valve to help narrow down the direction of the leak from where you started digging. You would use pressure drop recorded by a pressure gauge to determine this. Then you can complete more exploratory digging. You will eventually locate the leak or a small enough section of leaky pipe that it can replaced.

If the whole section of piping is old, and many leaks have been documented from the same neighborhood in the past few years, you may consider replacing the distribution piping for the entire neighborhood.

Metal Digging Bar

If your system has an atmospheric storage tank you can determine the amount of water used from it over a specific period of time. Observe and record how many feet or inches of water are drained out of the tank during that period of time. This is most useful during the middle of the night when expected water use is low. Multiply the number of feet or inches of water used during a specific time period by the gallons of water per foot or inches in the storage tank will tell you how much water drained out of the tank. If you know that very little water use is occurring, most of the water exiting the tank will be going through the leaks in the distribution piping.

Some well or transfer pumps have run time meters on them that tell how much time the pump runs. If a pump is running a lot during the middle of the night when it is not expected to run, or if it is running for more hours than it used to during a day, you may have a large leak.

> **Useful tip:** Wire an outside electric light bulb so that it turns on when the well or booster pump runs. You can observe this light as an indicator of how long the pump has been running. If the light is always on, or if it is on for more hours than usual, you will know to expect a leak in the system.

Another common method of leak identification is to record production meter readings daily from the source(s) and determine how many gallons of water have been pumped since the last time you read the meter. This daily water use will usually fall into an average range. One day when you observe an unusually high daily water use you will expect that a leak has occurred in the system. If this occurs for several days in a row you can be fairly certain that a large leak exists. You can then either read the meters to determine if this is the case, or use one of the other leak detection methods discussed later in this brochure to determine if and where a leak exists.

Now I know there's a leak, how do I find it?

If you have a storage tank in the system you can…
Measure the rate at which the water level is dropping in the tank. Record this rate in feet or inches over a period of time. An example would be feet per hour or inches per minute. If you have valves in your system you can close off one section and see if the water level drops at a slower rate. This would tell you that the section you just turned off contains the leak.

If you do not have valves in your system you will have to install some to complete this procedure. Try to locate where the water main intersects another water main and install a valve on each of the branches.

> **Useful tip:** For this technique to be most helpful the storage tank has to have enough water to sustain the water use that will occur during the time it takes to complete this test. It should be full. If you have a really leaky system you may have to haul water to add to it to get it full. It will also be simpler to determine if the source supply to this storage tank is temporarily taken out of service by closing valves or turning the electrical controls off. This ensures you get the most accurate measure of water used from the tank

Whether you have a storage tank or not you can…

Observe the pressure drop in an isolated section of piping in the distribution system to determine if leaks are occurring. The directions in the next few sections will take you through all of the steps you need to follow.

What you will need

1. A hand held pressure gauge that will connect to a threaded hose bib
2. Knowledge of the existing shutoff valves locations in your system
3. If you have very few shut off valves in your system you will need new shut off valves and whatever excavation equipment and personnel that will be necessary to install them.
4. A metal digging bar or geophone "coconuts" type listening device.

Step five:
If the leak is not present as standing or flowing water at the surface, you should go back to the streams, sewer manholes, and storm water drainage inlets to determine if more water than expected is flowing in them. If you chlorinate or fluoridate, you can check the residual of the stream flow and drainage inlet flow to determine if potable water from a leak has entered it. If chlorine or fluoride is detected, you will walk upstream checking the residual level until it is no longer present. When it is no longer detected you have just passed where water from the leak enters the stream or drainage. If no chlorine or fluoride is detected, or if you do not add chemicals to your water, you will have to walk up stream to determine if the stream, sewer flow, or storm drainage flow becomes larger at one specific point. This may indicate the location of the water leak. You can do this in the stream by walking the bank and in the sewer and storm drainage collection by looking into consecutive manholes or drainage inlets as you go uphill in the area near the expected leak. Even if you do not find the leak, hopefully you will at least narrow down the location of the leak to an even smaller area.

Step six:
Now that you have narrowed down the location of the leak to smaller area, you have some options about how to proceed. The option you choose will likely depend upon the equipment available, your experience in similar situations, and the size, age and extent of the water distribution system. These options include:

Install more shut off valves in the middle of the leaking section of piping to further narrow down the leaking section of piping, and then replace the leaking section when the cost of piping for the isolated section is cheaper than the cost of installing another valve.

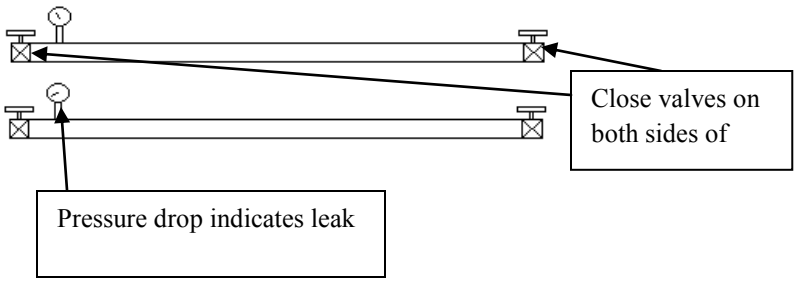
Use commercially available leak detectors to narrow the search. The types of devices available range from stethoscope type geophone devices that listen to the ground, to devices connected to valves or meters that use a computer to analyze the sound patterns to tell you at approximately what distance between these valves the leak exists. These may be purchased or rented. Some non-profit organizations such as Virginia Rural Water Association also have these available to borrow free of charge, and will often send staff along to assist you in locating the leak. There are companies that specialize in leak detection that can be hired to locate the leak for you with these devices.

How it's done…

Step one:
In order to locate a leak in the distribution piping, you must first be able to isolate separate sections of the piping with shut off valves. The theory is to check each isolated section of piping to determine which one contains the leak. This is done by closing shut off valves on both sides of a section of piping. You should first turn off the residential meters to make sure no water use takes place. If no use is taking place, the section of piping will still remain pressurized after the shut off valves are closed. This pressure can be observed by connecting the hand held pressure gauge to a hose bib or threaded water connection, like those provided for washing machines. If you do not have hose bib connections in the meter, you will turn on the water to the one home you are connecting your pressure gauge to. After connecting the gauge, turn the water on supplying the gauge to observe the pressure. If a leak exists in this section of piping you will observe the water pressure dropping over time. You may have to remain for ten or twenty minutes while this takes place. The pressure should drop at a constant rate based upon the size of the leak. If the pressure does not drop then the section of piping you are currently checking does not have a water leak.

Making sure that no water use takes place during the test is the most crucial factor in the success of this method of leak detection. Leaky valves can mimic leaks so make sure your valve is not leaking by listening to it with a digging bar or geophones.

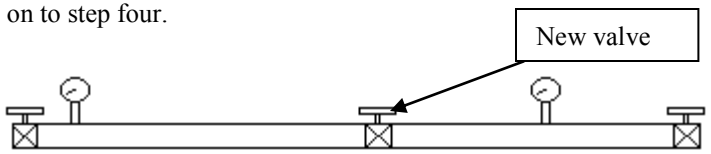
> **Useful Tip:** Notify customers prior to turning their water off to perform this test. Consider doing this portion of the test at night when water use is lower and fewer customers will be inconvenienced.



> **Useful tip:** This same procedure can also be used to determine if a leak exists after the meter in the service connection, or in the internal plumbing of the structure. A pressure gauge can be used at the residence with the shut off valve in the meter box closed. If the pressure is dropping and no water is being used, a leak is present. Very small systems should try this before dedicating resources to locate leaks in the distribution piping.

Step two:
As a section of piping proves not to be leaking you will move on to check another section. If you have an idea of where the leak is coming from you can start in that section of the distribution piping. If not, you should consider starting at the source or the tank and working from the beginning of the distribution piping all the way through to the end.

Step three:
When you identify a section of piping that has a leak you will have a pipe that is isolated by a valve on each end. To further narrow down the area of leaky pipe you will close a valve in the middle of this section of pipe. This will leave you with two sections of pipe with valves on each end. You will then check the pressure drop of each of the two new sections. Chances are, one of them will contain the leak and the other will not. If another valve does not exist to further divide the leaking section of piping in two, you may want to go to step four before installing new valves. If the leaking section of piping is sufficiently large, you may consider installing a few new valves to narrow down the leaky section before going on to step four.



Step four:
Now that you have hopefully narrowed down the leaky section of piping to a manageable area, you will try to locate the exact point of the leak. Depending on the size of the leak you should first drive or walk the length of the distribution piping to determine if water is coming to the ground surface. During this trip you should take note of any streams, sewer manholes, and storm water drainage inlets. If you are lucky you will find the leak in this manner. Most likely you will have to continue to step five.