

Working Toward Safer Drinking Water at Home, Work, and School

Tiong Aw

**Assistant Professor
School of Public Health and Tropical Medicine
Tulane University
taw@tulane.edu**

Core Team



PI Whelton



Shah



Salehi

PURDUE
UNIVERSITY



Lee

SJSU SAN JOSÉ STATE
UNIVERSITY



Aw

 **Tulane**
University



Mitchell



Rose



Beecher



Nejadhashemi



Abouali



Dreelin



Syal

MICHIGAN STATE
UNIVERSITY

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

Core Team Expertise

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

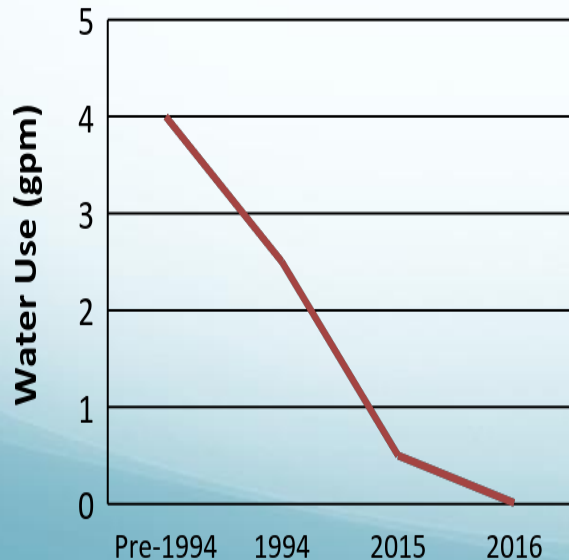
Partners

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



Our Project Goal

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



plumb·ing

['plʌmiŋ] **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)



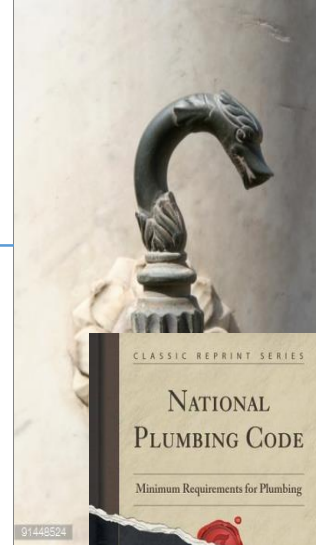
1500 BCE

Rainwater cisterns (Greece)



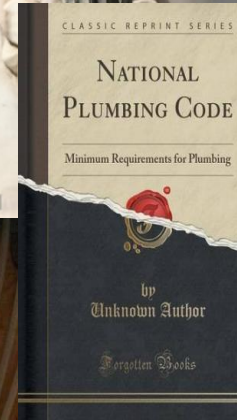
500 BCE- 250 AD

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



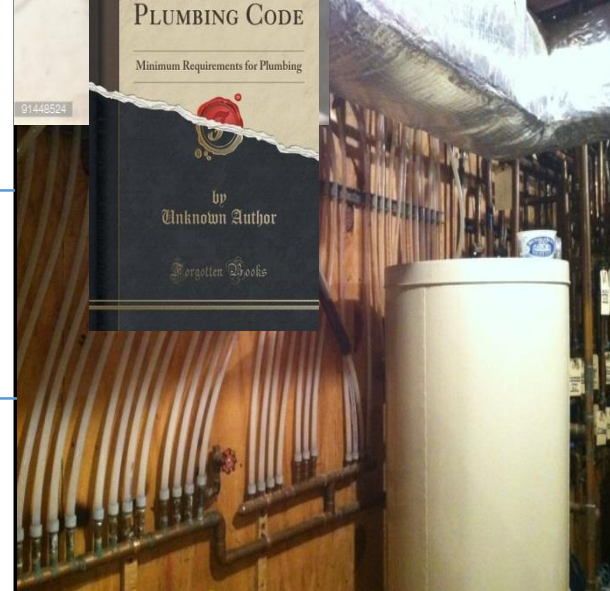
1928

First US plumbing code



1966

Copper shortage enabled plastics entry



Fixtures and Aerators

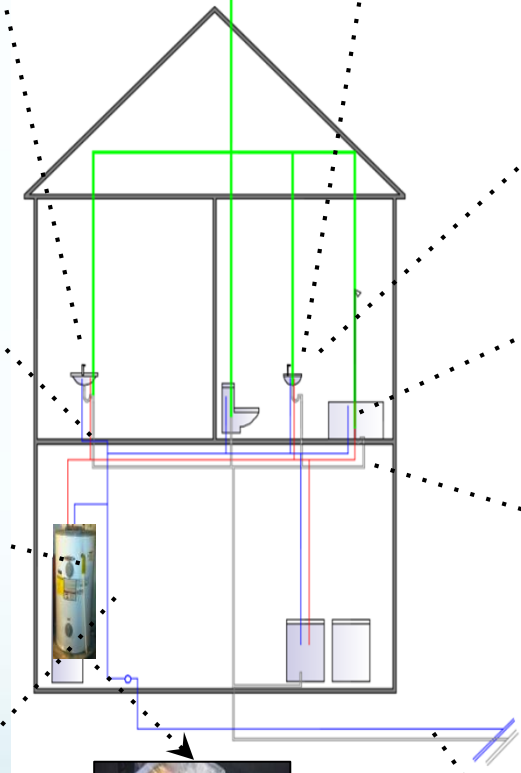
Metals and Plastics



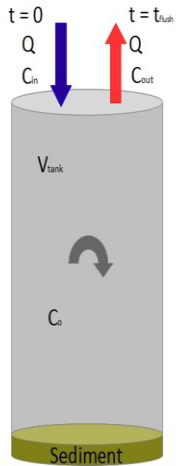
POU Devices



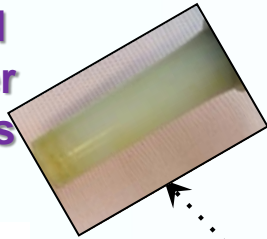
Corrosion Products



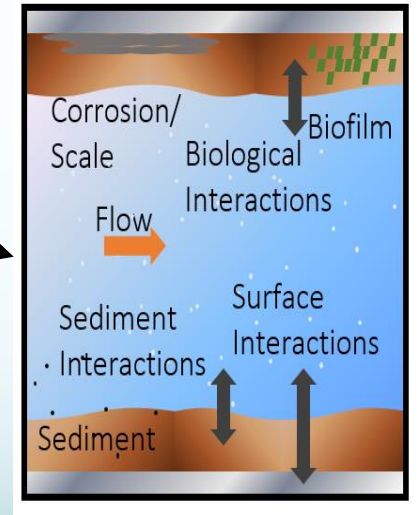
Water Heater



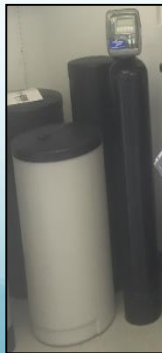
Hot vs. Cold Water Pipes



Habitat



Water Softener



Whole House Filter



Service Lines

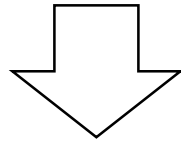


Building Water Use has Been Declining

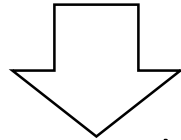
Water Use Energy Policy Act of 1992

**Water
Use has
Decreased
From
Lower-Flow
Faucets**

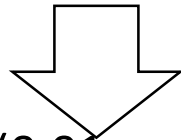
Pre-1994 (4+ gpm)



1994 (2.5 gpm)



2015 (0.5 gpm)



2016? (0.01 gpm)



How old is your water before reaching the faucet?

$$\frac{\text{Volume of water stored in pipes}}{\text{Flowrate of water exiting the Faucet}}$$



...our water systems are not designed to handle lower use

Safe Water at the Tap

- While the SDWA addresses national water quality, it will be the collective efforts of the water utilities, building/ housing and plumbing professionals that achieve safe water for consumers at the tap.
- Where ever there is water there are microbes and the distribution system and premise plumbing are no exceptions.
- There is a great need to manage the microbial biofilm for pathogens that cause disease via the plumbing system.

Opportunistic pathogens are those naturally occurring microbes that opportunistically - can cause disease in humans especially those who are immunocompromised

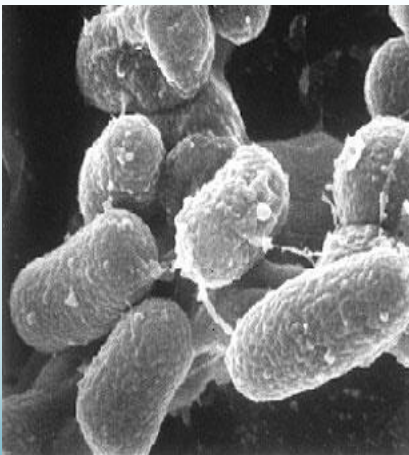
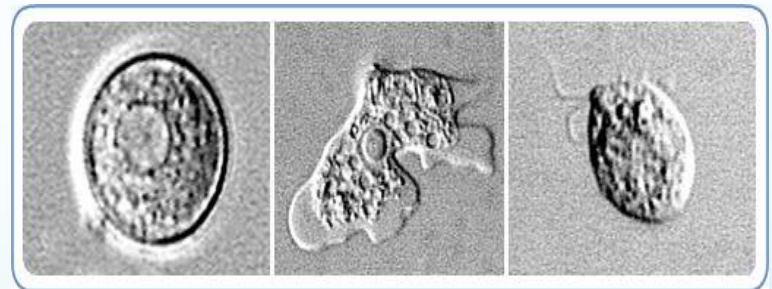
Legionella pneumophila



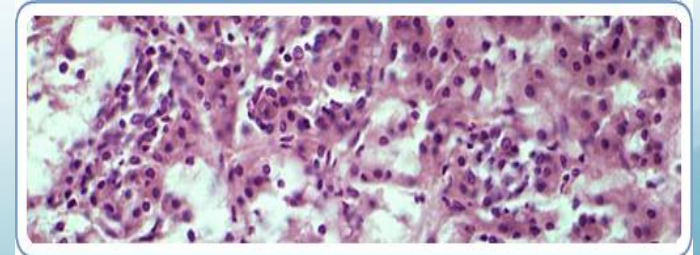
Pseudomonas aeruginosa



Naegleria fowleri



Acanthamoeba

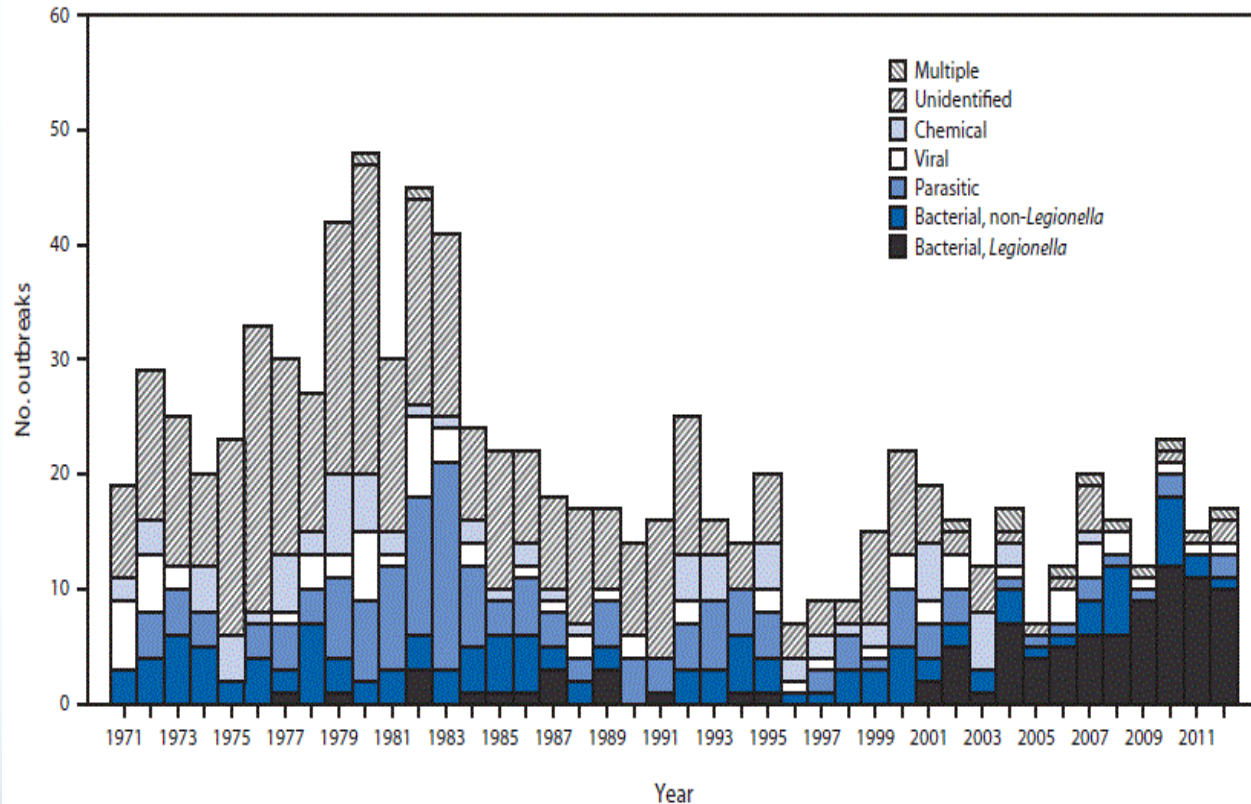


Mycobacterium avium complex (MAC)

Source: CDC

Opportunistic pathogens are now the primary source of waterborne disease outbreak in U.S.

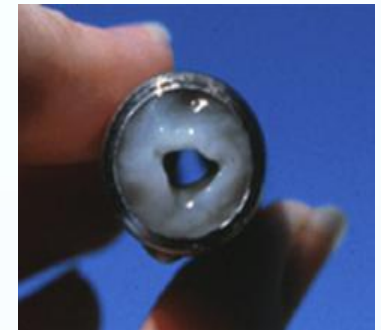
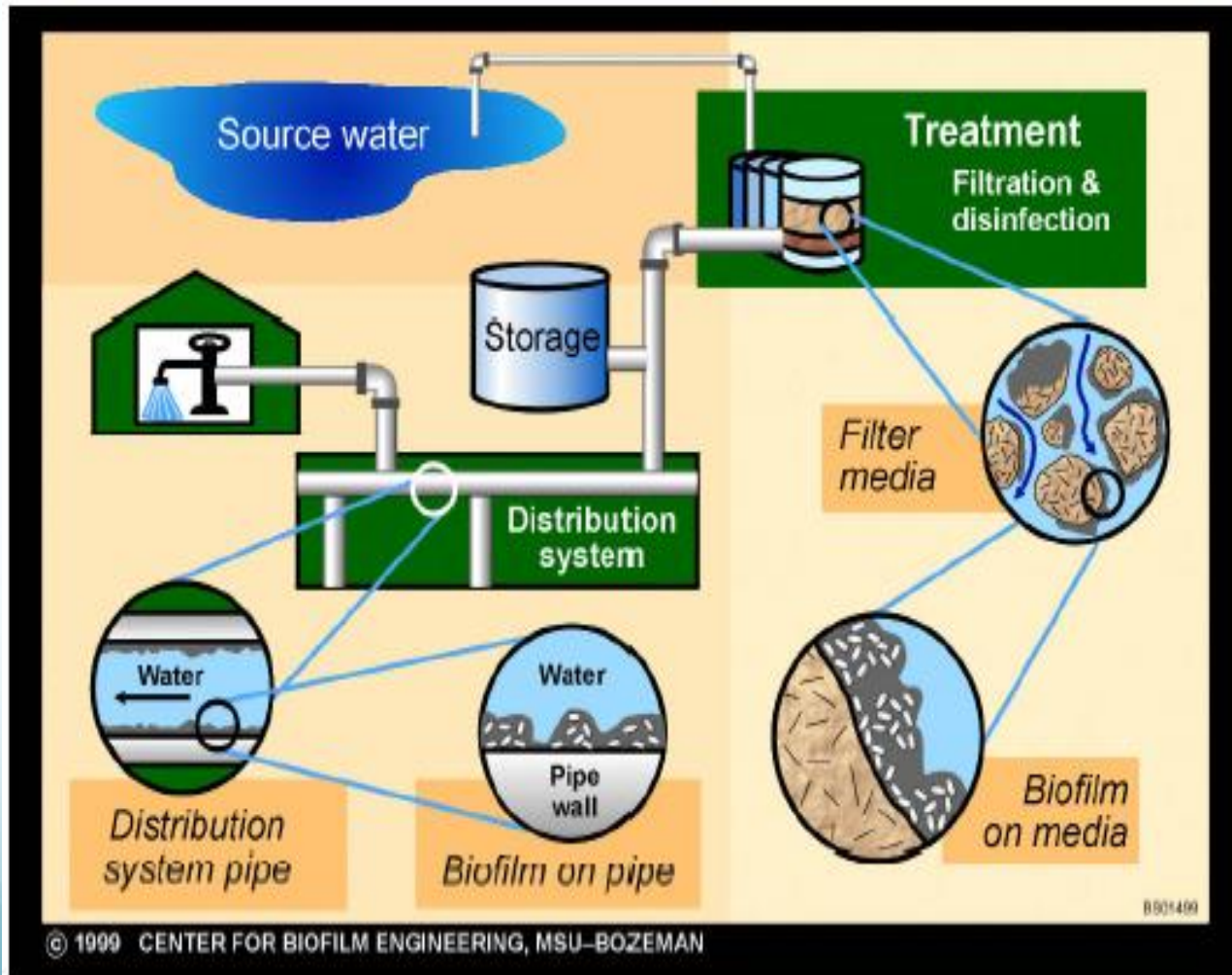
Etiology of 885 drinking water–associated outbreaks, by year — U.S. 1971–2012



Source: CDC

- **2011–2012**, 32 drinking water–associated outbreaks were reported
431 cases of illness, 102 hospitalizations, and 14 deaths
- ***Legionella*** was responsible for **66% of outbreaks** and **26% of illnesses**
- Most commonly identified deficiencies leading to drinking water–associated outbreaks were ***Legionella* in building plumbing systems (66%)** and **untreated groundwater (13%)**

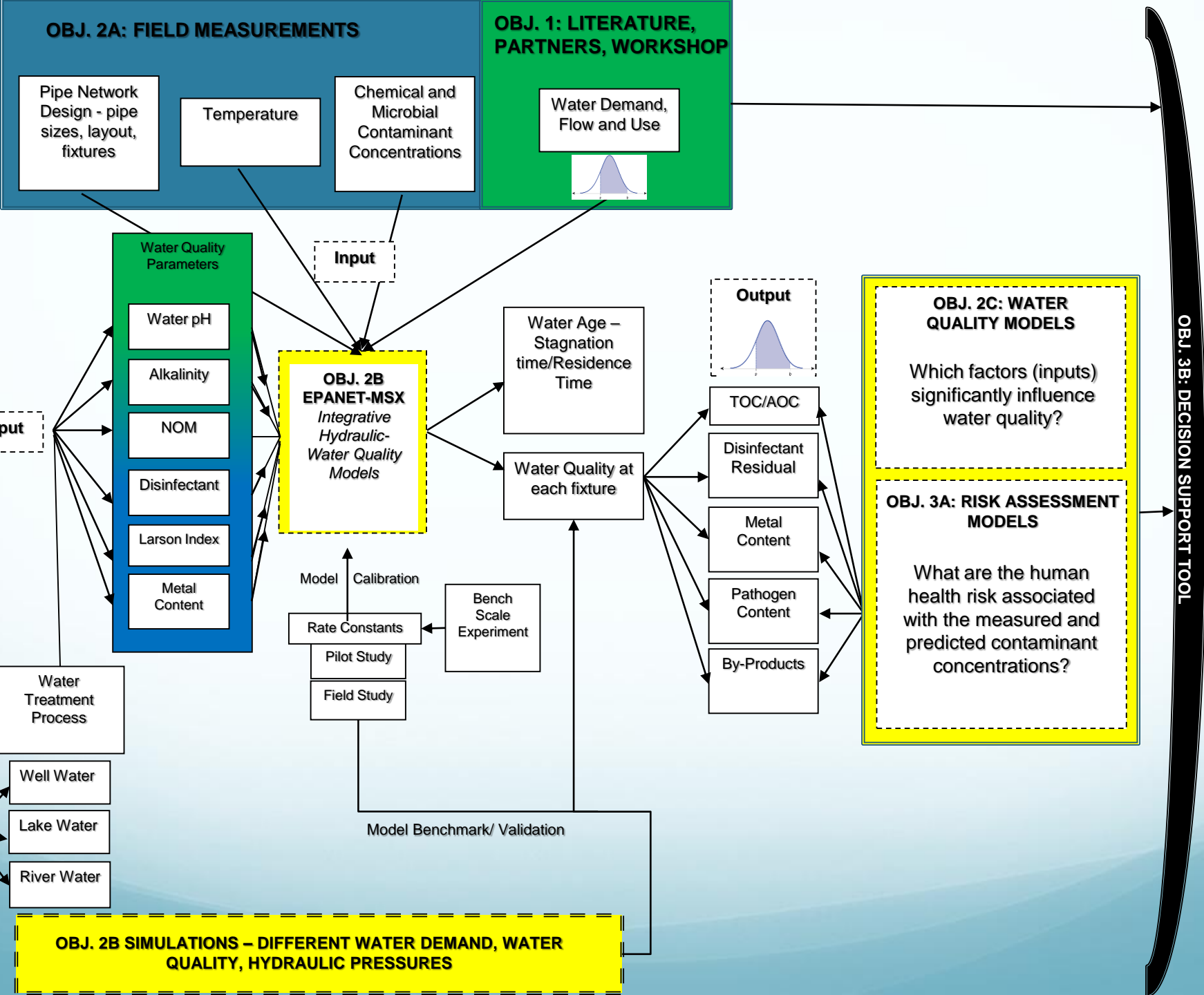
Biofilms are common in all pipes



Source: The Biofilms Hypertextbook;
http://biofilmbook.hypertextbookshop.com/public_version/contents/chapters/chapter001/section001/green/page001.html

Project Objectives

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.



Full-Scale Buildings



ReNEWW House,
Indiana

Efroymsen
Center, Indiana



MSU Chemistry Building,
Michigan



Avon Middle School, Indiana

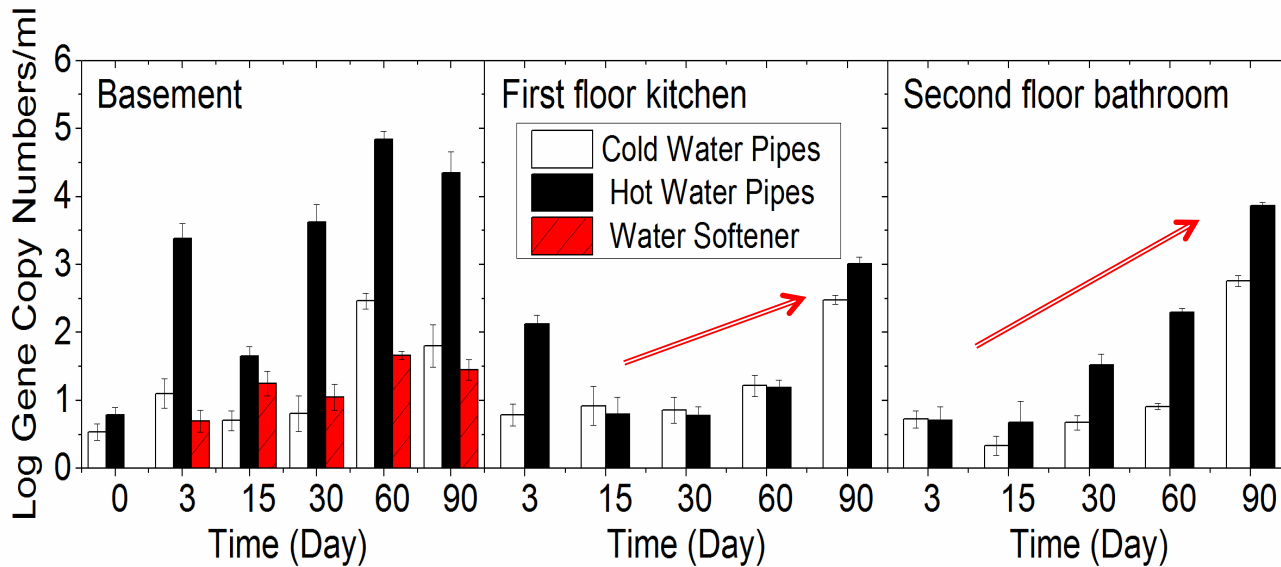
Legacy renovated office
building, 16 floors, Michigan

| December Water Use, Month 3 | | | | |
|-----------------------------|--|------------------|-----------------------------|-----------------------------|
| Water Sampling Location | Total Volume of Water Used, m ³ | Number of Events | Average Stagnation Time, hr | Maximum Stagnation Time, hr |
| Service Line | 5.2 | 3535 | 0.1 | 72 |
| Basement-Cold | 0.4 | 60 | 0.5 | 72 |
| Basement-Hot | 0.04 | 21 | 0.7 | 72 |
| 1st Floor-Cold | 0.3 | 619 | 0.6 | 72 |
| 1st Floor-Hot | 0.2 | 389 | 0.9 | 72 |
| 2nd Floor-Cold | 0.1 | 145 | 2.0 | 72 |
| 2nd Floor-Hot | 1.0 | 825 | 0.5 | 72 |

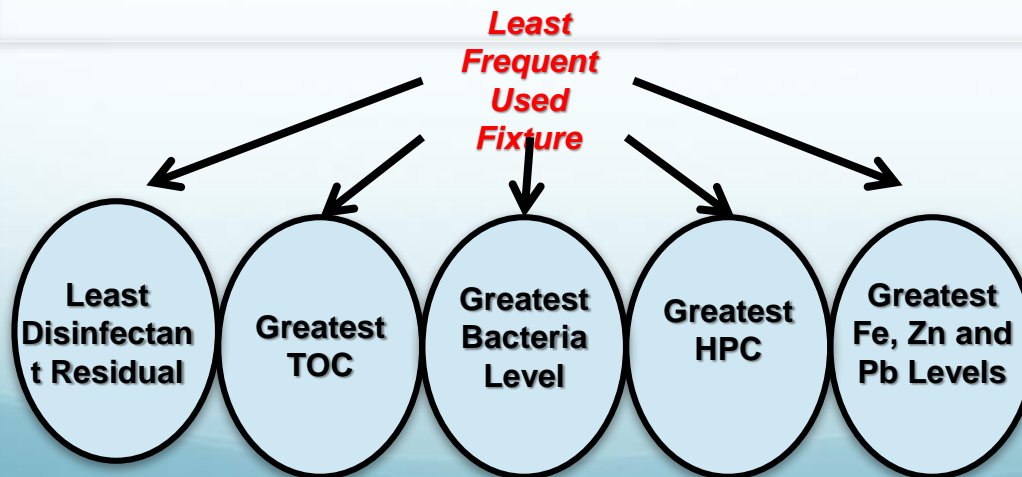
***Early Results:
We monitored
water use at 4
locations in a
new green
building
during a 3
month period
(Oct to Dec)***

Salehi et al. 2018.

During the same period, bacteria levels increased with time and bacteria were more numerous in hot water vs. cold water



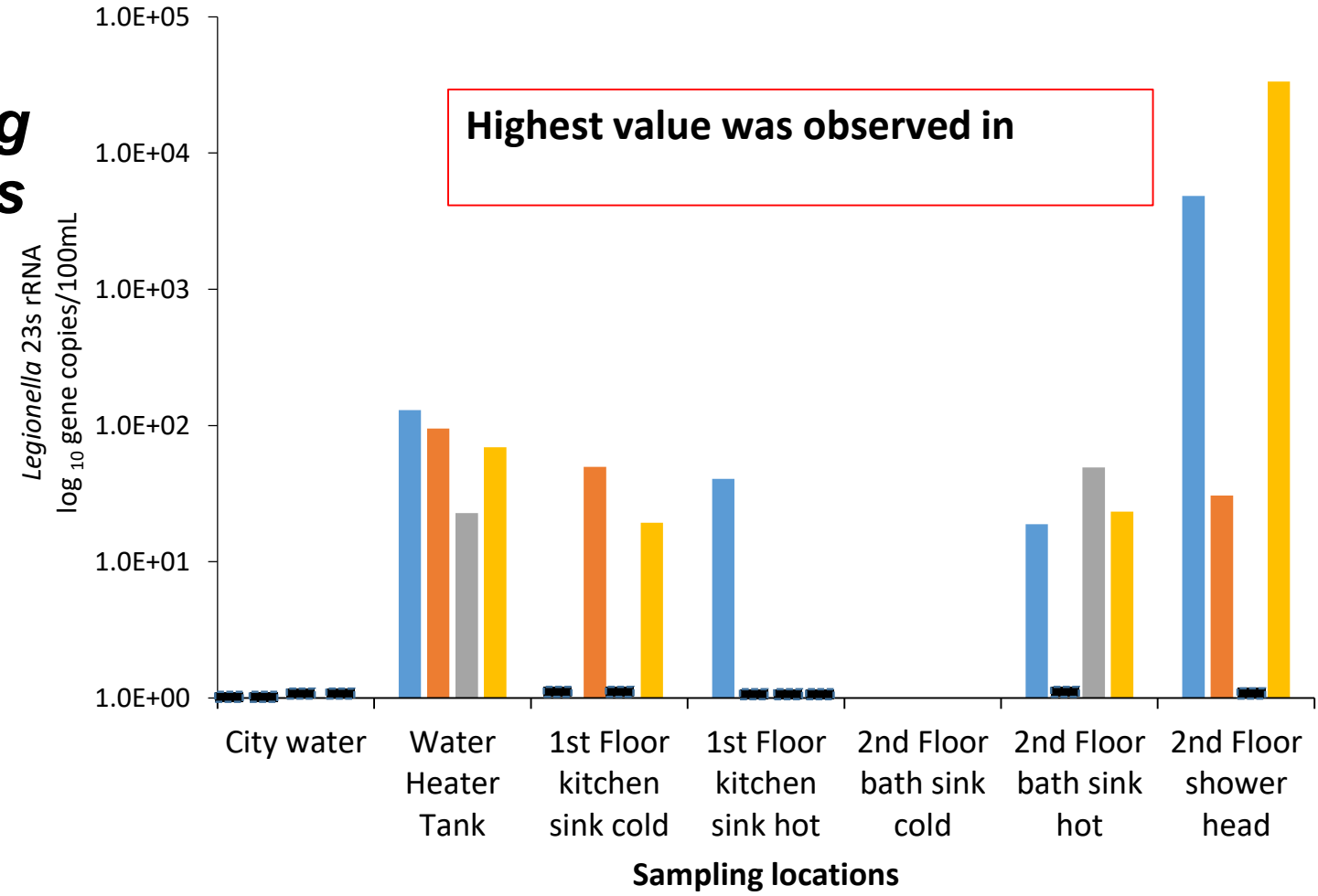
Both HPC levels & Gene Copy Numbers Increased at 1st & 2nd Floor



Salehi et al. 2018.

We're currently sampling the same building for pathogens

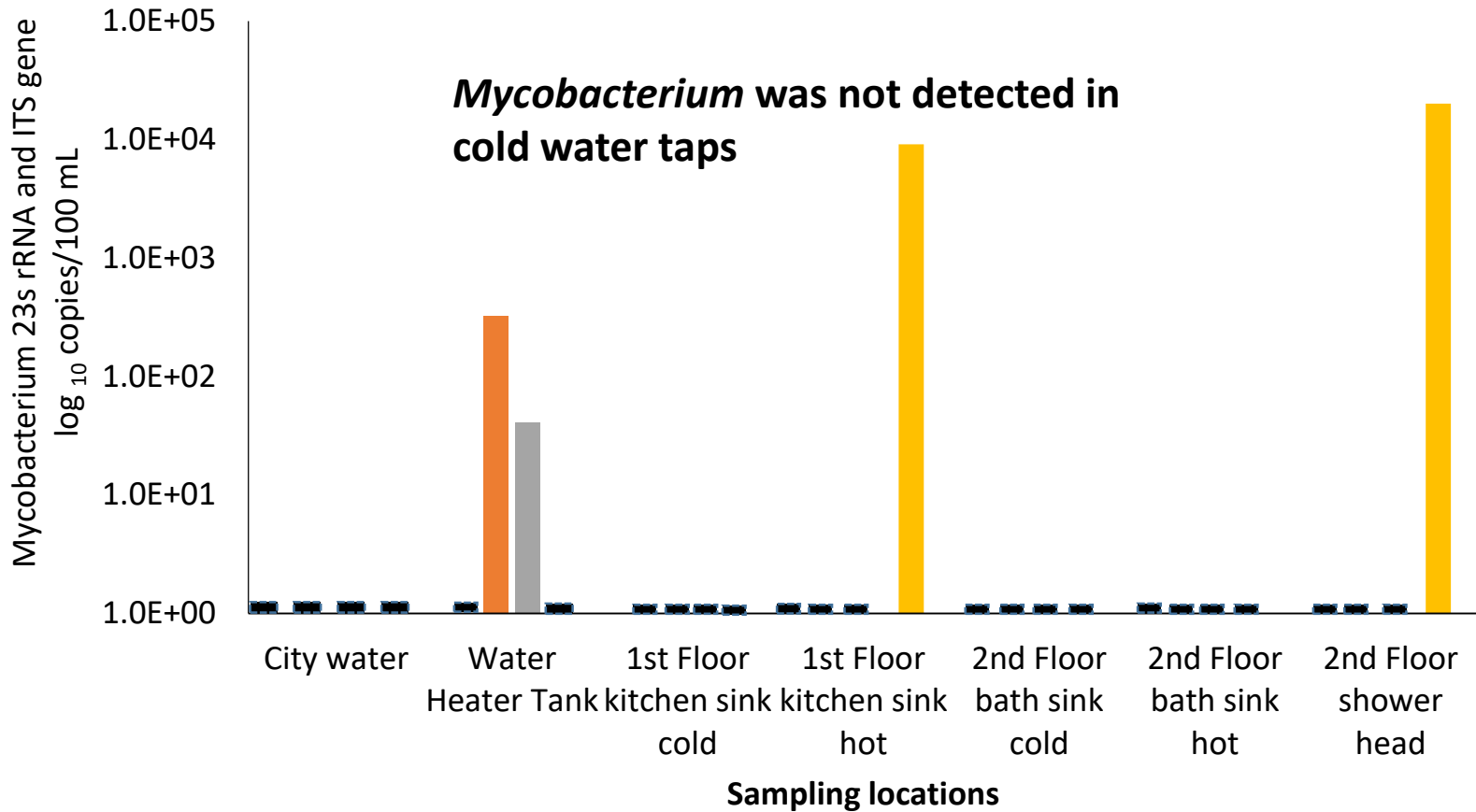
Legionella spp. log₁₀ gene copies/100 mL



- 10/10/2017
- 10/12/2017
- 10/14/2017
- 10/16/2017

█ Indicates values are below limit of detection of qPCR assay

Mycobacterium log₁₀ gene copies /100mL



- 10/10/2017
- 10/12/2017
- 10/14/2017
- 10/16/2017

■ Indicates Values are below limit of detection of qPCR assay

CDC *Legionella* Toolkit
- Provide guidance for developing, implementing and evaluating a *Legionella* water management program for your building



Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings

A PRACTICAL GUIDE TO IMPLEMENTING INDUSTRY STANDARDS



Top 10 Tips for Your Safety

1. Clean your aerators
2. Do not drink water from a shower
3. Do not drink hot water from a fixture
4. Water heater should be at least 120°F
5. Drain, flush-out your water heater
6. Flush unused faucets before use (i.e., guest bath, vacation)
7. Hotels, motels, hospitals? Flush taps before use
8. Determine what type of drinking water pipes are in your building
9. Do you have a lead pipe? Need a water filter
10. When told to flush for a certain time period ask how that time period was determined

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Thank You!

Acknowledgement:

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