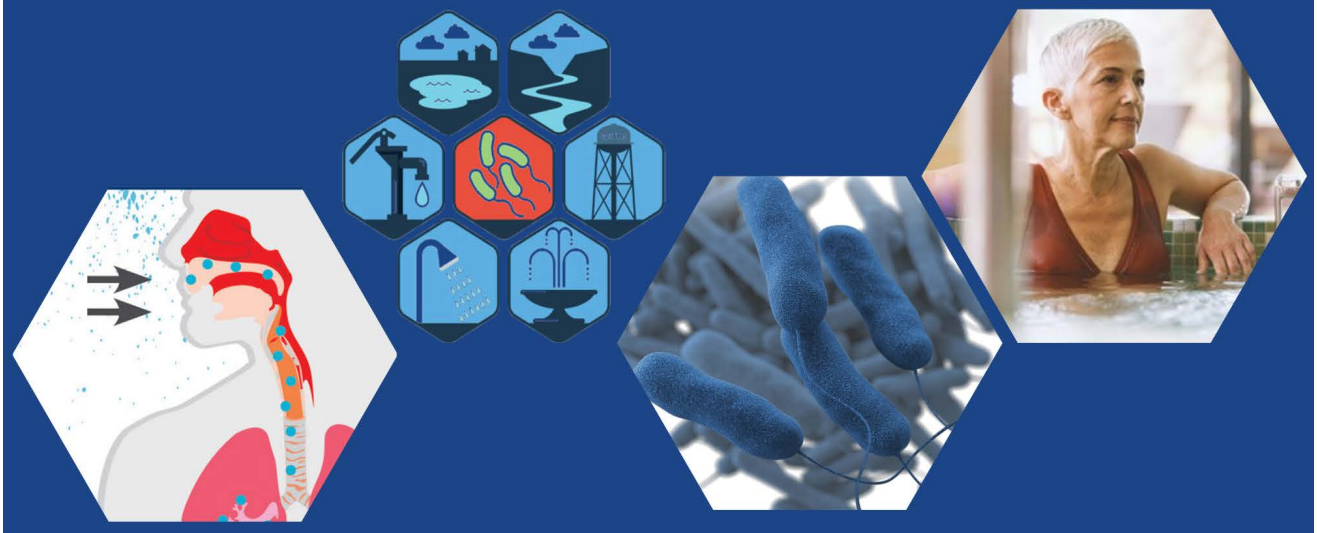

Legionella Outbreak Manual

WEST VIRGINIA
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Health & Human Resources
BUREAU FOR PUBLIC HEALTH

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Introduction

Legionnaires' disease and Pontiac fever outbreaks typically occur when two or more people are exposed to *Legionella* in the same place and get sick around the same time. Outbreaks are commonly associated with buildings or structures that have complex water systems, like hotels and resorts, long-term care facilities, hospitals, and cruise ships. The most likely sources of infection include water used for showering, hot tubs, decorative fountains, and cooling towers (structures that contain water and a fan as part of centralized air-cooling systems for a building or industrial processes).

Legionnaires' disease and Pontiac fever outbreaks can be difficult to identify. Sometimes people travel to a common location, are exposed to *Legionella*, and then return home before becoming sick. State, territorial, and local health departments take the lead in investigating outbreaks. They also identify control measures to remove *Legionella* from the water identified as the source of infection.

Etiology

Bacteria of the genus *Legionella* cause Legionnaires' disease, Pontiac fever, and extrapulmonary infections. There are at least 60 different species of the bacteria and at least 20 of them are known to cause human disease. Although there are many species of the bacteria, the majority of infections are caused by *Legionella pneumophila* with most isolates belonging to serogroup 1.

After *Legionella* grows and multiplies in a building water system, water containing *Legionella* can spread in droplets small enough for people to breathe in. People can get Legionnaires' disease or Pontiac fever when they breathe in small droplets of water in the air that contain the bacteria.

Less commonly, people can get sick by aspiration of drinking water containing *Legionella*. This happens when water accidentally goes into the lungs while drinking. People at increased risk of aspiration include those with swallowing difficulties.

In general, people do not spread Legionnaires' disease and Pontiac fever to other people. However, this may be possible under rare circumstances.

Basic Steps for All Outbreaks

When an outbreak is confirmed or suspected, public health officials will determine if a full investigation is needed. During a full investigation, the following basic steps should be taken (please refer to each type of outbreak for more specific actions related to each setting):

1. The outbreak is called in to the Epidemiologist on call in the West Virginia Department of Health and Human Resources (DHHR), Bureau for Public Health's Office of Epidemiology and Prevention Services (OEPS), an outbreak is opened, and involved entities are notified.
2. A meeting is conducted with all involved entities including the facility, environmental consultant (if applicable), local health, OEPS, and DHHR's Office of Environmental Health Services (OEHS).

3. A *Legionella* Environmental Assessment is conducted with the facility (within 72 hours of notification of the outbreak) and the Legionella Environmental Assessment Form (LEAF) is completed.
4. The LEAF is used to determine the sampling sites, and Environmental Sampling is completed (within one week of notification of the outbreak) using the *Legionella* Sampling Procedure and Potential Sampling Sites (LSPPSS) and samples are sent to a CDC Environmental *Legionella* Isolation Techniques Evaluation Program (ELITE) lab for testing.
5. The facility provides a copy of their Water Management Program to OEHS who assist with the review and potential revision of the document.
6. If any samples come back with positive detections of *Legionella* of any species, remediation begins (for more information, please see Remediation section on page 25).
7. The facility follows remediation and testing guidance provided by the local health department (LHD) and DHHR's Bureau for Public Health (BPH) following initial sampling until the outbreak is closed (details on length of sampling and outbreak closure below).

Local Health Department (LHD) Responsibilities

- As soon as a suspected/confirmed outbreak is discovered, notify the Epidemiologist on call immediately at 304-558-5358 ext 2.
- Notify the facility of the outbreak being opened and determine availability for a call to take place within the next 24 hours.
- Develop a line list for cases associated with the outbreak.
- Assist with collecting information and conducting sampling related to the case patient(s) and environmental sources identified.
- Follow the outbreak through closure, including the environmental sampling follow-up. Provide timely updates to OEPS regarding the progress of the investigation, challenges, needs, etc.

State Health Department Responsibilities

Office of Epidemiology and Prevention Services (OEPS)

- Open an outbreak and notify all involved parties including the Office Director and State Epidemiologist.
- Schedule a call with involved parties including the facility, environmental consultant (if applicable), local health, OEPS, and OEHS.
    - Discussion will include the information available at this time and to answer any questions and to discuss next steps for the investigation including the *Legionella* Environmental Assessment Form (LEAF) and the sampling plan.
- Perform a retrospective review of cases in the West Virginia Electronic Disease Surveillance System (WVEDSS) to identify earlier cases with possible exposures to the same setting or geographic area.
- Request Healthcare-associated Infections and Antimicrobial Resistance (HAI-AR) Infection Preventionist to perform an Infection Control Assessment Response (ICAR) to review a

healthcare facility's infection risks posed by water exposures, review related policies, and to help guide further investigations and educational needs as deemed appropriate.

- Obtain post-mortem specimens, when applicable.
- Work with appropriate parties to identify additional cases (e.g., through retrospective review of medical or laboratory records) and facilitate testing for *Legionella* using both culture of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test.
- Determine how long heightened disease surveillance and environmental sampling should continue to ensure the outbreak is over and communicate expectations to the facility.

Office of Environmental Health Services (OEHS)

- Assist in the evaluation of potential exposure points from the facility potable water system.
- Determine sampling sites in conjunction with the facility based on the *Legionella* Environmental Assessment Form (LEAF).
- Send an OEHS representative onsite to assist with the environmental assessment and sampling.
- Consult with and assist with sampling the potable water system and other water sources located at the facility with facility personnel and/or consultants, if necessary.
- Consider recommendations for restricting water exposures, including installation of Point of Use Filters.
- Make recommendations for remediation of possible environmental source(s), if indicated.
- Work with appropriate parties to review and possibly revise the water management program.
- Review and possibly make recommendations on the water sampling results and other recommendations as a follow up to assess the effectiveness of implemented measures for *Legionella* control.

Laboratory Responsibilities

- Environmental samples should be tested through a CDC ELITE lab.
    - Environmental consultants collecting samples can be sent through the lab they typically work with as long as they are one of the ELITE labs.
    - If sampling is completed by local health in conjunction with OEHS, the samples should be routed to the Office of Laboratory Services (OLS) to send off to an ELITE lab for testing.
- Any clinical samples related to an outbreak that need to be sent to CDC for culturing should be routed through the Office of Laboratory Services. Please contact OLS for approval at (304) 558-3530.
    - Accepted specimens for culture include sputum, bronchial lavage (BAL), bronchial washings, tracheal aspirate, endotracheal tube washes, and fresh lung tissue.
    - For more details on CDC testing and specimen shipping instructions, see CDC's Legionella species Detection and Identification from Clinical Specimens or Isolates.
- Subtype and compare clinical and environmental isolates, if available.

Facility Responsibilities

- Complete the LEAF **within 72 hours** of notification of the outbreak.
- Complete the first round of water and environmental sampling **within one week** of notification of the outbreak following the *Legionella* Sampling Procedure and Potential Sampling Sites (LSPPSS) document.
    - This sampling can be completed by an Environmental Consultant or facility personnel in consultation with the local health department (LHD) in conjunction with OEHS. All samples need to be tested by an ELITE certified laboratory.
- Provide the LHD and BPH with a copy of your facility's Water Management Program (WMP) within one week of notification of the outbreak.
- Follow remediation and testing guidance provided by LHD and BPH following initial sampling until the outbreak is closed.

Environmental Assessment

The purpose of conducting an environmental assessment is to gain a thorough understanding of a facility's building water systems and to assist facility management with minimizing the risk of Legionellosis. The assessment can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to develop a sampling plan. An Environmental Assessment includes visual inspections and monitoring of water quality parameters (e.g., water temperature, pH, residual disinfectant). The Environmental Assessment should be conducted by individuals with experience in environmental health, water management, and/or conducting *Legionella* assessments.

Before arriving on site, the LHD should make the following requests of the facility:

- Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility's water systems, such as facility engineer or industrial hygienist.
- Request that they have maintenance, and cooling tower water treatment logs in addition to plumbing blueprints available for the meeting.
- Bring the following supplies for testing water quality parameters including the following: clear plastic bottle or container, thermometer, pH test kit, and a chlorine test kit that can detect a wide range of residual disinfectant (<1 for potable water and up to 10 ppm for whirlpool spas).
- If the epidemiologic information available suggests a particular source (e.g., whirlpool spa, cooling tower, water feature, etc.) request that they shut it down for use, secure and do not replace the filter or filter media in use for a recreational water facility, secure the blowers/fans from use to prevent transmission, and do not drain or disinfect.

Legionella Environmental Assessment Form (LEAF)

The LEAF is a fillable form to document a facility's water systems, help determine whether to conduct *Legionella* environmental sampling, and, if so, develop a sampling plan. This needs to be completed by the facility within 72 hours of the notification of an outbreak. The LEAF Marking Guide is also available as an instructional resource to complete the LEAF.

For further resources and education on the environmental assessment, please see the following tools and instructional video from the Centers for Disease Control and Prevention (CDC):

Conducting and Interpreting the Environmental Assessment**:** Learn useful tips about conducting an environmental assessment and how to interpret the results of key questions on LEAF

Legionella Environmental Assessment Form (LEAF): Use this fillable form to document a facility's water systems, help determine whether to conduct *Legionella* environmental sampling, and, if so, develop a sampling plan.

Legionella Environmental Assessment Form Marking Guide: Use this instructional resource to complete the *LEAF*, as well as increase awareness of conditions that may promote *Legionella* growth and spread.

Environmental Sampling

Completing an environmental assessment is required before creating a sampling plan. The environmental assessment, epidemiologic information, and plumbing/floor plans should be used to determine whether to conduct *Legionella* environmental sampling in a facility. These documents are also utilized to develop a comprehensive sampling plan.

The following tools and videos were designed by the CDC to assist in developing sampling plans and how to sample:

- Sampling Procedure and Potential Sampling Sites: CDC's protocol for collecting environmental samples for *Legionella* culture during a cluster or outbreak investigation or when cases of disease may be associated with a facility.
- Sample Data Sheet: Use this form to keep track of bulk water and swab samples taken for *Legionella* culture during an investigation.
- How to Make a Sampling Plan: Learn how to choose the number of samples to take and where to take them.
- How to Sample Potable Water: Learn CDC's procedure for collecting potable water samples for *Legionella* culture.
- How to Sample Cooling Towers: Learn the CDC's procedure for collecting environmental samples from a cooling tower.
- How to Sample Spas and Fountains: Learn CDC's procedure for collecting environmental samples from spas (hot tubs) and decorative fountains.

List of Potential Sampling Sites

Site	Appropriate number of samples	Type of samples

Potable Water		
Incoming water main (where water enters the facility/campus/building from the municipality)	1	1L bulk water
Every well and water tower that supplies water to the facility/campus/building	1 per well or water tower	1L bulk water
Every holding tank or cistern	1 per holding tank/cistern	1L bulk water
Centralized water heater	1	1L bulk water (a biofilm swab if drained)
Expansion Tank for hot water (absorbs excess water pressure caused by thermal expansion within the hot water heater)	1	1L bulk water
Hot and cold water returns	1 each for hot and cold	1L bulk water
For buildings with water softeners, special filters and disinfections systems, sample water before and/or after these processes		1L bulk water
Shower	2 per shower	1 biofilm swab and 1L bulk water
Faucet	2 or 3 per faucet	1 biofilm swab inside the faucet, 1 biofilm swab of the of the inside of the aerator if visual inspection indicates it's overgrown with biofilm, 1L Bulk Water
Whirlpool baths (i.e., Jacuzzis)	1	1 biofilm swab inside the jets
Ice machines	2 - 4	1 bulk water ice sample collected in two one-liter bottles (equals one liter when melted), 1 bulk water sample from water dispenser (if equipped with one), 1 biofilm swab from ice discharge opening or

		the edges of the ice make tray, 1 biofilm swab of the water dispenser discharge tube
Hot Tubs		
Water in the tub	1	1L bulk water
Biofilm at the water line	2	Biofilm swabs (the quantity depends on the size of the tub)
Water jets	2	1L bulk water
Filter	1 per/filter	1L bulk water with a combination of water and filter material (sand in sand filters, diatom powder in DE filters or polyester filter media in cartridge filters) to keep the filter material moist during transport
Compensation Tank	1	1L bulk water
Cooling Towers		
Make-up water (water added to replace water loss because of evaporation, drift, or leakage)	1	1L bulk water
Collection basin (an area below the tower where cooled water is collected and directed to the sump)	2	1L bulk water and a biofilm swab at the waterline
Storage tank or reservoir in the system	1	1L bulk water
Drift Eliminators or other surfaces that remain moist	1	1L bulk water
Heat sources (e.g., chillers)	1	1L bulk water
Other Sources		
Decorative fountains	2	1L bulk water and a biofilm swab (number of swabs dependent on size and complexity of the fixture)
Sprinkler systems	>2	1L bulk water and one or several biofilm swab(s) of

		the sprinkler jets
Safety showers and eyewash stations	2	1L bulk water and a biofilm swab
Humidifiers	2	Bulk water (as close to 1L as possible) and at least one biofilm swab of moist surface
Nebulizers, hand-powered resuscitation bags, intermittent positive pressure breathing ventilators, and other respiratory care equipment that uses water for filling or cleaning	>2	1L bulk water used to clean the device and biofilm swabs of moist surfaces

All showers and faucets in all case rooms should be sampled with biofilm swabs in addition to both first draw and post-flush 1-Liter bulk water samples. Similarly, it is important to sample showers and sink faucets in additional rooms that are proximal, medial, and distal to risers or hot water heaters. These samples should include point-of-use devices (especially showers) on various floors based on environmental assessment findings. Ideally, a sample will be collected at point-of-use outlets on every floor and/or building wing.

Sampling Supplies

- Sterile plastic 1L bottles (glass bottles are not recommended due to the risk of breakage during transport).
- Sterile plastic 15 mL screw top tubes (with a tube rack) for biofilm swabs.
- Disposable Dacron/polypropylene-tipped swabs with wooden or plastic stems. Do NOT use cotton-tipped swabs as they inhibit *Legionella* growth.
- Labels.
- 0.1N solution of sodium thiosulfate (Na2S2O3) (15.81 g/L in distilled water. Replace every 12 months) OLS will prepare sampling supplies with sodium thiosulfate if their supplies are used during an investigation.
- Pipettes and bulbs for adding 0.5 mL of 0.1N sodium thiosulfate solution into 1L samples.
- Sterile plastic 500 mL or 1 L bottle for testing chlorine level, pH and temperature.
- pH test kit.
- Chlorine test kit sensitive enough to detect chlorine level from 0-10 ppm (may need two kits). Free chlorine may be measured when it is known that chlorine is the method of disinfection (as opposed to monochloramine, bromine, or another disinfectant). Otherwise, measure total chlorine.
- Thermometer.
- Sample data sheets and pens.

- Large cooler, preferably with wheels. A 70 quart (66.2 L) horizontal cooler (a standard large picnic cooler) should fit twenty-five 1 L bottles, twenty-five 15 mL plastic tubes for biofilm swabs, thermometer, pH and chlorine test kits. For sampling of a larger facility (60-100 samples total), a second cooler that holds nothing but bottles, swabs and tubes may be needed. The cooler may be packed ahead of time and stored at ambient temperature for an unlimited time if the sodium thiosulfate solution is replaced every twelve months.

Environmental Sampling Procedures

Perform an Environmental Assessment and create a sampling plan before collecting samples.

Sampling Hot and Cold Potable Water at the Points of Use

1. Swab sampling of showers/faucets

   When sampling showers with a swab remove shower heads, then turn on hot or cold water for a couple seconds to moisten the interior of the pipe. Collect 3-5ml of the first flush in a sterile plastic tube, then turn off the water. Insert a sterile swab deep into the shower pipe and swab around various surfaces inside the pipe (careful not to break the swab stick). Also swab the inside of the shower head if it has visible biofilm growth. Place the swab in the plastic tube with the first flush water and snap off (cut if necessary) the swab stick about one inch from the top of the tube, make sure there is enough water to cover the swab during transportation. Then add .1 ml normal sodium thiosulfate solution (to neutralize residual disinfectants), install tube cap, and label the tube with a unique identifier. Place the tube in a cooler for storage and transportation, then record the sample on the Sample Data Sheet.

   These same steps can be taken to collect a swab sample from a faucet by removing the faucet aerator.

2. Bulk water pre-flush sampling of water (hot or cold water)

   Collecting a pre-flush 1-liter bulk water samples of hot water lines turn on and immediately collect the water into the sterile 1-liter plastic sample bottle. Add .5 ml normal sodium thiosulfate solution to neutralize the residual disinfectant, and then cap the bottle. Label the bottle with a unique identifier, record the type and location of the sample on the sample data sheet then place the bottle into the cooler for storage and transportation.

3. Bulk water post-flush sampling of water (hot or cold water)

   When collecting a post-flush 1-liter bulk water sample of hot water, turn on the water and run until warm (a couple minutes). The goal is to collect water currently in the distribution system along with any material shed from the biofilm. Collect 1-liter of this water into a sterile plastic sample bottle, leaving one inch of space at the top of the bottle, then add .5 ml Normal Sodium Thiosulfate solution to neutralize the residual disinfectant, and cap the bottle. Label the bottle with a unique identifier, record the type and location of the sample on the sample data sheet then place the bottle into the cooler for storage and transportation.

   Measure hot water parameters in conjunction with each environmental sample collected. (See Measuring Hot Water Parameters below.

Sampling Potable Water at the Hot Water Heaters

1. Collect 1-liter bulk water samples. Fill a sterile 1-liter bottle from the hot water heater/tank drain valve leaving one inch of space at the top of the bottle. Add .5 ml Normal Sodium Thiosulfate solution to neutralize the residual disinfectant, and then cap the bottle. Label the bottle with a unique identifier and place it in the cooler for storage and transportation.

2. Measure Hot Water Parameters in Hot Water Heater & Water Storage Tanks

   Use a 1-liter bottle for all sample locations. Run the water until it is as hot as it will get then collect water in the bottle and perform the following:

   - Measure temperature
   - Measure pH with color indicator strips or a digital pH meter
   - Measure total chlorine residual

   For tankless water heaters samples need to be taken from a pipe as near as possible to the heater outlet.

   For a building with a recirculating hot water piping system, the hot water pipe sample should be taken as the water returns to the hot water storage/heater tank.

3. Measure Hot Water Parameters

   Use a 1-liter bottle for all sample locations. Run the water until it is as hot as it will get then collect some water in the bottle and perform the following:

   - Measure temperature
   - Measure pH with color indicator strips or a digital pH meter
   - Measure total chlorine residual

   Label the bottle with a unique identifier and place it in the cooler for storage and transportation.

4. Measure Cold Water Parameters

   Use the same bottle used for hot water parameter testing and perform tests for the same parameters. Record the results on the data sheet.

Sampling Hot Tubs

1. Secure Hot Tub

   Call ahead and instruct the facility to turn off the spa (i.e., blowers or jets) but DO NOT drain or shut off the pumps or the heater for the spa. This will limit the risk of aerosolization and exposure to the hot tub but allow samples to be collected in normal operating conditions. Instruct the facility to close off the spa to the public (i.e., out of service tape) and post visible signs stating that the spa is out of order. When aerosol producing devices cannot be secure, wear half face respirators equipped with N95 filters. Follow OSHA standard 29 CFR 1910.134.

2. Bulk Water Sample Collection

   Fill a sterile one-liter bottle to within 1" of the top with water from the spa and add .5 ml of sodium thiosulfate to sample. Label the bottle with a unique identifier and place it in the cooler with ice packs.

   If the spa is partially drained, a 15 ml swab tube may be used to collect remaining water. If the spa has been completely drained, ask facilities maintenance for access to the compensation tank for collection of overflow water and take a bulk water sample. Then add .5 ml of Sodium Thiosulfate to sample, cap, label with unique identifier, and place in the cooler.

3. Biofilm Swab Collection

   Collect several swabs from the jets and at the waterline of the spa in addition to a bulk water sample from the spa. Collect 3-5 ml of water from the spa into a 15 ml sterile plastic tube and place each individual swab into a sterile tube with .1N Sodium Thiosulfate (one drop), cap tube, label tube with unique identifier, record on data sheet, and place in cooler for transportation to the lab. Repeat for all swab samples.

   Helpful tip: When completing the Sample Data Sheet, draw a diagram of the hot tub on the back with locations of jet and waterline samples. This will facilitate consistent sampling if a repeat sampling event is warranted.

4. Filter Media Sample Collection

   Facilities maintenance personnel should provide access to equipment room(s) and open any filter assemblies. Collection of a sample from the filter assembly is very important. Gloves should be worn due to the high organic load and the abrasive or caustic nature of some filter media. Ask the facilities' maintenance personnel to open the filter assemblies for inspection and sampling.

   The three types of filters likely to be encountered:

   a. Sand - Collect sand and enough water to cover it in a 1-liter bottle.
   b. Cartridge - Cut some filter material, place in a test tube 1-liter bottle with enough water to cover it.
   c. Diatomaceous earth - Collect water from a filter chamber into a sterile one-liter bottle, use a sterile swab to scrape diatomaceous powder from the grid. Be sure the powder is covered by at least 1" of water.

   With each sample add .5 ml of 0.1N Sodium Thiosulfate, cover, label with a unique identifier and place in cooler.

5. Water Parameters Collection

   Collect water in a separate plastic bottle that is not being utilized for *Legionella* bacteria sample collection, and measure temperature, pH, residual biocide, and temperature. Spa's may use bromine as a biocide instead of chlorine. Log this important information on the Sample Data Sheet. If the residual biocide levels exceed the maximum limit of the test kit, perform serial dilutions to bring the sample within the test kit's range. If there is a very small amount of

disinfectant in the water, use the potable water test kit as its test range is much lower. Record all data on the sample data sheet. Remember it is possible for a hot tub to pass a routine environmental health inspection yet still harbor *Legionella*.

Sampling Cooling Towers

1. Secure Cooling Tower Fans
    a. If it is not possible to secure the fans, then attending personnel should don NIOSH N95 respirator filter masks.
    b. Use of some form of waterproof glove should also be considered.

2. Bulk Water Sample Collection

    Collect a 1-liter water sample from the cooling tower basin. This sample should be collected as far away from the cooling tower make-up water discharge line as possible, and preferably with the condenser or circulating pump in operation. Add 0.5 mL of a 0.1N sodium thiosulfate solution to the bulk water sample, put a lid securely on the bottle, label the bottle with a unique identifier, record the sample and unique identifier on the sample data sheet and place the bottle in a cooler with ice packs for storage/transportation to the lab.

3. Biofilm Swab

    Collection of biofilm samples should occur at various locations throughout the cooling tower. These are locations to consider when collecting biofilm swab samples:
    a. Basin waterline
    b. Tower fill
    c. Drift eliminators
    d. Tribution tray and associated nozzles

    Run swabs firmly along the wetted surfaces and collect 3-5 mL of associated cooling tower water in the 15 mL tube, place the swab into the tube with water and snap off the tip of the swab into the tube about one inch from the top of the tube. Add a drop of 0.1N sodium thiosulfate to water in the tube and cap the tube. Label the tube with a unique identifier, log the sample and its associated identifier on the sample data log sheet and place it in the tube rack of the cooler. The water will keep the swab tip moist during storage and transportation to the lab for culturing.

Water Parameter Collection

Collection of cooling tower environmental parameters should include biocide residual (either in ppm or ORP mV), pH and temperature. The ORP mV readings would be taken from the cooling tower biocide controller.

To perform these tests, collect basin water in a separate 1-liter bulk sample bottle that is not being utilized for *Legionella* bacteria sample collection, making sure to collect the water as far away as possible from the make-up water discharge into the cooling tower basin. Perform tests and record the data on the Sample Data Sheet.

Sampling Decorative Fountains

1. Secure Fountain Operation

   Call the facility ahead of visit and ask to have the fountain secured from operation to minimize the risk of exposure to aerosolized water being generated. Clearly state that the fountain should not be drained, nor should any remediation practices be conducted like chemical shocking or draining of the fountain water.

2. Bulk Water Sample Collection

   Fill a sterile 1-liter bottle with fountain water to within an 1" of the top of the bottle and add .5 ml of sodium thiosulfate to sample. If the fountain was partially drained, a 15 ml swab tube may be used to collect any remaining water. If the fountain has been completely drained, ask facilities maintenance for access to the compensation tank or filter assembly for collection of water and take a bulk water sample at that location. If it is possible, always collect bulk water or swab filter samples. Then add .5 ml of sodium thiosulfate to sample, cap, label with unique identifier, and place in the cooler.

3. Biofilm Swab Collection

   Collect several swabs at the waterline of the fountain in addition to the bulk water sample. Collect 3-5 ml of water from the fountain in a 15 ml sterile plastic tube and place each individual swab into that sterile tube with 0.1N sodium thiosulfate (one drop), cap tube, label tube with unique identifier, record on data sheet, and place in cooler for transportation to the lab. Repeat for all swab samples.

4. Water Parameter Collection

   Collect water in a separate plastic bottle that is not being utilized for *Legionella* bacteria sample collection, and measure temperature, pH, residual biocide and temperature. Fountains may use bromine as a biocide instead of chlorine. Log this important information on the data sheet. If the residual biocide levels exceed the maximum limit of the test kit, perform serial dilutions to bring the sample within the test kit's range. If there is a very small amount of disinfectant in the water, use the potable water test kit as its test range is much lower. Record all data on the Sample Data Sheet.

Special Considerations for Possible Sources of Exposure

Potable Water

- Potable water is a common source for *Legionella* outbreaks. Potable water outbreaks are typically less “explosive” than outbreaks associated with cooling towers. However, without remediation, building water systems colonized with *Legionella* may cause disease over years before a problem is recognized.
- Potable water can come from either a public utility or from a private source. The U.S. Environmental Protection Agency (EPA) regulates public water quality and requires a minimum amount of disinfectant to be present (i.e., disinfectant residual). Building owners are responsible

for maintaining the quality of the water once it enters the building water system(s). However, buildings that have their own disinfection systems may also be subject to EPA and/or state regulations. Water quality, including disinfectant level, can drop as water travels through building water systems. Residual disinfectant supplied by the public utility is lost as organic matter consumes it, it naturally off-gasses, and as water ages. Heating the water speeds up loss of residual disinfectant in pipes or fixtures.

- Treatment plants sometimes switch from one type of disinfectant to another, based on seasonal changes, or one-time changes in treatment methods. These changes can affect *Legionella* growth.
- Showerheads are only one possible source of potable water exposure. Spending time near sink faucets and aspiration of drinking water or ice chips are possible routes of transmission, particularly among immunocompromised patients.

Cooling Towers

- A cooling tower is a structure that contains water and a fan as a part of a centralized air-cooling system for a building or industrial processes. Cooling towers remove unwanted heat from the system by exposing heated water to cooler air. In contrast, home air conditioning units do not use water to cool, so they do not aerosolize water and are not a risk for *Legionella* growth and spread.
- In areas with many buildings, identifying all cooling towers can be challenging. However, some areas are starting to require registration of cooling towers to track their locations. Using Geospatial Information Systems (GIS) technology may be useful for aerial cooling tower identification. Sometimes certain entities, such as water utility companies, may provide permits for cooling towers and have location information.
- Some cooling towers are located on the ground or on sides of buildings and may be difficult to see from aerial photography. A physical assessment, street view imagery, or checking with building owners and managers is necessary in some circumstances. Learn about Procedures for Identifying Cooling Towers.
- If you implicate a cooling tower as a possible source of exposure, ensure that it has been shut down, but not drained or hyperchlorinated, before sampling.

Hot Tubs and Pools

- Being in or near a hot tub or hydrotherapy tub while it is turned on is a possible exposure risk because of the ability to aerosolize water containing *Legionella*.
- If you implicate a hot tub as a possible source of exposure, ensure that it has been turned off, but not drained, before sampling.
- *Legionella* are unlikely to grow in typical swimming pools because water temperatures are usually too cold. However, you should sample pools if they are associated with a possible exposure or temperatures are within the permissive range (i.e., 77–113°F).

Decorative Fountains

- Decorative fountains are a possible exposure source for *Legionella*, particularly in enclosed spaces.
- Submerged lighting and warm ambient temperatures in fountains can contribute to *Legionella* growth.
- If you implicate a fountain as a possible source of exposure, ensure that it has been turned off, but not drained, before sampling.

Clinical Specimen Collection

The preferred diagnostic tests for Legionnaires' disease are culture of lower respiratory secretions (e.g., sputum, bronchoalveolar lavage) on media that supports growth of *Legionella* paired with the *Legionella* urinary antigen test.

- Isolation of *Legionella* by culture is important for detection of all species and serogroups of *Legionella*. In contrast, the urinary antigen test only detects *Legionella pneumophila* serogroup 1.
- Culture also allows for comparison of clinical and environmental isolates during an outbreak investigation.
- Best practice is to obtain both lower respiratory culture and the urinary antigen test concurrently.
- You should ideally obtain lower respiratory culture prior to antibiotic administration. However, antibiotic treatment should not be delayed to facilitate this process (and culture can be attempted even after antibiotic therapy has been initiated).
- The urinary antigen test can detect Legionnaires' disease in some cases for days to weeks (or longer, under rare circumstances) after treatment.
- Laboratories sometimes reject lower respiratory specimens during a work-up for pneumonia based on specimen quality (e.g., due to lack of white blood cells in the sample, contamination with other bacteria). However, laboratories should *not* reject lower respiratory specimens for these reasons when working-up Legionnaires' disease because *Legionella* can often be recovered.
    - Sputum produced by patients with Legionnaires' disease may not have many white blood cells.
    - Contaminating bacteria does not negatively impact isolation of *Legionella* on selective media (e.g., Buffered Charcoal Yeast Extract [BCYE] agar plus antibiotics).

Healthcare-associated Outbreaks

Background

A patient's exposure to healthcare settings during the 14 days before the date of symptom onset is an important consideration when identifying the source of potential Legionnaires' disease outbreaks.

Healthcare facilities often have large, complex building water systems. They frequently undergo construction and plumbing changes. They often have aerosol-producing devices, like cooling towers, decorative fountains, and other devices unique to healthcare facilities (e.g., respiratory therapy equipment, hydrotherapy tubs, heater-cooler units), and other fixtures that may grow or spread *Legionella* (e.g., ice machines). Patients in these settings often have risk factors for Legionnaires' disease, such as advanced age, weakened immune systems, and chronic medical conditions.

Facilities

For Legionnaires' disease surveillance, CDC defines a healthcare facility as a hospital, long-term care facility, or clinic. Other healthcare facilities include associated sites such as pharmacies and outpatient laboratories. This healthcare definition does not include assisted living facilities, senior living facilities, prisons, or group homes (for these types of facilities, please follow steps for a Community-associated Outbreak).

CDC tracks the type of healthcare exposure (inpatient, outpatient, visitor or volunteer, employee) and the healthcare facility setting. Healthcare facility setting categories are as follows:

Hospitals	Long-term care facilities	Clinics
• Acute care hospitals (general or specialty) • Long-term acute care hospitals • Children's hospitals • Psychiatric hospitals	• Skilled nursing facilities • Nursing homes • Inpatient hospice • Rehabilitation hospitals • Psychiatric residential treatment facilities	• Outpatient clinics general and specialty • Ambulatory (same day) surgery centers • Outpatient rehabilitation clinics • Dialysis centers • Dental clinics

Definition of Healthcare Associated Case

Patients who meet clinical and laboratory criteria for confirmed Legionnaires' disease are further classified based on the duration of healthcare exposure:

- Presumptive healthcare-associated Legionnaires' disease: A case with ≥10 days of continuous stay at a healthcare facility during the 14 days before onset of symptoms.
- Possible healthcare-associated Legionnaires' disease: A case that spent a portion of the 14 days before date of symptom onset in one or more healthcare facilities but does not meet the criteria for presumptive healthcare-associated Legionnaires' disease.

Outpatient Exposure

Public health officials should consider patients with outpatient-only exposures as possible healthcare-associated cases. These patients could have acquired the infection at a healthcare

facility, but they also had other possible sources of exposure during the 14 days before the date of symptom onset.

Visitor and Employee Exposure

Public health officials should consider visitors to and employees at healthcare facilities during the 14 days before date of symptom onset as possible healthcare-associated cases.

Healthcare-associated Outbreak Definition

Conduct a full investigation if:

- ≥1 case of presumptive healthcare-associated Legionnaires' disease at any time.
- ≥2 cases of possible healthcare-associated Legionnaires' disease within 12 months of each other.

Specific Activities

How health department investigators respond to healthcare-associated cases and outbreaks of Legionnaires' disease depends on several factors. These factors include (but are not limited to):

- Type and size of the healthcare facility
- Existing capacity of the facility and health department
- Number of cases
- Water management program performance
- Routine environmental sampling results

Public health officials should work closely with healthcare facility staff at each step in the process. The appropriate healthcare facility point of contact (e.g., administrator, infection preventionist, clinician, quality assurance representative, facility manager or engineer) may vary, depending upon the step.

If public health officials determine a full investigation is needed, in addition to the basic steps listed above, they should:

- Develop a line list of possible and definite cases associated with the healthcare facility in the past year.
- Work with healthcare facility staff to identify all new and recent patients with healthcare-associated pneumonia and test them for *Legionella* using both culture of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test.

Conducting Additional Case Finding

Looking for patients with Legionnaires' disease with healthcare exposures is an important part of a healthcare-associated Legionnaires' disease outbreak investigation. To find cases, investigators should:

- Determine if the facility routinely conducts surveillance for healthcare-associated pneumonia and if the facility tests any identified patients for *Legionella*. If so, what tests does the facility use?
- Perform a retrospective chart review of patients for the past 12 months to identify pneumonia cases that could have been healthcare-associated. If additional cases are identified, determine if patients were tested for *Legionella*.
- Review facility laboratory records for all *Legionella* testing and any positive results. Consider also reviewing laboratory records for other healthcare facilities in the same catchment area, especially for patients recently discharged from the healthcare facility of concern.

CDC's Line List Template is a helpful tool to summarize case demographic, clinical, and exposure information specific to a healthcare-associated outbreak. The CDC Legionnaires' Disease Medical Record Abstraction Form Template may also assist with record review for healthcare facility investigations.

Conducting Active Clinical Surveillance

Active clinical surveillance is a period of enhanced surveillance during which healthcare facility staff proactively and systematically identify patients with healthcare-associated pneumonia (pneumonia with onset ≥48 hours after admission). During this time, they also ensure that clinicians perform *Legionella*-specific testing for each of those patients. It is crucial for detecting additional cases of healthcare-associated Legionnaires' disease in a healthcare facility.

Options for identifying patients with healthcare-associated pneumonia diagnoses could include:

- Daily review of chest radiographs and CT scans ordered to diagnose pneumonia.
- Daily review of new pneumonia diagnoses occurring in patients in intensive care units.
- Daily review of laboratory testing ordered to diagnose pneumonia (e.g., sputum Gram stain and culture).

Once cases of healthcare-associated pneumonia are identified, healthcare facility staff should perform *Legionella* testing. *Legionella* testing includes using both culture of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test. Healthcare facilities should retain clinical specimens for the duration of the investigation.

During a full investigation, public health officials should:

- Review the healthcare facility's protocol for active clinical surveillance (or work with healthcare facility staff to create one).
- Coordinate submission of clinical specimens for additional testing, as indicated.
- Coordinate submission of post-mortem tissue specimens to pathology and/or microbiology for *Legionella* testing, as indicated.
- Specify that laboratories performing *Legionella* urinary antigen tests should have a rapid turnaround time (within ~48 hours).

Timeframe for active clinical surveillance

Once initiated, active clinical surveillance should continue for at least 2 months, as described in the Healthcare Infection Control Practices Advisory Committee (HICPAC) guidance. Many public health jurisdictions will recommend active clinical surveillance for up to 6 months or longer, depending upon factors such as identification of additional cases or concerns regarding performance of the water management program.

Water Restrictions and Control Measures for Healthcare-associated Outbreaks

If the Local Health Department (LHD) believes a healthcare facility's internal potable water system is a source of *Legionella* transmission, implementation of water restrictions and/or installation of 0.2µm (micron) point-of-use (POU) filters by the facility should be considered immediately. Water control measures should take into consideration the structural characteristics of the building. Water restrictions and point-of-use filters do not remove the need for remediation actions to address the growth and amplification of *Legionella* bacteria in a facility's building water systems.

Examples of Water Restrictions and Control Measures

- Restrict the use of showers and whirlpools tubs/hot tubs (use sponge baths).
- Bottled water restrictions for individuals with swallowing difficulty—including no ice from ice machines.
- Remove aerators from sink faucets or avoid use of water from sink faucets to avoid creating aerosols.
- For immunocompromised patients, using sterile water for tooth brushing, drinking, and flushing feeding tubes; for other susceptible patients, using bottled water.
- For patients with swallowing difficulties, restrict the use of ice machines and non-sterile ice consumption.
- Confirm that contingency responses and corrective actions are implemented according to the facility's water management program.
- Shut down decorative fountains or other sources of aerosolization.
- Install 0.2µ POU water filters and replace them according to the manufacturer's recommendations.

Note: In healthcare settings, sterile water should be used to fill reservoirs of respiratory equipment intended for nebulization/aerosolization under all circumstances (not just during an outbreak).

Travel-associated Outbreaks

Background

Approximately 10% of all reported cases of Legionnaires' disease in the United States occur in people who have traveled during the 10 days before symptom onset. Travelers who are >50 years old, are current or former smokers, have chronic lung conditions, or are immunocompromised are at increased risk for infection when exposed to aerosolized water containing *Legionella* species. Patients with Legionnaires' disease often do not recall specific water exposures because exposure frequently occurs during normal activities. Travel-associated Legionnaires' disease outbreaks can occur:

- On cruise ships
- In hotels (or shared vacation properties such as Airbnb or VRBO rentals)
- In or near a hot tub
- At resorts
- Standing near a decorative fountain
- Touring in cities with buildings that have cooling towers

Travel-associated Outbreak Definition

CDC defines travel-associated outbreaks as two or more Legionnaires' disease cases associated with the same travel accommodation in a 12-month period.

Conduct a full investigation if:
You have identified two or more cases of Legionnaires' disease or Pontiac fever in people who:

- Stayed overnight in the same accommodation during the exposure period for Legionnaires' disease (14 days before date of symptom onset) or Pontiac fever (typically 24–72 hours before date of symptom onset), **AND**
- Had symptom onsets within 12 months of each other.

Specific Activities

Obtain a Detailed Exposure History and Identify Patterns:

- Ensure that you have obtained as detailed of an exposure history as possible for each case from the patient or a proxy. Capture this information on the Legionellosis Case Report Form.
- Use the CDC Line List Template to track the outbreak and summarize case demographic, clinical, and exposure information.

Conduct additional case finding for travel-associated cases:

- The Food and Waterborne Disease Epidemiologist will notify CDC of the outbreak via travellegionella@cdc.gov. CDC staff can search the Supplemental Legionnaires' Disease Surveillance System (SLDSS) for additional cases among people who reported staying at the accommodation during their exposure periods.
- The Food and Waterborne Disease Epidemiologist will submit an Epi-X call for cases to alert other states and request that they immediately report any additional cases associated with the accommodation to the investigating state, territorial, or local health department.

Communicate with travel accommodation owners/managers:

- Notify the accommodation manager or owner about the outbreak. Ask management whether they are aware of any guests or employees who have reported Legionnaires' disease symptoms or illness. Ask management to report any consistent illnesses to the health department.

- Depending upon the circumstances, consider notifying incoming guests and staff about possible exposure to *Legionella* and symptoms of Legionnaires' disease and Pontiac fever. Encourage them to speak with their physician if they develop symptoms.
- If the cases were recent, request a guest list for the prior investigation time period. Consider notifying past guests of their possible exposure to *Legionella* if they may still be within the exposure period or recently developed illness, as it may prompt them to seek care earlier if they experience symptoms.
- Review employee absentee data and/or employee clinic records to obtain information about clinically compatible illnesses among staff.
- Water sample collection should be encouraged for pools and hot tubs with exposure source indication. Sampling should be done *before* disinfecting and sanitizing. Detailed information on how to perform water sampling is discussed previously in the Environmental Sampling section.
- Encourage property owners and managers to establish or improve their cleaning and maintenance log for pools, hot tubs, and air conditioning systems.
- Discuss and ensure proper disinfecting procedures for their housekeeping staff or cleaning company for pools and hot tubs to prevent future cases (for both hotels and/or shared vacation properties such as Airbnb or VRBO rentals). Educational resources on cleaning can be found here through the CDC.

Community-associated Outbreaks

Background

Community outbreaks of legionellosis have been linked to decorative fountains, humidifiers, respiratory therapy devices, and misters (such as those found in the produce section of grocery stores), and most often cooling towers. While cooling towers are a common source of Legionnaires' disease outbreaks, outbreaks in correctional settings are rare and have not been reported in detail.

Community-associated Outbreak Definition

CDC defines community-associated outbreaks as an increase in Legionnaires' disease cases in a certain geographic area beyond what one would normally expect for the same time and place.

Conduct a full investigation if:

- You have identified one or more cases of Legionnaires' disease at a correctional facility or other facility where people cannot leave the premises (and therefore spent the entire exposure period there). In general, you should treat outbreaks of Legionnaires' disease at such facilities with the same considerations as healthcare-associated outbreaks.

Consider conducting a full investigation if:

- You have analyzed available data and found an increase in Legionnaires' disease in a certain geographic area (e.g., comparing 5-year average rate of Legionnaires' disease to the current incidence).

- Data can be used from various resources including interviews with suspected or confirmed cases, review of surveillance data, illness complaint systems, syndromic surveillance, increased absentee reports, increased calls to poison control centers, and passive surveillance from healthcare providers.

If epidemiologic evidence is not strong enough to warrant environmental sampling, consider conducting at least an environmental assessment to help determine if conditions for *Legionella* growth exist where cases may have been exposed.

Specific Activities

Obtain a detailed exposure history and identify patterns:

- Since *Legionella* is reportable in West Virginia, an initial interview should be conducted using the CDC extended case report form. Sometimes a second interview can be helpful based on new information that you have gathered during the course of the outbreak investigation. Ensure that you have obtained as detailed of an exposure history as possible for each case from the patient or a proxy.
- Use the CDC Line List Template to track the outbreak and summarize case demographic, clinical, and exposure information.

Conduct additional case finding for community-associated cases:

- Interview additional cases of *Legionella* to look for common exposures.
- Work with DIDE to notify local clinical laboratories and healthcare providers for additional case finding. Consider issuing a health advisory notification [HAN] and provide guidance for appropriate diagnostic testing and encourage retention of clinical *Legionella* isolates.

Other Considerations:

- Map all patient residences and sites for daily activities (e.g., work, shopping, destinations, home address).
- Contact the local water authority to determine changes that could have contributed to *Legionella* growth (e.g., modifications to potable water disinfection, water main breaks, major construction activity, water service interruptions).
- Consider cooling towers as a possible source if cases are tightly clustered in time and neighborhood but patients lack common potable water exposures. See Procedures for Identifying Cooling Towers for more information.

Remediation

Before remediation is conducted, request a copy of the remediation plan from the consultant or facility for review. Remediation options can include:

- Hyperchlorination
- Flushing the potable water system and unused plumbing outlets
- Draining and scrubbing devices

- Consider removing aerosolizing devices that are not necessary for the function of the facility (e.g., decorative fountains, waterfalls, hot tubs)
- Targeted disinfection for hot tubs, decorative fountains, and cooling towers

Post-Remediation Environmental Sampling

Sampling may be conducted by a facility's hired consultant, the LHD or OEHS. If remediation is necessary, the facility must hire a consultant with *Legionella*-specific environmental expertise to help make decisions about and/or perform remediation. Please refer to the CDC's Considerations When Working with *Legionella* Consultants for choosing a consultant with the proper expertise.

Recommendations regarding the frequency of environmental sampling and parameter testing after an outbreak include sampling every two weeks for the first three months post remediation. If no cases are identified and no positive samples are cultured during the three-month time frame the sampling frequency can be extended to once a month for another three-month time frame. Again, if no further cases are identified and no further positive samples are cultured during this three-month time frame the facility can fall back to the sampling frequency outlined in their water management program.

If at any time during the previously described six-month enhanced sampling schedule a new case is identified, or a sample culture is positive for *Legionella*, the six-month clock begins again after repeat remediation efforts are completed.

Potable Water Systems

Potable water, which is also known as drinking water, comes from surface and ground sources and is treated in a way that meets state and federal standards for consumption. If the presence of *Legionella* is confirmed in the potable water system in the presence of an outbreak, the following remediation steps should be taken. Choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Consult with a water treatment professional as certain procedures should only be undertaken by a professional. Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.

- Chemical shock using an elevated level of a disinfectant, such as chlorine, for a limited duration can control *Legionella* in a potable water system. Consult scientific evidence and technical expertise before choosing a specific chemical shock procedure. In addition:
    - Consider which components of the water system need remediation.
    - Chemical shock of a hot water system may have improved efficacy if the temperature is lowered.
    - Chemical shock options may be impacted by regulations (e.g., chemicals allowed into sewer discharge) and may require permitting.
- Thermal shock of water systems is not recommended due to frequent failure and rapid recolonization of *Legionella*.

Legionella Control Measures for Potable Water Systems

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	● Flush after an intrusion event (e.g., water main break). ● Clean and maintain water system components such as water heaters, mixing valves, aerators, showerheads, hoses, and filters regularly as indicated by water quality measurements.
Temperature	Control limits	● Store hot water above 140°F (60°C) and maintain circulating hot water above 120°F (49°C). ● Store and maintain circulating cold water below the growth range most favorable to *Legionella* (77–113°F, 25–45°C). Note that *Legionella* may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing	● Flush low-flow pipe runs and dead legs at least weekly. ● Flush infrequently used fixtures regularly.
Disinfectant Residual*	Control limits	● Chlorine: Detectable residual as directed by WMP. ● Monochloramine: Detectable residual as directed by WMP.

* Disinfectant residual recommendations apply to disinfectants delivered by the municipal water authority. Supplemental disinfection system control limits are not prescribed here and must be dictated by the water treatment professional and water management program.

Hot Tubs

Hot tubs that contain *Legionella* bacteria can cause outbreaks of disease. It is critical to collect water samples, then disinfect hot tubs linked to cases of Legionnaires' disease or Pontiac fever.

1. Drain all water from the hot tub. Dispose of the water to waste or as directed by the local regulatory authority.
2. Vigorously scrub all hot tub surfaces, skimming devices, and circulation components. Use water with free chlorine at a minimum concentration of 5 parts per million (ppm) to remove any biofilm (slime). After scrubbing, rinse the tub with clean water and flush to waste.

3. Replace filters (for cartridge or diatomaceous earth filters) or filter media (for sand filters). Bag these and dispose of them as normal solid waste.
4. Make any needed repairs. Inspect the hot tub thoroughly for any broken or poorly functioning components such as valves, sensors, tubing, or disinfectant feeders.
5. Refill and hyperchlorinated using 20 ppm free chlorine. Keep the hydrotherapy jets off and let the hyperchlorinated water circulate for 1 hour in all of the components of the hot tub including the compensation/surge tank, filter housing, and piping. Turn on the hydrotherapy jets to circulate the hyperchlorinated water for 9 additional hours. Maintain 20 ppm of free chlorine in the system for the entire 10 hours.
6. Flush the entire system. This removes hyperchlorinated water from all equipment.
7. Take new samples to confirm the elimination of *Legionella*. At least 48 hours after the device has been restored to normal operating conditions, have samples taken from:
    a. Tub
    b. Hydrotherapy jets
    c. Drain
    d. Filters or filter media
    e. Any part of the hot tub that originally tested positive for *Legionella*
8. Keep the hot tub closed until testing confirms the elimination of *Legionella*. If laboratory testing is positive for *Legionella*, repeat steps 1-7 until all testing is negative. If laboratory testing is negative for *Legionella*, proceed to step 9.
9. Ensure water quality prior to reopening the hot tub for use. Ensure that halogen (chlorine or bromine) and pH levels meet local and state standards.
10. Maintain water quality according to local and state standards. If the hot tub is associated with an outbreak, the above continued laboratory testing schedule will be recommended.

Legionella Control Measures for Hot Tubs and Whirlpool Spas

Water Parameter	**Control Measure**	**Recommendations**
Sediment and Biofilm	Cleaning frequency	● Vigorously scrub all surfaces each time tub is drained.
Temperature	Control limits unlikely met due to operating conditions	● Hot tubs operate within the favorable growth range for *Legionella* (77–113°F, 25–45°C). ● Additional measures are required to control *Legionella*. ● Water should not exceed 104°F (40°C) to prevent scalding.

Water Age	Bather load, frequency of use	• Water replacement frequency in days = (Spa volume in gallons/3)/average # users per day†
Disinfectant Residual‡	Control limits	• pH: 7.2–7.8† • Free chlorine: 3–10 ppm† • Bromine: 4–8 ppm†

†Recommendation based on guidance from CDC's *Model Aquatic Health Code* (MAHC), accessible at: https://www.cdc.gov/mahc/editions/current.html.

‡Cyanuric acid or stabilized chlorine products should not be used in hot tubs as they slow disinfection.

Cooling Towers

Cleaning, disinfecting, and remediating cooling towers involves a hierarchy of protocols. Determine how the following response protocols fit into your water management program. The protocols are listed in order of increasing intensity from routine treatment to offline emergency disinfection. Consult ASHRAE Guideline 12-2020 for instructions for each response. These steps may require customization based on system components, operating conditions, or other factors.

- Online remedial treatment
- Online disinfection
- Offline cleaning and disinfection
- Offline emergency cleaning and disinfection

If an associated outbreak or illness is suspected, perform an offline emergency cleaning and disinfection using the procedures below. Consult a water treatment professional for guidance on applying these procedures.

1. Review the current water treatment program (e.g., cleanliness, maintenance, disinfectant program).
2. Remove heat load from the cooling system. Shut off fans associated with the cooling tower. Disengage all automated chemical feed and control equipment.
3. Shut off system blowdown and keep make-up water valves open and operating.
4. Close building air intake vents near the cooling tower, especially those downwind, until after the cleaning procedure is complete.
5. Circulate water through all system equipment, including any bypass or standby components.
6. Add an oxidizing disinfectant sufficient to achieve a disinfectant residual of at least 20 ppm as free available oxidant.
7. Add an appropriate dispersant and apply antifoam, if needed. Apply appropriate corrosion inhibitors.
8. Reduce the cycles of concentration (if necessary) to achieve and maintain a pH of less than 8.0 for chlorine-based disinfectants or less than 8.5 for bromine-based disinfectants.

9. Maintain a free available oxidant residual of 10 ppm for a minimum of 24 hours. Shorter contact times can be effective at higher concentrations.
10. Drain the system after the disinfection period to the sanitary sewer, following all applicable rules, regulations, and permits that may be required.
11. Physically clean all accessible system equipment. Consideration should be given to all cooling tower equipment, including fill pack, drift eliminators, equalizer lines, remote sumps, basins, strainers, chillers, free cooling heat exchangers, and any bypass or standby components.
12. Refill the system and circulate water through all system equipment including any bypass or standby components.
13. Add an oxidizing disinfectant and maintain a free available oxidant residual of at least 10 ppm for one hour.
14. Drain the system after the disinfection period to the sanitary sewer following all applicable rules, regulations, and permits that may be required.
15. Refill the system and return all chemical feed and control equipment to normal operation.

Legionella Control Measures for Cooling Towers

Water Parameter	**Control Measure**	**Recommendations**
Sediment and Biofilm	Cleaning frequency, scale, and corrosion inhibitors	● Cleaning frequency varies based on operational factors. ● Remove from service, clean, and disinfect at least annually. ● Monitor scale and corrosion inhibitor levels frequently as indicated by water quality measurements.
Temperature	Control limits	● Operate at the lowest possible water temperature outside *Legionella's* favorable growth range (77–113°F, 25–45°C).
Water Age	Make-up water quality and turnover frequency	● Flush low-flow pipe runs and dead legs at least weekly. ● During wet system standby (water remains in system and shutdown for less than 5 days), maintain water treatment program and circulate water 3 times a week through the open loop of a closed-circuit cooling tower and entire open-circuit cooling system. Ensure system water quality is managed through automated system blow down. ● Use potable water for system make-up water or ensure reclaimed or condensate sources are appropriately managed.

Disinfectant Residual	Control limits	• pH: Maintain based on type of disinfectant used and manufacturer recommendations to prevent corrosion. • Oxidizing disinfectants (e.g., chlorine & bromine): Maintain measurable residuals throughout each day. Consult manufacturer recommendations. • Non-oxidizing disinfectants: Maintain based on product label concentration and contact time.

Decorative Fountains

If an associated outbreak or illness is suspected by public health, do the following:

1. Remove the decorative fountain from service.
2. Drain the decorative fountain.
3. Scrub all surfaces.
4. Replace filters or filter media (if applicable).
5. Repair parts as needed.
6. Refill the decorative fountain.
7. Hyperchlorinate, maintaining a minimum of 20 ppm free chlorine for 10 hours.
8. Drain and rinse all components of the decorative fountain.
9. Refill with fresh potable water.
10. Return the decorative fountain to the routine disinfectant residual level before use.

Legionella Control Measures for Decorative Fountains by Volume in US Gallons

Water Parameter	**Control Measure**	**Recommendations**		
		< 5 gallons	**5–25 gallons**	**> 25 gallons**
Sediment and Biofilm	Cleaning frequency	Weekly	Monthly	Routinely to remove scale and deposits as indicated by water quality measurements
		Any time there is visible biofilm or debris (in addition to above routine cleaning)		
Temperature	Control limits	Maintain water temperature below 77°F (25°C).*		

Water Age	Water turnover, flow, replacement	Water turnover and flow are needed to maintain water treatment applied for microbial control. Avoid idle periods. Run at least daily.		
Disinfectant Residual	Control limits	3–5 ppm free chlorine for at least 1 hour per day	3–5 ppm free chlorine for at least 1 hour per day	0.5 ppm free chlorine for at least 6 hours/day

* Exposure to warm air, heat-generating submerged lights, or other factors that elevate water temperature into the favorable growth range (77–113°F, 25–45°C) will require additional mitigation strategies.

Other Devices

In the absence of control, *Legionella* can grow in almost any system or equipment containing nonsterile water, such as tap water, at temperatures favorable to *Legionella* growth. Devices that may grow *Legionella* in the absence of control include the following:

- All types of secondary water collection, storage, and use for recycled water, gray water, rainwater, and groundwater
- Water storage for high-demand or emergency use and expansion tanks
- Lawn sprinklers and irrigation systems
- Solar water heating systems
- Fire suppression systems
- Safety showers and eyewash stations
- Produce and recreational misters
- Evaporative air coolers
- Spray and pressure washing equipment
- Machine/metalworking lubrication and coolant systems
- Dental and medical equipment (e.g., scalers, CPAP, bronchoscopes, heater-cooler units)
- Ice machines
- Humidifiers

If an outbreak or illness is suspected by public health, consider remediation options. Water system managers should choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Certain procedures should only be undertaken in consultation with a water treatment professional. Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.

Legionella Control Measures for Other Devices

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	● Clean and maintain water system components regularly in accordance with manufacturer recommendations.
Temperature	Control limits	● Store and maintain water at temperatures outside the favorable growth range for *Legionella* (77–113°F, 25–45°C); Note that *Legionella* may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing and water replacement	● Flush and replace water according to manufacturer recommendations.
Disinfectant Residual	Control limits	● Consider using a disinfectant appropriate for the system and in accordance with manufacturer recommendations.

Control

Use a Water Management Program (WMP) to protect building operators, staff, and visitors from exposure to *Legionella* in potable water systems. No single measure can ensure *Legionella* control. A comprehensive WMP allows water system operators to layer a series of complementary control measures to create environmental conditions that prevent bacterial intrusion, growth, and transmission. Develop or refine a WMP with the following guidelines in mind:

- Monitor temperature, disinfectant residuals, and pH frequently based on performance of water management program or *Legionella* performance indicators for control. Adjust measurement frequency according to the stability of performance indicator values. For example, the measurement frequency should be increased if there is a high degree of measurement variability.

- Store hot water at temperatures above 140°F (60°C) and ensure hot water in circulation does not fall below 120°F (49°C). Recirculate hot water continuously, if possible.
- Store and circulate cold water at temperatures below the favorable range for *Legionella* (77–113°F, 25–45°C); *Legionella* may grow at temperatures as low as 68°F (20°C).
- Ensure a disinfectant residual is detectable throughout the potable water system.
- Flush low-flow piping runs and dead legs at least weekly and flush infrequently used fixtures (e.g., eye wash stations, emergency showers) regularly as-needed to maintain water quality parameters within control limits.
- Clean and maintain water system components, such as thermostatic mixing valves, aerators, showerheads, hoses, filters, and storage tanks, regularly.
- Do not presume supplemental disinfection systems will control *Legionella* without an adequate WMP.
    - Selecting or operating a supplemental disinfection system inappropriately may result in system damage or health hazards (e.g., disinfectant byproducts). Consult with a water treatment professional regarding supplemental disinfection systems. They may require permitting.
- Recognize that point-of-use (POU) microbial filters with an effective pore size of 0.2-microns or less that comply with the requirements of ASTM F838 can provide immediate control at individual fixtures in a water system if integrated into a Water Management Program (WMP).
    - POU filters protect only the connected fixture. Correct location selection is critical to *Legionella* exposure prevention across the water system.
    - Follow the manufacturer recommendations regarding frequency of replacement and appropriate operating conditions.
    - POU filters may need to be removed before performing an acute remediation procedure.
- Consider testing for *Legionella* in accordance with the routine testing module of this toolkit.

For additional information for *Legionella* control, please refer to the Toolkit for Controlling *Legionella* in Common Sources of Exposure (*Legionella* Control Toolkit).

Determining When Outbreak or Investigation is Concluded

Public health officials performing the investigation will need to make decisions about the end of an outbreak on a case-by-case basis. Possible considerations include:

- No new cases of Legionnaires' disease identified during a period of careful monitoring for new cases.
- No new cases of Legionnaires' disease following implementation of long-term *Legionella* control strategies as part of a water management program.
- No detection of *Legionella* in post-remediation environmental samples.

Before you can consider an outbreak over, an effective water management program to prevent ongoing transmission of *Legionella* should be in place. You can extend the timeframe for enhanced

environmental and clinical surveillance following an outbreak at any point if public health officials have concern for the potential for ongoing transmission of *Legionella.* Concerns about the potential for ongoing transmission would be based on factors such as *Legionella*-positive environmental cultures, new cases of Legionnaires' disease, or suboptimal performance of the water management program.

*If you have confirmed an outbreak strain, efforts to monitor the building water system(s) can focus on the outbreak strain. However, identification of other *Legionella* species or serogroups indicates conditions support the growth of *Legionella*. All *Legionella* species or serogroups are potentially pathogenic. Therefore, you should consider needed adjustments to the water management program.

References

Centers for Disease Control and Prevention (2021, March 25). *Legionella (Legionnaires' Disease and Pontiac Fever)*. https://www.cdc.gov/*Legionella*/

Centers for Disease Control and Prevention (2021, March 25). *Legionella (Legionnaires' Disease and Pontiac Fever)*: *Defining Healthcare Facilities and Healthcare-associated Legionnaires' Disease*. https://www.cdc.gov/*Legionella*/health-depts/healthcare-resources/healthcare-facilities.html

Council of State and Territorial Epidemiologists (2022, June 1). *Legionnaires' Disease Risk Communication Toolkit*. https://cdn.ymaws.com/www.cste.org/resource/resmgr/leg-toolkit/ld_risk_communications_toolk.pdf

Cohn, P. D., Gleason, J. A., Rudowski, E., Tsai, S. M., Genese, C. A., & Fagliano, J. A. (2014). Community outbreak of legionellosis and an environmental investigation into a community water system. *Epidemiology and Infection*. https://doi.org/10.1017/S0950268814001964

Lucas, K. D., Wheeler, C., McLendon, P., Leistikow, B. N., & Mohle-Boetani, J. C. (2018). Outbreak of Legionnaires' disease associated with cooling towers at a California state prison, 2015. *Epidemiology and Infection*, *146*(3), 297-302. https://doi.org/10.1017/S0950268818000110

Linked Resources

Line List Templates: Healthcare-associated Outbreak Line List, Travel-associated Outbreak Line List, Community-associated Outbreak Line List

Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: This toolkit is designed to help people understand which buildings and devices need a *Legionella* water management program to reduce the risk for Legionnaires' disease, the key elements of a water management program, and how to develop it. https://www.cdc.gov/*Legionella*/downloads/toolkit.pdf

Toolkit for Controlling *Legionella* in Common Sources of Exposure: Provides public health and building owners and operators with concise, actionable information on controlling *Legionella* in commonly implicated sources of Legionnaires' disease outbreaks. It helps focus and improve *Legionella* control efforts and protect the safety of a building's employees, visitors, and surrounding community. https://www.cdc.gov/*Legionella*/downloads/Control-Toolkit-All-Modules.pdf

Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training): Take this free training from CDC and partners on creating a water management program to reduce risk for Legionnaires' disease. PreventLD Training aligns with industry standards (ASHRAE 188) on managing risk for *Legionella* bacteria. https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html

ANSI/ASHRAE Standard 188-2018, Legionellosis: Risk Management for Building Water Systems: Establishes minimum legionellosis risk management requirements for building water systems. https://www.ashrae.org/technical-resources/bookstore/ansi-ashrae-standard-188-2018-legionellosis-risk-management-for-building-water-systems

Worksheet to Identify Buildings at Increased Risk for *Legionella* Growth and Spread
https://www.cdc.gov/*Legionella*/wmp/toolkit/wmp-risk.html

Centers for Medicare and Medicaid Services (CMS) Requirement to Reduce *Legionella* Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD) https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/QSO17-30-HospitalCAH-NH-REVISED-.pdf

Legionnaires' Disease Risk Communication Toolkit: This offers comprehensive communications guidance for health departments, including setting- and scenario-specific modules.
https://cdn.ymaws.com/www.cste.org/resource/resmgr/leg-toolkit/ld_risk_communications_toolk.pdf

Infection Control Assessment and Response (ICAR) Tool for General Infection Prevention and Control (IPC) Across Settings Module 11: Water Exposure Facilitator Guide.
CDC ICAR Module 11: Water Management

Patient's Name *(Last, First, MI):* _____ Phone: _____ Hospital: _____

Address *(Number, Street, Apt No., City, State, ZIP):* _____

Patient Chart No.: _____ ***PATIENT IDENTIFIER INFORMATION IS NOT TRANSMITTED TO CDC***

Form Approved
OMB No. 0920-0728

CDC Use Only
Case No.: _____

National Center for Immunization and Respiratory Diseases

LEGIONELLOSIS CASE REPORT

(DISEASE CAUSED BY ANY *LEGIONELLA* SPECIES)

U.S. Department of Health and and Human Services
Centers for Disease Control and Prevention (CDC), Atlanta, Georgia 30329
https://www.cdc.gov/legionella/index.html

1. State health dept. case no.:	2. Reporting state:	3. City of residence:	4. County of residence:	5. State of residence:

6. Industry:	7. Occupation:	8a. Date of birth *(mm/dd/yyyy):*	8b. Age:	9. Sex:
			○ Days ○ Months ○ Years	○ Male ○ Female ○ Unknown

10. Ethnicity:
- ○ Hispanic/Latino
- ○ Not Hispanic/Latino
- ○ Unknown

11. Race *(check all that apply):*
- ☐ American Indian/ Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Unknown

12. Diagnosis:
- ○ Legionnaires' disease *(pneumonia, clinical or X-ray diagnosed)*
- ○ Pontiac fever *(fever and myalgia without pneumonia)*
- ○ Extrapulmonary legionellosis *(specify location):* _____

13. Date of symptom onset of legionellosis *(mm/dd/yyyy):* _____

14. Date of first report to public health at any level *(mm/dd/yyyy):* _____

15. Was the patient hospitalized during treatment for legionellosis?
- ○ Yes
- ○ No
- ○ Unknown

If yes, date of admission *(mm/dd/yyyy):* _____
Hospital name: _____
City, state: _____

16. Outcome of illness:
- ○ Survived
- ○ Died
- ○ Still ill
- ○ Unknown

17. In the 14 days before onset, did the patient spend any nights away from home (excluding healthcare settings)?
○ Yes ○ No ○ Unknown

If yes, please complete the following information:

Name of accomodation 1: _____

Street address: _____ Room number: _____

City: _____ State: _____ ZIP: _____

Country: _____ Date of arrival: _____ Date of departure: _____

Comments about travel:

_____

Name of accommodation 2: _____

Street address: _____ Room number: _____

City: _____ State: _____ ZIP: _____

Country: _____ Date of arrival: _____ Date of departure: _____

Comments about travel:

_____

To add additional accommodations, see page 7.

18. In the 14 days before onset, did the patient visit or stay in a healthcare setting (e.g., hospital, long-term care/rehab/skilled nursing facility, clinic)?
○ Yes ○ No ○ Unknown

If yes, please complete the following information:

Name of healthcare facility 1: _____

Type of healthcare setting/facility:
○ Hospital ○ Other, specify: _____
○ Long-term care
○ Clinic
○ Unknown

Type of exposure:
○ Inpatient ○ Unknown
○ Outpatient ○ Other, specify: _____
○ Visitor or volunteer
○ Employee

Is this facility also a transplant center?
○ Yes
○ No
○ Unknown

Street address: _____ City: _____

State: _____ ZIP: _____ Reason for visit: _____

Date of arrival: _____ Date of departure: _____

Did the healthcare facility have in place a water management program to reduce the risk of *Legionella* growth and spread? ○ Yes ○ No ○ Unknown

Comments about healthcare facility:

_____

Name of healthcare facility 2: _____

Type of healthcare setting/facility:
○ Hospital ○ Other, specify: _____
○ Long-term care
○ Clinic
○ Unknown

Type of exposure:
○ Inpatient ○ Unknown
○ Outpatient ○ Other, specify: _____
○ Visitor or volunteer
○ Employee

Is this facility also a transplant center?
○ Yes
○ No
○ Unknown

Street address: _____ City: _____

State: _____ ZIP: _____ Reason for visit: _____

Date of arrival: _____ Date of departure: _____

Did the healthcare facility have in place a water management program to reduce the risk of *Legionella* growth and spread? ○ Yes ○ No ○ Unknown

Comments about healthcare facility:

_____

***To add additional healthcare facilities, see page 7.**

19. Was this case associated with a healthcare exposure?
○ **Presumptive:** Patient had 10 or more days of continuous stay at a healthcare facility during the 14 days before onset of symptoms
○ **Possible:** Patient had exposure to a healthcare facility for a portion of the entire 14 days prior to onset
○ **No:** No exposure to a healthcare facility in the 14 days prior to onset
○ Unknown

20. In the 14 days before onset, did the patient visit or stay in an assisted living facility or senior living facility? Assisted/senior living facilities do not provide skilled nursing or medical care.
○ Yes ○ No ○ Unknown

If yes, please complete the following information:

Type of setting/facility: ○ Assisted living facility ○ Senior living facility ○ Unknown

Name of assisted/senior living facility 1: _____

Type of exposure: ○ Resident ○ Visitor or volunteer ○ Employee ○ Other, specify: _____ ○ Unknown

Street address: _____

City: _____ State: _____ ZIP: _____

Date of arrival: _____ Date of departure: _____

Did the assisted/senior living facility have in place a water management program to reduce the risk of *Legionella* growth and spread?
○ Yes ○ No ○ Unknown

Comments about assisted or senior living facility:

_____

21. Was this case associated with an assisted or senior living facility?
○ **Presumptive:** Patient had 10 or more days of continuous stay at an assisted/senior living facility during the 14 days before onset of symptoms
○ **Possible:** Patient had exposure to an assisted/senior living facility for a portion of the entire 14 days prior to onset
○ **No:** No exposure to an assisted/senior living facility in the 14 days prior to onset
○ Unknown

22. Was this case associated with a known outbreak or possible cluster?
○ Yes ○ No ○ Unknown

If yes, specify name of facility, city, and state of outbreak:

Name of facility:

_____

City: _____ State: _____

23. If this case was associated with an outbreak reported to NORS (National Outbreak Reporting System), what is the CDC-assigned NORS outbreak ID?

_____

24. Laboratory diagnostic tests:

Tests	Date collected *(mm/dd/yyyy)*	Specimen type	Results
Urinary antigen test (UAT)	_____	Urine	○ Positive ○ Indeterminant ○ Negative ○ Not performed ○ Unknown
Culture	_____	○ Lower respiratory secretions (e.g., sputum, BAL) ○ Other, specify: _____	○ Positive ○ Indeterminant ○ Negative ○ Not performed ○ Unknown
Nucleic acid assay (e.g., PCR)	_____	○ Lower respiratory secretions (e.g., sputum, BAL) ○ Other, specify: _____	○ Positive ○ Indeterminant ○ Negative ○ Not performed ○ Unknown
Direct fluorescent antibody (DFA) or immunohistochemistry (IHC)	_____	○ Lower respiratory secretions (e.g., sputum, BAL) ○ Other, specify: _____	○ Positive ○ Indeterminant ○ Negative ○ Not performed ○ Unknown

25. If culture, nucleic acid assay (e.g., PCR), or DFA/IHC were performed, specify species and/or serogroup identified:

Species: _____ Serogroup: _____

26. Serologic tests:

Antibody titer test	Date collected *(mm/dd/yyyy)*	Quantitative titer value	Results
Antibody titer to *Legionella pneumophila* serogroup 1	Acute: _____ Convalescent: _____	Acute: _____ Convalescent: _____	○ Positive (4x or greater rise in titer) ○ Indeterminant ○ Negative ○ Not performed ○ Unknown
Antibody titer OTHER THAN *Legionella pneumophila* serogroup 1 or to multiple species or serogroups of *Legionella* using pooled antigen	Acute: _____ Convalescent: _____	Acute: _____ Convalescent: _____	○ Positive (4x or greater rise in titer) ○ Indeterminant ○ Negative ○ Not performed ○ Unknown

27. Was a specimen(s) sent to CDC for testing?

○ Yes
○ No
○ Unknown

Date specimen(s) sent to CDC for testing: _____

28. Case status:

○ Confirmed
○ Suspect
○ Probable
○ Not a case

If probable, indicate epidemiologic link: _____

29. In the 14 days before onset, was the patient exposed to any of the following? *If yes,* indicate location and dates.

Potential exposure(s)	Yes/No/Unknown	Location (facility name, city, state)	Date(s)
Shower away from home	○ Yes ◉ No ◉ Unknown		
In or near a Hot tub	○ Yes ◉ No ◉ Unknown		
Near a decorative water fountain or water feature	○ Yes ◉ No ◉ Unknown		
Near a mister	○ Yes ◉ No ◉ Unknown		
Near a sprinkler	○ Yes ◉ No ◉ Unknown		
Recreational water park	○ Yes ◉ No ◉ Unknown		
Near some other water aerosolizing device: _____	○ Yes ◉ No ◉ Unknown		
Attend a convention, reception, conference, or other public gathering	○ Yes ◉ No ◉ Unknown		
Visit or live in a congregate living facility (e.g., correctional facilities, shelters, dormitories, etc.)	○ Yes ◉ No ◉ Unknown		
Visit an area with large buildings (e.g., shopping centers, high-rise complexes, etc.) that may have a cooling tower(s)	○ Yes ◉ No ◉ Unknown		
Construction/remodeling near home or place visited	○ Yes ◉ No ◉ Unknown		
Work with water device/system maintenance (e.g., cooling towers, plumbing, hot tub)	○ Yes ◉ No ◉ Unknown		
Work in water-related leisure (e.g., hotels, cruise ships, water parks)	○ Yes ◉ No ◉ Unknown		
Industrial/manufacturing plant with a water spray cooling system or processes involving spraying water	○ Yes ◉ No ◉ Unknown		
Commercial or long haul truck driving	○ Yes ◉ No ◉ Unknown		
Work in commercial kitchen	○ Yes ◉ No ◉ Unknown		
Work in custodial services (e.g., housekeeping, janitorial)	○ Yes ◉ No ◉ Unknown		
Work in construction (e.g., spraying water, demolition, refurbishing)	○ Yes ◉ No ◉ Unknown		
Work at wastewater treatment plant	○ Yes ◉ No ◉ Unknown		
Work in another occupation involving water exposures: _____	○ Yes ◉ No ◉ Unknown		

30. In the 14 days before onset, did the patient use respiratory therapy equipment (e.g., nebulizer, CPAP, BiPAP) for treatment of sleep apnea, COPD, asthma, or any other reason?

○ Yes ◉ No ◉ Unknown

**If yes* to respiratory therapy equipment, does this device use a humidifier?

○ Yes ◉ No ◉ Unknown

**If yes,* what type of water is used in the device? *(check all that apply)*

☐ Sterile ☐ Bottled ☐ Other
☐ Distilled ☐ Tap ☐ Unknown

31. In the 14 days before onset, did the patient take a cruise? ◯ Yes ◯ No ◯ Unknown

If yes,

Name of cruise line: _____ Name of ship: _____

Cruise departure city: _____ Cruise departure state: _____

Cruise departure country: _____ Cruise departure date: _____

Cruise return city: _____ Cruise return state: _____

Cruise return country: _____ Cruise return date: _____ Cabin number: _____

Ports of call:

City	State	Country	Date

32. Did the patient have any underlying conditions or prior illnesses? ◯ Yes ◯ No ◯ Unknown

If yes, indicate whether the patient has each of the following underlying conditions

Condition	Patient History		
AIDS	◯ Yes	◯ No	◯ Unknown
Alcohol abuse (current/past)	◯ Yes	◯ No	◯ Unknown
Asthma	◯ Yes	◯ No	◯ Unknown
Blood cancer	◯ Yes	◯ No	◯ Unknown
Bone marrow transplant	◯ Yes	◯ No	◯ Unknown
Broken skin	◯ Yes	◯ No	◯ Unknown
Cancer	◯ Yes	◯ No	◯ Unknown
Cancer treatment	◯ Yes	◯ No	◯ Unknown
Cerebrospinal fluid leak	◯ Yes	◯ No	◯ Unknown
Cerebrovascular accident	◯ Yes	◯ No	◯ Unknown
Chronic respiratory disease	◯ Yes	◯ No	◯ Unknown
Chronic hepatitis C	◯ Yes	◯ No	◯ Unknown
Cirrhosis/liver failure	◯ Yes	◯ No	◯ Unknown
Cochlear prosthesis	◯ Yes	◯ No	◯ Unknown
Complement deficiency disease	◯ Yes	◯ No	◯ Unknown
Congestive heart failure	◯ Yes	◯ No	◯ Unknown
Connective tissue disorder	◯ Yes	◯ No	◯ Unknown
Coronary arteriosclerosis	◯ Yes	◯ No	◯ Unknown
Corticosteroids	◯ Yes	◯ No	◯ Unknown
Current chronic dialysis	◯ Yes	◯ No	◯ Unknown
Deafness/profound hearing loss	◯ Yes	◯ No	◯ Unknown
Dementia	◯ Yes	◯ No	◯ Unknown
Diabetes mellitus	◯ Yes	◯ No	◯ Unknown
Emphysema/COPD	◯ Yes	◯ No	◯ Unknown
HIV infection	◯ Yes	◯ No	◯ Unknown
Hodgkin's disease (clinical)	◯ Yes	◯ No	◯ Unknown
Immunoglobulin deficiency	◯ Yes	◯ No	◯ Unknown
Immunosuppressive therapy	◯ Yes	◯ No	◯ Unknown
Intravenous drug user	◯ Yes	◯ No	◯ Unknown

Condition	Patient History		
Kidney disease	◯ Yes	◯ No	◯ Unknown
Leukemia	◯ Yes	◯ No	◯ Unknown
Multiple myeloma	◯ Yes	◯ No	◯ Unknown
Multiple sclerosis	◯ Yes	◯ No	◯ Unknown
Myocardial infarction	◯ Yes	◯ No	◯ Unknown
Nephrotic syndrome	◯ Yes	◯ No	◯ Unknown
Neuromuscular disorder	◯ Yes	◯ No	◯ Unknown
Obesity	◯ Yes	◯ No	◯ Unknown
Paralysis	◯ Yes	◯ No	◯ Unknown
Parkinson's disease	◯ Yes	◯ No	◯ Unknown
Peptic ulcer	◯ Yes	◯ No	◯ Unknown
Peripheral neuropathy	◯ Yes	◯ No	◯ Unknown
Peripheral vascular disease	◯ Yes	◯ No	◯ Unknown
Premature birth	◯ Yes	◯ No	◯ Unknown
Renal failure/dialysis	◯ Yes	◯ No	◯ Unknown
Seizure disorder	◯ Yes	◯ No	◯ Unknown
Sickle cell trait	◯ Yes	◯ No	◯ Unknown
Smoker – current	◯ Yes	◯ No	◯ Unknown
Smoker – former	◯ Yes	◯ No	◯ Unknown
Solid organ malignancy	◯ Yes	◯ No	◯ Unknown
Solid organ transplant	◯ Yes	◯ No	◯ Unknown
Spleen missing	◯ Yes	◯ No	◯ Unknown
Splenectomy/asplenia	◯ Yes	◯ No	◯ Unknown
Systemic lupus erythematosus	◯ Yes	◯ No	◯ Unknown
Trouble swallowing (dysphagia)	◯ Yes	◯ No	◯ Unknown
Other (specify):	◯ Yes	◯ No	◯ Unknown
Unknown	◯ Yes	◯ No	

33. Was the patient or proxy interviewed by public health?

◯ Yes ◯ No ◯ Unknown

Comments:

Interviewer's name: _____

Affiliation: _____ Phone: _____

State health dept. official who reviewed this report: _____

Title: _____ Phone: _____

Local Health Dept. please submit this document to:

State/DHD/SSS via your communicable disease clerk

State Health Dept. return completed form to:

travellegionella@cdc.gov
Respiratory Diseases Branch, MS H24-6
Office of Infectious Diseases
Center for Disease Control and Prevention and Control
1600 Clifton Rd. NE, Atlanta, GA 30329

Appendix (Additional Facilities)

(Additional accomodations – continued from page 1*)*

Name of accomodation 3: _____

Street address: _____ Room number: _____

City: _____ State: _____ ZIP: _____

Country: _____ Date of arrival: _____ Date of departure: _____

Comments about travel:

_____

Name of accomodation 4: _____

Street address: _____ Room number: _____

City: _____ State: _____ ZIP: _____

Country: _____ Date of arrival: _____ Date of departure: _____

Comments about travel:

_____

(Additional healthcare facilities – continued from page 2*)*

Name of healthcare facility 3: _____

Type of healthcare setting/facility:
- ○ Hospital
- ◉ Long-term care
- ◉ Clinic
- ◉ Unknown
- ◉ Other, specify: _____

Type of exposure:
- ○ Inpatient
- ◉ Outpatient
- ◉ Visitor or volunteer
- ◉ Employee
- ◉ Unknown
- ◉ Other, specify: _____

Is this facility also a transplant center?
- ○ Yes
- ◉ No
- ◉ Unknown

Street address: _____ City: _____

State: _____ ZIP: _____ Reason for visit: _____

Date of arrival: _____ Date of departure: _____

Did the healthcare facility have in place a water management program to reduce the risk of *Legionella* growth and spread? ○ Yes ◉ No ◉ Unknown

Comments about healthcare setting:

_____

(Additional assisted/senior living facilities – continued from page 2*)*

If yes, what type? ○ Assisted living facility ◉ Senior living facility ◉ Unknown

Name of assisted/senior living facility 2: _____

Type of exposure: ○ Resident ◉ Visitor or volunteer ◉ Employee ◉ Other, specify: _____ ◉ Unknown

Street address: _____

City: _____ State: _____ ZIP: _____

Date of arrival: _____ Date of departure: _____

Did the assisted/senior living facility have in place a water management program to reduce the risk of *Legionella* growth and spread?
○ Yes ◉ No ◉ Unknown

Comments about assisted or senior living facility:

_____

Centers for Disease Control and Prevention

Legionella Environmental Assessment Form

HOW TO USE THIS FORM

This form enables public health officials to gain a thorough understanding of a facility's water systems and aerosolizing devices and assists facility management with minimizing the risk of Legionnaires' disease. It can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to develop a sampling plan. In addition, findings from this environmental assessment can be used to develop a water management program (WMP) by identifying areas at risk for *Legionella* growth and spread. The assessment should be performed on site by an epidemiologist or environmental health specialist with knowledge of the ecology of *Legionella*, building water systems, and water treatment; this includes public health professionals familiar with CDC resources such as the *Legionella* Environmental Assessment Form Marking Guide, Toolkit for Controlling *Legionella* in Common Sources of Exposure, and PreventLD.The LEAF Marking Guide walks the user through this form by providing instructions and additional considerations for the questions by adding further context and discussing relevant risk factors for *Legionella* growth and spread that users may find helpful.

Complete the form in as much detail as possible.

- The content in the "Facility Characteristics" and "Water Supply Source" sections will be applicable to every assessment.
- Do not leave questions blank; if a question does not apply, write "N/A." If a question applies but cannot be answered, explain why.
- Where applicable, specify the units of measurement being used (*e.g.*, ppm).
- Take pictures and attach them to the form to visually support the written findings. Pictures should be taken of any significant findings in implicated mechanical components and water treatment systems.
- It may take several hours to complete the form.

Complete the **device-specific appendices** that pertain to the facility being assessed after completing the relevant portions of the main form.

Keep the following **key factors** that contribute to *Legionella* growth in mind as you complete the form:

Sediment and Biofilm – Mineral buildup in a system supports *Legionella* growth and consumes disinfectant residual. Microorganisms and the slime they secrete make up biofilms that stick to and grow on any continually moist surface. Biofilms provide a stable growth surface and an environment with nutrients for many types of germs, including *Legionella*.

Temperature – *Legionella* generally grow well between 77°F and 113°F. The optimal growth range for *Legionella* is between 85°F and 108°F. Growth slows between 113°F and 120°F, and *Legionella* begin to die above 120°F. Growth also slows between 68°F and 77°F, and *Legionella* become dormant below 68°F.

Water Age – Slowly moving or stagnant water increases water age, which provides opportunities for *Legionella* growth. Higher water age also contributes to disinfectant residual loss and favorable temperatures for growth.

Disinfectant Residual – Disinfectant residuals are the amount of chemical disinfectant available in the water to inhibit *Legionella* growth. Disinfectant residual decreases as water age and temperature increase.

Refer to CDC's *Legionella* Control Toolkit for detailed guidance on evaluating the key factors for *Legionella* growth in specific water systems and devices. For additional training and information, please see CDC's resources for health departments.

SAFETY PRECAUTIONS

If the epidemiologic information available suggests a device is a potential source (*e.g.*, hot tub, cooling tower), request that the facility management turn it off (but do not drain or disinfect) to stop transmission. Persons at increased risk of developing Legionnaires' disease if exposed to *Legionella* (*e.g.*, immunocompromised individuals) should not accompany the sampling team.

Optional Personal Protective Equipment (PPE)

Gloves are useful for sampling hot tub filters or other sites that may be heavily contaminated with organic material.

Wearing a half-face air-purifying respirator equipped with an N95 filter may be appropriate in the following situations: a. when sampling cooling towers if the fans cannot be turned off, or b. in enclosed spaces with an aerosol-generating device that cannot be turned off. Respirators must be used in accordance with a comprehensive respiratory protection program, which includes fit testing, training, and medical clearance ahead of their use (see OSHA standard 29 CFR 1910.134). For more information about N95 respirators, visit the National Institute for Occupational Safety and Health (NIOSH) website.

BEFORE ARRIVING ON SITE

- Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility's water systems, such as a facility engineer or industrial hygienist.
- Request that they have maintenance logs and facility construction as-built diagrams available for the meeting.
- Bring a plastic 500ml or 1L bottle for water parameter sampling, thermometer, pH test kit, and a colorimeter that can detect a wide range of residual disinfectant (<1 ppm for potable water and up to 10 ppm for hot tub water).

LEGIONELLA ENVIRONMENTAL ASSESSMENT FORM

Person(s) completing the assessment:

Name: _____ Job Title: _____

Organization: _____

Telephone: _____ E-mail: _____

Name: _____ Job Title: _____

Organization: _____

Telephone: _____ E-mail: _____

Assessment details:

Facility Name: _____

Date of Assessment: _____

Facility Address:

Street: _____ City: _____

State: _____ Zip: _____

Person(s) interviewed during the assessment:

Name: _____ Job Title: _____

Organization: _____

Telephone: _____ E-mail: _____

Name: _____ Job Title: _____

Organization: _____

Telephone: _____ E-mail: _____

Name: _____ Job Title: _____

Organization: _____

Telephone: _____ E-mail: _____

Facility Characteristics

1. Is this a healthcare facility or facility with skilled nursing care (*e.g.*, hospital, long term care/rehab/skilled nursing facility, clinic), or an assisted or senior living facility?

   ☐ YES *(If YES, skip to Question 2 and also complete Appendix A.)*

   ☐ NO

   If NO, indicate type of facility (check all that apply):

   ☐ Other residential building (*e.g.*, apartment, condominium)

   ☐ Hotel, motel, or resort

   ☐ Vacation rental property (e.g., Airbnb, VRBO, Vacasa)

   ☐ Recreational facility (*e.g.*, health club, water park)

   ☐ Office building

   ☐ Manufacturing facility

   ☐ Restaurant

   ☐ Other: _____

2. Total number of buildings on the premises:_____ Total number of buildings being assessed: _____

3. Total number of rooms that can be occupied overnight (*e.g.*, patient rooms, hotel rooms): _____

4. Does occupancy vary throughout the year?
   - ☐ YES
   - ☐ NO

   If YES, seasons with lowest occupancy (check all that apply):
   - ☐ Winter
   - ☐ Spring
   - ☐ Summer
   - ☐ Fall

5. Are any occupant rooms taken out of service (*e.g.*, annually for low season, routinely for inventory, permanently for reuse as storage or administrative purposes)?
   - ☐ YES
   - ☐ NO

   If YES, which rooms?_____

6. Did the facility recently experience (*i.e.*, last 12 months) a period of prolonged, reduced occupancy, or a building closure?
   - ☐ YES
   - ☐ NO

   If YES, which rooms/buildings? _____

7. Describe any interventions taken as a result of building occupancy changes or occupant rooms taken out of service (*e.g.*, flushing, hyperchlorination):

   _____

8. Average length of stay for occupants (check one):
   - ☐ 1 night
   - ☐ 2–3 nights
   - ☐ 4–7 nights
   - ☐ >7 nights

9. Does the facility have emergency water systems (*e.g.*, fire sprinklers, safety showers, eye wash stations)?
   - ○ YES
   - ○ NO

   If YES, are these systems regularly tested (*i.e.*, sprinkler head flow tests)?
   - ○ YES
   - ○ NO

   If YES, how often and when was the last test? _____

10. Are there any cooling towers or evaporative condensers on the facility premises?
    - ○ YES ***(If YES, also complete Appendix B.)***
    - ○ NO

11. Are there any hot tubs, whirlpool spas, or hydrotherapy spas on the facility premises?
    - ☐ YES ***(If YES, also complete Appendix C.)***
    - ☐ NO

12. Are there any decorative fountains, misters, water features, etc. on the facility premises?
    - ○ YES *(If YES, also complete Appendix D.)*
    - ○ NO

13. Does the facility have centralized humidification (*e.g.*, on air-handling units) or any room humidifiers?
    - ☐ YES
    - ☐ NO

    If YES, describe their location and operation:

14. Does the facility have ice machines?
    - ☐ YES
    - ☐ NO

    If YES, list manufacturer and model or catalog number: _____

15. Does the facility have a landscape irrigation or sprinkler system?
    - ○ YES
    - ○ NO

    If YES, describe their location and operation:

16. Has there been any recent (last 6–12 months) or ongoing major construction on or around the facility premises?
    - ○ YES *(If YES, also complete Appendix E.)*
    - ○ NO

17. Has this facility been associated with a previous legionellosis cluster or outbreak?
    - ○ YES
    - ○ NO

    If YES, please describe number of cases, dates, potential sources (if identified), and any interventions (immediate and long-term) to prevent recurrence:

18. Does the facility have a water management program (WMP)?
    - ○ YES
    - ○ NO

    If YES, does the facility ever test for *Legionella* in water samples?
    - ☐ YES *(If YES, obtain copies of results or summaries going back at least one year)*
    - ☐ NO

    If YES, please describe the program briefly here (does it include clinical disease surveillance and/or environmental *Legionella* surveillance?) and **obtain a written copy** of the program policy:

Water Supply Source

20. What is the source of the water used by the facility (check all that apply)?

- ○ **Public water system**

  If YES, name of supplier: _____

  How is the municipal water disinfected (select one)?

  - ☐ Chlorine
  - ☐ Monochloramine
  - ☐ Other: _____

  Has treatment of municipal water changed in the past year?

  - ☐ YES
  - ☐ NO

  If YES, specify: _____

- ☐ **Private well**

  If YES, how is the well water disinfected (select one)?

  - ☐ Chlorine
  - ☐ Other: _____
  - ☐ Not disinfected

  Is the water filtered on site?

  - ☐ YES
  - ☐ NO

- ☐ **Other**: _____

21. Have there been any pressure drops, boil water advisories, or water disruptions (*e.g.*, water main break) impacting the facility in the past 6 months (whether in the public water system before the point-of-entry and/or on facility property)?

- ○ YES
- ○ NO

If YES, describe what happened and which buildings or parts of buildings were affected:

22. Does the facility monitor incoming water parameters (*e.g.*, residual disinfectant, temperature, pH)?

- ○ YES *(If YES, obtain copies of the logs)*
- ○ NO

If YES, what is the range of disinfectant residual, temperature, and pH entering the facility on the day of the assessment?

Premise Plumbing System

Note: It is important to gain an understanding of where and how water flows, starting where it enters the facility and including its distribution to and through buildings to the points of use. Understand water processes, including but not limited to: heating, storage, filtration, UV irradiation, and addition of supplemental disinfectants. Refer to a facility map and blueprints, obtain copies of these and/or draw a diagram, and include with the completed assessment. For additional recommendations specific to potable water systems, see: https://www.cdc.gov/legionella/wmp/control-toolkit/potable-water-systems.html.

23. Are cisterns and/or water storage holding tanks used to store potable water before it's heated?
    - ☐ YES
    - ☐ NO

24. Are water softeners used on incoming water?
    - ☐ YES
    - ☐ NO

    If YES, are they installed on the hot, cold, or both water systems: _____

25. Are water filters used?
    - ☐ YES
    - ☐ NO

    If YES, are they installed on the water system centrally (whole system filtration) or at points of use?

    _____

    Filter type (*e.g.*, purpose) and manufacturer/model:

    _____

26. Is there a recirculation system (a system in which water flows continuously through the piping to ensure constant hot water to all endpoints) for the hot water?
    - ☐ YES
    - ☐ NO

    If YES, please describe where it runs and delivery/return temperatures if they are measured:

27. Are thermostatic mixing valves used?
    - ○ YES
    - ○ NO

    If YES, describe where they are located:

    Temperature set point(s):

    _____

28. How is the hot water system configured to deliver hot water to each building?

Building Name	**Type of System** (*e.g.*, instantaneous heater, water heater with a storage tank, solar heating)	**Name of System** (*e.g.*, Boiler #1, Loop #1)	**Areas Served** (*e.g.*, floor, rooms)	**Date of Installation**	**Total Capacity** (gallons)	**Usual Temperature Setting** (°F)	**Distal Outlet Temperature** (°F)
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Comments/notes:

29. What is the maximum **hot** water temperature at the point of delivery permitted by state and local regulations?

_____ °F or _____ °C

30. Are **hot** water temperatures ever measured by the facility at the points of use?

○ YES *(If YES, obtain copies of the temperature logs)*

If YES, what is the **lowest** documented **hot** water temperature measured at any point within the facility?

_____ °F or _____ °C documented on (mm/dd/yyyy): _____

○ NO

31. Are **cold** water temperatures ever measured by the facility at the points of use?

○ YES (If YES, obtain copies of the temperature logs)

If YES, what is the **highest** documented **cold** water temperature measured at any point within the facility?

_____ °F or _____ °C documented on (mm/dd/yyyy): _____

AND, what is the typical **cold** water temperature measured within the facility in the **summer**?

_____ °F or _____ °C

○ NO

32. Are the potable water disinfectant levels (*e.g.*, chlorine) ever measured by the facility at the points of use?

○ YES *(If YES, obtain copies of the logs)*

If YES, how often are they measured? _____

If YES, list the range of disinfectant residuals

Summer: _____ Winter: _____

○ NO

33. Does the facility have a supplemental disinfection system for long-term control of *Legionella* or other microorganisms?

○ YES

○ NO

If YES, obtain standard operating procedures (SOPs) for routine use and maintenance as well as maintenance logs and records of disinfection levels, and complete the table:

Buildings With Supplemental Disinfection	**Type of System** (*e.g.*, chlorine, monochloramine, chlorine dioxide, copper-silver)	**Date Installed**	**Serves Hot, Cold, or Both**	**Maintenance Personnel and Contact Information** (in-house or consultant)
			○ Hot ○ Cold ○ Both	
			○ Hot ○ Cold ○ Both	
			○ Hot ○ Cold ○ Both	

Comments/notes:

34. Please describe any maintenance activities (either routine or emergency) carried out on the potable water system in the past year. Obtain records/SOPs if available.

35. Measured Water System Parameters
It is very important to measure and document the current physical and chemical characteristics of the potable water, as this can help determine whether conditions are likely to support *Legionella* growth—think sediment, temperature, water age, and disinfectant residual.

STEP 1: Plan a sampling strategy that incorporates all central water heaters/boilers, storage tanks, and various points along each loop of the potable water system. For example, if the facility has one loop serving all occupant rooms, an occupant room near (proximal) the central hot water heater and another at the farthest point (distal) of the loop should be sampled, at a minimum.

STEP 2: For each sampling point (*e.g.*, tap in an occupant room), turn on the hot water tap and allow the hot water tap to run until it is as hot as it will get. Collect at least 50 ml and measure the temperature. Document the temperature and the time it took to reach the maximum temperature. Measure the disinfectant level and pH. (Note: Measure free chlorine if the disinfectant is chlorine. Measure total chlorine if another disinfectant [*e.g.*, monochloramine] is used.) Repeat for the cold water after letting the tap run for 30 seconds.

Building Name	Name of System (*e.g.*, incoming water, boiler #1, loop #1)	Part of System (Central heater/boiler=C Proximal occupant room=P Distal occupant room=D)	Sampling Site (*e.g.*, heater #1, hot water tap in room #436)	Free Chlorine (ppm)	Monochloramine or Other (ppm)	pH	Hot Temp Max, Cold Temp Min (°F)	Time to Reach Max Temp (min)

Comments/notes:

APPENDIX A. HEALTHCARE, ASSISTED LIVING, AND SENIOR LIVING FACILITIES

Complete for all facilities, including but not limited to hospitals, long-term care/rehab/skilled nursing facilities, assisted or senior living facilities, or clinics.

A1. Type of healthcare facility (check all that apply):

- ☐ Acute care hospital
  - If YES, does the facility have a solid organ or bone marrow transplant program?
    - ○ YES
    - ○ NO
- ☐ Long-term care facility (*i.e.*, nursing home, long term acute care)
- ☐ Rehabilitation facility or other skilled nursing care
- ☐ Assisted living facility
- ☐ Senior living facility
- ☐ Outpatient surgical center
- ☐ Other outpatient clinic (describe): _____
- ☐ Other facility (describe): _____

A2. Number of beds: _____

A3. Are ice machines used to provide ice for patient consumption or processing medical equipment?

- ○ YES
- ○ NO

If YES, list manufacturer and model or catalog number: _____

A4. Do patients or residents at this facility use respiratory therapy equipment (*e.g.*, CPAP, bronchoscopes)?

- ○ YES
- ○ NO

If YES, describe (*e.g.*, source of water used in devices, source of water used to clean devices, and cleaning and drying procedures):

A5. Has this facility experienced previous Legionnaires' disease cases that were "presumptively" or "possibly" facility-associated?
Note: *"Presumptive" healthcare-associated disease is defined as a case in which the person spent greater than or equal to 10 days of continuous stay at a healthcare facility during the 14 days before onset of symptoms. "Possible" healthcare-associated disease is defined as a case in which the person spent a portion of the 14 days before date of symptom onset in one or more healthcare facilities, but does not meet the criteria for presumptive healthcare-associated Legionnaires' disease.*

- ○ YES
- ○ NO

If YES, describe (*e.g.*, number of cases, dates):

APPENDIX B. COOLING TOWERS AND EVAPORATIVE CONDENSERS

This form enables public health officials to gain a thorough understanding of cooling towers/evaporative condensers and how to minimize the risk of Legionnaires' disease through good water management practices. It can be used along with epidemiologic information to determine if a water management program needs to be modified. Information produced using this form may also be used to determine the need for increased or modified environmental sampling, including *Legionella* sampling. The assessment should be performed on site by a person with knowledge of cooling tower mechanics, water treatment, and *Legionella* ecology such as the cooling tower content in the *Legionella* Control Toolkit and the LEAF Marking Guide.

Complete the form in as much detail as possible. Do not leave sections blank; if a question does not apply, write "N/A." If a question applies but cannot be answered, explain why. Where applicable, specify the units of measurement being used (*e.g.*, ppm). Remember to take pictures and attach them to the report to visually support the written findings.

BEFORE ARRIVING ON SITE

- Review CDC's *Legionella* Environmental Assessment Form Marking Guide.
- Review CDC's *Legionella* Control Toolkit: Controlling *Legionella* in Cooling Towers.
- Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility's cooling towers. Cooling towers are commonly maintained by an outside contractor, and they may need to be contacted if facility management does not have an in-depth knowledge of these systems.
- Bring a plastic bottle, thermometer, pH test kit, chlorine test kit, and necessary safety items.
- Request copies of maintenance logs, chemical test results, and sampling results for the previous 12-month period.

Please fill out the following information for each individual tower associated with an investigation. List all cooling towers and evaporative condensers on the facility premises:

Cooling Tower ID (*e.g.*, CT1)	**Operational** (Y/N)	**Manufacturer**	**Date of Installation**	**Location of Device**	**Number of Cells**	**Drift Eliminators Used?** (Y/N)	**Purpose of Towers** (*e.g.*, heating/cooling, industrial process)
	◯ Yes ◯ No					◯ Yes ◯ No	
	◯ Yes ◯ No					◯ Yes ◯ No	
	◯ Yes ◯ No					◯ Yes ◯ No	
	◯ Yes ◯ No					◯ Yes ◯ No	
	◯ Yes ◯ No					◯ Yes ◯ No	

Comments/notes:

General Cooling Tower Disinfection, Operation and Maintenance Characteristics

B1. Disinfectant used in cooling tower(s)?

- ○ YES
- ○ NO

B2. If YES, what type of disinfectant is used?

Oxidizing

- ○ YES
- ○ NO

Non-oxidizing

- ○ YES
- ○ NO

B3. List name(s) of disinfectant used (*e.g.*, chlorine, bromine): _____

B4. Target range in which the disinfectant is regularly maintained: _____

B5. Type of disinfectant dosing system:

Hand fed?

- ○ YES
- ○ NO

Dosing by automated chemical controllers?

- ○ YES
- ○ NO

B6. Schedule of adding disinfectant (*e.g.*, daily, weekly, as needed): _____

B7. Are disinfectant levels monitored?

- ○ YES
- ○ NO

If YES, how often and by whom?_____

Are chemical metering pumps properly maintained and in good condition?

- ○ YES
- ○ NO

B8. Scale and/or corrosion inhibitors used?

- ○ YES
- ○ NO

If YES, what is the schedule for adding scale and corrosion inhibitors (*e.g.*, daily, weekly, as needed):

_____

B9. Type of scale/corrosion inhibitor dosing system:

Hand fed?

- ○ YES
- ◉ NO

Dosing by automated chemical controllers?

- ○ YES
- ◉ NO

B10. Is there an adequate supply (at least 30 days) of chemicals on hand?

- ○ YES
- ◉ NO

B11. Is *Legionella* testing ever performed on the cooling tower?

- ○ YES
- ◉ NO

If YES, how often and by whom? _____

If YES, describe the testing method, frequency, and responsible party:

_____

If YES, request copies of recent (e.g., 6-12 months) test results.

B12. Is the cooling tower turned off at any time?

- ○ YES
- ◉ NO

If YES, include schedule: _____

B13. Are there start-up and shut-down procedures for the cooling tower?

- ○ YES
- ◉ NO

If YES, describe:

Specific Cooling Tower Disinfection, Operation and Maintenance Characteristics

Cooling Tower ID	Current Disinfectant Level	Current Water Temperature	Current Water pH

B14. Were there any recent (last 6 months) special (non-routine) treatments, maintenance or repairs to the cooling tower(s)?

- ○ YES
- ◉ NO

Specify tower ID(s), date, and actions taken:

B15. When was an offline cleaning last performed on the cooling tower(s)?

At what frequency are the scheduled cleanings and what do they include?

Visual Inspection of Cooling Towers

B16. Is pitting or other evidence of corrosion visible on internal metal surfaces?

- ○ YES
- ○ NO

Tower ID(s): _____

B17. How much scale, sediment, and debris are visible in the basin and on drift eliminators? Describe in the notes and include pictures in the report:

B18. Is biofilm build-up observed on cooling tower fill?

- ○ YES
- ○ NO

Tower ID(s): _____

Notes: _____

B19. Is poor water clarity observed in cooling tower basin (*e.g.*, green color, extreme foam)?

- ○ YES
- ○ NO

Tower ID(s): _____

Notes: _____

Record Keeping Review

B20. Are records available regarding cooling tower operation and maintenance?

- ○ YES
- ○ NO

Tower ID(s): _____

Notes: _____

APPENDIX C. HOT TUBS, WHIRLPOOL SPAS, AND HYDROTHERAPY SPAS

In many jurisdictions, public hot tubs are permitted and inspected by the local health authority. An environmental health specialist with expertise in pool and hot tub inspection should participate in assessment of hot tubs and will be aware of local regulations and enforcement powers. They should also have access to a pool sampling kit. Request copies of the last inspection report and routine maintenance logs, if applicable. For additional information related to controlling *Legionella* in hot tubs, see the hot tub module of the Legionella Control Toolkit.

C1. Who operates and maintains the hot tub (*e.g.*, name of on-site facilities management, name and affiliation of outside contractor)? Describe their role and frequency of maintenance:

C2. Describe each hot tub and how it is disinfected:

Hot Tub Questions	Hot Tub 1	Hot Tub 2	Hot Tub 3	Hot Tub 4
Hot Tub Descriptor/Location (*e.g.*, main, private room #)				
Indoor or outdoor	◯ Indoor ◯ Outdoor	◯ Indoor ◯ Outdoor	◯ Indoor ◯ Outdoor	◯ Indoor ◯ Outdoor
Max. bather load				
Filter type	◯ sand ◯ diatomaceous earth ◯ cartridge	◯ sand ◯ diatomaceous earth ◯ cartridge	◯ sand ◯ diatomaceous earth ◯ cartridge	◯ sand ◯ diatomaceous earth ◯ cartridge
Date filter was last changed				
Frequency of filter/filter media replacement				
Date of last filter backwash				
Frequency of filter backwash				
Compensation tank present	◯ Yes ◯ No	◯ Yes ◯ No	◯ Yes ◯ No	◯ Yes ◯ No
Type of disinfectant used Include chemical name, formulation, and amount used.				
Current measured disinfectant level (*e.g.*, free chlorine, bromine) (ppm)				
Current measured pH				
Method used for adding disinfectant (*e.g.*, automatic feeder, by hand)				
Method used for monitoring and maintaining disinfectant and pH levels (*e.g.*, automatic controllers)				
Date last drained and scrubbed				

Hot Tub Questions	Hot Tub 1	Hot Tub 2	Hot Tub 3	Hot Tub 4
Water replacement frequency (*e.g.*, complete drain and refill)				
Was there a recent (*e.g.*, past 2 weeks) disinfectant "shock" treatment? If YES, describe reason and procedures in comments field below. Provide SOP if available	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No
Operating as designed and in good repair If NO, describe issues in comments field below.	◉ Yes ○ No	◉ Yes ○ No	◉ Yes ○ No	◉ Yes ○ No

Comments/notes:

APPENDIX D. OTHER WATER DEVICES

Complete for decorative fountains, water walls, recreational misters, etc. This can also be modified for industrial-use water. If SOPs and maintenance logs exist, request copies. For additional information related to controlling *Legionella* in other water features, see the modules for decorative fountains and other water devices in the *Legionella* Control Toolkit.

Water Feature Questions	Location #1	Location #2	Location #3	Location #4
Descriptor/Location (*e.g.*, lobby fountain, cabana misters)				
Is the device equipped with a filter? If YES, record type in comments field below.	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No
Indoor or outdoor?	◉ Indoor ○ Outdoor	◉ Indoor ○ Outdoor	◉ Indoor ○ Outdoor	◉ Indoor ○ Outdoor
Source of water				
Operates continuously or intermittently	○ Continuously ◉ Intermittently	○ Continuously ◉ Intermittently	○ Continuously ◉ Intermittently	○ Continuously ◉ Intermittently
Presence of a heat source? (*e.g.*, incandescent lighting)				
Current water temperature				
Type of disinfectant used Include chemical name, formulation, and amount used.				
Current measured disinfectant level (*e.g.*, free chlorine, bromine) (ppm)				
Current measured pH				
Is there a maintenance protocol?	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No	○ Yes ◉ No
Date last cleaned and/or flushed				
Operating as designed and in good repair? If NO, describe issues in comments field below.	○ Yes ◉ No	◉ Yes ◉ No	◉ Yes ◉ No	◉ Yes ◉ No

Comments/notes:

APPENDIX E. RECENT* OR ONGOING MAJOR CONSTRUCTION

*Previous 6–12 months.

E1. Describe in general the extent of the construction:

E2. Was temporary water service provided to the new construction area (*i.e.*, separate meter)?

- ○ YES
- ○ NO

If YES, describe:

E3. Has jackhammering or pile-driving been used during the construction process?

- ○ YES
- ○ NO

If YES, list dates and locations:

E4. Have there been disruptions or changes to the existing potable water system during the construction?

- ○ YES
- ○ NO

If YES, describe:

E5. Has the potable water changed in terms of taste, odor, or color during the construction process?

- ○ YES
- ○ NO

If YES, describe the changes including when they started and ended:

E6. Is there an SOP for shutting down, isolating, and refilling/flushing for water service areas that have been subjected to repair and/or construction interruptions?

- ○ YES
- ○ NO

If YES, briefly describe the steps used in the SOP (attach a copy if possible):

E7. Was the potable water system flushed before occupying the new building space?

- ○ YES
- ○ NO

If YES, what period of time passed between flushing and when the building was occupied?

Complete table on next page.

E8. Complete the table below:

New Building/Wing Name or Remodeled Area	Date Construction Began	Estimated Date of Completion	Date Water Service Began or Restarted*	Relationship to Existing Potable Water System	Stories and Square Feet Involved (# and sq ft)	Uses (*e.g.*, hotel guest rooms, dining, recreation, utilities) For healthcare: Inpatient = I Outpatient = O Both = B Intensive Care = ICU Transplant = Tx	Date Occupants Began Occupying New or Remodeled Building	Floors Currently Occupied
				○ Independent ○ Extension				
				○ Independent ○ Extension				
				○ Independent ○ Extension				

*If remodeling of existing structure, include water shut-down date and re-start date.

Comments/notes:

Centers for Disease Control and Prevention

Legionella Environmental Assessment Form Marking Guide

HOW TO USE THIS GUIDE

The *Legionella* Environmental Assessment Form Marking Guide (Marking Guide) is supplemental to the *Legionella* Environmental Assessment Form (LEAF). The LEAF Marking Guide walks the user through the LEAF by providing instructions and additional considerations for the questions. Additional considerations for questions provide further context and discuss relevant risk factors for *Legionella* growth and spread that users may find helpful. Using the LEAF Marking Guide will improve users' understanding of a facility's water systems and aerosolizing devices and assist facility management with minimizing the risk of Legionnaires' disease. The LEAF and accompanying Marking Guide can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to inform a sampling plan. In addition, findings from the environmental assessment can be used to develop a water management program (WMP) by identifying areas at risk for *Legionella* growth or spread. The assessment should be performed on-site by an epidemiologist or an environmental health specialist with knowledge of the ecology of *Legionella*, building water systems, and water treatment. Public health professionals familiar with CDC resources such as the LEAF Marking Guide, *Legionella* Control Toolkit, and PreventLD have the appropriate knowledge to perform the environmental assessment and complete the LEAF.

For more information and detailed guidance on evaluating the key factors for *Legionella* growth in specific water systems and devices, refer to CDC's Toolkit for Controlling *Legionella* in Common Sources of Exposure. For additional training and information, please see CDC's resources for health departments.

LEGIONELLA ENVIRONMENTAL ASSESSMENT FORM

Please fill out the questions ***Person(s) completing the assessment*** and ***Person(s) interviewed during the assessment***. Several parts of this form may require communicating with a facility manager, facility engineer, facility consultant, industrial hygienist, infection preventionist, etc.

Environmental assessments may occur over multiple days. If this is true for your department, please provide the dates the assessment occurred.

FACILITY CHARACTERISTICS

Purpose of Questions 1–19: The growth of *Legionella* is largely dependent on the building water system and fixture characteristics, which include type, size, complexity, and associated devices (*e.g.*, cooling tower). Persons at increased risk of Legionnaires' disease may be more likely to be present at certain facility types, such as healthcare or senior living settings. Providing this information gives public health officials an idea of the possible level of risk of *Legionella* growth and spread. Consult with the facility's maintenance or design professionals when needed.

1. **Is this a healthcare facility or facility with skilled nursing care (*e.g.*, hospital, long term care/rehab/skilled nursing facility, clinic), or an assisted or senior living facility?**
   - ► Select ***Yes*** or ***No***. If unsure, consult with the facility leader(s). If any health care is provided at the facility, then select ***Yes***.
   - ► If ***Yes*** is selected, skip to Question 2 and complete Appendix A.
   - ► If ***No*** is selected, select all facility types that are applicable to the facility you are investigating.
   - ► If the facility type is not listed, check ***Other*** and provide a brief description of the facility on the line provided.

2. **Total number of buildings on the premises and Total number of buildings being assessed:**
   - ► Write the total number of buildings on the premises on the line provided.
   - ► Write the total number of buildings being assessed on the premises on the line provided.

   Additional Considerations: Total buildings assessed will likely be based on case epidemiology (*i.e.*, water systems and devices that people with Legionnaires' disease were exposed to). Keep in mind that if a person spent the entire 14 days prior to illness onset (*i.e.*, the entire exposure period) in a single room, then at a minimum the areas under investigation should include the entire water distribution system that serves that room, as well as any devices using water. If other areas are subject to the same conditions (*e.g.*, no WMP, similar water quality parameters), then they should be considered for inclusion, as well.

3. **Total number of rooms that can be occupied overnight (*e.g.*, patient rooms, hotel rooms):**
   - ► Write the total number of rooms that can be occupied overnight (*e.g.*, patient rooms, hotel rooms) on the line provided. This can help provide an estimate of the facility size and the number of people who may have been exposed to *Legionella*.

4. **Does occupancy vary throughout the year?**
   - ► Select ***Yes*** if there is a noticeable occupancy trend in relation to the seasons. Select all seasons with the lowest occupancy.
   - ► Select ***No*** if there is no noticeable occupancy trend, and skip to Question 6.

   Additional Considerations: Reduced occupancy can lead to reduced water flow. Slowly moving or stagnant water increases water age, which provides opportunities for *Legionella* growth. Increased water age also contributes to disinfectant residual loss and water temperatures favorable for *Legionella*. Please note any interventions in Question 7 to address occupancy-related water stagnation.

5. **Are any occupant rooms taken out of service (*e.g.*, annually for low season, routinely for inventory, permanently for reuse as storage or administrative purposes)?**
   - ► Select ***Yes*** if rooms are closed during times of reduced occupancy or for other reasons describe which rooms are closed and where they are located.
   - ► Select ***No*** if all rooms always remain in service.

   Additional Considerations: Note location of rooms taken out of service or unoccupied, as those can result in areas of stagnation without appropriate intervention. The purpose and use of some occupant rooms may have changed

(*e.g.*, from a patient room to an office space). Determine if associated water piping in the rooms was capped off to prevent dead legs. Note the location of identified case rooms in relation to rooms taken out of service or unoccupied. Identify any interventions in Question 7 to address potential water stagnation.

6. Did the facility recently experience (*i.e.*, last 12 months) a period of prolonged, reduced occupancy, or a building closure?

- ► Select ***Yes*** or ***No***. If unsure, consult with a facility manager.
- ► If ***Yes*** is selected, describe which rooms or buildings the reduced occupancy or closure impacted and where they are located.

Additional Considerations: The amount of time required for stagnant water to increase the risk of *Legionella* growth varies by building water system. In general, as occupancy decreases, potential for water quality issues increases. There is not scientific consensus about how to define prolonged stagnation. Prolonged stagnation events commonly occur due to seasonality, construction activities, or other events. Water age is a key factor in *Legionella* growth and increases with stagnation. There are ways to control water age and potential *Legionella* growth, discussed in Question 7.

7. Describe any interventions taken as a result of building occupancy changes or occupant rooms taken out of service (*e.g.*, flushing, hyperchlorination):

- ► If interventions take place to address issues such as water stagnation or water quality issues (*e.g.*, *Legionella* growth) during periods of reduced occupancy or closures, describe them on the lines provided.

Additional Considerations: To control *Legionella* growth during times of water stagnation, facilities may introduce flushing or remediation with disinfectant. Flushing removes old water from the system and replaces it with fresh water containing disinfectant. Note that flushing uses the routine building water supply, and disinfectant residual will not exceed that which is provided by the supply water. Remediation (*e.g.*, hyperchlorination) is an action taken to reduce *Legionella* growth in response to control measures, such as routine *Legionella* test results, that persistently exceed control limits or to events that pose an immediate risk to control of building water systems (*e.g.*, building related closures, reduced occupancy). Note that remediation involves addition of disinfectant beyond the levels provided in the routine water supply. Thermal remediation, or "super heating," is not recommended for building water systems. The CDC *Legionella* Control Toolkit provides more details on control methods.

8. Average length of stay for occupants:

- ► Select one of the stay lengths listed.

Additional Considerations: Longer stays may correspond to increased risk of exposure to *Legionella*. For example, occupants may be more likely to shower repeatedly and use recreational water features in a tourist destination hotel with longer average stays than an overnight accommodation at a roadside hotel.

9. Does the facility have emergency water systems (*e.g.*, fire sprinklers, safety showers, eye wash stations)?

- ► Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- ► If ***Yes*** is selected, select whether the systems are regularly tested by a professional through methods like sprinkler head flow tests.
  - ▷ If ***Yes*** is selected, describe how frequent the emergency water systems are tested and provide the date of the last test.

Additional Considerations: Fire sprinklers typically have a backflow preventer to prevent stagnant water in the sprinkler system from flowing into the other potable water systems while other emergency water systems (*e.g.*, safety showers, eye wash stations) may not. If an emergency sprinkler system was not in use or tested during the exposure period for cases, and there is backflow prevention in place, it typically is not necessary to evaluate that system further. Consider safety showers and eye wash stations that are not routinely flushed as a potential stagnation point, especially if they are connected to the potable water system that serves other areas under investigation.

10. Are there any cooling towers or evaporative condensers on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix B.

Additional Considerations: For more information on cooling tower design, please refer to the CDC *Legionella* Control Toolkit.

11. Are there any hot tubs, whirlpool spas, or hydrotherapy spas on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix C.

Additional Considerations: Please consider jetted bathtubs as a potential exposure source, especially in healthcare settings. All these devices have the potential to generate aerosols when in use. Components that do not drain fully between uses provide an opportunity for biofilm development. If infrequently used, these devices may also present potential stagnation points.

12. Are there any decorative fountains, misters, or water features on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix D.

Additional Considerations: Decorative fountains should not be operated in areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities. All decorative fountains produce aerosols. Disinfectant residual can be depleted quickly as the water aerosolizes, and it is not uncommon for decorative fountains to lack important control measures such as supplemental disinfectant.

13. Does the facility have centralized humidification (*e.g.*, on air-handling units) or any room humidifiers?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, describe the location in terms of area served in addition to how they are operated on the lines provided.

Additional Considerations: Humidifiers are devices capable of producing aerosols containing *Legionella* and have been associated with outbreaks. Humidifiers and associated equipment should be properly maintained (*e.g.*, cleaning). Multiple types of humidifiers (*e.g.*, heated element and steam-type, portable, portable impeller) exist with different operation and maintenance requirements. Consult the CDC *Legionella* Control Toolkit or ASHRAE Guideline 12 for additional information.

14. Does the facility have ice machines?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer. Hotel maps may describe their locations as well.
- If ***Yes*** is selected, indicate the manufacturer, model, and any other pertinent information.

Additional Considerations: Ice machines should be maintained according to manufacturer recommendations. Ice machines have been identified as the source of exposure to *Legionella* in multiple outbreaks. Ice machines often have carbon filters, which eliminate any disinfectant residual in the water supply. It is common for the compressor to generate heat, resulting in temperatures favorable for *Legionella* growth in the water lines. At temperatures below 68°F, *Legionella* becomes dormant but remains present. Ice used for consumption can be aspirated (*i.e.*, when water or ice "goes down the wrong pipe"), especially in healthcare settings where patients are at increased risk of aspiration. In healthcare settings, ice may also be used for medical procedures or equipment and pose atypical routes of exposure to water.

15. Does the facility have a landscape irrigation or sprinkler system?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe the location and operation by time of day and seasonality. Discuss how they are maintained, as well as other operational details.

Additional Considerations: Sprinkler systems and irrigation systems may generate aerosols. The systems may be less likely to have *Legionella* control measures in place, such as flushing to prevent stagnation or remediation following periods when not in use. In areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities, operation should be timed to minimize exposure (*e.g.*, overnight when fewer patients are entering or exiting the building adjacent to sprinklers).

16. Has there been any recent (last 6–12 months) or ongoing major construction on or around the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes***, also complete Appendix E.

Additional Considerations: Construction may result in pressure drops, which can dislodge biofilm containing *Legionella*. Pressure drops or broken pipes (*e.g.*, water main breaks) can result in intrusion of *Legionella* or sediment that provides conditions favorable for *Legionella* growth. In addition, construction may result in the closure of areas of the building water system, resulting in potential stagnation.

17. Has this facility been associated with a previous legionellosis cluster or outbreak?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or health department.
- If ***Yes*** is selected, describe pertinent outbreak information such as number of cases, dates, likely or confirmed source of *Legionella* transmission, if identified, root cause(s), and any interventions (immediate and long-term) to prevent recurrence. Review the extent to which previously identified root causes of *Legionella* growth do or do not persist.

18. Does the facility have a water management program (WMP)?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager, engineer, or infection preventionist.
- If ***Yes*** is selected, answer whether the facility ever tests for *Legionella* in water samples.
  - If ***Yes*** is selected, obtain copies of the test results or summaries going back at least one year.
- If ***Yes*** is selected, describe the water management program and obtain a written copy of the program policy.

Additional Considerations: Obtaining a copy of the water management program (WMP) is critical to evaluate the effectiveness of the WMP as part of the investigation. WMPs are an industry standard and recommended by CDC for certain building and device types (see the CDC worksheet to identify which buildings and devices should have a WMP: Legionella: Developing a Water Management Program). The lack of a WMP in a facility where recommended is of concern. If the facility lacks a WMP, the information gathered through the environmental assessment may be the only available information about the building water system and potential *Legionella* risk.

If a WMP is available, it is important to review the WMP and ensure that it clearly identifies the areas at risk of *Legionella* growth and spread, states the control measures to prevent *Legionella* growth and spread, lists control limits corresponding to each control measure, and describes corrective actions to take when control limits are not met. The facility should have clear plans for WMP verification (ensuring that the activities are occurring as described in the WMP) and validation (ensuring that the WMP activities are effectively controlling *Legionella* growth). The facility should provide documentation for both verification (*e.g.*, completed checklists and water quality parameter measurements) and validation (*e.g.*, routine environmental sample results for *Legionella*).

If routine environmental sampling has been performed for *Legionella*, review the results, testing method, frequency, and responsible party. See the Routine Testing Module of the *Legionella* Control Toolkit for more information about test type and frequency. Additionally, see Figure 1 for interpretation of routine sampling results.

19. Describe each building that shares water systems (or air systems with centralized humidification), including the main facility.

- In the table provided, fill in all details available on building shared water systems and air systems with centralized humidification. Note that under the "Occupancy Rate" column, "High period" is defined as the time in which the occupancy rate is at its highest in the year. "Low period" is defined as the time in which the occupancy rate is at its lowest in the year.

Additional Considerations: This table is about gaining a better sense of the facility layout, construction history, and facility use to inform the environmental assessment. "Original Construction" indicates age of building piping. "Later Construction" indicates age of building piping and potential complexity of the building water system. "Stories or Levels" indicates complexity of the building water system and is often useful for determining environmental sampling locations. "Occupancy Rate" and "Daily Census" indicates potential for water stagnation and may be used to determine the number of persons potentially exposed to *Legionella*. "Use" indicates potential for people at increased risk for Legionnaires' disease to be exposed to *Legionella*.

Water Supply Source

20. What is the source of the water used by the facility?

- Select all water sources used by the facility. If the water source is not listed, select **Other** and provide a brief description.
- If **Public water system** is selected, provide the name of supplier, check disinfectant used, and whether the disinfectant has been changed within the past year. Consult with municipal water representative if needed.
- If **Private well** is selected, select the disinfectant used and whether the water is filtered on site.

Additional Considerations:

Public water system: Selecting **Other** as the public water system disinfectant is unlikely. Chlorine and monochloramine are the primary disinfectants used throughout the United States. Use the free chlorine test method to measure available chlorine and the total chlorine test method to measure monochloramine.

Changes to municipal water treatment can change the ecology of the public water system. Public water systems that use monochloramine often conduct an annual "chlorine burn" where they temporarily switch to chlorine to reduce nitrification within the public water system. A "chlorine burn" can potentially impact building water quality and result in conditions favorable for *Legionella* growth. Please note the timing of any "chlorine burn" as it relates to case epidemiology (*i.e.*, water systems and devices to which patients were exposed).

Private well: Typically, private wells are not treated with a disinfectant such as chlorine or monochloramine; however, private wells often have filtration or other water quality treatment devices on site (*e.g.*, to reduce sulfur and hardness). Water softener regenerative media and pressure tanks can be a potential reservoir for *Legionella* growth. Additionally, water softeners and filtration can deplete disinfectant.

Other: "Other" sources might include Non-Transient Non-Community Water Systems and Transient Non-Community Water Systems. Per the EPA:

- **Non-Transient Non-Community Water System (NTNCWS):** A public water system that regularly supplies water to at least 25 of the same people at least six months per year. Some examples are schools, factories, office buildings, and hospitals that have their own water systems.
- **Transient Non-Community Water System (TNCWS):** A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods.

21. Have there been any pressure drops, boil water advisories, or water disruptions (*e.g.*, water main break) to the facility in the past 6 months (whether in the public water system before the point of entry and/or on facility property)?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager, engineer, or municipal water representative.
- Is ***Yes*** is selected, describe the incident and which building(s) or part of building(s) were affected.

Additional Considerations: Changes in water pressure and water main breaks may dislodge biofilm containing *Legionella*, increase sediment that promotes *Legionella* growth, or result in intrusion of *Legionella* into the building water supply.

22. Does the facility monitor incoming water parameters (*e.g.*, residual disinfectant, temperature, pH)?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, obtain copies of the logs and describe the ranges for disinfectant residual, temperature, and pH entering the facility.

Additional Considerations: Monitoring incoming water quality is a critical component of a building water management program. It allows facility managers to identify incoming water quality trends over time and make appropriate adjustments to the WMP. Historical readings are relevant when comparing to conditions observed during the environmental assessment. Review values across seasons if possible, as water quality parameters may vary according to ambient temperatures and any routine changes in water treatment (*e.g.*, annual "chlorine burns" described above in Question 20). If there is a clear time frame for potential exposures associated with cases, review water quality parameters for that time (*e.g.*, if there were multiple cases in the first week of December, review water quality parameter values for the month of November to see if changes were made preceding the cases).

Premise Plumbing System

23. Are cisterns and/or water storage holding tanks used to store potable water before it's heated?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.

Additional Considerations: Water storage tanks holding potable water can increase water age, resulting in a decrease in disinfectant. Additionally, improperly insulated tanks or cisterns exposed to sunlight or heat can increase water temperature into the favorable range for *Legionella* growth (77–113°F, 25–45°C). Storage tanks and cisterns can experience irregular flow due to the lack of complete water mixing within the tank or cistern. Recirculation pumps may be installed inside storage tanks and cisterns to ensure proper water mixing and ultimately reduce water aging and avoid temperature stratification.

24. Are water softeners used on incoming water?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, briefly describe whether they are installed on the hot, cold, or both water systems on the line provided.

Additional Considerations: Water softeners can deplete disinfectant residual. Try to measure disinfectant residual prior to the water softener and just after the water softener to identify any impact on disinfectant residual.

25. Are water filters used?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- Is ***Yes*** is selected, describe where the filters on the water system are installed. In addition, describe the filter type and manufacturer/model.

Additional Considerations: Some filters can deplete disinfectant (*e.g.*, carbon filtration) and are potential reservoirs for microbial growth. It's important to note the location of these filters because a centrally located water filter may affect the entire building's water quality. For example, carbon filters located near the building's water point of entry may result in water without

a detectable disinfectant residual throughout the building, creating conditions favorable for *Legionella* growth. Point-of-use microbial filters used to filter for *Legionella* (with an effective pore size of 0.2 microns or less that comply with the requirements of ASTM F838) typically do not impact disinfectant levels, although they may result in reduced water flow and increased water age. Follow manufacturer recommendations on how often filters should be replaced and review documentation to ensure manufacturer recommendations are being followed.

26. Is there a recirculation system (a system in which water flows continuously through the piping to ensure constant hot water to all endpoints) for the hot water?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe where the recirculation system runs and what the delivery/return temperatures are, if measured.

Additional Considerations: A recirculation system decreases hot water stagnation and is a common *Legionella* risk reduction measure through temperature control. Buildings without hot water recirculation are at increased risk of *Legionella* growth if the water age of the hot water system is not controlled. It may be difficult to measure the temperature of the water prior to reheating at the water heater if there is not a sampling port. If there is not a sampling port, measure the water temperature at the most distal fixture on the recirculating system (the fixture furthest from the hot water heater along the distribution system). Note the difference between the water supply temperature just after being heated and the return temperature prior to reheating. Deviations between the two temperatures should be noted as they indicate water age and potential stagnation (*i.e.*, as hot water recirculates faster and more efficiently, the temperature differential should decrease). The *Legionella* Control Toolkit recommends that recirculating temperatures do not drop below 120˚F (49°C). If anti-scald regulations require that hot water be delivered at lower temperatures, other controls may be necessary, such as thermostatic mixing valves located adjacent to fixtures (see Question 27).

27. Are thermostatic mixing valves used?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe where the valves are located on the line provided. In addition, describe the temperature set point(s).

Additional Considerations: Thermostatic mixing valves (*i.e.*, temperature valves) are used to blend hot and cold water to prevent scalding. There are two types of mixing valves: master mixing valves and point-of-use valves. Master mixing valves are centrally located after the water heater, and point-of-use mixing valves are located at the individual fixture level. Thermostatic mixing valves are recommended to be installed as close as possible to fixtures to prevent scalding while permitting circulating hot water temperatures above 120°F (49°C). Master mixing valves may result in temperatures throughout the building water system that are favorable for *Legionella* growth. If a facility is unable to maintain hot water temperatures throughout the system to prevent *Legionella* growth, then other control measures will be critical, such as maintaining presence of disinfectant residual in the hot water.

28. How is the hot water system configured to deliver hot water to each building?

- Fill in the table provided.

Additional Considerations:

Type of System (*e.g.,* instantaneous heater, water heater with a storage tank, solar heating): There are two general types of water heaters: 1) instantaneous and 2) water heater with a storage tank. Instantaneous water heaters do not store water, which is a *Legionella* growth control measure. Water heaters with a storage tank store water and maintain water at a set temperature until the water is used, which increases water age. Water heaters with storage tanks can have temperature stratification (*i.e.*, layers of varying water temperature) resulting in potential temperatures in the favorable range for *Legionella* growth (77–113°F, 25–45°C) despite having a higher temperature set point. Water heaters with storage tanks can also build up sediment and need to be routinely cleaned according to manufacturer recommendations. It is important to

determine whether the heater is gas-fired or electric. Electric heaters may be more prone to temperature stratification due to the heating element design, especially without a pump to recirculate water within the tank. Solar heating is uncommon for potable water and is noteworthy if present, as it has been associated with increased risk of *Legionella* growth.

Name of System (*e.g.*, Boiler #1, Loop #1): Establish a naming convention for individual hot water systems and water heaters. The naming convention allows for efficient communication and development and interpretation of sampling results.

Areas Served (*e.g.*, floor, rooms): Indicate the areas served by each of the systems.

Date of Installation: Installation date of water heater.

Total Capacity (gallons): Storage volume for water heater storage tank. Not applicable for instantaneous heater.

Usual Temperature Setting (˚F): Temperature set point for water heater.

Distal Outlet Temperature (˚F): Maximum temperature observed at distal outlets (*i.e.*, the outlets furthest from the water supply).

29. What is the maximum hot water temperature at the point of delivery permitted by state and local regulations?

- ► Write in the temperature in Fahrenheit or Celsius that the state and local regulations permit at the point of delivery.

Additional Considerations: Regulations to prevent scalding may result in water temperatures within the favorable range for *Legionella* growth (77–113°F, 25–45°C) or under the recommended circulating hot water minimum temperature of 120°F (49°C). Note whether thermostatic mixing valves are installed and, if so, their location (see Question 27). It is concerning if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C) along the water distribution system. Installation of thermostatic mixing valves near fixtures may enable the facility to increase hot water temperatures along the distribution system and maintain compliance with anti-scald regulations at the fixture.

30. Are hot water temperatures ever measured by the facility at the points of use?

- ► Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- ► If ***Yes*** is selected, obtain copies of the temperature logs and write the lowest documented hot water temperature measured at any point within the facility and date it occurred in the space provided.

Additional Considerations: It is important to know whether the hot water temperatures fall within the favorable range for *Legionella* growth (77–113°F, 25–45°C) as water moves through the building water system. Note the difference between the water supply temperature just after being heated and the temperatures at fixtures. Deviations between the two temperatures should be noted as they indicate water age and potential stagnation (*i.e.*, as hot water moves faster and more efficiently, the temperature differential should decrease). Measuring temperatures at points of use is recommended for WMPs. If this is not occurring, facility managers may not be aware of potential risk of *Legionella* growth or building water system control issues, if present.

31. Are cold water temperatures ever measured by the facility at the points of use?

- ► Select ***Yes*** or ***No***.
- ► Is ***Yes*** is selected, obtain copies of the temperature logs. In addition, on the lines provided, record the highest documented cold water temperature measured at any point within the facility and date it occurred. Provide the typical cold water temperature measured within the facility in the summer in Fahrenheit or Celsius on the lines provided.

Additional Considerations: Measuring cold water temperatures at the point of use is recommended in WMPs. If this is not occurring, this may be indicative of a building water system control issue and a potential *Legionella* growth risk factor. Note whether the typical cold water temperature measured within the facility during summer falls within the favorable range for *Legionella* growth (77–113°F, 25–45°C).

32. Are the potable water disinfectant levels (*e.g.*, chlorine) ever measured by the facility at the points of use?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, obtain copies of the logs. Describe how often they are measured in the line provided. Lastly, list the range of disinfectant residuals seen in the summer and winter on the lines provided.

Additional Considerations: Measuring potable water disinfectant levels at the points of use is recommended in water management programs. If this is not occurring, facility managers may not be aware of potential risk of *Legionella* growth or building water system control issues, if present. If disinfectant residual measurements are available, note if there is a difference between summer and winter disinfectant residuals. Note if the lower disinfectant level approaches zero or trace levels, which is a *Legionella* growth risk factor. Note the difference between the disinfectant residual value at the water supply (if measured) and at the fixtures. The difference between incoming and point-of-use values can indicate water age, sediment and biofilm, or warm temperatures that increase depletion of disinfectant residuals.

33. Does the facility have a supplemental disinfection system for long-term control of *Legionella* or other microorganisms?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, obtain the standard operating procedures (SOPs) for routine use and maintenance as well as maintenance logs and records of disinfection levels, and complete the table provided. Review maintenance logs and records of disinfection levels for any changes preceding the exposure period for persons with Legionnaires' disease.

Additional Considerations:

Buildings with Supplemental Disinfection: Supplemental disinfection occurs when adding disinfectant to a water system on site; this may require permitting for potable water systems. Supplemental disinfection systems for potable water should always be automated and require a trained operator based on regulatory requirements. Ensure a trained operator is available during the environmental assessment.

Types of System (*e.g.*, chlorine, monochloramine, chlorine dioxide, copper-silver): Types of supplemental disinfection include chlorine, monochloramine, chlorine dioxide, and copper-silver ionization. More information on supplemental disinfection systems and other methods for *Legionella* control (*e.g.*, ultraviolet light, ozone) can be found at Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review (epa.gov).

Date Installed: Date of installation for supplemental disinfection system(s).

Serves Hot, Cold, or Both: Supplemental disinfection systems typically serve the hot water system. However, they may be installed on the cold water system and/or both systems depending on building water-specific needs.

Maintenance Personnel and Contact Information (in-house or consultant): Personnel familiar with the supplemental disinfection systems are necessary to provide further pertinent information needed in an investigation. Ensure a trained operator is available during the environmental assessment. Supplemental disinfection systems often have consultants who manage the systems. In-house expertise may exist for day-to-day activities.

34. Please describe any maintenance activities (either routine or emergency) carried out on the potable water system in the past year. Obtain records and SOPs, if available.

- Describe in the line provided the maintenance that occurred on the potable water system within the past year.
- If possible, obtain records and SOPs, and attach them to the LEAF.

Additional Considerations: Maintenance activities may result in water pressure changes and water main breaks that may dislodge biofilm containing *Legionella*, increase sediment (which promotes *Legionella* growth), or result in intrusion of *Legionella* into the building water supply. In addition, maintenance may result in the closure of areas of the building water system, resulting in potential stagnation. Maintenance may also alter the design configuration of the building water system, potentially impacting building water quality.

35. Measured Water System Parameters

► Fill in the table provided.

Additional Considerations: Use a thermometer capable of measuring water temperatures up to the maximum water heater temperature. Water heater temperatures may be up to or even greater than 150°F. Ensure that the thermometer is calibrated prior to beginning the environmental assessment.

A digital colorimeter intended for potable water use is recommended to measure disinfectant levels. Digital colorimeters provide accurate objective results, whereas visual test kits are subjective and limit data quality. Ensure necessary reagent is not expired and colorimeter is calibrated per manufacturer recommendations prior to beginning the environmental assessment. Do not use a pool test kit for potable water because it lacks the sensitivity required for the lower disinfectant levels found in potable water versus swimming pools. Ensure that you have distilled water to clean colorimeter sampling components between samples.

Building Name: Building names should be copied from those entered in the Question 19 table.

Name of System: The name of the system should be copied from those entered in the Question 19 table.

Part of System: Increase in distance from water heating source or building cold water entry (*e.g.*, distal fixture location furthest from the water supply) is associated with increased risk of *Legionella* growth. Increased *Legionella* growth risk is due to water age, disinfectant loss, and temperature falling into the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Sampling Site: Provide a name or description of the sampling location that can be easily understood by other staff members and consistent across the document (*e.g.*, "3rd floor, women's bathroom, sink furthest from the door" rather than "1").

Free Chlorine (ppm): Parts per million (ppm) and milligrams per liter (mg/l) are interchangeable. Free chlorine reagent is used to indicate the disinfectant residual available for *Legionella* control when chlorine is the disinfectant. If chlorine is not the disinfectant for the potable water system, then indicate "N/A" for "not applicable."

Monochloramine or Other (ppm): Parts per million (ppm) and milligrams per liter (mg/l) are interchangeable. Total chlorine is used to indicate the disinfectant residual available for *Legionella* control when monochloramine is the disinfectant. Chlorine dioxide requires a specialized reagent to measure for the disinfectant residual available for *Legionella* control. Copper-silver ionization and chlorine dioxide disinfectant, in nearly all cases, will be installed as a supplemental disinfection system. Having the trained operator on site is recommended as they can assist in chlorine dioxide and copper-silver sampling. A commercial laboratory will be needed to analyze the copper-silver samples.

pH: Ensure the pH meter is calibrated prior to performing the environmental assessment. Certain disinfectants have an optimal pH range. More information can be found at Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review (epa.gov). For example, the "anti-microbial efficacy of chlorine declines as pH increases >7, with significant loss of efficacy at pH ≥8." In addition, monochloramine's "optimum pH range for formation of monochloramine is 7.5 to 9" (Technologies for *Legionella* Control in Premise Plumbing Systems).

Hot Temp Max, Cold Temp Min: Temperature can be a key factor in *Legionella* growth if in the favorable range for growth (77–113°F, 25–45°C). If warm water temperatures fall below 113°F (45°C) or if cold water temperatures rise above 77°F (25°C), there is potential for *Legionella* growth in the absence of other *Legionella* controls. Hot temp max should be measured after running hot water until it is as hot as it can get. This indicates the maximum circulating hot water temperature in the building in that particular fixture. Cold temp min should be measured after running the cold until it is as cold as it can get. This indicates the minimum cold water temperature in the building in that particular fixture.

Time to Reach Max Temp (min): Measuring the time that it takes for hot water to reach the maximum temperature is an indication of how quickly or efficiently hot water is traveling from the central heater to the point of use. Comparing the time difference across sampling sites in the building water system is helpful to identify potential building water system issues (*e.g.*, cross connection with cold potable water, stagnation, or plumbing design issue). For example, if showers on floors 1–5 take approximately 30 seconds to reach maximum temperature and showers on floors 6–7 take approximately 2 minutes to reach maximum temperature, despite being on the same hot water recirculating system, then further investigation is needed to understand what may be leading to that difference.

APPENDIX A. HEALTHCARE, ASSISTED LIVING, AND SENIOR LIVING FACILITIES

Healthcare, assisted living, and senior living facilities serve at-risk populations and can have large, complex building water systems. It is important to identify the type of facility (*e.g.*, outpatient clinic), population served (*e.g.*, solid organ or bone marrow transplant recipients), building water systems, and devices that use water during the environmental assessment. The environmental assessment and case epidemiology should inform recommendations to interrupt transmission of *Legionella* (*e.g.*, water restrictions, point-of-use filters).

A1. Type of facility

- Select all facilities that apply.
- If **Acute care hospital** is selected, select whether the facility has a solid organ or bone marrow transplant program.
- If the facility type is not listed, check either **Other outpatient clinic** or **Other facility** and provide a brief description.

A2. Number of beds:

- In the blank provided, write the total number of patient beds or units in the facility. If the facility does not house patients or residents overnight, indicate "N/A" for "not applicable."

Additional Considerations: The number of beds gives both an idea of the size of the facility and the number of persons potentially exposed. The latter can enable calculation of attack rate by dividing the number of cases by the number of persons exposed.

A3. Are ice machines used to provide ice for consumption or processing medical equipment?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, list the manufacturer and model or catalog number in the line provided.

Additional Considerations: Ice machines should be maintained according to manufacturer recommendations. Ice machines have been identified as the source of exposure to *Legionella* in multiple outbreaks. Ice machines often have carbon filters, which eliminate any disinfectant residual in the supply water. It is common for the compressor to generate heat resulting in temperatures favorable for *Legionella* growth in the water lines. At temperatures below 68°F, *Legionella* becomes dormant but remains present. Ice used for consumption can be aspirated (*i.e.*, when water or ice "goes down the wrong pipe"), especially in settings where patients are at increased risk of aspiration. In healthcare settings, ice may also be used for medical procedures or equipment and pose atypical routes of exposure to water.

A4. Do patients or residents at this facility use respiratory therapy equipment (*e.g.*, CPAP, bronchoscopes)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the source of water used in devices, source of water used to clean devices, and cleaning and drying procedures.

Additional Considerations: Respiratory therapy equipment that uses water containing *Legionella* can cause Legionnaires' disease. Always follow the manufacturer recommendations for operating and cleaning these devices, including the use of sterile water or ice as indicated. More information on cleaning devices can be found at Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008 (cdc.gov).

A5. Has this facility experienced previous Legionnaires' disease cases that were "presumptively" or "possibly" facility-associated?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the number of cases, dates, etc.

Additional Considerations: "Presumptive" healthcare-associated disease is defined as a case in which the person spent greater than or equal to 10 days of continuous stay at a healthcare facility during the 14 days before onset of symptoms. "Possible" healthcare-associated disease is defined as a case in which the person spent a portion of the 14 days before date of symptom onset in one or more healthcare facilities, but does not meet the criteria for presumptive healthcare-associated Legionnaires' disease.

Compare current case epidemiology (*i.e.*, potential sources of exposure to water systems and aerosolizing devices for cases) to previous cases of Legionnaires' disease. This may indicate whether current cases are associated with the recurrence of a past issue based on overlapping exposures. Facilities that have experienced cases in the past may have information about prior root cause(s) that can aid in the environmental assessment. Additionally, facilities with a history of associated cases may have experience with response activities and carrying out corrective actions. Healthcare facilities should have a water management program that includes a protocol for responding to associated cases of Legionnaires' disease.

APPENDIX B. COOLING TOWERS AND EVAPORATIVE CONDENSERS

The environmental assessment should be performed on site by a person with knowledge of cooling tower mechanics, water treatment, and *Legionella* ecology. Public health professionals familiar with CDC resources such as the LEAF Marking Guide, Legionella Control Toolkit, and PreventLD have the appropriate knowledge to perform this assessment. Complete the form in as much detail as possible. Do not leave sections blank; if a question does not apply, write "N/A" in the space. If a question applies but cannot be answered, explain why. Where applicable, specify the units of measurement being used (*e.g.*, ppm). Remember to take pictures and attach them to the report to visually support the written findings.

Please fill out the LEAF Appendix B for each individual cooling tower associated with an investigation. List all cooling towers and evaporative condensers on the facility premises.

- Fill in the table provided.

Additional Considerations:

Cooling Tower ID (*e.g.*, CT1): Establish a naming convention for cooling towers. The naming convention allows for efficient communication and development and interpretation of sampling results.

Operational (Y/N): Determining if the cooling tower was operational during the case exposure period(s) can rule in or rule out a cooling tower as a possible exposure source. Cooling towers that operate intermittently due to cooling demand (*e.g.*, industrial or seasonal) may be at increased risk for *Legionella* growth if improperly maintained (CDC *Legionella* Control Toolkit).

Manufacturer and Model #: Manufacturer and model are useful information in understanding individual cooling tower design characteristics. There are many types of cooling tower configurations (*e.g.*, open- and closed-circuit cooling towers).

All cooling towers use the evaporation of water to remove heat and release it into the atmosphere. Cooling towers use circulating water to cool chillers, heat pumps, compressors, condensers, heat exchangers, and other process devices. Both open- and closed-circuit cooling towers require the same basic operation and maintenance protocols. Both types of cooling towers can release aerosolized water to the atmosphere and are at risk for potential *Legionella* growth and spread. If *Legionella* is present, the aerosolized water can spread the bacteria over long distances (typically within 0.5–1 miles, but greater distances are possible). Closed-circuit cooling towers have an additional closed loop that can keep the fluid used in the cooling processes from being exposed to the atmosphere. Closed-circuit cooling towers can operate in cool temperatures in a "dry" mode that does not use water or generate aerosols.

Date of Installation: The age of the cooling tower may impact system performance and risk of *Legionella* growth due to normal wear and tear over the lifespan of system components. For example, accumulation of scale and sediment may occur on cooling tower fill despite routine maintenance (see Questions B16 and B17).

Location of Device: Describe the location of the device (*e.g.*, on roof of medical building). Cooling tower drift (*i.e.*, aerosols blown from the cooling tower fan) can be pulled into nearby building air intakes and open windows. Cooling towers should be located at least 25 feet from building air intakes to reduce likelihood that the cooling tower's drift is not drawn into a ventilation system (CDC *Legionella* Control Toolkit). Cooling towers at ground level or those on roofs adjacent to outdoor areas intended for use (*e.g.*, rooftop patios, open-air parking garage) may be at greater risk for spread if they contain *Legionella*.

Number of Cells: Cooling towers can appear as one unit but have individual subunits (*e.g.*, cells) contained within the single structure. Each cell will have a fan and a water basin which may share water between the other cells. If there are multiple cells, it is possible that some operate less frequently and intermittently idle depending on cooling demand.

Operating times should be balanced among cooling towers (when multiple cooling towers exist) and among cells (when multiple cells exist) to prevent stagnation (CDC *Legionella* Control Toolkit). Understanding the number of cells and, if multiple, their operational relationship is important for identifying areas of potential *Legionella* growth and for developing a representative sampling plan.

Drift Eliminators Used (Y/N): Drift is aerosolized water from a cooling tower that can contain *Legionella*. Drift represents only a small percentage of the water circulating in the cooling tower. Drift eliminators are installed at the air discharge to minimize the escape of drift from the cooling tower and can have different designs (*e.g.*, wavy plastic or metal). Drift eliminators should not be confused with cooling tower fill, which can appear similar in design. Cooling tower fill is used to increase the surface area where water flows, which allows for more contact between the air and the water, to increase evaporation rates and improve cooling. Most cooling tower fill is made up of a plastic-like material. (See Question B18 regarding fill.) Water droplets can contain *Legionella* if the cooling tower is improperly maintained. The absence of drift eliminators increases the potential for cooling towers to disperse *Legionella* when present. High-efficiency drift eliminator designs are recommended and defined by ASHRAE Guideline 12.

Purpose of Cooling Towers (*e.g.*, heating/cooling or industrial process): Cooling towers are heat rejection devices that transfer heat to the atmosphere through evaporation. The most common uses include air conditioning and removing heat from commercial and industrial processes. Cooling towers can operate infrequently or year-round based on cooling need.

Note that individual room air-conditioning units do not use water to cool the air, so they are not a risk for *Legionella* growth.

General Cooling Tower Disinfection, Operation and Maintenance Characteristics

B1. Disinfectant used in cooling tower(s)?

- Select ***Yes*** or ***No***.

Additional Considerations: Disinfectant programs are recommended for cooling towers. Cooling towers without a disinfectant program are at significant risk of *Legionella* growth.

B2. What type of disinfectant is used?

- Select ***Yes*** or ***No*** if the disinfectant is oxidizing.

Additional Considerations: Cooling towers will alternate between oxidizing and non-oxidizing biocides as a best practice for managing bacterial growth. Chlorine- and bromine-containing compounds, including some with proprietary trade names, are typical oxidizing biocides. Examples of non-oxidizing biocides include glutaraldehyde, isothiazolone, and products with proprietary trade names. When in doubt, consult with a person familiar with the operation and maintenance of the cooling tower.

B3. List name(s) of disinfectant used (*e.g.*, chlorine, bromine):

- Name the disinfectant(s) used.

Additional Considerations: Make sure to indicate which are oxidizing or non-oxidizing if multiple disinfectants are used.

B4. Target range in which the disinfectant is regularly maintained:

- Give the target range.

Additional Considerations: The disinfectant range is based upon manufacturer recommendations including product label concentration and contact time (CDC *Legionella* Control Toolkit).

B5. Type of disinfectant dosing system.

- Select ***Yes*** or ***No*** if the disinfectant dosing system is hand-fed.
- Select ***Yes*** or ***No*** if the disinfectant dosing system is automatic.

Additional Considerations: Hand-feeding a cooling tower disinfectant is not recommended. Risk of *Legionella* growth and spread is higher for cooling towers with disinfectant that is hand-fed than for cooling towers with automated disinfectant application. Cooling tower disinfectant application should be automated, as should the disinfectant level monitoring (CDC *Legionella* Control Toolkit). Check that chemical feed pumps are working properly. Chemical feed pumps may have lights or display screens that will indicate if they are not working or are in an error status.

B6. Schedule of adding disinfectant (*e.g.*, daily, weekly, as needed):

- Describe the frequency in which disinfectant is added to the cooling tower(s) on the line provided.

Additional Considerations: Disinfection frequency varies depending on factors such as manufacturer recommendations, cooling tower operation, and cooling tower water management program performance. Note that if the cooling tower is operating with non-oxidizing biocide at the time of the assessment, there may be little to no oxidizing disinfectant. It is recommended that oxidizing disinfectants (*e.g.*, chlorine and bromine) maintain measurable residuals throughout each day when in use. For non-oxidizing disinfectants, maintain disinfectant residual based on product label concentration and contact time (CDC *Legionella* Control Toolkit).

B7. Are disinfectant levels monitored?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe how often and by whom on the line provided. In addition, select ***Yes*** or ***No*** to indicate whether chemical metering pumps are properly maintained and in good condition.

Additional Considerations: Cooling tower disinfectant level monitoring should be automated, as should the disinfectant application (CDC *Legionella* Control Toolkit). If disinfectant level monitoring is not automated, risk of *Legionella* growth increases. Routine monitoring of disinfectant levels and other water parameters such as pH is a best practice and is an important component of cooling tower water management. The frequency of monitoring should be based on performance of the water management program or other performance indicators for control of *Legionella*. Monitoring frequency should be adjusted according to the stability of these performance indicators. For example, the monitoring frequency should be increased if there is a high degree of measurement variability (CDC *Legionella* Control Toolkit).

B8. Scale and/or corrosion inhibitors used?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the frequency at which scale and corrosion inhibitors are added to the cooling tower(s) on the line provided.

Additional Considerations: Scale and corrosion inhibitors are typically used in cooling towers. Alternatives exist, including careful control of pH or addition of polymeric dispersants. If scale and corrosion are not being managed in a cooling tower, the potential for *Legionella* growth increases. The frequency with which scale and corrosion inhibitors should be added is based on manufacturer recommendations and cooling tower operation and maintenance effectiveness. Monitor scale and corrosion inhibitor levels as indicated by water quality measurements (CDC *Legionella* Control Toolkit).

B9. Describe the scale/corrosion inhibitor dosing system.

- Select ***Yes*** or ***No*** if the scale/corrosion inhibitor dosing system is hand-fed.
- Select ***Yes*** or ***No*** if the dosing is done by automated chemical controllers.

Additional Considerations: Hand-feeding scale/corrosion inhibitor is not recommended and increases risk of *Legionella* growth. It is recommended to automate scale/corrosion inhibitor dosing and monitoring (CDC *Legionella* Control Toolkit).

B10. Is there an adequate supply (at least 30 days) of chemicals on hand?

- Select ***Yes*** or ***No***.

Additional Considerations: Having an adequate supply of chemicals on hand ensures there is enough available between maintenance intervals. Typical maintenance intervals can range from weekly to monthly with facilities using external consultants. Having enough chemicals on hand also provides time to order additional chemicals before existing chemicals run out.

B11. Is *Legionella* testing ever performed on the cooling tower?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the testing method, frequency, and responsible party on the line provided.
- If **Yes**, request copies of recent (e.g., 6–12 months) test results.

Additional Considerations: Past *Legionella* testing results, if available, are valuable during an environmental assessment. *Legionella* testing results are an indicator of past cooling tower performance (possibly during the Legionnaires' disease case exposure period).

If routine environmental sampling has been performed for *Legionella*, review the results, testing method, frequency, and responsible party. See the Routine Testing Module of the *Legionella* Control Toolkit for more information about test type and frequency. Additionally, see Figure 1 for interpretation of routine sampling results.

B12. Is the cooling tower turned off at any time?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the schedule on the line provided.

Additional Considerations: When turned off, water in cooling towers can become stagnant, lose disinfectant, and increase risk for *Legionella* growth.

B13. Are there start-up and shut-down procedures for the cooling tower?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the procedures on the lines provided.

Additional Considerations: Cooling towers may be shut down due to system maintenance, low cooling demand, redundant design (*e.g.*, multiple cooling towers), or seasonal operation (*e.g.*, cool temperatures in winter). It is important that procedures to reduce *Legionella* growth are performed during system shut-down or start-up. For example, during wet system standby (*i.e.*, when water remains in the system and the system is shut down for less than five days), the water treatment program should be maintained and water should be circulated three times per week through the open loop of a closed-circuit cooling tower and through an entire open-circuit cooling system (CDC *Legionella* Control Toolkit). Consult ASHRAE Guideline 12 for detailed dry shut-down and system start-up procedures.

Specific Cooling Tower Disinfection, Operation, and Maintenance Characteristics

- Fill in the table provided.

Additional Considerations:

Cooling Tower ID: Copy Cooling Tower ID from the table at the beginning of Appendix B.

Current Disinfectant Level: Report the current observed disinfectant residual level. The absence of disinfectant residual is a Legionella growth risk. Please refer to Questions B2–4, which identify type and target range. Use free chlorine to measure chlorine residual and total chlorine to measure bromine residual. It is typically impractical to measure non-oxidizing disinfectant levels on site. A cooling tower maintenance contractor may be of assistance in measuring disinfectant levels.

Current Water Temperature: Report the current observed water temperature. Note if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Current Water pH: Report the current observed water pH. As detailed in Question 35. Measured Water System Parameters, Additional Considerations, there are optimal pH ranges for each disinfectant. Ensure the pH levels are based on manufacturer recommendations.

B14. Were there any recent (*i.e.*, last 6 months) special (non-routine) treatments, maintenance, or repairs to the cooling tower(s)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, specify cooling tower ID(s), date, and actions taken.

Additional Considerations: Recent special or non-routine treatments may indicate a cooling tower system that was at increased risk of *Legionella* growth. Treatment decisions may have been based on *Legionella* test results or other water quality parameters. Understanding what led to implementation of non-routine treatments may better inform whether the system was at increased risk of *Legionella* growth. Maintenance or repairs may similarly indicate a cooling tower system that was at increased risk of *Legionella* growth if either the issue that prompted repair or the repair process resulted in conditions favorable for *Legionella* growth. It is important to understand what type of repairs and/or system components were impacted (e.g., disinfection feeder).

B15. When was an offline cleaning last performed on the cooling tower?

- Write the date that the cooling tower was last cleaned on the line provided.
- Describe the frequency of the cleanings and the cleaning process.
- At what frequency are the scheduled cleanings performed and what do they include?

Additional Considerations: It is recommended to perform an offline disinfection and cleaning at least annually (CDC *Legionella* Control Toolkit). Note that cleaning means taking the cooling tower offline and physically scrubbing and disinfecting surfaces.

Visual Inspection of Cooling Towers

Purpose of Questions B16–19: It is important to compare the visual inspection with the other elements in the cooling tower environmental assessment. The goal is to confirm that visual inspection findings are consistent with the WMP.

Some scale, sediment, debris, and biofilm may be encountered in a well-managed cooling tower. If a cooling tower is not cleaned at least yearly as recommended, the visual inspection is more likely to reveal increased amounts of scale, sediment, debris, and biofilm compared to one that is cleaned regularly. Other factors, such as whether scale or corrosion is managed through inhibitors or pH, will also have an impact on visual appearance. Take pictures of the cooling tower and any observed scale, sediment, and debris for documentation and additional interpretation.

B16. Is pitting or other evidence of corrosion visible on internal metal surfaces?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided.

Additional Considerations: Pitting and corrosion may be indicative of water quality issues that could impact *Legionella* growth. Water quality issues could include disinfectant and pH levels outside the manufacturer recommendations. The cooling tower should have a scale and corrosion management program (see Question B8). Sediment build-up can also lead to corrosion.

B17. How much scale, sediment, and debris are visible in the basin and on drift eliminators? Describe in the notes and include pictures in the report:

- Describe the amount of scale, sediment, and debris that is visible in the basin and drift eliminators. Include notes and pictures with the LEAF.

Additional Considerations: Note that in areas that are dusty (*e.g.*, desert or construction environments), sediment may build up more quickly in the basin, which may necessitate more frequent cleaning. The potential for significant scale, sediment, and debris build up increases with poor cooling tower operation and maintenance.

B18. Biofilm build-up observed on cooling tower fill?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Cooling tower fill is used to increase the surface area where water flows, which allows for more contact between the air and the water to increase evaporation rates and improve cooling. Most cooling tower fill is a plastic-like material. Visible biofilm build-up is of particular concern as *Legionella* can survive within biofilm. Some biofilm may be encountered in a well-managed cooling tower. It is important to take pictures of observed biofilm for documentation and additional interpretation. The potential for biofilm increases with poor cooling tower operation and maintenance.

B19. Is poor water clarity observed in cooling tower basin (*e.g.*, green color, extreme foam)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Basin water should appear clear in a well-managed cooling tower. Some foam is acceptable. Green or discolored basin water are indicators of poor cooling tower operation and maintenance.

Record Keeping Review

B20. Are records available regarding cooling tower operation and maintenance?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Records indicate past cooling tower operation and maintenance. It is helpful to request cooling tower operation and maintenance records dating back 12 months prior and/or the previous cooling tower season, if seasonally operated. The records review supports the findings of the environmental assessment. For example, check for start-up and shut-down procedures, disinfectant operating levels, cooling tower equipment issues, and any operation and maintenance abnormalities. Pay particular attention to the time of case exposure period and several months prior, focusing on any cooling tower operation and maintenance issues or anomalies described above.

APPENDIX C. HOT TUBS, WHIRLPOOL SPAS, AND HYDROTHERAPY SPAS

C1. Who operates and maintains the hot tub (*e.g.*, name of on-site facilities management, name and affiliation of outside contractor)? Describe their role and frequency of maintenance:

► Provide the hot tub operator contact information and describe their role and frequency of maintenance on the line provided.

Additional Considerations: Public hot tubs are frequently maintained by an outside contractor. The contractor may visit periodically depending on contract requirements (this may range from weekly to monthly). In the meantime, daily oversight of the hot tub (*e.g.*, disinfectant level checks) may be performed by on-site staff. During the environmental assessment, look for gaps in routine operation and maintenance (*e.g.*, daily record keeping requirements). Not all hot tubs are subject to regulation, but they are all at risk for *Legionella* growth and spread, and all should have *Legionella* control measures in place.

C2. Describe each hot tub and how it is disinfected:

► Fill in the table provided. For any information deemed pertinent, place in the notes section.

Additional Considerations:

Hot Tub Descriptor/Location: Note location as it relates to case epidemiologic information. For example, did patients with Legionnaires' disease report using the hot tub or being around the hot tub; or is the hot tub located in an area (*i.e.*, near a lobby or meeting space) where people may have been exposed to hot tub aerosols without realizing it? If the hot tub is an enclosed area, observe whether there are vents that may direct hot tub aerosols to other areas where people could be exposed.

Indoor or outdoor: Indoor and outdoor hot tubs generate aerosols that can expose bathers and anyone spending time near a hot tub. Persons near indoor hot tubs may be at increased risk of aerosol exposure in areas with limited ventilation. Outdoor hot tubs may be exposed to the sun, which can further deplete disinfectant levels which increases the potential for *Legionella* growth.

Max. bather load: Exceeding the maximum bather load can impact hot tub water quality (*e.g.*, deplete disinfectant residual, alter pH), increasing the risk of *Legionella* growth.

Filter type: Each filter type has different operation and maintenance requirements (*e.g.*, backwashing, cleaning, replacement frequency). Filter types include granular media (*e.g.*, sand), precoat, and cartridge. Cartridge filters are difficult to clean and have been associated with *Legionella* growth in previous outbreaks (MAHC annex). A filter containing *Legionella* represents a central source of *Legionella* growth and spread for the hot tub. Please note, filter cartridges cannot be remediated. If the filter contains *Legionella*, then the filter or filter media should be replaced.

Date filter was last changed: Indicate the date the filter was last changed and confirm with records if possible.

Frequency of filter/filter media replacement: Manufacturer recommendations for filter/filter media replacement should be followed. During the environmental assessment, it is important to establish whether the facility has a filter replacement schedule. If they do not replace filters routinely or at the recommended interval, it is a potential *Legionella* growth risk. *Legionella* can grow in filter media, resulting in dispersal of *Legionella* throughout the hot tub (CDC *Legionella* Control Toolkit).

Date of last filter backwash: Sand and diatomaceous earth filters should be backwashed routinely per manufacturer recommendations. During the environmental assessment, it is important to establish whether the facility is backwashing hot tub filters. If they do not backwash filters routinely, it is a potential *Legionella* growth risk. *Legionella* can grow in filter media, resulting in dispersal of *Legionella* throughout the hot tub (CDC *Legionella* Control Toolkit).

Frequency of filter backwash: Filters need to be backwashed frequently per manufacturer recommendations to maintain hot tub water quality. See above paragraph.

Compensation tank present: A compensation tank is for water overflow during times of increased bather load when water in the hot tub is displaced into a temporary holding tank. A compensation tank ensures that appropriate water level depths are maintained in the hot tub. The compensation tank may represent a potential source of stagnant water or biofilm growth. The compensation tank may be inaccessible or hard to reach.

Type of disinfectant used (include chemical name, formulation, and amount used): Either bromine or chlorine can be used as a hot tub disinfectant. Cyanuric acid or stabilized chlorine products are not recommended for use in hot tubs according to the CDC Model Aquatic Health Code (MAHC).

Current measured disinfectant level (*e.g.*, free chlorine, bromine) (ppm): Report the current observed disinfectant residual level. Disinfectant residuals at levels below the recommended range pose a *Legionella* growth risk. Use the free chlorine test method to measure chlorine disinfectant residuals and the total chlorine test method to measure bromine disinfectant residuals. Free chlorine should be 3–10 ppm for chlorine, and total chlorine should be 4–8 ppm for bromine (CDC *Legionella* Control Toolkit). Refer to and follow state and local regulations for specific requirements, which may differ from CDC recommendations.

Current measured pH: Report the current observed water pH. The recommended pH level should be 7.2–7.8 to ensure disinfectant effectiveness (CDC *Legionella* Control Toolkit). Refer to and follow state and local regulations for specific requirements, which may differ from CDC recommendations.

Method used for adding disinfectant (*e.g.*, automatic feeder, by hand): Hand-feeding disinfectant is not recommended and increases *Legionella* growth risk. Disinfectant addition, as well as monitoring, should be automated (CDC *Legionella* Control Toolkit).

Method used for monitoring and maintaining disinfectant and pH levels (*e.g.*, automatic controllers): Disinfectant monitoring, as well as addition, should be automated (CDC *Legionella* Control Toolkit, MAHC).

Date last drained and scrubbed: Scrubbing can help remove sediment or biofilm build-up. Hot tubs should be vigorously scrubbed each time a tub is drained. Routinely draining and scrubbing a hot tub is an important *Legionella* risk reduction measure because biofilm and sediment promote *Legionella* growth (CDC *Legionella* Control Toolkit).

Water replacement frequency (*e.g.*, complete drain and refill): It is recommended to replace water in hot tubs using the following formula: Water replacement frequency in days = (spa volume in gallons/3)/average # users per day (CDC *Legionella* Control Toolkit, MAHC). Water replacement is an important tool for managing overall water quality in hot tubs.

Was there a recent disinfectant "shock" treatment? If yes, describe the reason and procedures. Provide SOP if available: Recent disinfectant "shock" treatment or hyperchlorination may indicate past water quality issues. A recent "shock" treatment may impact *Legionella* test results (*i.e.*, conditions post-shock may not represent normal operating conditions). The CDC *Legionella* Control Toolkit recommends removing hot tubs from service daily to carry out disinfection with a higher-than-normal disinfectant residual. For example, a free residual of 10 mg/L or 10 times the combined chlorine level, whichever is greater, for at least one to four hours is commonly used (CDC *Legionella* Control Toolkit).

Operating as designed and in good repair? If no, describe issues: If the hot tub is not operating as designed and is not in good repair, it may be an indication of potential *Legionella* growth risk.

APPENDIX D. OTHER WATER DEVICES

- Fill in the table provided.

Additional Considerations:

Descriptor/Location: Note location as it relates to case epidemiologic information. For example, did patients with Legionnaires' disease report being near the water device (*e.g.*, decorative fountains, water walls, recreational misters)? Note that all decorative fountains produce aerosols. Decorative fountains or other aerosol-generating devices (*e.g.*, misters, water walls) should not be placed in areas intended for use by persons at increased risk of Legionnaires' disease, such as in healthcare facilities (CDC *Legionella* Control Toolkit) .

Is the device equipped with a filter? Not all decorative fountains or other aerosol-generating devices are equipped with a filter. Filters should be maintained according to manufacturer recommendations. Filters should be considered as a potential reservoir of *Legionella* during the environmental assessment (e.g., sand or cartridge filters). Note that some filters can deplete disinfectant (e.g., carbon filtration), resulting in conditions favorable for *Legionella* growth downstream. Additionally, some filter media can promote biofilm accumulation and *Legionella* growth within the media.

Indoor or outdoor: Indoor and outdoor water devices can generate aerosols that can expose persons near the device. Outdoor water devices (*e.g.*, decorative fountains or recreational misters) may be exposed to the sun, which can further deplete disinfectant levels and increase water temperatures into the favorable range for *Legionella* growth (77–113°F, 25–45°C). When located in enclosed spaces, indoor fountains that contain *Legionella* increase the potential for exposure due to decreased opportunity for aerosol dispersal compared to outdoor devices.

Source of water: Water may come from a public water system, private well, or other source. The source water may or may not have disinfectant.

Operates continuously or intermittently: Devices that work intermittently may be prone to stagnation or disinfectant depletion and be at increased risk of *Legionella* growth. Devices that operate continuously may also deplete disinfectant residual without frequent water replacement or disinfectant addition (see "Type of disinfectant used" below).

Presence of a heat source: A heat source can warm the water into the favorable range for *Legionella* growth (77–113°F, 25–45°C). Common heat sources include lights and the sun. Look for lighting within decorative fountains and determine the bulb type if present. Incandescent bulbs, typically produce more heat than other bulb types, such as LED bulbs.

Observed water temperature: Report the current observed water temperature. Note if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Type of disinfectant used (include chemical name, formulation, and amount used):

Decorative fountains: Disinfectant feed and monitoring systems should be automated, if possible. For fountains using up to 25 gallons of water, treatment with 3–5 ppm free chlorine for at least 1 hour per day is recommended. For fountains using more than 25 gallons, treatment with 0.5 ppm free chlorine for at least 6 hours per day is recommended (CDC *Legionella* Control Toolkit).

Other Devices: Determine if the facility is using a disinfectant appropriate for the system and in accordance with manufacturer recommendations (CDC *Legionella* Control Toolkit).

Current measured disinfectant level (ppm): Report the current observed disinfectant level. Use the free chlorine method to measure chlorine disinfectant residual and the total chlorine method to measure bromine disinfectant residual. Absence of disinfectant residual is a *Legionella* growth risk.

Current measured pH: Report the current observed water pH. Ensure the pH meter is calibrated prior to performing the environmental assessment. Certain disinfectants have an optimal pH range. More information can be found at EPA's Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review. For example, the "anti-microbial efficacy of chlorine declines as pH increases >7, with significant loss of efficacy at pH ≥8." In addition, monochloramine's "optimum pH range for formation of monochloramine is 7.5 to 9" (Technologies for *Legionella* Control in Premise Plumbing Systems).

Is there a maintenance protocol: If yes, describe any type of maintenance being performed not otherwise captured in this section. Refer to the CDC *Legionella* Control Toolkit or ASHRAE Guideline 12 for more details.

Date last cleaned and/or flushed: Cleaning and/or flushing can help remove sediment or biofilm build-up. Routine cleaning and/or flushing water devices is an important *Legionella* risk reduction measure because biofilm and sediment promote *Legionella* growth. Refer to manufacturer recommendations for device cleaning and/or flushing. See Table 1: *Legionella* Control Measures for Decorative Fountains by Volume in U.S. Gallons in the CDC *Legionella* Control Toolkit for cleaning frequency.

Operating as designed and in good repair? If no, describe issues: If not operating as designed and not in good repair, it may be an indication of potential *Legionella* growth risk.

APPENDIX E. RECENT* OR ONGOING MAJOR CONSTRUCTION

**Previous 6–12 months*

E1. Describe in general terms the extent of the construction:

- ► Describe the extent and type of construction on the line provided.

Additional Considerations: Changes in water pressure and water main breaks may dislodge biofilm containing *Legionella*, increase sediment that promotes *Legionella* growth, or result in intrusion of *Legionella* into the building water supply. In addition, nearby construction may result in the closure of areas of the building water system, potentially resulting in stagnation. Note the type of construction. For example, new building construction, potable water construction, and jackhammering or pile-driving may result in conditions favorable for *Legionella* growth, while cosmetic updates to a nearby building are less likely to impact conditions for *Legionella* growth. Note the location of potable water construction as it relates to case epidemiology (*i.e.*, water systems and devices to which associated cases were exposed). For example, did the construction occur on the same hot water recirculating system to which cases were exposed?

E2. Was temporary water service provided to the new construction area (*i.e.*, separate meter)?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the temporary water service on the line provided.

Additional Considerations: If a temporary water service is provided, determine if it was separate from the existing potable water system. A temporary construction water service may be a stagnation risk. Look for any potential cross-connections with the existing potable water system.

E3. Has jackhammering or pile-driving been used during the construction process?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, list dates and locations where jackhammering or pile-driving was used on the line provided.

Additional Considerations: Jackhammering or pile-driving nearby (or even across the street) can dislodge biofilm containing *Legionella* and/or increase sediment which promotes *Legionella* growth.

E4. Have there been disruptions or changes to the existing potable water system during the construction?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the disruptions or changes on the line provided.

Additional Considerations: Disruptions or changes can impact the building water quality. Disruptions can impact various rooms, floors, or wings where the water was shut off during the construction process. Changes can include altering the design of the existing potable water system such as the installation or removal of water heaters, recirculating system pumps, water storage tanks, and water fixtures. Look for changes or disruptions that can increase the risk of *Legionella* growth. For example, installation of a new water heater set to temperatures in the favorable range for *Legionella* growth (77–113°F, 25–45°C), or removal of a sink in a patient room converted to administrative space that creates a dead leg in the piping could increase risk of *Legionella* growth.

E5. Has the potable water changed in terms of taste, odor, or color during the construction process?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the potable water changes including when they started and ended on the line provided.

Additional Considerations: Changes in taste, odor, or color may be indicative of a water quality issue including sediment or biofilm being dislodged during the construction process.

E6. Is there a standard operating procedure (SOP) for shutting down, isolating, and refilling/flushing for water service areas that have been subjected to repair and/or construction interruptions?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, briefly describe the steps used in the SOP on the line provided and include a copy with the LEAF, if possible.

Additional Considerations: Shutting down, isolating, and refilling/flushing are established construction practices and/or required by code. Increased water age may occur in new construction or renovated areas where building water systems are completed, filled with water, and are unused for prolonged periods before the building or floor is occupied. It is important to establish when water system filling/flushing occurred. Note filling/flushing timeframes that extend before two weeks to a month of building use or reoccupation as a potential *Legionella* growth risk.

E7. Was the potable water system flushed before occupying the new building space?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the length of time that passed between flushing and when the building was occupied on the line provided.

Additional Considerations: Note filling/flushing timeframes that occur two or more weeks prior to building use or reoccupation are a potential *Legionella* growth risk. See Question 6 for more information.

E8. Complete the table below:

- ► Fill in the table provided.

Additional Considerations:

New Building/Wing Name or Remodeled Area: Note as it relates to case epidemiology (*i.e.*, water systems and devices to which associated cases were exposed).

Date Construction Began: Note as it relates to case epidemiology.

Estimated Date of Completion: Date of completion is useful in determining when water systems or devices came online and potential for case exposure.

Date Water Service Began or Restarted: Date water service began or restarted is useful in determining when water systems or devices came online and the potential for case exposure.

Relationship to Existing Potable Water System: Determining if the water system is independent or an extension of the existing water system is important for focusing the environmental assessment as it relates to case epidemiology. For example, if the water system under construction is separate from the existing water system (*i.e.*, independent) and there is no known case exposure to the water system under construction, then a detailed investigation of that particular system is not necessary.

Stories and Square Feet Involved (# and sq ft): Understanding the scale of the construction assists in narrowing down potential exposures in the environmental assessment based upon case epidemiology. Additionally, the scale of construction and square feet involved also impact the potential amount of stagnant water.

Uses: Understanding the use of the building and water system under construction (*e.g.*, hotel guest rooms, dining, recreation, utilities, and for healthcare settings: inpatient, outpatient, both, intensive care, transplant) will be helpful in determining the degree of population susceptibility and vulnerability. Additionally, if an area was originally designed for one use but has since been repurposed, it's important to review how fixture types may have changed. For example, if sinks are removed from rooms to update them from patient care to administrative space, then removal of the fixtures could result in dead legs if not capped off at the supply pipe.

Date Occupants Began Occupying New or Remodeled Building: Note as it relates to case epidemiology and answers to Questions E6 and E7. Also review whether occupation may have been gradual in terms of overall occupancy (*e.g.*, periods of lower occupancy overall may have resulted in increased water age) or in terms of area occupied (*e.g.*, if occupants were introduced one floor at a time, then unused floors may have stagnant water if flushing is not implemented).

Floors Currently Occupied: Indicates where occupants (*e.g.*, patients, guests, residents) are located. Compare against relationship with existing water system and other questions in this section. The completed environmental assessment can be used to identify potential risk to occupants on the floors currently occupied and can inform immediate control measures such as installation of point-of-use filters or water restrictions. Note that unoccupied areas may result in stagnant water if flushing is not implemented.

GLOSSARY

Aerosolized water: Small droplets of water in the air (generally, 5 microns in diameter or less), which can contain *Legionella* or other bacteria and can be deeply inhaled into the lungs

Biocide: See disinfectant

Biofilm: Germs and the slime they secrete that stick to and grow on any continually moist surface; provides a stable growth surface and an environment with nutrients for many types of germs, including *Legionella*

Building water systems: Includes hot and cold water distribution systems and all devices that use water to which people can be exposed, such as hot tubs, decorative fountains, and cooling towers

Control: To manage conditions within the building according to a water management program or to maintain established criteria

Control limits: Maximum value, minimum value, or range of values acceptable for the control measures being monitored to reduce risk for *Legionella* growth and spread

Control measures: Actions that can be taken for building water systems to limit growth and spread of *Legionella*, such as heating, adding disinfectant, or cleaning; control measures enable maintenance of control limits

Cooling tower fill: The medium over which water runs to increase surface area and provide increased heat transfer, resulting in increased cooling efficiency

Corrective action: Actions taken to reestablish control when monitoring values or measurements are outside control limits

Dead legs: Piping subject to low or no flow because of design or decreased water use; for example, capped pipes or unused faucets

Disinfectant: Chemical or physical treatment to kill germs; for example, chlorine, monochloramine, chlorine dioxide, bromine compounds, copper-silver ionization, ultraviolet light, or ozone

Disinfectant residual: Amount of disinfectant available in water to kill bacteria

Drift: Water mist or small droplets carried by air, which may include aerosols

Drift eliminator: Device installed in cooling towers where air is discharged to minimize the escape of aerosolized water

Healthcare facility: Hospitals, long-term care facilities, clinics, or other settings where patients seek care, such as dental offices, pharmacies, or outpatient laboratories

***Legionella*:** Bacteria that can cause Legionnaires' disease

Legionnaires' disease: A serious type of pneumonia caused by *Legionella*

Non-potable water: Water not intended for people to drink or ingest, such as water for industrial processes, irrigation, or equipment like cooling towers

People at increased risk for Legionnaires' disease: Includes people 50 years or older, current or former smokers, people with a chronic lung disease (like emphysema), people with weakened immune systems or who take drugs that weaken the immune system, people with cancer, and people with underlying illnesses such as diabetes, kidney failure, or liver failure

Potable water: Hot or cold water intended for people to drink or ingest, such as drinking, bathing, food preparation, and dishwashing

Remediation: Response activities taken to reduce contamination in response to control measures, such as routine *Legionella* test results, that persistently exceed control limits or to events that pose an immediate risk to control of building water systems; required whenever Legionnaires' disease occurs; may also be appropriate for unexpected events such as equipment failure or acts of nature that disrupt the water system

Residual: See *Disinfectant residual*

Routine *Legionella* testing: Testing for *Legionella* to establish a baseline measurement for performance indicators or for validating a water management program or corrective action. Methods and objectives vary from those of non-routine *Legionella* testing

Sediment and scale: Mineral build-up in a water system that uses up disinfectant and supports growth or survival of bacteria

Stagnation: When water does not flow well; areas of stagnation encourage biofilm growth, ambient temperatures, and disinfectant residual reduction

Supplemental disinfection: Adding disinfectant to a water system on site; may require permitting for potable water systems

Thermostatic mixing valves: Plumbing devices used to blend hot and cold water (*i.e.*, to temper water), often to prevent scalding

Validation: Activities to confirm the water management program are working as intended and are effective for *Legionella* control; testing for *Legionella* is one method for validation of a water management program

Verification: Activities to confirm the water management program procedures are occurring as intended; reviewing temperature logs to ensure temperature measurement is occurring at the intended frequency is one method for verification of a water management program

Water age: Amount of time it takes for water to reach a point of use or fixture/device from the point of entry; for example, slow moving water has a greater water age than water moving quickly through a building water system

Water management program (WMP): Multistep process to reduce *Legionella* growth and spread; includes establishing a team, describing building water systems, identifying areas or devices where *Legionella* might grow or spread to people, determining control measures, monitoring control measures, establishing remediation activities and interventions when control measures are not met, ensuring the program is running as designed and is effective, and documenting all program activities

RESOURCES

CDC *Legionella* Control Toolkit:
https://www.cdc.gov/legionella/wmp/control-toolkit/index.html

CDC *Legionella* Water Management Program Toolkit:
https://www.cdc.gov/legionella/wmp/toolkit/index.html

CDC *Legionella* Environmental Assessment Form:
https://www.cdc.gov/legionella/downloads/*legionella*-environmental-assessment-p.pdf

CDC Model Aquatic Health Code (MAHC):
https://www.cdc.gov/mahc/index.html

CDC Model Aquatic Health Code (MAHC) Annex:
https://www.cdc.gov/mahc/pdf/2018-MAHC-Annex-Clean-508.pdf

ASHRAE Guideline 12:
https://www.ashrae.org/technical-resources/standards-and-guidelines

ASHRAE Standard 188:
https://www.ashrae.org/technical-resources/standards-and-guidelines

Cooling Technology Institute Legionellosis Guideline (GDL-159):
https://www.coolingtechnology.org/product-page/legionellosis-guideline-gld-159

EPA Information about Public Water Systems:
https://www.epa.gov/dwreginfo/information-about-public-water-systems

EPA Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review:
https://www.epa.gov/sites/default/files/2016-09/documents/legionella_document_master_september_2016_final.pdf

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Centers for Disease Control and Prevention
National Center for Environmental Health

CDC *Legionella* Control Toolkit: https://www.cdc.gov/*legionella*/wmp/control-toolkit/index.html

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Centers for Disease Control and Prevention

Sampling Procedure and Potential Sampling Sites

Protocol for collecting environmental samples for ***Legionella*** **culture** during a **cluster or outbreak** investigation or when **cases of disease** may be associated with a facility.

Sampling should only be performed after a thorough environmental assessment has been done and a sampling plan has been made. This protocol describes how to take standard biofilm swab, bulk water, and filter samples from commonly sampled sites. This protocol may be used in conjunction with the following tools:

LEGIONELLA ENVIRONMENTAL ASSESSMENT FORM

SAMPLE DATA SHEET

LEGIONELLOSIS OUTBREAK INVESTIGATION VIDEOS:

Legionella Ecology and an Introduction to Environmental Health and Engineering

Conducting and Interpreting the Environmental Assessment

How to Make a Sampling Plan

How to Sample Potable Water

How to Sample Cooling Towers

How to Sample Spas and Fountains

Centers for Disease Control and Prevention
National Center for Immunization and Respiratory Diseases

MATERIALS NEEDED

- ❒ Sterile plastic 1 L bottles. (Glass bottles are not recommended due to risk of breakage during transport.)
- ❒ Sterile plastic 15 mL screw top tubes (with a tube rack) for biofilm swabs.
- ❒ Disposable Dacron/polypropylene-tipped swabs with wooden or plastic stems. Do NOT use cotton-tipped swabs as they inhibit *Legionella* growth.
- ❒ Labels.
- ❒ 0.1N solution of sodium thiosulfate ($Na_2S_2O_3$) (15.81 g/L in distilled water, filter sterilize, replace every 12 months).
- ❒ Pipettes and bulbs for adding 0.5 mL of 0.1N sodium thiosulfate solution into 1 L water samples.
- ❒ Sterile plastic 500 mL or 1 L bottle for testing chlorine level, pH, and temperature.
- ❒ pH test kit.
- ❒ Chlorine test kit sensitive enough to detect chlorine level below 2 ppm and up to 10 ppm (may need two kits). Free chlorine may be measured when it is known that chlorine is the method of disinfection (as opposed to monochloramine, bromine, or another disinfectant). Otherwise, measure total chlorine.
- ❒ Thermometer.
- ❒ Sample data sheet and pens.
- ❒ Large cooler, preferably with wheels. A 70 quart (66.2 L) horizontal cooler (a standard large picnic cooler) should fit twenty-five 1 L bottles, twenty-five 15 mL plastic tubes for biofilm swabs, thermometer, pH, and chlorine test kits. For sampling of a larger facility (60–100 samples total), a second cooler that holds nothing but bottles, swabs, and tubes may be needed. The cooler may be packed ahead of time and stored at ambient temperature for an unlimited time as long as the sodium thoisulfate solution is replaced every 12 months.

OPTIONAL MATERIALS

- ❒ Packing tape and scissors for sealing the cooler for mailing or air travel.
- ❒ Biohazard waste bags are useful for collecting trash.

SAFETY PRECAUTIONS

The facility should be notified in advance to turn off (but do not drain or disinfect) any aerosol-generating devices to minimize the risk to the sampling team. Persons at an increased risk of developing Legionnaires' disease if exposed to *Legionella* (e.g., immunocompromised individuals) should not accompany the sampling team.

Optional personal protective equipment (PPE):

- ❒ Gloves are useful for sampling whirlpool spa filters or other sites that may be heavily contaminated with organic material.
- ❒ Wearing a half-face air-purifying respirator equipped with an N95 filter may be appropriate in the following situations: a.) when sampling cooling towers if the fans cannot be turned off, or b.) in enclosed spaces with an aerosol-generating device that cannot be turned off. Respirators must be used in accordance with a comprehensive respiratory protection program, which includes fit testing, training, and medical clearance ahead of their use (see OSHA standard 29 CFR 1910.134). For more information about N95 respirators, visit the National Institute for Occupational Safety and Health (NIOSH) website.

SAMPLING POTABLE WATER AT THE POINTS OF USE

Note: In most situations, it's appropriate to sample only the hot water. However, there are situations where taking some cold water samples is helpful. For example, in hot climates, the cold water may be warm enough for rapid *Legionella* amplification (>77°F). Desalination may also elevate cold water temperature. Cold water could also be warm due to lack of insulation between hot and cold water pipes.

Collect one biofilm swab and one bulk water sample from each sampling site (i.e., each showerhead or faucet).

1. For showers, ask facility maintenance personnel to remove the showerhead. For faucets, ask them to remove the aerator.

Take biofilm swabs:

2. Turn on the water for a couple of seconds to moisten the pipe, and then turn it off. Insert a sterile Dacron- or polypropylene-tipped swab deep into the faucet/pipe. Try to get beyond the bend and swab around the inside surface firmly without breaking the swab stem. (If there is visible biofilm on the inside of the showerhead or faucet aerator when these are removed, they can also be swabbed.)
3. Place the swab into a 15 mL sterile plastic tube and add 3–5 mL of water from the same faucet to keep the swab tip moist during transport. Snap the wooden or plastic swab stem approximately 1 in. from the top of the tube. Add a drop of 0.1N sodium thiosulfate solution to neutralize residual disinfectants. Tighten the tube top to prevent leakage.
4. Label the tube with a unique identifier. Record the type and location of the sample on a Sample Data Sheet, and place the tube into a cooler.

Take bulk water samples:

5. After the biofilm swab is collected, turn on the water and let it run until the water is warm but not hot. The goal is to obtain water currently in the piping behind the fixture along with any material shed from biofilm. Avoid heating water excessively (approximately 122°F or higher) since free-floating *Legionella* will die quickly at elevated temperatures. Collect 1 L of water from the faucet into a sterile 1 L bottle, leaving a 1 in. space at the top.
6. Add 0.5 mL of 0.1N sodium thiosulfate solution to the water sample to neutralize residual disinfectants. Tighten the bottle top to prevent leakage.
7. Label the bottle with a unique identifier. Record the type and location of the sample on the Sample Data Sheet, and place it into the cooler.

Measure water parameters:

8. Run the hot water until it is as hot as it will get. Collect 100–300 mL of water in a separate plastic sampling bottle. The same bottle can be used for measuring water parameters at every sampling site. Measure temperature, pH, and chlorine level of the sample. Record all measured data on the Sample Data Sheet. If it takes more than a minute for the water to get hot it could indicate a local problem, such as with a mixing valve, or a system-wide imbalance.

SAMPLING POTABLE WATER AT THE HOT WATER HEATERS

1. Collect a bulk water sample only; it is rare that a biofilm sample can be obtained from a hot water heater since this would require completely draining the tank.
2. Ask facility maintenance personnel to open the drain valve of the hot water heater and collect 1 L of water into a sterile 1 L bottle, leaving a 1 in. space at the top.
3. Add 0.5 mL of 0.1N sodium thiosulfate solution to the water sample to neutralize residual disinfectants. Tighten the bottle top to prevent leakage.
4. Label the bottle with a unique identifier. Record the type and location of the sample on the Sample Data Sheet, and place it into the cooler.
5. Always measure and record the temperature, pH, and chlorine level of a bulk water sample collected from a hot water heater.

SAMPLING WHIRLPOOL SPAS

1. Take biofilm swabs from inside several jets and at the water line.
2. Place each swab into a 15 mL sterile plastic tube (one swab per tube) and add 3–5 mL of water from the whirlpool spa tub to keep the swab tip moist during transport. Snap the wooden or plastic swab stem approximately 1 in. from the top of the tube. Add a drop of 0.1N sodium thiosulfate solution to neutralize residual disinfectants. Tighten the tube top to prevent leakage.
3. Label each tube with a unique identifier. Record the type and location of the sample on a Sample Data Sheet, and place the tube into a cooler.
4. If the whirlpool spa tub is not drained, collect a 1 L bulk water sample in a sterile 1 L bottle. If the pool is partially drained, a sterile 15 mL tube may be used to collect the remaining whirlpool water. If the spa has been completely drained, ask facility maintenance personnel for access to the compensation tank (for collection of overflow water) and take a bulk water sample from there.
5. Add 0.5 mL of 0.1N sodium thiosulfate solution to neutralize residual disinfectants to the 1 L water sample. Tighten the bottle top to prevent leakage.
6. Label the bottle with a unique identifier. Record the type and location of the sample on the Sample Data Sheet, and place it into the cooler.
7. Collect 100–300 mL of water from the whirlpool spa tub (or the compensation tank if drained) in a separate plastic sampling bottle. Measure temperature, pH, and free chlorine or bromine level of the sample. Record all measured data on the Sample Data Sheet.
8. It is very important to collect a filter sample from whirlpool spas. Request access to the filter (which is usually located in a separate maintenance room) from the facility maintenance personnel. Gloves should be worn due to heavy organic loads typically found in filters and the abrasive or caustic nature of some filter filling material. The methodology for filter sample collection depends on the filter type.
    a. Sand filters: Collect some sand and enough water from the filter to cover the sand and keep it moist. Collect 300–500 mL of water from the filter chamber into a sterile 1 L bottle. Use the same or a new bottle to scoop sand from the chamber, and pour the sand into the bottle making sure that it is completely covered by water.
    b. Cartridge filters: Cut a portion of the filter to fit inside a 1 L bottle and add enough water from the filter chamber to cover it and keep it moist.
    c. Diatomaceous earth filters: Collect 300–500 mL of water from the filter chamber into a sterile 1 L bottle and use a sterile swab to scrape diatom powder from the grid. Place the powder into the bottle making sure that it is completely covered by at least 1 in. of water.
    d. Add 0.5 mL of 0.1N sodium thiosulfate solution to the sample to neutralize residual disinfectants. Tighten the bottle top to prevent leakage.
    e. Label the bottle with a unique identifier. Record the type and location of the sample on the Sample Data Sheet, and place it into the cooler.

LIST OF POTENTIAL SAMPLING SITES*

POTABLE WATER

Site	Approximate number of samples	Type of samples	Sample processing†
Incoming water main (where water enters the facility/campus/building from the municipality)	1	1L bulk water	Concentrate
Every well and water tower that supplies water to the facility/campus/building	1 per well or water tower	1L bulk water	Concentrate
Every holding tank or cistern	1 per holding tank/cistern	1L bulk water	Concentrate
Centralized water heater	1	1L bulk water (a biofilm swab if drained)	Direct
Expansion tank for hot water (absorbs excess water pressure caused by thermal expansion within the hot water heater)	1	1L bulk water	Concentrate
Hot and cold water returns	1 each for hot and cold	1L bulk water	Concentrate
For buildings with water softeners, special filters, and disinfection systems, sample water before and/or after these processes		1L bulk water	Concentrate
Shower	2 per shower‡	1 biofilm swab and 1L bulk water	Concentrate
Faucet	2 or 3 per faucet‡	1 biofilm swab inside the faucet, (1 biofilm swab of the inside of the aerator if visual inspection indicates that it's overgrown with biofilm), 1L bulk water	Concentrate
Whirlpool baths€ (i.e., Jacuzzis)	1	1 biofilm swab inside the jets	Concentrate

*COOLING TOWERS*Ω

Site	Approximate number of samples	Type of samples	Sample processing†
Make-up water (water added to replace water loss because of evaporation, drift, or leakage)	1	1L bulk water	Direct
Collection basin (an area below the tower where cooled water is collected and directed to the sump)	2	1L bulk water and a biofilm swab at the water line	Direct
Sump (a depressed chamber contiguous to the basin, where water flows to facilitate pump suction; may also be used as collection point for silt and sludge)	2	1L bulk water and a biofilm swab at the water line	Direct
Storage tank or reservoir in the system	1	1L bulk water	Direct
Drift eliminators or other surfaces that remain moist	1	1 biofilm swab	Direct
Heat sources (e.g., chillers)	1	1L bulk water	Direct

WHIRLPOOL SPAS

Site	Approximate number of samples	Type of samples	Sample processing†
Water in the tub	1	1L bulk water	Direct (concentrate if chlorine is detected by odor or direct testing)
Biofilm at the water line	2	Biofilm swabs (the quantity depends on the size of the tub)	Direct
Water jets	2	Biofilm swabs of several jets	Direct
Filter	1 per filter	Combination of water and a filling (sand in sand filters, diatom powder in DE filters, or polyester filling in cartridge filters) to keep the filing moist during the transport	Direct
Compensation tank	1	1L bulk water	Direct (concentrate if chlorine is detected)

OTHER SOURCES

Site	Approximate number of samples	Type of samples	Sample processing†
Decorative fountains	2	1L bulk water and a biofilm swab (number of swabs dependent on size and complexity of the fixture)	Direct
Sprinkler systems	>2	1L bulk water and one or several biofilm swab(s) of the sprinkler jets	Concentrate
Safety showers and eye wash stations	2	1L bulk water and a biofilm swab	Concentrate
Humidifiers	2	Bulk water (as close to 1L as possible) and at least one biofilm swab of moist surface	Concentrate
Nebulizers, hand-powered resuscitation bags, intermittent positive pressure breathing ventilators, and other respiratory care equipment that uses water for filling or cleaning	>2	1L bulk water used to clean the device and biofilm swabs of moist surfaces	Concentrate

*This table is a list of commonly sampled sites; however, all sites need not be sampled during every outbreak. Important: Use CDC sampling procedures.

†This table provides general recommendations on whether a sample should be processed directly or concentrated based on the assumption that potable water samples typically contain less bacteria and fungi than non-potable water samples. For each sample, decisions about the processing strategy should be made depending on specific circumstances (e.g., a decorative fountain contains water with a strong odor of chlorine or a bulk water sample from a faucet that has no detectable chlorine level).

‡All showers and faucets in all case rooms should be sampled, along with showers and sink faucets in additional rooms. Choose rooms proximal and distal to risers or hot water heaters and on various floors based on the results of the environmental assessment. Ideally, sample at least a couple of outlets on every floor and/or wing.

€Whirlpool baths are filled from the tap and drained after each use.

ΩNot all cooling towers have all listed components. Engage an engineer or maintenance technician familiar with the facility to identify appropriate sampling sites for a particular cooling tower.

Sample Data Sheet

Use this form to keep track of environmental samples taken for *Legionella* culture during a legionellosis outbreak investigation.

NOTE: this is NOT a chain of custody form.

Sample ID	Date Collected	Specimen Type (e.g., water, swab, filter)	Sample Description (e.g., room 253 shower)	Temp (ºF)	Free Cl_2 (ppm)	Total Cl_2 (ppm)	pH

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