COVID-19: Reopening Buildings and Challenges with Building Water Safety

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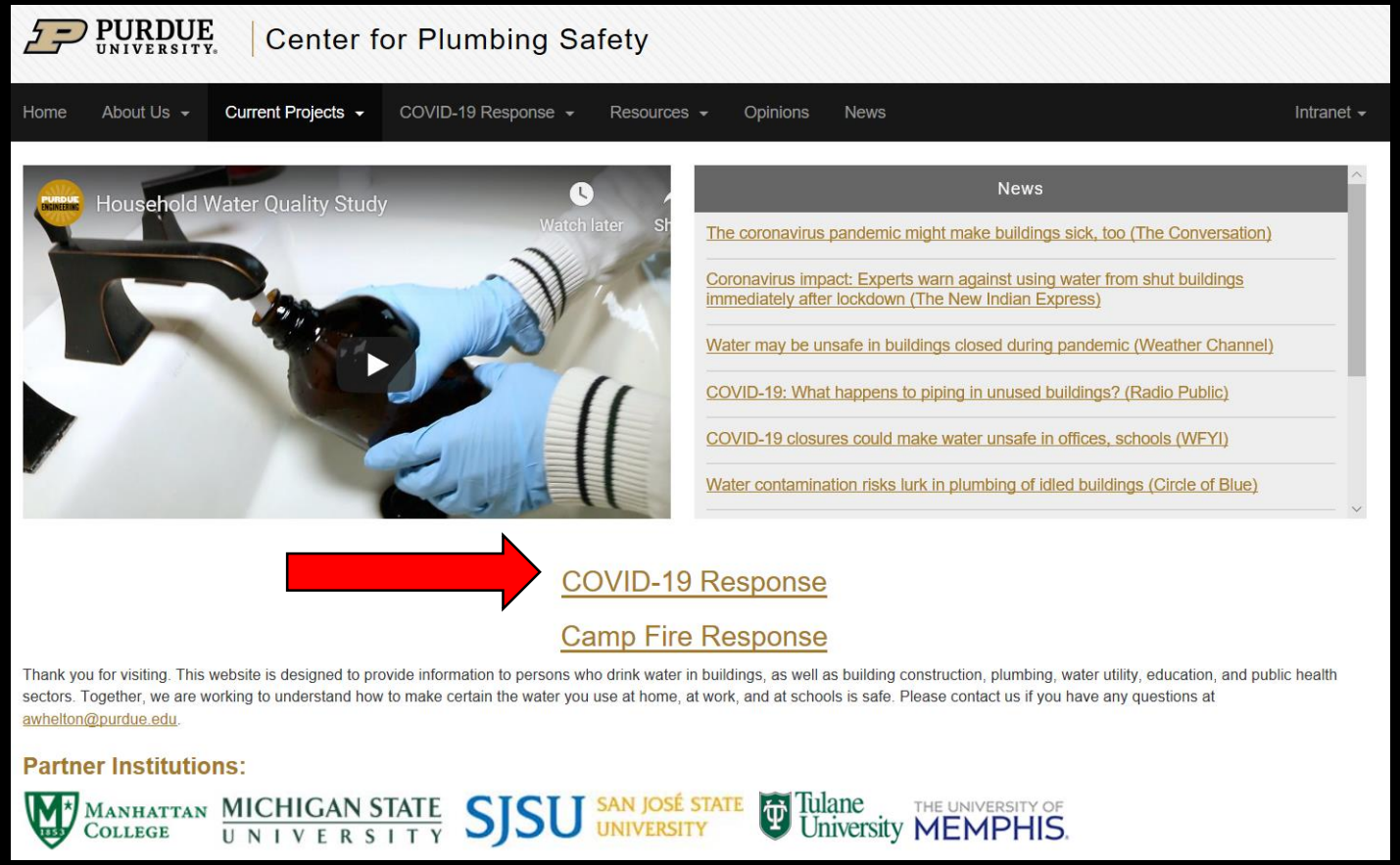
Plumbing Testing Facility at Purdue

Onsite Testing and Technical Support

More information here… www.PlumbingSafety.org



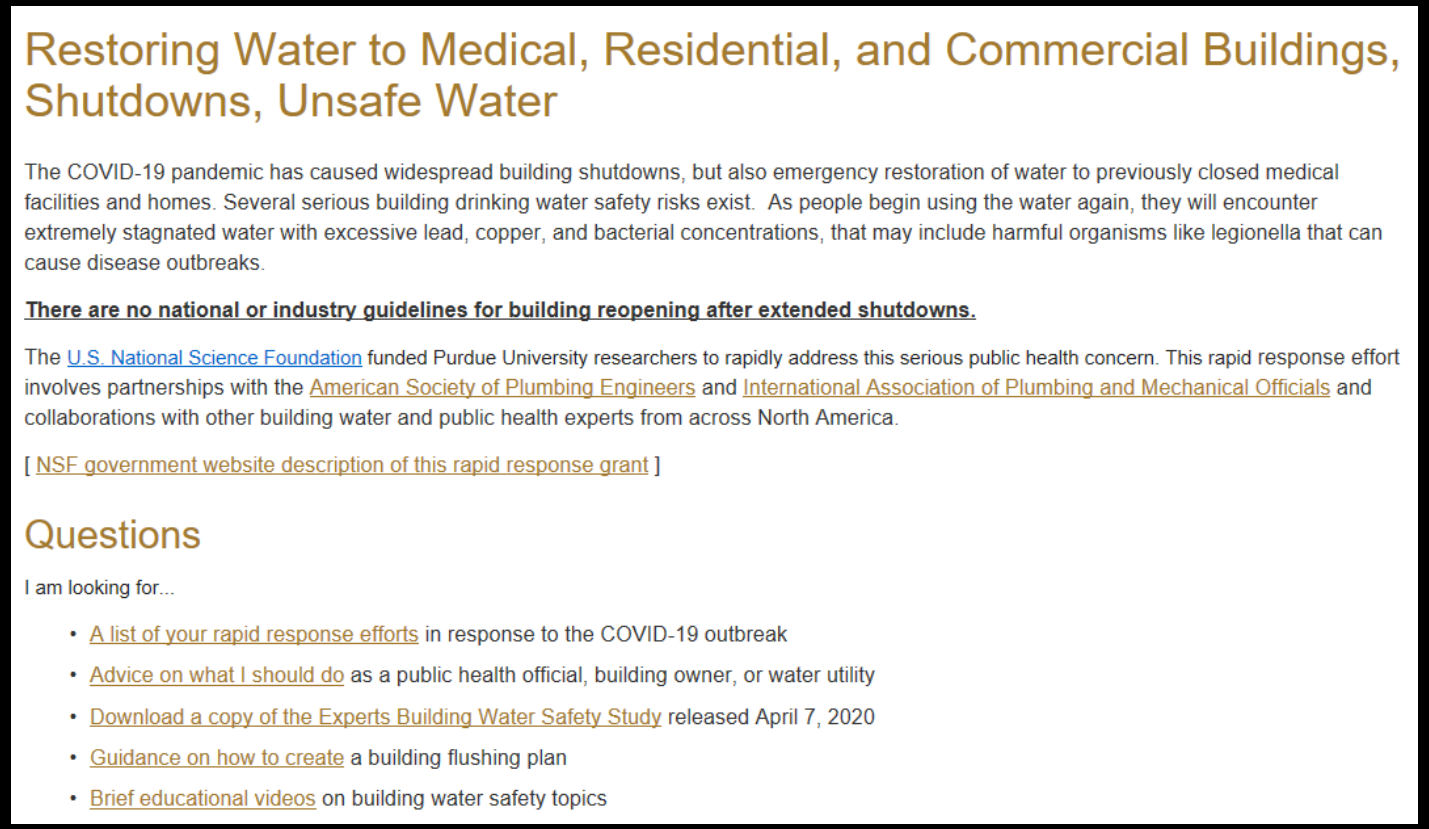
Access to world-class expertise, capabilities, and education in and outside Purdue

A Resource for All

- ✓ Plumbing news
- ✓ Plumbing education videos
- ✓ Plumbing explainers
- ✓ List of projects
- ✓ Scientific opinions
- ✓ Resources ➔ presentations
- ✓ Scientific reports
- ✓ External plumbing docs

Many thanks to Brad Caffery at Purdue University

COVID Specific Building Water Safety Support Resources



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.

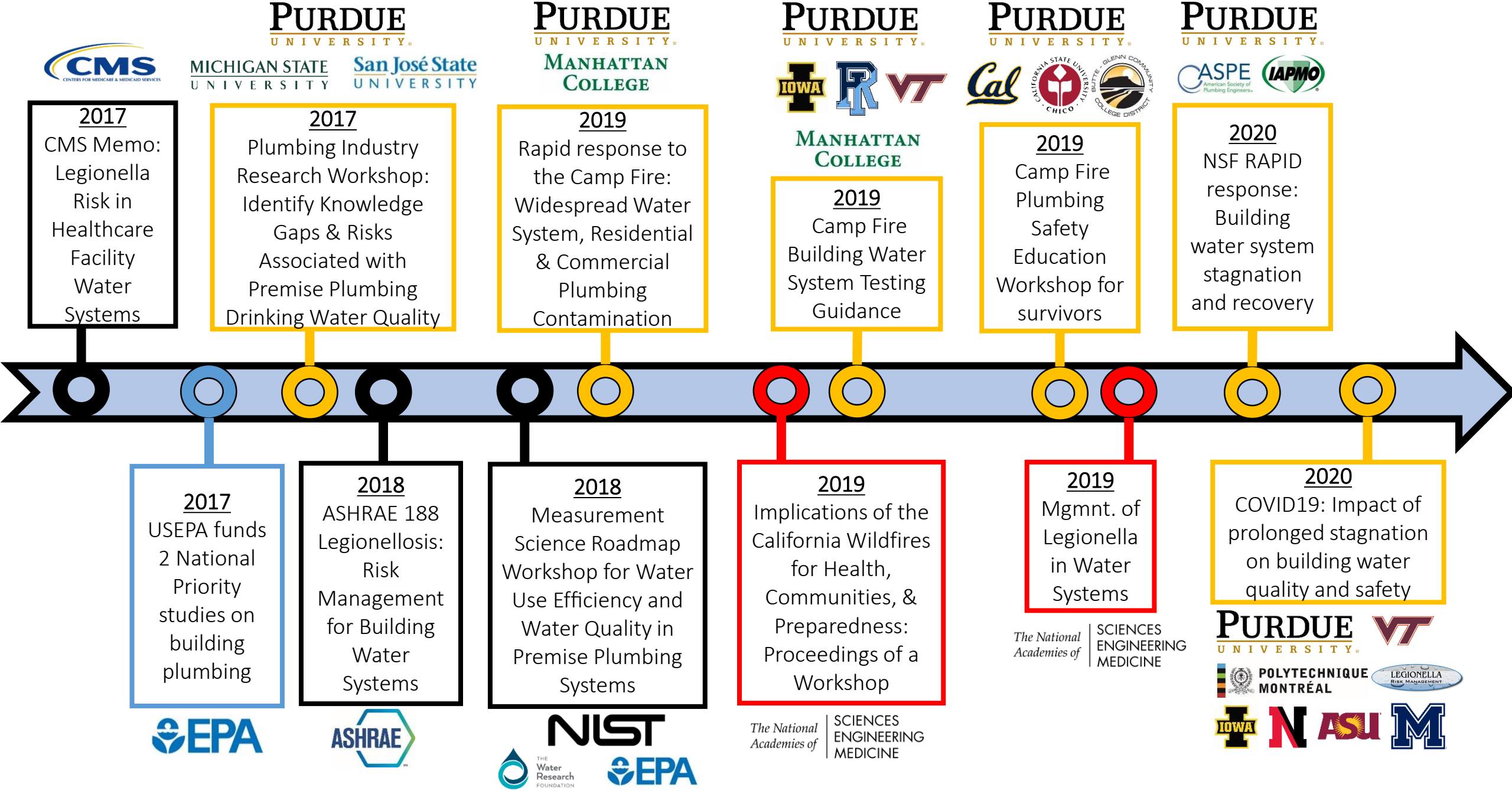
[NSF government website description of this rapid response grant]

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

- ✓ 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


2017
CMS Memo: Legionella Risk in Healthcare Facility Water Systems
2017
USEPA funds 2 National Priority studies on building plumbing
2017
Plumbing Industry Research Workshop: Identify Knowledge Gaps & Risks Associated with Premise Plumbing Drinking Water Quality
2018
ASHRAE 188 Legionellosis: Risk Management for Building Water Systems
2018
Measurement Science Roadmap Workshop for Water Use Efficiency and Water Quality in Premise Plumbing Systems
2019
Rapid response to the Camp Fire: Widespread Water System, Residential & Commercial Plumbing Contamination
2019
Camp Fire Building Water System Testing Guidance
2019
Implications of the California Wildfires for Health, Communities, & Preparedness: Proceedings of a Workshop
2019
Camp Fire Plumbing Safety Education Workshop for survivors
2019
Mgmnt. of Legionella in Water Systems
2020
NSF RAPID response: Building water system stagnation and recovery
2020
COVID19: Impact of prolonged stagnation on building water quality and safety

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

Bathrooms

Water fountains

Food preparation areas

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

Components	Description
Water source	Municipal water, onsite well, treated surface water, rainwater.
Service line	Pipe system that carries water from the source to the building water system. Service line materials are variable and may or may not be the same as indoor pipes.
Safety devices including valves	Pressure relief valve, pressure reduction value, isolation valve, mixing valve, thermostatic mixing valves, backflow prevention device, water hammer arrestors. Materials can include aluminum, brass, copper, lead, plastic, and stainless steel.
Water treatment devices	Filter, strainer, water softener, chemical addition equipment for disinfection and corrosion control.
Water service and distribution piping and faucet connectors	Various material types have been used to include acrylonitrile butadiene styrene (ABS), brass, cast iron (CI), chlorinated polyvinyl chloride (CPVC), copper, crosslinked polyethylene (PEX), ductile iron (DI), high density polyethylene (HDPE), lead, lead lined steel, multilayer pipes, polyethylene raised temperature (PERT), polypropylene (PP), unplasticized polyvinyl chloride (uPVC), polyvinylidene fluoride (PVDF), black steel, stainless steel.
Hot water recirculation system	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. Operation of pumps may be intermittent in some systems.
Fixtures and fixture fittings	Aerator, air washers, atomizers, bathtub, bidet, decorative fountains, dishwasher, drinking fountain, eyewash stations, manual faucet, electronic faucet, faucet flow restrictors, hoses, point of use mixing valves, hot tubs, humidifiers, ice machines, misters, shower head, shower wand, sink, tub spout, toilet, urinal, washbasin
Pumps	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 distal locations. Pumps are also used for hot water recirculation systems.
Tanks	Standard water heater, pressure tanks, on-demand water heater, hydropneumatic tanks, cold water supply storage tank. Water heaters can contain Mg or Al sacrificial anodes and plastic dip tubes.
Point-of-use devices	On-faucet treatment system, under sink treatment system.

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

Stagnation *noun*

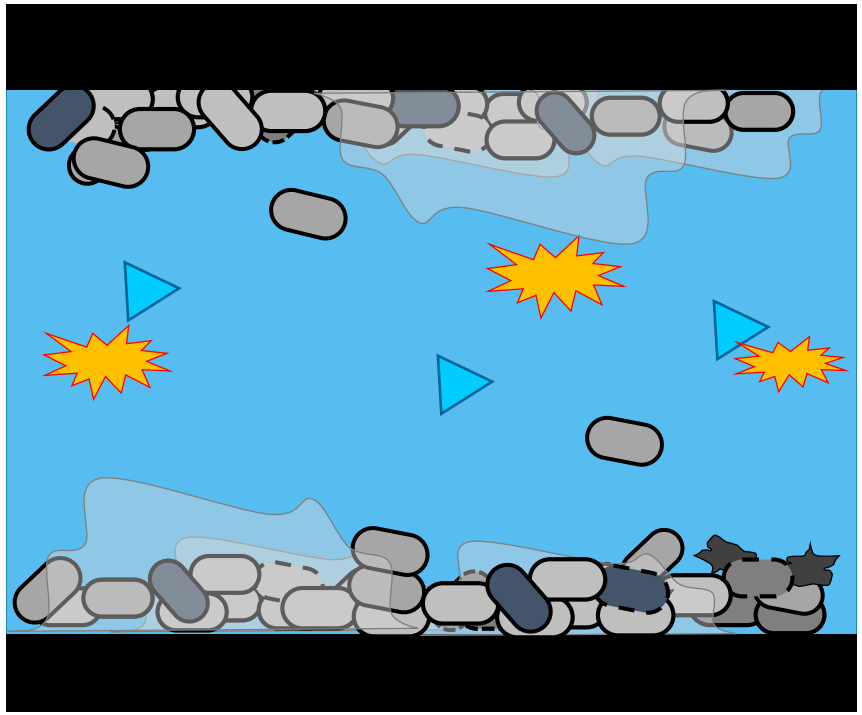
stag·na·tion | \ stag-ˈnā-shən

a state or condition marked by lack of flow, movement

Stagnation causes water to get older

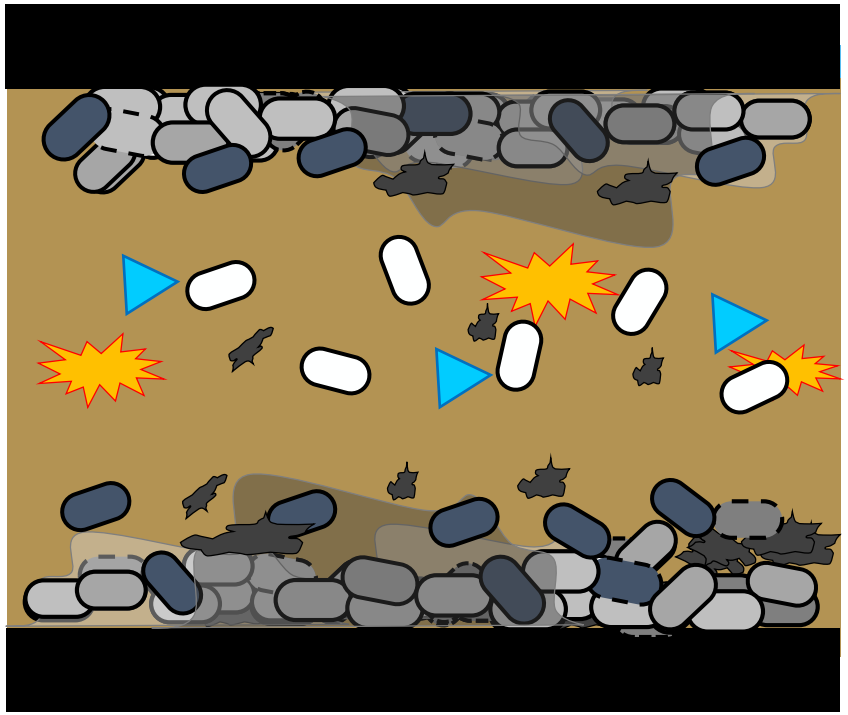
Normal water use refreshes:

- disinfectant residual &
- corrosion control



Old water (not refreshed):

- bacterial growth &
- corrosion not controlled



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

Slide from our YouTube Videos

Prior to the pandemic, stagnation posed health risks

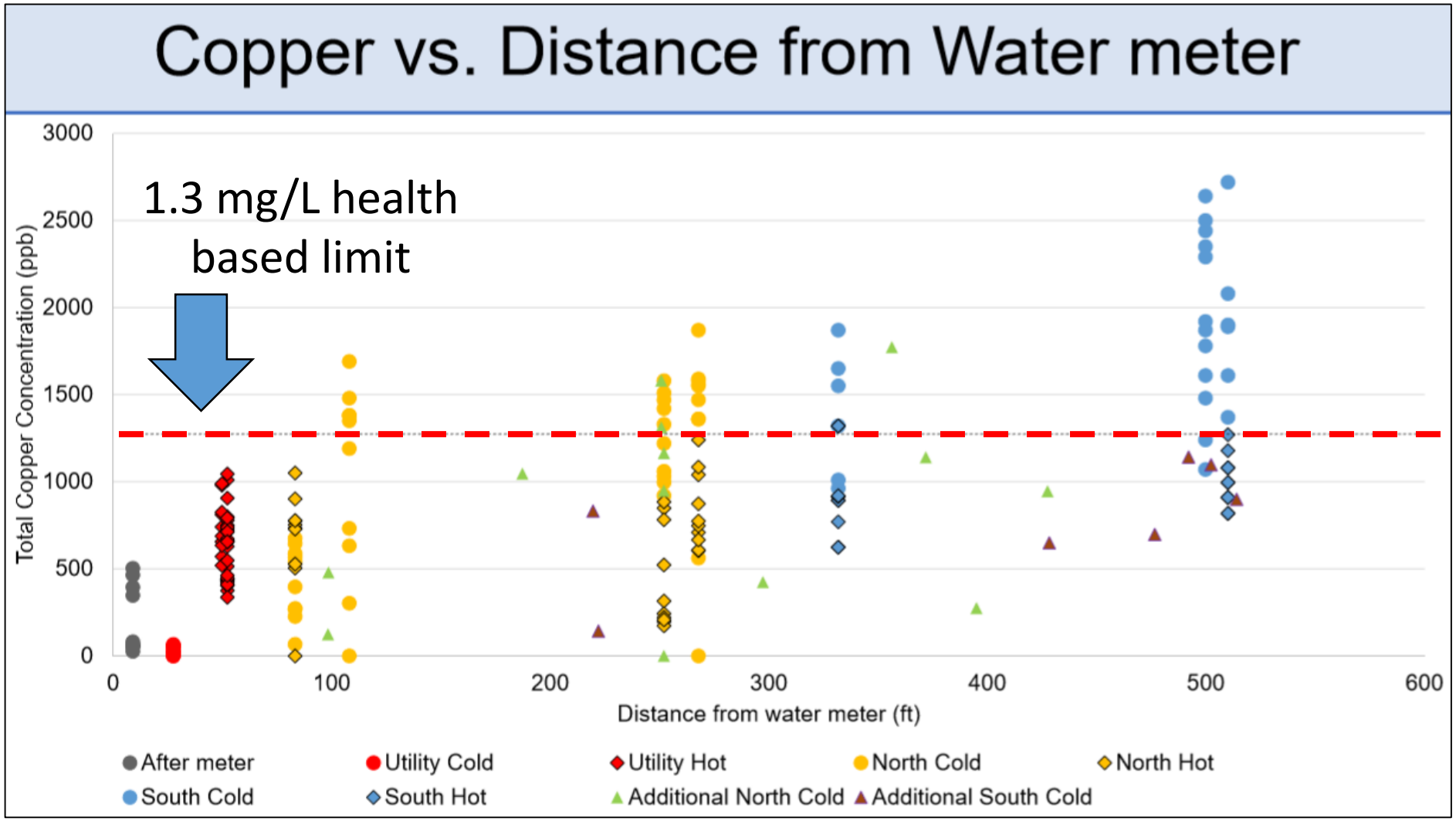
During short-term stagnation, high concentrations of metals and harmful organisms have been found in building water systems. A few issues include…

- **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

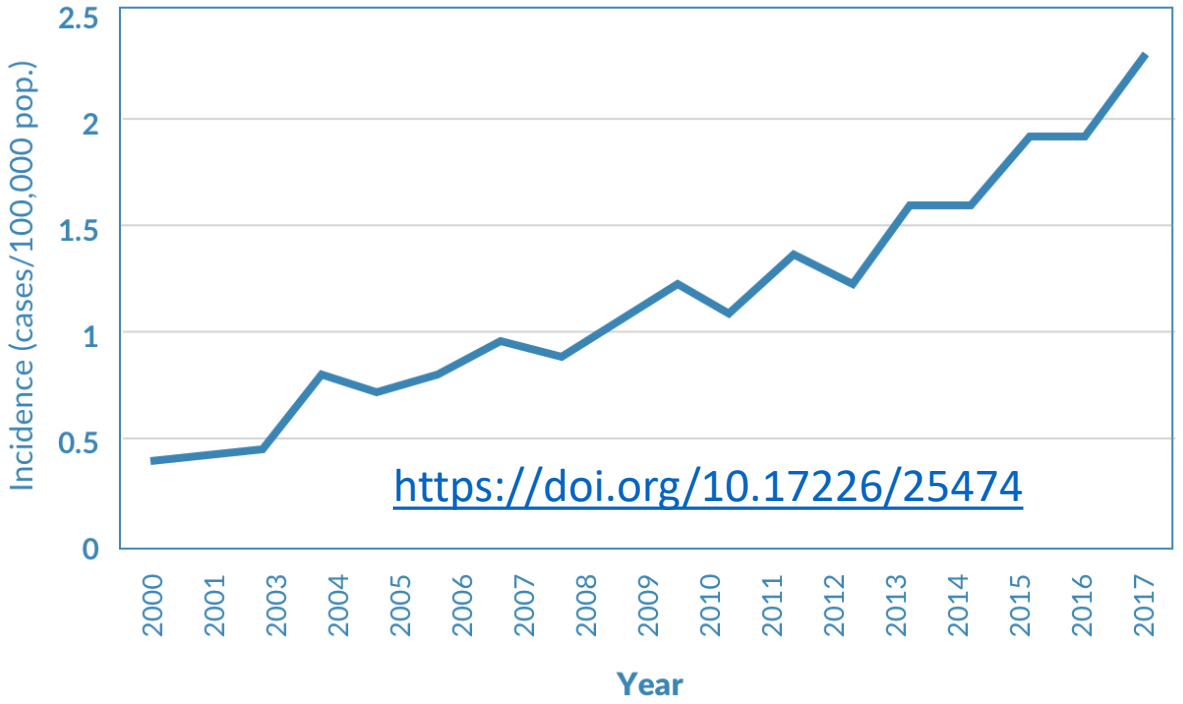
Exposure Routes
- Ingestion
- Dermal
- Inhalation

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



- ✓ 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



Precautions Are Needed for COVID-19 Patients with Coinfection of Common Respiratory Pathogens

24 Pages • Posted: 12 Mar 2020

Quansheng Xing
Qingdao University - Qingdao Women and Children's Hospital

Guo-ju Li
Qingdao University - Qingdao Women and Children's Hospital

More...

[2020 Preprint]

THE LANCET

http://dx.doi.org/10.2139/ssrn.3550013

"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%).**"

U.S. National Science Foundation RAPID Award 2027049

Shutdowns and Consequences - Extreme Plumbing Stagnation and Recommissioning

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***

Helping

IAPMO

American Water Works Association

astho™

SLOAN

NRDC

Washington State Department of Health

ASDWA

Ohio Environmental Protection Agency

ASPE American Society of Plumbing Engineers

NEHA TRAINING

Whirlpool CORPORATION

SAFE WATER ENGINEERING

#2. Building water safety review due to prolonged stagnation with experts from 7 private and public sector organizations

Collaborative effort

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Tim Keane, Legionella Risk Management, Inc.

Maryam Salehi, Ph.D., University of Memphis

Kerry Hamilton, Ph.D., Arizona State University

Kelsey J. Pieper, Ph.D., Northeastern University

David R. Cwiertny, Ph.D., University of Iowa

Michele Prévost, Ph.D., Polytechnique Montreal

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9. Purdue University, Lyles School of Civil Engineering, Division of Environmental and Ecological Engineering, 550 Stadium Mall Drive, West Lafayette, IN 47906; awhelton@purdue.edu; T: (765) 494-2160

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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

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

OSHA

N95 respirators, but recommends voluntary use of N100 “if *Legionella* contamination is possible”.

AIHA®

Protecting Worker Health

P100 HEPA filter respirators when sampling building water and *Legionella* may be present

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 pubic 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

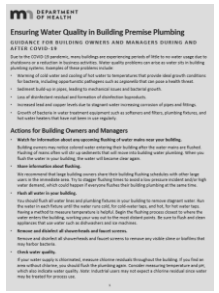
Public and private utilities

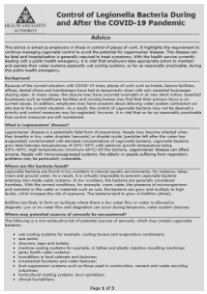
Private contractors

Trade industry associations

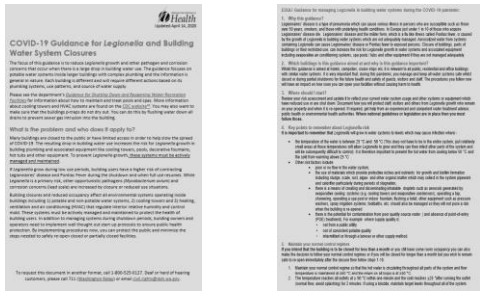
Nonprofit organizations

Device manufacturers


Ensuring Water Quality in Building Premise Plumbing

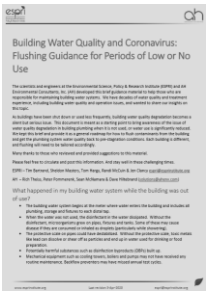

Control of Legionella Bacteria During and After the COVID-19 Pandemic

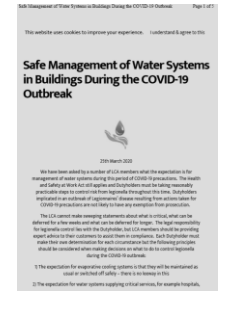
Advice


COVID-19 Guidance for Legionella and Building Water System Closures

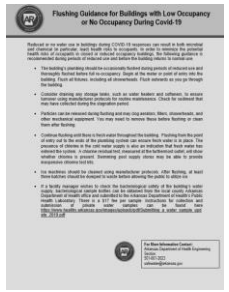

Public Health England

Building Water Quality and Coronavirus: Flushing Guidance for Periods of Low or No Use


Safe Management of Water Systems in Buildings During the COVID-19 Outbreak

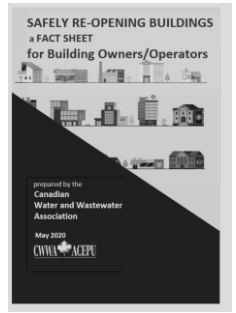

Ohio Department of Health

Guidance for Premise Plumbing Water Service Restoration


Flushing Guidance for Buildings with Low Occupancy or No Occupancy During Covid-19

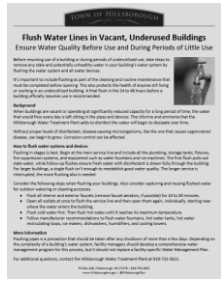
These ***NEW*** documents have been informed by our paper, the document writer's firsthand experience, extrapolated from short-term evidence, and/or documents issued by others.

But, some lack key info.

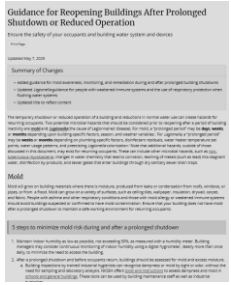

SAFELY RE-OPENING BUILDINGS a FACT SHEET for Building Owners/Operators

prepared by the Canadian Water and Wastewater Association

May 2020

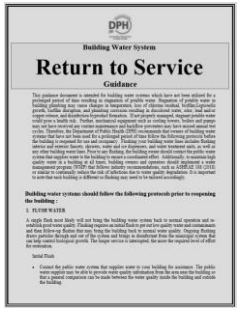

Flush Water Lines in Vacant, Underused Buildings

Ensure Water Quality Before Use and During Periods of Little Use


Guidance for Reopening Buildings After Prolonged Shutdown or Reduced Operation

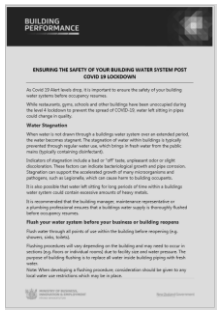
Summary of Changes

5 steps to minimize mold risk during and after a prolonged shutdown

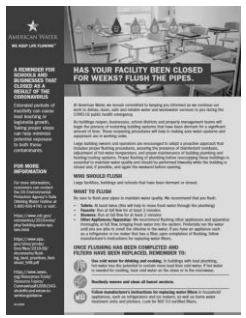

Building Water System

Return to Service

Guidance

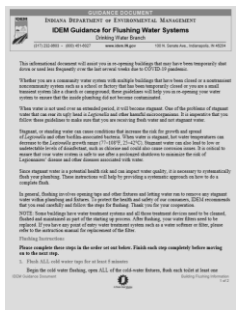

BUILDING PERFORMANCE

ENSURING THE SAFETY OF YOUR BUILDING WATER SYSTEM POST COVID 19 LOCKDOWN


HAS YOUR FACILITY BEEN CLOSED FOR WEEKS? FLUSH THE PIPES.

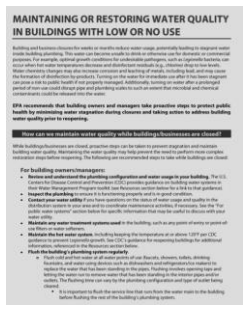

Public Health

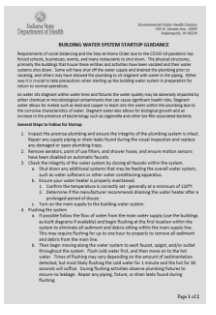
Water Quality and Your Business: Tips for Re-opening After Closure

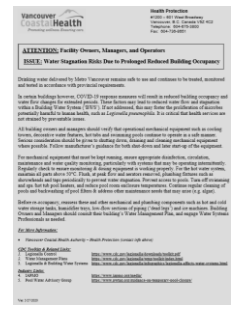

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

IDEM Guidance for Flushing Water Systems

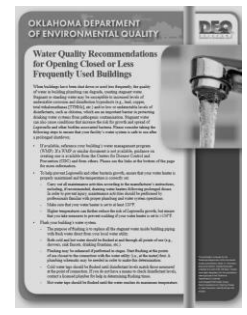
Drinking Water Branch


MAINTAINING OR RESTORING WATER QUALITY IN BUILDINGS WITH LOW OR NO USE


BUILDING WATER SYSTEM STARTUP GUIDANCE


Vancouver Coastal Health

ATTENTION: Facility Owners, Managers, and Operators


OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Water Quality Recommendations for Opening Closed or Less Frequently Used Buildings

HOT TOPIC: How do we avoid "recommissioning" the building water system due to low or no use?

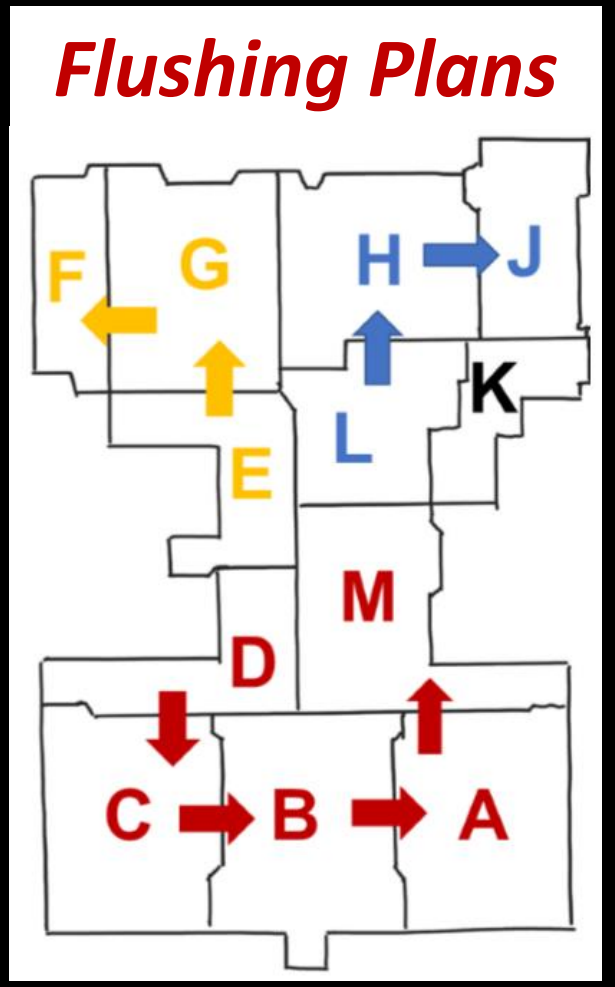
Keep the water moving! ≠ stagnation

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

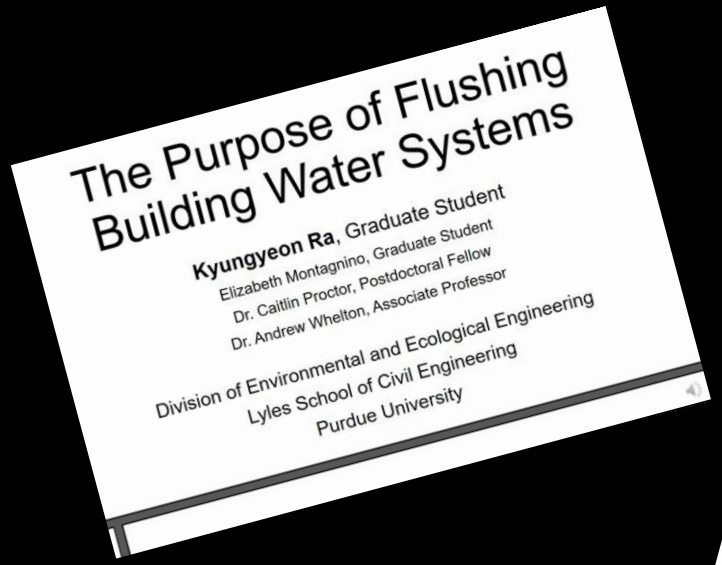
Shock disinfection should occur within 3 weeks of planned occupancy.

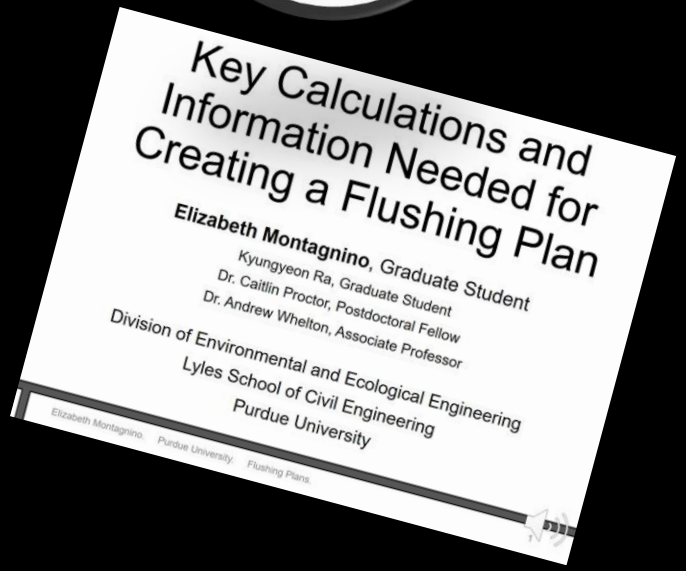
If occupancy is delayed >4 weeks, another shock disinfection is required prior to occupancy.

Key Considerations

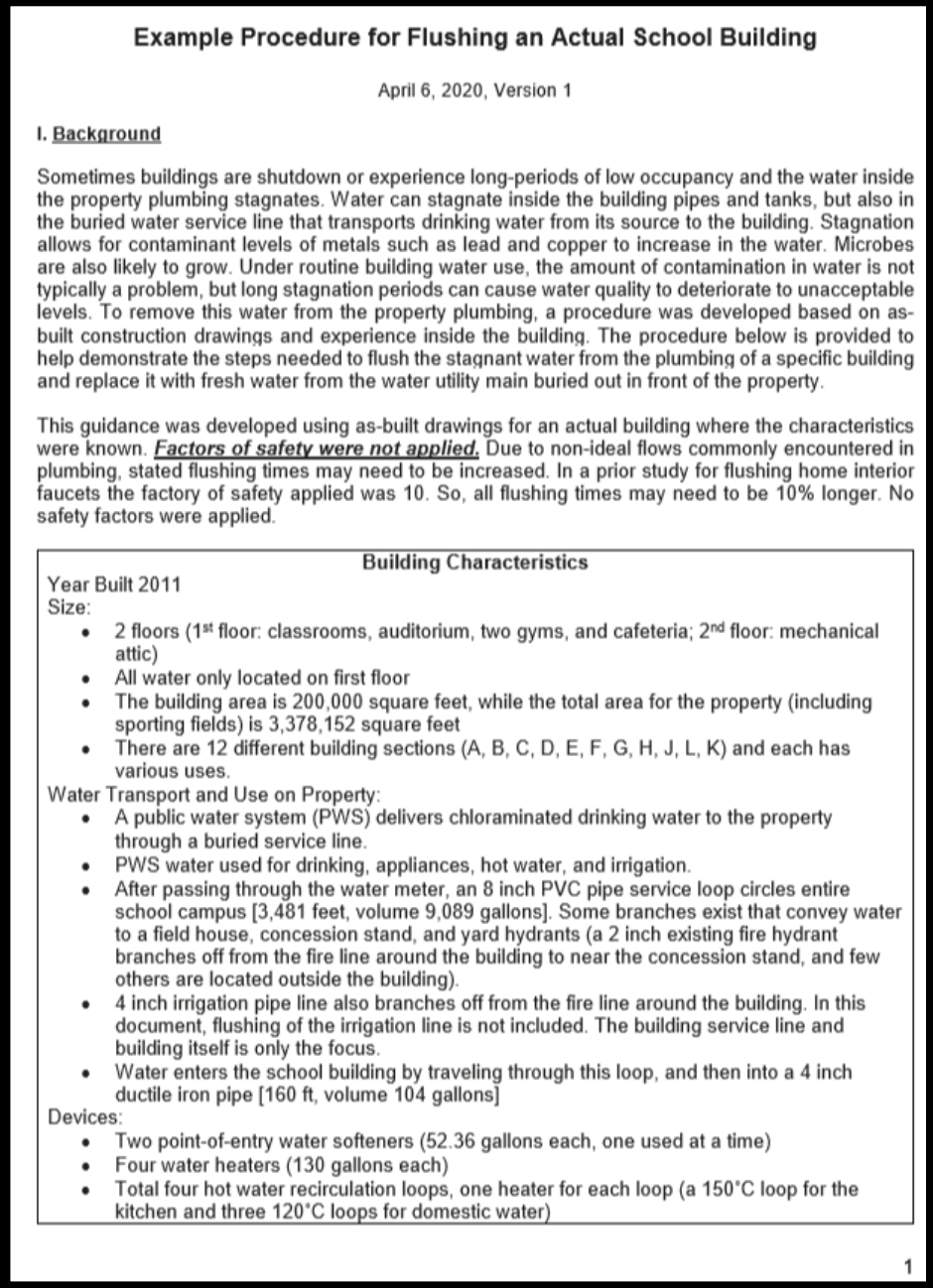
1. System integrity, clean devices and equipment
2. Flushing
3. Shock disinfection (chemical, thermal)
4. Testing with a purpose and plan
5. Communicate with a purpose

Learn how to create a building flushing plan





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 shutdown 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 the plumbing of a specific building and replace it with fresh water from the water utility main buried out in front of the property.

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 non-ideal flows commonly encountered in plumbing, stated flushing times may need to be increased. In a prior study for flushing home interior faucets the factory of safety applied was 10. So, all flushing times may need to be 10% longer. No safety factors were applied.

Building Characteristics

Year Built 2011
Size:
- 2 floors (1st floor: classrooms, auditorium, two gyms, and cafeteria; 2nd floor: mechanical attic)
- All water only located on first floor
- The building area is 200,000 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 chloraminated 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 9,089 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 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 104 gallons]

Devices:
- Two point-of-entry water softeners (52.36 gallons each, one used at a time)
- Four water heaters (130 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)

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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.

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.

Many building owners need public health support.

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?

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

Thanks for doing what you do.

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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

***Legionella* CFU/Liter**	**Action Required**
Not Detected	Acceptable – continue monitoring
< 100 to 1,000	Refer to responsible person and assure water quality values are within target
> 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.

Washington State Department of Health Guidance

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.
4. Flush at least weekly. *More frequent is better.* Document! Create a flushing plan.
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.