

H₂O ops

P4 The Big Chill
Prepare your drinking water infrastructure: winter is coming

P5 Under Pressure
Maintaining air valves is simple and vital to your system's health

P7 I've Been Slimed
Biofilm basics: what it is, and what to do about it

OUT AND ABOUT: THE DISTRIBUTION SYSTEM ISSUE

SEPTEMBER 2017

WATER QUALITY AND THE DISTRIBUTION SYSTEM

Because most of the distribution system is buried, we often don't give it a lot of thought until something goes wrong. Waterborne disease outbreak statistics from the U.S. Environmental Protection Agency show that the main health risks associated with distribution systems stem from cross-connection control events, contamination during storage, corrosion, broken or leaking water mains, and contamination of service lines or household plumbing.

We spend significant time, effort, and resources ensuring the water from our sources or treatment plants is of the highest quality before it enters the distribution system. Although customers only drink a small percentage of the water supplied, the primary function of the distribution system is to ensure that water delivered to customers is the same high quality water that enters the water main.

Water systems can secure the quality of the water they deliver by using the multiple barrier approach to safe and reliable drinking water. The multiple barrier approach uses a series of technical and managerial barriers to prevent contamination of the drinking

water source and distribution system. This approach assumes that if you have multiple barriers to prevent contamination and one fails, the other barriers will still protect customers.

The Multiple Barriers in a Distribution System

A **physical barrier** to prevent external contamination from entering the drinking water supply. The physical barrier includes the pipes, tanks, and components that physically separate the water supply from contact with external substances. To protect the physical barrier, you should have:

- ◆ Sufficient cross-connection control practices.
- ◆ Proper hydrant and valve maintenance.
- ◆ Proper holding tank maintenance.
- ◆ Strong water main break repair practices.
- ◆ Strong quality control efforts for new construction.

A **hydraulic barrier** to ensure adequate water pressure during all normal and emergency operating conditions. The hydraulic barrier relies

on adequate pumping, control of friction losses, and accounting for system elevations. Hydraulic barrier considerations include:

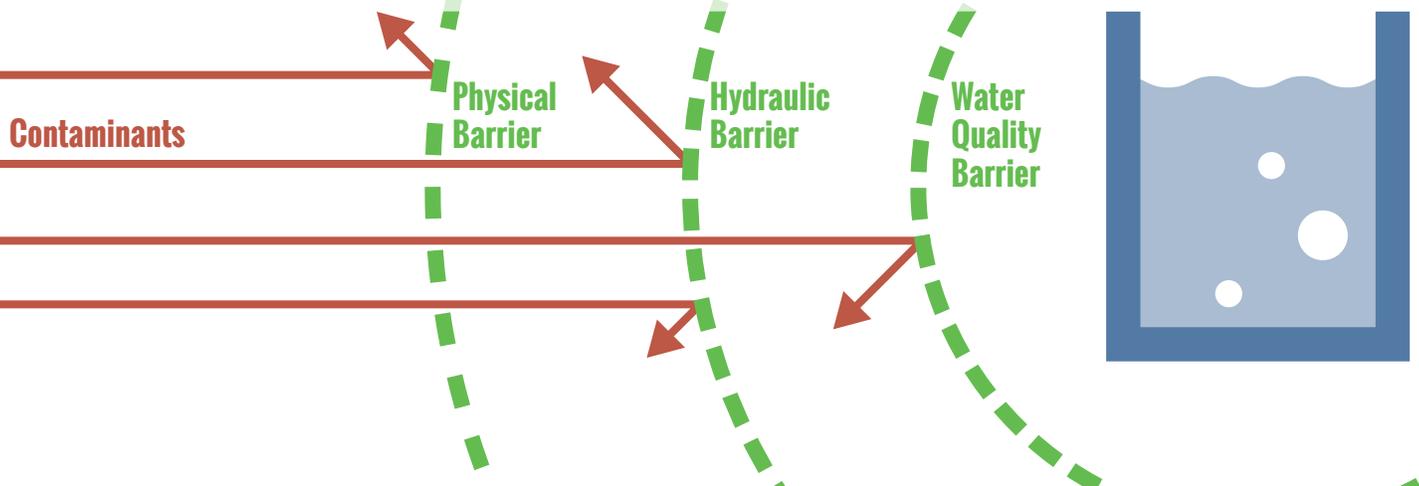
- ◆ Adequate and controlled flushing programs.
- ◆ Water age management.
- ◆ Hydraulic modeling.
- ◆ Proper design and planning.
- ◆ Pumping and pressure management.

A **water quality barrier** to maintain water quality in the distribution system. This is challenging because of the complexity of most systems. Factors include:

- ◆ Type and concentration of disinfectants used.
- ◆ Formation of disinfection by-products.
- ◆ Biofilm management.
- ◆ Corrosion control strategies.
- ◆ Thorough complaint tracking.
- ◆ Representative sampling.

For More Information

You can find publications on these topics at doh.wa.gov/odwpubs. If you want more information about how you can evaluate your distribution system, please contact one of our regional offices.



DISTRIBUTION SYSTEM CHLORINE RESIDUALS

Disinfection of drinking water is widely regarded as one of the most important advances in the field of public health. Chlorine, commonly used for primary disinfection, kills or inactivates harmful microorganisms, which can cause illnesses such as typhoid, cholera, hepatitis and giardiasis.

Clean and safe drinking water relies on multiple barriers of protection. Providing a disinfection barrier against contamination and water quality deterioration in the distribution system is the last barrier for protecting public health. If unstable water enters the distribution system, it can cause rapid decay in chlorine residuals and wide swings in the quality of water delivered to customers.

Residual chlorine remaining in the water supply after initial disinfection provides secondary disinfection, available to fight against contamination in water distribution and storage systems that might be released from biofilms or enter through leaks, cross connections and broken pipes.

Chlorine also reacts with materials in the water. It oxidizes iron and other inorganic metals, reacts with ammonia to form chloramines, and combines with organic compounds to form disinfection byproducts.

Free chlorine is the amount of chlorine that has not reacted with these materials and is still available for disinfection. Combined chlorine includes organochlorine and chloramine compounds. Total chlorine is the sum of both the free and combined chlorine. Free chlorine is a much stronger and effective disinfectant than combined chlorine.

Most systems monitor free chlorine, but don't always monitor total chlorine. There are some benefits to checking total chlorine levels routinely. In a recent study, we found a system that had free chlorine of 0.22 mg/L, but total chlorine of 11.2 mg/L! It turns out that the system has elevated levels of naturally occurring ammonia that combine with chlorine to form combined chlorine (or chloramines). While this combined chlorine does have some disinfecting properties, it is not as strong as free chlorine. You may need to manage combined chlorine to prevent nitrification in the distribution system. The maximum residual disinfectant limit of 4 mg/L applies to all forms of chlorine.

Testing for total chlorine uses a different reagent (powder) and method than free chlorine, so it's important to follow the manufacturer's instructions.

PERMIT RENEWAL

We can now accept online payment (ACH, Visa or Mastercard) for operating permits and system certification invoices. Access the payment portal and instructions at doh.wa.gov/payOPnow. You can pay by check, too. For information, call Diana Horan at 360-236-3170.

The drinking water rule requires systems that chlorinate to measure chlorine residuals at the same time and in the same location where they collect coliform samples. Systems have additional requirements beyond this minimum, depending on the reason for chlorination.

By taking additional investigative monitoring samples at different locations in your distribution system, you can tell whether you have areas of stagnant water or high chlorine demand (no residual), which can indicate a main break allowing contamination into your system or other distribution issues. Knowing the water quality in your distribution system can also help you better manage customer complaints and ensure you are providing the best possible water quality to your customers.

USE WATER METER DATA TO ASSESS DISTRIBUTION SYSTEM HEALTH

As water systems completed their service meter-installation requirement, many operators and owners were able to use data from source and service meters to calculate actual water loss values for the first time. Instead of saying, "We don't have any leaks and we fix leaks when we see them," on their Water Use Efficiency Reports this year, they had a different perspective of understanding the condition of the pipes underground through a collection of metered data.

Now it's time to stop and think about how you can use metered data to assess your ability to provide water through those pipes reliably into the future. To help water systems better understand and evaluate the data they report to us, we will initiate a pilot program later this year to introduce water systems to the key concepts of AWWA's water auditing and water-loss control tools.

"If you really want to know the health and condition of your distribution system, you

need to know the difference between the perceived level of water loss and actual water loss," said Mike Dixel, manager of our Water Use Efficiency Program. "You can do so by examining the data coming from meters and reported annually on WUE reports."

Dixel went on to explain the importance of confirming and validating the data collected from the meters. Any water system can use AWWA's free water audit software now to improve the quality of data collected and reported. Through water auditing, you can learn more about water loss control and:

- ◆ Achieve cost-effective water loss management, which leads to improved technical, financial and managerial capacity.
- ◆ Maintain the health of water distribution systems and support conservation objectives.

During our pilot program, we will select 10 water systems and provide them with

effective tools and methods to promote accountability and efficiency in their supply operations. Through expanded use of the AWWA audit, we can help them establish data more realistic for their work. The pilot will position them to make better capital investment decisions to improve the health and condition of their infrastructure.

Pilot participants will gain a strong foundational understanding of the AWWA M36 methodology. They'll learn how to use the water audit software, water audit data validation, and water-loss control program design. They'll be able to use water audit data to assess and improve water-loss control activities based on their specific audit results.

If you'd like your water system to be one of the 10 selected for the pilot, or you have questions, please contact Mike Dixel at michael.dixel@doh.wa.gov or 360-236-3154.

DEMYSTIFYING LEVEL 1 ASSESSMENTS

The lab informs you the coliform sample you collected yesterday is unsatisfactory. You collect your repeat samples, one at the site of the unsatisfactory sample, one upstream, one downstream and then raw water source samples. You know what to do because you have an updated coliform monitoring plan. Then you get the call: your repeat samples are positive for total coliform!

Under the Revised Total Coliform Rule (RTCR), you have a treatment technique trigger (TTT). You need to complete a Level 1 assessment. Don't worry, you've been conducting Level 1 assessments all along. The RTCR just formalizes the process you always used to determine the cause of the contamination and document your findings.

A Level 1 assessment finds and fixes any issues that may have caused contamination to enter the water system. It is a basic water system evaluation that an owner, operator or other knowledgeable person can do.

We will send a Level 1 Assessment Guide to walk you through your investigation. You have 30 days from the date of the TTT to submit the completed Level 1 assessment form to your regional office.

Because the RTCR is a distribution rule, the guide starts in distribution, looking at sampling sites, then working your way through your system to your source. During your assessment, follow the guide and look for pathways of entry for contamination into your system or any failure in a barrier that is already in place.

Sample site and sample protocol.

Evaluate where and how the sample was taken.

Distribution system. Did you have a low-pressure event? Did you make any repairs to the system lately? Did your system implement a cross-connection control program?

Finished water storage tank, if you have one. You will need to climb the tank and inspect the hatch and vent. Is the hatch watertight? Is the vent screened and intact? Do you see anything in the reservoir? Is there evidence of vandalism?

Source or sources. Are there any contaminants within the sanitary control area? Did your system put a new source online? Is the well cap sealed and the vent screened? Is the spring box free of unprotected openings? Surface water systems should evaluate their treatment plant operations.

Pressure tanks, if you have them. Are they water logged? When was the last time they were drained and recharged?

System treatment, if you have it. Did the chlorination pump fail? Did you have problems maintaining a free chlorine residual? Are treatment vessels free from unprotected openings? Did you do any recent maintenance, such as add new filter material?

On the assessment form, document what you found and whether you need any corrective action. Corrective actions can be easy fixes, such as replacing a watertight gasket on the reservoir hatch. They can also be procedural, such as developing standard operating procedures for disinfecting and flushing after a water main break.

Document your corrective actions and your plan to address any items you can't finish before you submit the form. Include any supporting documentation you have, including photos and work receipts.

Review your coliform monitoring plans and decide who will conduct a Level 1 or 2 assessment if you need one. Remember, a Level 2 assessment is more complex and may only be conducted by a certified water distribution manager 2, 3, or 4, or a professional engineer.

ONLINE WATERWORKS CERTIFICATION RENEWAL

The Waterworks Operator Certification Program and our partners at Washington Certification Services are updating the annual renewal process. Beginning in November 2017, eligible certified waterworks operators will receive their 2018 renewal notice via email. Operators must make their renewal payments online with a debit or credit card. We will not accept checks or money orders. The payment login will activate in November. More information about online renewal for operators is at wacertservices.org/waterrenewals. Benefits of the online renewal process include:

- ◆ Email reminders if an operator hasn't paid the renewal fee.
- ◆ Opportunity to pay immediately using the link in the electronic renewal notice.
- ◆ Ability to print a receipt immediately and payment confirmation via email
- ◆ A validation card mailed quickly, usually within 10 business days of payment.
- ◆ Employers that choose to pay the annual renewal fee for their operators can also use the online system.

Make sure Department of Health always has your current contact information to ensure you receive renewal notices, validation cards, and other important information. If you move or change your email address, visit doh.wa.gov/OnlineRenewals for instructions to update your information.

We are excited about the improvements in the Waterworks Operator Certification Program and the opportunity to provide online renewals. If you have questions, contact Washington Certification Services at 253-288-3357, or our Operator Certification staff at dwopcert@doh.wa.gov.

DISTRIBUTION SYSTEM TRAINING

The PNWS-AWWA Distribution System Committee organizes regional training for water system operators to gain current and relevant education on water distribution issues and practices. The committee's largest effort consists of coordinating a series of three-day training sessions for the PNWS-AWWA Annual Conference, along with several other technical committees. It also seeks to host smaller, regional training opportunities for professionals who couldn't attend the annual conference. Anyone can join. For information, visit pnws-awwa.org and look for "Committees" under "Member Groups."

PROTECT YOUR INFRASTRUCTURE FROM FREEZING

Protect the reservoir. Operate an exposed reservoir in a way that maximizes movement of the reservoir water level (up and down) each day, without wasting water.

Weatherproof the well house. During cold weather, check the well house daily to ensure the heating system maintains a temperature above freezing. In cold climate locations, you will need a reliable heat source, adequate roof and wall insulation, weather-stripping around doors, and tight-fitting vents and louvers to ensure your water system runs reliably. When you consider whether your heat source and weatherproofing are adequate, focus on the temperature needed to keep your water treatment chemicals flowing as designed. Certain water treatment chemicals may become thick and difficult or impossible to pump or flow at near-freezing temperatures.

Bury water mains and water service lines below the frost line. Local building codes likely specify the depth for your area. If you know of water mains or service lines buried too shallow, and subject to freezing, put them on your water system’s list for replacement or reinstallation at a lower depth. In the meantime, add fill or rigid foam insulation over shallow pipeline segments and over shallow valve vaults and meter boxes (if practical).

Retrofit pipelines exposed to severe weather. Even temperate areas of our state can have episodes of severely cold weather. Therefore, you should insulate most pipelines located above ground or hanging off bridges. If flow in the pipe is very slow at times (dead ends), consider installing heat tape along the pipe before covering with insulation. Be sure to check any insulated or heat taped pipelines in your system to ensure these anti-freezing measures are intact.

Check the drain line. Pump or manually drain hydrants, air-vacuum relief valves, and truck fill-station risers situated in a high-groundwater location or with plugged drains or no drains.

Keep facilities accessible. Above and belowground structures containing operational control and treatment facilities must remain accessible at all times. Prepare your utility to keep the way in and out of these structures sufficiently clear of ice and snow throughout the winter season.

WATER MAIN BREAK RESPONSE PROTOCOLS

An estimated 700 water main breaks occur in the United States every day and need repair. Water utilities repair most of these breaks quickly and without interruption in water service or risk to water quality. However, some breaks can affect water service to people and businesses and present a significant risk to public health.

The key factor in controlling risk is pressure—or more specifically loss of pressure—in the distribution system. The Water Research Foundation identified several key findings in its *Effective Microbial Control Strategies for Main Breaks and Depressurization* (report 4307a, Kirmeyer et al. 2014):

- ◆ Contamination risk is real! And, viruses are the most difficult to control.
- ◆ Soil particles may shield viruses from disinfectant residuals.
- ◆ Effective flushing can remove a significant percentage of particles.
- ◆ An appropriate CT value (at least 100 mg/L) of free chlorine for disinfection after repairs can control virus risk.
- ◆ If you lose pressure in the distribution system for more than a few minutes, you should issue a health advisory and collect coliform samples.

The state Department of Health, in collaboration with the water industry, established four categories of water main breaks to standardize communication and response efforts in Washington State. These categories describe public health risk across the spectrum of water main failure effects to utility operations.

You can find the complete water main break response protocol for chlorinated water systems by searching for Publication 331-583 at doh.wa.gov/odwpubs. The protocol describes the recommended response, communication, and repair procedures for each type of water main break for chlorinated water systems. Chlorinated water systems can use distribution disinfectant residuals to help assess response efforts and, in some cases, to perform post-repair disinfection. A water main break response protocol for unchlorinated water systems is our next step!

Type I Break	Type II Break	Type III Break	Type IV Break
Positive pressure maintained through completion of repair.	Controlled pipe repair with limited depressurization during pipe segment shutdown.	Uncontrolled loss of pressure at break site or depressurization elsewhere in the system.	Catastrophic main break or water loss event resulting in the complete loss of water service.
Pressure maintained in pipe during repair.	Pressure maintained at break site until pipe is exposed and trench dewatered. Shutdown limited to immediate valved-off area. No loss of pressure elsewhere.	Pressure loss at break site while pipe is still buried or submerged and/or pressure loss elsewhere in the system.	Extensive water loss compared to system capacity, with no pressure/no water. Storage loss leaves limited flushing capacity.
Contamination is unlikely.	Limited possibility of contamination.	Significant possibility of contamination.	Contamination likely or certain.

THE IMPORTANCE OF MAINTAINING AIR VALVES

BY JOHN OKONESKI, GC SYSTEMS, INC.

When troubleshooting problems in the field, operators and maintenance workers often overlook air release and vacuum relief valves. The simplicity of these valves leads us to discount them and focus on complicated pieces of equipment when things go wrong.

In addition, engineers frequently install them in a below-grade valve box or in a well house or pump house where there are more important things to pay attention to, such as pumps, control valves, water meters, control panels, and so on. As a result, systems may have improperly maintained valves, or valves not inspected for proper operation.

Air relief valves release air automatically to prevent air blockage, or allow air to enter a line if the internal pressure falls below atmospheric pressure. They come in three types: air release, vacuum relief, and combination valves, which incorporate air release and air vacuum functions into a single body or a dual body configuration.

For your water system to operate efficiently, you must maintain all types of air valves. Air trapped in pipelines can alter hydraulic gradients, increase pumping costs, and cause water hammer and pipe corrosion. It can also affect water meters, automatic control valves and pump volutes. In addition, damage to equipment and pipelines may occur if air is not exhausted during initial pipe filling or air is not admitted during pipe draining.

Air Valve Maintenance is a Straightforward, Simple Process

Start with a visual inspection. Any air valve continuously exhausting water out of the valve orifice requires maintenance. This problem usually occurs when damage to the float or the disc keeps the valve

from seating tightly. Occasionally debris caught between the disc and the float keep the valve from closing. The fix for this is to isolate the valve, remove the cover (don't forget to have a cover or body gasket in hand before disassembly), inspect and replace the damaged parts, or remove the debris.

If the float is deformed, the disc is cut, or there is damage to the linkage, there are forces at play that you need to address, or the valve will malfunction again.

On air vacuum relief valves, another cause of continuous water discharge could be low operating pressures. In most cases, you can remedy this problem by replacing the disc in the valve with a softer rubber compound or Durometer. If, upon initial inspection, there seem to be no problems, you may decide to test the air valve to make sure it is functioning correctly.

To test an air release valve

Most manufactures do not provide a means to test air release valves smaller than 2-inch inlet sizes. However, depending on the type of valve, you can test some 1-inch valves. To test an air release valve, follow the steps below.

- 1 Close the inlet shutoff valve, then remove the drain plug located low and on the side of the valve body.
- 2 Install a drain valve, typically a quarter turn ball valve. Be careful because there will be system pressure in the valve body.
- 3 Open the inlet valve and partially open the drain valve until you can hear flow. Water should be flowing out of the drain valve. If air is exhausting, follow steps 4 through 7.
- 4 Close the inlet valve and slowly open the drain valve to allow the water to drain from the valve. If draining is diffi-

Devices with air vents must not be installed below ground level, or in areas where they may be flooded. Flooding of the pit or area could result in a direct cross connection through the air vent.

In areas subject to freezing, air valves may be installed below ground if the vent extends at least 18 inches above ground with a screened downward-facing vent opening.

cult, debris may be clogging the valve. You will need to remove it and clean it.

- 5 Close the drain valve and slowly open the inlet valve to fill the valve with water. Observe the seating action and verify that the valve closes without leakage.
- 6 If leakage occurs, remove the valve and inspect it for wear or possible damage.
- 7 If there is no leakage, perform steps 3 and 4 again. If air is exhausted, remove the valve, inspect it, and repair it.

All major manufacturers of air valves have parts breakdowns and repair parts available. The average cost to repair an air valve is about a third less than the cost to replace it with a new one. Air valves are an intricate part of your distribution system. You should inspect and repair them periodically to avoid the problems outlined in this article. Remember the old axiom: An ounce of prevention is worth a pound of cure.



ADVENTURES IN HYDRAULIC MODELING

BY TODD KRAUSE, P.E., NORTHWEST WATER SYSTEMS

People often view hydraulic modeling as “boring” and relegate it to the “engineers only” club. However, a good hydraulic analysis requires input and insight from operators. When an operator and a manager work together with an engineer, their hydraulic model comes to life—a useful tool instead of just another stack of papers.

At its core, a hydraulic analysis models pressures and flows throughout your distribution system. An engineer may run the hydraulic modeling software, but a good hydraulic model is not only a useful tool, it can also be fun. For example, you can have your engineer run different scenarios to “see what happens” if you add another line, increase demands, or shut off a reservoir.

For small water systems there is free hydraulic modeling software called EPANet

(www.epa.gov/water-research/epanet). After an engineer makes the model, you can get a copy for yourself and, with a little explanation, you can learn to play with it and run your own scenarios.

Another important part of hydraulic modeling is calibration, which involves going into the field and measuring pressures and flows (usually at hydrants or blow-offs), then adjusting your model to fit real-world observations. By calibrating your model, you often find “surprises.”

There are well-established laws of pressure and flow, so a hydraulic model should be accurate. When the model does not match measurements, you can gain new insights as you discover why. Perhaps what you assumed was an old 4-inch AC line is actually ductile iron pipe, or 3-inch PVC. You can use your model to investigate, or try different pipe types

or sizes until something works and you have a better guess at what is actually in the ground.

If you have a low-pressure area or want to do a replacement or expansion, a hydraulic analysis lets you try various solutions without breaking ground. What pipe size is optimal? We no longer have the big plant in town, do we really need to replace that line again with 12-inch, or is 6-inch OK? Is it better to install a booster station, or extend the main to loop a section of the distribution system? If a big development connects to the far end of the water system, will it affect pressure to the customers in the core of town? How low will the pressure get when we flush, or have a major line break?

The answers to these questions and more await you as you embark on your next hydraulic modeling adventure!

KEEP COMMUNICATION WITH CUSTOMERS FLOWING

There's always room to improve your customers' perceptions about the value of water and their water system. We have a unique opportunity to establish trust and build positive relationships with customers on a continual basis—not just when an emergency occurs.

By communicating with your customers, you help them understand the value they receive from you. Communication shows customers you care, which can pay dividends now and in the future.

Below are examples of ways to reach out to customers. Use these tools to win their trust, respect and support. If customers understand the value of water, they likely will be more willing to get onboard when it comes time to increase rates.

Tracking complaints

When a customer calls to report low water pressure, how do you follow up? Do you get back to that customer and let them know what you found, what you did about it, and thank them for reporting the problem? A one-minute phone call or short written response shows customers you heard them and you care.

Value of Water bill stuffers

You can order free Value of Water bill stuffers from the Office of Drinking Water to send out with your water bills. They promote awareness and educate customers about water's role in the economic, environmental, physical and social well-being of our country. Follow the instructions at doh.wa.gov/ODWMarketing.

Consumer Confidence Reports

You can turn these required annual reports to customers into a public relations goldmine. The report must include information about water quality issues, but you can also use it to share your accomplishments. Use short articles and photos to show how you're investing in customers' health and wellbeing and the steps you're taking to keep their water safe.

Water Use Efficiency Reports

These required reports contain great information for telling your story. Add it to your consumer confidence report to show customers what you're doing to conserve water for future generations by using water efficiently. It doesn't get much better than that!

Health Advisories

You might be tempted to think of public notices associated with health advisories as negative communication, but there's another way to view them. These notices, if delivered quickly, tell your customers you're working to protect their health. In addition to the legally required language, you can add messages to customers. When you end an advisory, thank your customers for their patience and cooperation, and tell them what you did to ensure the safety and reliability of their water.

Maintenance projects

If you replace water lines, you may need to cut off service for short periods of time. Always notify your customers ahead of time—and use the opportunity to tell them what they'll gain when the project is over.

FOCUS: ISOLATION VALVES

Water systems install isolation valves so they can shut off a portion of the pipeline for inspection or repair. To ensure your isolation valves work when you need them, you should have an effective valve maintenance program.

Your valve maintenance program will include exercising valves every year. This will help your valves last longer and give you a chance to see whether they work the way they should. You will benefit greatly by finding malfunctioning valves now, rather

than waiting until an emergency occurs. Emergency repairs and replacements are always more expensive than planned ones.

A valve maintenance program should:

- ◆ Make safety a priority.
- ◆ Identify all the valves in your distribution system.
- ◆ Maintain detailed records for each valve (size, number of turns to operate, condition, location, parts supplier, and so on).
- ◆ Develop a maintenance schedule and exercise

each valve from fully opened to fully closed at least once a year.

- ◆ Verify the condition of valves and valve boxes.
- ◆ Identify problem valves and schedule repairs.

Tips

- ◆ The valve size determines the number of turns to fully open gate valves. The rule of thumb is 3 times the valve size plus 2 (a 6-inch valve takes about 20 turns to fully operate).

- ◆ When operating a gate valve, make 4-5 turns then reverse for 1 turn, and repeat until fully open or closed. This will scrub off accumulated debris from the gate.
- ◆ Never force the valve; small turns in each direction will help avoid a broken valve stem.
- ◆ Count the turns to fully open to fully shut... they should match.
- ◆ After exercising a valve, open a nearby hydrant to flush out scrubbed debris.

BIOFILM BASICS

Biofilm is that slimy surface coating that forms on the inside of water facilities, particularly pipelines and reservoirs. A biofilm generally consists of microorganisms, such as bacteria, fungi, protozoa, viruses, and organic and inorganic matter held together with polymer material. Biofilms form in all drinking water distribution systems, and can cause a number of water quality issues and other problems.

Microorganisms will not attach to brand new, clean water pipes. But, over time, as organic material adheres to and “conditions” the pipe, bacteria and other organisms will attach. This conditioning process may take years. When the density of bacteria is high enough, they begin producing a gelatinous material called “extracellular polymer substances” or EPS. EPS make up the bulk of the weight and volume of biofilm and give it the characteristic slimy texture. The slime layer can trap additional organic material, which provides food for bacterial growth and replication.

Biofilm can become a diverse and flourishing micro-ecology and food chain. Some species of microorganisms in the slime layer feed on others. The biofilm traps the metabolic by-products and wastes from the microorganisms, and one species may feed on the wastes of another species.



Image courtesy Washington Environmental Training Center at Green River Community College

Water quality and other concerns

Pathogens can get into water systems through treatment failure or inadvertent contamination, such as main breaks, cross connections, or breaches in storage tanks. These pathogens can get trapped in the biofilm where they grow and multiply. Studies show that drinking water system biofilms can contain the pathogens that cause various waterborne diseases, although there is little information on outbreaks conclusively linked to biofilm as the source.

In addition to public health issues, biofilms can cause taste, odor, and color issues in drinking water. Some biofilm organisms act as a catalyst for corroding some types of pipe. Iron-oxidizing bacteria cause iron and steel pipes to rust faster, creating raised deposits called tubercles. And, sulfur-oxidizing and sulfur-reducing bacteria, which release sulfuric acid and hydrogen sulfide, can cause pipe surfaces to pit.

Controlling biofilms

A successful biofilm control program uses a variety of techniques. It starts with keeping contamination out of the system as much as possible by optimizing source water treatment, having a robust cross-connection control program, and using best practices when making repairs and other changes to the water system infrastructure.

Regular unidirectional flushing is an effective way to keep water mains clean and can limit biofilm development. Maintaining a robust disinfectant residual also limits biofilm growth. Free chlorine is most effective on relatively thin biofilms, so it is most effective when coupled with a regular flushing program. Conventional pigging is effective at removing biofilm, and can also be useful for removing corrosion and tubercles. Ice pigging is a relatively new method of removing biofilm and sediment build-up in water mains.



PO Box 47822
Olympia, WA 98504-7822

H₂Ops is a publication of the Washington State Department of Health Office of Drinking Water, 331-500. If you want to receive this publication in an alternative format, call 800-525-0127 (TDD/TTY call 711). This and other publications are available at www.doh.wa.gov/drinkingwater.

Reference in this document to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not imply endorsement or recommendation by the Washington State Department of Health. References and images of commercial products are provided only for informational or educational purposes.

Printed on recycled paper.



HIGH 5: LAKEHAVEN WATER AND SEWER

A big High 5 to Lakehaven Water and Sewer District for hosting the annual Area Wide Optimization Program (AWOP) workshop on distribution system optimization. The daylong May workshop got participants from EPA, Montana, Utah, Colorado, and Washington together to focus on distribution water quality and the effect of reservoir water age and reservoir mixing on water quality.

AWOP is a collaborative multi-state effort to develop and implement programs to help water systems optimize existing treatment processes and increase public health protection.

Lakehaven was the ideal host. It has several large standpipes equipped with sample taps at multiple levels, making sample collection for water quality analysis very convenient.

Special thanks to Stan French, water operations manager; Tom Zawacki, assistant water operations manager; Craig Hurley, operator 1; and John Vindivich, operator 2. They located and opened hydrants near the standpipe of interest for distribution sampling, answered many questions, provided SCADA data on water level elevations and chlorine residuals, and made sure we had everything we needed.

The workshop findings reinforced what Lakehaven long understood about water quality in the standpipes. Years ago, after Lakehaven installed sample taps at various heights in each tank, water quality results verified that stratification occurred. They installed mixers in each standpipe to provide better water quality. While mixing doesn't lower water age, it does help to maintain a stable chlorine residual throughout the tank and prevent or reduce stagnation and tank stratification.

Thank you, Lakehaven, for a successful workshop and your continued participation in AWOP.