

Plumbing Innovation and Safety



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Journal of Hazardous Materials
Volume 339, 5 October 2017, Pages 385-394




Crude oil contamination of plastic and copper drinking water pipes




Journal of Environmental Chemical Engineering
Volume 5, Issue 4, August 2017, Pages 3622-3631



In-situ cleaning of heavy metal contaminated plastic water pipes using a biomass derived ligand



Chemosphere
Volume 195, March 2018, Pages 80-89




Case study: Fixture water use and drinking water quality in a new residential green building




Journal of Hazardous Materials
Volume 325, 5 March 2017, Pages 8-16




The interaction of surfactants with plastic and copper plumbing materials during decontamination



Water Research
Volume 67, 15 December 2014, Pages 19-32




Release of drinking water contaminants and odor impacts caused by green building cross-linked polyethylene (PEX) plumbing systems




Journal of American Water Works Association
Peer Reviewed

Predicting Contaminated Water Removal From Residential Water Heaters Under Various Flushing Scenarios



Journal of American Water Works Association
Peer Reviewed

Metal Accumulation in Representative Plastic Drinking Water Plumbing Systems



Journal of American Water Works Association
Peer Reviewed

PEX and PP Water Pipes: Assimilable Carbon, Chemicals, and Odors

Original Articles


Contaminant Migration From Polymeric Pipes Used in Buried Potable Water Distribution Systems: A Review


Andrew J. Whelton & Tinh Nguyen

Pages 679-751 | Accepted author version posted online: 21 Feb 2012, Published online: 21 Feb 2012


Download citation | <https://doi.org/10.1080/10643389.2011.627005>

Decontaminating chemically contaminated residential premise plumbing systems by flushing


From the journal:
Environmental Science: Water Research & Technology



Journal of Hazardous Materials
Volume 347, 5 April 2018, Pages 242-251



Investigation of the factors that influence lead accumulation onto polyethylene: Implication for potable water plumbing pipes


TAP WATER AND INDOOR AIR CONTAMINATION DUE TO AN UNINTENTIONAL CHEMICAL SPILL IN SOURCE WATER

Interaction between Theory and Practice in Civil Engineering and Construction

The cleaning method selected for new PEX pipe installation can affect short-term drinking water quality

© IWA Publishing 2015 **Journal of Water and Health | 13.4 | 2015**

Residential Tap Water Contamination Following the Freedom Industries Chemical Spill: Perceptions, Water Quality, and Health Impacts



And
more..

plumb·ing

[ˈplʌmiŋ] **NOUN**

*the system of **pipes**, **tanks**, **fittings**, and **other apparatus** required for the drinking water supply, heating, and sanitation in a building*

4000-3000 BCE

Copper water pipes in buildings (India)

1500 BCE

Rainwater cisterns (Greece)

500 BCE- 250 AD

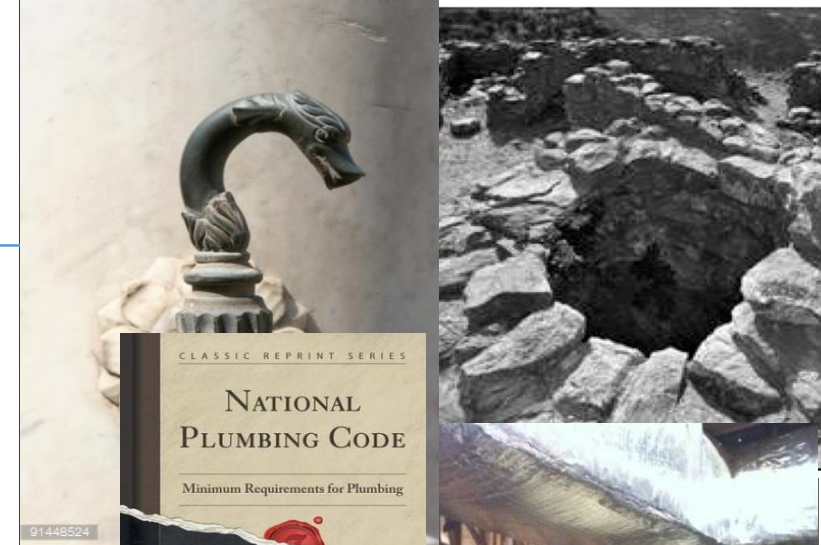
Lead & bronze pipes, marble fixtures, gold & silver fittings (Egypt)

1928

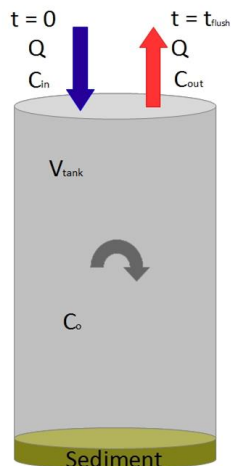
First US plumbing code

1966

Copper shortage enabled plastics entry



Hot vs. Cold
Water Pipes

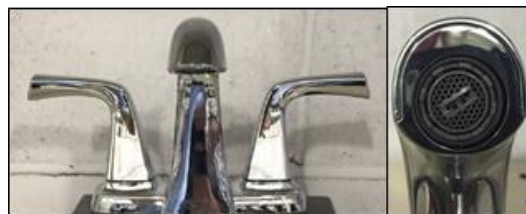


Water
Heater

Metals and Plastics



Fixtures and Aerators



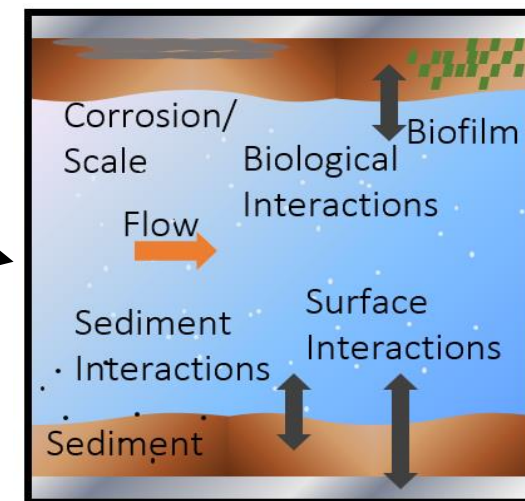
POU
Devices



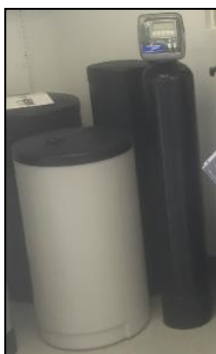
Corrosion
Products



Habitat



Water
Softener



Whole House Filter



Service Lines



Building plumbing is complex

Food Prep Facility



Domestic Hot Water



PEX pipe with copper manifold



Hospital



Cartridge Filters



Copper pipe to cPVC pipe



Some images courtesy of: Gordon & Rosenblatt, LLC

Plumbing, Pathogens, & Disease

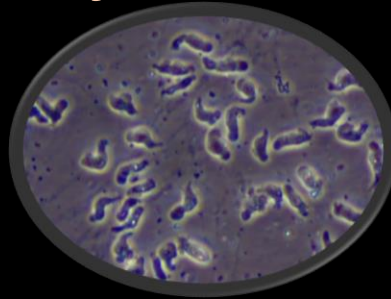
“Pathogens in plumbing are the 1^o source of waterborne disease in developed countries”

Pruden et al. (2013)

Legionella p.



Naegleria fowleri



P. aeruginosa



Waterborne diseases in the US
2000-2014

56% due to drinking water

22% cooling towers

7% hot tubs

44% at hotels and resorts

19% at long-term care facilities

15% percent at hospitals

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

Ongoing National Priorities Project, 2016-Present

To better understand and predict water quality and health risks posed by declining water usage and low flows

1. Improve the public's understanding of decreased flow and establish a range of theoretical premise plumbing flow demands from the scientific literature and expert elicitation with our strategic partners
2. Elucidate the factors and their interactions that affect drinking water quality through fate and transport simulation models for residential and commercial buildings
3. Create a risk-based decision support tool to help guide decision makers through the identification of premise plumbing characteristics, operations and maintenance practices that minimize health risks to building inhabitants.

Visit www.PlumbingSafety.org for more information

Our Project was Developed Based on Feedback from the Public, Regulators, Water Utilities, Building Designers, Owners, and Educational Institutions

Our Team's Expertise

- Environmental Engineers
- Hydraulics Engineers
- Civil Engineers
- Microbiologists
- Analytical Chemists
- Data Scientists
- Risk Assessors
- Political Scientists

Partners

- Drinking water providers
- Architectural, Plumbing, and Engineering Firms
- Nonprofit organizations
- Educational institutions
- Professional associations



Visit www.PlumbingSafety.org

Obj 1. Industrial Stakeholder Plumbing Research Questions



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

Thermocouples throughout piping, 1x per second

Indoor air temperature, 1x per second

Flowrates at every fixture, 1x per second

Energy use per device, 1x per second

www.ReNEWWHouse.com

ReNEWW Home Preliminary Results

October 2017 to October 2018

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

600+ million online plumbing related measurements

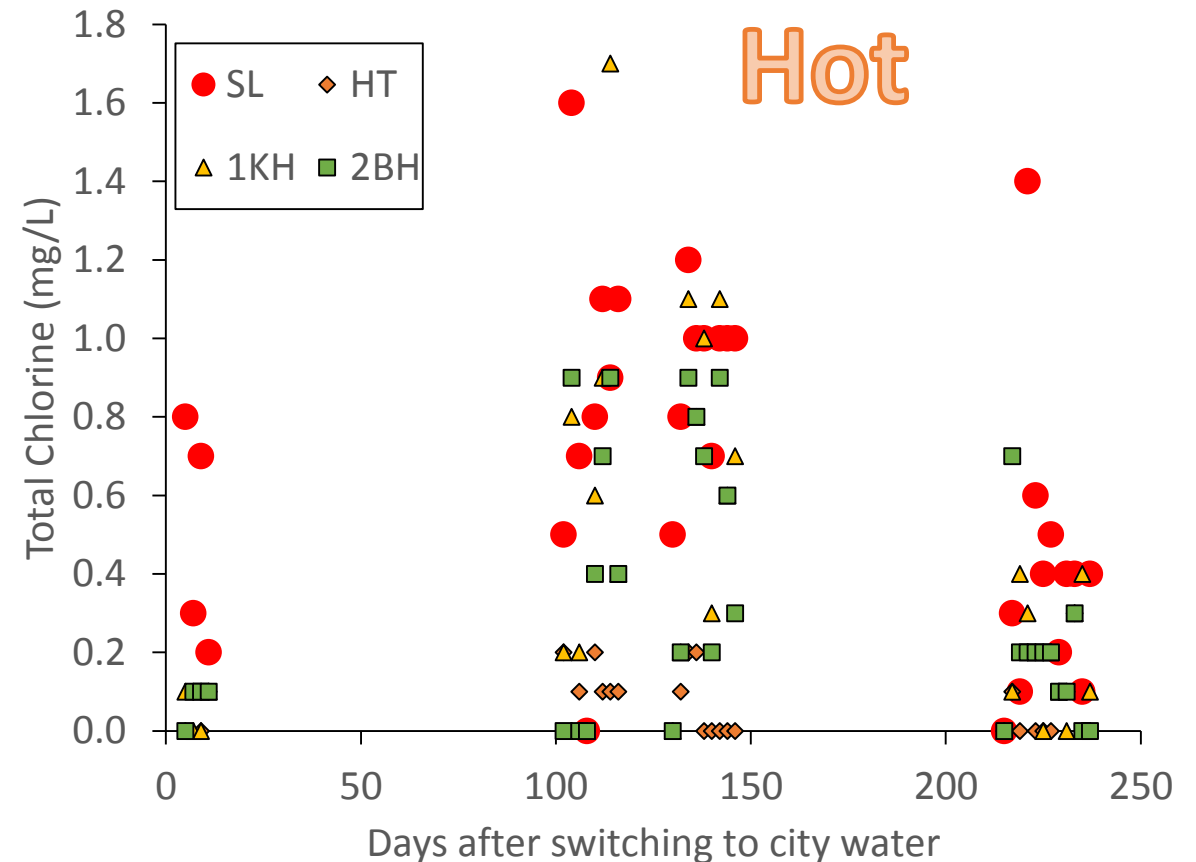
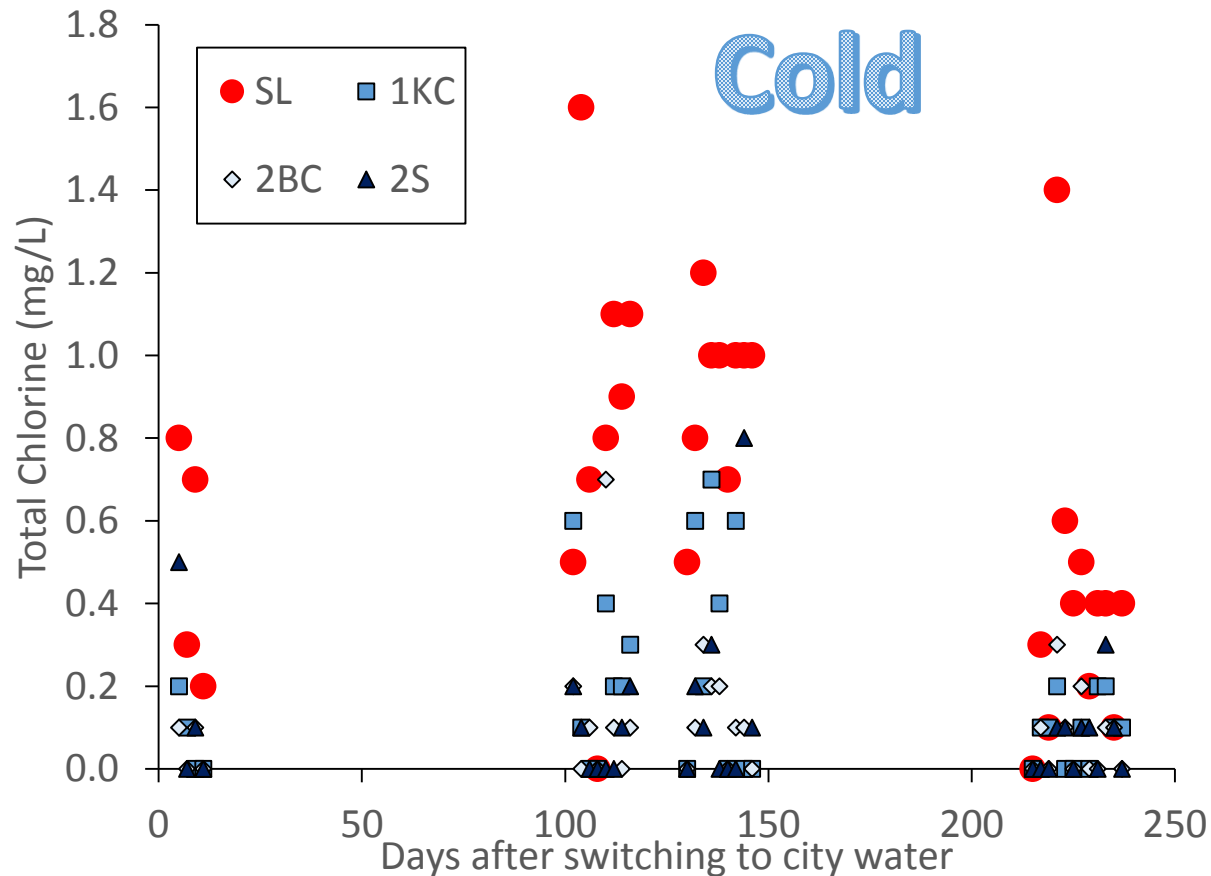
Water in pipes equilibrates to ambient temperature quickly (<4 hours)

Usage events are often short

Snapshot of Preliminary Total Chlorine Results

(Service line = **red**)

not found in more than 50% of water samples exiting the water heater,
at the 1st floor kitchen sink cold, 2nd floor bathroom sink cold, and 2nd floor shower



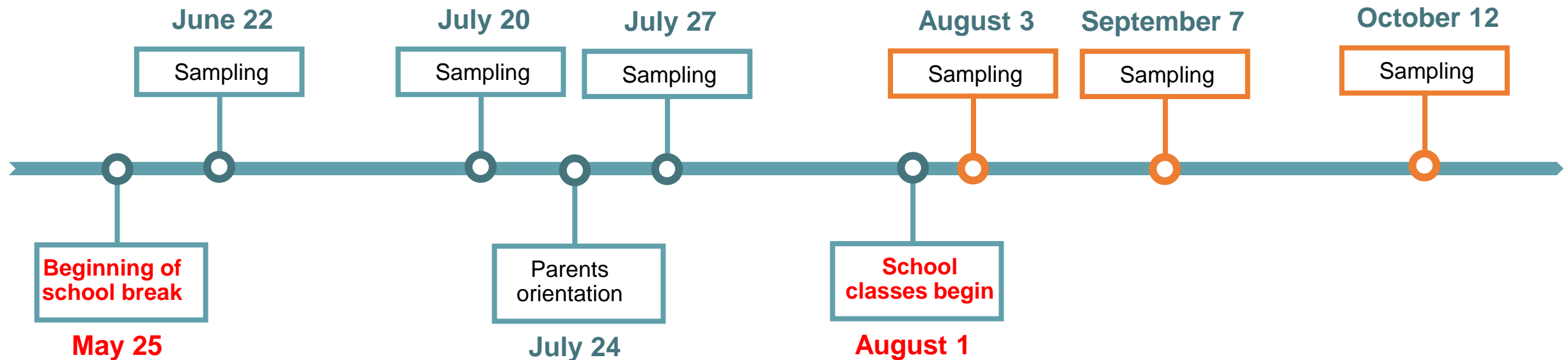
Field Study School



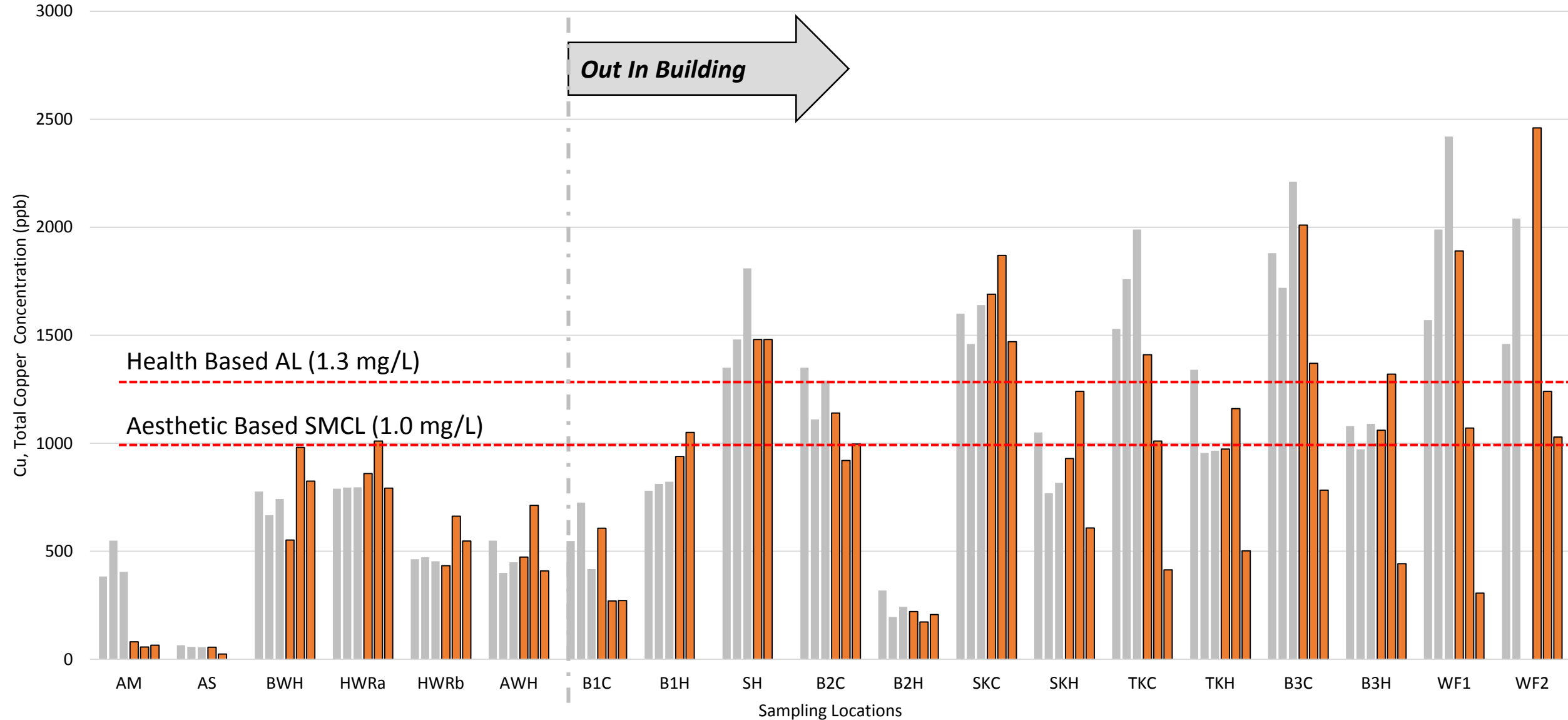
7 year old LEED school receives chloraminated water from a public water system; Copper plumbing, water softener, hot water recirculation system - 4 zones.

Study Goal: Understand how drinking water chemical and microbial parameters change during the **transition from Summer to Fall**

- Service line, staff kitchens, bathrooms, showers, classroom, water bubblers



More than 4,500 tests: Copper drinking water action level was exceeded June 2018 to October 2018



Our Pilot Plumbing Facility:

Plumbing, Water Use, and Water Quality Relationships

Full-Scale Testing



Plumbing Testing Facility
@ Purdue



Other Field/Bench-scale tests





News

[Plumbing research newsletter - September 2018](#)

Check out the September 2018 issue of Tapped Into Plumbing, featuring a variety of articles on plumbing safety and research.

[Project focuses on reducing pathogen threat in low-flow water systems](#)

Low-flow building water systems designed to conserve water pose potential health hazards because they may cause an increase in disease-causing organisms and harmful chemicals. A new EPA-funded project led by Purdue University strives to help solve the problem.

[All News...](#)

In 2016, the U.S. government provided our multi-university team a \$1,989,000 grant to initiate this project in addition to \$1,100,000 contributed by our research partners. This project involves organizations from the building construction, plumbing, water utility, education, and public health sectors and input from homeowners and representatives from the general public. Together, we are working to understand how to make certain the water you use at home, at work, and schools is safe. The title of the project is "[Right Sizing Tomorrow's Water Systems for Efficiency, Sustainability, and Public Health](#)".

This website will be evolving as the project team gets started in 2017. Stay tuned for additional details. [Download PDF Presentation about this project.](#)