Disasters & Plumbing Contamination Decisions: Wildfires, Floods, Chemical Spills & More

ASPE Convention and Exposition
Indianapolis, Indiana

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www.PlumbingSafety.org

PURDUE UNIVERSITY

September 21, 2022

Our Focus

Water Safety and Disasters

Infrastructure Construction and Repair Technologies

Waste Materials and Management Solutions








Disaster Response and Recovery Guidance for Municipalities, Public Health and Elected Officials

- ✓ Post-fire chemicals to test for
- ✓ Brief videos for emergency managers and health officials
- ✓ Guidance for private well owners
- ✓ Guidance for building owners
- ✓ Federal and state government agency resources
- ✓ FEMA mitigation guidance
- ✓ Other training resources

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System Basics

Building water system public health **risks**

Exposure Routes of Concern: Ingestion, Dermal, Inhalation

Routine Operations

Disinfectant residual may not be replenished

Heavy metals can leach (Cu, Mn, Ni, Pb, Zn..)

Organics can leach/form (VOCs, SVOCs, DBPs)

Scale can destabilize and suspend

Harmful organisms can grow (e.g., *L. pneumophila, MAC, P. aeruginosa* …)

Accident and Post-Disasters

Pressure loss, backflow, chemical spill, hurricane, flooding, wildfire, intentional attack, and more

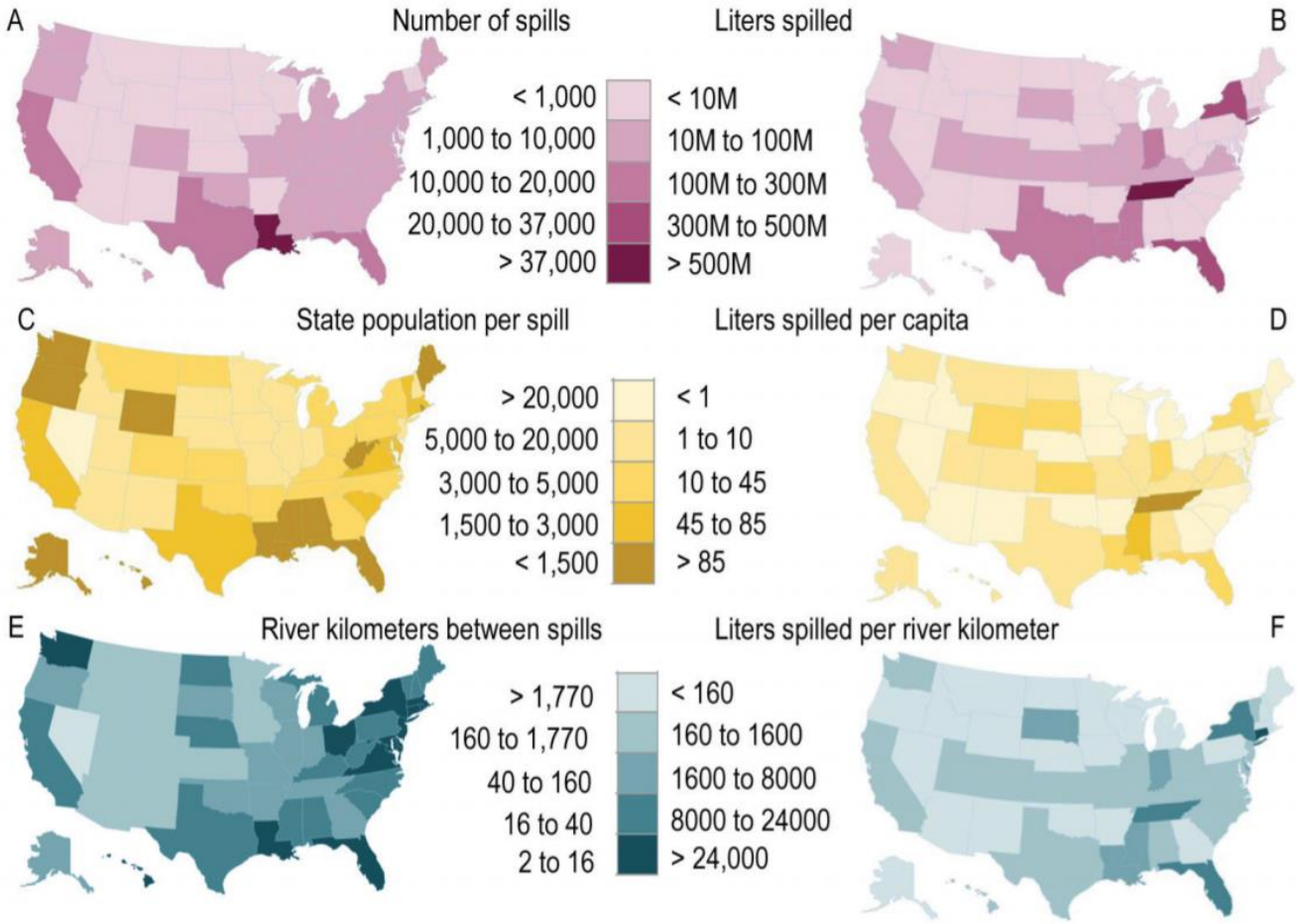
From 2004-2014, 351,000+ chemical spills affected water resources, National Response Center

351,000+: incidents or chemical spills

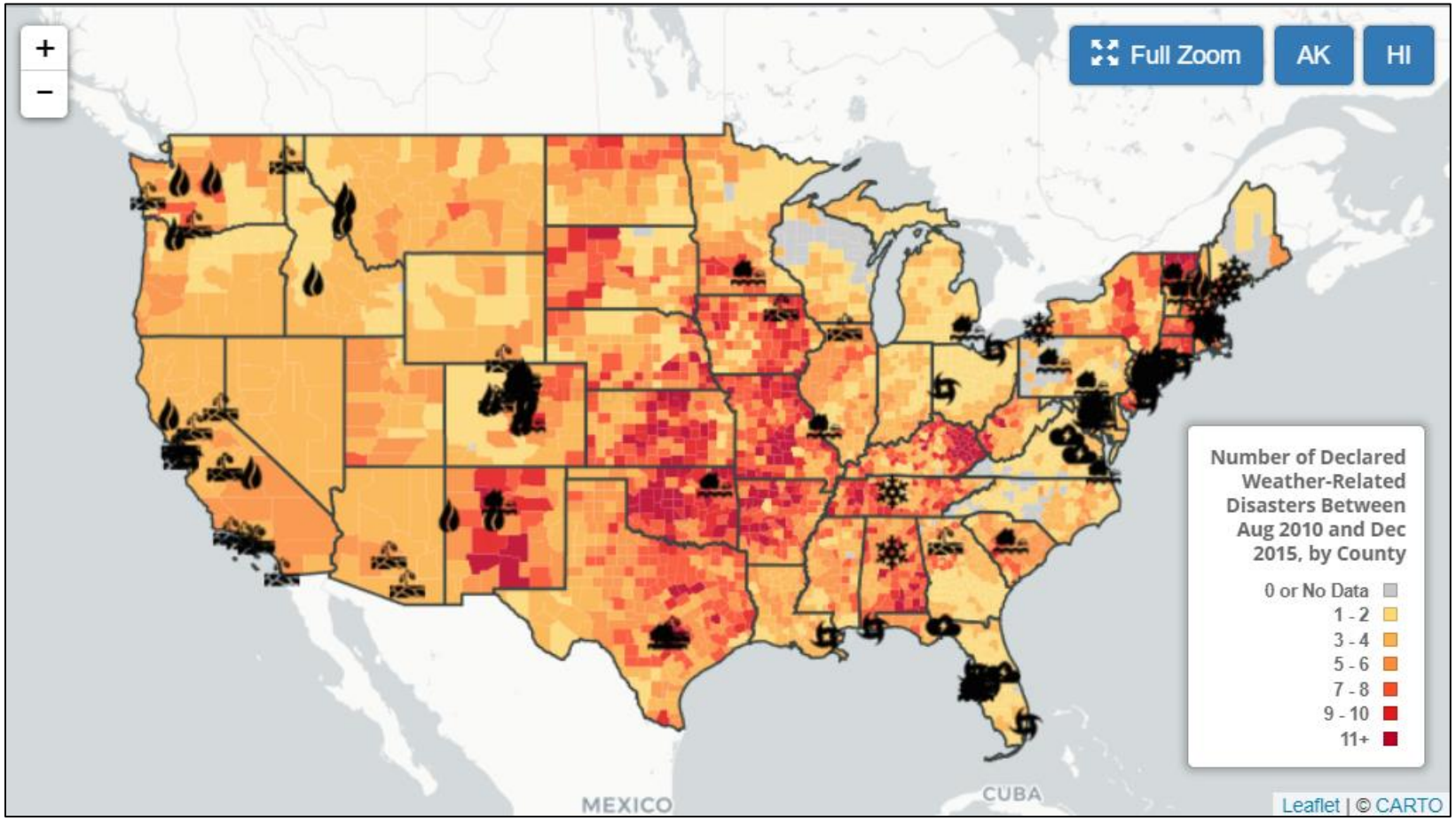
172,000+: impacted US water bodies in areas with higher population centers

88,000: petroleum and natural gas

8,000: chemicals with known and limited toxicity information available



Weidhass et al. 2016. Enabling Science Support for Better Decision-Making when Responding to Chemical Spill. https://www.doi.org/10.2134/JEQ2016.03.0090



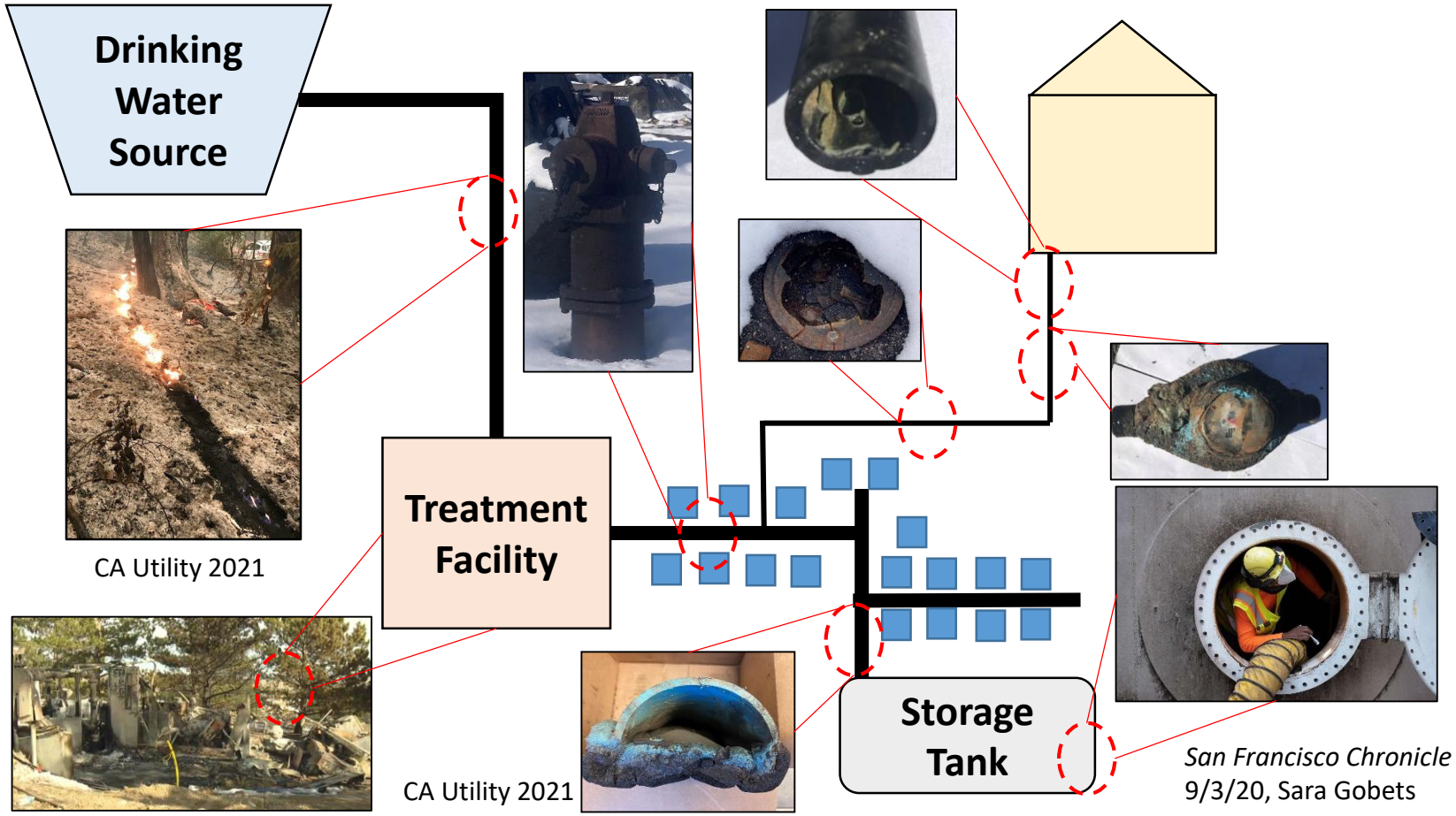
Wildfires
Droughts
Floods
Tornadoes
Snow & Ice
Tropical Storms
Severe Storms
Hurricanes

Natural disasters affect 1,000s of communities each year prompting microbial and chemical risks

EnvironmentAmerica.org

Wildfires damage public and private drinking water systems

USGS 2009



CA Utility 2021

CA Utility 2021

San Francisco Chronicle 9/3/20, Sara Gobets

Assets

Water source
Treatment
Distribution
Plumbing

Damage

Loss of water pressure
Water contamination
Infrastructure contam.
Plumbing contam.

Year	Fire Event / Location	Max. Benzene, ppb	Pop.	System
2021	Marshall Fire/ Colorado	221	20,319	City of Louisville
	Marshall Fire/ Colorado	5.1	300	East Boulder County Water District
2020	Echo Mountain Fire/ Oregon	5.5	120	Whispering Pines Mobile Home Park
	Echo Mountain Fire/ Oregon	11.3	362	Hiland WC-Echo Mountain
	Echo Mountain Fire/ Oregon	1.1	760	Panther Creek Water District
	Almeda Fire/ Oregon	76.4	6,850	City of Talent
	Lionshead Fire/ Oregon	44.9	205	Detroit Water System
	CZU Lightning Complex Fire/ California	1.8	1,650	Big Basin Water Company
	CZU Lightning Complex Fire/ California	42	21,145	San Lorenzo Valley Water District
2018	Camp Fire/ California	>2,217	26,032	Paradise Irrigation District
	Camp Fire/ California	38.3	924	Del Oro Water Co.-Magalia
	Camp Fire/ California	8.1	1,106	Del Oro Water Co.-Lime Saddle
	Camp Fire/ California	530	11,324	Del Oro Water Co.-Paradise Pines
2017	Tubbs Fire/ California	40,000	175,000	City of Santa Rosa

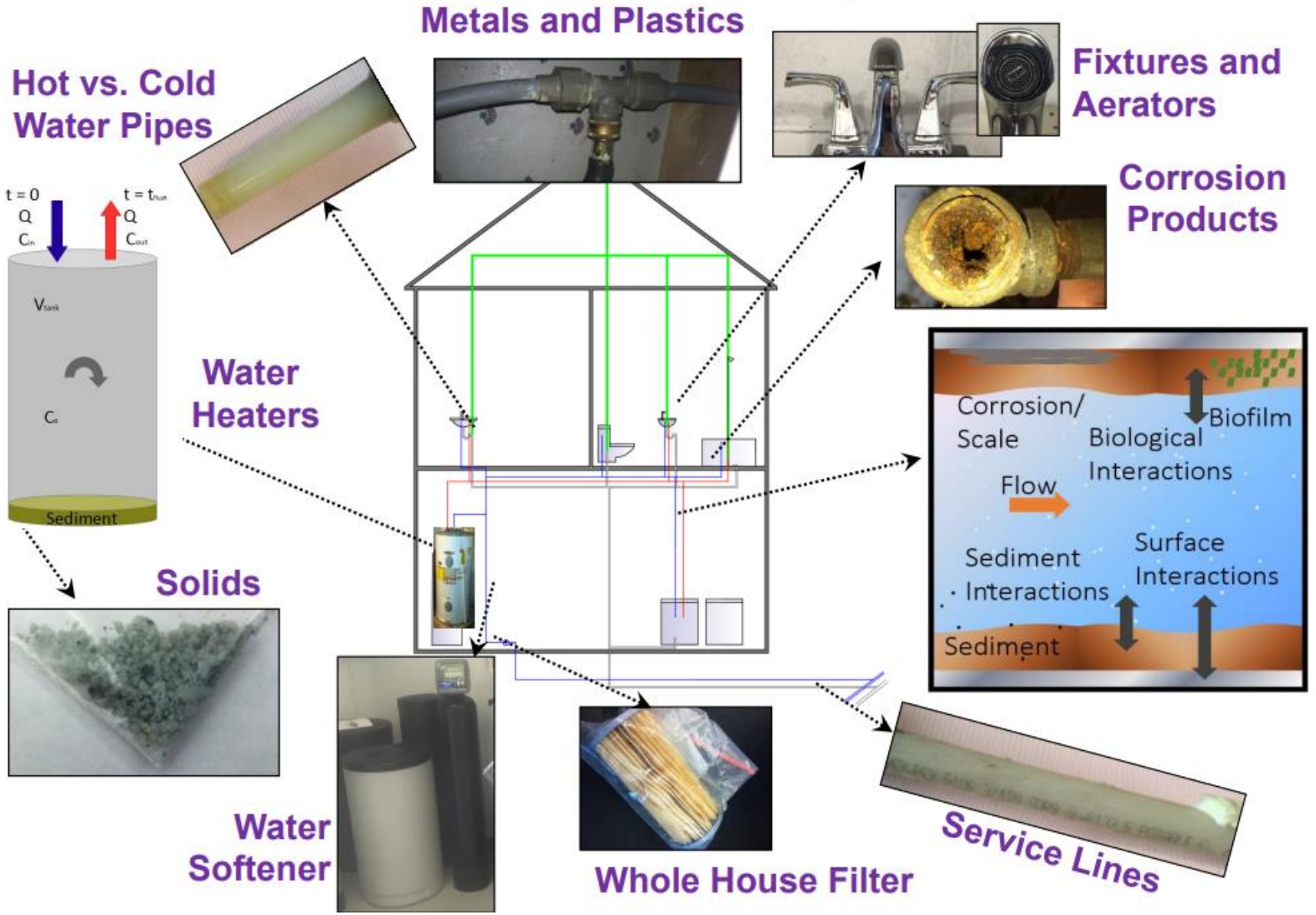
Location	Year	Cause	Contaminant	Plumbing system decon method	Population affected	Health impacts	Duration, days
Nibley City, UT[45]	15	Truck spill	Diesel fuel	Flushing	5000	nr	1
Glendive, MT[46]	15	Pipe rupture, spill	Crude oil	Flushing	6000	Yes	5
Longueuil, QC, CN	15	Tank rupture, spill	Diesel fuel	None	230 000	No	2
Washington, D.C.[47]	14	Unknown	Petroleum product	Flushing	Est. 370	nr	3
Toledo, OH[48]	14	Algal bloom	Microcystins[c]	Flushing	500 000	No	2
Charleston, WV[1]	14	Tank rupture, spill	Coal chemical	Flushing	300 000	Yes	9[b]
Jackson, WI[49]	12	Pipe rupture, spill	Petroleum product	nr	50	nr	30
Safed, Israel[38]	10	DS backflow	Diesel fuel	Flushing; surfactant	3000	nr	3
Boise, ID[50]	05	Unknown	TCE	Flushing	117	nr	nr
Stratford, ON, CN[51]	05	DS backflow	2-Butoxyethanol	Flushing	32 000	Yes	Up to 7
Northeast Italy[52]	02	New pipe install	Cutting oil	Flushing	4 bldgs	nr	Months
Guelph, CN[53]	97	DS backflow	Petroleum product	nr	48 000	nr	3
Charlotte, NC[36]	97	DS backflow	Fire suppressant (AFFF)[d]	Flushing	29 bldgs	No	nr
Tucumcari, NM[32,54]	95	DS backflow	Toluene, phenol, *etc.*[a]	Flushing	nr	Yes	nr
Uintah Highlands, UT[32]	91	DS backflow	TriMec; 2,4-D; dicamba	nr	2000 homes	Yes	nr
Hawthorne, NJ[36]	87	DS backflow	Heptachlor	Cl_2 flush; replacement	63	No	nr
Gridley, KS[54]	87	DS backflow	Lexon DF	nr	10 homes, 1 business	nr	nr
Hope Mills, NC[36]	86	DS backflow	Heptachlor, chlordane	Flushing	23 homes	No	3
Pittsburgh, PA[54]	81	DS backflow	Heptachlor, chlordane	Flushing; replacement	300 (23 bldgs)	No	27
Lindale, Georgia[55]	80	DS construction	Phenolic compounds	Super-chlorination	Hospital	Yes	nr
Montgomery Cnty, PA[35]	79	Tank rupture, spill	TCE	nr	500	Yes	nr

Casteloes et al. 2015. Decontaminating chemically contaminated residential premise plumbing systems by flushing. https://doi.org/10.1039/C5EW00118H.

Residential Systems are Complex

Objects: Fixtures, pipes, tanks, fittings, valves, gaskets

Materials: Sediment, corrosion scale, biofilm, plastics vs. metals



2015 Study: Flushing as a plumbing decontamination approach for chemical contamination

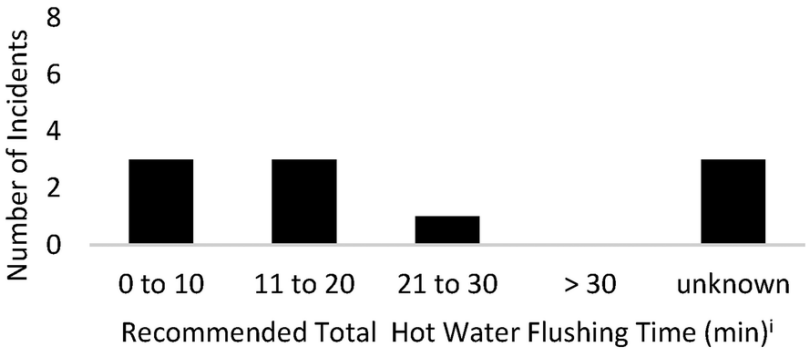
Decontaminating chemically contaminated residential premise plumbing systems by flushing

Download FREE here:

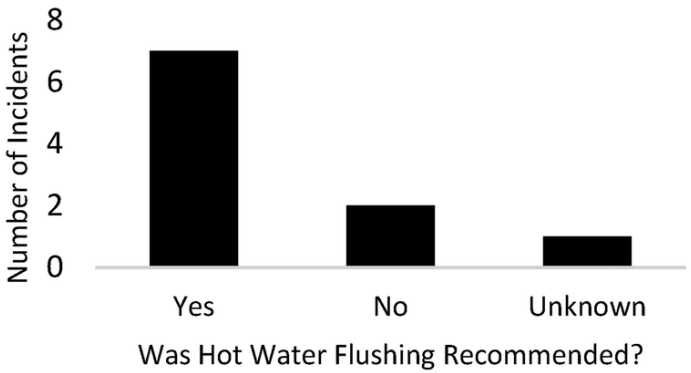
https://doi.org/10.1039/C5EW00118H

Minimal data available on flushing protocol design and effectiveness.

Plumbing design, operational conditions, contaminants present and their properties, as well as building inhabitant safety have not been fully considered in flushing protocol design.



(a)



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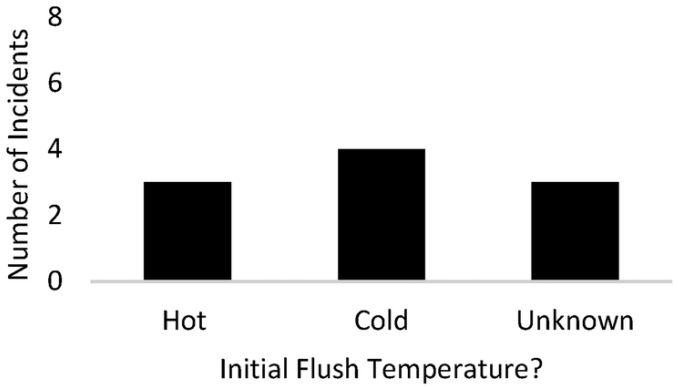
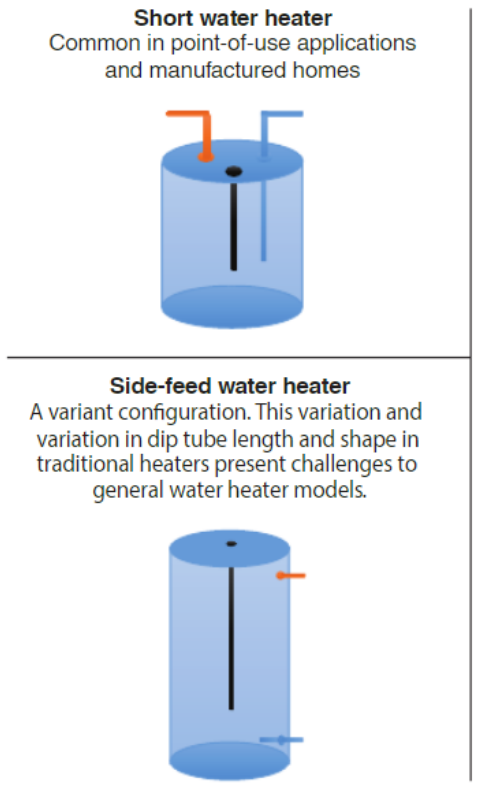
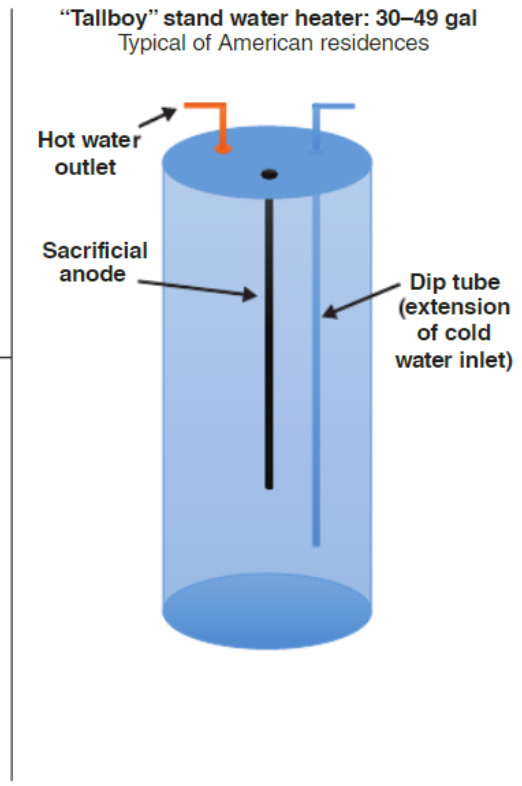


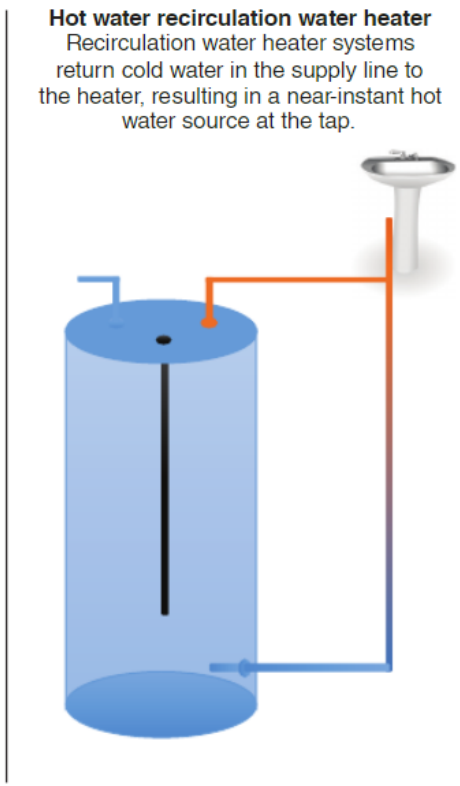
(c)

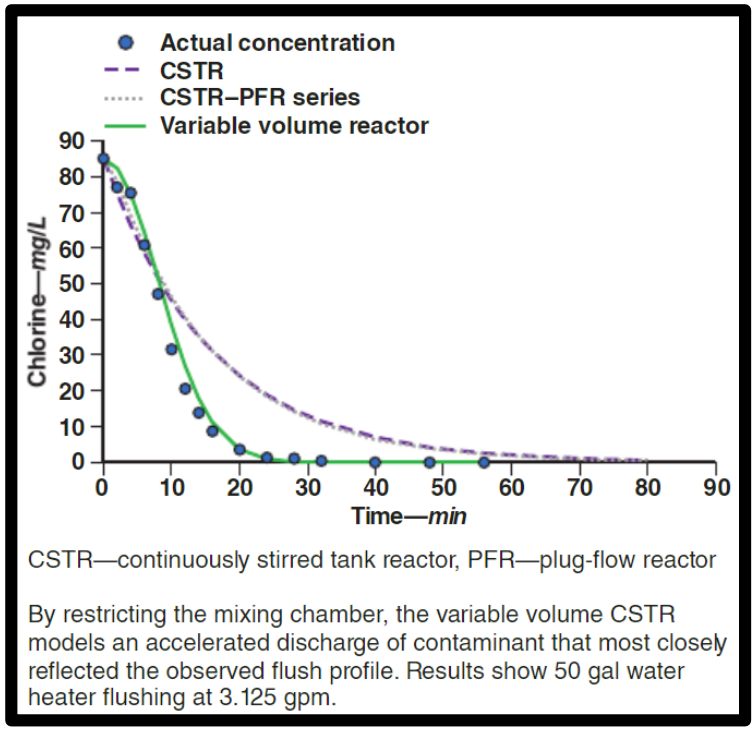
When you look back at U.S. incidents, flushing guidance for single family homes varied drastically, would likely not work, nor was it followed up with confirmatory sampling

Flushing protocols often did not consider water heater volume or fluid dynamics









Hawes et al. 2016. Predicting Contaminated Water Removal From Residential Water Heaters Under Various Flushing Scenarios. https://doi.org/10.5942/jawwa.2017.109.0085

Plumbing Replacement and Surfactants have been Used

Elk River Chemical Spill, January 2014

Statement by environmental activist:

"…the amount of chemical likely destroyed your home water treatment system."

"…if you had an RO system, the chemical likely ate the membrane."

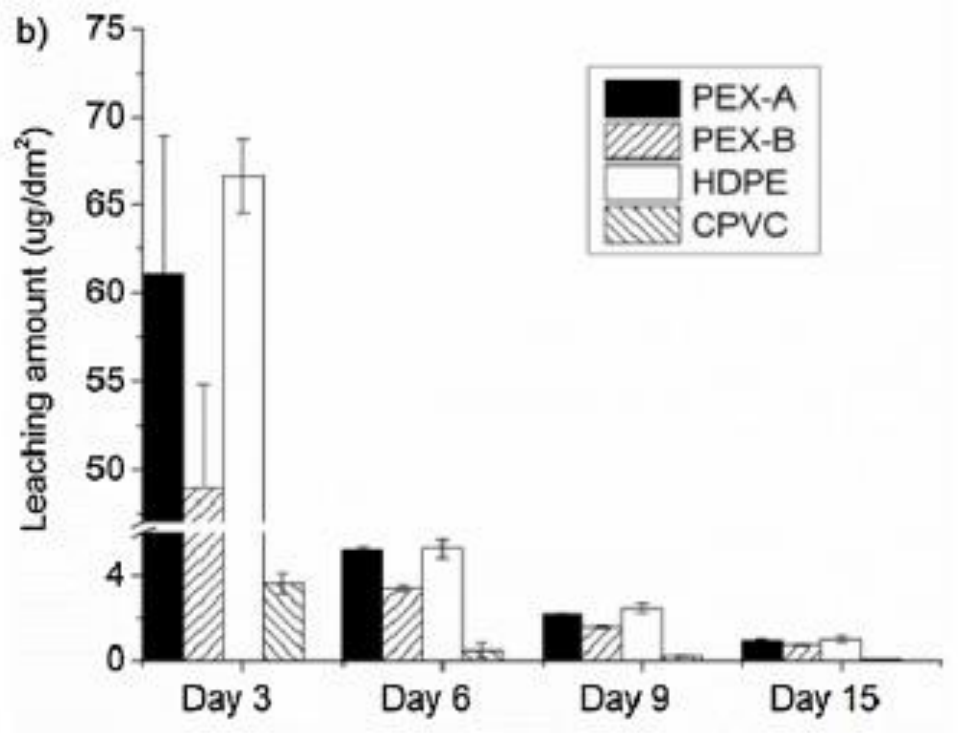
"…your [plumbing] pipe material will not be impacted…"

Statement by scientist:

"It's a hydrophobic molecule like oil. You can't just flush it out of a system, a substance like that. It sticks to surfaces, and you have to use soap and water."

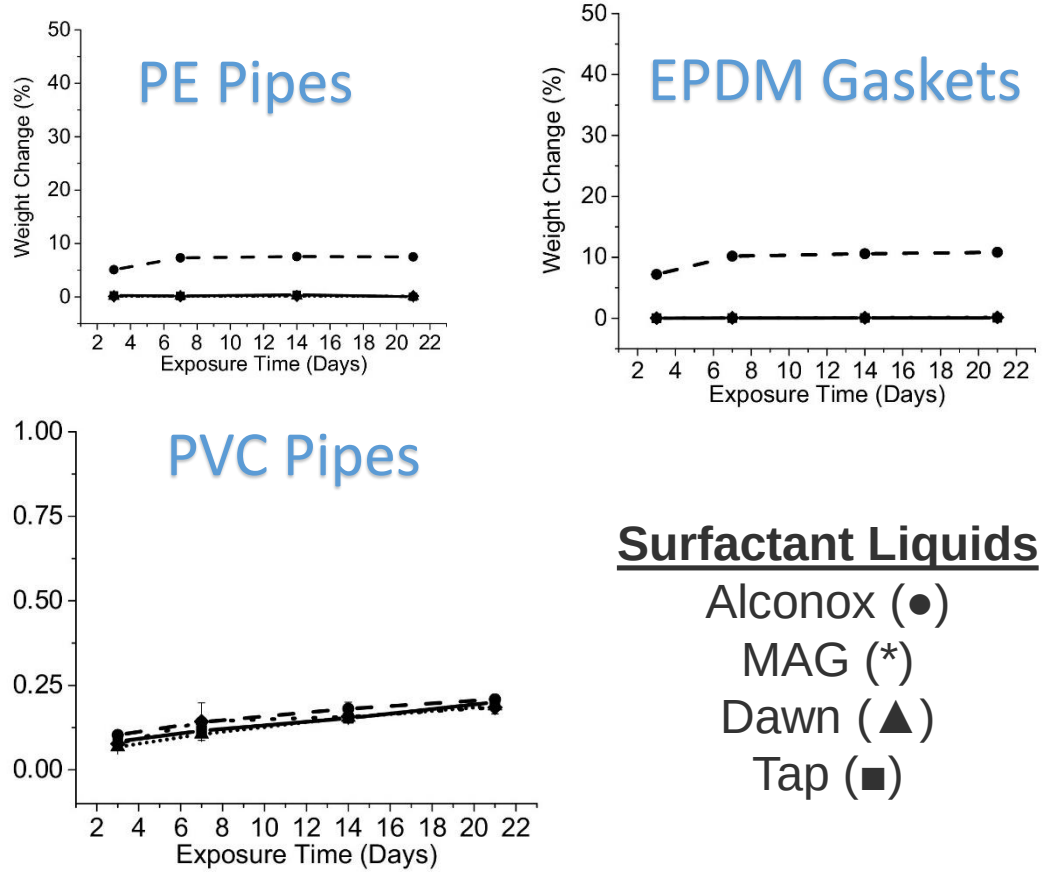
Q: *Will surfactants solutions damage the piping system?*

Not Considered: VOCs Diffuse In and Out of Plastic Plumbing Slowly



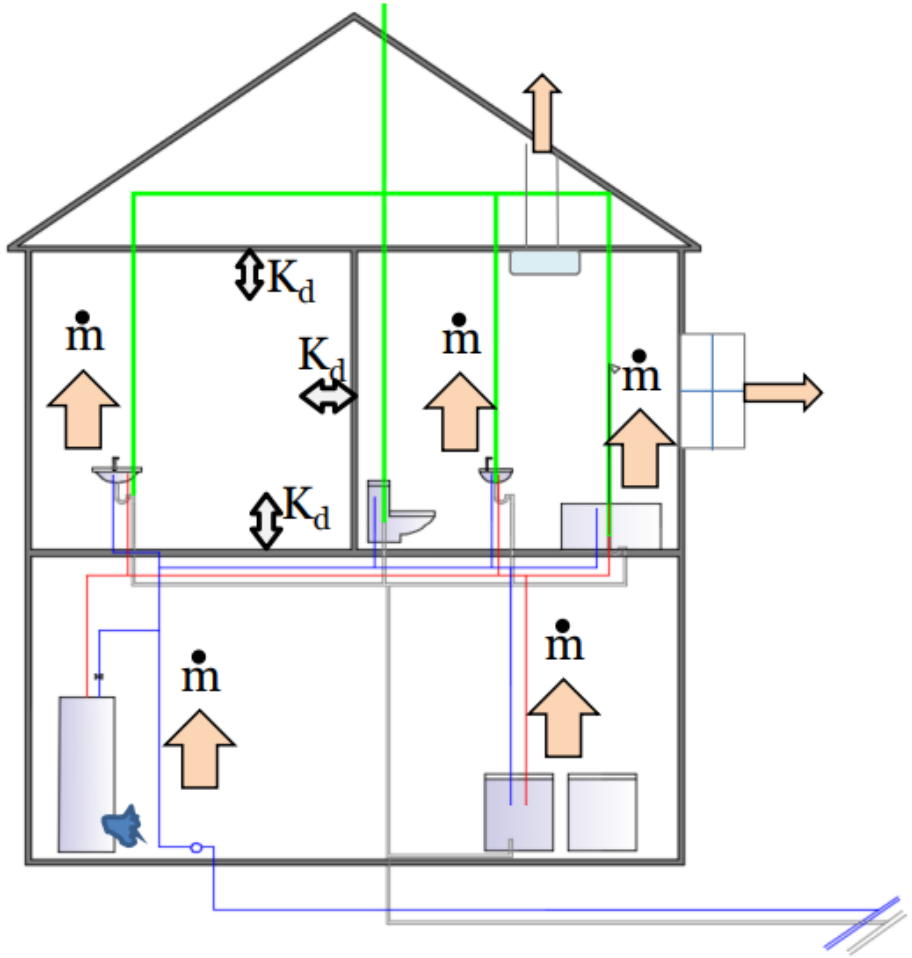
Casteloes et al. 2016. Crude oil contamination of plastic and copper drinking water pipes. https://doi.org/10.1016/j.jhazmat.2017.06.015

Surfactant-Plastic Interactions are Not Trivial



Huang et al. 2017. The interaction of surfactants with plastic and copper plumbing materials during decontamination. https://doi.org/10.1016/j.jhazmat.2016.11.067

Building Inhabitant Protection During Flushing



Protect most sensitive population

Appropriate PPE

Building evacuation

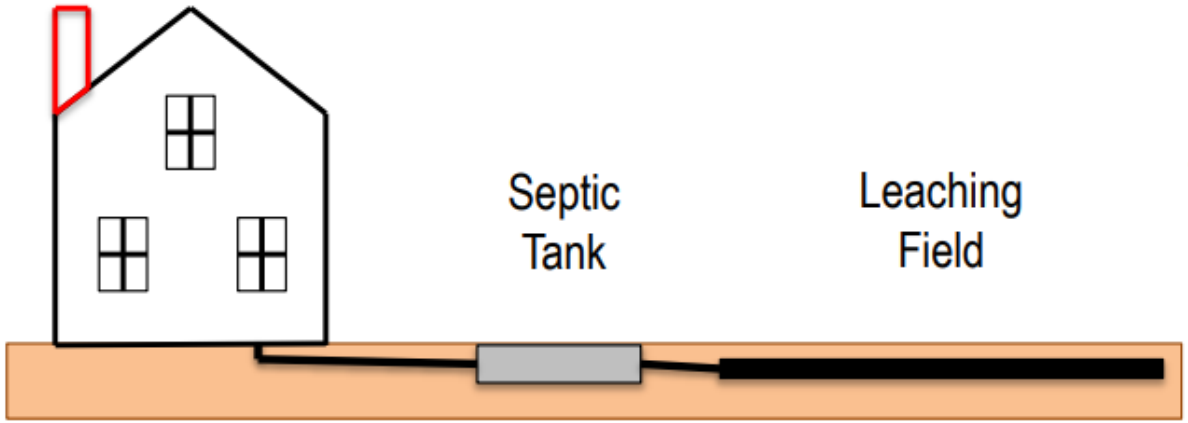
Models to predict contaminated air

Expel air by opening windows and doors/use fans

Shutoff water heaters?

"I ran it for about ten minutes and had to open up the door for five minutes to get the smell out," she said. "My God, did I end up getting a headache.“ – 2015, Glendive, MT

Wastewater Treatment and Disposal



Septic Tanks

Typical size: 500 to 2,000 G

500 GPD (4 BR)

700 GPD (6 BR)

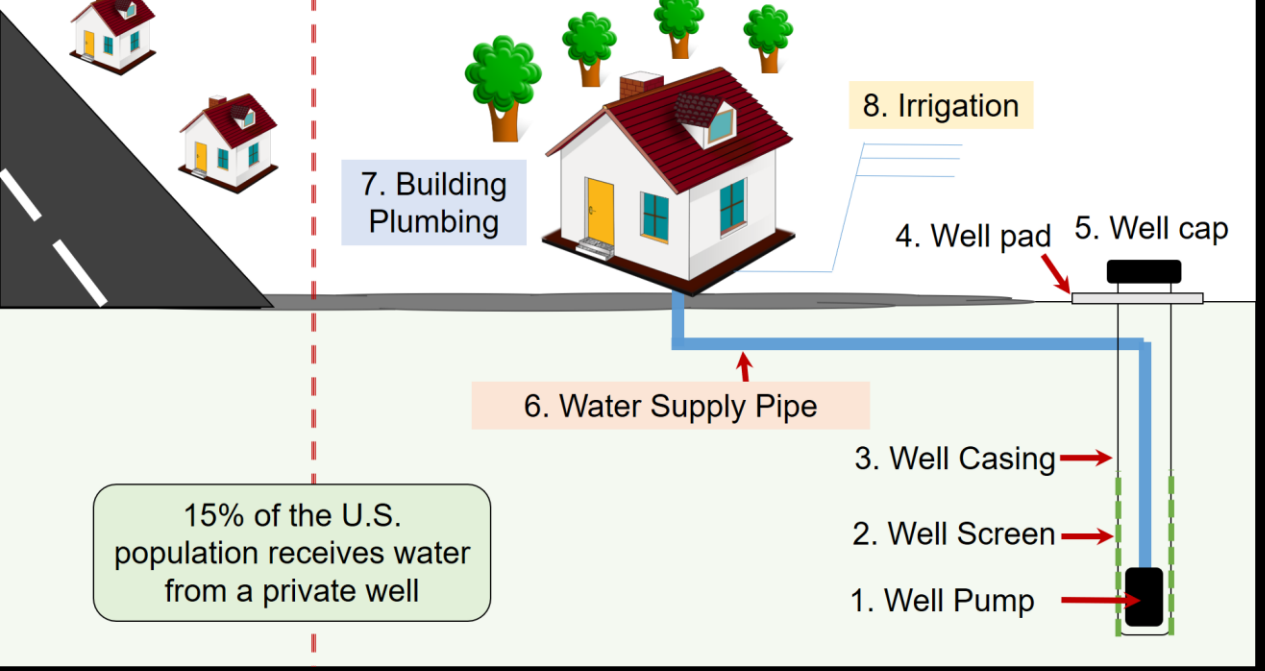
900 GPD (8 BR)

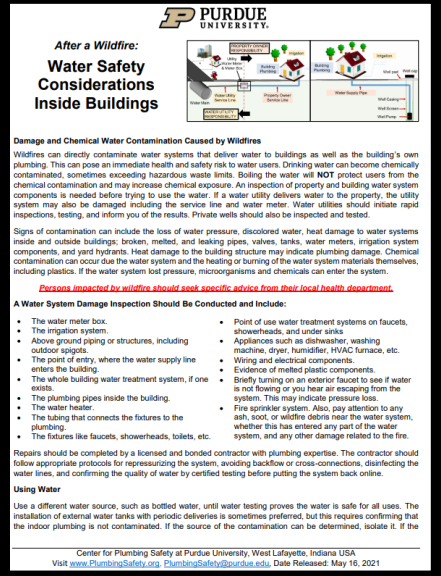
Do not overload

Contaminated water disposal / ecotoxicity: Soil, waterways, air, WWTP, septic tank, tanker trucks, NPDES permit(s)

Downstream impacts of flushing

- Hydraulic capacity of system
- Corrosivity and toxicity of wastewater
- Health and safety
- Chemical fate (i.e., Volatilization, transformation, sorption)





After a Wildfire:

Water Safety Considerations Inside Buildings

Damage and Chemical Water Contamination Caused by Wildfires

Wildfires can directly contaminate water systems that deliver water to buildings as well as the building's own plumbing. This can pose an immediate health and safety risk to water users. Drinking water can become chemically contaminated, sometimes exceeding hazardous waste limits. Boiling the water will **NOT** protect users from the chemical contamination and may increase chemical exposure. An inspection of property and building water system components is needed before trying to use the water. If a water utility delivers water to the property, the utility system may also be damaged including the service line and water meter. Water utilities should initiate rapid inspections, testing, and inform you of the results. Private wells should also be inspected and tested.

Signs of contamination can include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings; broken, melted, and leaking pipes, valves, tanks, water meters, irrigation system components, and yard hydrants. Heat damage to the building structure may indicate plumbing damage. Chemical contamination can occur due the water system and the heating or burning of the water system materials themselves, including plastics. If the water system lost pressure, microorganisms and chemicals can enter the system.

Persons impacted by wildfire should seek specific advice from their local health department.

A Water System Damage Inspection Should Be Conducted and Include:

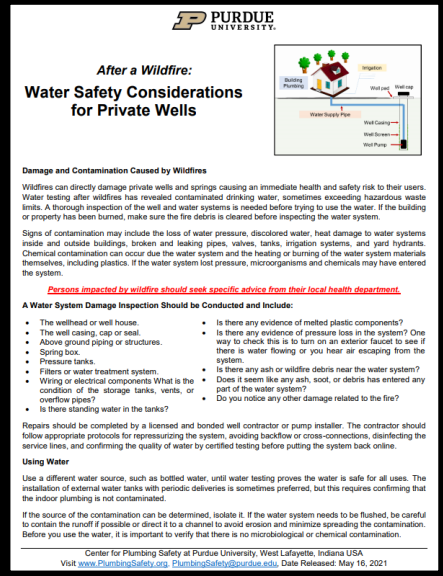
- The water meter box.
- The irrigation system.
- Above ground piping or structures, including outdoor spigots.
- The point of entry, where the water supply line enters the building.
- The whole building water treatment system, if one exists.
- The plumbing pipes inside the building.
- The water heater.
- The tubing that connects the fixtures to the plumbing.
- The fixtures like faucets, showerheads, toilets, etc.
- Point of use water treatment systems on faucets, showerheads, and under sinks
- Appliances such as dishwasher, washing machine, dryer, humidifier, HVAC furnace, etc.
- Wiring and electrical components.
- Evidence of melted plastic components.
- Briefly turning on an exterior faucet to see if water is not flowing or you hear air escaping from the system. This may indicate pressure loss.
- Fire sprinkler system. Also, pay attention to any ash, soot, or wildfire debris near the water system, whether this has entered any part of the water system, and any other damage related to the fire.

Repairs should be completed by a licensed and bonded contractor with plumbing expertise. The contractor should follow appropriate protocols for repressurizing the system, avoiding backflow or cross-connections, disinfecting the water lines, and confirming the quality of water by certified testing before putting the system back online.

Using Water

Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated. If the source of the contamination can be determined, isolate it. If the

Center for Plumbing Safety at Purdue University, West Lafayette, Indiana USA
Visit www.PlumbingSafety.org, PlumbingSafety@purdue.edu, Date Released: May 16, 2021



After a Wildfire:

Water Safety Considerations for Private Wells

Damage and Contamination Caused by Wildfires

Wildfires can directly damage private wells and springs causing an immediate health and safety risk to their users. Water testing after wildfires has revealed contaminated drinking water, sometimes exceeding hazardous waste limits. A thorough inspection of the well and water systems is needed before trying to use the water. If the building or property has been burned, make sure the fire debris is cleared before inspecting the water system.

Signs of contamination may include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings, broken and leaking pipes, valves, tanks, irrigation systems, and yard hydrants. Chemical contamination can occur due the water system and the heating or burning of the water system materials themselves, including plastics. If the water system lost pressure, microorganisms and chemicals may have entered the system.

Persons impacted by wildfire should seek specific advice from their local health department.

A Water System Damage Inspection Should be Conducted and Include:

- The wellhead or well house.
- The well casing, cap or seal.
- Above ground piping or structures.
- Spring box.
- Pressure tanks.
- Filters or water treatment system.
- Wiring or electrical components What is the condition of the storage tanks, vents, or overflow pipes?
- Is there standing water in the tanks?
- Is there any evidence of melted plastic components?
- Is there any evidence of pressure loss in the system? One way to check this is to turn on an exterior faucet to see if there is water flowing or you hear air escaping from the system.
- Is there any ash or wildfire debris near the water system?
- Does it seem like any ash, soot, or debris has entered any part of the water system?
- Do you notice any other damage related to the fire?

Repairs should be completed by a licensed and bonded well contractor or pump installer. The contractor should follow appropriate protocols for repressurizing the system, avoiding backflow or cross-connections, disinfecting the service lines, and confirming the quality of water by certified testing before putting the system back online.

Using Water

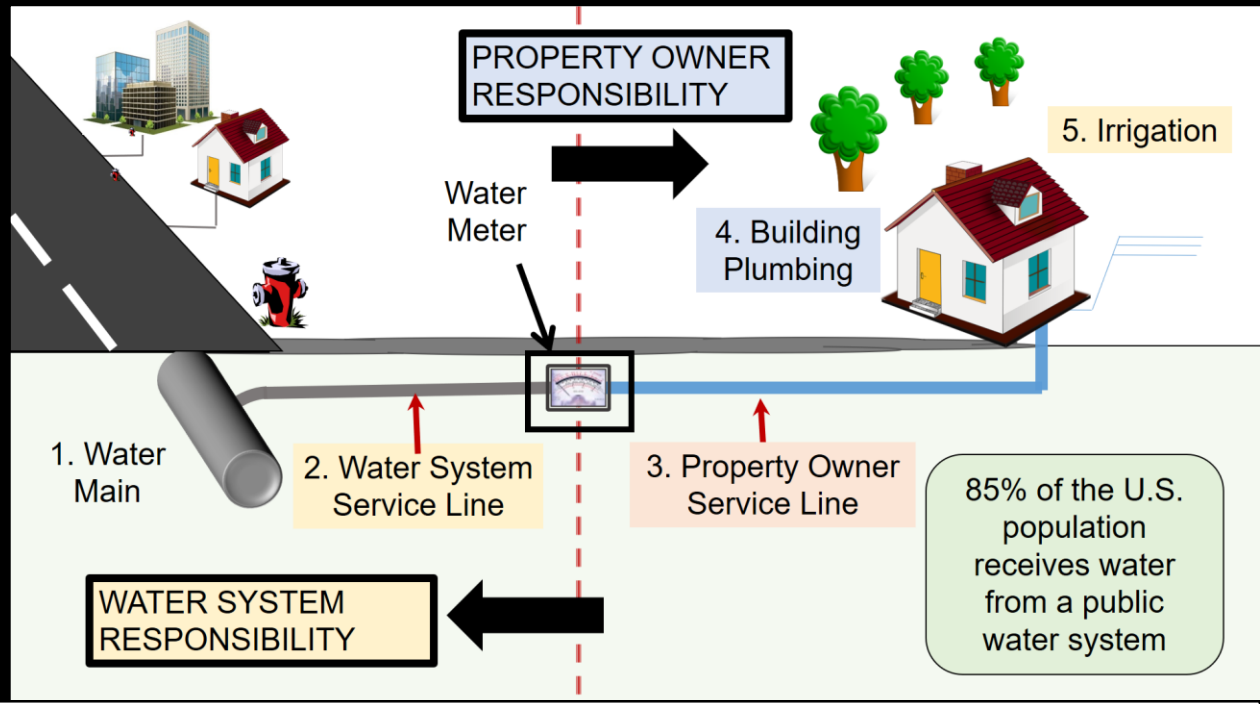
Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated.

If the source of the contamination can be determined, isolate it. If the water system needs to be flushed, be careful to contain the runoff if possible or direct it to a channel to avoid erosion and minimize spreading the contamination. Before you use the water, it is important to verify that there is no microbiological or chemical contamination.

Center for Plumbing Safety at Purdue University, West Lafayette, Indiana USA
Visit www.PlumbingSafety.org, PlumbingSafety@purdue.edu, Date Released: May 16, 2021

There are two 1 page inspection and water testing guidance sheets for building owners and well owners

Access here ➔ www.PlumbingSafety.org



Emerging Discoveries

ASPE Convention and Exposition Indianapolis, Indiana

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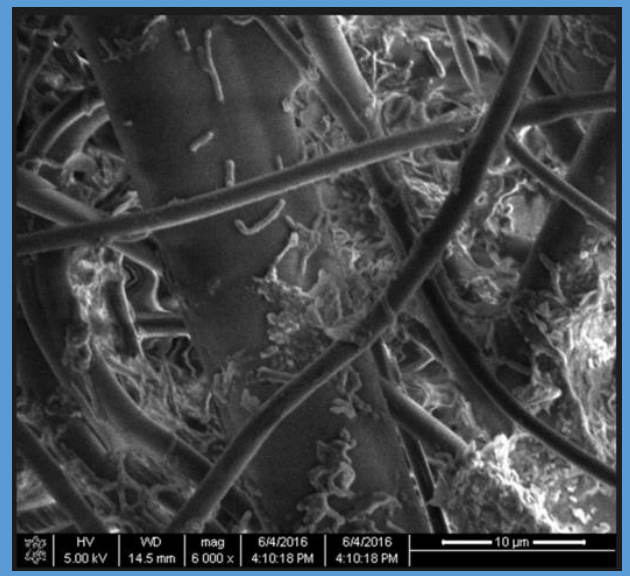
Right Sizing Tomorrow's Water Systems for Efficiency, Sustainability, & Public Health


Completed: 2017-2022

Andrew Whelton, Jade Mitchell, Joan Rose, Juneseok Lee, Pouyan Nejadhashemi, Erin Dreelin, Tiong Gim Aw, Amisha Shah, Matt Syal, Maryam Salehi

Funded by: United States Environmental Protection Agency

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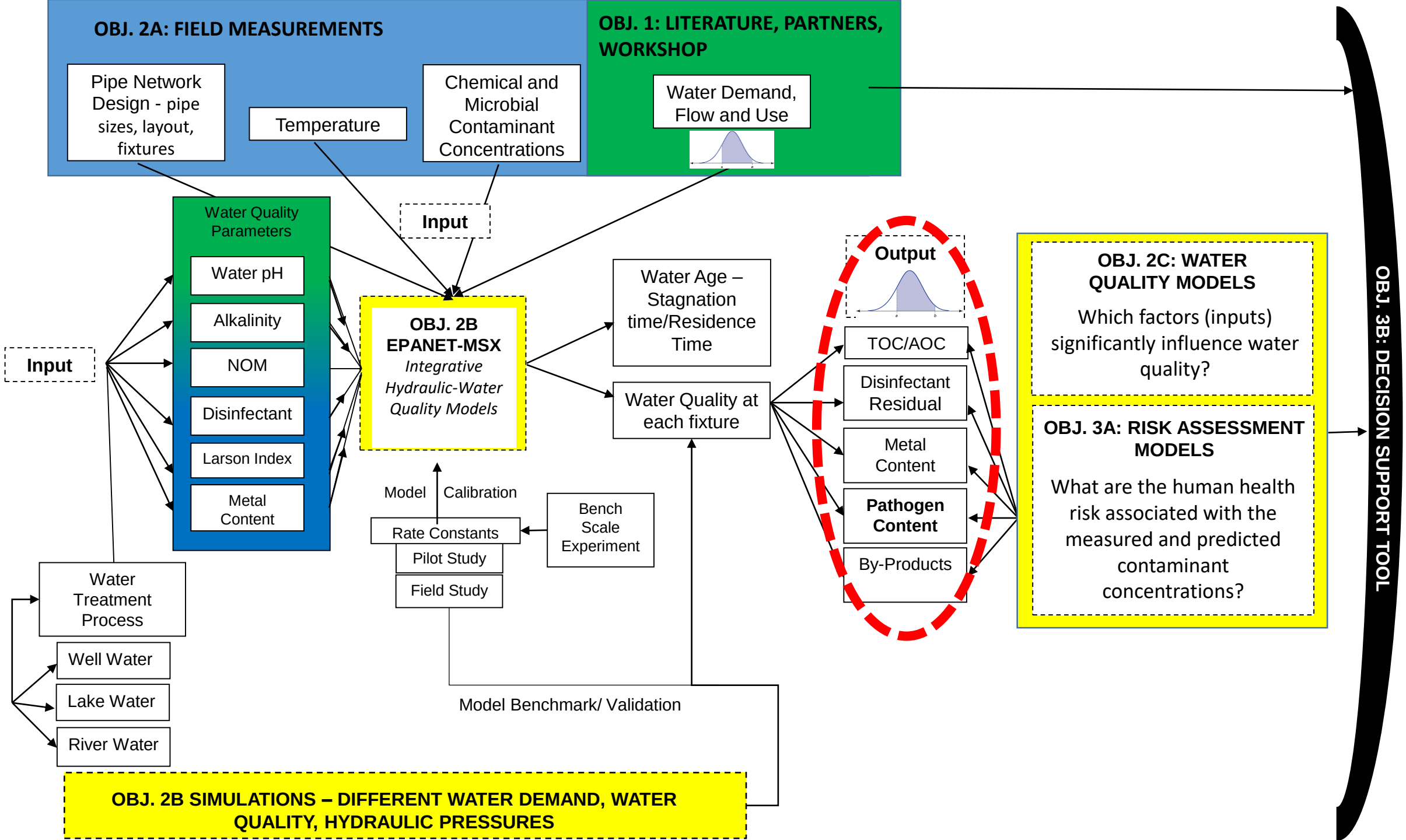
OBJ. 2A: FIELD MEASUREMENTS
Pipe Network Design - pipe sizes, layout, fixtures
Temperature
Chemical and Microbial Contaminant Concentrations
OBJ. 1: LITERATURE, PARTNERS, WORKSHOP
Water Demand, Flow and Use
Input
Water Quality Parameters
Water pH
Alkalinity
NOM
Disinfectant
Larson Index
Metal Content
Input
OBJ. 2B EPANET-MSX Integrative Hydraulic-Water Quality Models
Water Age – Stagnation time/Residence Time
Water Quality at each fixture
Output
TOC/AOC
Disinfectant Residual
Metal Content
Pathogen Content
By-Products
OBJ. 2C: WATER QUALITY MODELS
Which factors (inputs) significantly influence water quality?
OBJ. 3A: RISK ASSESSMENT MODELS
What are the human health risk associated with the measured and predicted contaminant concentrations?
OBJ. 3B: DECISION SUPPORT TOOL
Model
Calibration
Rate Constants
Pilot Study
Field Study
Bench Scale Experiment
Water Treatment Process
Well Water
Lake Water
River Water
Model Benchmark/ Validation
OBJ. 2B SIMULATIONS – DIFFERENT WATER DEMAND, WATER QUALITY, HYDRAULIC PRESSURES

Thermocouples throughout piping, 1x /sec
Indoor air temperature, 1x /sec
Flowrates at every fixture, 1x /sec
Energy use per device, 1x /sec

www.ReNEWWHouse.com

The Most Monitored Home in America

West Lafayette, Indiana
Less than 100 yards from Purdue
3 Bedroom, 1.5 baths
Water saving fixtures
Trunk-and-Branch design
PEX piping
Renovated in 2014

October 2017-October 2018

30,000+ individual water quality measurements completed - does not include flow monitoring, pressure monitoring, or qPCR

2.64 billion online plumbing related measurements

PURDUE UNIVERSITY | MICHIGAN STATE UNIVERSITY | SJSU SAN JOSÉ STATE UNIVERSITY | MANHATTAN COLLEGE | Tulane University | THE UNIVERSITY OF MEMPHIS

Water microbiology varied seasonally and spatially through the low-flow residential building

Legionella spp. and *Mycobacterium spp.* were highest during summer months.

Fixture	*Legionella spp.* % pos			*Mycobacterium spp.* % pos		
	Sum	Fall	Winter	Sum	Fall	Winter
SL	12.5	30.8	14.3	87.5	38.5	37.5
KC	100	61.5	62.5	100	69.2	87.5
BC	100	69.2	50	100	69.2	75
WH	100	100	50	100	92.3	87.5
KH	100	84.6	75	85.7	76.9	75
BH	100	92.3	87.5	100	69.2	87.5
SH	100	92.3	100	100	76.9	100

HPC were correlated with TCC, *Legionella spp.*, *Mycobacterium spp.*

Reduced water use weakly correlated with TCC, *Legionella spp.*, and *Mycobacterium spp.*

Ley et al. 2020. Drinking water microbiology in a water-efficient building: stagnation, seasonality, and physicochemical effects on opportunistic pathogen and total bacteria proliferation. *ES:WR&T*. https://www.doi.org/10.1039/d0ew00334d

Using advanced statistical approaches, relationships between plumbing use and water quality were investigated

Variable name	Variable description	Units	Log transformed	Percentile (natural scale) 2.5%	50.0%	97.5%	Number of observations
pH	pH	NA	No	7.36	8.00	9.04	406
Temp	Temperature	C	No	15.63	22.90	26.30	406
DO	Dissolved oxygen	mg/L	No	4.30	8.40	10.56	406
Total.Cl	Total chlorine	mg/L	Yes	BDL	0.10	1.00	406
Free.Cl	Free chlorine	mg/L	Yes	BDL	0.01	0.75	259
TOC	Total organic carbon	mg/L	Yes	0.42	0.81	15.36	406
DOC	Dissolved organic carbon	mg/L	Yes	0.42	0.73	18.97	371
Alka	Alkalinity	mg/L as $CaCO_3$	Yes	264.15	287.25	332.65	377
TTHM	Total trihalomethanes	mg/L	No	0.05	15.57	31.55	399
TCC	Total cell count	#cells/ml	Yes	1.54E+03	3.77E+04	1.56E+06	406
HPC	Heterotrophic plate count (by culture)	CFU/100 ml	Yes	4.03E+00	1.01E+04	3.60E+07	390
Leg.sp	*Legionella* spp. (by qPCR)	Gene copies/100 ml	Yes	2.29E+01	4.02E+03	1.78E+05	258

Increased water age prompted:
↓↓ DO, FAC
↑↑Temp, TOC, TTHM, TCC, HPC….

Legionella spp. concentration primarily driven by water age

Julien et al. 2022. Identifying water quality variables most strongly influencing Legionella concentrations in building plumbing. AWWA Water Science. https://www.doi.org/10.1002/aws2.1267

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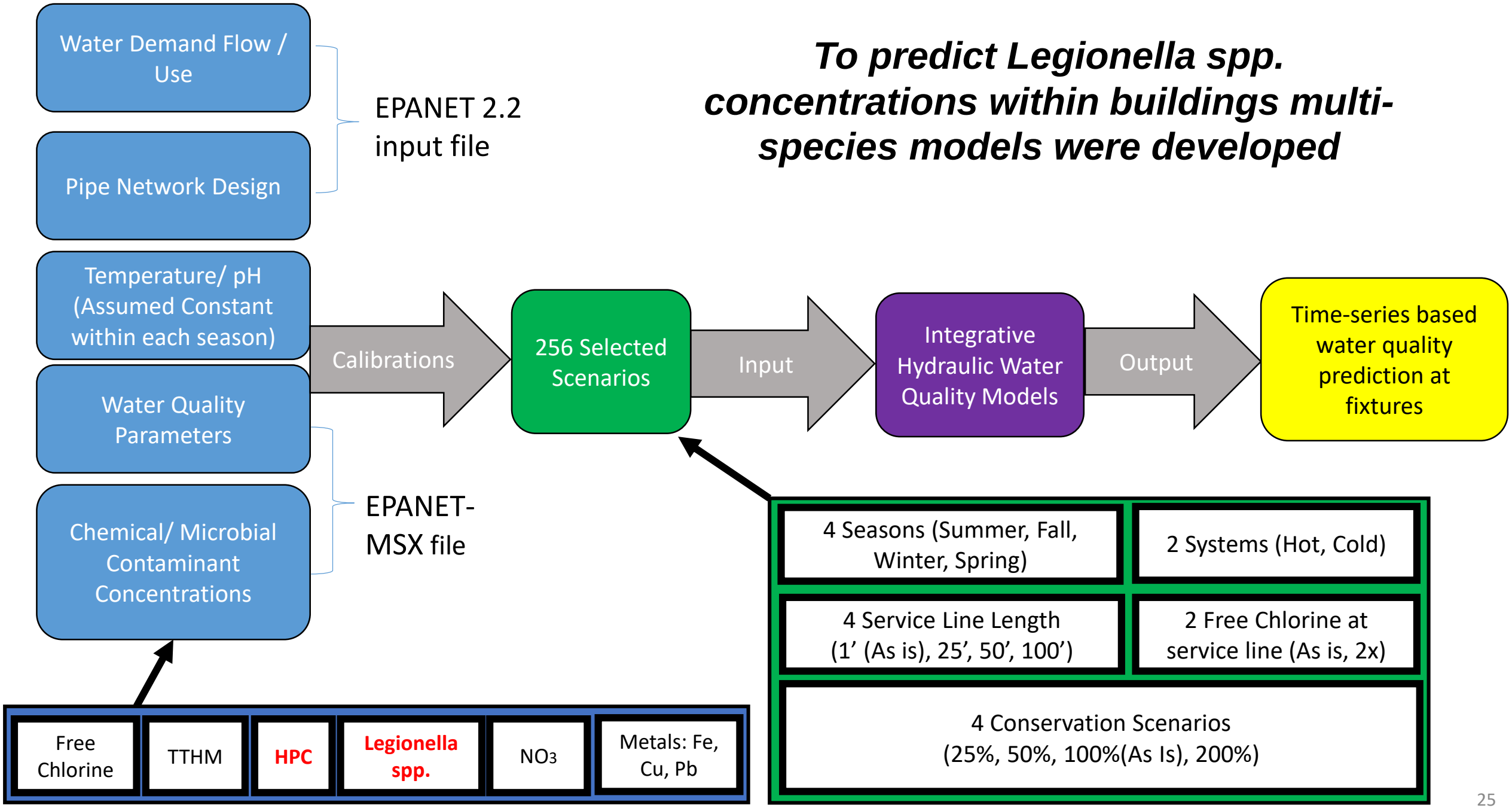
To predict Legionella spp. concentrations within buildings multi-species models were developed



8 Integrated hydraulic-water quality models were created to predict fixture water quality:

They're free to use online!

For microbiology, the models revealed …

Water use reduction by 25% **increased HPC and *Legionella spp.* by a factor of 100,000**

As service line length increased, ***Legionella* spp. concentrations increased by 1,000,000 GNC/L** (in the Summer).

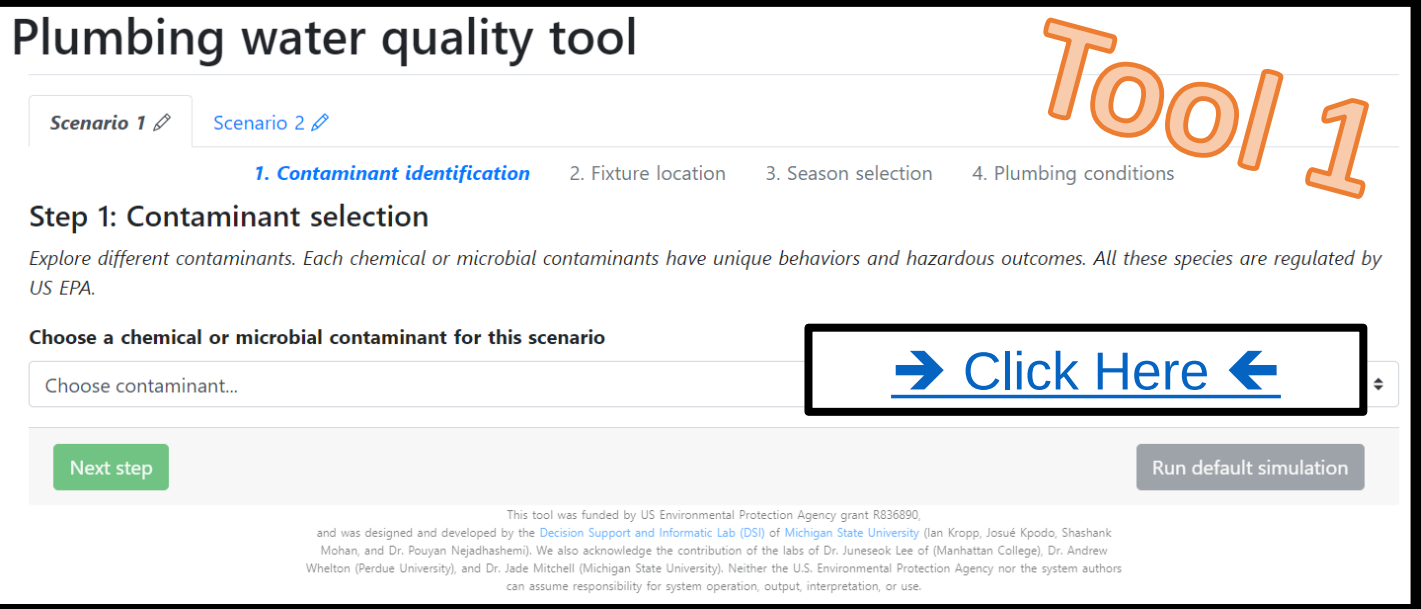
Limitations

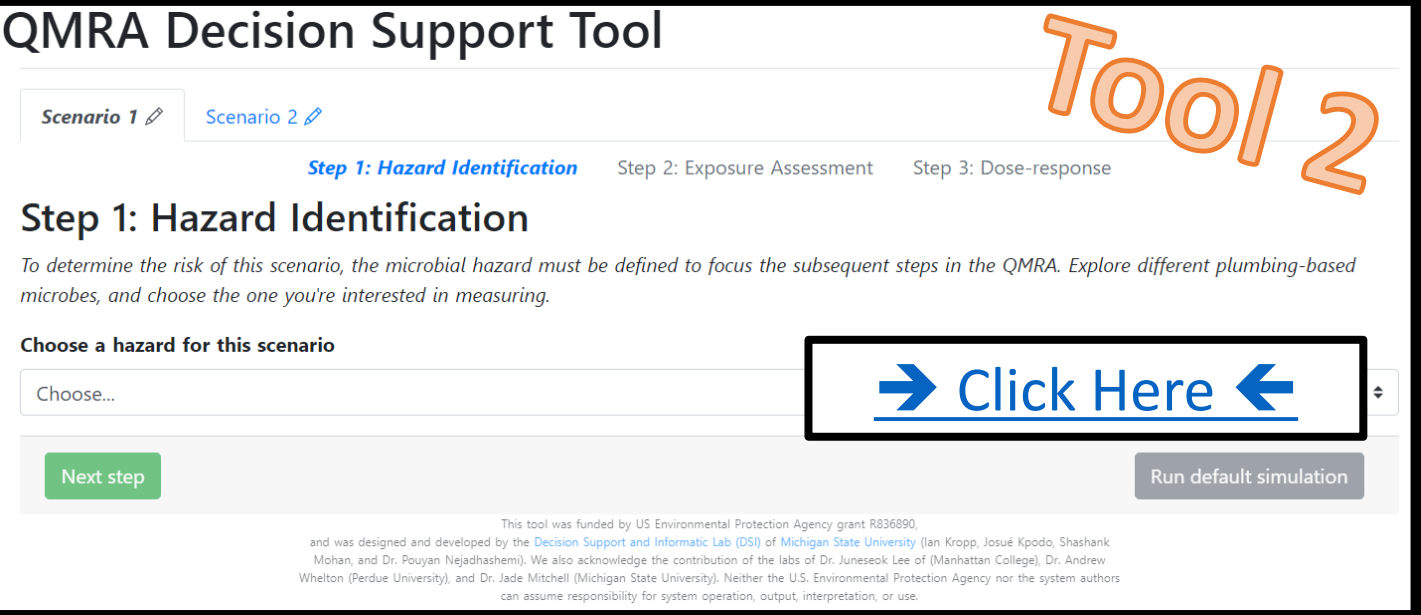
No other full-scale models are available for predictions

Carrying capacity of *Legionella spp.* (and other organisms) in other buildings unknown

This study was extremely labor intensive, technology innovations needed

Palmegiani et al. 2022. New integrative hydraulic-water quality models can predict *Legionella spp.* concentrations at fixtures. *AWWA Water Science.* https://doi.org/10.1002/aws2.1280





Online and FREE Building Water Quality Tools Now Available

Usefulness

Multiple contaminants: *Legionella spp.*, HPC, Cl_2, Cu, Fe, Pb, NO_3^-, TTHM

Compare exposure scenarios

Examine plumbing design impacts

Examine water use impacts

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Water Age Strongly Influences Water Quality

A 7 year old LEED School in Indiana

(250+ outlets, 1 floor, 3 recirc loops, chloramines)

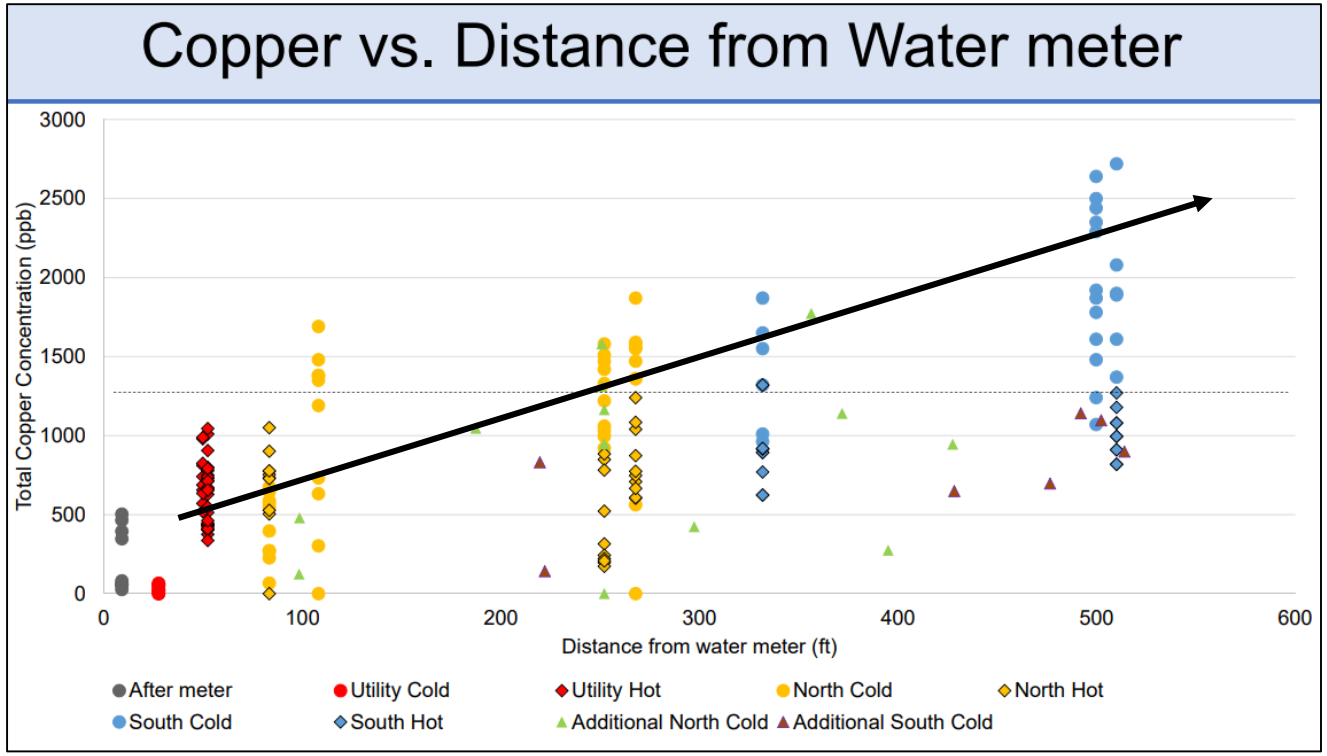
Summer 2019

↓

Fall 2019

Prior testing:

Lead only



Ra et al. 2020. Finding building water quality challenges in a 7 year old green school: implications for building design, sampling, and remediation. *ES: WR&T.* https://doi.org/10.1039/D0EW00520G

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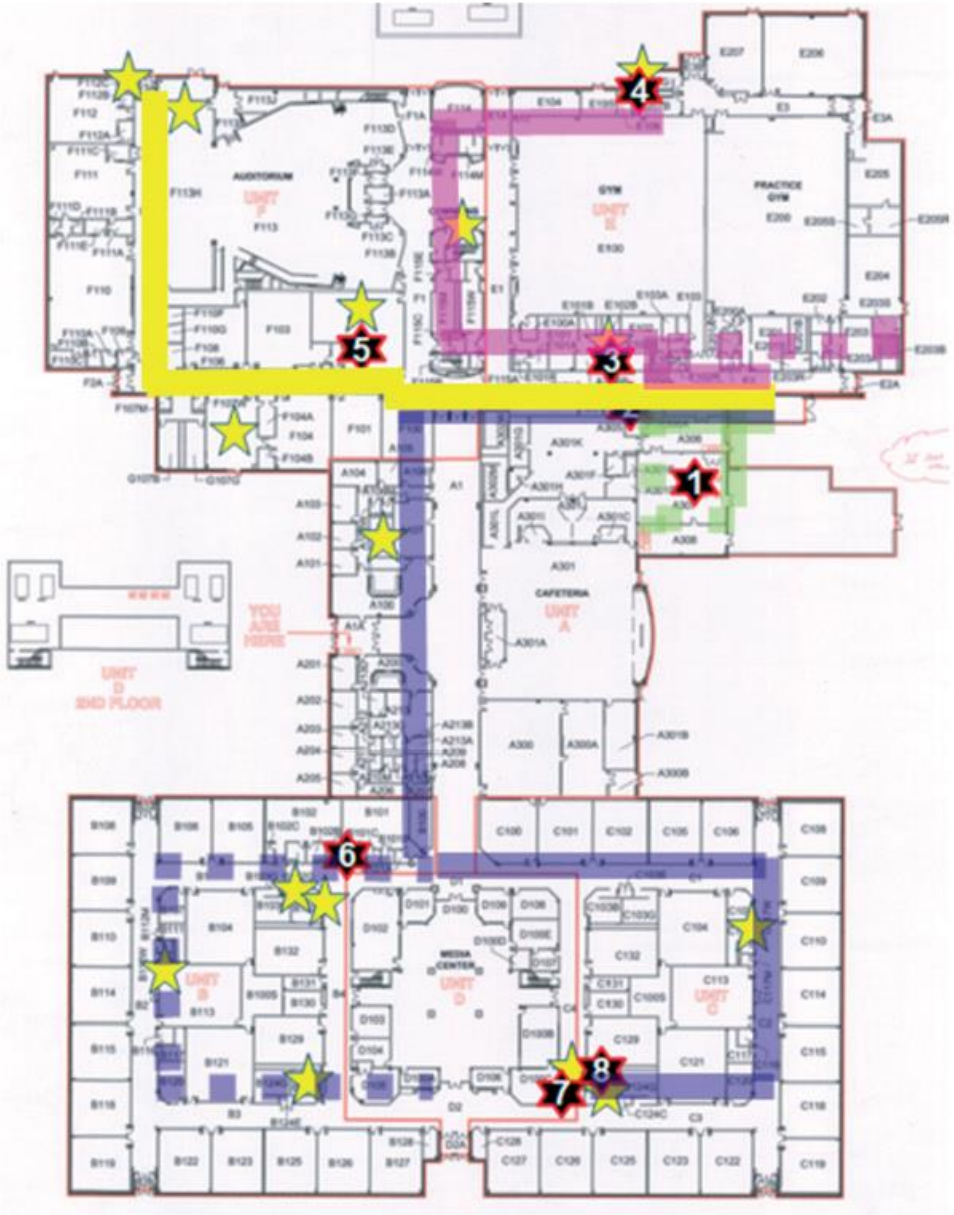

Detected:

Legionella spp. 100%; *Mycobacterium spp.* 99%

M. avium 75%; *Acanthamoeba spp.* 17.5%

Cultivable *Legionella* during low water use.

NOT detected:

L. pneumophila, *Naegleria fowleri*

Summer ➔ Fall: Levels statistically ↓↓↓

Legionella spp., *Mycobacterium spp., M. avium*

The water softener was an incubator for growth

Aw et al. 2022. Prevalence of opportunistic pathogens in a school building plumbing during periods of low water use and a transition to normal use. *IJHEH.* https://doi.org/10.1016/j.ijheh.2022.113945

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A Large School in Ohio (450+ outlets, 2 floors, no recirc loops, yes showers)

Sample type	Fixture type	*L. pneumophila* Concentration (MPN/100 mL)	Suggested *L. pneumophila* Limit (CFU/mL)
Initial stagnation	Water fountain (cold)	239.6	106
	Staff sink (cold)	1,289.6	106
	Cafeteria sink (cold)	3.5	106
	Cold faucet (distal end)	1	106
	Cold faucet (central)	1.1	106
Pre-shock chlorination	Various	0	106
Immediately after shock chlorination	Various	0	106
Immediately after shock chlorination	Fountain (cold) Bathroom sink (cold)	3.9 7.9	106 106
72 hours post-shock	Various	0	NA
1 month post-shock chlorination	Various	0	NA

Stagnation:
Approximately 5.3% (5/94) of fixtures positive for *L. pneumophila*

Right after shock:
L. pneumophila was detected at two fixtures (drinking fountain and TMV sink)

1 month after shock:
No *L. pneumophila* was detected

Nickel exceeded health based limits in kitchen

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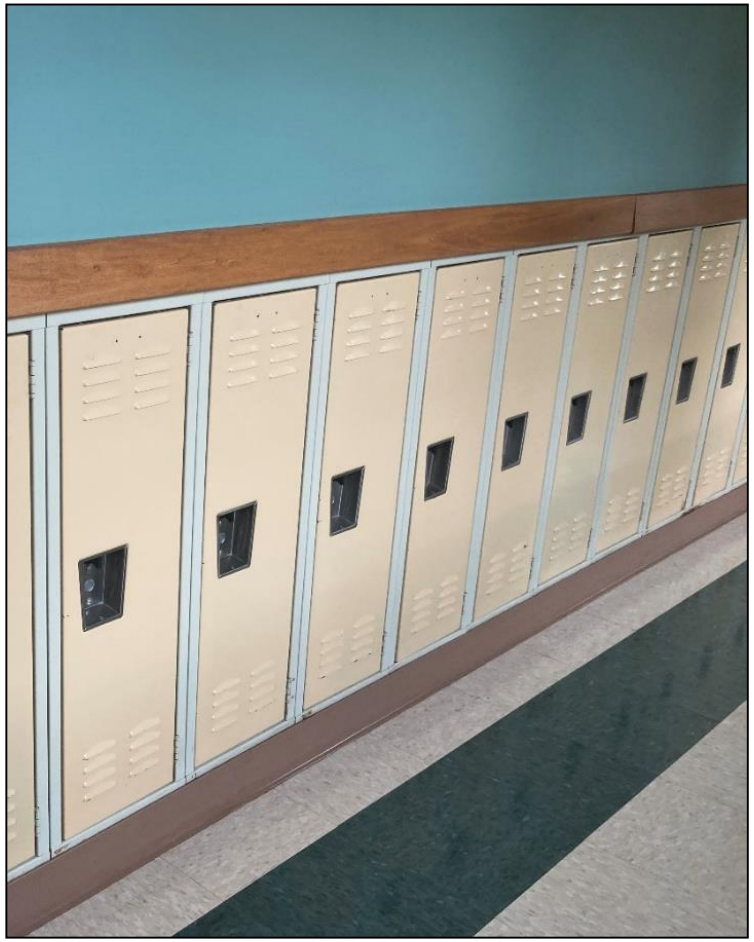
A small school in Indiana…multiple buildings



3 buildings, built in the 1960s

3 months of **low/no** water use

Characteristics

- POE free chlorine residual <0.2 to 1.3 mg/L
- Per building: 1 service line, 1 heater, Cu plumbing
- *No recirc loops, no showers, no cooling towers*

Stagnant water: 1-2 *L. pneumophila* detects/building (<188 MPN/ 100mL). Total cold (4 of 25 locations), Hot (1 of 21 locations)

Flushed water: No detects

2 weeks later: Several detects at *new* locations (<61 MPN/ 100mL); 5 of 7 detects were hot water

Ra et al. *In Prep*. The role of flushing on reducing low levels of L. pneumophila from a stagnant school building water system

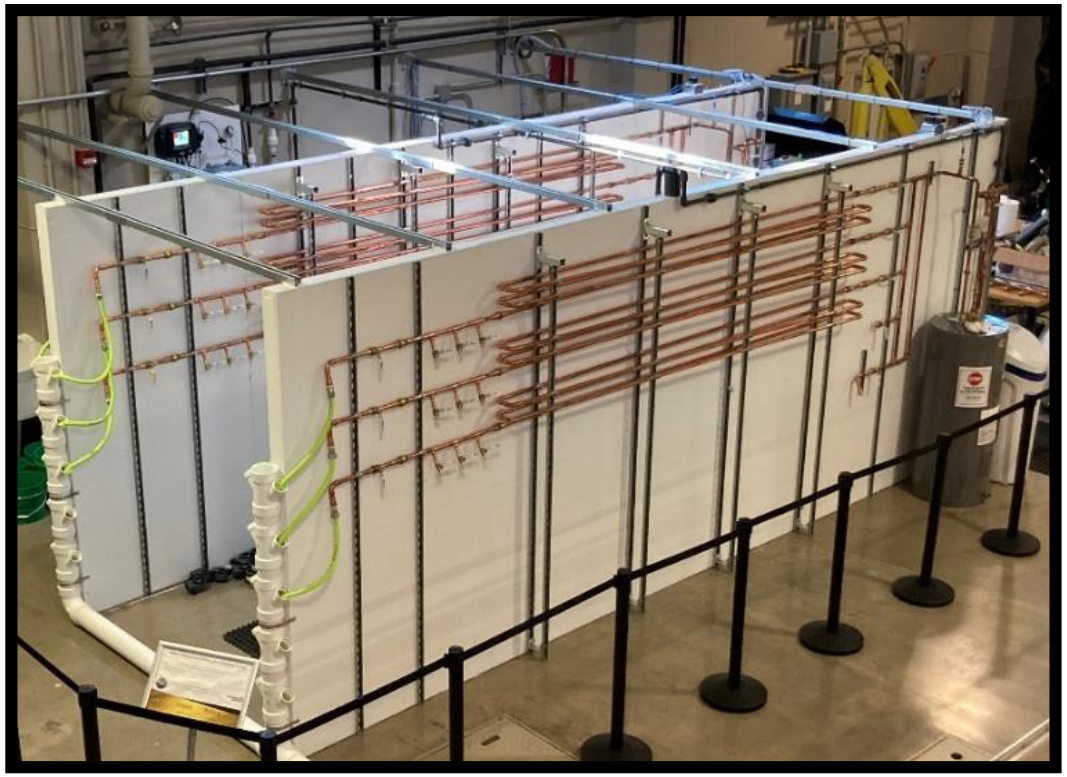
School and childcare center drinking water: Copper chemistry, health effects, occurrence, and remediation

1. Only 0.2% of 598,000 schools and childcare centers had copper testing data
2. Where present, widely different sampling and remedial actions were reported
3. Plumbing and fixture flushing was unreliable, copper quickly rebounded
4. Building treatment systems have been used, but some were not effective
5. A national drinking water testing campaign and field studies are recommended

Watch out for elevated alkalinity levels with near neutral pH!

Montagnino et al. 2022. School and childcare center drinking water: Copper chemistry, health effects, occurrence, and remediation. *AWWA Water Science.* https://doi.org/10.1002/aws2.1270

NEW:
Plumbing Testing Facility

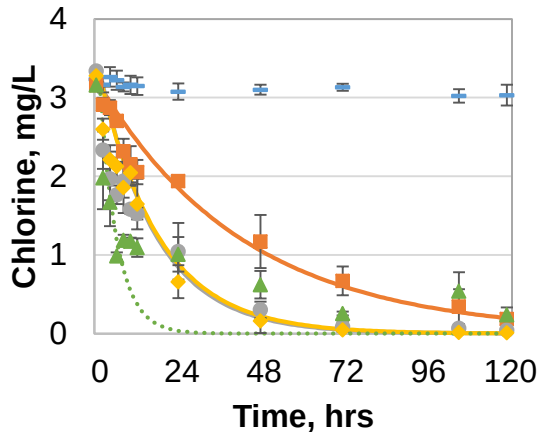


1,000 sqft, online water quality and flow monitoring, auto-flushing, 4 replicate systems, POE/POU treatment, storage, municipal source, expansion primed

Impact of New Water Softeners on Drinking Water Quality

1st flush
937 mg/L as C (40% POC)
1,200 mg/L as S

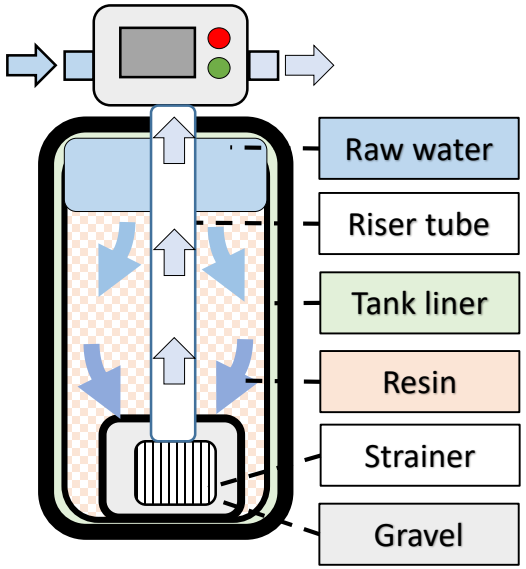
When 3.1 mg/L as Cl_2
3-5 days before it is nondetectable



After 1 week of use, the softener was still prompting TOC and total cell count levels to be 4x above background levels

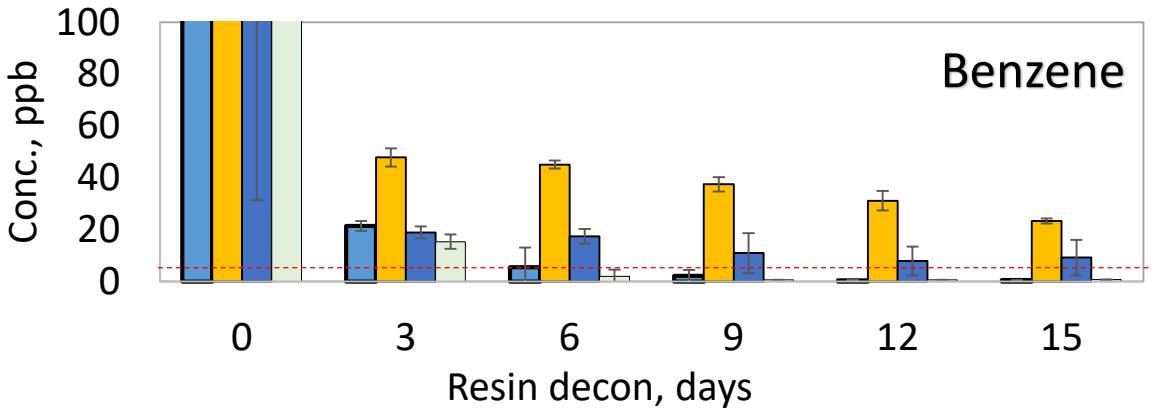
Jankowski et al. *In Prep.*

Hydrocarbon Contamination and Decontamination of Water Softeners



Surface area

Resin: 2,800,000+ cm^2
Liner: 9,300 cm^2
Gaskets: 32 cm^2



…. of Water Supply Connectors

After the 2014 West Va. chemical spill, the Health Department recommended discarding tubing at restaurants

Dishwasher connector – PVC

Softener connector – PVC

Ice-maker tubing – PE

Multipurpose tubing – PVC

Faucet supply line – PVC

Ice-maker tubing – PEX

All plastics sorbed 93-100% of the BTEX in 24 hr

9 of 11 materials still exceeded the benzene MCL after 9 days of decon

Washing machine hose – EPDM

Jankowski, Le et al. *In Prep.*

The Healthy Plumbing Consortium (2021 – Pres)

Mission: To advance health and quality of life by innovating new and existing technologies and providing transformative education.

DELTA FAUCET COMPANY

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Cu Copper Development Association Inc. Copper Alliance

1. Technological and operational approaches for maximizing building water health
2. Smart technology for improved building water health
3. Education of systems and technology

…Interested? Contact Me.

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Building Water Essentials
10 Hour, Online Short-Course



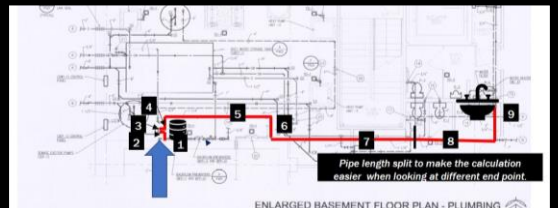





Audience: Public health, code officials, utility staff, manufacturers, architects, engineers

Learn the basics:
8 modules do not have to be taken in sequence.

A training tool, an encyclopedia, and an extensive FAQ, designed to be immediately applicable in the field.

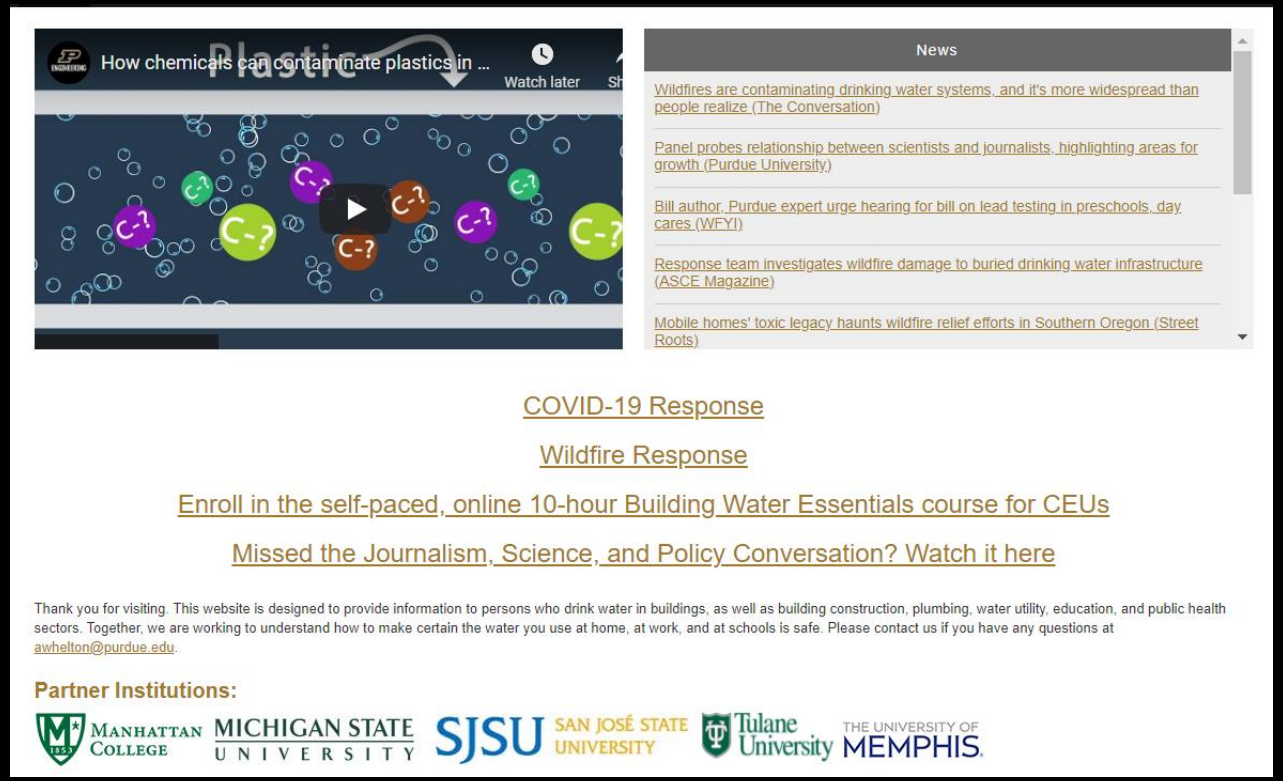


If interested e-mail awhelton@purdue.edu

Info and registration: https://cutt.ly/Sg4RXJv

Thank you.

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



www.PlumbingSafety.org

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https://engineering.purdue.edu/online/certifications/building-water-essentials