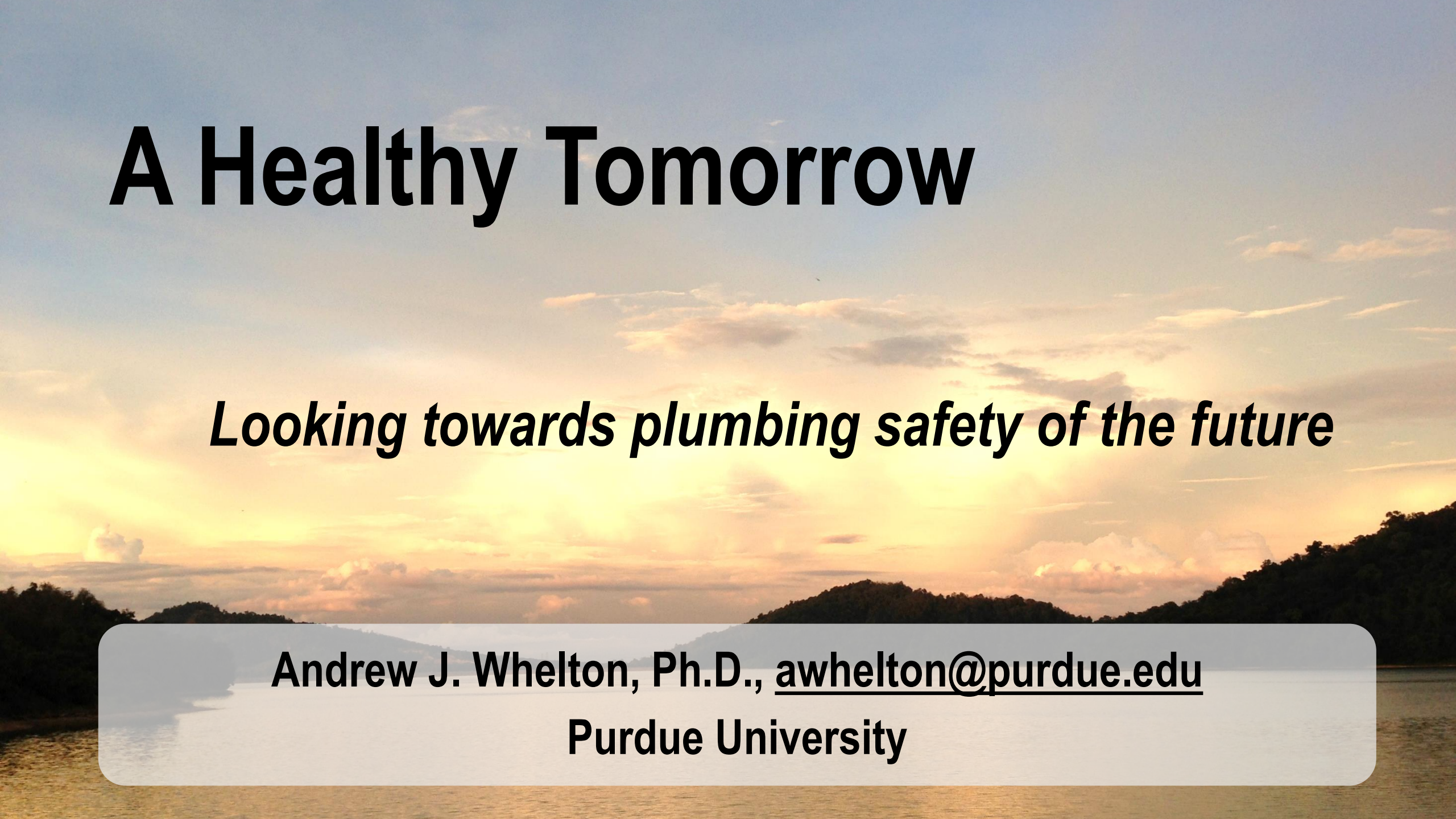


A Healthy Tomorrow

Looking towards plumbing safety of the future

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

Purdue University

Safe water is critical to life, economic prosperity, and security.

plumb·ing

['pləmiNG] **NOUN**

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

4000 to 3000 B.C. – Copper water pipes in buildings (India)

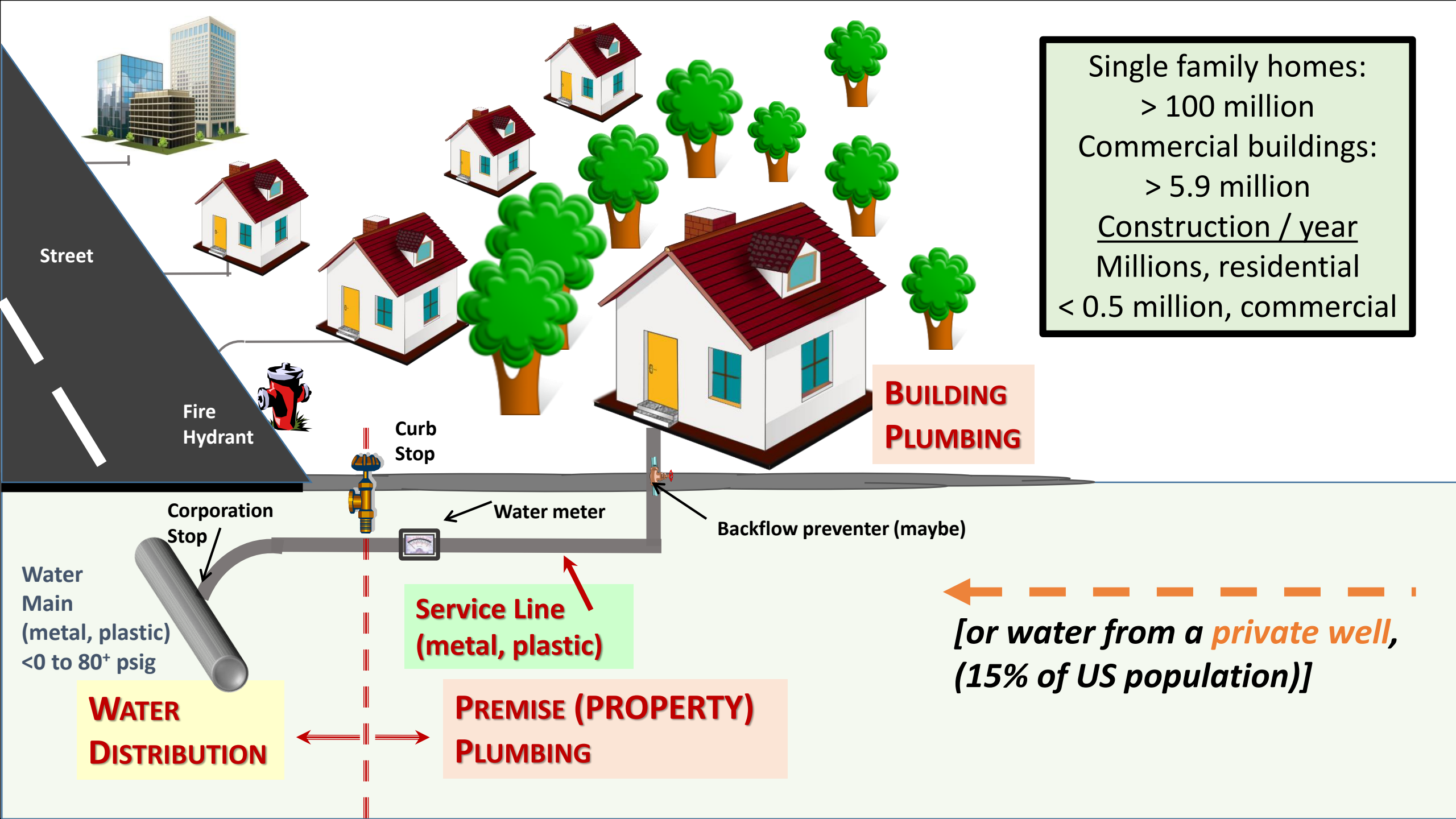
1500 B.C. – Rainwater cisterns (Greece)

500 B.C. to 250 A.D. – Lead and bronze pipes, marble fixtures, gold and silver fittings (Egypt)

1870s – First water heaters

1928 – First U.S. plumbing code

1966 – Copper shortage enabled plastics entry


Single family homes:
> 100 million
Commercial buildings:
> 5.9 million
Construction / year
Millions, residential
< 0.5 million, commercial
Street
Fire Hydrant
Curb Stop
Corporation Stop
Water meter
Backflow preventer (maybe)
BUILDING PLUMBING
Water Main (metal, plastic) <0 to 80+ psig
Service Line (metal, plastic)
WATER DISTRIBUTION
PREMISE (PROPERTY) PLUMBING
[or water from a private well, (15% of US population)]

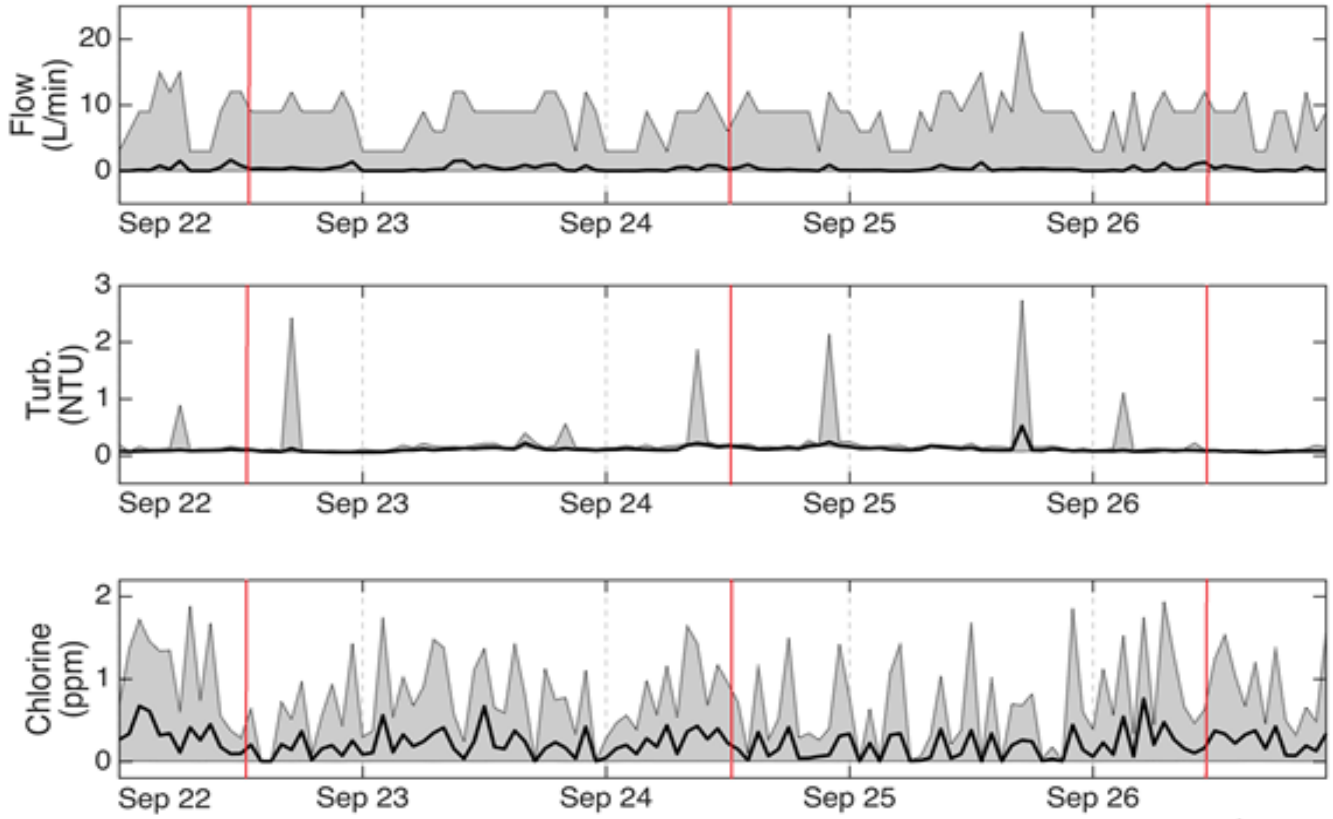
Today, we use a patchwork of sometimes disparate actions then –hope– water will not harm people

1. Plumbing design practices/codes do not directly link to fixture water safety
2. Occupancy permits are not linked to fixture water safety
3. Plumbing materials often not tested under actual use conditions
4. Except for 1, safety regulations stop at the water meter
5. Building certification systems do not link to fixture water safety

For example, we want to predict fixture water safety but…

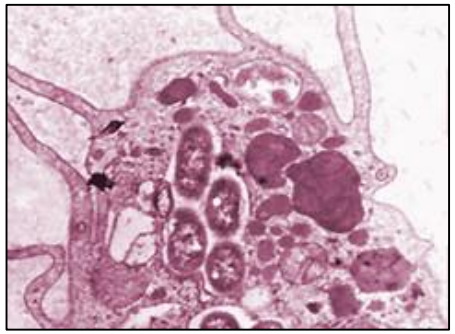
It's not widely known that water quality can vary drastically at the service line

i.e., No detectable disinfectant entered
…in summer 25% of the time
…in winter 6% of the time

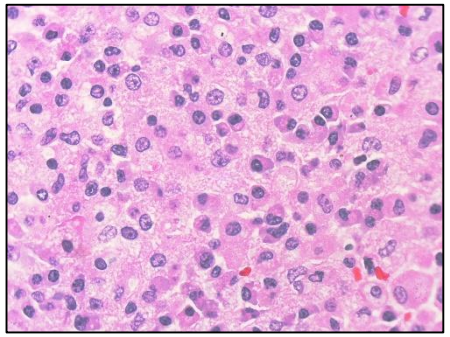


Shown: 5 day period, 1x/min, 24 hr/day
Water quality varied by season, time of day, and day of week

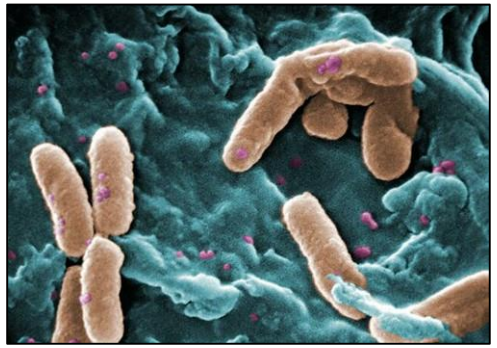
Salehi et al. (2019), https://www.doi.org/10.1016/j.buildenv.2019.106566



Legionella pneumophila



Mycobacterium avium complex



Pseudomonas aeruginosa

At a 7-yr old lead school
2-3 mg/L copper widespread

At a 10-yr old office building
1.3+ mg/L copper after 19 hrs

[Acute Exposure Limit: 1.3 mg/L]

PWS compliant with *Lead and Copper Rule*

Other metals
Other organisms
DBPs
Organics
Plastics















Disasters Expose a Critical Lack of Plumbing Knowledge: Federal, State, County agencies, and in Households

There are direct mental and physical health consequences on the population – More than 60% population reported anxiety, stress, or depression related to drinking water contamination (Camp Fire Community Survey, June 2019)

What's Needed

Basic understanding of plumbing design, use, materials, and aging

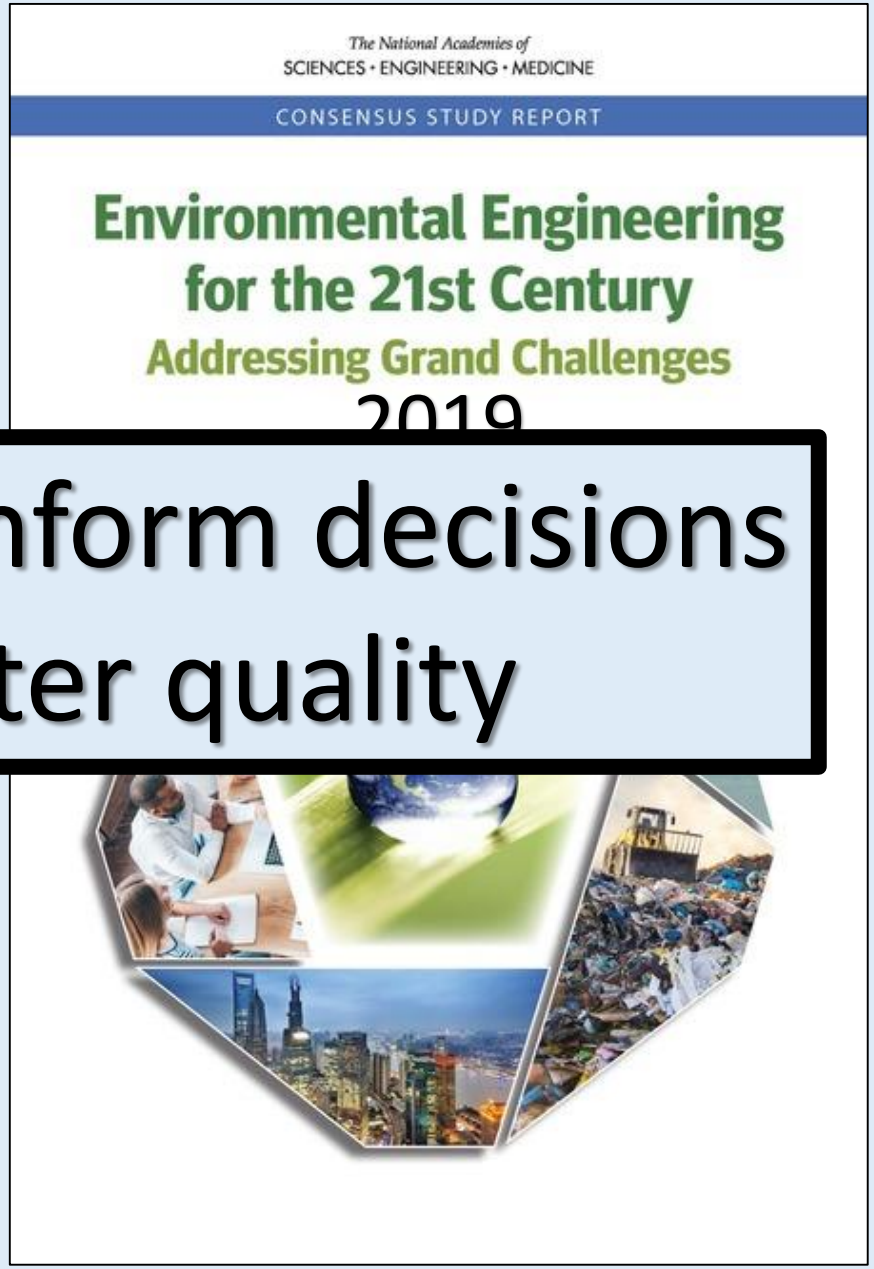
What products are in plumbing

How to use damaged plumbing post-disaster

How to test plumbing post-disaster

How to clean plumbing post-disaster

https://doi.org/10.1007/s11069-021-04714-9



We must use data to inform decisions

IWQ = indoor water quality

Technology of The Future

Voice activated fixtures
Artificially Intelligent systems
IWQ sensors
Refreshing fixtures
Communicative appliances
Integrated home intelligence
Greywater to landscaping
And more…

To make giant leaps, we must learn from the past.

Merriam-Webster

tap water noun

Definition of *tap water*

: water as it comes from a tap (as in a home)

Systems and technology education

Plastics, plastics, plastics

Systems, systems, systems

20 to 50 years from now… today's building plumbing will still exist.

- Test, test, test, even Franken-plumbed buildings

Support studies for evidence-based public health decisions and integrating technology

Embrace partnerships to innovate technologies

We must seek out new knowledge and develop predictive water safety models – for the faucet

4 Seasons (Summer, Fall, Winter, Spring)	2 Systems (Hot, Cold)
4 Service Line Length (1' (As is), 25', 50', 100')	2 Free Chlorine at service line (As is, 2x)
2 Pressure boundary conditions (35/40psig (As is cold/hot), 80psig)	4 Conservation Scenarios (25%, 50%, 100%(As Is), 200%)

Manhattan College

Purdue University

Michigan State University

Funded by:

We need to be able to predict water quality at the fixture

↑ Service line **length** 1 ft → 50 ft, **Legionella spp.** GCN / L increased up to 1,000,000.

↑ Service line **length** 1 ft → 50 ft **Copper** concentration increased up to **4x**.

↑ **Pressure** from 35 psig → 80 psig, **Legionella spp**. GCN / L decreased up to 10,000x.

↑ **Pressure** from 35 psig → 80 psig, **Copper** concentration decreased up to 15x.

↓ **Water use** to 25% of normal condition, **HPC** levels increased 100x.

Courtesy of Prof. Juneseok Lee, Maria Palmegiani, and others ….

Adopt and embrace field-validated, transformative technologies

Utility service line low cost sensors – product quality (delivery chain)

Plumbing sensors for intelligent buildings

Fixture refreshing technologies

Apply transparent and evidence-based technology premarket performance verification testing

Encourage adoption and follow-up monitoring

The U.S. Safe Buildings Act

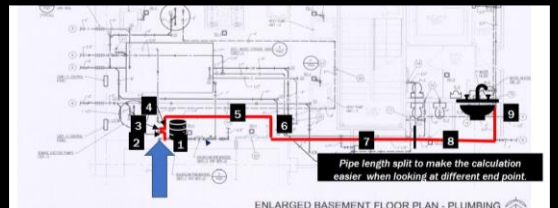
Require building water system public health risk be minimized through design, construction, maintenance, and operation.

1. Designate roles and responsibilities for local/state public health departments and PWS primacy agencies; Designate a NRF building water lead
2. Require water testing of new buildings (with stagnation) for occupancy permits
3. Require new commercial buildings establish WMPs [flush plan, testing]
4. Provide tax credits for the adoption of in-building water quality sensor technologies
5. CDC, EPA, and Partners examine material testing standards and policies
6. NIST and Partners develop science-based measurement standards with a focus on water quality/materials/plumbing use
7. Support solutions for plumbing contamination response/recovery decisions

NEW: Building Water Essentials
10 Hour, Online Short-Course







Input from practicing engineers, scientists, utilities and public health officials.

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

Modules do not have to be taken in sequence.




If interested e-mail EngrOnline@purdue.edu

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

PurdueX: Massive Open Online Course (MOOC)

Plastics in Infrastructure and the Environment

May 17, 2021 - July 11, 2021
Online 8 week course
6-8 hours/week
FREE

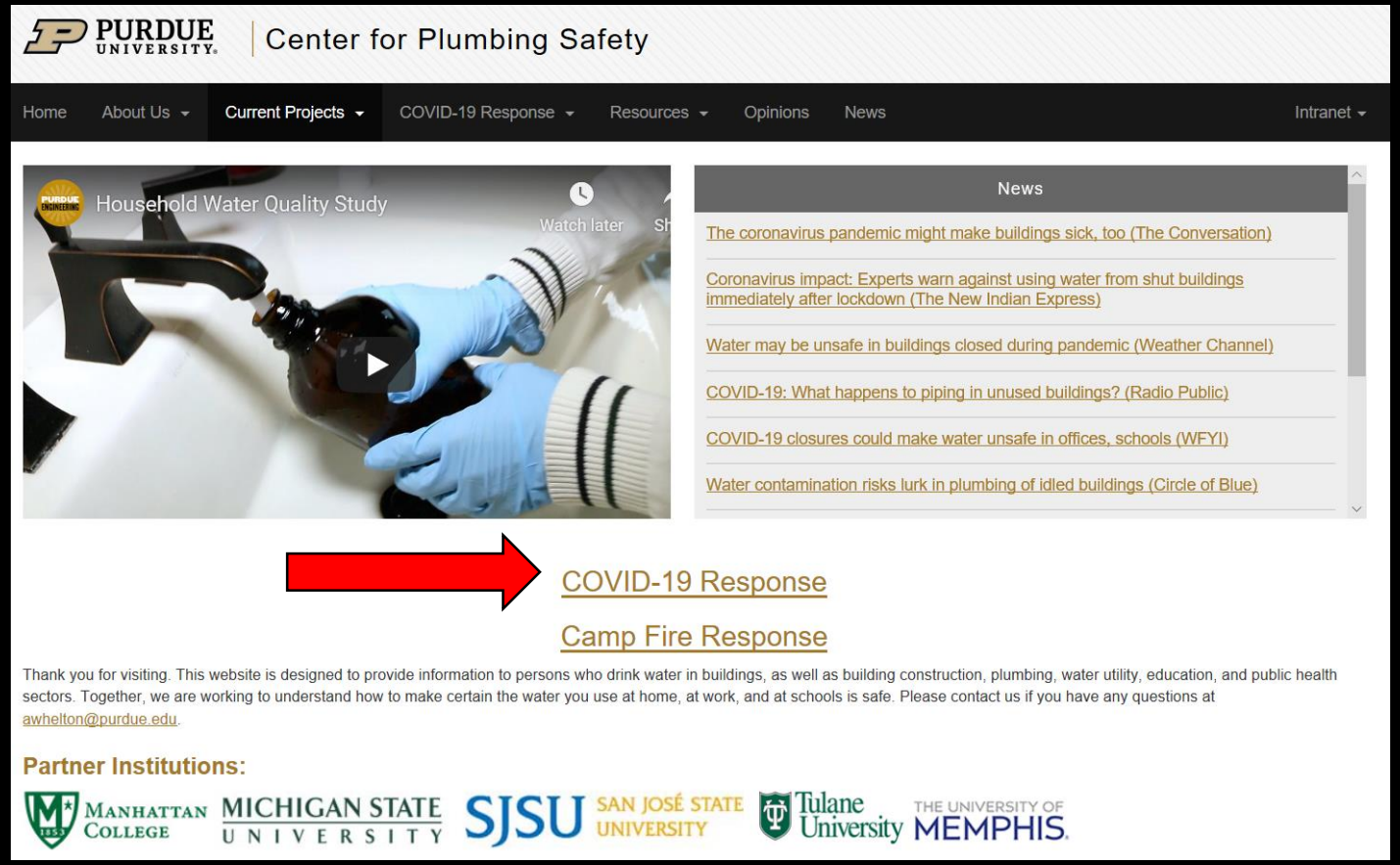
Learning Objectives

- Explain the properties of polymer materials.
- Recognize the performance differences between polymeric materials.
- Describe the advantages and disadvantages of polymers for engineering applications.

More info and enroll: https://www.edx.org/course/plastics-in-infrastructure-and-the-environment

Many Science, Engineering, Public Health, and Architecture Professionals have and Continue to Work on this…. & more…

www.PlumbingSafety.org



A Resource for All

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

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