Guidance for Public Water Systems (PWS) regarding Legionella Bacteria

Provided by the State of Maine Drinking Water Program

Purpose: This document offers general guidance for municipal water systems that provide water to numerous types of establishments including homes, businesses, schools, and health care facilities.

Scope: This document applies primarily to municipal public water systems that use chlorine as a disinfectant. For systems that use chloramines or ozone, information provided is applicable with consideration that the level of disinfectant (expressed herein as mg/L free chlorine) that provides similar disinfection properties differs for chloramine and ozone vs. free chlorine.

Background: Legionella bacteria are common in the natural environment. There are over 60 different species of Legionella but the species *Legionella pneumophila* is the one overwhelmingly found in association with disease cases and outbreaks. *Legionella pneumophila* becomes a problem in drinking water systems when it reaches a location where it can grow rapidly, often protected within biofilms. Exposure through inhalation of aerosolized water (e.g., water vapor, mist, or steam) can cause legionellosis in some people; the disease is also known as Legionnaires' disease or legionella pneumonia. Rapid growth of this 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 uses and/or aerosolizes water. Although Legionella bacteria are not typically present in high numbers within a public water system's distribution system, even small amounts of Legionella bacteria can become the "seed" for expansive growth of the bacteria within premise plumbing, under the right conditions. Therefore, it is important for every PWS to engage in best practices to control, minimize, and preferably eliminate *Legionella pneumophila* bacteria in their water system.

Definitions:

> **Premise Plumbing:** the plumbing within a building or residence. Premise plumbing is not part of a public water system's distribution system.

> **CT:** The term CT is a measure of the effectiveness of the disinfection process and should not be confused with the measure of "Contact Time" alone; CT and Contact Time are two different measurements. CT = Disinfectant Concentration X Contact Time

> **Legionella:** A Gram negative, aerobic, rod-shaped, flagellated bacteria of the species *Legionella pneumophila* that is the causative agent of legionellosis (Legionnaires' disease, Legionella pneumonia) (https://en.wikipedia.org/wiki/Legionella_pneumophila)

Legionellosis: The broad term used to describe either a serious type of pneumonia (lung infection) called Legionnaires' disease or the less serious illness called Pontiac fever.

PWS Compliance: There is no federal regulation that specifically addresses Legionella bacteria. However, related PWS compliance occurs by maintaining free chlorine or other disinfectant residual throughout the distribution system, for those systems that are required to maintain a disinfectant residual. Since total coliform sampling sites are intended to be representative of the distribution system, for those systems that disinfect, formal compliance for maintaining a residual in the distribution system is measured at the total coliform sampling sites at the time of routine sampling. Although this defines the minimum regulatory requirement for disinfectant residual measurement, the intent of the regulation is to have a detectible disinfectant residual at all points in a PWS distribution system, to provide continual, effective, yet minimal, water system disinfection.

Recommendations and Best Practices:

1. For control and management of *Legionella pneumophila* bacteria within a PWS distribution system, a free chlorine residual of at least 0.1 mg/l is recommended. At this time, it is not well known what minimal level of other disinfectants is necessary to control and manage this Legionella bacteria in a PWS distribution system. Regarding chloramination, from "The Science of Chloramination" presentation, Maine Water Utilities Association, 6/8/10: in comparison to chlorine, "Chloramines are weaker oxidizing agents, and a higher disinfectant residual is required for similar results. A chloramine residual of 2.0 mg/L is comparable to a free chlorine residual of 0.5 mg/L". This would suggest that a chloramine level of .4 mg/l would have similar disinfectant results as 0.1 mg/l free chlorine.
2. It is not known definitively what free chlorine levels are necessary to purge a system that already has Legionella bacteria in it. However, a level of 0.5 mg/l throughout the distribution system is an initial target level to obtain 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.
3. If it can be determined that *Legionella pneumophila* bacteria is present (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. [ref. "Principals of Water Treatment" (Wiley and Sons)]
4. Water systems should be looking for locations in their distribution system where any of these conditions exist:
    a. Water temperature is 18 deg C (64 deg 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

These are the conditions that cause concern about Legionella growth in a distribution system. When locations are identified where these conditions exist, strategic flushing and chlorine level increases need to be considered to raise the free chlorine residual until it is continually 0.1 mg/l or higher. In Maine, plant and distribution system water temperatures of 18 deg C (64 deg F) tend to occur during summer months, not as likely during fall, winter, or spring.

5. Taking O&M (Operations & Maintenance) *Legionella pneumophila* samples at distribution locations with low chlorine residual readings (less than 0.1 mg/l) is recommended for evaluating the distribution system's condition regarding Legionella bacteria. Before taking O&M samples for Legionella, the PWS should develop a plan for communicating the test results to consumers, particularly if the results are positive (above the detection limit). Prior to instituting testing, consult with public relations professionals, such as those in emergency management, to develop a strategy for communicating with consumers.   Communication should include plans for how the municipal water system will be disinfected, health precautions to take if applicable, and recommendations to home owners and building owners on how to manage *Legionella pneumophila* within their premise plumbing (see #17 below in this document).

6. *Legionella pneumophila* samples are collected in bottles used for routine Total Coliform testing and results normally take seven days to become available. 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.

7. 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. For the purpose of addressing Legionella in a PWS's distribution system, chlorine residuals need to be measured where water enters the building. Similarly, Legionella samples need to be representative of the PWS's infrastructure providing water to the customer (water mains), not of the premise plumbing.

8. To raise disinfectant residual levels, use system valving to flush strategically and directionally to bring water with higher chlorine levels into a specific area.

9. To maintain residual levels, use valving to increase system flow wherever possible. Use bleeders as needed, considering the proper disposal of purged water.

10. Taking *Legionella pneumophila* samples at routine total coliform sampling sites is recommended, yet sampling at other locations can be part of evaluating a distribution system.

11. 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 on-line.

12. Increasing chlorine 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, maximize water turnover when increasing chlorine levels in order to minimize DBPs. The balance between raising chlorine levels to ensure chlorine residuals throughout the system and minimizing DBPs requires constant attention to this simultaneous compliance effort. If plant chlorine levels are increased to address low chlorine residual levels, it is suggested that O&M DBP samples are taken to evaluate and manage DBP levels within the system.

13. 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 formation of trihalomethanes (THMs).

14. Increasing disinfectant residual during flushing will help bring higher levels of disinfectant throughout the system.

15. Flushing while the water treatment plant is running helps to bring water with higher chlorine levels into system.

16. Complete a systemwide analysis to look at all options available for managing residual levels throughout the system, including a review of pH, the potential presence of biofilm, pipe material (cast iron), adding a booster station, and other applicable actions.

17. PWSs can assist home owners to control *Legionella pneumophila* bacteria in their premise plumbing by encouraging them to routinely clean shower heads and faucet aerators. In addition, hot water heaters should be drained and cleaned annually. Additional information can be found at https://amwater.com/corp/legionella-homeowners

18. PWSs can assist building owners, including health care facilities, to control *Legionella pneumophila* bacteria in their premise plumbing by referring them to a federal CDC (Center for Disease Control) document titled "*Developing a Water Management Program to Reduce Legionella Growth & Spread in Buildings*" which can be found on the web at https://www.cdc.gov/legionella/wmp/toolkit/ . There are several applicable, reference documents developed by national organizations listed at the end of this publication.

19. Additional information on Legionella can be obtained at:

a. US Centers for Disease Control and Prevention (CDC): https://www.cdc.gov/legionella/index.html

b. Dr. Mark W. LeChevallier, 2020, "Monitoring distribution systems for *Legionella pneumophilia* using Legiolert", funded by IDEXX Laboratories, Westbrook, ME.

c. Dr. Mark W. LeChevallier, 2020. Managing Legionella pneumophila in Water Systems. JAWWA. 112(2): 11-23. https://doi.org/10.1002/awwa.1444

d. Dr. Jennifer Clancy, 2019, *Customer Messaging on Opportunistic Pathogens in Plumbing Systems*, WRF Project 4664: https://www.waterrf.org/research/projects/customer-messaging-opportunistic-pathogens-plumbing-systems