Onsite Education & Plumbing Safety YouTube Channel

Plumbing Testing Facility at Purdue

Nearby Innovation Partner with Full-Scale Testing Facility

Onsite Testing and Technical Support

NEHA Presentation, May 22, 2020
More information here... www.PlumbingSafety.org

A Resource for All
- Plumbing news
- Plumbing education videos
- Plumbing explainers
- List of projects
- Scientific opinions
- Resources ➔ presentations
- Scientific reports
- External plumbing docs

Access to world-class expertise, capabilities, and education in and outside Purdue

Many thanks to Brad Caffery at Purdue University
COVID Specific
Building Water Safety Support Resources

- Advice for building owners, health officials and utilities
- Building water safety education videos
- Guidance on how to create flushing plan
- Access to the Building Water Safety Study
- Guidance on building water safety from multiple nations and U.S. states

Restoring Water to Medical, Residential, and Commercial Buildings, Shutdowns, Unsafe Water

The COVID-19 pandemic has caused widespread building shutdowns, but also emergency restoration of water to previously closed medical facilities and homes. Several serious building drinking water safety risks exist. As people begin using the water again, they will encounter extremely stagnated water with excessive lead, copper, and bacterial concentrations, that may include harmful organisms like legionella that can cause disease outbreaks.

There are no national or industry guidelines for building reopening after extended shutdowns.

The U.S. National Science Foundation funded Purdue University researchers to rapidly address this serious public health concern. This rapid response effort involves partnerships with the American Society of Plumbing Engineers and International Association of Plumbing and Mechanical Officials and collaborations with other building water and public health experts from across North America.

[NSF government website description of this rapid response grant]

Questions
I am looking for...

- A list of your rapid response efforts in response to the COVID-19 outbreak
- Advice on what I should do as a public health official, building owner, or water utility
- Download a copy of the Experts Building Water Safety Study released April 7, 2020
- Guidance on how to create a building flushing plan
- Brief educational videos on building water safety topics
The coronavirus pandemic has prompted low to no water use in more than 5.6 millions buildings – in the U.S. alone.
Schools, gyms, retail and arts centers, salons, places of worship, hotels, casinos, government, sports and entertainment, colleges and universities, & more
Food preparation areas

Bathrooms

Water fountains

Point-of-entry devices

Point-of-use devices

Breakrooms

Point-of-use devices
There are several key components of building systems

- Water source
- Service line
- Safety devices including valves
- Water treatment devices
- Water service and distribution piping and faucet connectors
- Hot water heating, recirculation system
- Fixture and fixture fittings
- Pumps, tanks
- Point-of-use devices

Table 1. Types of building plumbing components

<table>
<thead>
<tr>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water source</td>
<td>Municipal water, onsite well, treated surface water, rainwater.</td>
</tr>
<tr>
<td>Service line</td>
<td>Pipe system that carries water from the source to the building water system. Service line materials are available and may or may not be the same as indoor pipes.</td>
</tr>
<tr>
<td>Safety devices including valves</td>
<td>Pressure relief valve, pressure reduction valve, isolation valve, mixing valve, thermostatic mixing valves, backflow prevention device, water heater anode rod. Materials can include aluminum, brass, copper, lead, plastic, and stainless steel.</td>
</tr>
<tr>
<td>Water treatment devices</td>
<td>Filter, strainer, water softener, chemical addition equipment for disinfection and corrosion control.</td>
</tr>
<tr>
<td>Water source and distribution piping and faucet connectors</td>
<td>Various material types have been used to include acrylonitrile butadiene styrene (ABS), brass, cast iron (CI), chlorinated polyvinyl chloride (CPVC), copper, cross-linked polyethylene (PEX), ductile iron (DI), high density polyethylene (HDPE), lead, lead lined steel, multilayer pipes, polyethylene raised temperature (PERT), polypropylene (PP), unplasticized polyvinyl chloride (PVC), polyvinylidene fluoride (PVDF), black steel, stainless steel.</td>
</tr>
<tr>
<td>Hot water recirculation system</td>
<td>Hot water is pumped through primary and secondary water heater loops, which serve different building zones to reduce delivery time of hot water. These have to be hydraulically balanced. Equipment includes master mixing valves, local mixing valves, flow balancing valves, pressure reducing valves hot water return pumps and water heaters. Multiple temperature loops may exist. Operations of pumps may be intermittent in some systems.</td>
</tr>
<tr>
<td>Fixtures and fixture fittings</td>
<td>Aerator, air whirler, atomizer, bathtub, bidet, decorative fountains, dishwasher, drinking fountain, eye wash stations, manual faucets, electronic faucets, faucet flow restrictors, hose, point-of-use mixing valves, hot tubs, humidifiers, ice machines, misters, shower head, shower wand, VFA, tub, spa, bidet, urinal, washbasin.</td>
</tr>
<tr>
<td>Pumps</td>
<td>Pumps are often used for pressure boosting within the building (i.e. for multi-story buildings) where water pressure entering the building is not adequate for water use at distant locations. Pumps are also used for hot water recirculation systems.</td>
</tr>
<tr>
<td>Tanks</td>
<td>Standard water heater, pressure tank, on-demand water heater, hydropneumatic tanks, cold water supply storage tank. Water heaters can contain Mg or Al sacrificial anodes and plastic discharge tubes.</td>
</tr>
<tr>
<td>Point-of-use devices</td>
<td>On-faucet treatment system, under sink treatment system.</td>
</tr>
</tbody>
</table>

https://doi.org/10.31219/osf.io/qvj3b

NEHA Presentation, May 22, 2020
Stagnation  *noun*

stag·na·tion  |  \stag-ˈnā-shən

a state or condition marked by lack of flow, movement
Stagnation causes water to get older

**Normal water use** refreshes:
- disinfectant residual & [image]
- corrosion control [image]

**Old water** (not refreshed):
- bacterial growth & [image]
- corrosion not controlled [image]

**Disinfectant** in water – used to reduce microbial growth in water, typically chlorine
**Corrosion control** – used to reduce metals leaching, stabilizes pH and may add chemicals
Prior to the pandemic, stagnation posed health risks

During short-term stagnation, high concentrations of metals and harmful organisms have been found in building water systems. A few issues include...

- **Copper** can leach from pipes (an exceed safe limits in just 48 hours sometimes)
  - This can increase to toxic levels causing gastrointestinal distress

- **Lead** can also leach from water system components
  - Lead causes developmental issues with children

- **Harmful organisms** (e.g., *Legionella pneumophila* and other opportunistic pathogens)
  - Many of these organisms cause respiratory illness
  - Other infections can occur

Most building water systems we’ve encountered often go untested, lack water management plans. Phenomena have not been studied in the long-term.
Copper vs. Distance from Water meter

1.3 mg/L health based limit
Drinking water systems that support biofilm growth to include cooling towers, hot tubs, fountains, and building plumbing systems and their outlets like faucets and showerheads.

Warm temperatures + stagnant water + and no chemical disinfectant

Exposure route: Inhalation of contaminated aerosols

https://doi.org/10.17226/25474

NEHA Presentation, May 22, 2020
“The most common respiratory pathogens detected in Qingdao COVID-19 patients were influenza virus A (60.00%) and influenza virus B (53.30%), followed by mycoplasma pneumoniae (23.30%) and legionella pneumophila (20.00%).”
1. Support to the plumbing and public health sectors on building water safety guidance and decisions, **ongoing**

2. Building water safety review due to prolonged stagnation with experts from 8 private and public sector organizations, **ongoing**

3. Field testing to determine how impacted building water safety is in actual large buildings, **ongoing**

4. Lab testing to determine how to fully recover contaminated building water system devices and equipment, **planned**

5. Help transform public awareness, **ongoing**
#2. Building water safety review due to prolonged stagnation with experts from 7 private and public sector organizations

Collaborative effort

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William Rhoads, Ph.D., Virginia Tech
Tim Keane, Legionella Risk Management, Inc.
Maryam Salehi, Ph.D., University of Memphis
Kerry Hamilton, Ph.D., Arizona State University
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https://doi.org/10.31219/osf.io/qvj3b
What actions can be taken to **prevent** water quality deterioration?

Normal use:
- Building water management plans

Extended stagnation/low-use
- Periodic flushing
- Change water heater operation
- Drain plumbing?

COVID-19 considerations
- Utility mains also have stagnation
- Slow ramp-up of economic activity
What actions can be taken to deal with water quality deterioration?

- Recommissioning plumbing
  - System integrity checks
  - Flushing (and cleaning)
  - Shock disinfection
  - Testing

- Professional help might be needed
  - Address complex mechanical and treatment equipment
  - Develop effective flushing plans
  - Perform shock disinfection safely (thermal or chemical)
  - Perform accurate testing

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Safety: Engineering, Administrative, and Personal Protective Equipment (PPE) Controls

PPE

- OSHA and other agencies recommend respirators if Legionella is suspected or possible

Reducing exposure

- During flushing (especially initial), many methods to reduce exposure
- Cover toilets, showerheads, faucets, reduce splashing

Temporary closures of facilities

- Temporarily forbidding high-risk exposure activities (showering)
- Temporarily closing facilities to concentrate use

Technical considerations

- Fill sink and floor drains traps with water
- Flooding, cross-connections, dealing with waste
- Pressure issues with high flowrate flushing

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Who should be involved in monitoring and/or returning the building water system to use?

• Public health departments, environmental health
• Communication about risks
  • Public health departments
  • Building owners [should seek advice from public health departments]
  • Utilities [generally don’t understand plumbing]
• Taking action (flushing, disinfecting)
  • Building owners can task maintenance/facilities managers
  • Plumbers, contractors, engineers may need to be involved
When the pandemic struck, no guidance documents about building plumbing stagnation and recommissioning existed.

ZERO.

Today, more than 45 different building water system stagnation and recommissioning “guidance” docs have been created by

- National governments
- State governments
- City governments
- Public and private utilities
- Private contractors
- Trade industry associations
- Nonprofit organizations
- Device manufacturers
These **NEW** documents have been informed by our paper, the document writer’s firsthand experience, extrapolated from short-term evidence, and/or documents issued by others. **But, some lack key info.**
**HOT TOPIC:** How do we avoid “recommissioning” the building water system due to low or no use?

**Keep the water moving! ≠ stagnation**

- Source water must be fresh (utility, onsite well, Source may need to flush)
- Clean devices and equipment
- Flushing – Keep water fresh
- Water heater and recirculation loops – Keep hot water hot, Keep cold water cold
**HOT TOPIC:** What plumbing recommissioning actions are needed after low to no water use?

What needs to be done when? – Evidence is lacking.

*for perspective:* ASHRAE 188 for NEW CONSTRUCTION

Shock disinfection should occur within 3 weeks of planned occupancy.
If occupancy is delayed >4 weeks, another shock disinfection is required prior to occupancy.

**Key Considerations**

1. System integrity, clean devices and equipment
2. Flushing
3. Shock disinfection (chemical, thermal)
4. Testing with a purpose and plan
5. Communicate with a purpose
Learn how to create a building flushing plan

The Purpose of Flushing Building Water Systems

Kyunghwan Ra, Graduate Student
Kwanghee Cho, Graduate Student
Dr. Calvin Poindexter, Professor
Dr. Amanda Hinson, Assistant Professor

Division of Environmental and Ecological Engineering
Lyons School of Civil Engineering
Purdue University

Visit our Plumbing Safety YouTube Channel for Short Education Videos

Example Procedure for Flushing an Actual School Building
April 6, 2020, Version 1

I. Background

Sometimes buildings are shut down or experience long-periods of low occupancy and the water inside the property plumbing stagnates. Water can stagnate inside the building pipes and tanks, but also in the buried water service line that transports drinking water from its source to the building. Stagnation allows for contaminant levels of metals such as lead and copper to increase in the water. Microbes are also likely to grow. Under routine building water use, the amount of contamination in water is not typically a problem, but long stagnation periods can cause water quality to deteriorate to unacceptable levels. To remove this water from the property plumbing, a procedure was developed based on as-built construction drawings and experience inside the building. The procedure below is provided to help demonstrate the steps needed to flush the stagnant water from a specific building and replace it with fresh water from the water utility main buried out in front of the property.

II. The Procedure

This guidance was developed using as-built drawings for an actual building where the characteristics were known. Factors of safety were not applied. Due to nonideal flows commonly encountered in plumbing, actual flushing times may need to be increased. In a prior study for flushing home interior faucets the factory of safety applied was 19. So, all flushing times may need to be 10% longer. No safety factors were applied.

- Year Built 2011
- Size:
  - 2 floors (1st floor: classrooms, auditorium, two gym, and cafeteria; 2nd floor: mechanical attic)
  - All water only located on first floor
  - The building area is 209,000 square feet, while the total area for the property (including sporting fields) is 3,378,152 square feet
  - There are 12 different building sections (A, B, C, D, E, F, G, H, J, L, K) and each has various uses.
- Water Transport and Use on Property:
  - A public water system (PWS) delivers chlorinated drinking water to the property through a buried service line.
  - PWS water used for drinking, appliances, hot water, and irrigation.
  - After passing through the water meter, an 8 inch PVC pipe service loop circles entire school campus (3,481 feet, volume 9,069 gallons). Some branches exist that convey water to a field house, concession stand, and yard hydrants (a 2 inch existing fire hydrant branches off from the fire line around the building to the near the concession stand, and few others are located outside the building).
  - 4 inch irrigation pipe line also branches off from the fire line around the building. In this document, flushing of the irrigation line is not included. The building service line and building itself is only the focus.
  - Water enters the school building by traveling through this loop, and then into a 4 inch ductile iron pipe (160 ft, volume 164 gallons)
- Devices:
  - Two point-of-entry water softeners (52.36 gallons each, one used at a time)
  - Four water heaters (139 gallons each)
  - Total four hot water recirculation loops, one heater for each loop (a 150°C loop for the kitchen and three 120°C loops for domestic water)
Health departments: Short-term

1. **Determine the threshold that would prompt you** to require restrictions on water use in buildings with low or no occupancy such as: Handwashing Only, Do Not Drink Water, Do Not Use Water.

2. **Prepare communication materials** for building owners to distribute to occupants regarding water quality in buildings with low or no occupancy. These may include signs to post at water outlets to alert occupants about the status of the plumbing.

3. **Identify and alert regional labs** about a potential surge in the need for metals and harmful organism analysis.

4. Make certain they possess trained personnel, tools, and resources to assist society with re-occupancy efforts.

5. **Prepare to deliver guidance** to building owners and managers re-occupying buildings. Create a checklist for building water system re-occupancy approvals.

6. **Recommend building owners refresh their plumbing** by flushing fixtures to bring in fresh water. This can help prevent harmful organisms from growing in plumbing, and dispose of water with unacceptable levels of lead and copper.

7. **Prepare to assist building owners** assess potential health risks. This includes determining whether to require water testing, when and to collect water samples to assess human health risks.

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Health departments: **Longer-term**

1. **Prioritize oversight of water being restored** to decommissioned health facilities, clinics, and long-term care facilities, and buildings serving vulnerable populations.

2. **Notify building owners** about the process your department has established for certifying or consenting to plumbing use where there’s been low or no occupancy. Not all buildings, or even of the same type, will undergo the same process for restoring water quality.

3. **Determine the threshold that would prompt you** to require recommissioning actions such as flushing, fixture cleaning, disinfection, as well as chemical and microbiological testing.

4. **Prepare to deliver guidance** to building owners and managers re-occupying buildings. Create a checklist for building water system re-occupancy approvals.

5. **Remind regional labs** about a potential surge in the need for metals and harmful organism analysis.

6. **Reconfirm** the Health Department possesses trained personnel, tools, and resources to assist society with re-occupancy efforts.
Is legionella the only health risk?
Will the hospital / doctors detect legionella outbreaks?
Where do I find building water system reopening guidance?
What are the health risks of flushing?
What does a building water system flushing plan look like?
How long does each faucet need to flush?
How should the water be tested?
What legionella test method should I use?
If legionella is found, what should be done?
What is the right water heater temperature?
Can the water be treated in the plumbing without flushing it?
What needs to be done to the filters and other devices?
When is shock disinfection recommended?
How do I clean [insert name] device?

Many building owners need public health support.

We are very interested learning about your experiences, your needs, the questions you have received, and helping you.

Thanks for doing what you do.

Andrew Whelton, Ph.D.
awhelton@purdue.edu

Summer 2020 Course
EEE 495: Building Water Systems
3 Credits

Instructors:
Professor Andrew Whelton, Civil, Environmental, & Ecological Engineering, awhelton@purdue.edu
Dr. Caitlin Proctor, Biomedical, Materials, Civil, Environmental & Ecological Engineering, proctor@purdue.edu

Prerequisites: Chemistry or biology, mass balance

Building water systems are sitting allow to no occupancy across the globe due to the COVID-19 pandemic. Stagnant water in them can pose significant human health risks due to chemical and microorganism accumulation and exposure. Students will be introduced to engineering and science principles underlying building water systems, current issues associated with the pandemic, and how prior disasters affected water systems.

The learning objectives are to:
1. Describe the chemical and microbiological contaminants common to building water systems,
2. Explain the factors that control contaminant accumulation in building water systems,
3. Apply mass balance principles to predict contaminant levels and exposure concentrations,
4. Identify remediation practices for reducing contaminated water from the systems, and
5. Use as-built construction drawings to determine how to avoid and remediate water quality problems.

Students will:
1. Complete out of class learning assignments,
2. Participate in mediated discussions with the Instructors, and
3. Create a final project. This will include creating a flushing plan for a specific building and evaluating officially issued guidance. Students will read and interpret construction drawings, calculate volumes and flowrates, and use Microsoft® Excel.

Extra Slides
### What do I test for?

**BASIC PARAMETERS**

- **Cold water** = disinfectant concentration, temperature
- **Hot water** = temperature

For others, you need a plan about what you will do if you test: Lead, copper, legionella, and more

### Section 3.185 Table 6: European Union Action Levels for *Legionella* in Potable Hot and Cold Water Systems

<table>
<thead>
<tr>
<th>Legionella CFU/Liter</th>
<th>Action Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Detected</td>
<td>Acceptable – continue monitoring</td>
</tr>
<tr>
<td>&lt; 100 to 1,000</td>
<td>Refer to responsible person and assure water quality values are within target</td>
</tr>
</tbody>
</table>
| > 1,000 to < 10,000  | i) Resample if small percentage (10-20%) are positive; review control measures  
                          | ii) If >20% positive may indicate low level colonization, disinfection of system, and risk assessment to determine additional actions |
| > 10,000             | Resample, immediate review of control measures, disinfection of whole system |

Source: EU (2017).

The EU guidelines emphasize the goal to achieve no cultural *Legionella*, but acknowledge that occasional detection (<20%) of low levels of *Legionella* (< 1,000 CFU/L) may be acceptable provided that other water quality values (e.g., temperature, disinfectant) and operational parameters are within the water management plan guidelines. Intermediate levels (> 1,000 to < 10,000 CFU/L) and high levels (≥ 10,000 CFU/L) trigger a series of actions including resampling, remedial measures such as disinfection, and overall review of the water management plan program.
10 actions building owners should consider

1. Contact with the public health department, they may have specific requirements.
2. Communicate info provided by the health department to your occupants.
3. Don’t have a building water management plan? Document everything, that’s a start.
5. Conduct maintenance: Aerators, POU/POE treatment devices, water heaters, showerwand tubing, etc.
6. Start an inventory of building water system components
7. Use an inexpensive digital handheld disinfectant analyzer to monitor in-building levels. Document!
8. Contact a plumber or engineer for assistance
9. Do not shock disinfect, drain plumbing, shut off water heaters and recirculation loops without expert help. These can have potential health implications.
10. Reach out to us if you have questions.