

# Alaska Water Sewer Challenge – Phase 3

## *Team University of Alaska Anchorage*

### Presenter

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Associate Professor

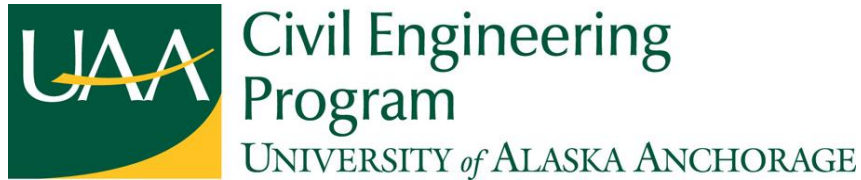
Water Innovations for Health Arctic Homes

September 18-22, 2016



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# Our Team



# Our Communities

**Kipnuk, AK**

Population: 639 (2010)

**Koyukuk, AK**

Population: 95 (2014)



# Team and Community Design Features

## **Community Features**

- Real (durable) toilet
- Minimal home modification
- Assured quality/safety
- Choice in fixtures

## **Team**

- Physical / Chemical Treatment Processes ONLY
- Minimize chemical usage
- A treatment goal of 85% water recovery

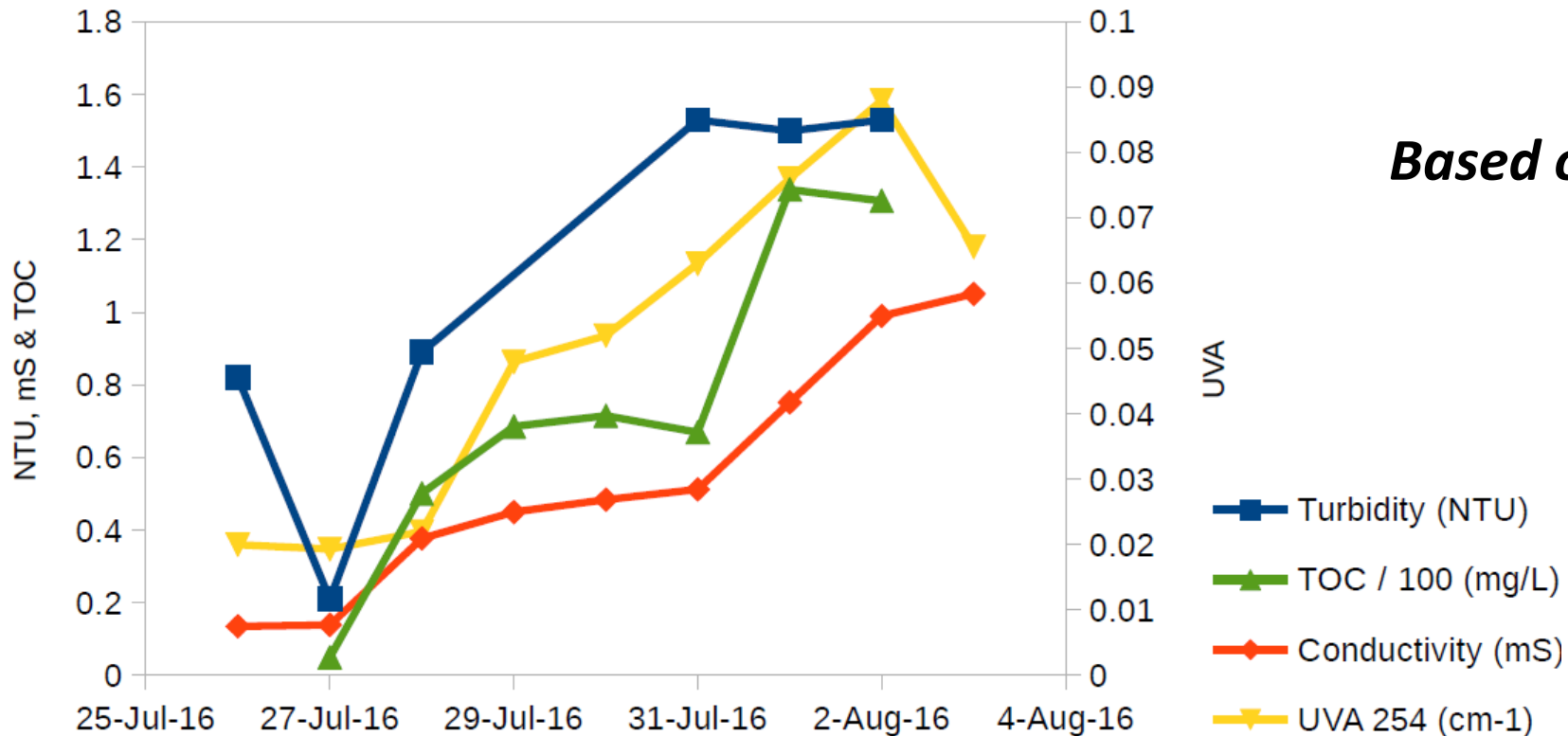
# Design Evolution during this Phase

***Our focus on effectiveness has required design changes***

1. Acceptable water quality (human contact & premise plumbing)
2. Acceptable cost and effort of operation
3. Passes challenge tests of the State and our Team

# Design Evolution during this Phase

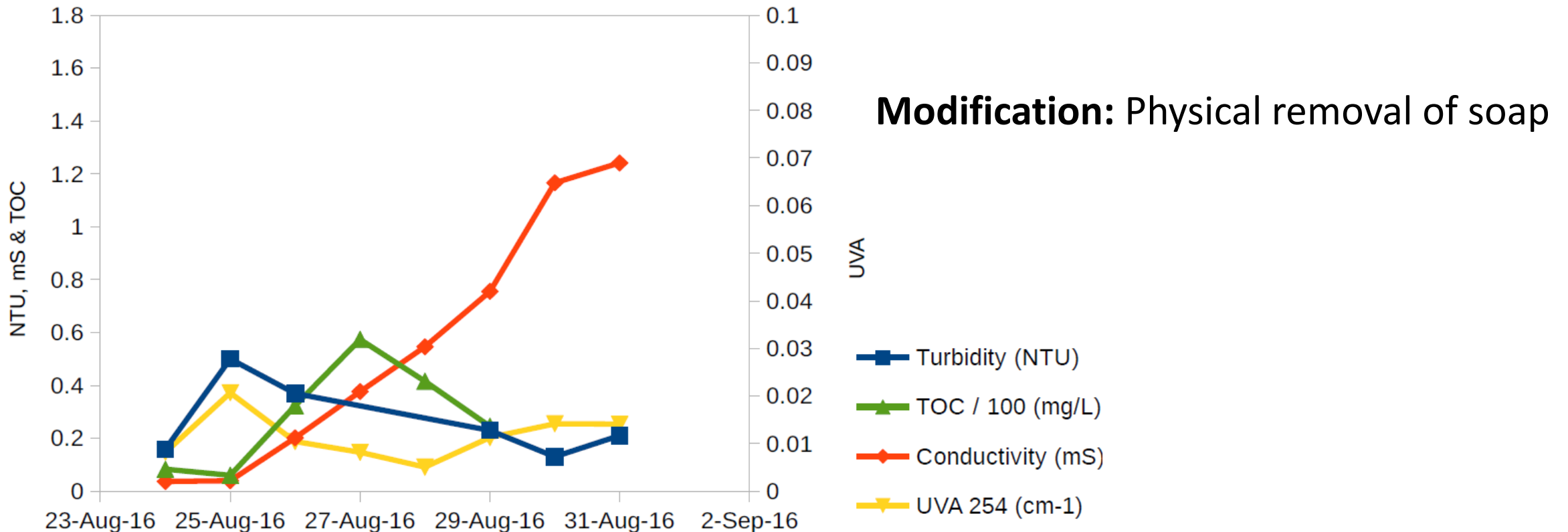
To date – based on improving water quality



***Based on design after Phase II***

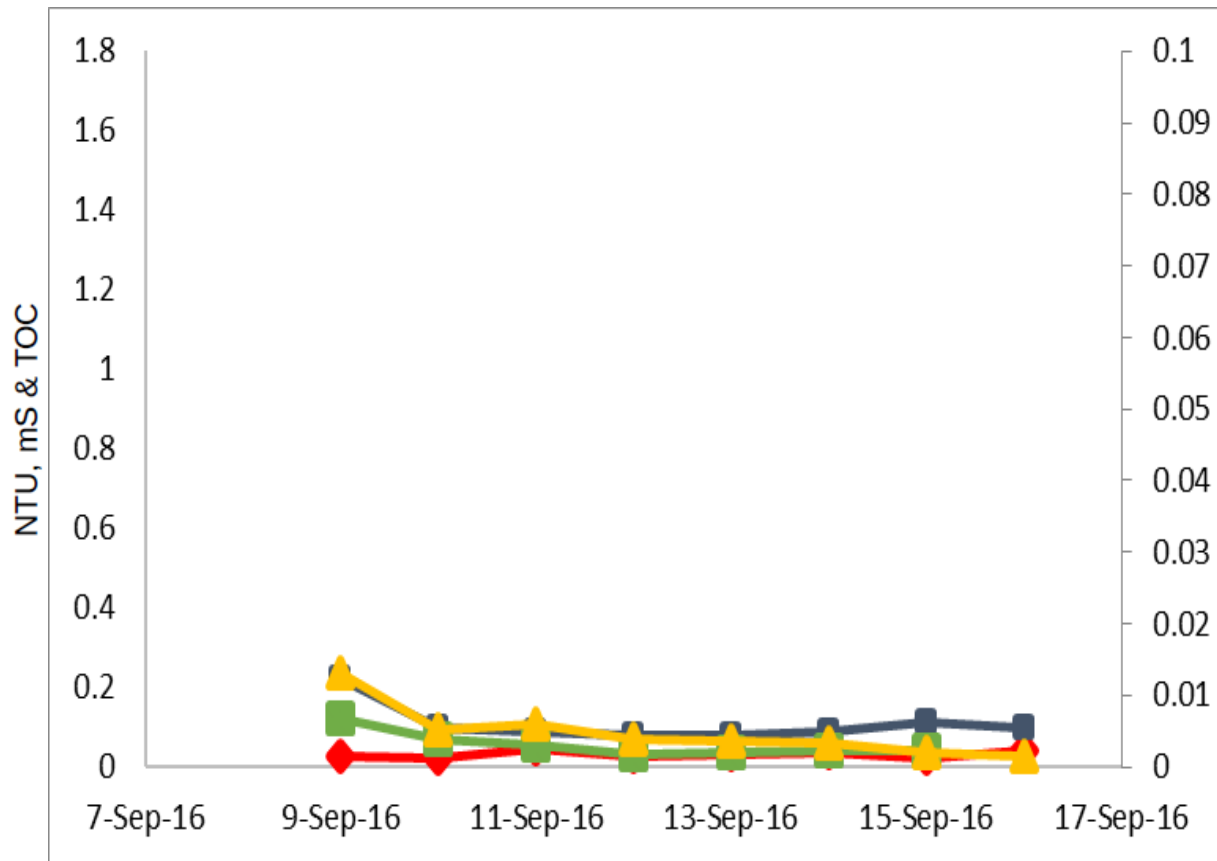
# Design Evolution during this Phase

To date – based on improving water quality

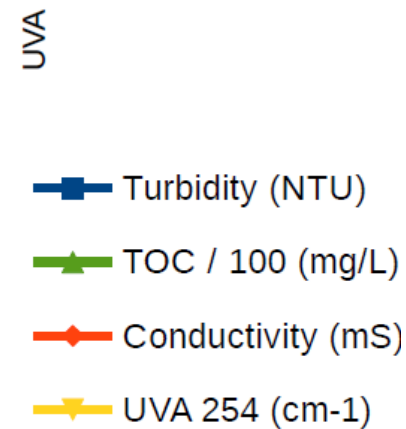


# Design Evolution during this Phase

To date – based on improving water quality



**Modification:** Stopped urine recycle  
2 step treatment for all reuse

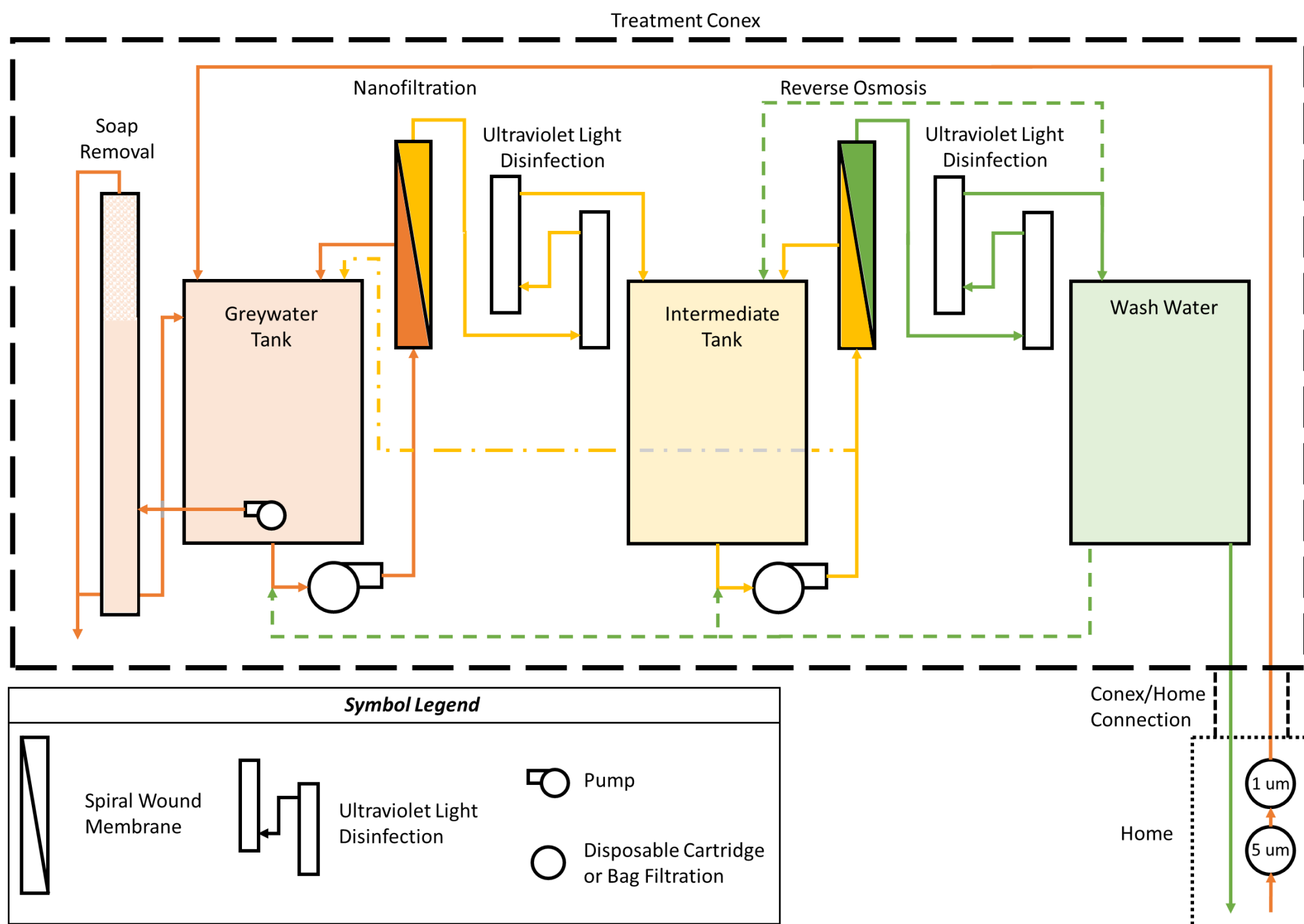




# How do we achieve the quality?

Through treatment in our treatment context





Wastewater

Adding

Useful Water

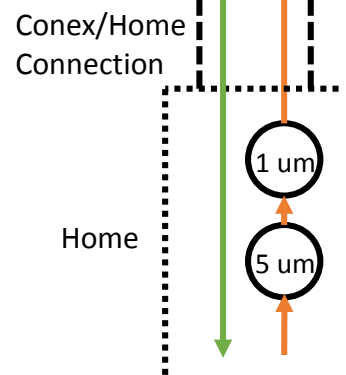
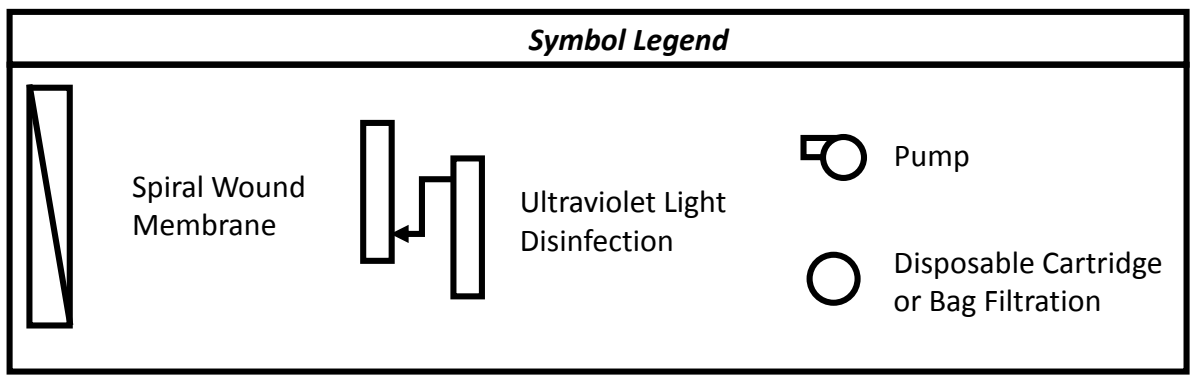
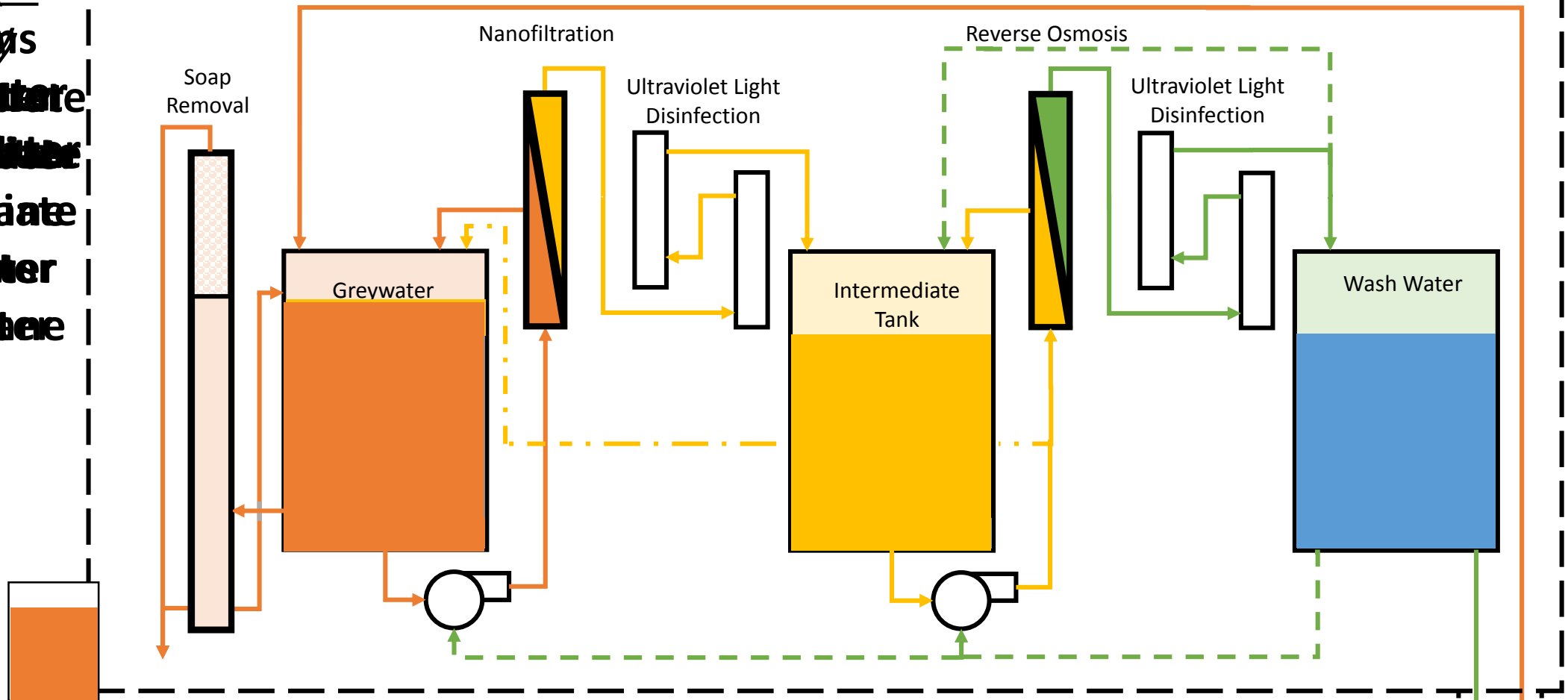
Return Water

Reverse

Heat & Greywater

Rinse Water

Treatment Conex



# Treatment System Water Balance

- Goal is to achieve at least 85% recovery from our membranes
  - 20 gallons removed weekly
    - 19 gallons membrane concentrate
    - 1 gallon bubble concentrate
  - 20 gallons of source water added to replace weekly
- Reuse Factors
  - 20x reuse with dry toilet (8 weeks to replace entire water volume)!
  - 8x reuse with flush separating toilet (3 weeks to replace entire water volume)!



# Where does the water come from?



**Rain Water**



**Surface Water**



**Treated Water**

# Treatment Cost and Effort

**Assumptions:** 6 month cleaning cycle maintenance interventions

3 year membrane and UV lamp replacements

Water Source	Paid Haul	Weekly Water In	Weekly Waste Out	Monthly Usage Cost
Washeteria	Yes	20	20	\$ 59.70
Washeteria	No	20	20	\$ 21.50
Rain/Surface	Yes	20	20	\$ 33.50
Rain/Surface	No	20	20	\$ 13.50

# Upcoming Modifications

- Enhance Bubble Removal
  - Add recirculating filter
  - Upgrade to industrial components
- Purpose of Modification
  - Increase time between membrane cleanings (i.e. maintenance effort)
  - Reduce rate of membrane pressure rise (i.e. reduce operating cost)



How is this system connected to my home?

What about the drinking water and my toilet?

**Drinking Water  
System**

**Kitchen Sink**

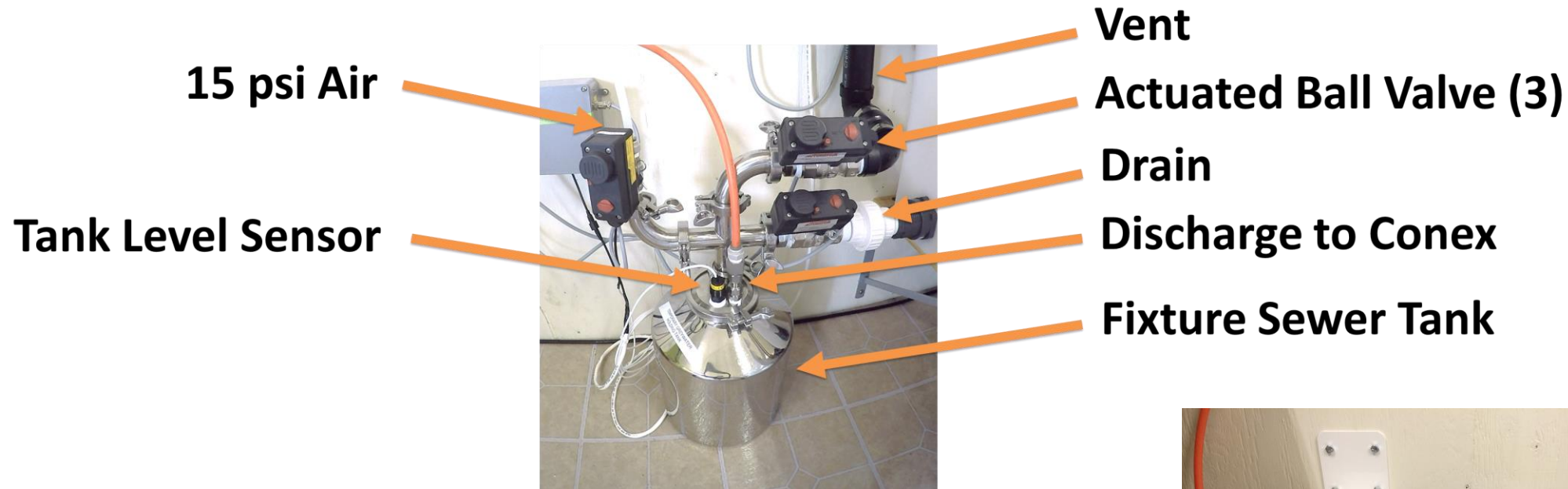
**Washer/Dryer**

**Bathroom  
Sink**

**Shower**



# Fixture Associated Air-Driven Sewer



5 um bag filter

1 um cartridge filter



# Fixture Associated Small Pump Water



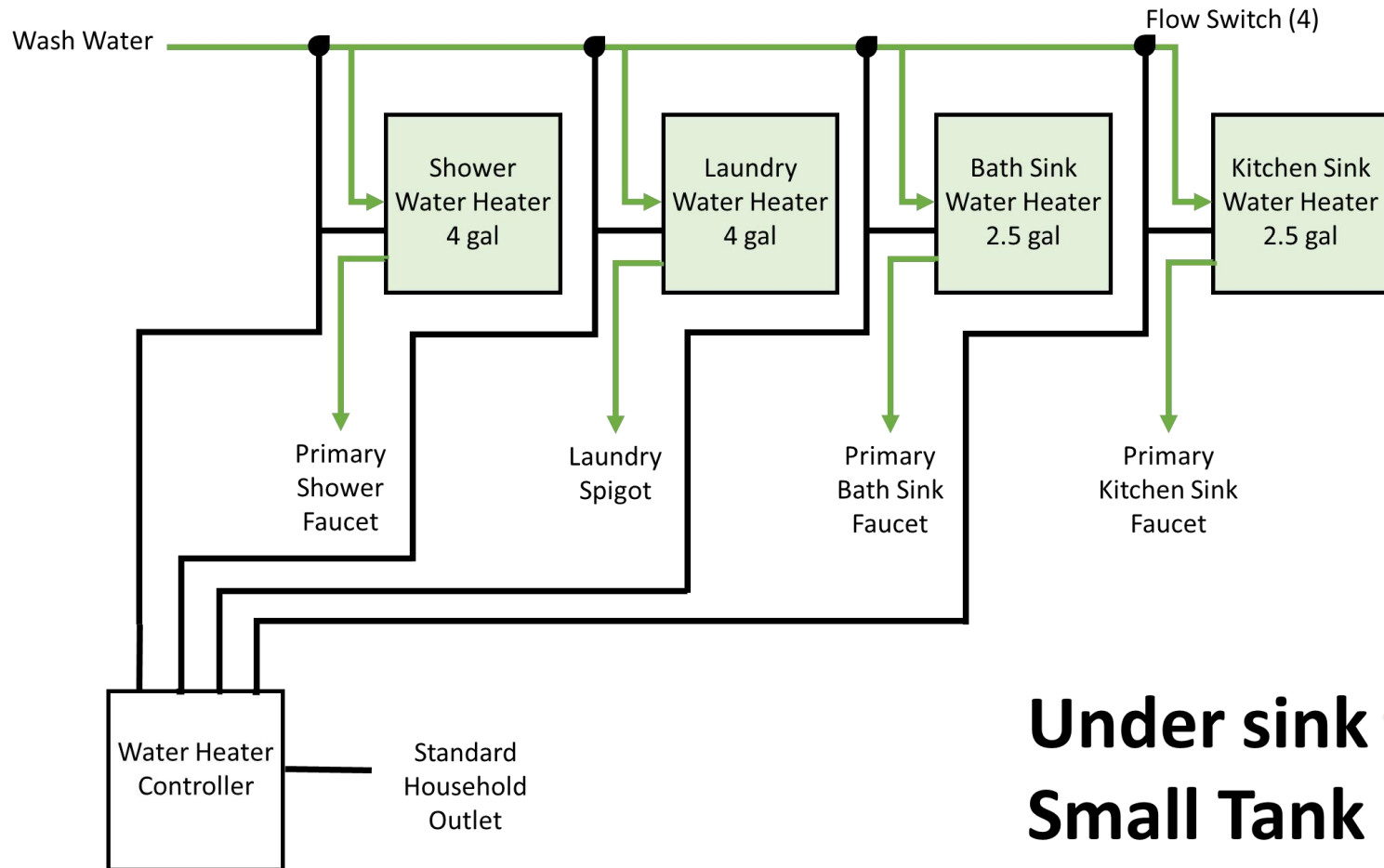
**1 pump per fixture**

**12 V DC**

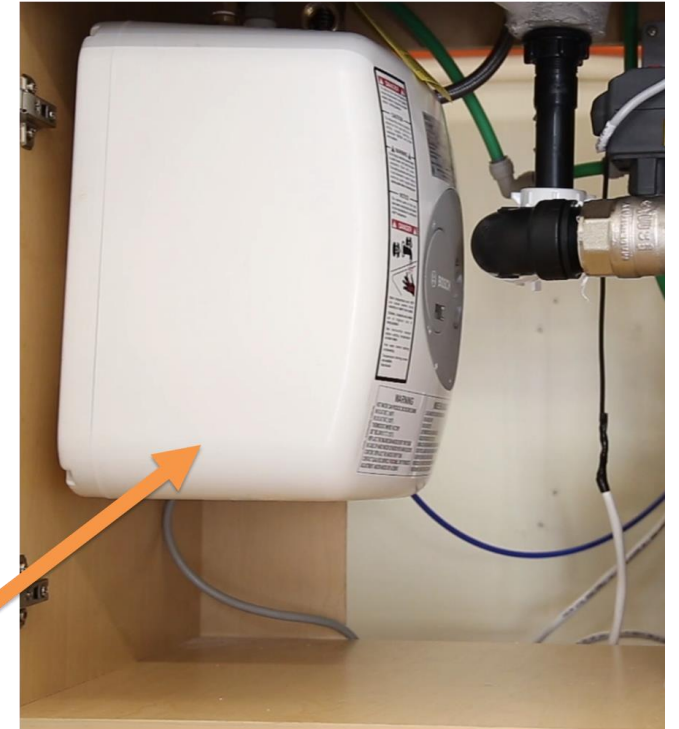
**1.1 gal per min**



# Fixture Associated Small Tank Water Heating



**Under sink  
Small Tank  
Water Heater**



# Drinking Water System



**Drinking Water Faucets**



**Drinking  
Water Tank**

**UV  
Disinfection**

**1um Filter**



# Porcelain Separating Toilet – Small Tank Haul



**Urine Drain  
to Full Flush Tank**

## ***Dual Flush System***

**0.7 gallons/full flush**

**0.1 gallons/urine flush**



***Toilet Selection  
Is largest cost driver!***



**Gravity Full  
Flush Tank**

## Capital Costs – Not paid by Homeowner

Category	Low	High
Materials & Construction Labor	\$80,000	\$100,000
Shipping & Location at Home	\$5,000	\$10,000
State Oversight Fee	\$40,000	\$50,000
Total Estimate	\$125,000	\$160,000

## Capital Costs – Paid by Homeowner

- washer & dryer



# Monthly Water/Sewer Operating Costs Paid by Homeowner

Water Source	Paid Haul	Monthly Cost
Washeteria	Yes	\$ 170.40
Washeteria	No	\$ 97.90
Rain/Surface Water	Yes	\$ 141.50
Rain/Surface Water	No	\$ 60.50

*All costs include \$40/month Co-op fee.  
UV lamps and membrane replacement included  
General maintenance covered by Co-op fee.*

## Other Monthly Operating Costs based on Usage Paid by Homeowner

Component	kWh/day	Cost
Condensing Washer/Dryer Combo	1	\$ 6.90
Small Volume Electric Point-of-Use Water Heaters	1	\$ 15.20

*Appliance choice may have significant effect on  
water usage also and must be considered.*

# We appreciate your interest in our progress!



open source  
hardware

*Code and Design Plans*  
<http://www.github.com/dotsonlab>

*Blog*  
<http://www.reusewaterak.com>

*Facebook*  
<http://www.facebook.com/reusewaterak>

*Human Contact*

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open source

**\*\* Sign up for Tuesday's System Tour \*\***