

TO:

Genesee County Health Department

FROM:

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

DATE: October 7, 2016**UPDATED: November 3, 2016****REFERENCE:** McLaren Flint *Legionella* Investigation**INTRODUCTION****Purpose of the Investigation**

A patient, admitted to McLaren Flint on July 28, 2016, underwent a surgical procedure followed by a complicated hospitalization; the patient was transferred from McLaren Flint to a rehabilitation facility in Genesee County on August 5, 2016, where the patient was documented to have developed signs of pneumonia on August 8. Following transfer back to McLaren Flint on August 10, the patient was diagnosed with Legionnaires' disease. This was the first Legionnaires' disease case reported in a patient who had received treatment at McLaren Flint in 2016. CDC and Genesee County Health Department (GCHD) staff conducted an on-site investigation at McLaren Flint on August 25 and 26, 2016. The response to this recent Legionnaires' disease case was due to reports of Legionnaires' disease cases during 2014 and 2015 among patients who had received treatment at McLaren Flint during their incubation periods. The objectives of the investigation were to:

1. Review McLaren Flint's current procedures for case surveillance and clinical testing to ensure that cases of Legionnaires' disease (a) are diagnosed and treated in a timely manner and (b) trigger an appropriate epidemiologic investigation;
2. Review and evaluate the existing written water management plan compared to best practices identified in CDC's water management plan toolkit;
3. Determine if the water management plan is being implemented and followed as written; and
4. Conduct an independent environmental assessment of McLaren Flint to assess the current risk for *Legionella* growth and transmission.

Background

Legionellosis is a respiratory disease caused by inhalation of aerosolized droplets of water contaminated with the bacterium *Legionella* and can present as either Legionnaires' disease or Pontiac fever. Legionnaires' disease is a severe, sometimes fatal pneumonia, while Pontiac fever is a milder illness without pneumonia that generally resolves on its own. The incubation period for Legionnaires' disease is most commonly 2 to 10 days after exposure, with an average of 5 to 6 days.¹

To be considered confirmed, a case of Legionnaires' disease must be clinically compatible (i.e., evidence of clinical or radiographic pneumonia) and meet one of the confirmatory laboratory criteria:

- By culture: isolation of any *Legionella* organism from respiratory secretions, lung tissue, pleural fluid, or other normally sterile fluid;

¹ Phin N, Parry-Ford F, Harrison T, et al. Epidemiology and clinical management of Legionnaires' disease. *Lancet Infect Dis*. 2014;14(10):1011–21.

- By detection of *Legionella pneumophila* serogroup 1 antigen in urine using validated reagents; or
- By seroconversion: fourfold or greater rise in specific serum antibody titer to *Legionella pneumophila* serogroup 1 using validated reagents.²

Exposure to *Legionella* in freshwater environments, such as lakes or streams, does not lead to disease; however, in manmade water systems, *Legionella* can grow and be transmitted to susceptible hosts, including persons aged 50 years or older, smokers, and persons with underlying medical conditions such as chronic lung disease or immunosuppression. Because they host susceptible populations and often have cooling towers and complex premise plumbing systems, *Legionella* growth and transmission are particular concerns for water systems in hospitals and other healthcare facilities.³ CDC typically recommends that a full investigation for the source of *Legionella* be performed when:⁴

- ≥1 case of **definite** healthcare-associated Legionnaires' disease (a case in a patient who spent the entire 10 days prior to onset of illness in a healthcare facility) is identified, or
- ≥2 cases of **possible** healthcare-associated Legionnaires' disease (cases in patients who spent a portion of the 10 days before symptoms began in a healthcare facility) are identified within 6 months of each other.

However, where there is a history of Legionnaires' disease cases associated with a facility and there is concern that a potential risk for *Legionella* transmission still exists, investigating even a single case of possible healthcare-associated Legionnaires' disease is prudent

The Setting

McLaren Flint is 404-bed tertiary facility comprised of 5 buildings. Buildings A, B/C, and F have patient care rooms, Building D has an auditorium area with a decorative fountain (SEE ADDENDUM 1), and Building E has a power plant. The City of Flint uses chlorine as a disinfectant in its municipal water. Three water service lines, which deliver chlorine from the water utility, meet together in a mechanical room where the water supply passes through a booster pump and is distributed throughout the facility. A fourth service line serves Building E and 4 large cooling towers. The hospital consists of 7 circulating hot water systems, 6 of which have secondary monochloramine systems. The seventh hot water system serves the kitchen area.

METHODS

On August 25, 2016, details of the patient's medical history, clinical course, and possible exposures to water were reviewed by CDC, GCHD, and McLaren Flint staff. CDC and GCHD staff then conducted a targeted environmental assessment focused on potential case patient water exposures that may have occurred during the hospital stay. Sampling locations included Emergency Room (ER) exam room 15, the post anesthesia care unit (PACU), patient rooms, and rooms with machines involved in building operations.

² CDC. CSTE Position Statement: Strengthening Surveillance for Travel-Associated Legionellosis and Case Definitions for Legionellosis. Available at: <http://www.cdc.gov/legionella/health-depts/inv-tools-single/cste-position-statement.html>

³ Garrison LE, Kunz JM, Cooley LA, et al. Vital Signs: Deficiencies in Environmental Control Identified in Outbreaks of Legionnaires' Disease — North America, 2000–2014. *MMWR*. 2016;65(22):557–561.

⁴ CDC. Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings. Available at: <http://www.cdc.gov/legionella/maintenance/wmp-toolkit.html>

On August 26, 2016, CDC and GCHD staff conducted a limited environmental assessment of other areas of the McLaren Flint facility. Investigators were accompanied by hospital staff and consultants, and split swab and bulk water sampling was conducted. Swab sampling was used to evaluate only for the presence of legionella, while the bulk water samples were evaluated for both legionella pH, temperature, total chlorine, and free chlorine. One set of samples was submitted to CDC's *Legionella* Laboratory in Atlanta, GA, for processing, and the other was sent by hospital staff to the Special Pathogens Laboratory, a private lab managed by Janet Stout in Pittsburgh, PA, for analysis. Because of time constraints, only a few representative control points of those identified in the water management plan were assessed in addition to the sites visited on August 25. If additional time had been available, CDC and GCHD would have expanded the environmental assessment to include additional control points and inspection of all cooling towers, decorative fountains, whirlpool therapy spas, and ice machines.

The environmental assessment included a review of water system operation and maintenance records, as well as discussion with staff about training and experience with *Legionella* prevention and control. CDC, GCHD, and McLaren Flint staff reviewed and discussed the McLaren Flint water management plan and clarification was provided regarding previous monitoring locations, sampling frequency, corrective actions, and control locations for routine water quality parameter checks. Additionally CDC, GCHD, and McLaren Flint staff discussed and confirmed the proximal and distal sampling locations for the environmental assessment. Together, a sampling plan representative of the water system was developed and included sampling locations in patient rooms, the gym, auditorium restrooms, machine rooms, and a cooling tower (**Appendix A**). Sampling was also performed at locations where the case patient may have been exposed to aerosolized water (**Table 1**). Finally, sampling was performed at a subset of locations where recent *Legionella* cultures processed by the Special Pathogens Laboratory (Janet Stout, PA lab) for McLaren Flint in July 2016 were positive.

Table 1. Sampling locations of possible case patient exposures at McLaren Flint

Locations	Type of Potable Water Fixtures Present
Building F (Upper), Room 1118	Sink, shower, toilet
Building F (Upper), Room 908	Sink, shower, toilet
Building F (Lower), ER Exam Room	Sink
Building F (Lower), Post Anesthesia Care Unit (PACU)	Sink

The following parameters were measured at each sampling location: pH, temperature, total chlorine, and free chlorine. *Legionella* cultures were performed on water from a subset of sampling sites. A visual inspection and records review was performed for cooling tower systems #1 through #4, and water sampling (temperature, free chlorine, and pH) was conducted for cooling tower #3.

CDC and GCHD staff utilized the total chlorine and free chlorine analysis method to measure for the presence of chloramines. This method measures the total chlorine value as the sum of the free chlorine, monochloramine and dichloramine present in the water. The free chlorine method measures the free chlorine level only. The difference between the two values (total chlorine minus free chlorine) is the sum of the monochloramine and dichloramine levels in the water. A limitation of this method is that free chlorine levels may fluctuate slightly in the presence of high concentrations of monochloramine; as such, the total chlorine and free chlorine analysis is used as a screening tool to estimate free chlorine and chloramine concentrations.

RESULTS

Patient Exposures and Disease Surveillance

Upon review, the patient was noted to have multiple underlying risk factors for Legionnaires' disease (77 years of age with history of lung cancer requiring partial pneumonectomy, former smoker, and chronic obstructive pulmonary disease requiring supplemental oxygen). Prior to onset of compatible symptoms on August 8, 2016, the patient was hospitalized at McLaren Flint on July 28 through August 5, 2016 before being transferred to a rehabilitation facility in Genesee County on August 5. All patient care activities occurred in Building F, and included the areas listed in **Table 1**, plus the operating room. The patient is not known to have showered during hospitalization; the patient's bathroom contained a sink, shower, and toilet. The patient was not exposed to any decorative fountains, therapy tubs, or respiratory therapy equipment, and was not documented to be at risk for aspiration of liquids.

On August 31, 2016, at the request of CDC, McLaren Flint staff provided flow diagrams depicting the clinical algorithms for ordering Legionnaires' disease testing for patients diagnosed with pneumonia on admission (**Appendix B**), as well as new onset of pneumonia occurring after admission (**Appendix C**). Active surveillance for patients diagnosed with pneumonia following admission, which should address newly diagnosed pneumonia in all hospitalized patients, is limited to pneumonia diagnosed on critical care rounds (i.e., according to the algorithm "new infiltrates identified in critical care rounds forwarded to [infection control] for case review," **Appendix C**).

Water Management and Environmental Assessment

Water management plan review

Our review of the written water management plan found that many aspects align with the best practices identified in ASHRAE 188⁵ (and described in CDC's water management toolkit⁶), as it identified control measures, control limits, control points, and corrective actions within the hospital; included verification and validation procedures; and included program review and communication procedures. The plan included a contingency response in the event of a case of Legionnaires' disease, but instructions on how to respond were not included. The plan (pages 35 through 37) utilizes the percent of distal sites that test positive for *Legionella* for the potable water system as a set of criteria to inform corrective actions, a practice not included in the ASHRAE guidance. Three categories were defined in the McLaren Flint plan: *Legionella* distal site positivity 0–30%, *Legionella* distal site positivity ≥30%, not serogroup 1, and *Legionella* distal site positivity ≥30%, serogroup 1.

The water management plan was not fully implemented at the time of the investigation. The water management plan indicated the hot water distal outlet operating goal is 110 to 120°F, however distal hot water temperatures ranged from 83.66 to 112.64°F. These measured temperatures overlap the optimum range for *Legionella* growth (77 to 108°F). The McLaren Flint water management team indicated they are no longer conducting disinfectant checks at their control points within the potable water system due to the time burden and competing priorities for engineering staff. McLaren Flint is considering the installation of automated devices to record disinfectant levels. Additionally, a log of any corrective actions taken was not provided. McLaren Flint personnel were actively working with their contractor, Special Pathogens Laboratory (Janet Stout, PA lab), to optimize operations to meet the requirements of the water management plan.

⁵ ASHRAE 188: *Legionellosis: Risk Management for Building Water Systems* June 26, 2015. ASHRAE: Atlanta. www.ashrae.org

⁶ CDC. Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings. Available at: <http://www.cdc.gov/legionella/maintenance/wmp-toolkit.html>. This document is based on recommendations in ASHRAE 188.

Water quality parameters and cooling tower assessment

The locations of *Legionella* environmental sampling and corresponding water parameter measurements are listed in **Appendix A**. Temperatures observed at the hot water heater ranged from 100° to 106.2°F. Return locations temperatures at the hot water heater ranged from 98.4 to 108.5°F. Adequate hot water chloramine disinfectant levels (range: 0.4 to ≥2.2 mg/L) were observed at all sampling points. Estimates of free chlorine disinfectant levels (range: 0.9 to 2.1 mg/L) were found to be adequate at all sampling points in the hot water system. With the exception of patient room 520, adequate cold water free chlorine disinfectant levels (range: 0.7 to 1.5 mg/L) were observed in distal locations throughout the entire facility. Patient room 520 exhibited no observable chlorine in the cold water. Cold water free chlorine disinfectant levels (range: 0.9 to 1.0 mg/L) entering the building from the water main were within limits recommended by the U.S. Environmental Protection Agency (EPA).

Visual inspection of cooling tower #3 revealed minimal scale, corrosion, and buildup of organic matter sediment. All 4 cooling towers are served by automated disinfectant (NALCO STABREX ST 70: sodium hypochlorite and sodium bromide) and scale and corrosion inhibitors (NALCO 3D TRASAR 3DT265: ingredients not available) systems. Additionally, the cooling towers employ remote monitoring technology where water quality parameters are continuously monitored. Any abnormal readings result in adjustments to the automated disinfection system or a phone call to McLaren Flint to follow-up in person. Record keeping was observed for daily cooling tower water quality parameter checks at the 4 cooling tower disinfection systems (towers #1 through #4) visited during the environmental assessment.

Legionella culture results

The results of CDC's testing for *Legionella* in environmental samples are listed in **Appendix D**. None of the areas where the patient was known to have been exposed to the building water systems tested positive for *Legionella*. Patient room 260, a site routinely tested according to the water management plan, tested positive for *Legionella pneumophila* serogroup 1. According to results from the Special Pathogens Laboratory (Janet Stout, PA lab), water from this room's restroom sink tested positive for *Legionella* in the 30 days before the CDC environmental assessment and during other testing time periods (August 12 and 17, 2015; October 12, 2015; February 3, 2016; and July 28, 2016). The McLaren Flint water management team indicated corrective actions were not performed because the total number of positive samples was below the 30% cutoff. Note that, because the CDC laboratory did not have access to any clinical isolates or historic environmental isolates, no comparison could be performed between these and the environmental isolate from patient room 260.

CONCLUSIONS AND RECOMMENDATIONS

Disease Monitoring

Overall, McLaren Flint's procedures for identification of Legionnaires' disease were adequate for testing patients newly admitted to the hospital with pneumonia, but additional measures could be taken to ensure that all patients who develop pneumonia after admission receive appropriate testing and are actively tracked. For example, active clinical surveillance for Legionnaires' disease entails ensuring that appropriate testing is ordered for patients with new onset of pneumonia after admission to a healthcare facility (healthcare-associated Legionnaires' disease), as well as patients presenting with signs and symptoms compatible with pneumonia at admission (community-acquired Legionnaires' disease), provided they meet certain clinical indications. The preferred diagnostic tests for Legionnaires' disease are culture of lower respiratory secretions on selective media and the *Legionella* urinary antigen test. Best practice is to obtain lower respiratory specimens for culture at the time urinary antigen testing is ordered, preferably before the administration of antibiotics. When feasible, endotracheal aspirates or

bronchoscopy specimens can be obtained in lieu of sputum. All isolates obtained in the future should be saved for molecular analysis. Full guidelines for management of Legionnaires' disease patients are available from the Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS).⁷

Recommendations for Legionnaires' disease testing on admission (community-acquired pneumonia)

Continue to follow current GCHD guidance (**Appendix E**) and McLaren Flint's clinical algorithms for ordering Legionnaires' disease testing for patients diagnosed with pneumonia on admission (**Appendix B**).

Recommendations for active clinical surveillance of healthcare-associated Legionnaires' disease (cases of pneumonia with onset after admission to McLaren Flint)

To appropriately diagnose newly diagnosed pneumonia in all hospitalized patients, additional steps for active clinical surveillance for healthcare-associated Legionnaires' disease cases, as outlined below, should be continued at McLaren Flint for at least 6 months following identification of the *last possible* healthcare-associated case (i.e., a more systematic approach for reviewing all new pneumonia diagnoses should be incorporated into McLaren Flint's testing algorithm).

- Expand pneumonia case finding by quality or infection prevention staff beyond critical care rounds, to include daily review of:
 - Radiographic pneumonia diagnoses,
 - Sputum cultures ordered to diagnose pneumonia,
 - All urinary antigen tests and respiratory cultures performed specifically to diagnose Legionnaires' disease, and
 - Clinical pneumonia diagnoses occurring in patients in the intensive care unit (ICU).
- For all newly diagnosed pneumonia cases not already being investigated for Legionnaires' disease, culture of lower respiratory secretions for *Legionella* and urinary antigen testing should be routinely ordered to ensure timely diagnosis and treatment for Legionnaires' disease.
- After the period of active clinical surveillance has been completed, surveillance for cases of pneumonia with onset after admission to McLaren Flint should continue with testing for Legionnaires' disease among patients at increased risk for developing Legionnaires' disease,⁸ particularly patients with severe pneumonia (in particular those requiring intensive care), or if any of the following are identified at McLaren Flint:
 - Patients with Legionnaires' disease, no matter where they acquired the infection,
 - Positive environmental tests for *Legionella*, or
 - Changes in water quality that may lead to *Legionella* growth (such as low residual disinfectant levels).

Recommendations for legionellosis reporting

- Continue to report all positive legionellosis laboratory tests to GCHD.
- If a case occurs in a patient who spent part of the 10 day incubation period at McLaren Flint, continue to notify GCHD immediately and work with health department staff to help determine possible sources of exposure. Also immediately report the event to the hospital's water management team.

⁷ Mandell, Wunderink, Anzueto, et al. IDSA/ATS Guidelines on the Management of Community-Acquired Pneumonia in Adults. *Clin Infect Dis*. 2007;44(Suppl 2):S27–72.

⁸ CDC. What Clinicians Need to Know about Legionnaires' Disease. Available at: <http://www.cdc.gov/legionella/downloads/fs-legionella-clinicians.pdf>

Water Management Plan

We had limited ability to draw conclusions about specific conditions that may have resulted in exposure of the recent McLaren Flint patient to *Legionella* during the hospital stay. Because disinfectant levels had not been routinely checked at McLaren Flint (SEE ADDENDUM 2), we do not know if conditions at the time of the recent case patient's hospitalization were different from what we observed during our assessment and could have been conducive to *Legionella* growth and transmission.

Considerable effort has been taken by the McLaren Flint water management team to implement a water management plan. The size and complexity of the water systems in McLaren Flint present a challenge and will require strict adherence to and periodic evaluation of the water management plan to reduce the risk of *Legionella* growth and transmission. Overall, the disinfectant levels observed throughout the water system during the environmental assessment were adequate; however, the observed hot water temperatures were within the ideal range for *Legionella* growth. Therefore, any degradation in hospital water quality could increase the risk for *Legionella* growth and transmission. The following water management actions are recommended:

1. Implement the water management plan contingency response when cases of Legionnaires' disease are detected among patients who had been hospitalized at McLaren Flint for part or all of their incubation periods. Aspects of the contingency plan should be strengthened.
 - Quality and/or infection prevention staff should continue to notify facilities/engineering staff of the case patient including his/her possible exposures so that a response can occur quickly.
 - The contingency response plan should describe a procedure to rapidly evaluate water quality parameters at the known and nearby locations where a case patient may have been exposed. The investigation should try to discern the root cause of a patient's exposure to *Legionella*.
 - The McLaren Flint water management team should implement corrective actions as informed by environmental surveillance in the case patient areas to reduce the risk of future exposure. Surveillance of environmental factors such as disinfectant levels and water temperatures should be enhanced in the areas where a case patient may have been exposed to water sources or in the parts of the water system serving those areas.
 - The water management plan should also be reviewed and reassessed for gaps in the plan itself or in its execution.
2. Strengthen implementation of the current water management plan.
 - Reinstate regular disinfectant and temperature control checks as indicated in the water management plan, including points of use. Frequent monitoring of water system disinfectant levels and temperature as part of the environmental surveillance system can serve as an alert to changing water conditions. Therefore, if a monochloramine system fails or there are changes in water chemistry due to factors such as low flow, the water management team will be able to quickly implement corrective actions and/or contingency response plans.
 - Continue to monitor free ammonia levels as indicated in the water management plan to prevent potential nitrification within the monochloramine system. Nitrification and biofilm growth can occur when there are low monochloramine residuals and excess free ammonia is oxidized to form nitrates/nitrites.

- Investigate why there is no free chlorine residual in the cold water in patient room 520. Consider flushing the water supply lines in patient room 520 if low water use is determined to be the problem. Ensure that housekeeping staff are adhering to flushing protocols and consider spot checking or other monitoring to confirm that water supply line flushing is being done.
3. Update aspects of the water management plan to further reduce risk of *Legionella* growth and transmission.
- A positive *Legionella* environmental sample should generate some level of review and action according to the water management plan. Although most cases of disease are linked to *L. pneumophila* serogroup 1, all serogroups and species are potentially pathogenic and could be hazardous to a hospitalized population. It is critically important to not rely on the 30% threshold (regardless of serogroup) for considering review and/or contingency responses within the potable water system. Patients can get Legionnaires' disease in settings where fewer than 30% of sites tested are positive; the recent patient who developed Legionnaires' disease after a hospitalization at McLaren may be an example of this. There is no known safe level of *Legionella*; therefore, active environmental surveillance should monitor for positive *Legionella* samples and assess trends over time to inform appropriate corrective actions and/or contingency responses. For example, environmental surveillance should include:
 - Monitoring for clustering or recurring positives in specific building water systems and/or devices such as cooling towers or decorative fountains; note that positives occurring weeks or months apart should be considered recurrences, not only positives from consecutive tests.
 - Monitoring for recurring positives in a specific room and/or surrounding rooms.
 - Monitoring for any positive samples within the hot or cold potable water distribution system, such as water heaters, storage tanks, return hot water recirculating loops, etc.
 - Each time a room or location tests positive for *Legionella* on more than one occasion, such as patient room 260, an environmental assessment should be performed to identify the root cause of *Legionella* growth (e.g., water stagnation, poor disinfectant levels).
 - Corrective actions should be taken as indicated by the assessment.
 - Consider retesting following a corrective action and/or contingency response in the potable water system to determine if areas that tested positive for *Legionella* in the past are now clear.
 - If the monochloramine system(s) fail to meet control limits as indicated in the water management plan (i.e., disinfectant levels are not in acceptable ranges), and/or there are additional cases associated with individual hot water systems, then additional engineering changes to the implicated hot water system should be considered. Engineering changes could include, but are not limited to, increasing the temperature throughout the hot water system to a range that is more likely to control *Legionella* growth. Appropriate engineering changes to prevent scalding would also need to be addressed.
 - Hospital staff should remain vigilant of external factors that could impact the hospital water quality such as water main breaks and/or changes in water quality being delivered from the water utility and immediately contact the water utility if they observe changes in water quality entering the campus.

Addendum 1 (November 3, 2016): Page 2 of this report states that Building D has an auditorium area with a decorative fountain. Upon further discussion, McLaren Flint staff clarified that there are two *exterior* water features at McLaren Flint, but no *interior* water features, as stated on page 7 of the McLaren Flint Water Safety Plan. Nevertheless, the same recommendations apply for monitoring and maintenance of decorative fountains connected to the facility plumbing system, regardless of location.

Addendum 2 (November 3, 2016): On page 7 of this report, it is stated that disinfectant levels had not been routinely checked at McLaren Flint. Upon further discussion, McLaren Flint staff clarified that monochloramine levels were being checked at least weekly in multiple machine rooms, Sub C, and the boiler room, but not at points of use. The same recommendation applies to reinstate regular disinfectant and temperature control checks as indicated in the water management plan, *including points of use*.

APPENDIX A. LEGIONELLA ENVIRONMENTAL SAMPLE LOCATIONS AND CORRESPONDING WATER PARAMETERS

ID	Date	Time	Sample Type	Sample Description	pH	Temp (°F)	Temp (°C)	Total Cl ₂ (ppm) ⁹	Free Cl ₂ (ppm)	Chloramine estimate (ppm)
006	8/25/16	5:25 PM	Swab	ER-Exam Room 15 Faucet	NA ¹⁰	NA	NA	NA	NA	NA
	8/25/16	5:28 PM		ER-Exam Room 15 Faucet (cold)	7.35	72.68	22.6	NC ¹¹	1	NC
007	8/25/16	5:28 PM	Bulk	ER-Exam Room 15 Faucet (hot)	7.14	98.96	37.2	2.5	1.1	1.4
008	8/25/16	5:44 PM	Swab	PACU Faucet	NA	NA	NA	NA	NA	NA
009	8/25/16	5:46 PM	Bulk	PACU Faucet (hot)	7.06	97.7	36.5	1.8	1.4	0.4
010	8/25/16	5:58 PM	Swab	Patient Room 1118 Shower	NA	NA	NA	NA	NA	NA
011	8/25/16	6:00 PM	Bulk	Patient Room 1118 Shower (hot)	7.2	104.9	40.5	2.2	1.6	0.6
012	8/25/16	6:05 PM	Swab	Patient Room 1118 Faucet	NA	NA	NA	NA	NA	NA
	8/25/16	6:07 PM		Patient Room 1118 Faucet (cold)	7.2	74.66	23.7	1	1.2	NC
013	8/25/16	6:09 PM	Bulk	Patient Room 1118 Faucet (hot)	7.26	107.96	42.2	2	1.2	0.8
014	8/25/16	6:23 PM	Swab	Patient Room 1118 Faucet (hot)	NA	NA	NA	NA	NA	NA
	8/25/16	6:24 PM		Patient Room 908 Shower (cold)	7.64	73.76	23.2	1	1.1	NC
015	8/25/16	6:26 PM	Bulk	Patient Room 908 Shower (hot)	7.45	103.46	39.7	1.8	1.2	0.6
016	8/25/16	6:32 PM	Swab	Patient Room 908 Faucet	NA	NA	NA	NA	NA	NA
	8/25/16	6:33 PM		Patient Room 908 Faucet (cold)	NC	NC	NC	1.1	1.1	NC
017	8/25/16	6:35 PM	Bulk	Patient Room 908 Faucet (hot)	7.31	104.18	40.1	2.1	2.1	NC
018	8/25/16	6:48 PM	Bulk	Machine Room 24 Unit 1 Supply	7.61	106.16	41.2	2.9	1.6	NC
019	8/25/16	6:53 PM	Bulk	Machine Room 24 Unit 1 Return	7.61	108.5	42.5	2.6	1.6	NC
020	8/25/16	7:08 PM	Bulk	Machine Room 31 Unit 2 Supply	7.63	100.04	37.8	1.1	1.1	NC
021	8/25/16	7:14 PM	Bulk	Machine Room 31 Unit 2 Return	7.62	98.42	36.9	1.6	1	NC
	8/25/16	7:21 PM		Flint Main/Detroit Water	7.95	73.22	22.9	1.2	1	NC
	8/26/16	11:15 AM		Building BC 7th North Sink (hot)	7.15	92.84	33.8	2	1.1	0.9
	8/26/16	11:24 AM		Building BC 7th North Sink (cold)	7.25	73.58	23.1	1.4	0.8	NC
	8/26/16	11:29 AM		Building BC Patient Room 520 Sink (hot)	6.96	112.46	44.7	3	1.6	1.4

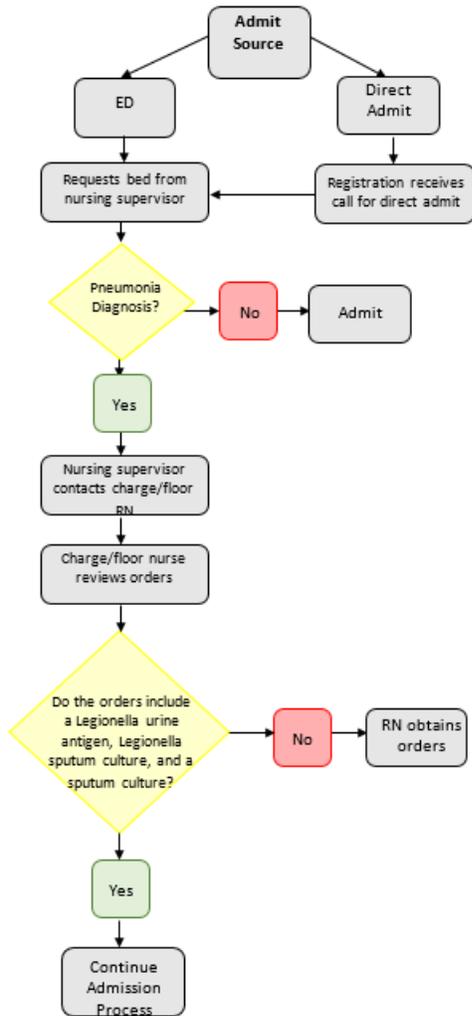
⁹ Upper limit of detection (LOD) for total chlorine is 3.5ppm. Results above the upper LOD are listed as ≥3.5.

¹⁰ NA = not applicable

¹¹ NC = not collected

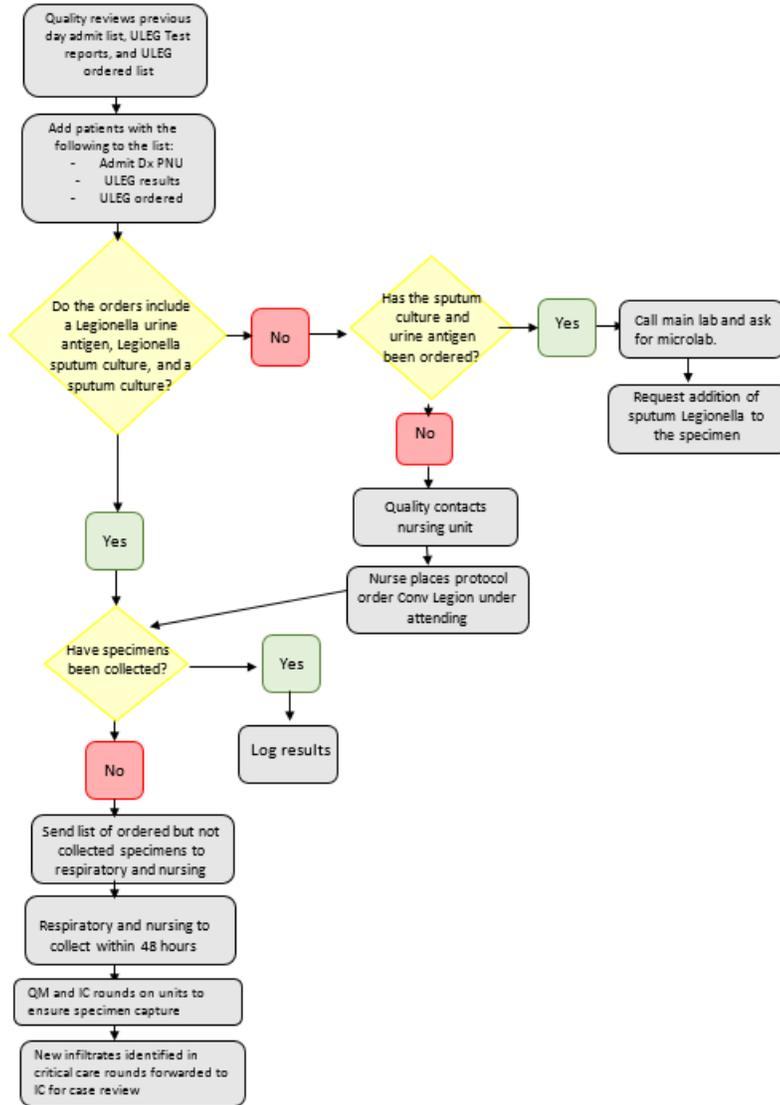
ID	Date	Time	Sample Type	Sample Description	pH	Temp (°F)	Temp (°C)	Total Cl ₂ (ppm) ⁹	Free Cl ₂ (ppm)	Chloramine estimate (ppm)
	8/26/16	11:33 AM		Building BC Patient Room 520 Sink (cold)	7.16	78.44	25.8	0	0	NC
	8/26/16	11:39 AM		Building BC Cherrywood Gym Sink (hot)	6.98	111.56	44.2	2.5	2.1	0.4
	8/26/16	11:43 AM		Building BC Cherrywood Gym Sink (cold)	7.29	78.62	25.9	0.8	1	NC
	8/26/16	11:52 AM		Building BC Lower Nourishment Room Sink (hot)	7.09	112.64	44.8	≥3.5	1.6	≥1.9
	8/26/16	11:56 AM		Building BC Lower Nourishment Room Sink (cold)	7.44	76.28	24.6	1.1	0.9	NC
	8/26/16	12:03 PM		Building BC 3rd Floor Exam Room Sink (hot)	7.37	83.66	28.7	≥3.5	1.3	≥2.2
	8/26/16	12:06 PM		Building BC 3rd Floor Exam Room Sink (cold)	7.45	75.92	24.4	0.4	0.5	NC
	8/26/16	12:13 PM		Building BC Lower Cardiac Rehab Men's sink (hot)	7.17	100.22	37.9	≥3.5	1.6	≥1.9
	8/26/16	12:17 PM		Building BC Lower Cardiac Rehab Men's sink (cold)	7.39	75.2	24	0.7	0.7	NC
	8/26/16	12:26 PM		Building BC Ballinger Auditorium Men's sink (hot)	7.2	106.7	41.5	≥3.5	1.9	≥1.6
	8/26/16	12:30 PM		Building BC Ballinger Auditorium Men's sink (cold)	7.48	75.02	23.9	1.3	1.4	NC
	8/26/16	12:38 PM		Building A Patient Room 260 Sink (hot)	7.25	102.56	39.2	≥3.5	1.5	≥2.0
	8/26/16	12:43 PM		Building A Patient Room 260 Sink (cold)	7.53	75.02	23.9	0.9	NC	NC
022	8/26/16	12:49 PM	Swab	Building A Patient Room 260 Sink	NA	NA	NA	NA	NA	NA
023	8/26/16	12:51 PM	Bulk	Building A Patient Room 260 Sink	NC	NC	NC	NC	NC	NC
024	8/26/16	1:08 PM	Swab	Building A Patient Room 756 Sink	NA	NA	NA	NA	NA	NA
025	8/26/16	1:10 PM	Bulk	Building A Patient Room 756 Sink	NC	NC	NC	NC	NC	NC
	8/26/16	1:15 PM		Building A Patient Room 756 Sink (blended)	7.38	80.96	27.2	1.4	0.9	NC
	8/26/16	1:26 PM		Building A Machine Room 16 Supply	7.73	103.1	39.5	≥3.5	1.5	NC
	8/26/16	1:32 PM		Building A Machine Room 16 Return	7.57	103.46	39.7	≥3.5	1.7	NC
	8/26/16	1:43 PM		Building F Machine Room 31 City Water	7.81	73.04	22.8	1	0.9	NC
	8/26/16	2:15 PM		Cooling Tower #3	9.22	80.42	26.9	≥3.5	0.9	NC

APPENDIX B. TESTING ALGORITHM FOR NEW DIAGNOSES OF PNEUMONIA UPON ADMISSION



APPENDIX C. TESTING ALGORITHM FOR NEW DIAGNOSES OF PNEUMONIA FOLLOWING ADMISSION

POST ADMIT FLOW FOR LEGIONELLA MONITORING



6/17/2016



APPENDIX D. LEGIONELLA ENVIRONMENTAL SAMPLING TEST RESULTS

Outbreak: M116-1



Project ID	DNSL#	Collected	Processed	Sample Date Description	Test Results	Specimen Type	Comments
M116-1-006	3015358964	08/25/2016	08/26/2016	McLaren ER Exam Room 15 Faucet	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-007	3015358965	08/25/2016	08/26/2016	McLaren ER Exam Room 15 Faucet (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-008	3015358966	08/25/2016	08/26/2016	McLaren PACU-Faucet	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-009	3015358967	08/25/2016	08/26/2016	McLaren PACU-Faucet (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-010	3015358968	08/25/2016	08/26/2016	McLaren Patient Room 1118 Shower	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-011	3015358969	08/25/2016	08/26/2016	McLaren Patient Room 1118 Shower (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-012	3015358970	08/25/2016	08/26/2016	McLaren Patient Room 1118 Sink	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-013	3015358971	08/25/2016	08/26/2016	McLaren Patient Room 1118 Sink (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-014	3015358972	08/25/2016	08/26/2016	McLaren Patient Room 908 Shower	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-015	3015358973	08/25/2016	08/26/2016	McLaren Patient Room 908 Shower (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-016	3015358974	08/25/2016	08/26/2016	McLaren Patient Room 908 Sink	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-017	3015358975	08/25/2016	08/26/2016	McLaren Patient Room 908 Sink (hot)	Final Identification = No Legionella Isolated	Water	
M116-1-018	3015358976	08/25/2016	08/26/2016	McLaren Machine Room 24- Unit 1 Supply	Final Identification = No Legionella Isolated	Water	
M116-1-019	3015358977	08/25/2016	08/26/2016	McLaren Machine Room 24- Unit 1 Return	Final Identification = No Legionella Isolated	Water	
M116-1-020	3015358978	08/25/2016	08/26/2016	McLaren Machine Room 31- Unit 2 Supply	Final Identification = No Legionella Isolated	Water	
M116-1-021	3015358979	08/25/2016	08/26/2016	McLaren Machine Room 31- Unit 2 Return	Final Identification = No Legionella Isolated	Water	
M116-1-022	3015359334	08/26/2016	08/29/2016	McLaren Building A- Patient Room 260 Sink	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-023	3015359335	08/26/2016	08/29/2016	McLaren Building A- Patient Room 260 Sink	Final Identification = No Legionella Isolated	Water	



Centers for Disease Control & Prevention
Legionella

Outbreak: M116-1



Project ID	DASH ID	Collected	Processed	Sample Data Description	Test Results	Specimen Type	Comments
M116-1-023	3015389235	08/26/2016	08/29/2016	McLaren Building A - Patient Room 260 sink	M116-1-023 C1 Final Identification = LP 1,12 = negative	Water	
M116-1-023	3015389235	08/26/2016	08/29/2016	McLaren Building A - Patient Room 260 sink	M116-1-023 C2 Final Identification = LP 1,12 = negative	Water	
M116-1-023	3015389235	08/26/2016	08/29/2016	McLaren Building A - Patient Room 260 sink	M116-1-023 C3 Final Identification = LP 1,12 = negative	Water	
M116-1-023	3015389235	08/26/2016	08/29/2016	McLaren Building A - Patient Room 260 sink	M116-1-023 C4 Final Identification = LP 1,12 = negative	Water	
M116-1-024	3015389236	08/26/2016	08/29/2016	McLaren Building A - Patient Room 250 sink	Final Identification = No Legionella Isolated	Environmental swab	
M116-1-025	3015389237	08/26/2016	08/29/2016	McLaren Building A - Patient Room 250 sink	Final Identification = No Legionella Isolated	Water	

Date Printed: 09/08/2016 1:38 pm

Contact Information: (404) 639-3563
Mailstop G03, 1600 Clifton Rd, NE, Atlanta, GA 30333

APPENDIX E. GENESEE COUNTY HEALTH DEPARTMENT LEGIONELLOSIS GUIDANCE FOR CLINICIANS AND LABORATORIES

Legionellosis Guidance for Clinicians and Laboratories

In the past two years, over 80 cases of Legionellosis have been reported from health-care providers in Genesee County, Michigan. Public health investigations are ongoing in 2016 to determine possible common sources of exposure. The Michigan Department of Health and Human Services (MDHHS) and Genesee County Health Department (GCHD) are asking that the clinical community assist in case finding through accurate identification, testing and reporting of all suspected cases of Legionellosis.

Epidemiologic Risk Factors for Legionellosis

- Age ≥ 50 years
- Chronic renal or liver disease including end-stage organ disease
- Diabetes
- Chronic lung disease
- Solid organ or hematologic malignancy
- Immune system suppression (e.g., organ transplant recipients, immunosuppressive medication usage)
- Current or former smoker
- Recent travel with an overnight stay away from home (up to 14 days prior to symptom onset)
- Recent inpatient or outpatient healthcare exposure (up to 14 days prior to symptom onset)
- Exposure to hot tubs (e.g., whirlpool spas) including either direct use, walking or sitting near a spa
- Recent repairs or maintenance work on domestic (i.e., household) plumbing

Diagnosing Legionellosis

Characteristic	Legionnaires' Disease	Pontiac Fever
Clinical features	Pneumonia (fever, cough, chills, dyspnea), neurologic abnormalities, myalgia or arthralgia, diarrhea, chest pain, headache (e.g., obtundation, seizures and focal neurological findings) and nausea/vomiting may also be present	Flu-like illness (fever, chills, malaise) without pneumonia
Radiographic	Yes	No
Incubation period	2 to 14 days after exposure	24 to 72 hours after exposure
Etiologic agent	<i>Legionella</i> species	<i>Legionella</i> species
Attack rate	< 5%	> 90%
Isolation of organism	Possible	Never
Outcome	Hospitalization common Case-fatality rate: 5- 30%	Hospitalization uncommon Case-fatality rate: 0%

Source: <http://www.cdc.gov/legionella/clinicians.html>

Who to Test for Legionnaires' Disease

Clinicians should use the following guidance to determine which patients to test for Legionnaires' disease. Additionally, infection control practitioners can use these guidelines to determine which respiratory specimens may be eligible for further testing.

- Any adult or pediatric patient with pneumonia
- Review of clinical presentations of Genesee County residents diagnosed with Legionnaires' disease during 2014-2015 demonstrates that respiratory symptoms (e.g., shortness of breath, cough) may be subtle or even absent initially and that a subset of patients may present with mental status changes and gastrointestinal symptoms (e.g., diarrhea, vomiting) in addition to or prior to the onset of pneumonia. While a pneumonia diagnosis is still a necessary threshold for pursuing testing for Legionnaires' disease, it is critical for healthcare providers to maintain a high index of suspicion for Legionnaires' disease, particularly in patients with multiple risk factors.

Testing for Legionnaires' Disease

Isolation of *Legionella* from respiratory secretions, lung tissue, or pleural fluid is still an important method for diagnosis, despite the convenience and specificity of urinary antigen testing. Investigations of outbreaks of Legionnaires' disease rely on detection of *Legionella* in both clinical and environmental isolates. Clinical and environmental isolates can be compared using monoclonal antibody and nucleic acid-based typing tests. Because *Legionella* are commonly found in the environment (including residential water systems), bacterial isolates from case-patients are necessary to trace back to possible sources of exposure and to interpret the findings of an environmental investigation in order to prevent disease from that source. Further, Legionnaires' disease may require enhanced therapy beyond the usual community-acquired or hospital-acquired pneumonias, so swift diagnosis is important.

- The *Legionella* urinary antigen test **AND** culture of lower respiratory tract secretions on selective media are the recommended diagnostic tests for Legionnaires' disease (Please note that the *Legionella* urinary antigen test detects serotype 1 of *Legionella pneumophila*; other *L. pneumophila* serotypes and other *Legionella* species may not be detected by the urinary antigen test).
- If a provider obtains a *Legionella* urinary antigen test on a patient with suspected Legionellosis, a lower respiratory tract specimen should be collected for *Legionella* culture at the same time.
 - A tracheal aspirate or bronchoalveolar lavage may be collected in patients who are intubated or undergoing bronchoscopy.
 - Sputum sample collection should be attempted in patients who are not intubated or not undergoing bronchoscopy.
 - Oropharyngeal or nasopharyngeal swabs are **not** acceptable clinical specimens for *Legionella* culturing.
- Culture for *Legionella* should specifically be requested so that specimens are plated on the correct growth media. Any clinical specimen remaining from the respiratory culture **should be immediately frozen** and stored by the hospital laboratory. If hospital laboratory capacity is limited, then sputum samples can be transported and stored at the MDHHS Bureau of Laboratories (BOL) **free-of-charge**.

Note: For new onset community-acquired pneumonia or health-care associated pneumonia, testing by a *Legionella* urinary antigen test and respiratory secretion culture is recommended within 24 hours of patient

Revised: 05/23/2016

2 of 5

presentation to a healthcare provider. This diagnostic approach is recommended to facilitate early identification of patients with Legionellosis and help guide early appropriate treatment which can reduce mortality. This activity will also help identify increases of illness in Flint and Genesee County as well as institute targeted Legionellosis prevention measures.

For patients with a *Legionella* urinary antigen test that is positive or negative, collection and submission of lower respiratory tract secretion specimens for *Legionella* culture test is recommended.

We request that your facility perform culture isolation of *Legionella*, lower respiratory tract secretion specimen samples for all urinary antigen positive Legionellosis patients. Respiratory samples from patients whose urinary antigen test is negative should be sent with specific request to have the specimen cultured for *Legionella* at the MDHHS Bureau of Laboratories (BOL). Any hospital laboratory experiencing concerns with laboratory capacity in performing cultures can communicate those concerns to GCHD or MDHHS and we will provide assistance.

A positive *Legionella* culture isolate identified in hospital laboratories should be preserved and shipped to the BOL for confirmatory testing.

Clinical Isolates or Specimen Shipping

The MDHHS state laboratory will test clinical isolates or respiratory specimens submitted to the BOL for *Legionella*. **Please note: There is no fee for specimen shipping or testing.** Please avoid repeated freezing and thawing of isolates/specimens. Contact the MDHHS BOL with any questions about isolate/specimen submission or shipment at: (517) 335-8067.

Treatment

Adults

Recommended treatment for Legionellosis in most patients includes either a fluoroquinolone (e.g., levofloxacin, 750 mg once daily or moxifloxacin, 400 mg once daily) or a macrolide (e.g., azithromycin, one gram on day one, followed by 500 mg once daily) for a total treatment duration of 10 to 14 days. Because macrolides may interfere with drugs metabolized by cytochrome P450 (CYP) 3A4 isoenzyme (e.g., cyclosporine), the quinolones mentioned above are suitable alternatives to treat Legionnaires' disease in patients taking cyclosporine or other CYP3A4 substrates.

Children

Azithromycin is the drug of choice for children with suspected or confirmed Legionellosis. The initial course should be intravenously administered. After a good clinical response is observed, azithromycin can be switched to the oral route. The recommended duration of therapy is 5 to 10 days for azithromycin and 14 to 21 days for other drugs. Longer courses of therapy are recommended for patients who are immunocompromised or who have severe disease (American Academy of Pediatrics Red Book 2015, 30th Edition).

Reporting

By law, Legionellosis is a reportable disease in Michigan. We are asking health care professionals to report both Legionnaires' disease and Pontiac Fever cases via the Michigan Disease Surveillance System (MDSS) or directly to the Local Health Department. Physicians are requested to collect and record illness onset dates as part of the patient record. An accurate illness onset date is extremely important to determine the

Revised: 05/23/2016

3 of 5

patient's potential environmental exposures and is vital to the investigation of an outbreak. In patients with chronic respiratory conditions, the first appearance of fever may be a useful indicator of Legionellosis onset date.

Legionellosis Prevention Measures

- Be sure to ask about travel history including cruise ship related travel.
- Smoking increases the risk of Legionnaires' disease if exposed to *Legionella* bacteria. This is an opportunity to promote smoking cessation.
- The mode of transmission can include inhalation of vapor or aspiration.
- This is also an opportunity to promote use of pneumococcal and flu vaccines.
- Recommend use of bottled water for drinking/cooking/brushing teeth for vulnerable populations: immunocompromised/suppressed, diabetics, cancer, leukemia, lymphoma, COPD, CHF and the frail/elderly, including those with swallowing difficulties.
- Also, recommend tub baths for these vulnerable populations unless there is a risk for falls.
- While public health experts believe the risk of getting Legionnaires' disease from a home water system is much smaller than the risk from large water systems, home owners may be able to reduce the risk further by maintaining their water systems.
- Showers: Because they remain damp, shower heads could hold *Legionella* bacteria. Removing the shower head, manually cleaning it to remove scale and sediment, and soaking it in a mixture of 1 tablespoon of household bleach to 1 gallon of water for about 2 hours will disinfect the shower head.
- Humidifiers: Some homes have whole house humidifiers. You should clean and disinfect humidifiers regularly according to manufacturer's directions. Always unplug the humidifier first. Clean the inside of the humidifier per the manufacturer's instructions, using a mixture such as 1 tablespoon of household bleach to 1 gallon of water, and dry. Thoroughly clean the outside of the humidifier before and after storage.
- CPAP machines and nebulizers should also be cleaned per manufacturer's recommendations. Distilled water should be used. If the manufacturer's instructions cannot be located, the healthcare equipment supplier can provide them.
- Water Heaters: In some cases, *Legionella* bacteria have been found in residential water heaters. When found, it's more often been in electric water heaters than in gas water heaters. Regularly maintaining the water heater according to manufacturer's instructions is recommended to help reduce the risk of *Legionella* bacteria growing. Most manufacturers recommend that water heaters be flushed on an annual basis. If you cannot locate the manufacturer's instructions, seek the advice of a licensed plumber.

- Water scientists, public health officials, and healthcare experts are currently discussing the risks and benefits of increasing the recommended water heater temperature from 120°F to 130°F which may reduce the risk of *Legionella* bacteria growing. However, because of the **risk of scalding**, increasing the water heater temperature from 120°F to 130°F is not currently being recommended. Updated guidelines regarding water heater management for risk prevention will be provided should recommendations change.

For additional information, please contact:

Genesee County Health Department: (810) 257-1017 or (810) 257-3815 or

MDHHS Communicable Disease Division: (517) 335-8165.