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https://youtu.be/K1ubp51PEpk

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PHO Rounds Series: *Legionella* Outbreak Investigations: A Practical Approach Session 3

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Presenter Disclosures – Colin Lee

- I do not have a relationship with a for-profit and/or a not-for-profit organization to disclose

Presenter Disclosures – Karen Kivilahti

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Acknowledgements

Danielle Hachborn

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SMDHU's investigation teams

- **Clinical**
- **Environmental**

Public Health Ontario

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Presentation Objectives

By the end of this session, participants will be able to:

1. Describe how to do an environmental risk assessment of a cooling tower including evaluation of bacteria control maintenance programs.
2. Discuss the value and interpretation of various environmental testing protocols when investigating *Legionella* outbreaks.
3. Describe potential interventions and communication strategies during a community *Legionella* outbreak.

Outline

- Outbreak summary
- Communication
- Environmental investigation
- Environmental sampling

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Outbreak Summary

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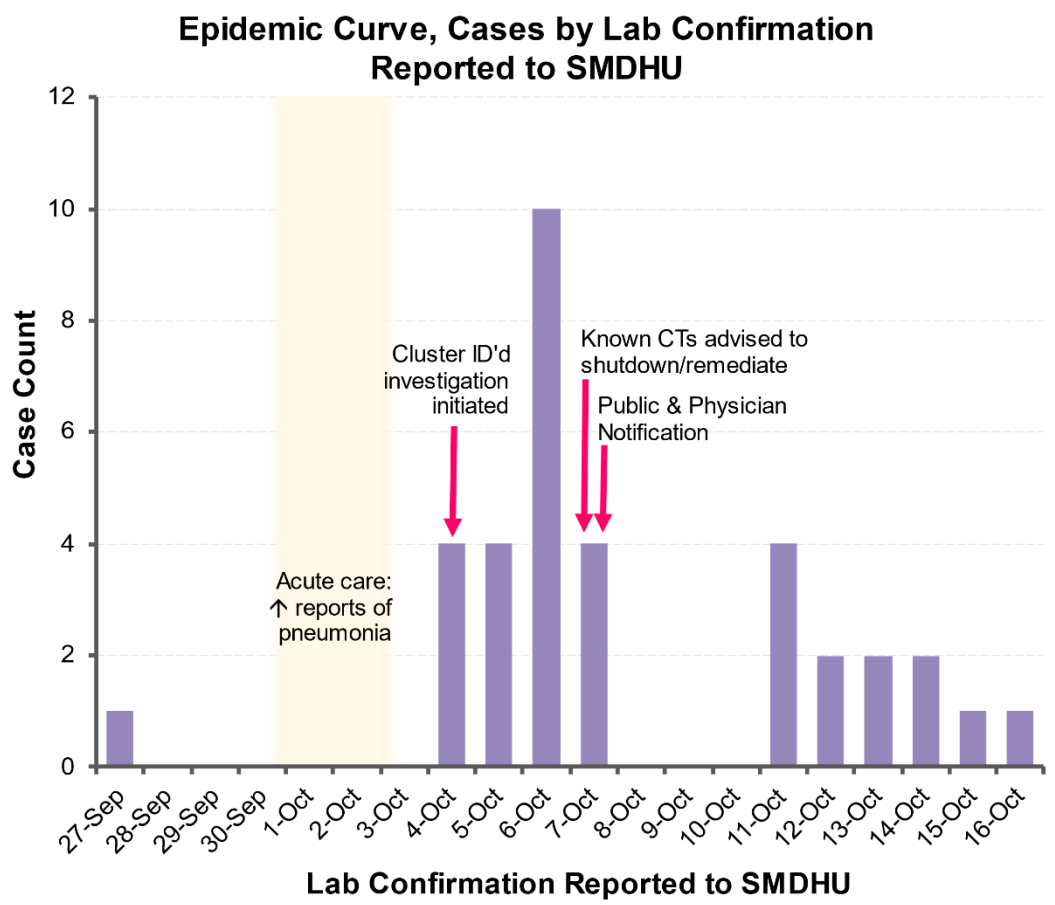
Clinical Summary

- Thirty-five laboratory-confirmed legionellosis cases were reported to the Simcoe Muskoka District Health unit between September 27, 2022, and October 15, 2022, including seven residents within a long-term care home (LTCH).
- The community outbreak resulted in one death and 29 hospitalizations.
- One laboratory isolate (sputum) from a confirmed clinical case was identified as having the same rare sequence-based typing as an environmental isolate from a water sample collected from a cooling tower (CT).
- An outbreak of legionellosis in the same community in 2019 resulted in 10 cases (all admitted to hospital) and one death.

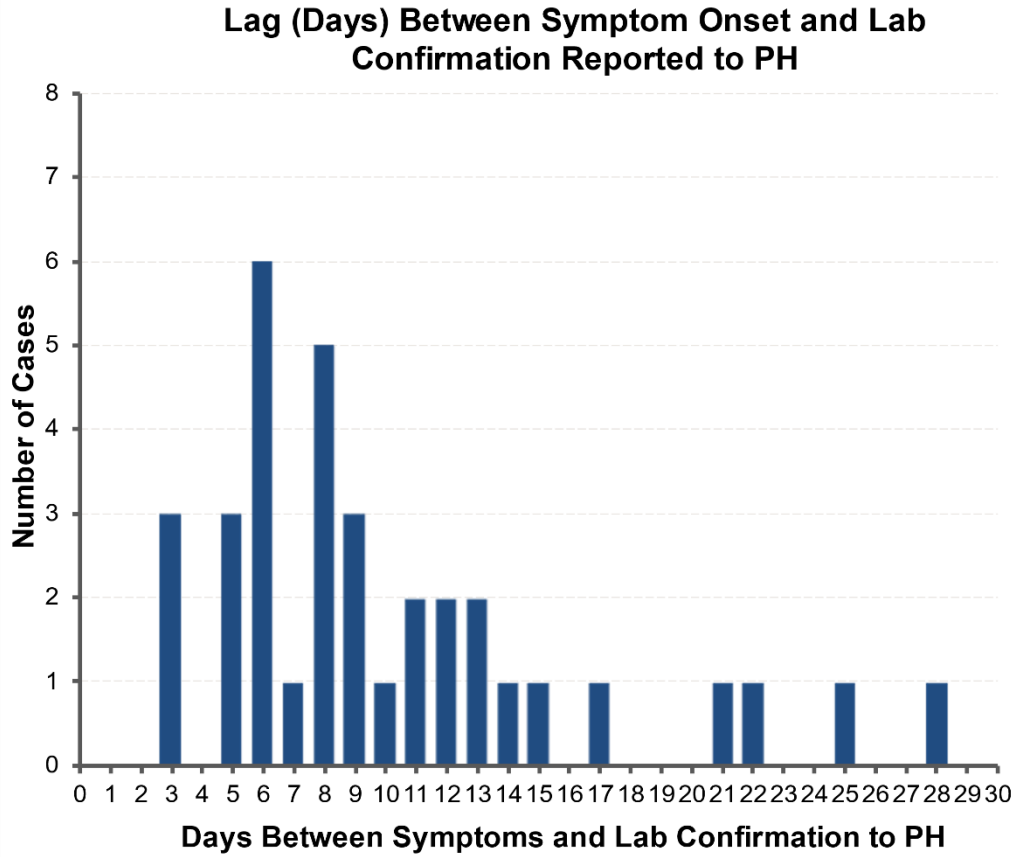
Environmental Investigation Summary

- Based on case investigation and case activity within the community (residing, visiting, or employed within) and lack of a common source identified , a 6 km radius was established to assist with the identification of a common community source of transmission.
- During the investigation 27 CTs were identified and 19 CTs sampled within the 6 km radius.
- Sampling was also conducted from plumbing in a long-term care facility due to multiple legionellosis cases residing there.

Case Reporting



Data Sources: Investigation Line List, extracted June 1, 2023.



Data Sources: Investigation Line List, extracted June 1, 2023
Note: For two out of jurisdication cases linked to outbreak, lag is based on time b etween symptom onset and date SMDHU received notification which is likely after lab confirmation received by original PHU.

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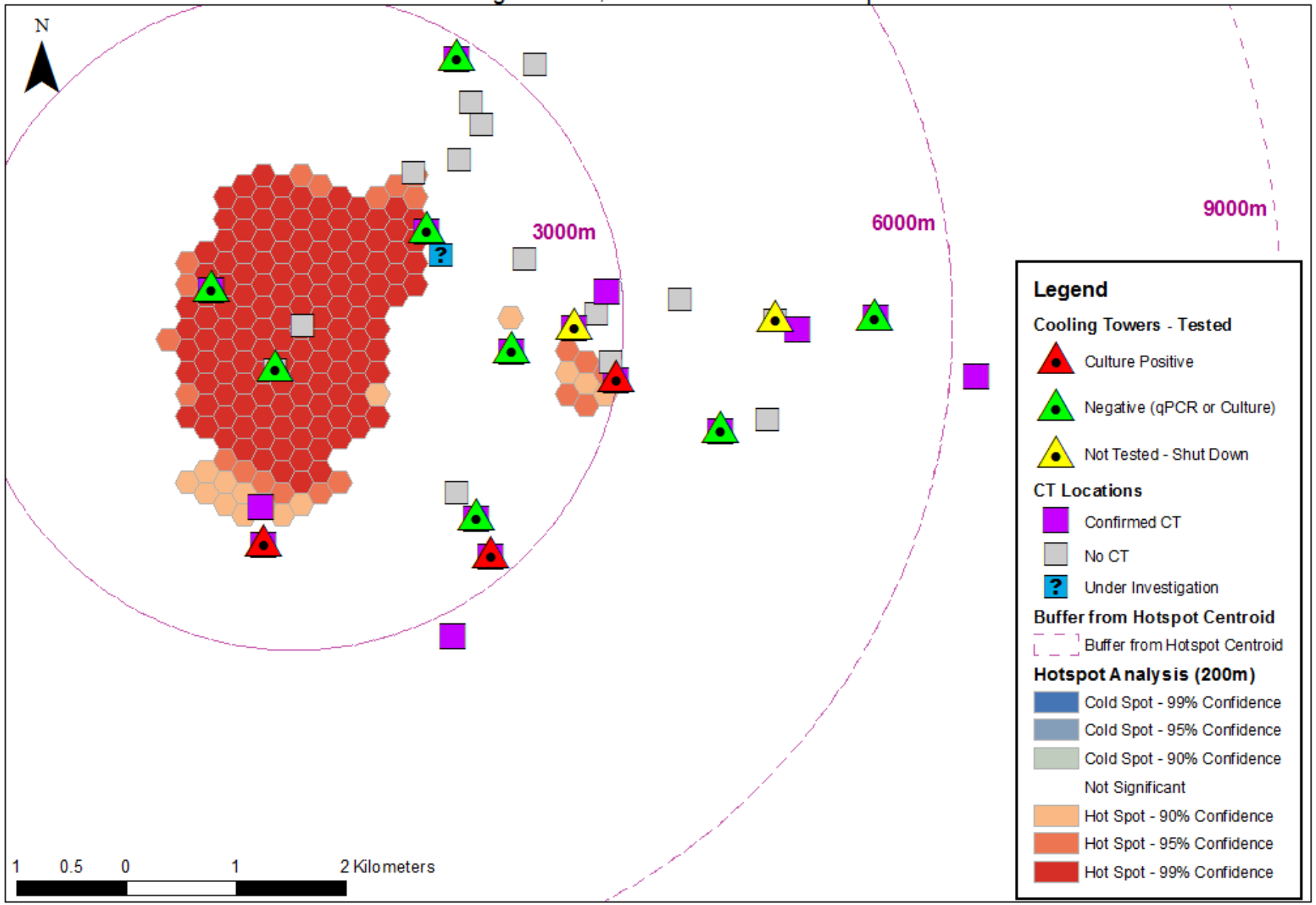
Legionellosis Cluster Map:
Cooling towers with testing results for *L. pneumophila* with hotspot analysis
and buffer rings at 3km, 6km and 9km from hotspot centroid



Source: Legionellosis Cluster 2022 Investigation Case Data and Environmental Health data
qPCR = quantitative polymerase chain reaction; m=metres

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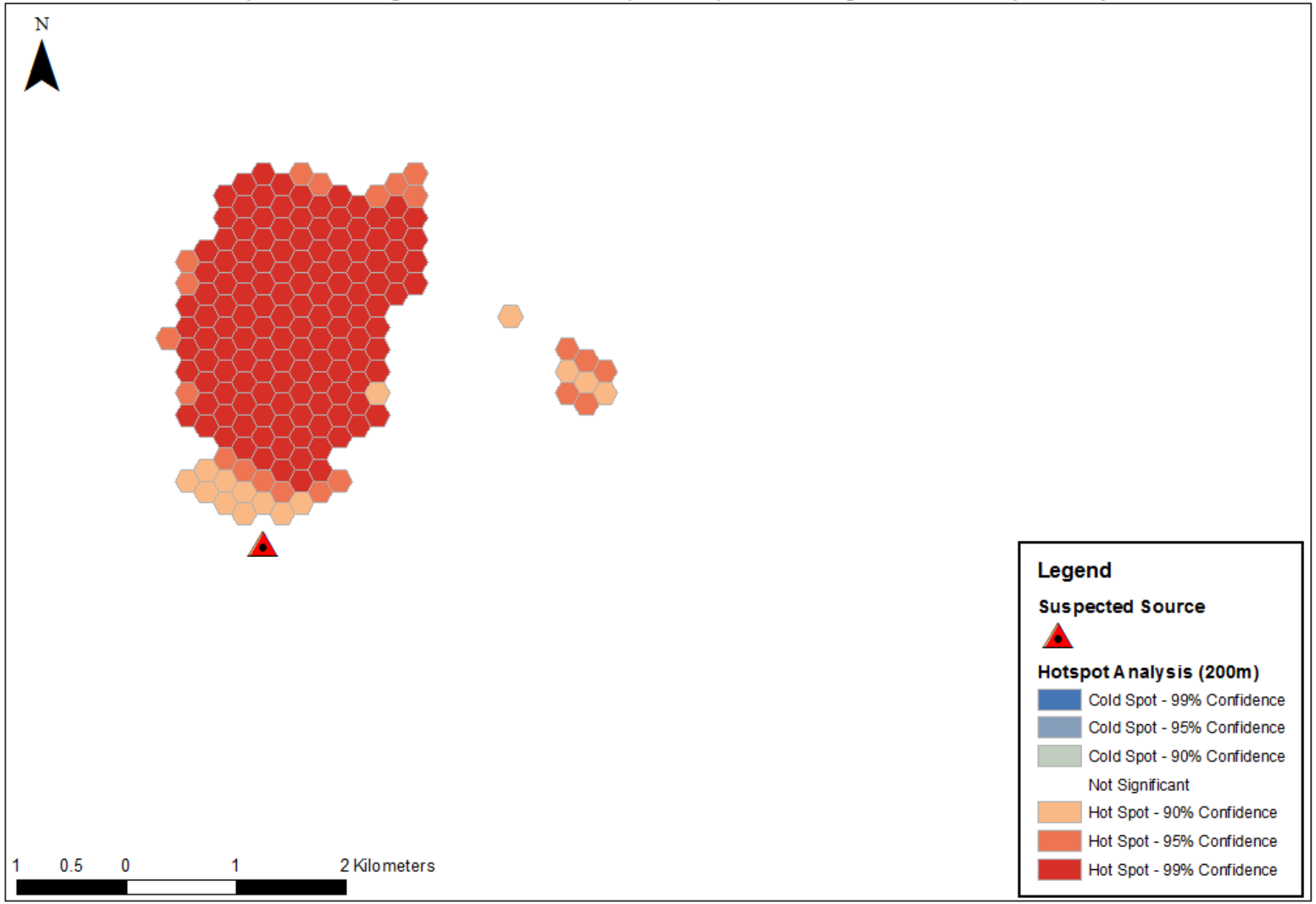
Legionellosis Cluster Map:
Suspected cooling tower location for *L. pneumophila* investigation with hotspot analysis



Source: Legionellosis Cluster 2022 Investigation Case Data and Environmental Health data
qPCR = quantitative polymerase chain reaction; m=metres

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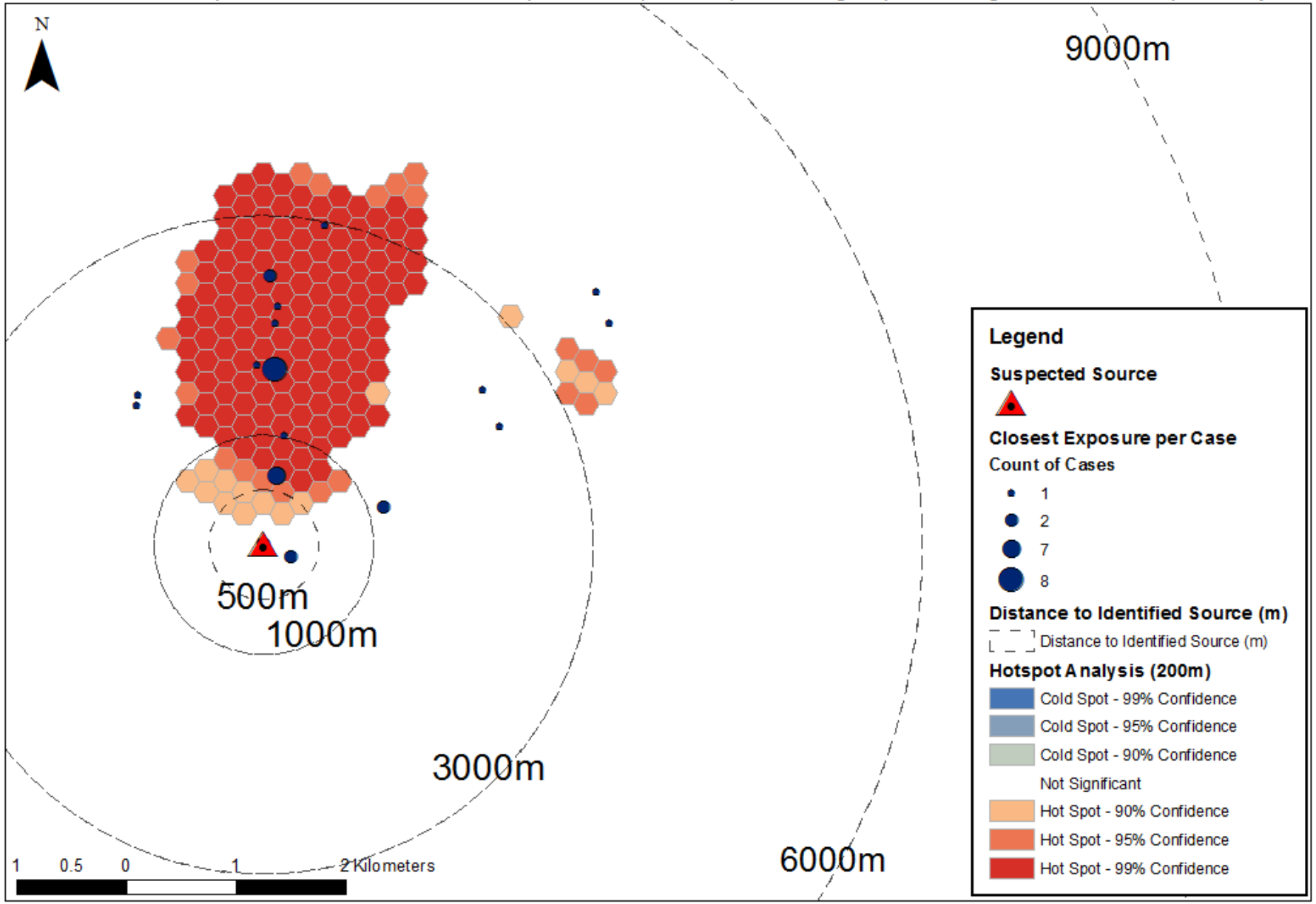
Legionellosis Cluster Map:
Closest case exposure location in relation to positive *L. pneumophila* serogroup 1 cooling tower with hotspot analysis



Source: Legionellosis Cluster 2022 Investigation Case Data and Environmental Health data
qPCR = quantitative polymerase chain reaction; m=metres

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Communication

Communication

- Health Care Provider communication on October 7, 2022 (3 days after cluster detection)
  - For case-finding
  - Appropriate testing and treatment of suspected cases
- Public Communication on October 7, 2022
  - Done early to ensure transparency of investigation
  - Contextualize risk to the public: e.g. risk mainly for those over 50, smokers, those with existing lung issues and medical conditions
  - Provide appropriate health seeking behaviour
  - Ongoing interest until final press release on November 8, 2022, to declare outbreak over

Polling Question

What are some of the key components of a comprehensive *Legionella* control maintenance program? Select all that apply.

1. Maintaining water quality
2. Cleaning and disinfection
3. Testing water quality
4. Monitoring disinfectant levels, if applicable
5. Assessing mechanical components and equipment
6. Maintenance records
7. Evaluation of maintenance program
8. All the above

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Environmental Investigation

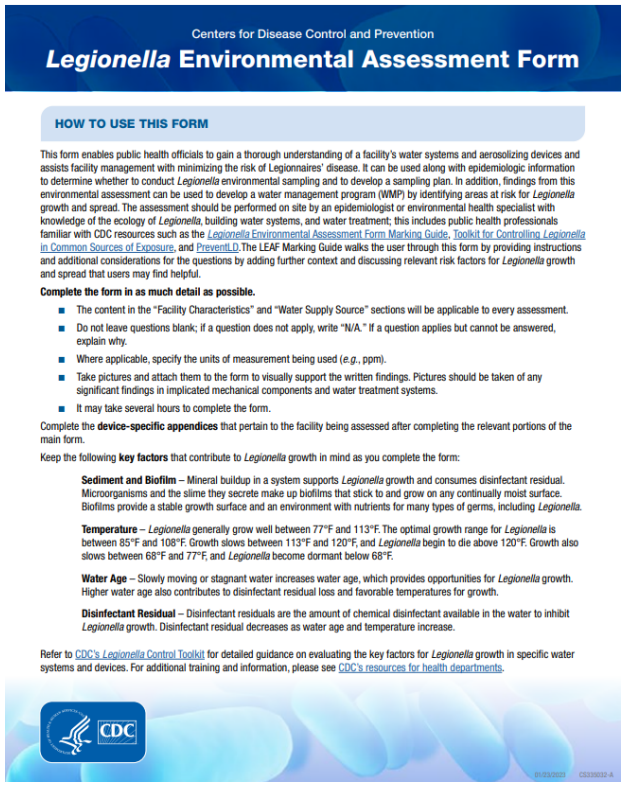
Cooling Tower ID

No CT registry, so we used the following resources to assist:

- Satellite imagery
- Assistance from municipality
  - Larger buildings
  - Cross-connection and backflow prevention program
- Consultants
- Ground searching

Adapted from: Centers for Disease Control and Prevention (CDC). **Procedures for Identifying Cooling Towers** [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 28]. Available from: https://www.cdc.gov/legionella/health-depts/environmental-inv-resources/id-cooling-towers.html.

Assessment:
Cooling Towers and Evaporative Condensers



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.

CDC

Photo credit: SMDHU

- Disinfectant type, dosing and monitoring
- Scale and/or corrosion inhibitors
- *Legionella* testing and results
- Recent history of the cooling tower
  - Major repairs or alterations
  - Non-routine treatment or maintenance
- Date of last offline cleaning/disinfection

Adapted from: Centers for Disease Control and Prevention (CDC). **Controlling *Legionella* in Cooling Towers** [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 21]. *Legionella* Environmental Assessment Form. Available from: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment-p.pdf.

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Assessment Findings

Assessment Criteria	Observations
Disinfectant type, dosing and monitoring	• Proprietary chemicals – oxidizing vs non-oxidizing • Lack of routine monitoring • Target range unknown by on-site personnel
Scale and/or corrosion inhibitors	• Lack of routine monitoring
Legionella testing and results	• Testing methods and frequencies varied across sites • Band-aid fixes
Recent history of the cooling tower	• Availability of maintenance/repair records and service logs varied across sites
Date of last offline cleaning/disinfection	• Not completed annually at all sites

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Visual Inspection of Cooling Towers

Photo credit: SMDHU

- Pitting, evidence of corrosion
- Scale, sediment, debris
- Biofilm
- Water clarity (e.g., green colour, extra foam)

Photo credit: SMDHU

Adapted from: Centers for Disease Control and Prevention (CDC). Controlling *Legionella* in Cooling Towers [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 21]. *Legionella* Environmental Assessment Form. Available from: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment-p.pdf.

Controlling *Legionella* in Cooling Towers

- Preventable!
- Site specific
- Design considerations
- Operation, maintenance, and control limits
- Routine maintenance and monitoring are key
- Sampling is only a snapshot in time
  - Test results validate that maintenance and control measures are working

Adapted from: Centers for Disease Control and Prevention (CDC). Controlling *Legionella* in Cooling Towers [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 23]. Available from: https://www.cdc.gov/legionella/wmp/control-toolkit/cooling-towers.html

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Environmental Sampling

Polling Question

Which is the best testing method for the prevention and control of *Legionella* in cooling towers?

1. Dip-slide test
2. Quantitative polymerase chain reaction (qPCR)
3. PCR (non-quantitative)
4. Culture
5. None of the above
6. All the above

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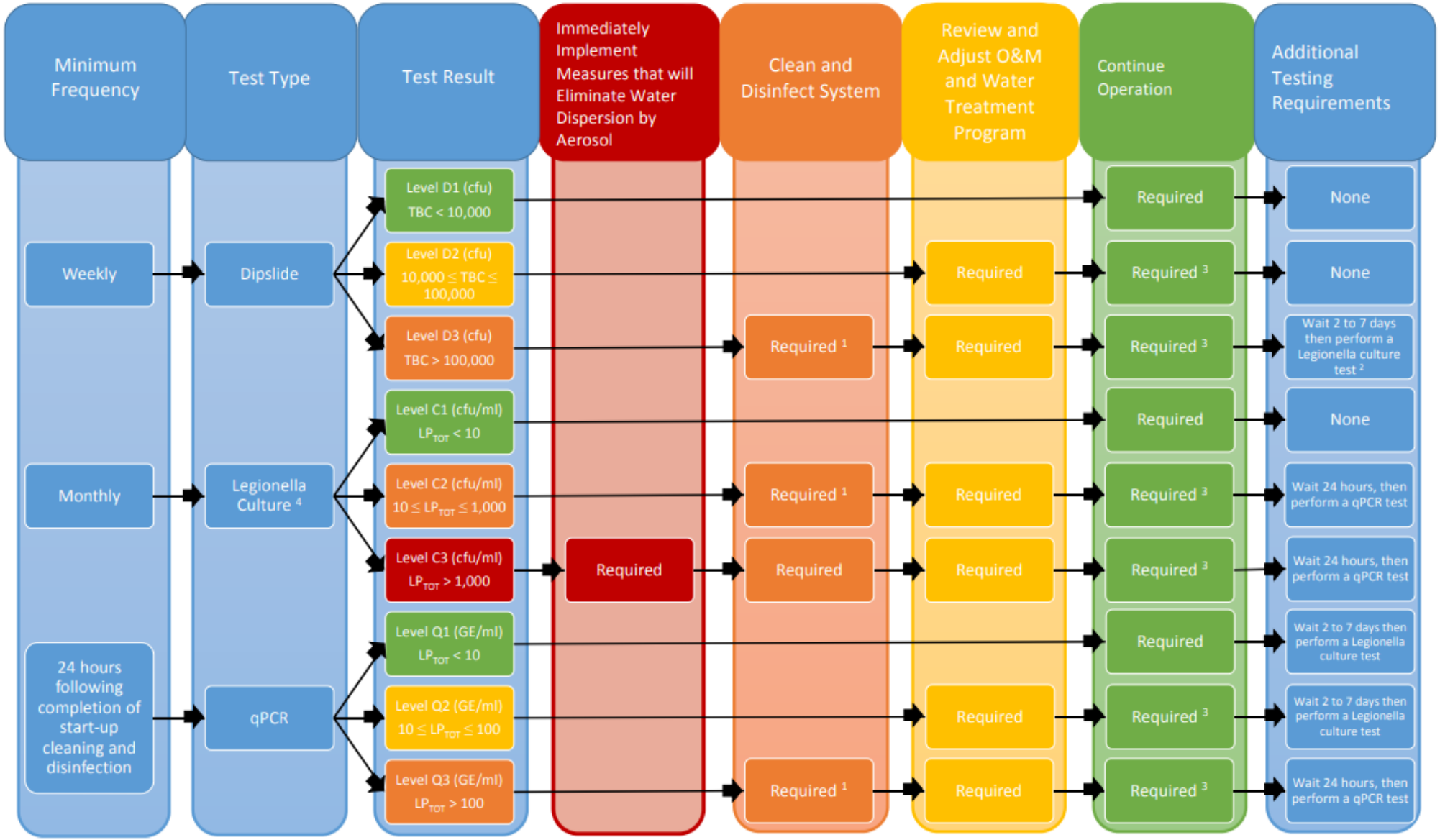
Test method	Comments	Pros	Cons
Culture	• Gold standard • Available at PHO (only qualitative, not quantitative) • Available at private labs as well (quantitative) • If quantitative, reported in colony forming units (CFU)	• Can identify all known species and subspecies • Can be serotyped • Can be sequenced (PHOL only) • Sequence can be correlated with clinical isolates (PHOL only) • Different remediation options based on CFU quantity	• Long turn-around time (typically 7-14 days) • If not quantitative, more difficult to ascertain specific risk and remediation steps.
PCR	• Available at PHO as a screening qualitative test which would be followed by culture if positive	• Rapid (up to 2 days) • Detects presence of *Legionella species, Legionella pneumophilia* and specifically Lp serogroup 1 • Highly sensitive (negative can usually rule out *legionella* presence)	• Not quantitative • Can't be sequenced • Can have false positives as PCR can detect non-viable or residual dead DNA that may remain post-remediation
qPCR	• Private laboratories/equipment • Testing equipment accessible to PHUs/owners for a price. • Results reported in genomic units (GU) which is not directly equivalent to CFU	• Rapid (up to 2 days) • Results available in less than an hour (if using a non-laboratory or mobile unit) • Quantitative • Different remediation options based on GU quantity	• Can't be sequenced • May overestimate counts, as qPCR can detect non-viable or residual dead DNA. • Some platforms claim to be able to only "filter out" non-viable legionella • New technologies not yet widely used in Ontario, and lack of comparative studies against laboratory-based testing

FRAMEWORK:

- *Legionella* bacteria control management program
- System risk and hazard assessment guidelines
- CT Design
- Operation and maintenance
- Minimum bacterial testing requirements
- Corrective action limits

Public Works and Government Services Canada. MD 15161 – 2013: control of *Legionella* in mechanical systems [Internet]. Ottawa, ON: Government of Canada; 2016 [cited 2023 May 21]. Available from: https://www.tpsgc-pwgsc.gc.ca/biensproperty/documents/legionella-eng.pdf

Figure 1: Cooling Tower Bacterial Test Protocol Normal Mode



O&M: Operation and maintenance

TBC: Total bacteria count

LP_{TOT}: Legionella Pneumophila (total all serogroups)

Public Works and Government Services Canada. MD 15161 – 2013: control of *Legionella* in mechanical systems [Internet]. Ottawa, ON: Government of Canada; 2016 [cited 2023 May 2]. Available from: https://www.tpsgc-pwgsc.gc.ca/biensproperty/documents/legionella-eng.pdf

Environmental Sampling

- **LTCH home was PCR negative – ruled out concurrent outbreak**
- ***Legionella* was detected in all CT's via PCR**

PCR Results	Number of Cooling Towers*
L. pneumophila serogroup 1	4
L. pneumophila	5
Legionella spp.	13
Indeterminate	1
Not Detected	0
*includes both pre and post remediation results	

"There is no "safe" level or type of *Legionella*." (CDC)

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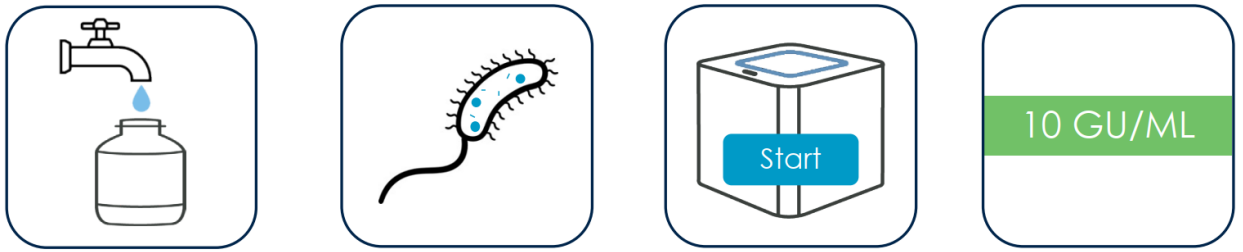
Centers for Disease Control and Prevention (CDC). Routine Testing for *Legionella* [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 28]. Available from: https://www.cdc.gov/legionella/wmp/control-toolkit/routine-testing.html

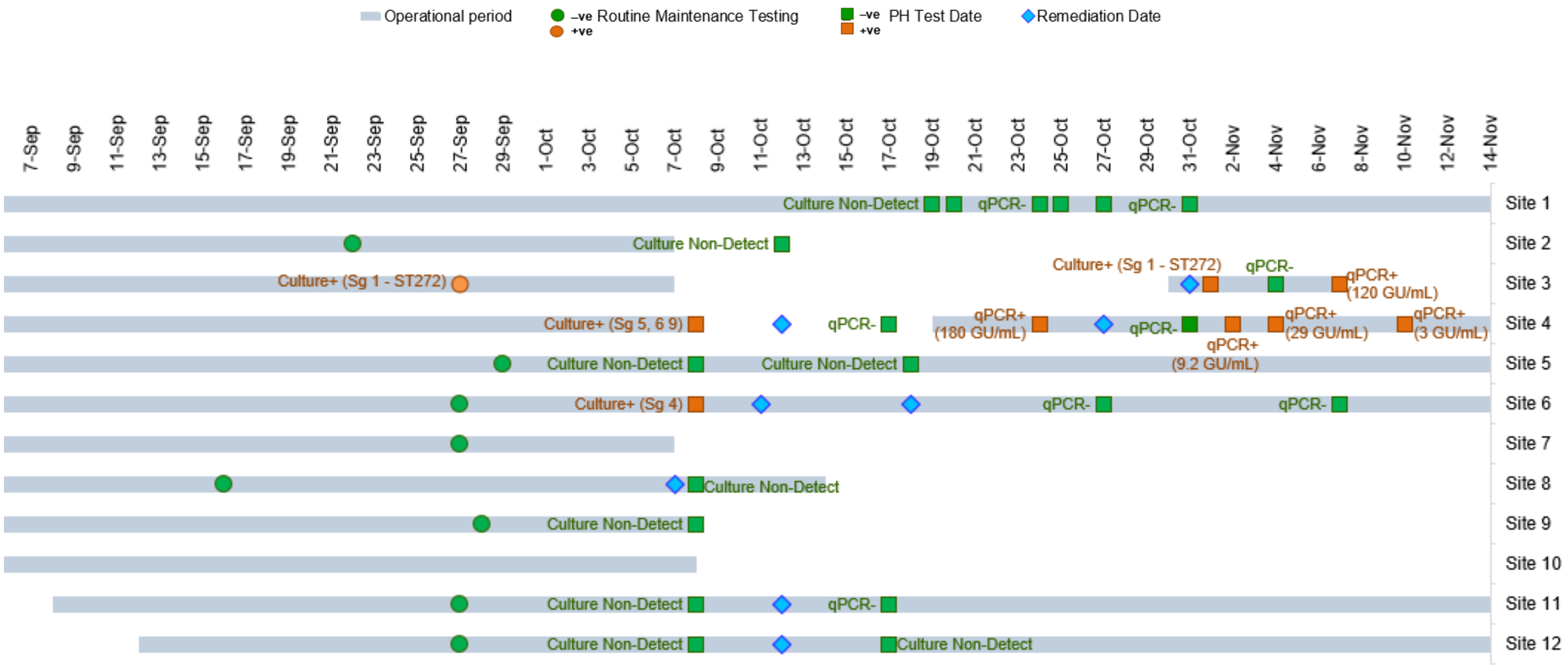
Quantitative PCR

- qPCR conducted while awaiting culture results (10-14 days)
- Rapid, quantifiable and actionable results
- Recommended weekly during “emergency mode”
  - Multiple reported cases of Legionnaires’ disease in the past 30 days with 10 km radius
  - Recurring Legionella detection by culture test that required cleaning and disinfection within past 90 days
  - Public health requires more stringent testing
- Can be conducted in the field/office or by private lab



Public Works and Government Services Canada. MD 15161 – 2013: control of *Legionella* in mechanical systems [Internet]. Ottawa, ON: Government of Canada; 2016 [cited 2023 May 2]. Available from: https://www.tpsgc-pwgsc.gc.ca/biensproperty/documents/legionella-eng.pdf
Genomadix Inc, "Genomadix Cube *Legionella* System-Specifications Document", CUS-00202 (Version 1.0), Feb 2023

Epidemic Curve for Legionellosis Cluster Investigation with Cooling Tower Operations and Testing*



Data Sources: Investigation Line List and Environmental Health Sample Collection spreadsheet.
* Only includes cooling towers with testing results
+ve = positive qPCR = quantitative Polymerase Chain Reaction
-ve = negative OOJ = Out of Jurisdiction
Sg = serogroup LTCH = Long term care home

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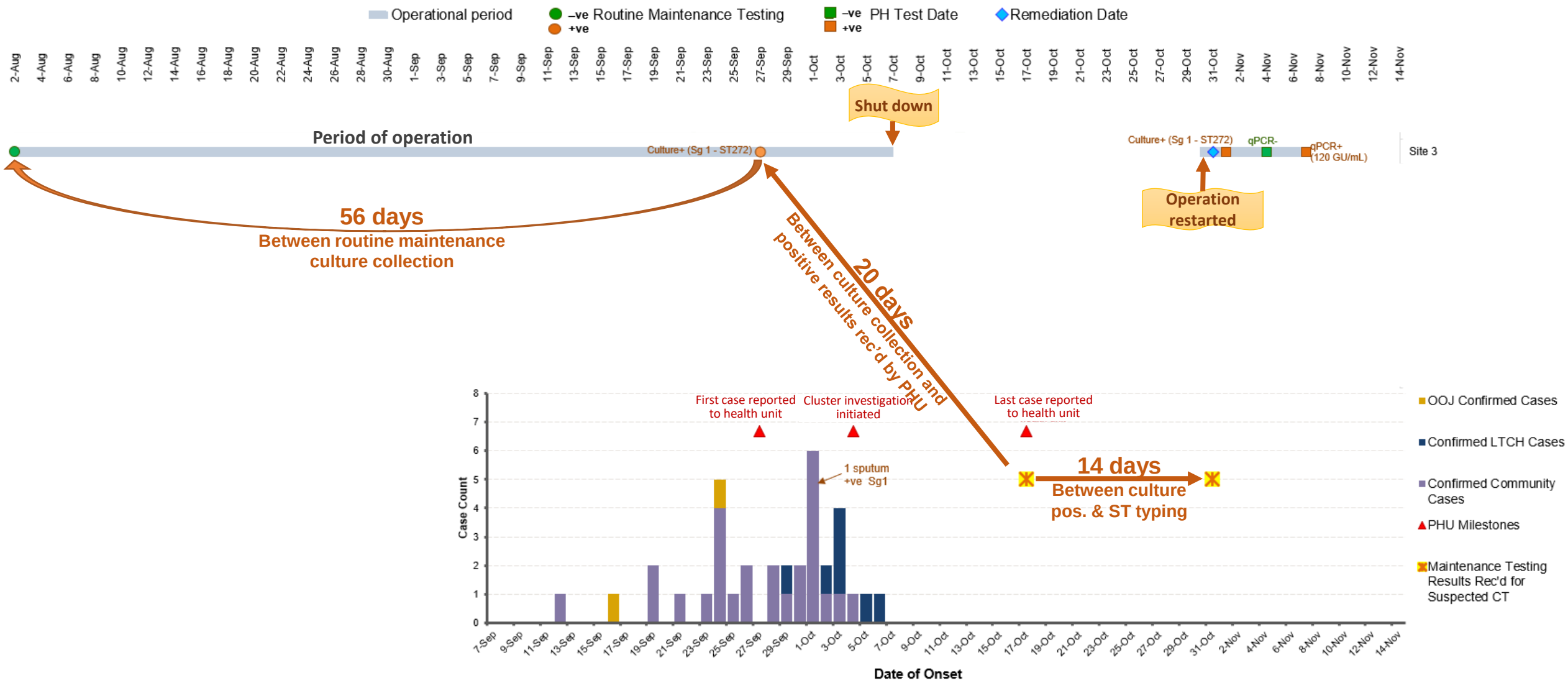
Epidemic Curve for Legionellosis Cluster Investigation with Cooling Tower Operations and Testing*



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Transferring *legionella* isolate from private lab to public lab for culture and SBT

- Receive positive culture results from a Sept 27, 2022 private lab routine monitoring sample on Oct 17, 2022
- Private lab may keep positive isolates for a few months
- Discussion and coordination between PHOL, health unit and private lab required to transfer isolate from private lab to PHOL for culture and SBT.

Our experience with qPCR

- **Ensure private lab is certified. We looked for** certification for *Legionella* analysis by the Environmental *Legionella* Isolation Techniques Evaluation (ELITE) program from the US Centers for Disease control and Prevention (CDC). Cost is about $250 per test
- Decided to use mobile *legionella* testing technology (Genomadix Cube, previously known as Spartan Cube) in 2019 based on discussion with colleagues' experience in New Brunswick outbreak and again in 2022.
  - Not much field experience in Ontario or elsewhere in Canada and not many comparative studies to formal laboratory qPCR testing. Cube cost is about $5000 but was loaned to us. Cost is about $100 per test.
  - Easy to use and results available within an hour of sampling which was useful for timely action
  - Technology claims to only detect preferentially live *legionella* which seems to be our and New Brunswick's experience. Wish there would be future local comparative studies to validate claims.

Steps Taken After the Outbreak

- Letters sent via municipalities to inform known cooling tower operators of importance of preventive maintenance of cooling towers with reference to the Federal Buildings document as a recommended template.
- Advocacy and communication to PHO, PHOL, OCMOH, MOHLTC on the value and importance of a provincial registry of cooling towers for the purposes of monitoring preventive maintenance and quicker identification when outbreaks occurred. New York State has such a registry https://www.nyc.gov/site/doh/business/permits-and-licenses/cooling-towers.page
- An academic paper has been submitted to share our experience with our colleagues in the field.

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Summary of Lessons Learned

- Important for clinical and environmental teams to collaborate, as well with PHOL and PHO because of the complexities
- Knowing where to look can save lives - cooling tower registry
- Requirement for owners/operators to maintain and monitor system
- Don't judge a book by its cover
- Remediation doesn't happen overnight – request it as an early intervention
- qPCR is a valuable tool that can give you quick, quantifiable and actionable results when used in combination with PHOL's PCR & culture

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Resources

- Centers for Disease Control and Prevention (CDC). Controlling *Legionella* in Cooling Towers [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 23]. Available from: https://www.cdc.gov/legionella/wmp/control-toolkit/cooling-towers.html
- Centers for Disease Control and Prevention (CDC). Developing a water management program to reduce *Legionella* growth and spread in buildings: a practical guide to implementing industry standards [Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 24]. Available from: https://www.cdc.gov/legionella/downloads/toolkit.pdf
- Centers for Disease Control and Prevention (CDC). *Legionella* Environmental Assessment Form Marking Guide[Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 25]. Available from: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment-marking-guide-508.pdf
- **Centers for Disease Control and Prevention (CDC).** Routine Testing for *Legionella* **[Internet]. Atlanta, GA: CDC; 2021 [cited 2023 May 28]. Available from: https://www.cdc.gov/legionella/wmp/control-toolkit/routine-testing.html**
- Ontario Agency for Health Protection and Promotion (Public Health Ontario). *Legionella*: questions and answers, 2nd ed. Toronto, ON: Queen's Printer for Ontario; 2019.
- Public Works and Government Services Canada. MD 15161 – 2013: control of *Legionella* in mechanical systems [Internet]. Ottawa, ON: Government of Canada; 2016 [cited 2023 May 21]. Available from: https://www.tpsgc-pwgsc.gc.ca/biensproperty/documents/legionella-eng.pdf

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