



Maine CDC Drinking Water Program

Department of Health and Human Services

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Guidance for Municipal Public Water Systems on Controlling the Growth of *Legionella* Bacteria

Purpose

This document provides general guidance and best practices for a municipal public water system (PWS) to reduce the risk of *Legionella* growth in the distribution system, as well as recommended steps a water system may take following the detection of *Legionella* in the premise plumbing of an establishment served by the PWS or as part of a Maine CDC investigation into an unusually high number of legionellosis cases in the PWS service area.

Scope

This document applies primarily to municipal public water systems with large or complex distribution systems that include significant lengths of piping and storage components such as water tanks or towers.

Definitions

Premise Plumbing: the pipes and other plumbing components within a building or residence. Premise plumbing is not part of a public water system's distribution system.

CT Value: The term CT is a measure of the effectiveness of the disinfection process based on Concentration (C) and Time (T), thus "CT". This term should not be confused with the measure of "Contact Time". The CT Value and Contact Time are two different values. However, Contact Time is part of the CT Value equation ($CT = \text{Disinfectant Concentration} \times \text{Contact Time}$).

***Legionella*:** A type of gram-negative, aerobic, rod-shaped, flagellated bacteria that includes the species *Legionella pneumophila*, which is the causative agent of legionellosis (Legionnaires' disease). *Legionella* bacteria are common in most natural aquatic environments and may also be present in water distribution systems and premise plumbing (<https://www.epa.gov/ground-water-and-drinking-water/Legionella>).

Legionellosis: A serious type of pneumonia (lung infection) also known as Legionnaires' disease caused by *Legionella* bacteria. Note: *Legionella* bacteria can also cause a less serious illness known as Pontiac fever (<https://www.cdc.gov/Legionella/index.html>).

Important: Community engagement and preparation prior to any *Legionella* detection and/or case investigation will help a PWS to respond more effectively during the event. The DWP recommends that all municipal PWS **1)** have representation on its Local Emergency Planning Committee; **2)** meet with high-risk customers such as hospitals, kidney centers, nursing homes, etc. to discuss a plan for response; **3)** prepare informational documents in advance to share with customers, such as *Legionella* information and how to manage *Legionella pneumophila* within premise plumbing. More information is available from the US CDC: <https://www.cdc.gov/Legionella/wmp/toolkit/>

Background

Legionella bacteria are common in the natural environment. There are over 60 different species of *Legionella* but the species *Legionella pneumophila* is the species that is most commonly associated with disease cases and outbreaks. People are typically exposed to *Legionella pneumophila* through inhalation of aerosolized water (e.g.,

water vapor, mist, or steam). Some people may develop serious, even life-threatening, respiratory symptoms while others may not develop symptoms at all.

Under the right conditions, rapid growth of *Legionella* bacteria can occur in hot water tanks, showers, shower heads, sinks, pools, hot tubs, kitchen appliances, decorative fountains, ice machines, water storage tanks, cooling towers, and similar equipment that use and/or aerosolize water.

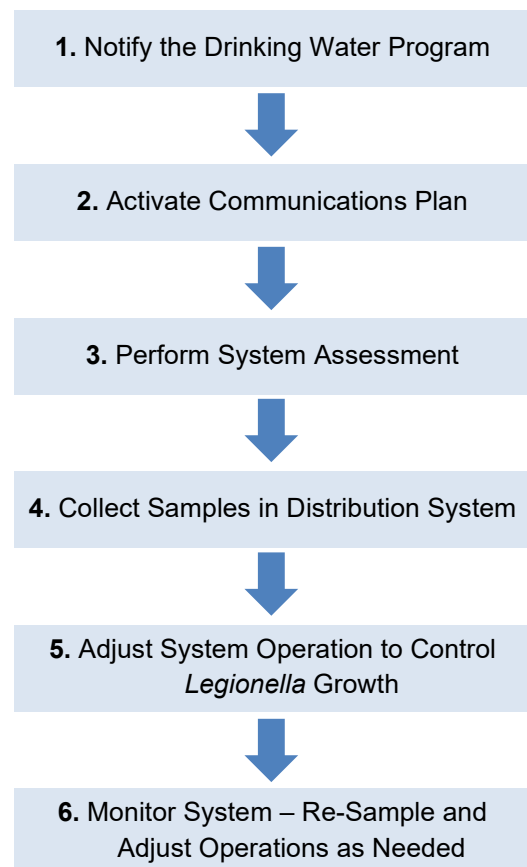
There are generally three conditions which present an increased risk for *Legionella* growth in a PWS distribution system:

- a. Water temperature is 18°C (64°F) or higher,
- b. Low flow or stagnant water areas (prone to biofilm accumulation) and/or
- c. Where free chlorine residual is less than 0.1 mg/L

Although *Legionella* bacteria are not typically present in high numbers within a public water system's distribution system, even small amounts of *Legionella* bacteria within the distribution system can become the “seed” for expansive growth of the bacteria within premise plumbing. Therefore, it is important for every PWS to engage in best practices to control, minimize, and preferably eliminate or bring below detection levels *Legionella pneumophila* bacteria in their water system.

Recommended Actions

In the event of a detection of *Legionella* bacteria in premise plumbing (e.g., in a healthcare facility or any other buildings connected to the PWS) or when assisting the Maine CDC in an investigation of a rise in Legionellosis cases, it is recommended the PWS take the steps shown in the flowchart shown at right.



Action Steps

1. Notify the Drinking Water Program. When you are notified of a detection of *Legionella* bacteria within your water system or within the premise plumbing of a building served by your water system, or when you are made aware of an ongoing Maine CDC investigation into an elevated number of legionellosis cases in your area, please contact your Public Water System Inspector at the Maine Drinking Water Program. A list of inspectors and their contact information can be found at: <https://www.maine.gov/dhhs/mecdc/environmental-health/dwp/pws/contactUs.shtml#PWSI>.

You may also call the DWP:

- Main Line (during business hours): (207) 287-2070
- Emergency Line (after hours): (207) 557-4214

2. Activate Communications Plan. Before the system samples for *Legionella* bacteria in the distribution system, ensure the public water system has communication strategies and tools in place. The Drinking Water Program, Maine CDC's Public Health District Liaison, and the Maine CDC's Communications Director can all serve as resources to help craft and distribute communications.

- The communication strategy should identify stakeholders (both internal and external to the utility), primary and alternate communication channels for stakeholder groups, and should include communication tools such as messages, fact sheets, etc. A PWS may consult with public relations professionals, such as those in Maine CDC and the local (County) or State Emergency Management Agency (EMA), to develop a strategy for communicating with consumers. Contacts for local EMA can be found at the Maine Emergency Management Agency (MEMA) website at: <https://www.maine.gov/mema/ema-community/county-local/county-emergency-management-agencies>.
- Communication should include plans for how the municipal water system will be disinfected, health precautions people can take if applicable, and recommendations for homeowners and building owners on how to manage *Legionella pneumophila* within their premise plumbing.
- Public water systems can assist building owners, including healthcare facilities, to control *Legionella pneumophila* bacteria in their premise plumbing by referring them to a federal CDC document titled "Developing a Water Management Program to Reduce Legionella Growth & Spread in Buildings" which can be found on the U.S. CDC website at: <https://www.cdc.gov/Legionella/wmp/toolkit/>.
- Additional guidance for homeowners is available at the American Water Works Association website at: <https://amwater.com/corp/Legionella-homeowners>. The PWS and homeowner may also contact Maine CDC for more guidance.

3. Perform System Assessment. Perform a system assessment by evaluating the PWS distribution system for any place where *Legionella* could grow and multiply. Look for dead ends or portions of the system that may contain stagnant water with low disinfectant residuals (free chlorine residual less than 0.1 mg/L), areas of high water temperature (greater than 18°C or 64°F), storage tanks with limited turnover, areas with a recent change in pressure such as caused by a water main break or scheduled repair work. Once any of these conditions have been identified, the PWS should begin to implement the practices outlined in the *Recommendations and Best Practices for Legionella Bacteria Prevention and Management* section below as soon as possible. The PWS should also evaluate its Cross Connection Control Program to ensure the system cannot be contaminated by premise plumbing from customers of the system.

4. Collect Samples in Distribution System. Once communication measures are in place and areas which may promote *Legionella* growth have been identified, the PWS may sample for *Legionella*. *Legionella* sampling is not required. However, this is the best way to quickly confirm the presence or absence of *Legionella* in the drinking water.

- The PWS may sample for *Legionella pneumophila* by collecting water in the same sample bottles used for routine Total Coliform testing. The lab may use the IDEXX Legiolert test, which normally takes seven days to produce results. To work with the week-long wait for sample results, a strategy should be employed on how frequently samples are taken in order to gauge the effectiveness of changes being made to the system (i.e., flushing, increased disinfectant residual).
- *Legionella* and chlorine residual samples should be representative of the PWS's infrastructure providing water to the customer (water mains), not of the premise plumbing. Whenever possible, take chlorine residuals and *Legionella pneumophila* samples at a tap at the meter, or entrance of the water service line into a building. Avoid taking samples at locations within premise plumbing.
- Taking *Legionella pneumophila* samples at routine total coliform sampling sites on the distribution side is recommended, yet sampling at other locations can be part of evaluating a distribution system. Sampling sites may include distribution locations with low disinfectant residual (chlorine residual less than 0.1 mg/L), locations with stagnant water, and at locations with *Legionella* bacteria detection in premise plumbing.

5. Adjust System Operation to Control *Legionella* Growth. Whether or not a water system has chosen to sample for *Legionella* in its distribution system, it is recommended the PWS works to improve its water quality by limiting the conditions for *Legionella* growth, as outlined in the *Recommendations and Best Practices for Legionella Bacteria Prevention and Management* section below. Inform stakeholders (including customers) of steps that have been taken to minimize the risk from *Legionella* in the public water system.

6. Monitor System – Resample and Adjust System Operations as Needed. Now that the PWS has data from its system assessment and any *Legionella* tests, the PWS should continue to monitor its distribution system water quality and conduct further system assessments or sampling for *Legionella* as needed. Continue communications with stakeholders.

Recommendations and Best Practices for *Legionella* Bacteria Prevention and Management

Considering the conditions for *Legionella* growth described in the previous section, public water systems can implement standard practices to prevent *Legionella* growth and to reduce or eliminate *Legionella* after a detection occurs, including:

- Maintain adequate disinfectant residuals through all seasons. Disinfectant demand changes seasonally and with variations in temperature, especially with surface water sources. Residual concentration is also dependent upon type of disinfectant being applied (e.g., chlorine vs. chloramines).
- Optimize water treatment to remove Total Organic Carbon (TOC) from source waters when necessary to reduce disinfection by-product (DBP) formation and improve disinfectant residuals throughout the distribution system.
- Adhere to a regular system flushing program aimed to reduce sediment and biofilm, and to maintain adequate disinfectant residuals to the ends of the system. The PWS may consider automatic flushers for low flow areas.

- Turn over stored water in tanks to prevent stagnation (also increasing disinfectant residual in the system and reducing DBPs). Tank mixers can also be installed.
- Practice regularly scheduled cleaning and maintenance of storage tanks to reduce nutrient availability and contamination.
- Maintain a Cross-Connection Control Program to ensure the system is not contaminated by premise plumbing from customers of the system.

Water systems should be looking for locations in their distribution system where high temperatures, low-flow or stagnant conditions exist. In Maine, treatment plant and distribution system water temperatures of 18°C (64° F) tend to occur during summer months, and are not as likely during fall, winter, or spring. However, low-flow and/or stagnation can occur throughout the year. When locations are identified in the PWS distribution system where one or more of these conditions exist, the water system should practice strategic flushing to move the water and increase the disinfectant residual, e.g., until the free chlorine residual is continually 0.1 mg/L or higher or the chloramine residual is continually 0.4 mg/L or higher.

When *Legionella* bacteria is detected and/or an increase in legionellosis cases has been identified by Maine CDC, the PWS should focus its immediate efforts on maintaining adequate disinfectant residual and reducing tank stagnation, as follows:

1. Disinfectant Residual

- A free chlorine residual of at least 0.1 mg/L at all points in the distribution system is recommended. For chloraminated systems, due to the relatively weaker oxidizing properties, a higher disinfectant residual is required for similar results. Therefore, a chloramine level of 0.4 mg/L is recommended. **It is important to ensure that calibrated disinfection residual measuring equipment is used.**
- It is not known definitively what disinfectant levels are necessary to purge a system that already has *Legionella* bacteria in it. However, a level of 0.5 mg/L free chlorine throughout the distribution system is an initial target level to disinfect contaminated systems. “Principals of Water Treatment” (Wiley and Sons) states that the CT required for 99% inactivation of *Legionella* using free chlorine is 100-300 mg-min/L.
- If it is determined that the *Legionella pneumophila* bacteria strain is present in the distribution system, (this type of *Legionella* bacteria is most commonly the cause of legionellosis) then CT for 99% inactivation is accomplished with 1 (one) mg-min/L (“Principals of Water Treatment”, Wiley and Sons).
- To raise disinfectant residual levels, use system valving to flush strategically and directionally to bring water with higher disinfectant residual into a specific area with low disinfectant residual.
- Flushing while the water treatment plant is running helps to bring water with higher disinfectant residuals into system. Increasing disinfectant residual at the treatment plant while flushing will help bring higher levels of disinfectant throughout the system.
- To maintain residual levels, use valving to increase system flow wherever possible. Use bleeders as needed, considering the proper disposal of purged water.
- Increasing chlorine or chloramine levels in a water system, particularly those with a surface water source (higher organic content), may increase disinfection by-product (DBP) levels. Since DBPs increase with the age of water, water systems should maximize water turnover when increasing chlorine levels in order to minimize DBPs. The balance between raising disinfectant levels to maintain residuals throughout the system and minimizing DBPs requires constant attention to this simultaneous compliance effort. If plant chlorine levels are increased to address low disinfectant residuals, it is suggested that O&M DBP samples are taken to evaluate and manage DBP levels within the system.

- Beyond flushing and increased disinfectant dosage, a system-wide analysis for all options available to manage residual levels should be completed, including: a review of pH; the potential presence of biofilm; pipe material (e.g., cast iron may provide niches and nutrients for increased *Legionella* bacteria growth); adding a booster station to increase chlorine residual in the distribution system; and other applicable actions.

2. Tank Stagnation

- Tank stagnation is a major concern for *Legionella* growth. Flushing strategies to increase chlorine levels in a distribution system may include isolating a tank from system flow to allow plant water with a higher residual to circulate in water mains. Avoid isolating a tank for more than half a day. During this period with an isolated tank, consider draining the tank 50% to allow more highly chlorinated water to fill that tank when it is brought back online.
- Tank mixing accomplished with spray nozzles above the surface of the water in a tank creates two important benefits: **1)** Creating water movement in the tank which will help reduce or eliminate tank stratification and stagnation; **2)** Aerate the water which reduces the formation of trihalomethanes (THMs).

3. Recommendations for Homeowners/Building Managers

Legionella can become a health concern when it grows and spreads in human-made building water systems like sinks, cooling towers, hot tubs, fountains, and large plumbing systems. Most healthy people exposed to *Legionella* do not get sick. Those at increased risk of getting sick are people aged 50 years and older; current or former smokers; people with a chronic lung disease, weak immune systems, or cancer; and people with other underlying illnesses such as diabetes, kidney failure, or liver failure. *Legionella* is less likely to contaminate the water in houses than in large buildings with complex water systems. However, all building managers, including homeowners, can take steps to reduce the risk further, including:

- **Water Heaters:** In some cases, bacteria have been found in residential water heaters, more often in electric water heaters than in gas water heaters. Most manufacturers recommend that water heaters be flushed on an annual basis, which can help reduce the risk of bacteria growth. This should be done with caution and performed by a qualified plumber
- **Showers:** Because they remain damp, shower heads can grow bacteria. Removing the shower head, manually cleaning it to remove scale and sediment, and soaking it in a mixture of 1 tablespoon of household bleach to 1 gallon of water for about 2 hours will disinfect the shower head.
- **Humidifiers:** Some homes have whole-house humidifiers. Humidifiers should be cleaned and disinfected regularly according to the manufacturer's directions. Always unplug the humidifier first. Clean the inside of the humidifier per the manufacturer's instructions, using a mixture such as 1 tablespoon of household bleach to 1 gallon of water, and dry.
- **CPAP Machines and Nebulizers:** These devices should be used only with distilled water and should be cleaned regularly, per manufacturer's recommendations.

Additional Resources

- US Centers for Disease Control and Prevention (CDC) *Legionella* webpage
<https://www.cdc.gov/Legionella/index.html>
- US Centers for Disease Control and Prevention (CDC) *Legionella* resources and materials
<https://www.cdc.gov/Legionella/resources/materials.html>
- LeChevallier, Mark W. "Occurrence of culturable *Legionella* pneumophila in drinking water distribution systems." *AWWA Water Science* 1.3 (2019): e1139
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