Water Reuse Track

Adventure Room - April 20th, 2016

Alaska Water and Wastewater Management Association

Why this track is important

- *Alaska is **<u>leading</u>** the way to a new form of water reuse*

- *This is not a challenge to be **<u>won</u>** but a challenge to be **<u>overcome</u>** together*

This Track's Agenda

Wednesday, April 20		*Title*	Speaker
8:00	9:00	Reuse Regulations and Challenge of Regulating On-site Systems	Guy Carpenter
9:00	10:00	Applying Premise Plumbing and Small Systems Knowledge to Household Reuse	Chad Seidel
10:00	10:30	***Coffee Break***	
10:30	11:30	Alaskan Situation & Regulatory/Code Reuse Framework & Panel Discussion	Bill Griffith & Moderator (TBA)
11:30	13:00	Lunch (Keynote - Guy Carpenter - Trends in National Water Reuse)	
13:00	14:00	Design Sharing - CDM Smith/DOWL & Summit Consulting	Chris Schulz (CDM) & Parke Ruesch (Summit)
14:00	15:00	Design Sharing - UAA and YKHC	Aaron Dotson (UAA) & Brian Lefferts (YKHC)
15:00	15:30	***Coffee Break***	
15:30	16:30	Panel Discussion - Open Technology Discussion - Challenge/Sucesses/ Projections	Moderator (TBA)
16:30	17:30	How to talk about water & panel discussion	Guy Carpenter & Moderator (TBA)

Reuse Regulations and Challenge of Regulating On-site Systems

Guy Carpenter, PE
Vice President
Carollo Engineers

There is not a national regulation for Water Reuse

Graphic credit: www.healthywaterways.org

- In the gap between CWA and SDWA
- All water is recycled
  - De facto
  - Intentional
- Regulations tend to be for centralized systems

Traditional centralized types of Water Reuse

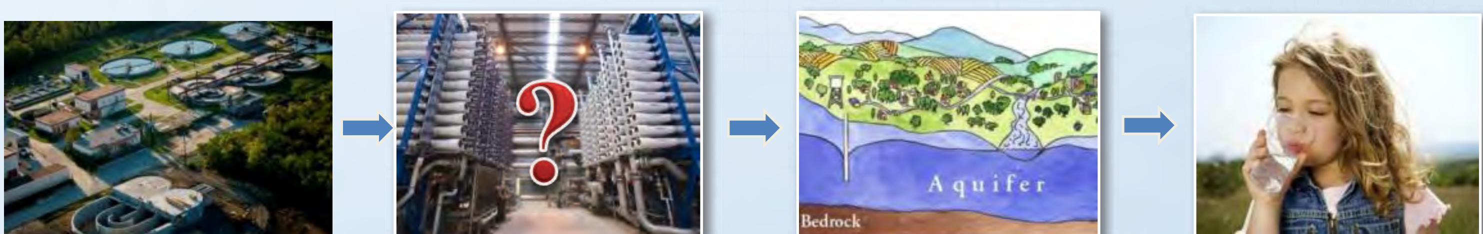
Non-Potable Reuse (NPR) or
"Direct Reuse" (Purple Pipe)

"De Facto"
Potable Reuse

Traditional centralized types of Water Reuse

Non-Potable Reuse (NPR) or
"Direct Reuse" (Purple Pipe)

Indirect Potable Reuse - Surface Water Augmentation



Indirect Potable Reuse - Groundwater Recharge

Direct Potable Reuse

Reuse Regulations Driven by Local Water Rights and Water Quality Rules

- Prior Appropriation
- Riparian Rights
- Case Law
- Management of Aquifers (Quality & Quantity)
- Potable Reuse Regulations Based on SDWA Risks
  - No greater than 1 per 10,000 persons exposed annually
  - 70 kg person drinking 2 liters/day

Drivers Toward Decentralized Water Management

Operational Technology and Information Technology

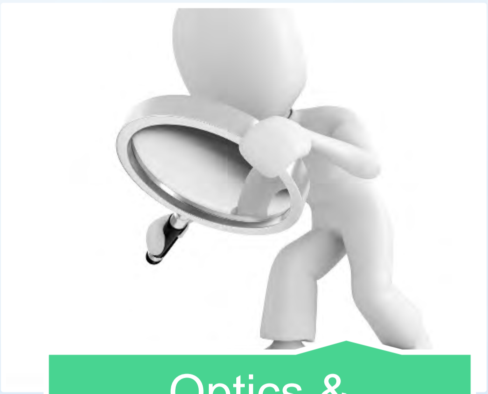
Automation and Computing Capacity

Locally Available and Controllable

Holistic Pollution Prevention

Impediments to Decentralized Water Management

Regulatory Framework



Optics & Perception

A&E Capacity

Profitability

Qualified Operators

Decentralized Reuse is Gaining Ground Nationwide

- Greywater Ordinances
- Non-Potable Water Ordinances (SFPUC)
- NSF 350 and 350-1: Onsite Residential and Commercial Reuse Systems
- But, no Greywater to Potable Water
- Biggest challenge for potable is assurance of water quality

Status of Greywater Regulations

Table 4.1. State Analysis of Graywater/Wastewater Regulations

States without Formal Graywater Regulations			States Allowing Graywater Reuse		
States allowing wastewater reclamation that define graywater as wastewater (4.1.1)	**States not defining graywater (4.1.2.1)**	**States treating graywater as septic (4.1.2.2)**	**States permitting graywater using a tiered approach (4.2.1)**	**States regulating graywater reuse without a tiered approach (4.2.2)**	**States allowing residential irrigation only (4.2.3)**
Alabama	Illinois	Connecticut	Arizona	Florida	Hawaii
Alaska	Kansas	Kentucky	California	Georgia	Idaho
Arkansas	North Dakota	Maryland	New Mexico	Montana	Maine
Colorado	Ohio	Michigan	Oregon	Massachusetts	Nevada
Delaware	South Carolina	Minnesota	Washington	North Carolina	
Indiana	Tennessee	Nebraska		South Dakota	
Iowa		New Hampshire		Texas	
Louisiana		New Jersey		Utah	
Mississippi		New York		Virginia	
Missouri		West Virginia		Wisconsin	
Oklahoma				Wyoming	
Pennsylvania					
Rhode Island					
Vermont					

Table from "Treatment, Public Health, and Regulatory Issues Associated with Greywater Reuse. *Guidance Document*. By Sybil Sharvelle et. al. for WERF

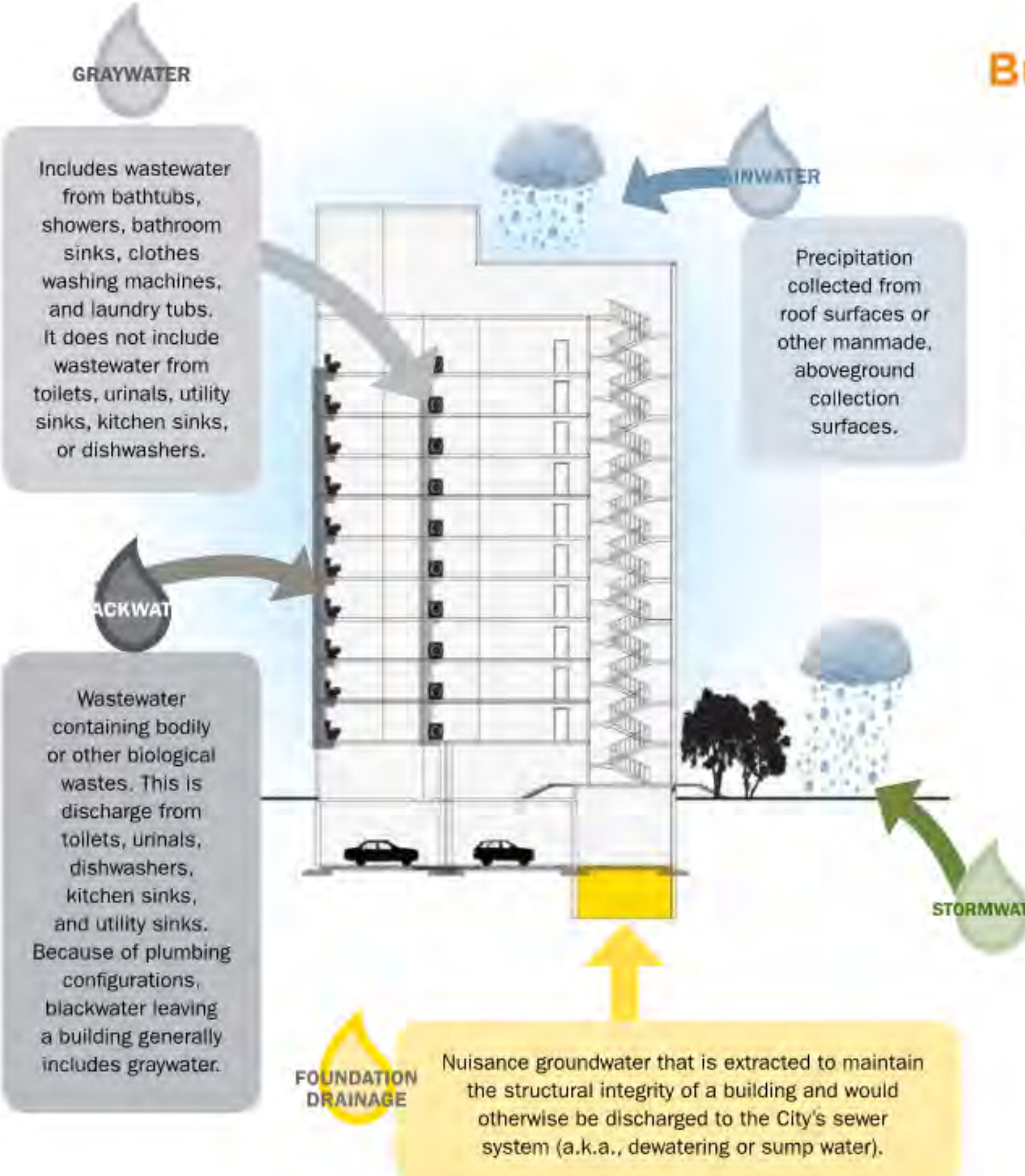
SFPUC Non-Potable Water Ordinance

- Developed in context of watershed management
- On-site vs. centralized capacity
- Integrated across departments
- Supported by Guidance Manual
- Clear, concise on-line information
- Mandated implementation for all buildings 250,000 square feet and larger

San Francisco
Water
Power
Sewer

Services of the San Francisco Public Utilities Commission

Build Water Resilience



Buildings, including commercial, mixed-use, and multi-family residential buildings, generate several types of alternate water sources. In San Francisco, alternate water sources that are treated to meet SFDPH approved water quality standards can be used for a variety of non-potable uses within and outside a building. Rainwater, stormwater, graywater, blackwater, and foundation drainage are the most common types of alternate water sources collected and treated by buildings in San Francisco.

Green building initiatives, like LEED® and 2030 Districts®, often encourage onsite water systems as a sustainable water management tool. As green building strategies and practices progress in San Francisco, more onsite water systems will be incorporated within buildings and districts throughout the City.

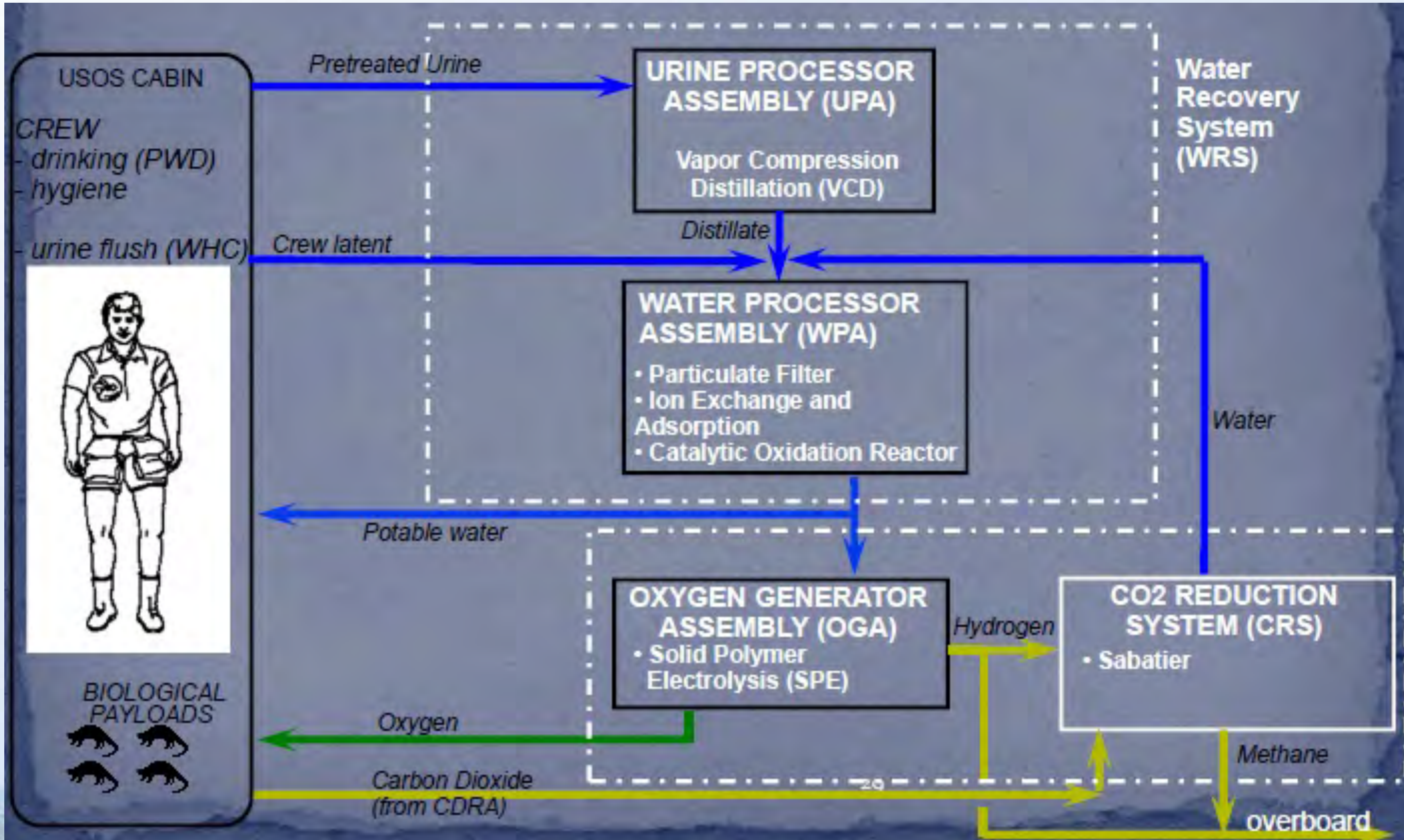
SFPUC Non-Potable Water Ordinance

- Sources cannot include dishwasher or kitchen sinks.
- None of recycled water would come into direct contact with people
  - Toilet & urinal flushing
  - Landscape irrigation
- Can't be used for washing food or clothing
- Doesn't do rural Alaska much good.

NSF/ANSI 350 Only Goes So Far

- Very onerous process to get certified
- Sources cannot include dishwashers or kitchen sinks
- Limited on-site uses
  - Urinal & toilet flushing
  - Landscape irrigation
- Doesn't do rural Alaska much good

Why don’t we just do what NASA does, and drink our own recycled urine?



So what principles can we apply for on-site systems in rural Alaska?

- Exposure risk assessments
  - Centralized systems: cancer and gastrointestinal pathogens
  - Decentralized systems: Same, but also skin maladies
- Low complexity / loosely coupled systems
- Risk mitigation
  - Redundant treatment
  - Real time monitoring
  - Storage & re-processing of off-spec water
  - Homeowner basic training & best practices
  - System testing program (like backflow prevention)

Questions/Discussion?

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Applying Small Systems and Premise Plumbing Knowledge to Household Reuse

Chad Seidel, Ph.D., P.E.
Vice President, Corona Environmental Consulting, LLC
Technical Director, DeRISK Center, Univ. of Colorado Boulder

AWWMA Session on In-Home Water Reuse
April 20, 2016

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Joy Barrett, Rural Community Assistance Partnership
Aaron Dotson, University of Alaska Anchorage

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Grant # 83560301

Discussion Overview

- Current national dialog regarding…
  - Small drinking water systems
  - Premise plumbing
- How does this apply and where does it leave us here in Alaska?

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Small Drinking Water Systems

- Facts
- Compliance challenges
- Capacity development

EPA definitions

- EPA classifies water systems by:
  - Size (population served)
  - Source water
  - Characteristics of population served

Size

- From EPA’s web site
  - Very Small water systems serve 25-500 people
  - Small water systems serve 501-3,300 people
  - Medium water systems serve 3,301-10,000 people
  - Large water systems serve 10,001-100,000 people
  - Very Large water systems serve 100,001+ people
- The centers are focusing on community water systems serving a population fewer than 10,000

Source water

- Ground water (GW)
- Surface water (SW)
- Ground water under the direct influence of surface water (GWUDI)

Public Water Systems (PWS)

- Water for human consumption
- Through pipes or other conveyances
- At least 15 service connections or 25 people
- At least 60 days a year
- There are over 150,000 PWSs in the US
- EPA has defined three types of public water systems according to whether they serve the same customers year-round or on an occasional basis.

Community Water System (CWS)

- A public water system that supplies water to the same population year-round.

Non-Transient Non-Community Water System (NTNCWS)

- A public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round.

- Some examples are schools, factories, office buildings, and hospitals which have their own water systems.

Transient Non-Community Water System (TNCWS)

- A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time.

Data from SDWIS 2013

	<=100	101-500	501-1,000	1,001-3,300	3,301-10,000		Total small systems	% of small system
All PWS	79,881	41,814	9,269	9,574	5,151		145,689	97%
	53%	28%	6%	6%	3%			
Ground Water	77,077	38,943	7,942	6,935	2,890		133,787	92%
Surface Water	2,753	2,858	1,326	2,637	2,260		11,834	8%
CWS	12,264	15,511	5,524	8,094	4,920		50,452	35%
NTNCWS	8,576	6,534	1,636	879	137		17,778	12%
TNCWS	59,041	19,769	2,109	601	94		81,627	56%
Private	66,591	29,417	3,748	2,016	620		102,392	70%
Local gov't	5,465	7,924	4,336	6,431	4,088		28,244	19%
Federal Gov't	2,255	930	168	156	98		3,607	2%
Native American	236	323	129	155	66		909	1%
Public Private	2,856	1,800	408	402	133		5,599	4%
State Gov't	2,478	1,420	480	414	146		4,938	3%
Private								% of Private
CWS	10,326	9,341	1,562	1,324	519		23,072	23%
NTNCWS	7,142	4,041	723	401	72		12,379	12%
TNCWS	49,123	16,035	1,463	291	29		66,941	65%

Size (SDWIS 2013)

- 97% (145,689) serve fewer than 10,000
- 94% serve fewer than 3,300
- 81% serve fewer than 500
- 53% (79,881) serve fewer than 100

Other characteristics

- 92% (133,787) use ground water
- 8% (11,834) use surface water or GWUDI

- 34% CWS
- 12% NTNCWS
- 54% TNCWS

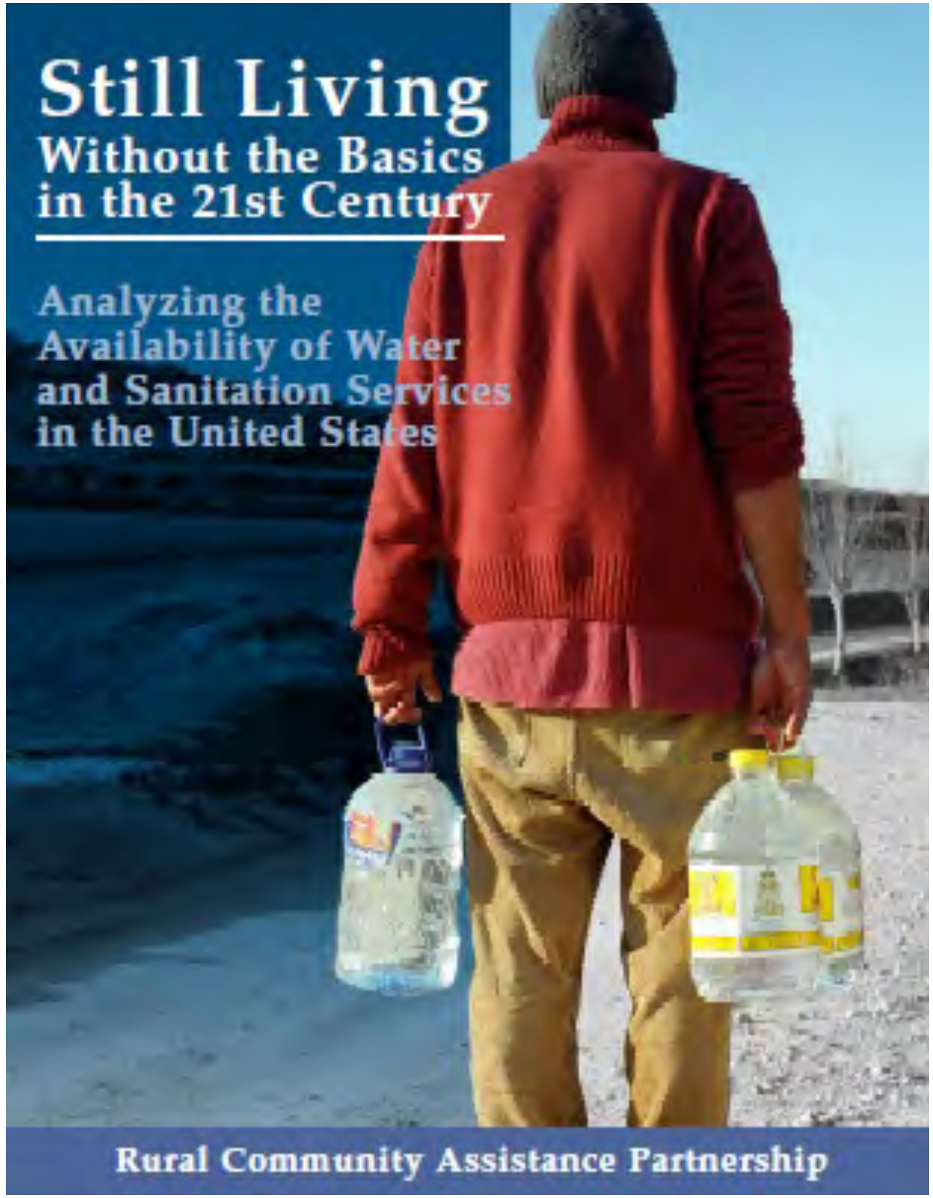
- 70% Private (HOAs, camps, restaurants, etc.)

Does everyone have water service in the U.S. ?

- RCAP's 2004 Publication, based on the U.S. 2000 Census: Still Living Without the Basics

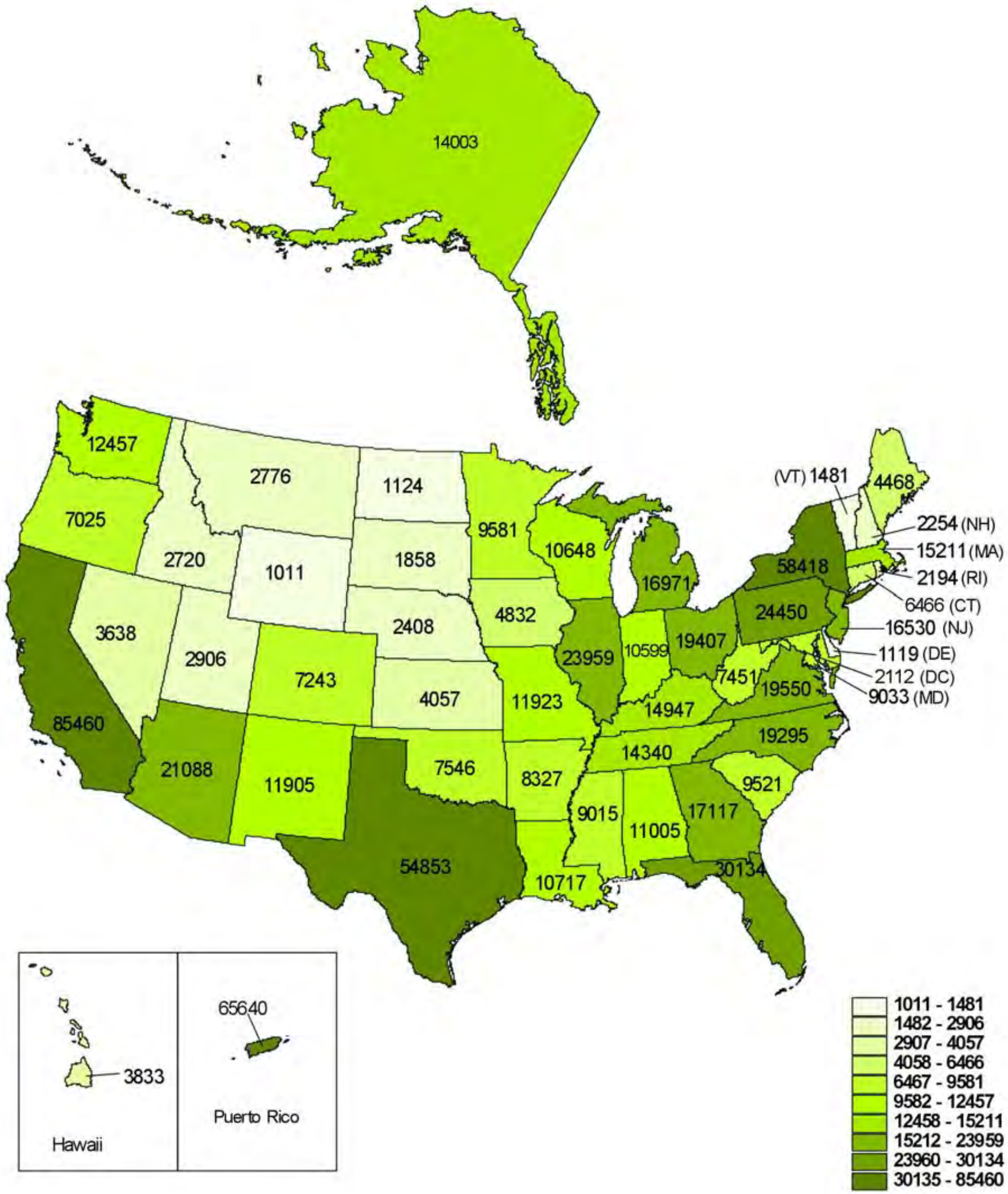
- 1.7 million people in the U.S. do not have indoor plumbing!

RCAP
Rural Community Assistance Partnership

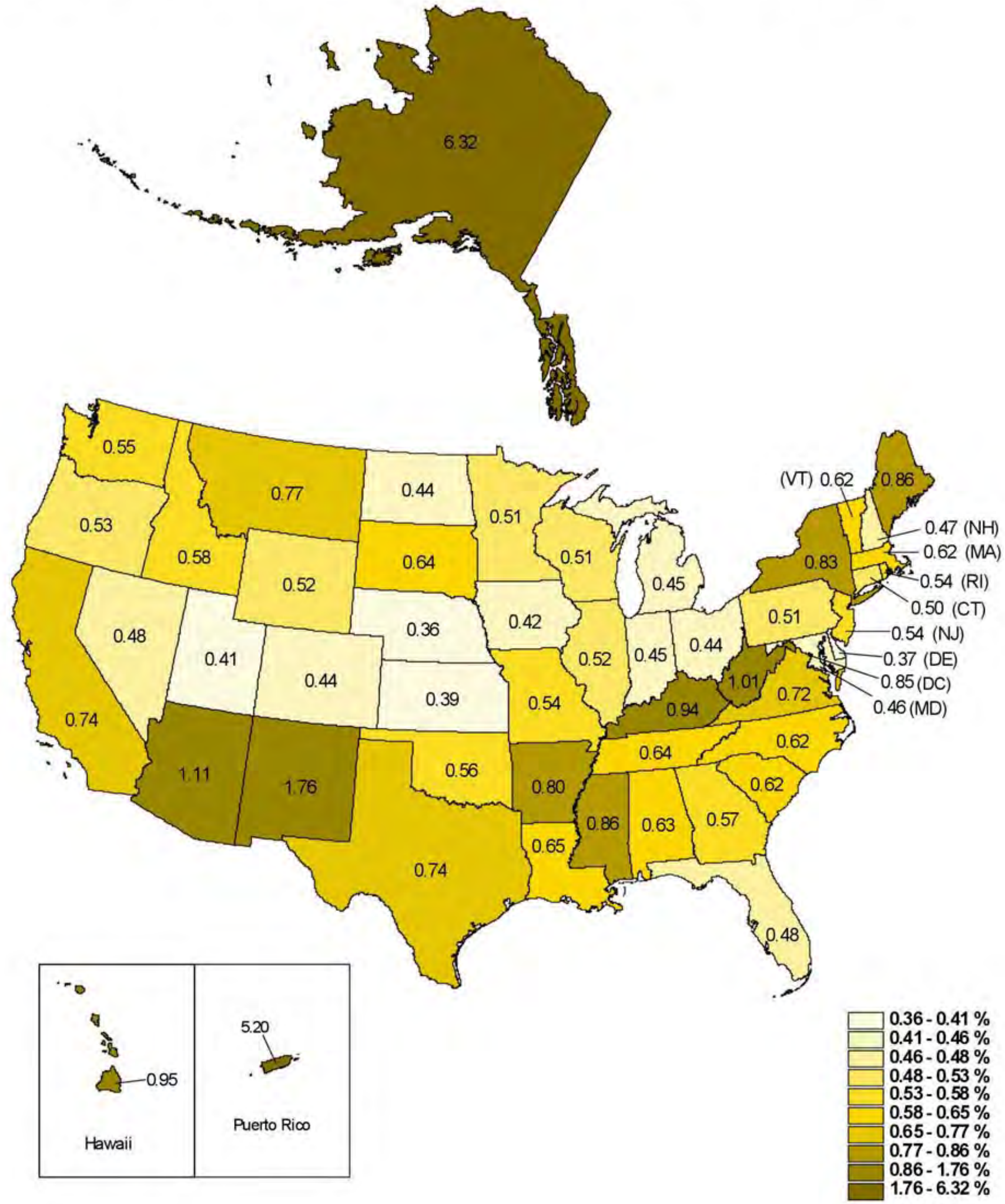


"Improving the quality of life in rural communities"

Map 1. US: Total Occupied Housing Units Lacking Complete Plumbing Facilities



Map 2. US: Percent of Occupied Housing Units Lacking Complete Plumbing Facilities



Small vs. Large
What are the Characteristics?

Small	Large
Operations	
Part-time or contract operator	Many full-time staff
Low level of certification	High level of certification
Treatment and distribution combined	High degree of specialization
Reactive maintenance	Preventive maintenance

RCAP

Small vs. Large

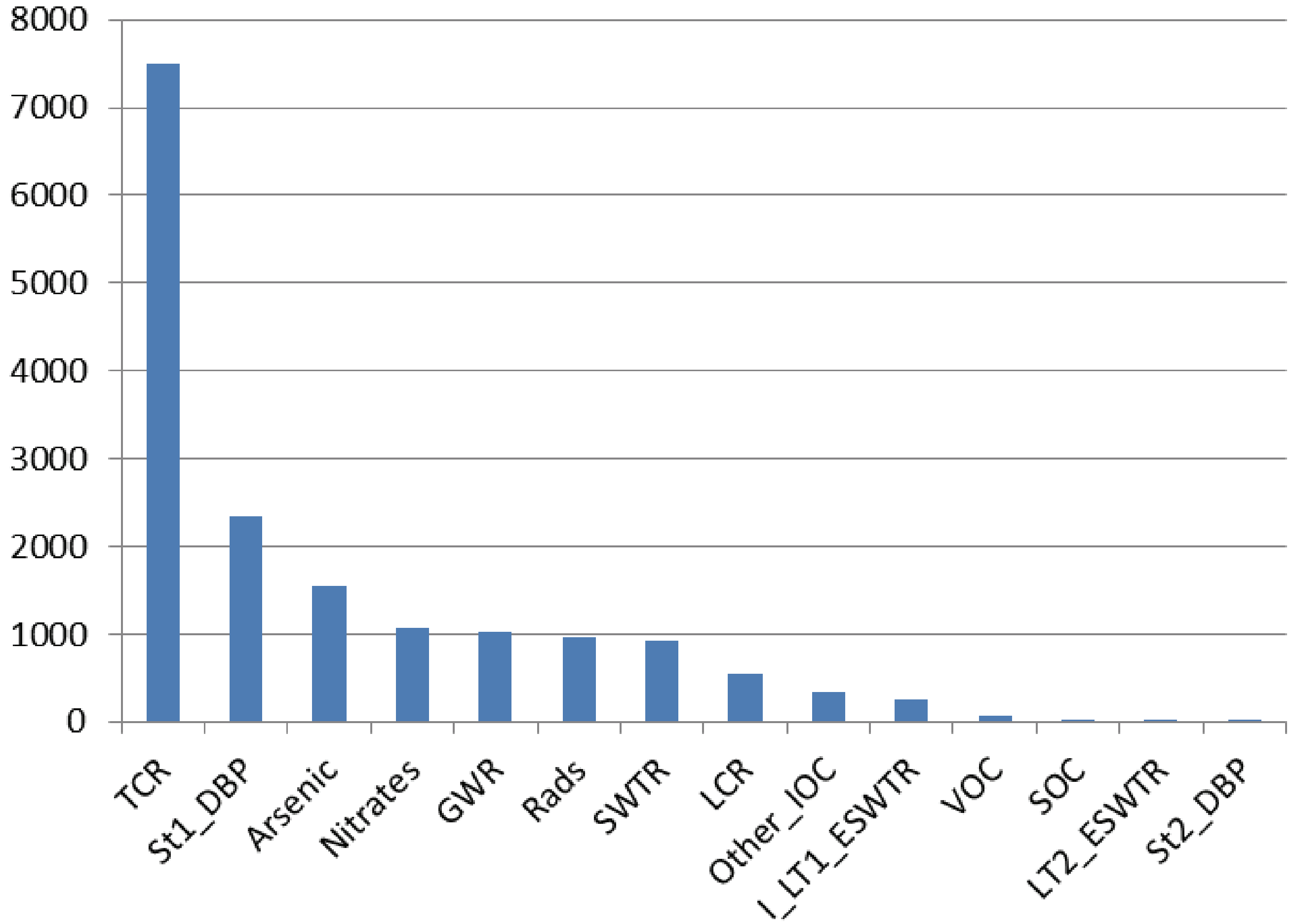
What are the Characteristics?

Small	Large
Equipment	
Maybe only disinfection	Can be complex (filtration, etc.)
High capital cost per connection	Low capital cost per connection
Manual sampling and monitoring	Automated sampling and monitoring
Management	
Board does other things, often volunteer	Board specific to the water utility
Minimal capital improvement plan	Complex asset management program
Rates set by politics	Rates set by analysis … and politics
Others???	

RCAP

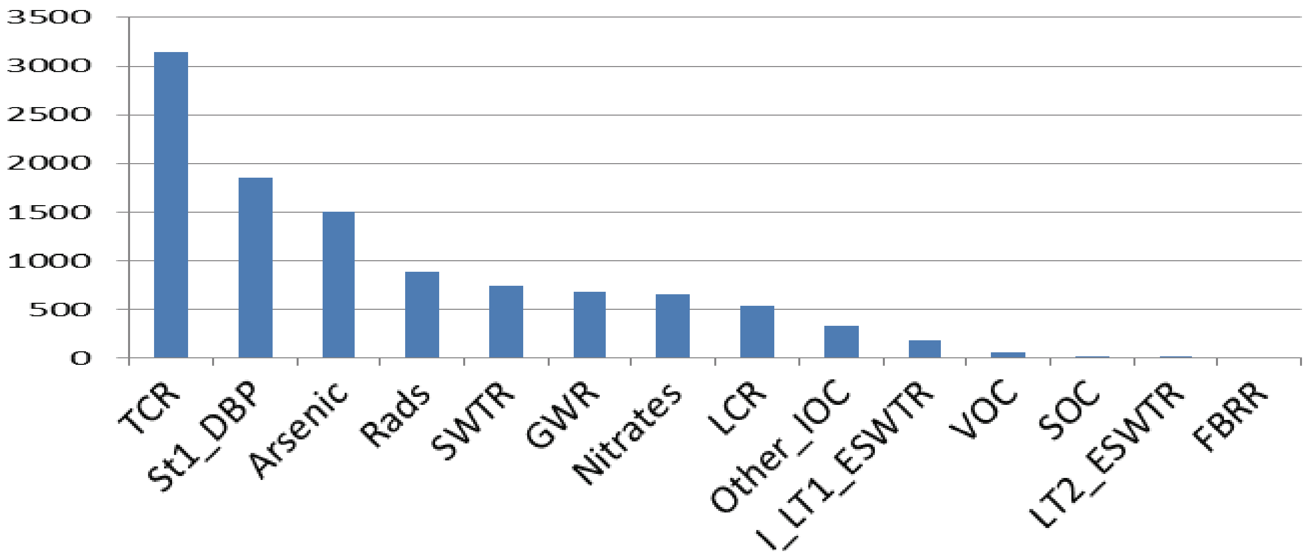
Compliance issues

Health- Based Violations (All systems in SDWIS)



Health Based Violations

PWS serving < 10,000



TCR Violations by System Size

Population	% M+R violations	% MCL violations
<500	11%	4%
501-3,300	7%	3%
3,301-10,000	4%	4%
10,000-100,000	3%	4%
>100,000	3%	1%

SDWIS Sanitary Survey Data

Significant deficiencies – Systems serving <10,000 (SDWIS, 2013)

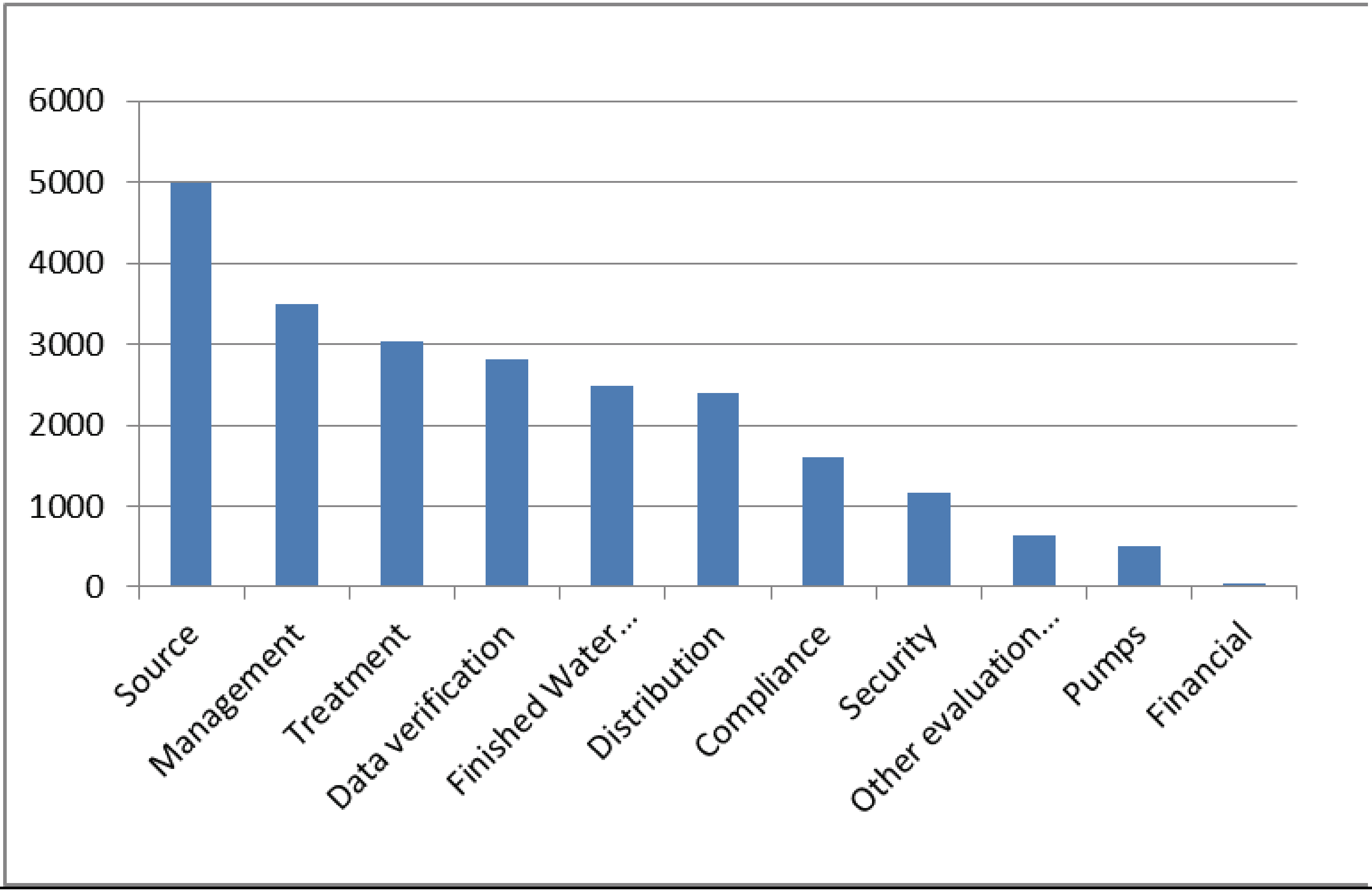


Table of top deficiencies by category

Common Types of Deficiencies Identified for Sanitary Survey Categories				
Source	Management	Treatment	Data Verification monitoring and reporting	Finished Water Storage
• Improper sanitary seal • Cracked well slab • No well vent, vent height not adequate, no vent screen • No source sampling tap • Area around well subject to contamination • Well discharge pipes and other appurtenances are not properly screened, oriented, and air gapped. • Unsanitary conditions inside the well house	• Emergency Operations Plan • Operation and Maintenance plan • Cross connection control plan • No TCR sampling plan • Records maintenance • Last sanitary survey deficiencies not addressed • No CCR (*Also in monitoring and reporting*	• Non NSF approved additives used (or AWWA standards followed) • Proper storage and handling of chemicals (including alarms, chlorine safety) • Deficiency 4 Log Removal Not Meeting CT • Minimum Disinfectant Residual at Entry to Distribution • Redundant units available	• Failure to meet primary drinking water standards • Failure to follow state specified procedures • Lack of sampling plans (TCR, disinfection, IOC, DBP, etc) • Failure to Maintain Adequate Records • Failure to monitor (Chlorine, turbidity, …) or meet • System does not have the appropriate raw water (GW) sampling tap(s) – *Also found as a source deficiency* • PWS has not turned in monitoring reports	• Missing screens – on vents, overflows, and/or drains • Vents improperly constructed • Overflows improperly constructed • Hatch – Not overlapping, no rubber gasket, no lock • Leaks or Openings • Interior or exterior coating problems. • Storage tank needs painting • Storage tank needs to be cleaned • Security issues (locks, fences, etc

Capacity development

- Emphasis on managerial and financial strengths of systems, as opposed to just technical
- Capacity assessment tools
- Training and technical assistance
- Facilities improvement

U.S. EPA Request for Assistance

Center's mission to:

identify, develop, demonstrate and facilitate widespread acceptance and applicability of <u>novel</u> and <u>innovative</u> technologies and approaches to measure or treat groups of microbiological or chemical contaminants, or their precursors;

apply novel new information technology systems; and

improve the <u>sustainability</u> of small drinking water systems.

University of Colorado Boulder

This research is funded by
U.S. EPA - Science To Achieve Results (STAR) Program
Grant # 83560301

U.S. EPA STAR NATIONAL CENTERS FOR INNOVATION IN SMALL DRINKING WATER SYSTEMS

Design of Risk Reducing, Innovative Implementable Small System Knowledge (DeRISK) Center

http://www.colorado.edu/deriskcenter/

RCAP Rural Community Assistance Partnership

University of New Hampshire

UAA College of Engineering
University of Alaska Anchorage

The University of Texas
Health Science Center at Houston

ASU Ira A. Fulton Schools of Engineering

DeRISK Center Approach

Through the utilization of a new cumulative risk assessment methodology, the Relative Health Indicator (RHI), we have identified

- **two contaminant groups:**
  - **pathogenic microorganisms – acute risk**
  - **disinfection by-products (DBPs) – chronic risk**
- **one inorganic compound:**
  - **nitrate – chronic risk**

which collectively pose the greatest risk to drinking water consumers.

DeRISK Center Approach

Innovative technology selection criteria:

a) their potential to provide quantifiable risk reduction in these key contaminant groups

b) the lack of required chemical addition

c) the likelihood of being successfully implemented and sustained by small systems

Project 1: Assessment and Implementation

Goal

To develop, refine and disseminate a <u>risk reduction</u> based strategy that will facilitate improvements in the effectiveness and <u>sustainability</u> of small drinking water systems by focusing on the <u>implementation</u> of <u>innovative</u> water treatment technologies

Jim Malley, CoPI
Chad Seidel, Co-Director

University of New Hampshire
University of Colorado Boulder

Assessment and Implementation - Activities

Develop and apply

1) a relative risk-based index, RHI, to evaluate how treatment decisions impact overall risk reduction and avoidance
2) a sustainability index in order to comprehensively evaluate treatment technologies
3) a methodology to evaluate systems and technologies with the purpose of determining if an innovative technology is feasible, appropriate and implementable for a specific small system's needs
4) a training design support tool

Case study – utilize above assessment approach and implement innovative polychromatic UV technologies

Evaluate a regional alliance strategy for very remote rural communities

Project 2: Photon-based Treatment

Goal

To explore the applications of photochemical processes, including both sunlight and engineered light sources

Activities

- evaluate shallow pretreatment basins for disinfection efficiency and control of DBP formation
- field-test a small-system sized UV - LED disinfection module containing UV - LEDs of varying wavelengths
- evaluate photocatalytic reduction of nitrate in IX brines
- evaluate an innovative UV-membrane hybrid process

Prof. Karl Linden, Co-PI

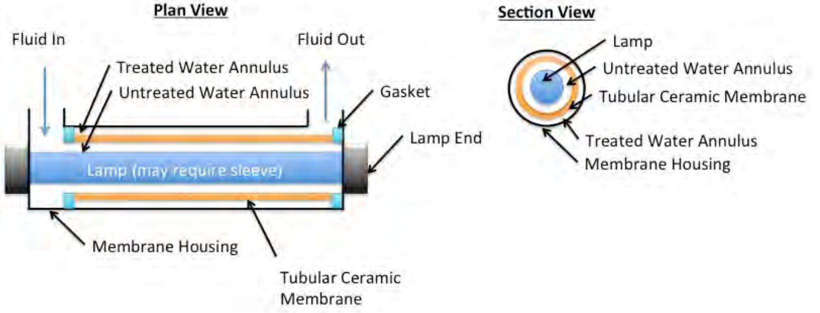
University of Colorado Boulder

Photon-based Treatment - Activities

Evaluate an innovative UV-membrane hybrid process

Approach

- Using a prototype parallel flat ceramic membrane UV system compare low pressure UV and vacuum UV at varied cross flow rates (1-5 m/s), UV fluxes at membrane surface (pathlength 1.5 – 3 cm), and UV transmittance (0.05 – 0.5 cm-1) in the presence of reactive solutes
- Apply in field



Prof. Aaron Dotson

UAA College of Engineering
UNIVERSITY of ALASKA ANCHORAGE

Project 3: Extended Biofiltration

Goal

Control of microbial contaminants, particles and DBPs by novel biotreatment processes

Activities

- evaluate novel roughing filter pretreatment configurations (horizontal and upflow)
- evaluate innovative filter modifications and operations with the goal of extending the EBCT to somewhere between conventional – and slow-sand

Prof. R. Scott Summers PI
University of Colorado Boulder

Project 4: Distribution System Technologies

Goal

To explore, develop, and model technologies that will offer a better understanding of the distribution system and will reduce preformed DBPs at the most problematic locations

Activities

- evaluate the efficacy of using a readily adaptable horizontal diffused aeration system to remove THMs
- evaluate the use of GAC in the distribution system to adsorb and biodegrade preformed DBPs and DBP precursors
- develop real-time analytics and protocols to better manage distribution system resources - residence times, chlorine residuals, non-revenue losses and pipe break detections

Prof. Robin Collins - CoPI

University of New Hampshire

Moving from small systems to premise plumbing…

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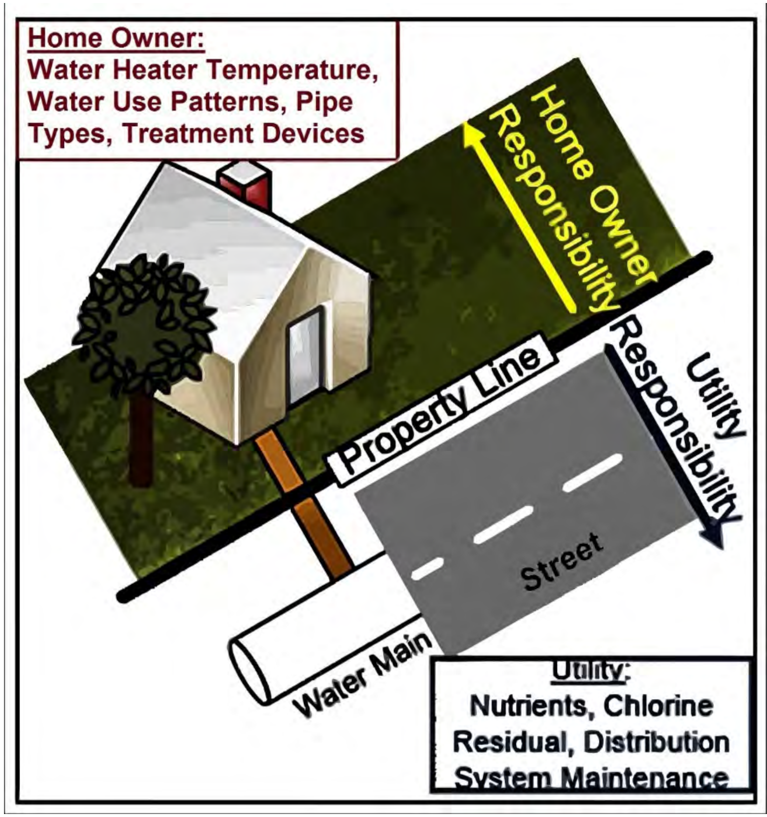
Premise Plumbing

- The point from the service connection line from the public distribution system to the private supply
- Utility no longer legally responsible for WQ in pipes (exception is the Lead and Copper Rule)
- WQ responsibility becomes that of building owner-individual, business, property manager
- Some buildings with treatment may be subject to regulation under the SDWA



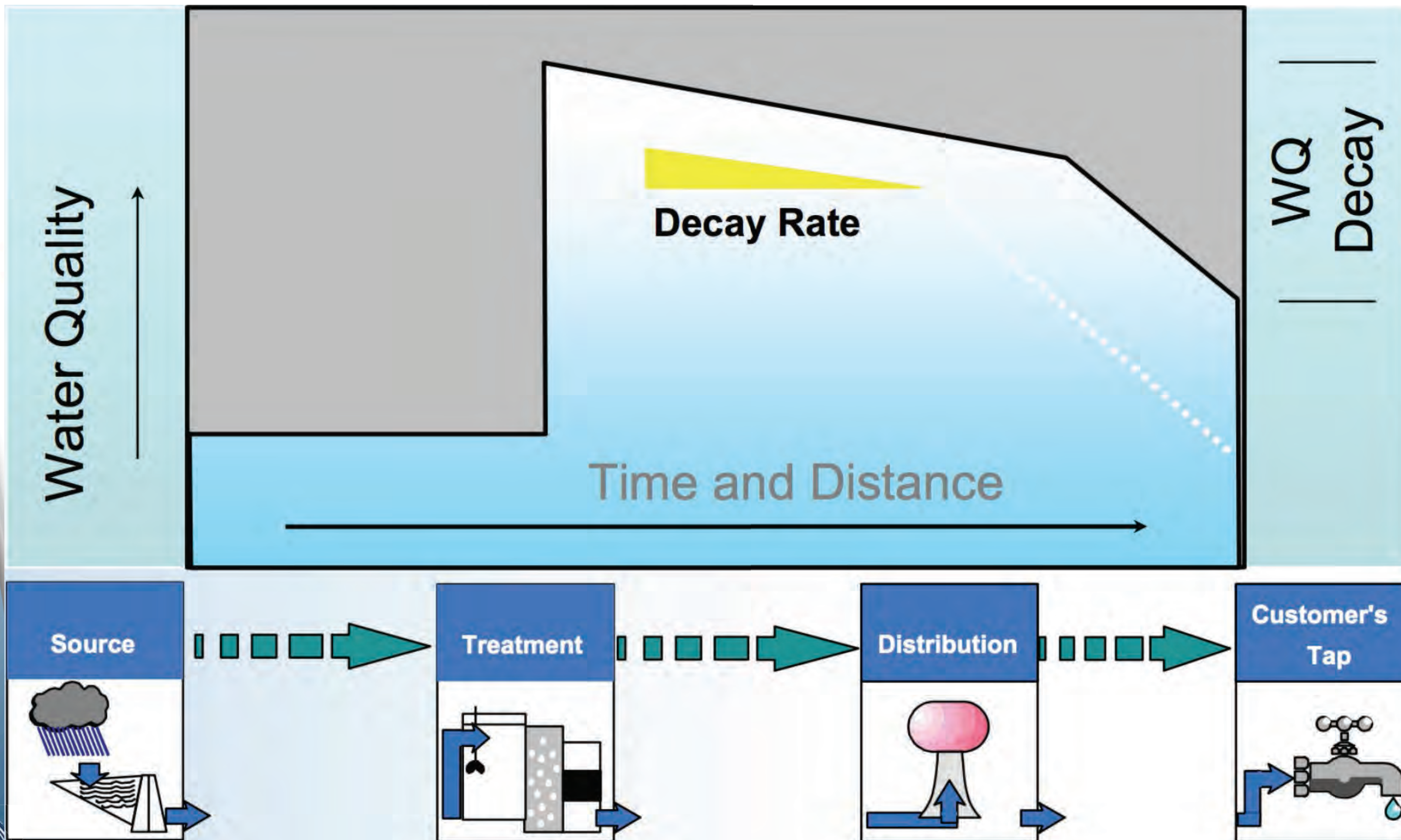
Premise Plumbing Challenges

- Premise plumbing has all of the same water quality issues as the distribution system…

  …ONLY TO A FAR GREATER EXTENT!

- Lack of knowledgeable professionals to recognize, prevent or mitigate water quality problems
- Unclear and changing regulation of water quality after it enters a building

Water Quality Deterioration in Distribution Systems

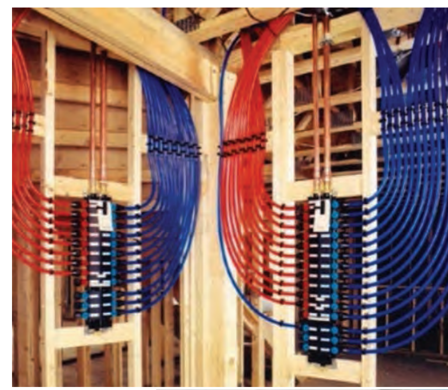


Modified from EPA, 2009. Best Practices for Simultaneous Compliance

Premise Plumbing Challenges: Presence of Different Materials

Main Materials

Premise Plumbing Materials

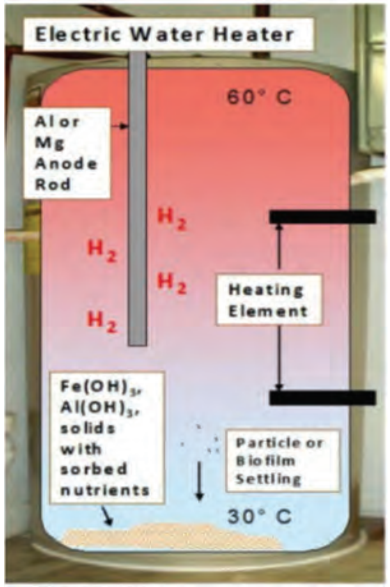


Premise Plumbing Challenges:
Unit Processes in Premise Plumbing:

From *MN Department of Health (2013)*

GAC Filters:

- Remove chemical contaminants but also remove chemical disinfectant



From *Pruden et al. (2014)*

Water heaters:

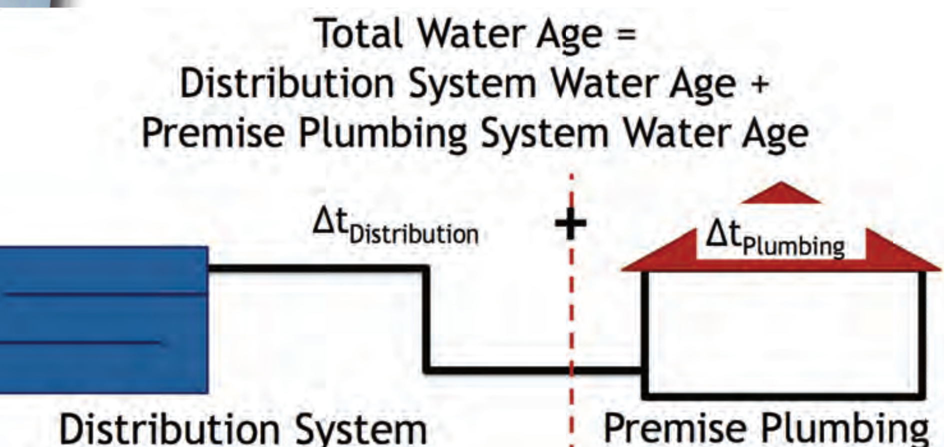
- High temperatures cause rapid disinfectant decay
- Can create ideal conditions for pathogen growth

Premise Plumbing Challenges: <u>High Surface Area to Volume Ratio</u>

- ~10 times more surface area per unit length compared to distribution mains
- 25% of the total surface area in the distribution systems
- <2% of the total volume of water in the system
- The greater surface area increases microbial growth, chemical leaching and ultimately disinfectant residual decay rates

National Academy of Science, 2006

Premise Plumbing Challenges: <u>High Water Age</u>



Rhoads et al, 2015

http://www.firstdigitalghana.com/green-building-as-a-business-imperative/

<u>Every building is a dead end:</u>

- Disinfectant decays
- Nitrification and regrowth increases
- DBPs form

<u>Water age issues likely to increase:</u>

- More green buildings (water age orders of magnitude higher)
- Installation of low flow fixtures
- Changing consumer behavior

Unique Premise Plumbing Characteristics Can Result in Major Water Quality Issues:

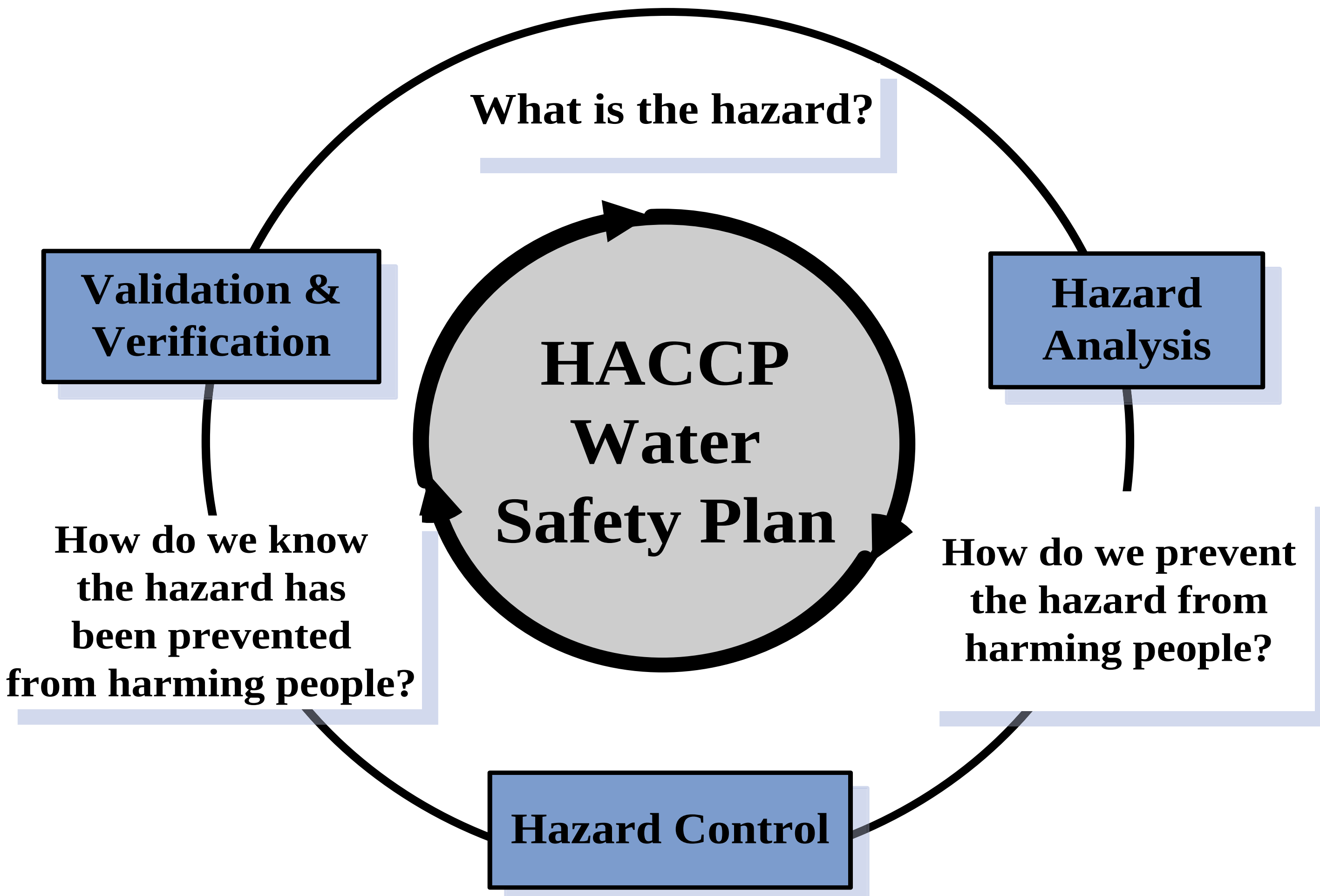
- Growth of opportunistic pathogens including *Legionella pneumophila*, nontuberculous mycobacteria (NTM), *Pseudomonas aeruginosa*
- Pipe corrosion resulting in lead and copper contamination or infrastructure damage
- Taste and odor
- Disinfection byproduct formation

Legionellosis and other premise plumbing issues are preventable

Building Water Quality Audit

- Inform building owners about new standards and regulatory requirements
- Evaluate building characteristics and points of concern using National Sanitation Foundation (NSF) Hazard Analysis and Critical Control Points (HACCP) guidelines
- Identify locations and features that are susceptible to microbial or chemical contamination
- Outline recommendations and options
- Develop long-term building maintenance and monitoring strategy

HACCP for Building Water Systems



Seven HACCP Principles

- Conduct a Hazard Analysis
- Determine the Critical Control Points (CCPs)
- Establish Critical Limits
- Establish Monitoring Procedures
- Establish Corrective Actions
- Establish Record-keeping and Documentation Procedures
- Establish Verification Procedures

Treatment, Monitoring and Building Water Quality Audits

- Treatment and monitoring are building-specific
- Generally, better to control building plumbing system water quality through system design and operation than addition of treatment
- Monitoring must be selected in consideration of treatment and control

Most Likely Treatment Options

Purpose	Technologies
Disinfection (either ongoing or for remediation)	Supplemental chemical disinfection • Free chlorine; chloramines • Chlorine dioxide • *Ozonation (unlikely to recommend)* • *Copper-silver (unlikely to recommend)* • *UV (only in a recirculated loop; no residual disinfectant)* • *Thermal shock*
Particle removal	Filtration (point of entry or point of use) • Strainers (could become source of WQ problems) • Activated carbon (could become source of WQ problems) • Reverse osmosis • *Sedimentation*
Chemical contaminant removal	• Softening (probably already in place if needed) • Activated carbon filtration • *Ion exchange (unlikely)*
Corrosion control	• Corrosion inhibitor

Monitoring and Water Quality Assessment

When

- In initial phases of building plumbing system audit
- Ongoing
- Event

"If you cannot measure it, you can not improve it."

Lord Kelvin

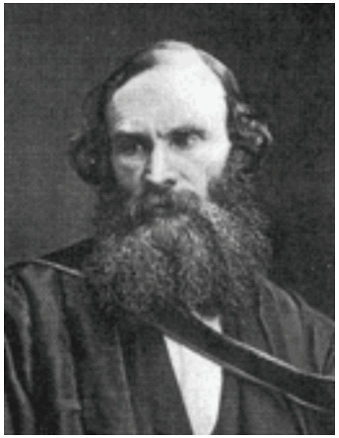


Image and quote from http://zapatopi.net/kelvin/quotes/

Why

- Establish baseline water quality and develop recommendations
- Process monitoring and control
- Reporting

"If I can't do anything about it, why would I want to monitor it?"

Anonymous

Initial Water Quality Assessment, Point of Entry and Key Locations

Strongly Recommended

- Disinfectant residual
- HPC
- Lead and copper
- Flow rate
- Time to reach temperature
- pH
- Turbidity
- Color

Recommended

- Ammonia
- Nitrate + nitrite
- Organic carbon (UV254, TOC, FDOM or other)
- Disinfection byproducts (primarily TTHM; especially hot water)
- ATP
- Free living amoebae
- *Legionella pneumophila*
- Non-tuberculous Mycobacteria (NTM)

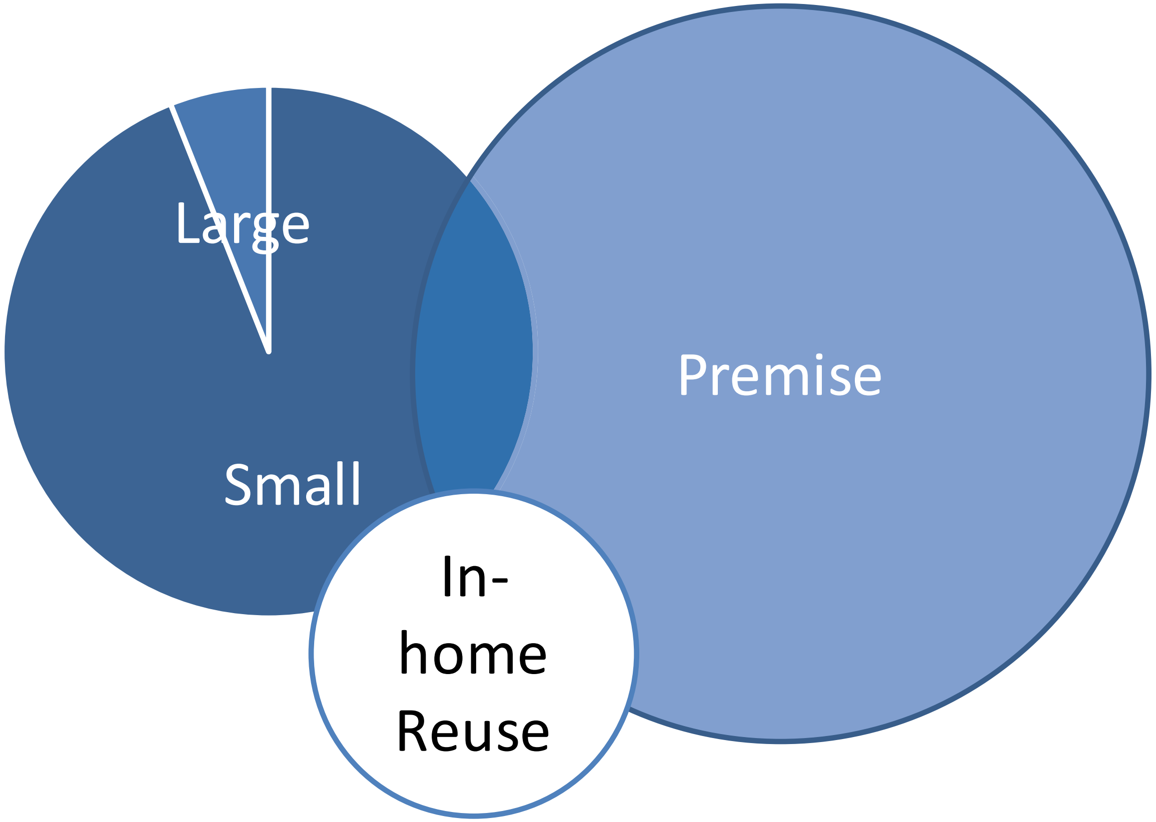
Ongoing Monitoring → Building Plumbing System Actions

Purpose	Related actions
Critical control point monitoring	Change set points Modify system design and operation
Usage monitoring	Reporting Automate usage management (e.g., automatic flushing) System modification
Operate supplemental treatment	Adjust disinfect dose Maintain filters
Compliance monitoring	Report Modify system design and operation
Demonstrate value to tenants	Communicate Modify system (e.g., add filtration)
Event detection	Communicate Shut off Flush

Most Likely Online Monitoring Recommendations

What	Why	Where
Usage	Water use accounting and conservation; water age indicator	POE; branches; non-potable uses
Disinfectant residual	Ensure adequate residual maintained; compliance monitoring	POE; after supplemental disinfection; distal location(s)
Ammonia (or ORP)	Determine disinfectant demand; ensure correct chlorine dosing	POE or upstream of supplemental disinfection
pH	Assess disinfectant efficacy; identify nitrification onset	POE
Temperature	Critical control parameter; growth risk indicator	POE; water heater effluent; loops and branches
Color	Aesthetic concern; contamination indicator	POE
Turbidity	Aesthetic concern; contamination indicator	POE

How does this apply in Alaska?



Common and Unique Alaskan Attributes

Attribute	Alaska Context
Objectives	• Improve public health • Increased water availability • Sustainable resource
System size	Smallest of small
Distribution	Trucked or self-haul rather than piped
Regulatory reach	Just like national experience…shades of grey

Questions?

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The Alaska Water and Sewer Challenge: Cost and Regulatory Considerations

Bill Griffith

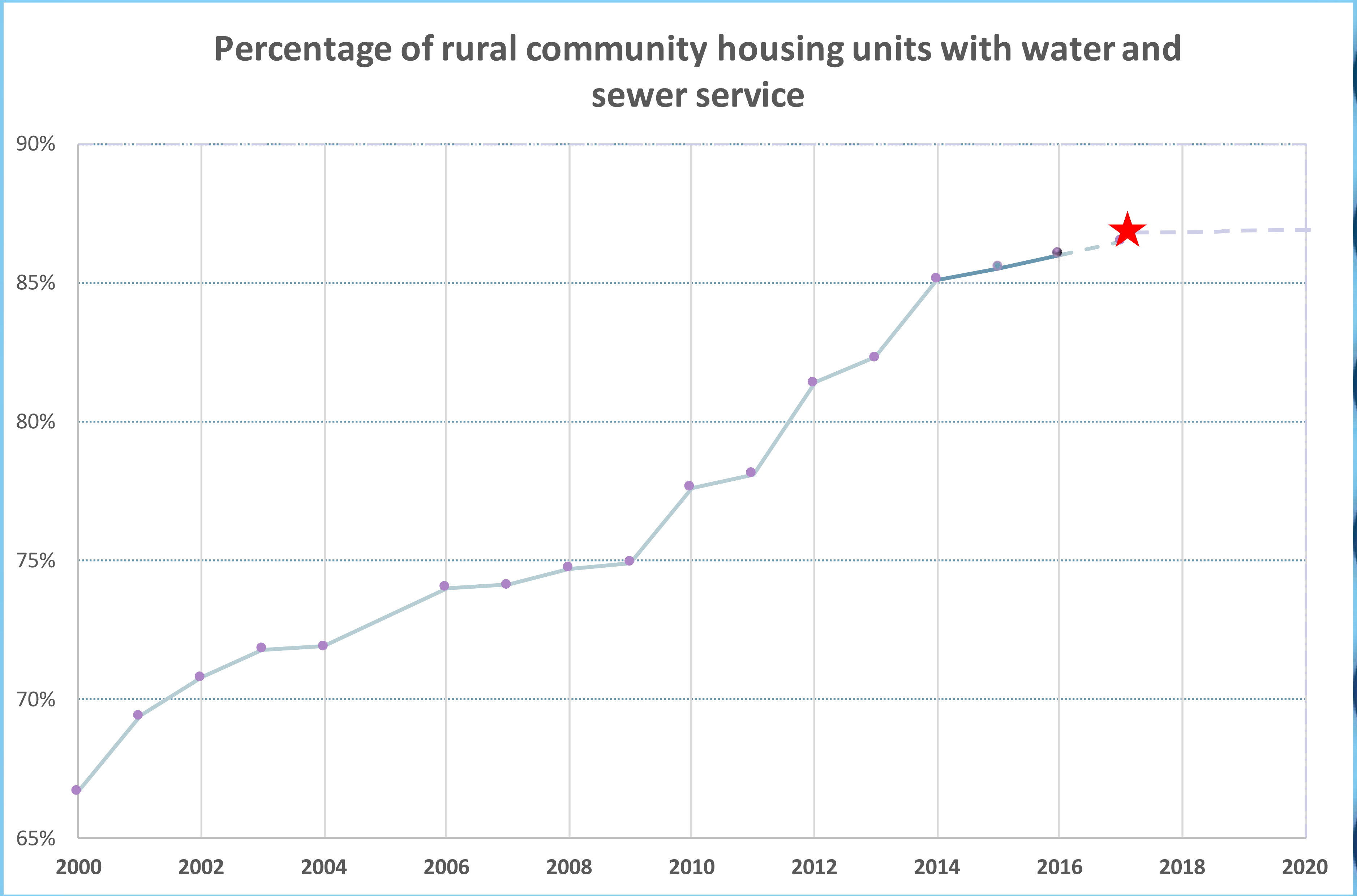
Facility Programs Manager

Alaska Department of Environmental Conservation

Progress in Alaska Village Sanitation

- 30 years ago, fewer than 25% of rural Alaska households had running water and flush toilets.
- In 1996, 55% of rural homes had piped or covered haul service.
- Today, approximately 85% of rural homes have indoor plumbing (over 90% if regional hubs are included in the calculation).

Healthy Alaskans 2020: Rural Sanitation Target



"Centralized" Approach Since 1970:

- 100% water treatment to full regulatory compliance (regardless of ultimate use)
- Storage of large quantities of water, usually requiring heat addition
- Distribution of treated water to individual homes via pipes or haul vehicle, usually requiring heat addition
- Collection of all household sewage for lagoon disposal, usually requiring heat addition

However…

- Conventional, community-wide piped systems and truck haul systems are expensive to construct, maintain and replace.
- Many communities cannot afford the high operation and maintenance costs associated with piped or haul systems.
- Available funding is not adequate to serve remaining homes and make needed improvements.
- Innovative approaches were needed in order to address health problems associated with water and sewer system deficiencies.

Comparison of Health Benefits vs. Cost and Complexity of Different Water and Sewer Service Types

January 2016

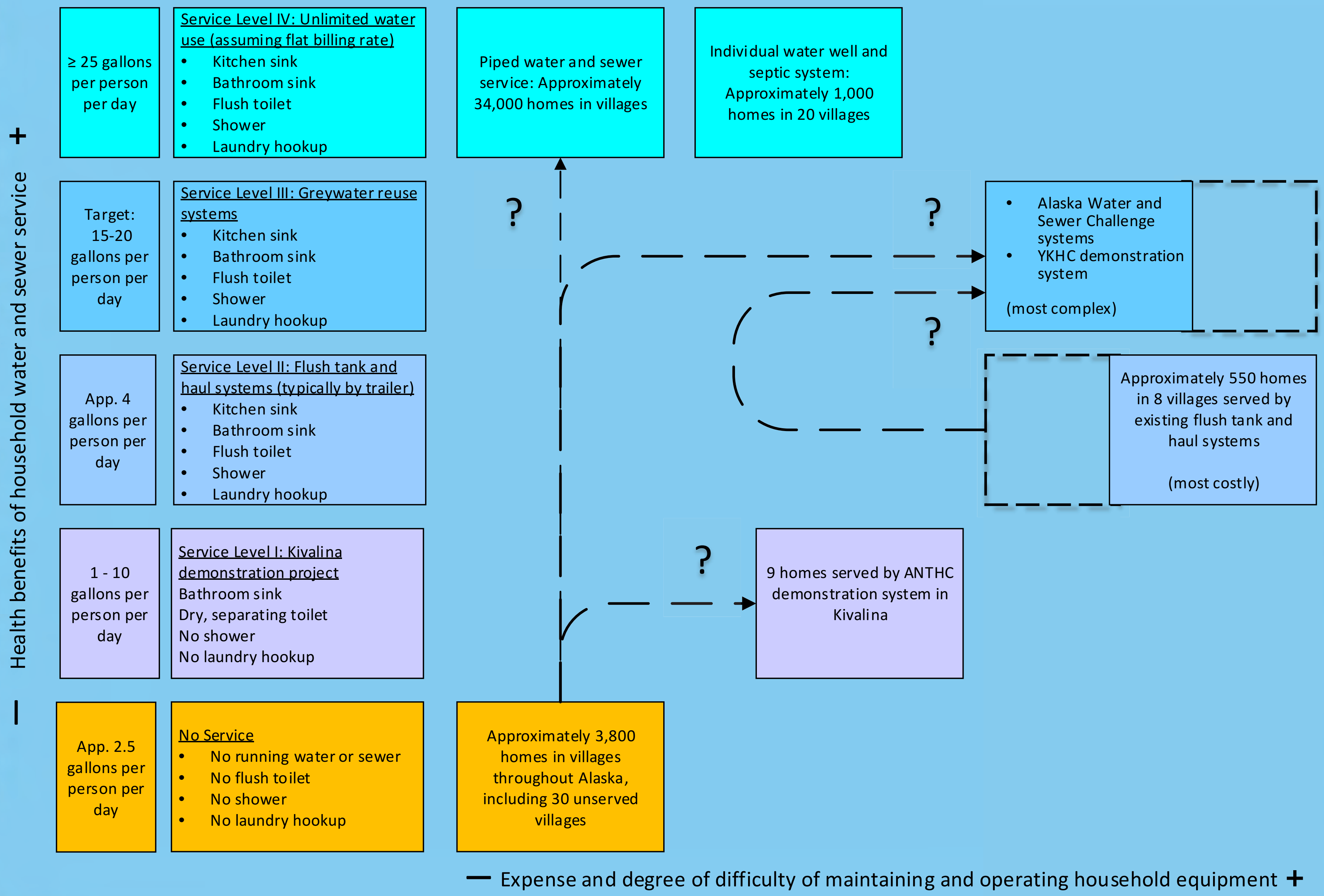
Water use	Service type	Homes served		
≥ 25 gallons per person per day	<u>Service Level IV: Unlimited water use (assuming flat billing rate)</u> • Kitchen sink • Bathroom sink • Flush toilet • Shower • Laundry hookup	Piped water and sewer service: Approximately 34,000 homes in villages	Individual water well and septic system: Approximately 1,000 homes in 20 villages	
Target: 15-20 gallons per person per day	<u>Service Level III: Greywater reuse systems</u> • Kitchen sink • Bathroom sink • Flush toilet • Shower • Laundry hookup			• Alaska Water and Sewer Challenge systems • YKHC demonstration system (most complex)
App. 4 gallons per person per day	<u>Service Level II: Flush tank and haul systems (typically by trailer)</u> • Kitchen sink • Bathroom sink • Flush toilet • Shower • Laundry hookup			Approximately 550 homes in 8 villages served by existing flush tank and haul systems (most costly)
1 - 10 gallons per person per day	<u>Service Level I: Kivalina demonstration project</u> Bathroom sink Dry, separating toilet No shower No laundry hookup		9 homes served by ANTHC demonstration system in Kivalina	
App. 2.5 gallons per person per day	<u>No Service</u> • No running water or sewer • No flush toilet • No shower • No laundry hookup	Approximately 3,800 homes in villages throughout Alaska, including 30 unserved villages		

Vertical axis: + Health benefits of household water and sewer service −

— Expense and degree of difficulty of maintaining and operating household equipment +

Comparison of Health Benefits vs. Cost and Complexity of Different Water and Sewer Service Types

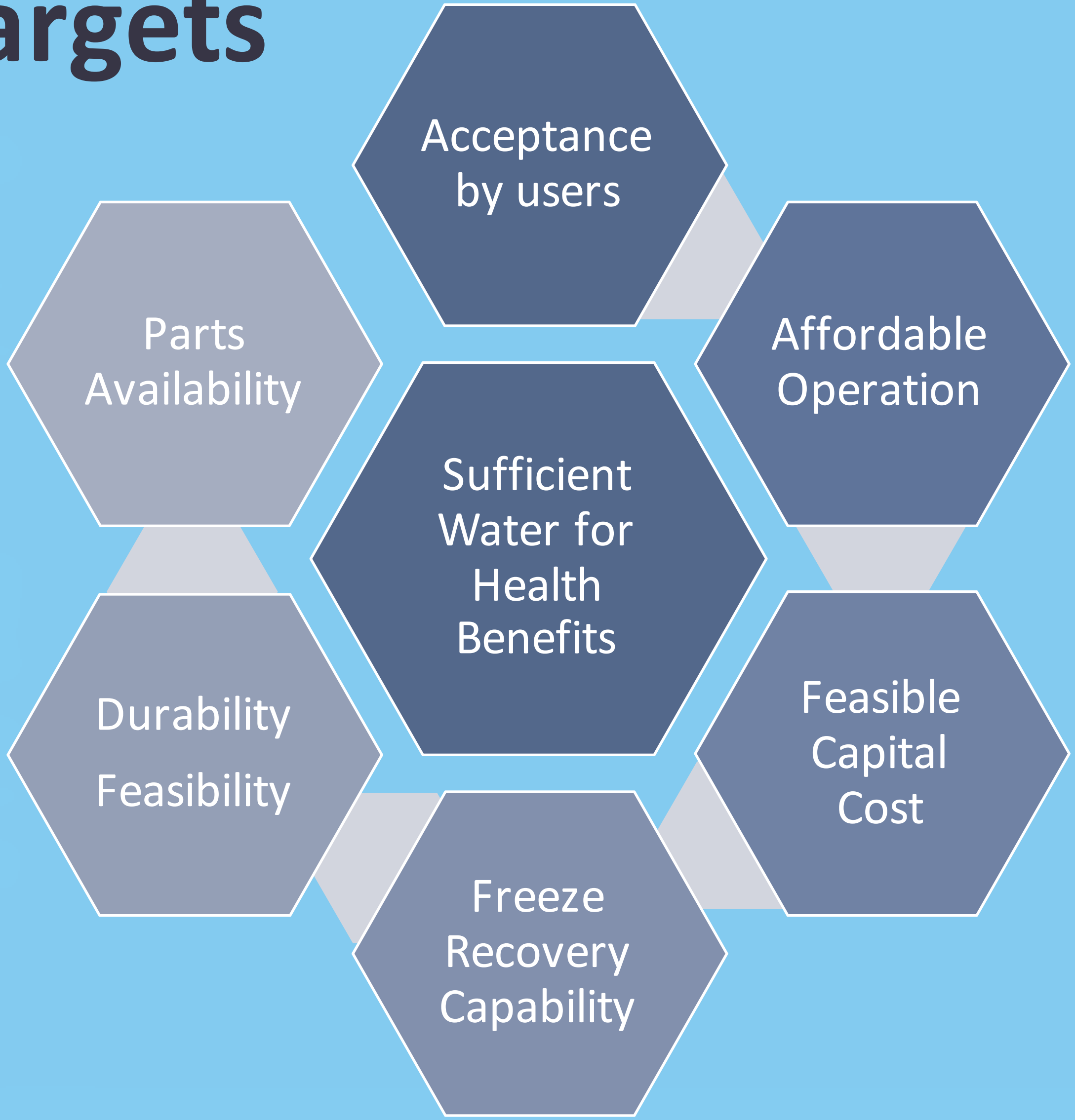
January 2016



Alaska Water and Sewer Challenge

- State-funded research and development project projected to last 5 – 7 years
- Focus is on "decentralized" approaches – household based systems that utilize water re-use technologies
- Private sector driven – with ownership of intellectual property retained by project teams
- Goal is to significantly reduce the capital and operating costs of in-home running water and sewer in rural Alaska homes
- Funding to date is $4 million in state and federal funding. Additional funding will be required to complete the project

Performance Targets



Cost Comparison of Different Approaches to First-Time Water and Sewer Service

Method of Providing First-Time Service to 3,800 homes	Capital Cost per Home	Total Cost for all 3,800 Homes	Number of Years to Fund all 3,800 Homes*
Community Piped Water and Sewer	$ 400,000	$ 1,520,000,000	42
Household System A	$ 160,000	$ 608,000,000	17
Household System B	$ 120,000	$ 456,000,000	13
Household System C	$ 80,000	$ 304,000,000	8

*Using $36 million per year

Regulatory Considerations

Regulation or Code	Coverage/Limitations	Considerations for Household Treatment, Recycling and On-Site Disposal
AK Drinking Water Regulations	Applies to public water systems serving at least 25 people	• Primary drinking water standards for any drinking water (consumption) source • Exploration of alternative standards for "hygiene water" • Potential for specific standard for toilet flushing.
AK Pollutant Discharge Elimination System (APDES) Regulations	Most wastewater discharge is covered by these regulations	• On-site disposal would require permit and/or approval of treatment • Most household approaches call for hauling black water to village lagoon
AK Plumbing Code (Uniform Plumbing Code, by adoption)	"An organized municipality or unorganized village having less than 2,500 population is exempt…"	• Alternative methods/systems can be requested, as long as equivalence can be demonstrated. • Testing will be required to demonstrate equivalent safety and health protection.

Project Timeline

Phase	Approximate Timeframe	Duration (months)
Team Formation	Fall 2013 – Spring 2014	9
Proposal Development + Presentation	Fall 2014 – Summer 2015	8
Prototype Development + Pilot Testing	Fall 2015 – Summer 2017	21
Field System Development + Testing	Fall 2017 – Summer 2019	21
Technology Refinement + Improvement	2020 and beyond	?

Phase III: 2015 - 2017

Prototype Development and Testing

- Three proposals funded for prototype development and testing.
- Targets and testing requirements have been provided.
- Engineering plans will be reviewed and approved.
- The results of testing phase will be presented to the Steering Committee.
- Systems that demonstrate promising results will be selected for field system development and testing.

THANK YOU!

More questions?

bill.griffith@alaska.gov

WaterSewerChallenge.Alaska.gov

Project Website

ALASKA WATER + SEWER CHALLENGE

Summit Consulting Services

Prototype Update

April 20, 2016

SUMMIT CONSULTING SERVICES Inc.
REMOTE PROJECT CONSTRUCTION MANAGEMENT & DESIGN SERVICES

AGNEW :: BECK

RELOCATE

Phase II Outreach & User Input

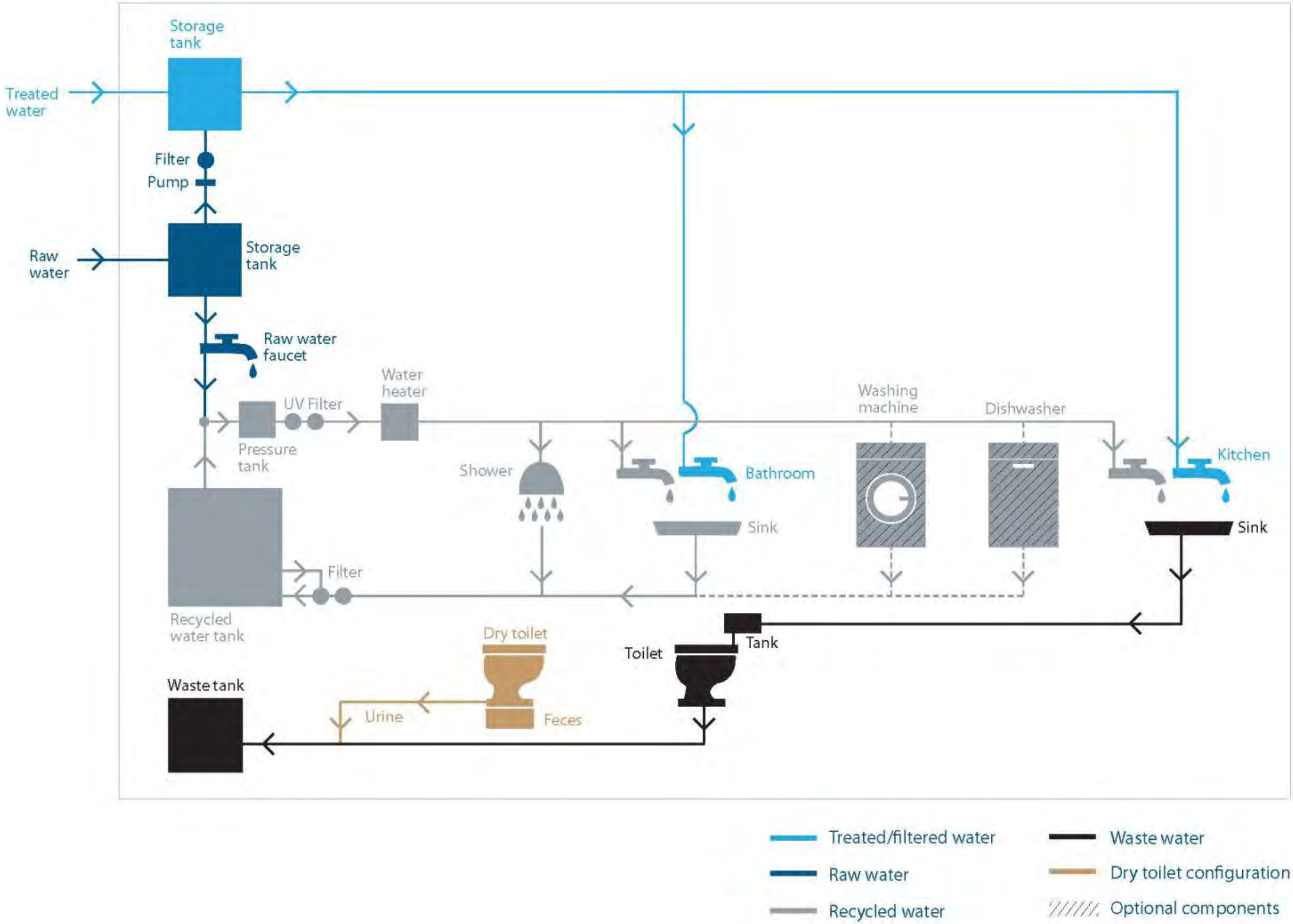
Phase III Outreach & User Input

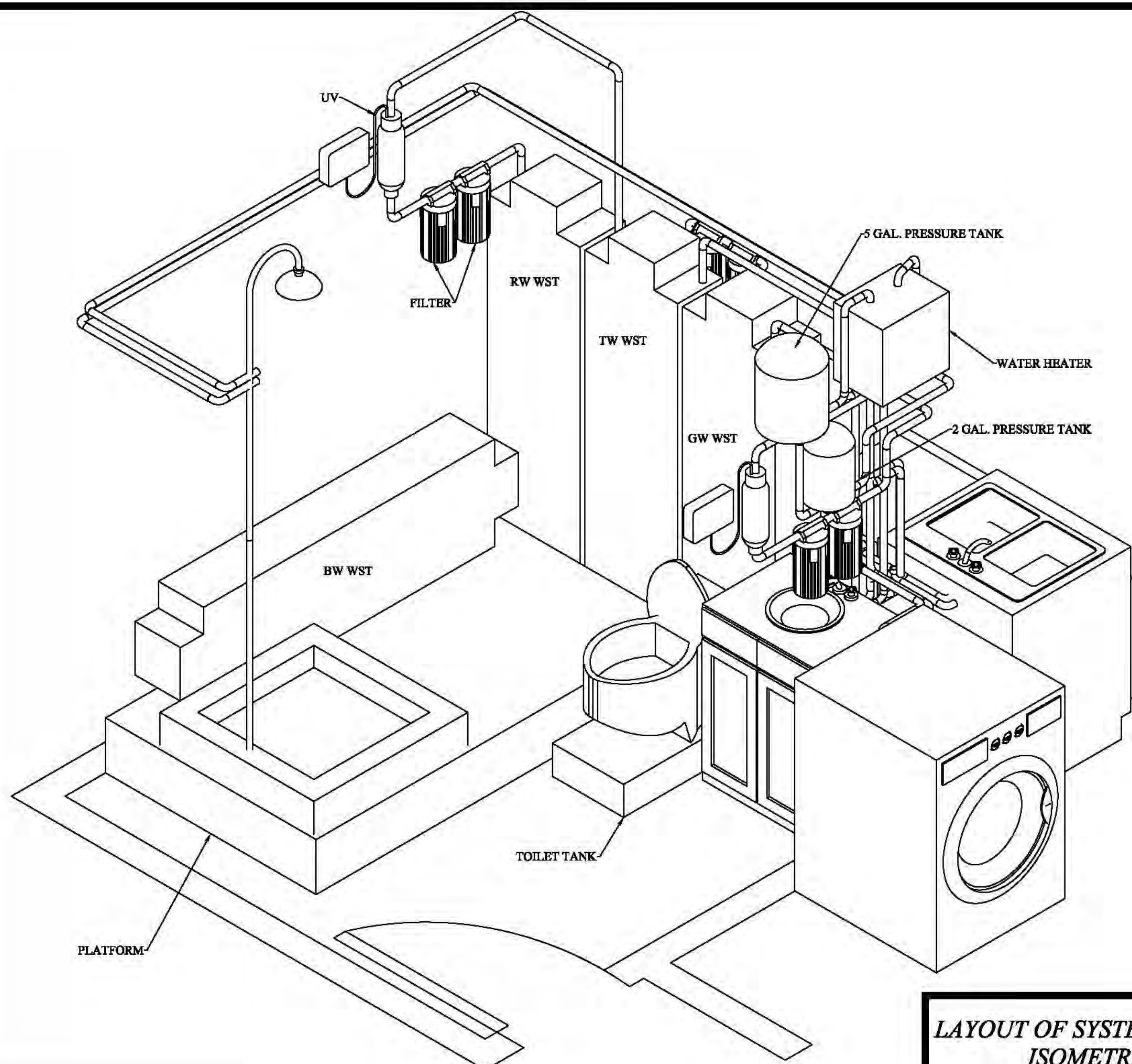
Our Website:

http://summitwsc.com/

FB @ Alaska Water and Sewer Challenge::SummitTeam

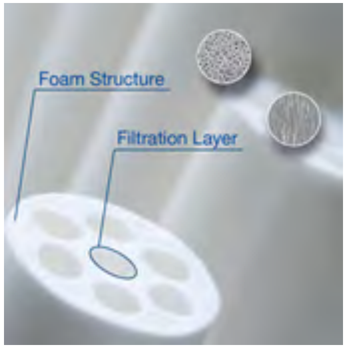
Phase II - System Configuration





LAYOUT OF SYSTEM COMPONENTS
ISOMETRIC VIEW 1

Phase III – Potable Treatment



Ultrafiltration Membrane

Membrane area = 27 ft^2

Flux Rate = ~53 GFD

Treatment Rate = ~1 gpm

Reliable rejection of microorganisms and viruses

Material: (PES)

BASF The Chemical Company

inge® heart of pure water

Membrane Test Results

Table 2: Measured Data and Calculated Removal

Modules of inge AG, Flux 100 L/(m² h)					Date of pilot testing: 2009-10-06		
Test No.	Sample No.	Probe	PFU MS2-Phages [pfu/mL]	Fitration mode	Rejection [%]	log-Removal [$\log_{10}$ units]	mean value log-Removal
Test 1	V1-F1	Feed 1	4.70E+05	Dead-End			5.70
	V1-F2	Feed 2	5.00E+05				
	V1-F3	Feed 3	5.20E+05				
	V1-P1	Filtrate 1	0.00E+00		99.9998%	5.67	
	V1-P2	Filtrate 2	0.00E+00		99.9998%	5.70	
	V1-P3	Filtrate 3	0.00E+00		99.9998%	5.72	
Test 2	V2-F1	Feed 1	1.20E+06	Dead-End			6.14
	V2-F2	Feed 2	1.40E+06				
	V2-F3	Feed 3	1.60E+06				
	V2-P1	Filtrate 1	0.00E+00		99.9999%	6.08	
	V2-P2	Filtrate 2	0.00E+00		99.9999%	6.15	
	V2-P3	Filtrate 3	0.00E+00		99.9999%	6.20	
Test 3	V3-F1	Feed 1	3.70E+05	Dead-End			5.59
	V3-F2	Feed 2	3.90E+05				
	V3-F3	Feed 3	4.10E+05				
	V3-P1	Filtrate 1	0.00E+00		99.9997%	5.57	
	V3-P2	Filtrate 2	0.00E+00		99.9997%	5.59	
	V3-P3	Filtrate 3	0.00E+00		99.9998%	5.61	

Note: In all 3 tests, no MS2 was detected in the filtrate.
For the purpose of calculating a mean LRV, a value of 1 MS2-phage in each of three filtrates has been assumed (95 % confidence).
LRV in reality is higher then this value.

Graywater Treatment Options

Aqua2use®
"The Answer for Greywater Reuse"

aquacell

BIO MICROBICS®

INTEWA

NUBIAN WATER SYSTEMS

wahaso
WATER HARVESTING SOLUTIONS

Greyter Water Systems

Nexus eWater

mall

MarineFAST®
SEWAGE TREATMENT SYSTEMS

Graywater/Hygiene Specification

Measure	Single Sample Maximum	Test Average	NSF-350 Single Sample Max	NSF-350 Test Average
BOD5 (mg/L)	25	10	25	10
Total Suspended Solids (mg/L)	30	10	30	10
Turbidity	10	5	10	5
Total Coliform	Non-detectable	Non-detectable	N/A	N/A
E. coli (MPN/100	N/A	N/A	240	14
pH	N/A	6.0 – 9.0	N/A	6.0 – 9.0
Color	N/A	Measured and reported	N/A	Measured and reported
Odor	N/A	Non-offensive	N/A	Non-offensive
Oily film and foam	Non-detectable	Non-detectable	Non-detectable	Non-detectable

Graywater Treatment Systems

Common Features

Prefiltration

Aeration

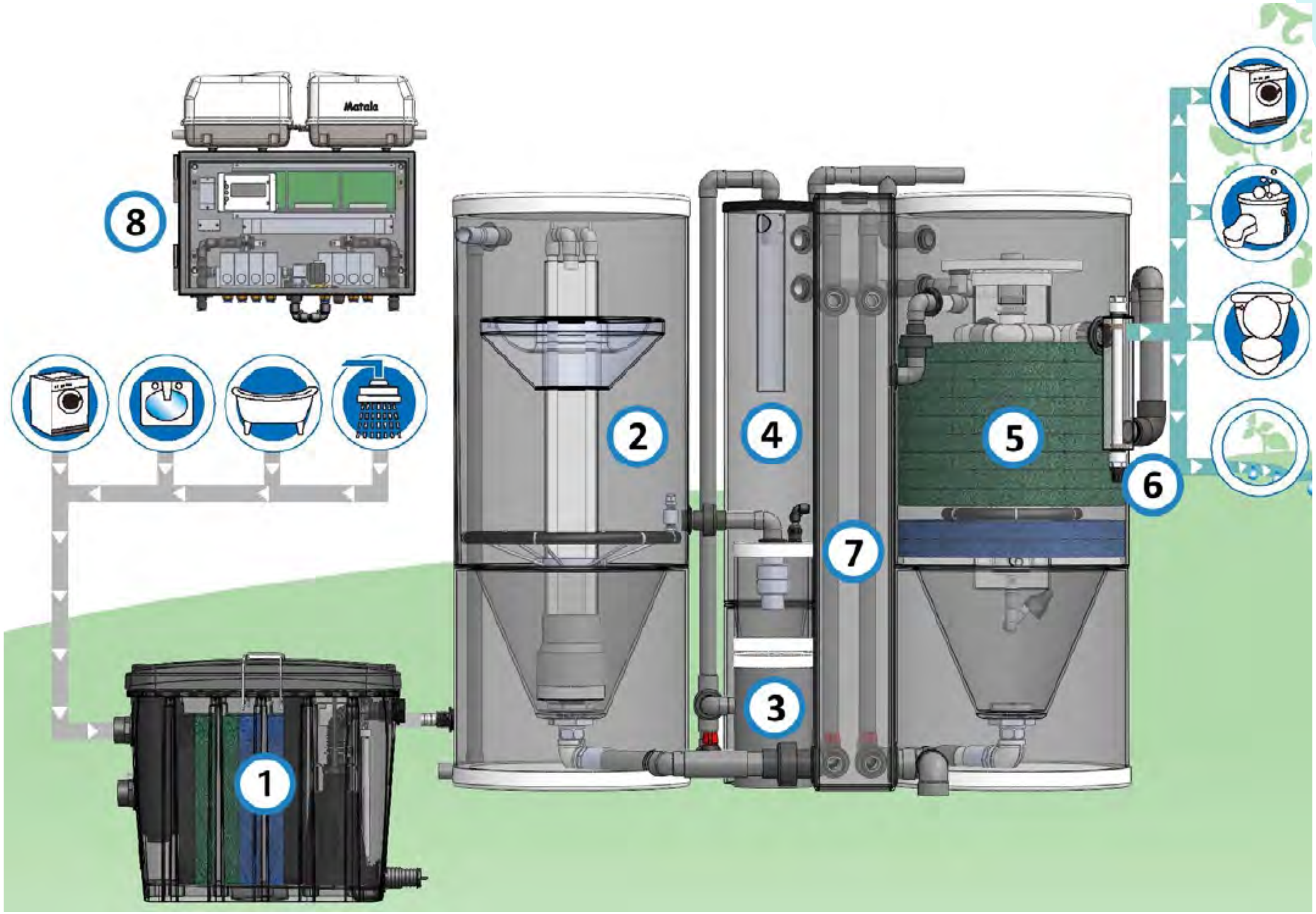
Fixed Media for biological filtration

or

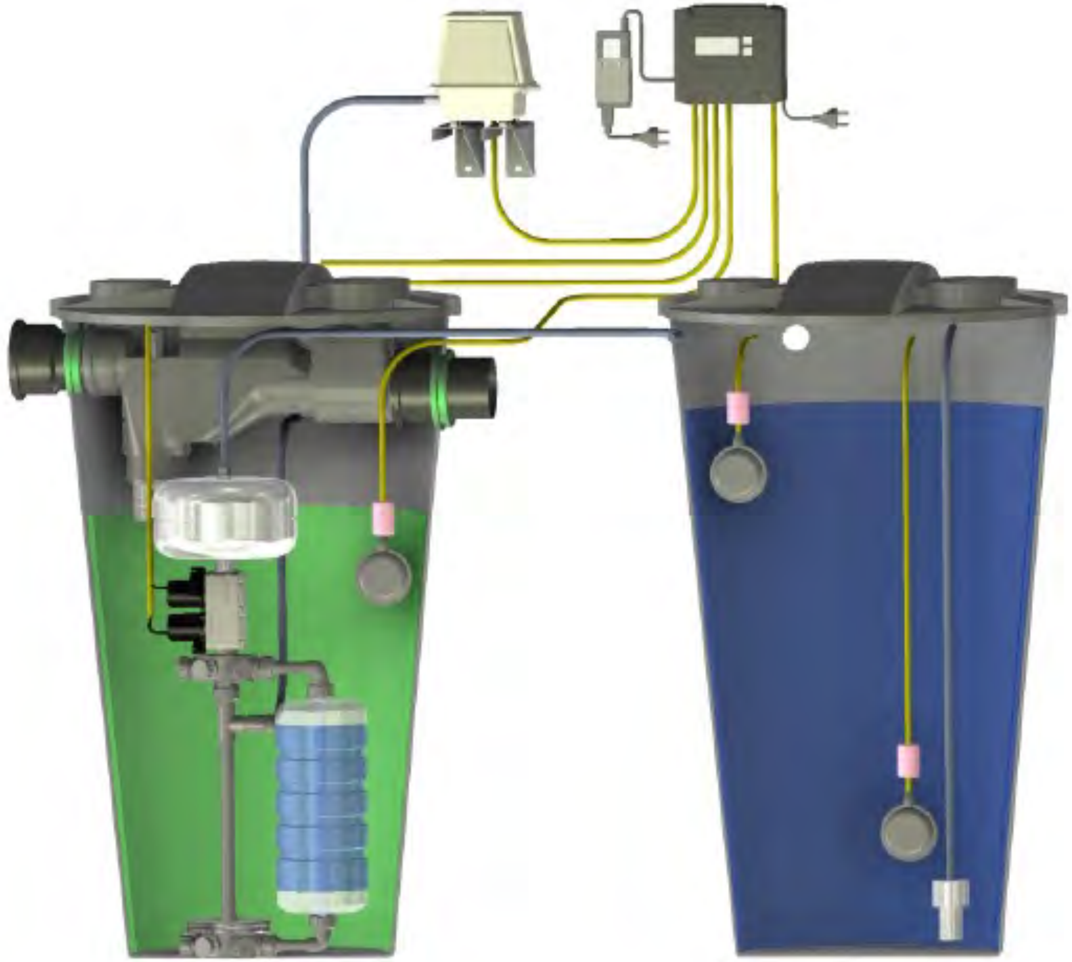
Membranes

Disinfection with UV light

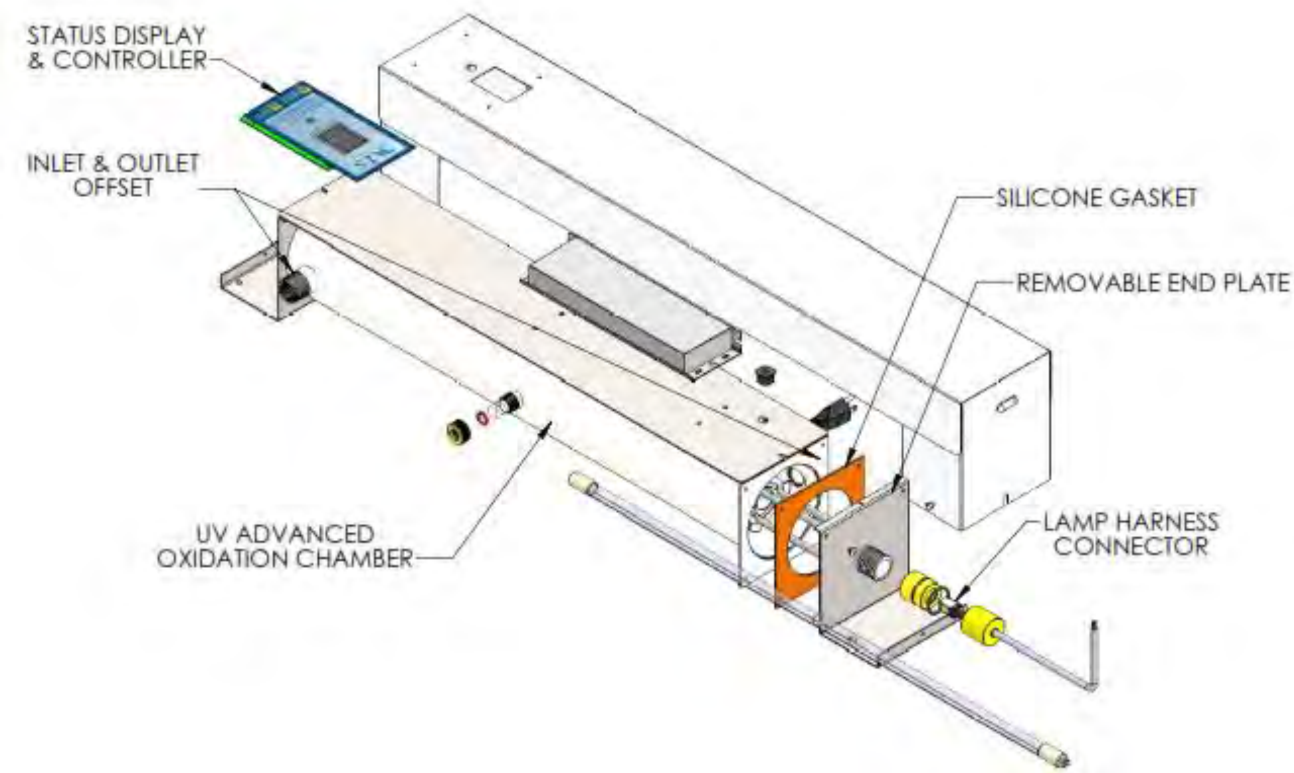
Aqua2use – GWTS500



Aqualoop



UVOX 20


STATUS DISPLAY
& CONTROLLER
INLET & OUTLET
OFFSET
SILICONE GASKET
REMOVABLE END PLATE
UV ADVANCED
OXIDATION CHAMBER
LAMP HARNESS
CONNECTOR

Tank Freeze Test

Protocol:

- Fill the tank to 7/8 full.
- Freeze to 0° F.
- Duration of 48 hours or until frozen solid.
- Thaw completely.
- Observe for cracking and tank stress
- Repeat freezing for 48 hours
- Thaw again

Tank Pressure Test

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Alaska Water & Sewer Challenge

AK

April 20 ,2016

Designing a Household Water & Waste System (HW2S) Using the Design-Think Process

Chris Schulz & Janelle Rogers, CDM Smith

Chase Nelson & Mitch Titus, DOWL

Bruno Grunau, CCHRC

Laurie Krieger, Manoff Group

CDM Smith

DOWL
WWW.DOWL.COM
INSPIRATION • INNOVATION • INTEGRITY

Presentation Topics

- Original HW2S design concept
- Village trips and takeaways
- HW2S and mock household plumbing prototype design
- HW2S prototype testing

What we originally designed

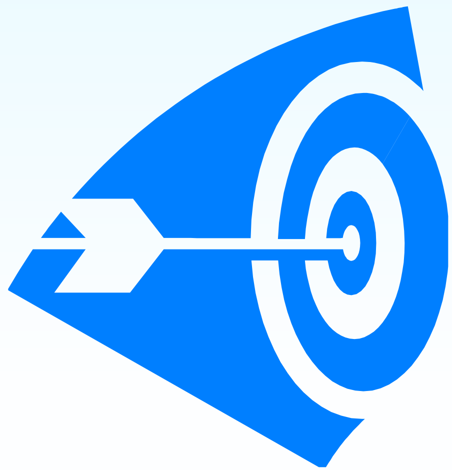
ADEC performance requirements informed our design approach

Constructability

Capital Costs

Modularity

Feasibility



Freeze/Thaw

User Acceptance

Regulation Compliance

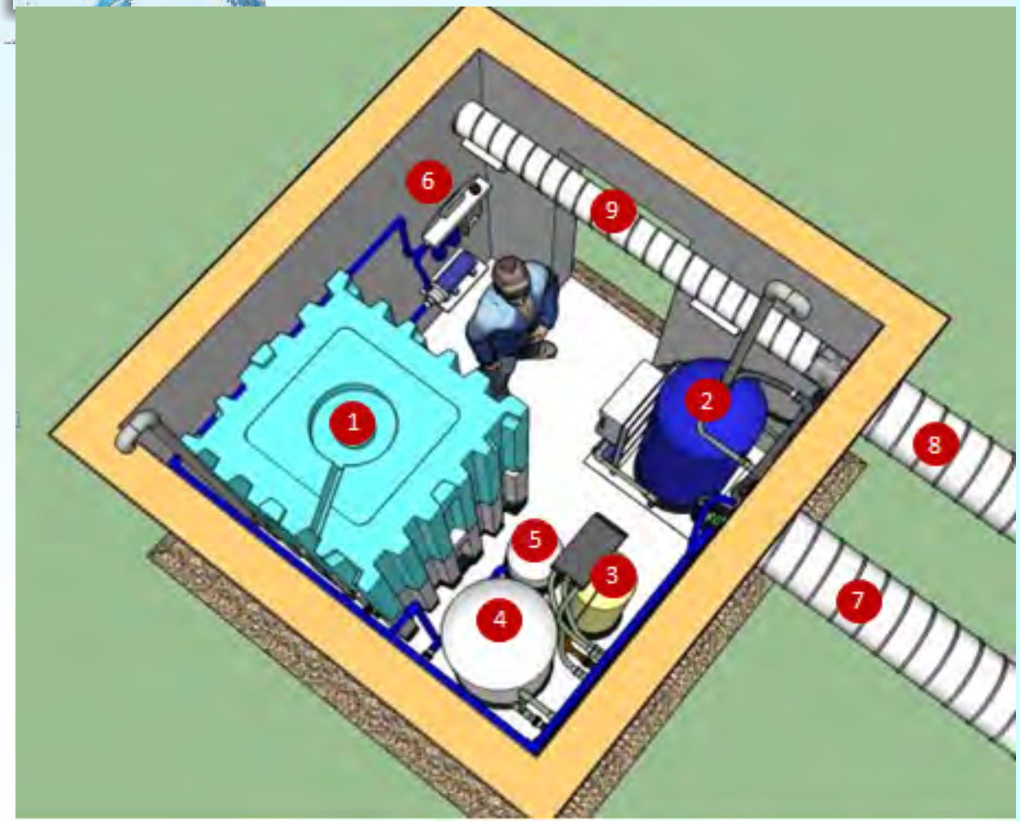
Water for Health

Parts Availability

Operating Costs

We wanted off-the-shelf system components and no chemicals for ease of maintenance and sustainability

Original HW2S design concept



1. Stacked Water/Waste Storage Tanks
2. Recycled Water Tank
3. Recycled Water Disinfection
4. Recycled Water Pressure Tank(60 gal)
5. Drinking Water Pressure Tank (15 gal)
6. Drinking Water Filter and UV Lamp
7. Insulated Carrier Pipe (for plumbing)
8. Insulated Ventilation Pipe
9. Ventilation Duct

Separate treatment, pumping and storage systems for *potable* and *non-potable* uses - and a graywater treatment and recycle system

Initial topics to elicit user input

Connected to the house, or not?

Separate recycled water tap or not?

Bag or LVF toilet?

In keeping with the design thinking process, we wanted to offer initial ideas to stimulate discussion

Trips and takeaways

In March 2015 – travelled to the villages (4 days)

Shishmaref

Janelle Rogers
Chris Schulz

Kwigillingok

Laurie Krieger
Chase Nelson

Council design-thinking presentation

themes

"Co-designing system with them" and "opportunity for household systems given new technology"

Talking with homeowners

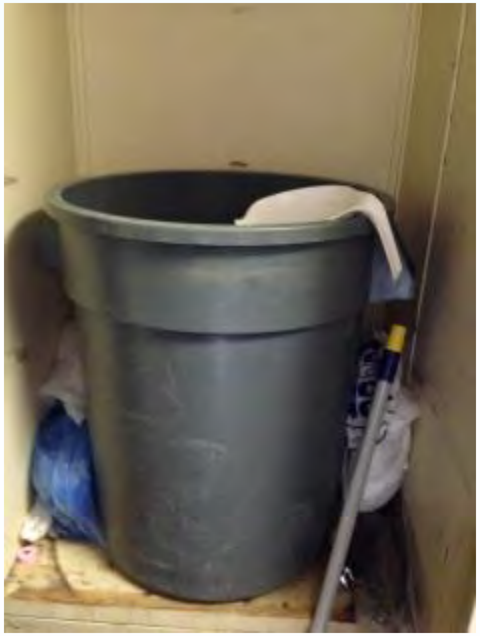
- Interviewed 21 men and 19 women, plus 3 casual conversations on water and plumbing (43 residents)

Key findings
both villages – drinking water

- All (but one person) drank & cooked only with ice melt or rain water – several people filtered this

Key findings
both villages

- All used community treated water for dish washing



Shishmaref

- Most did laundry and took showers in washeteria
- Observed variety of toilets & honeybuckets

Macerator toilet

Honey bucket

Toilet abandoned for honey bucket given high electricity costs

Toilet augmented with used sink water in order to flush

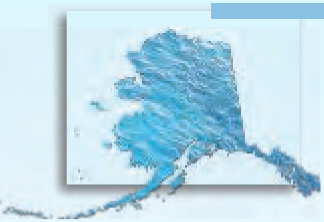
Shishmaref low-cost pump/drain/haul systems

End user input – summary both villages

- Anxiety over high electricity costs
- Preference for rainwater/melted ice-water
- Preference for vestibule attached to the house
- Preference for reducing wastewater haul costs
- Preference to have indoor plumbing and toilet if it can be made affordable

Focus Group posing for photo

HW2S and Mock Household Plumbing Prototype Design



Design-think constraints

Provide a common building enclosure and base layout to accommodate equipment, tankage, and piping arrangements

Use ambient heat transfer from house to vestibule to maintain air temperature

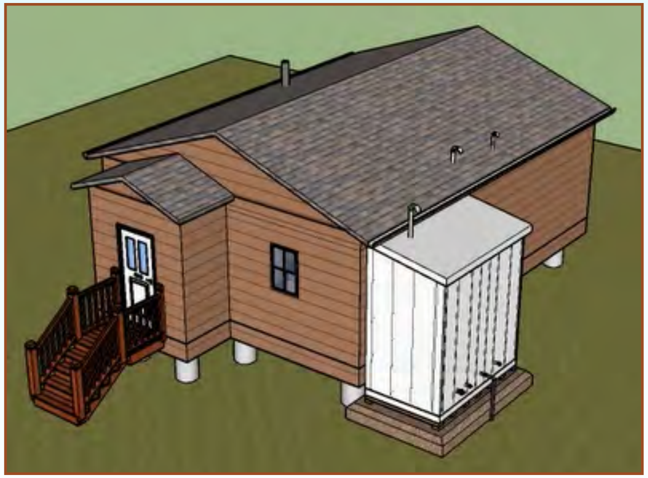
Attach enclosure/vestibule to one side of the house for direct access by end user

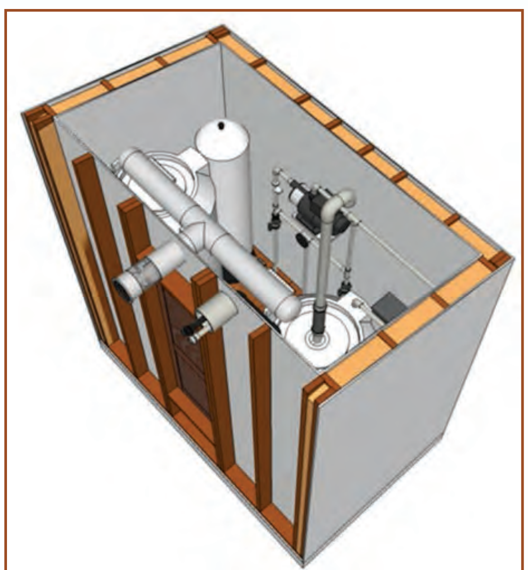
Provide a POU filter system for treatment of melted ice water in the winter and rainwater in the summer for drinking water use

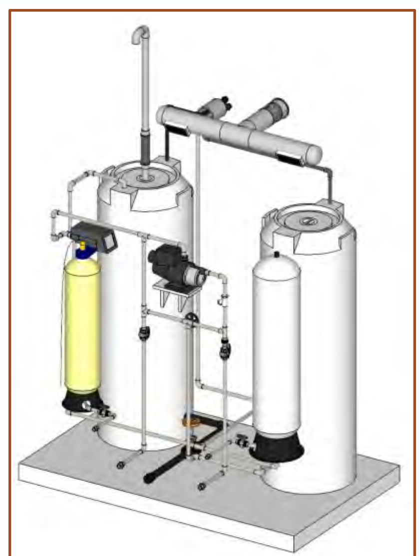
Select technologies to minimize power consumption given the high cost of electricity ($0.64 & $0.67/kW-hr), and avoid use of chemicals not generally available

Design constraints were based on user input

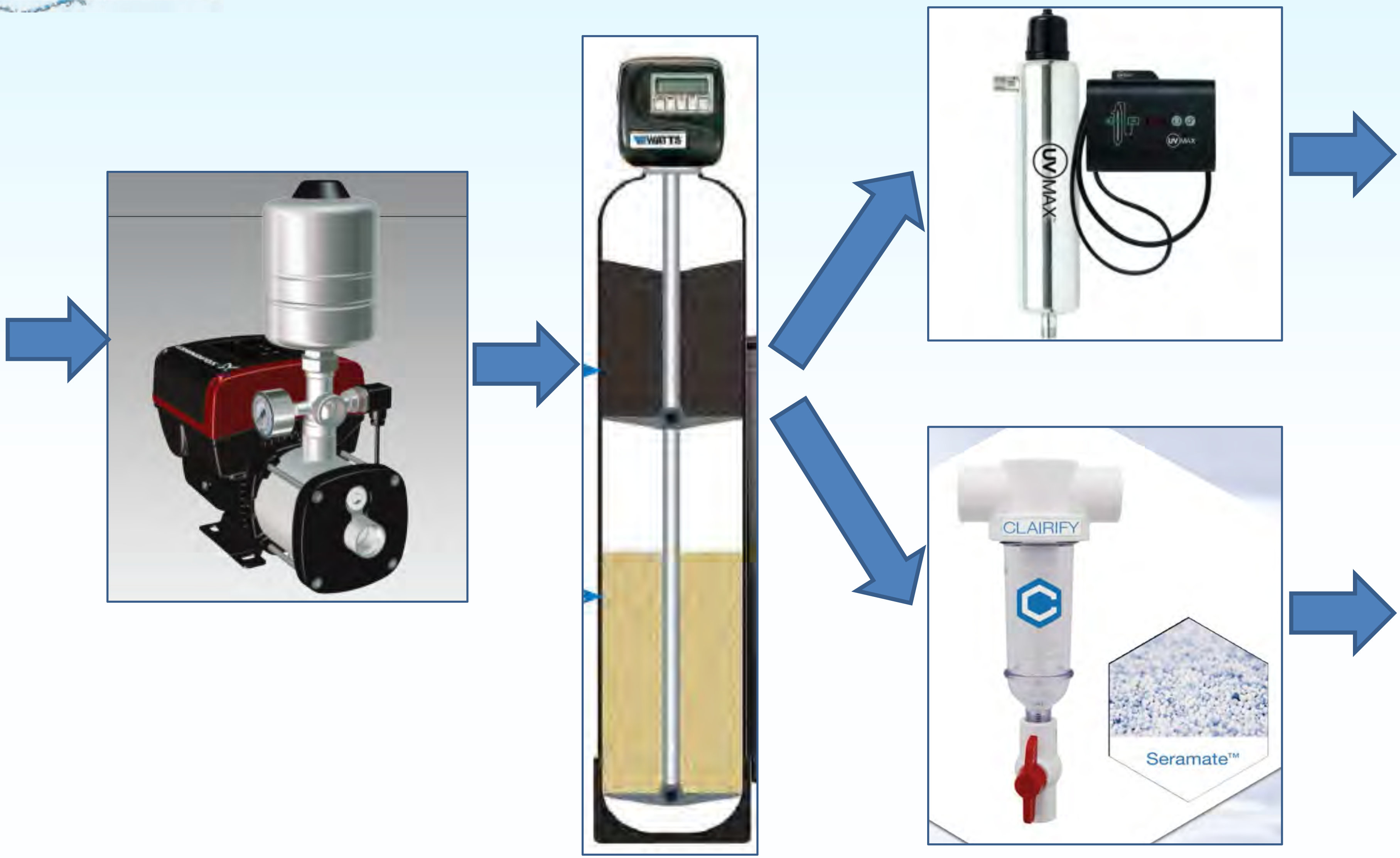
Proposed HW2S system components







Graywater Recycle Treatment Components



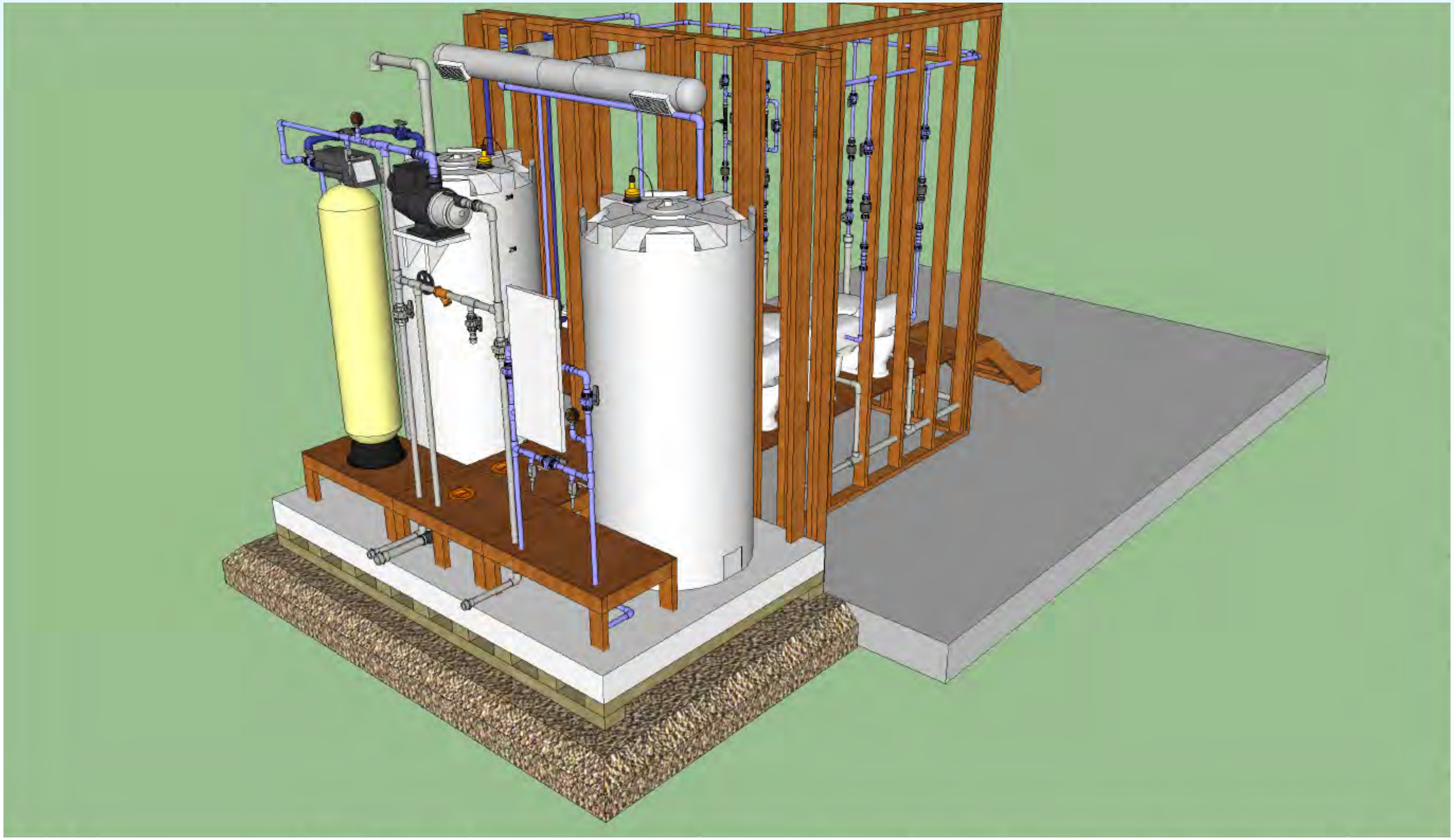
POU Drinking Water Treatment Units

POU Filter Lab Challenge Test Results (April 20, 2016)

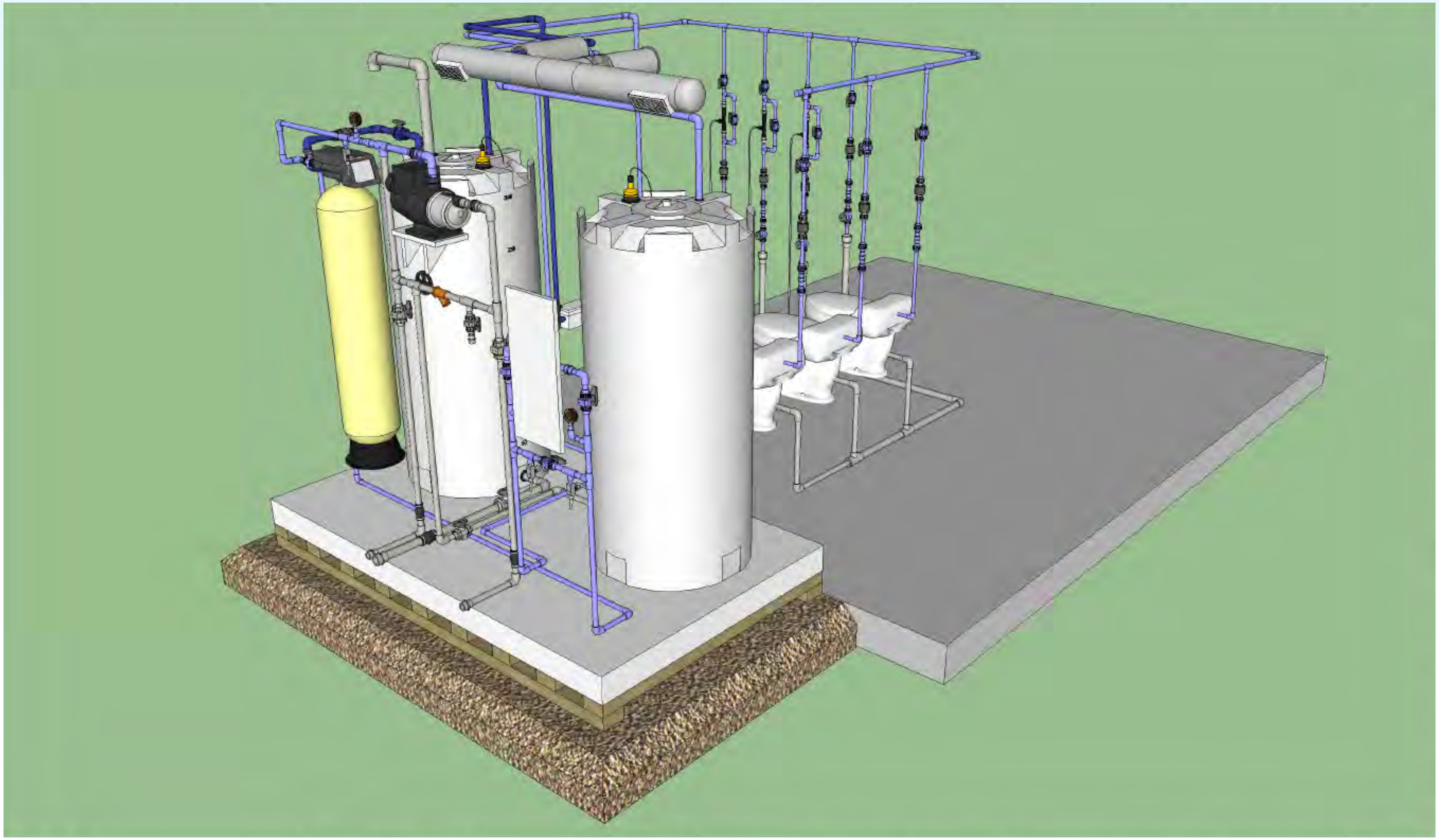
Water Depth Above Filter Cartirdge - inches	Flow L/Hr	Kohler Clarity Filter		Stacked Bucket Filter	
		E. Coli Log Reduction (Log)	Outlet E.Coli concentration (CFU/100 mL	E. Coli Log Reduction (Log)	Outlet E.Coli concentration (CFU/100 mL
10.5	3.4	NA	<1	> 6.6	<1
7	2.3	NA	<1	> 6.6	<1
3 (5 liters)	0.9	> 7.1	<1	> 6.6	<1
1.8 (3 liters)	0.5	> 7.1	<1	> 6.6	<1
0.9 (1.5 liters)	0.3	> 7.1	<1	> 6.6	<1

3D Model—HW2S Prototype System

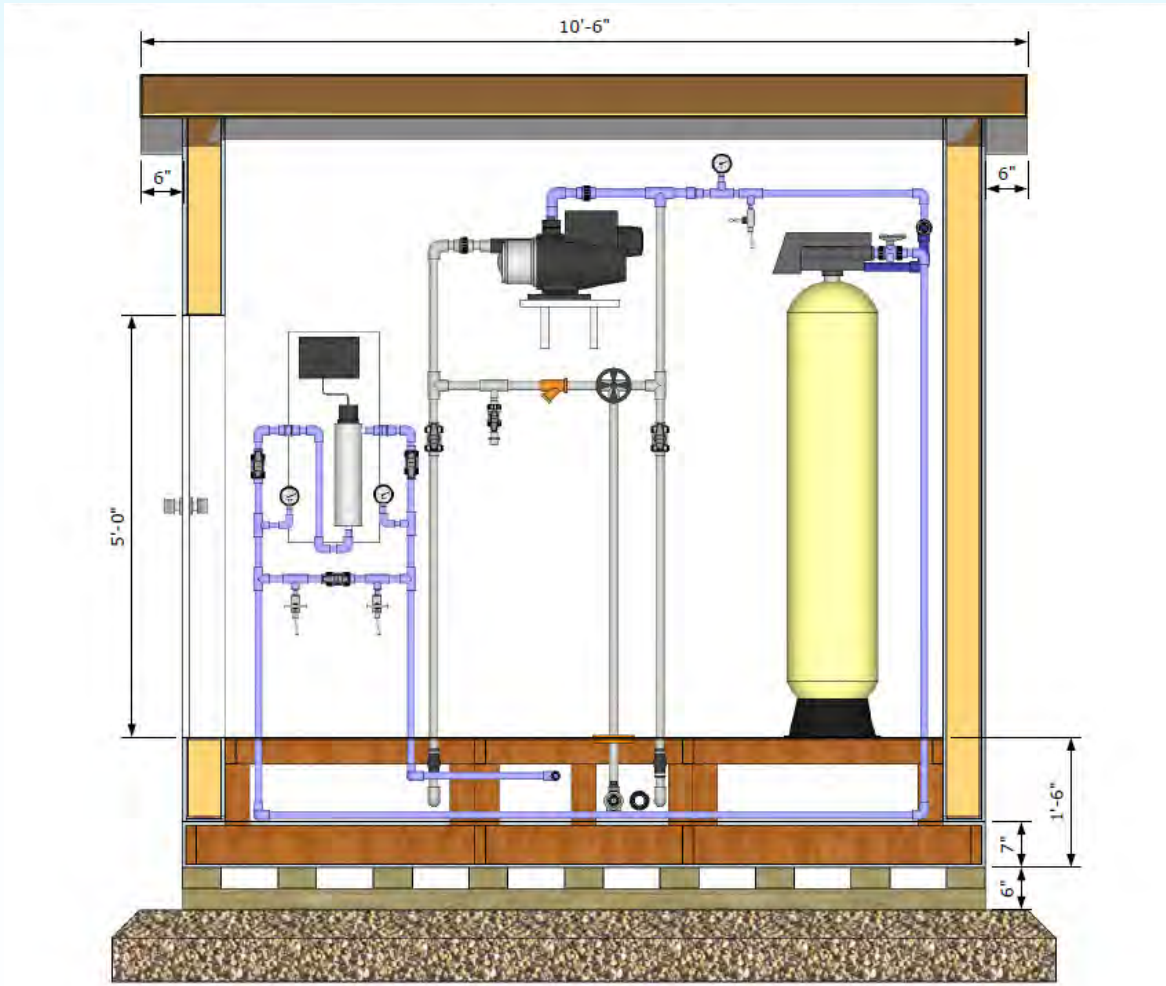
3D Model—HW2S Prototype System



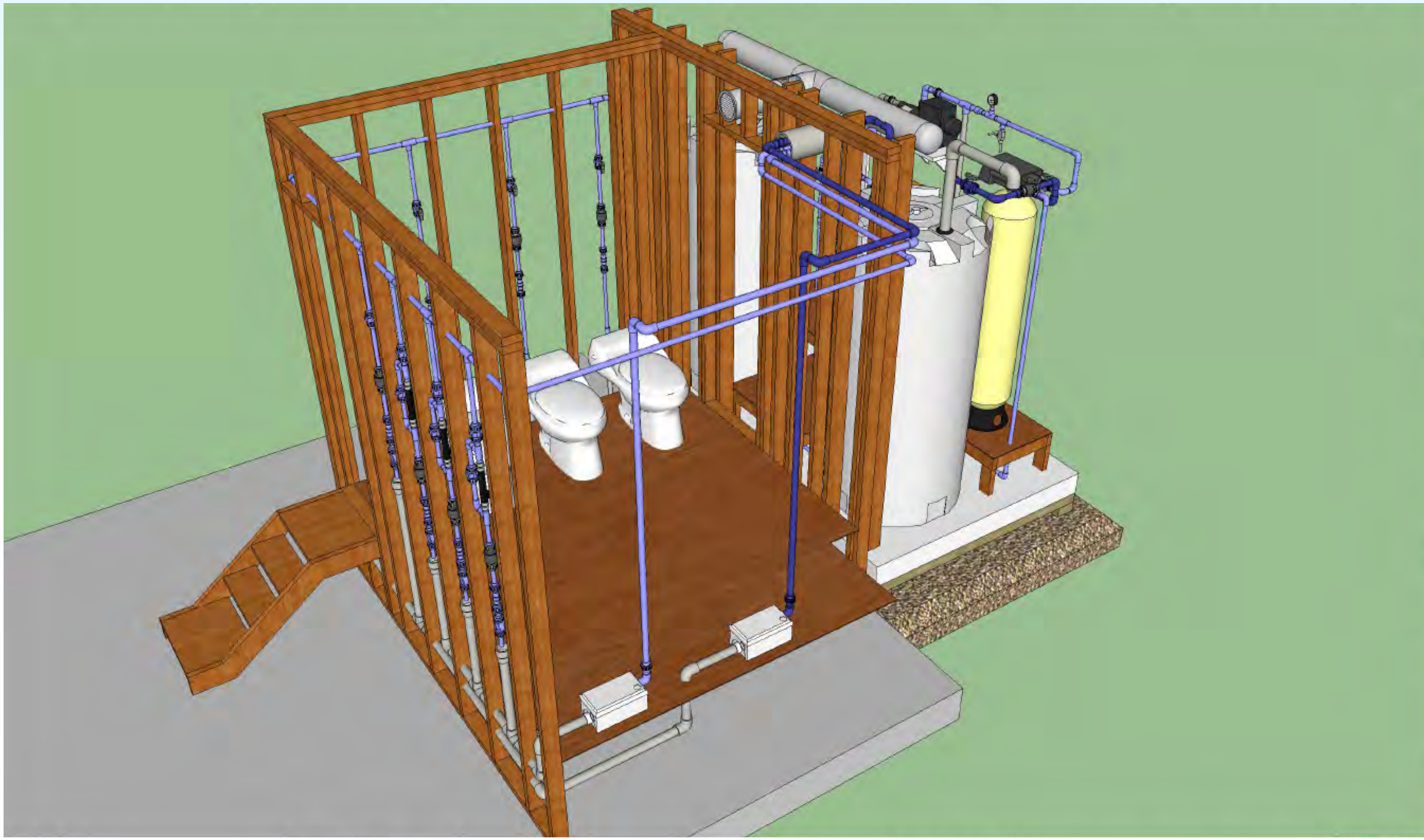
3D Model—HW2S Prototype System



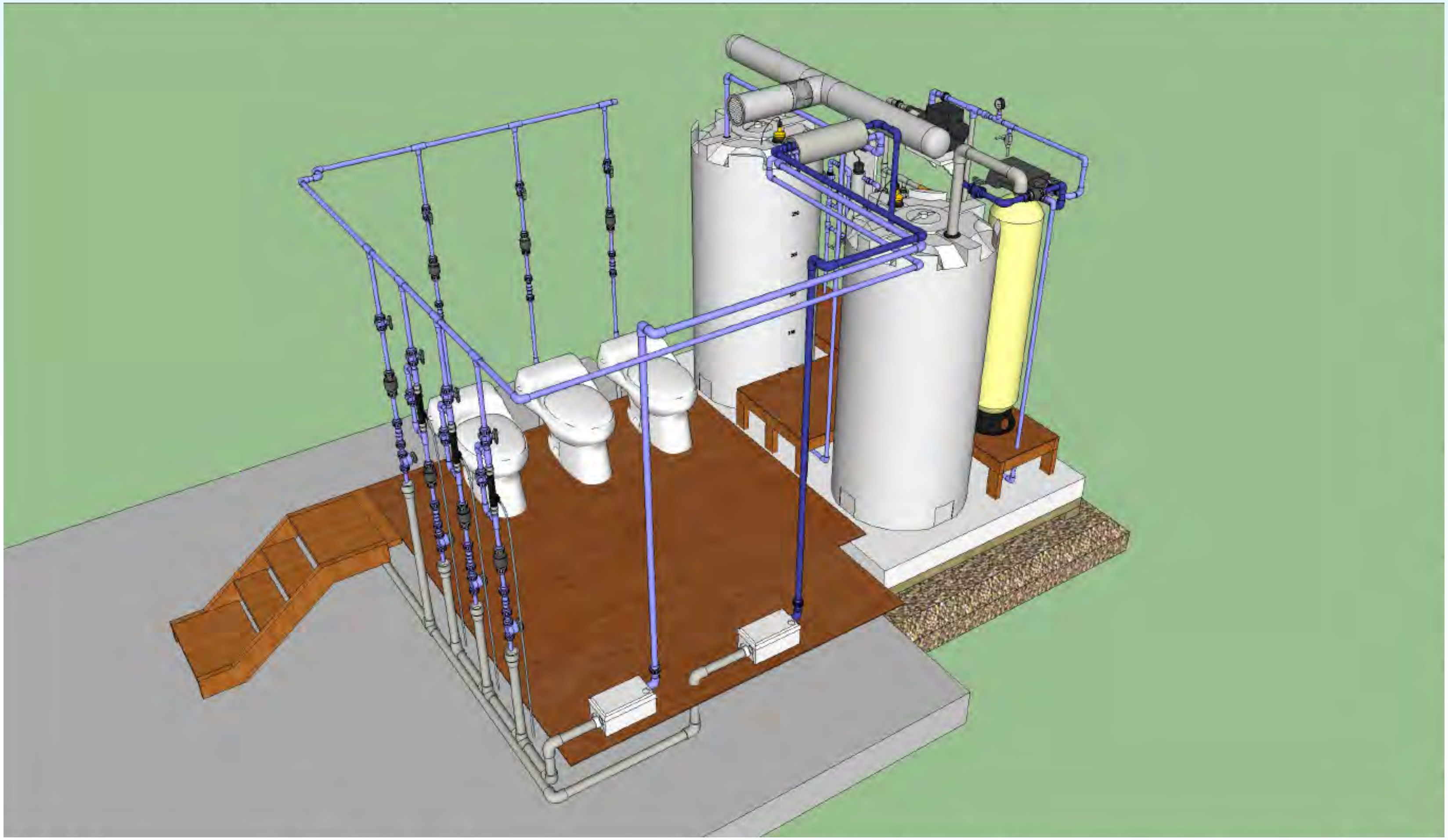
3D Model—HW2S Prototype System



3D Model—Mock Household Plumbing System



3D Model—Mock Household Plumbing System

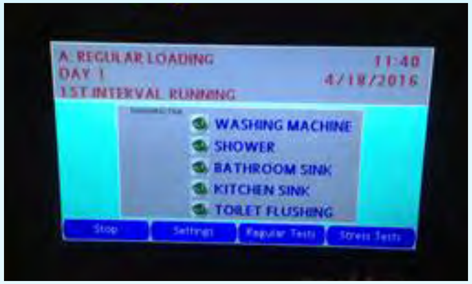


HW2S Prototype Testing

HW2S Prototype Test Plan Highlights

- 9-month test period with 1 regular flow scenario and12 stress flow scenarios
- Three DW and GW sources: rainwater, river water and pond water
- PLC-based continuous monitoring of five plumbing fixtures, BW/GW tank levels and power usage
- Daily water fill and flow rate monitoring for POU filters
- Weekly LVF toilet flushing tests for bulk waste removal
- Monthly sampling of raw, treated DW and treated GW flows to meet USEPA and NSF water quality standards

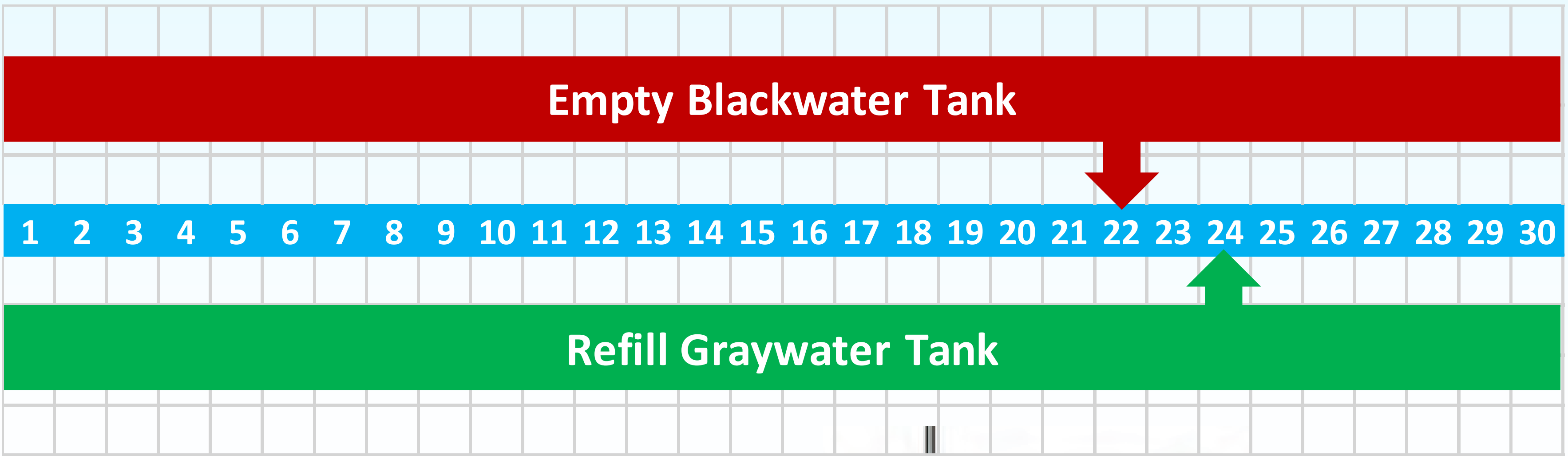
Regular and Stress Test Flow Scenarios

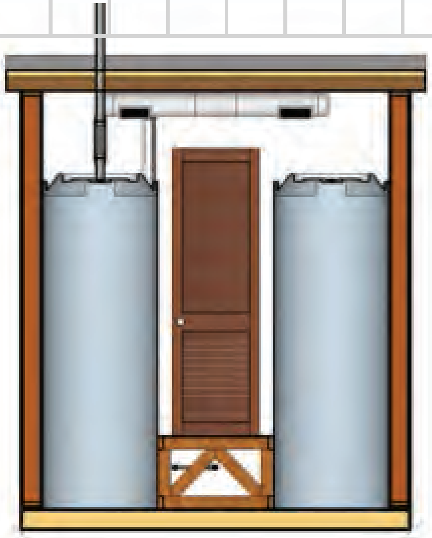


Scenario Label	Scenario Description
A	Regular Loading - water demand varies as percent of prototype treatment capacity for three 3-hour intervals each day
B	Freeze-Thaw Stress - Prototype fully drained and allowed to freeze for 24 hours, left for 2 days, and then warmed up and put back into service for 24 hours at regular hydraulic loading
C	Wash Parent Stress- water demand is 40% of prototype treatment capacity in morning and 60% in evening
D	Wash Vacation Stress- water demand varies as percentage of prototype treatment capacity on Day 1 and Day 9 with no water demand in between for 8 consecutive days
E	Wash Day Surge Stress- water demand varies as multiplier of prototype treatment capacity
F	Power Equipment Failure Stress- Water demand is 40% of daily capacity in evening, followed by power shutdown for 48 hours, followed by restoring power and hydraulic loading of 60% of capacity
G	Wash Water Efficiency Stress- Water demand is 40% of regular loading with greywater concentration factor of 1.4

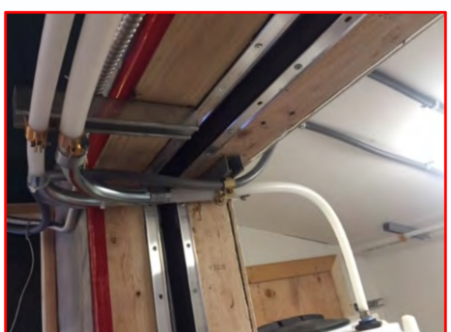
30-day refill/empty cycle for 310-gallon GW and BW tanks

Refill water tank every **24** days and empty waste tank every **22** days





HW2S Vestibule Structure



HW2S Equipment Inside Vestibule

Mock Household Plumbing Structure

Mock Household Plumbing System

THANK YOU

Reuse Water AK

Alaska Water Sewer Challenge by UAA

Presented by

Aaron D. Dotson

Associate Professor and Team Leader

2016 Alaska Water & Wastewater Management Association Conference

Project Funding

Work to date has been supported by

Alaska Department of Environmental Conservation

Our Team

UAA Civil Engineering Program
UNIVERSITY of ALASKA ANCHORAGE

UAA Master of Public Health Program
UNIVERSITY of ALASKA ANCHORAGE

College of Engineering & Applied Science
UNIVERSITY OF COLORADO BOULDER

UNC GILLINGS SCHOOL OF GLOBAL PUBLIC HEALTH

USC Viterbi
School of Engineering

UBC THE UNIVERSITY OF BRITISH COLUMBIA

DALHOUSIE UNIVERSITY

POLYTECHNIQUE MONTRÉAL

First Nations Health Authority
Health through wellness

ALASKA NATIVE TRIBAL HEALTH CONSORTIUM

Cold Climate Housing Research Center
CCHRC

streamlineAM

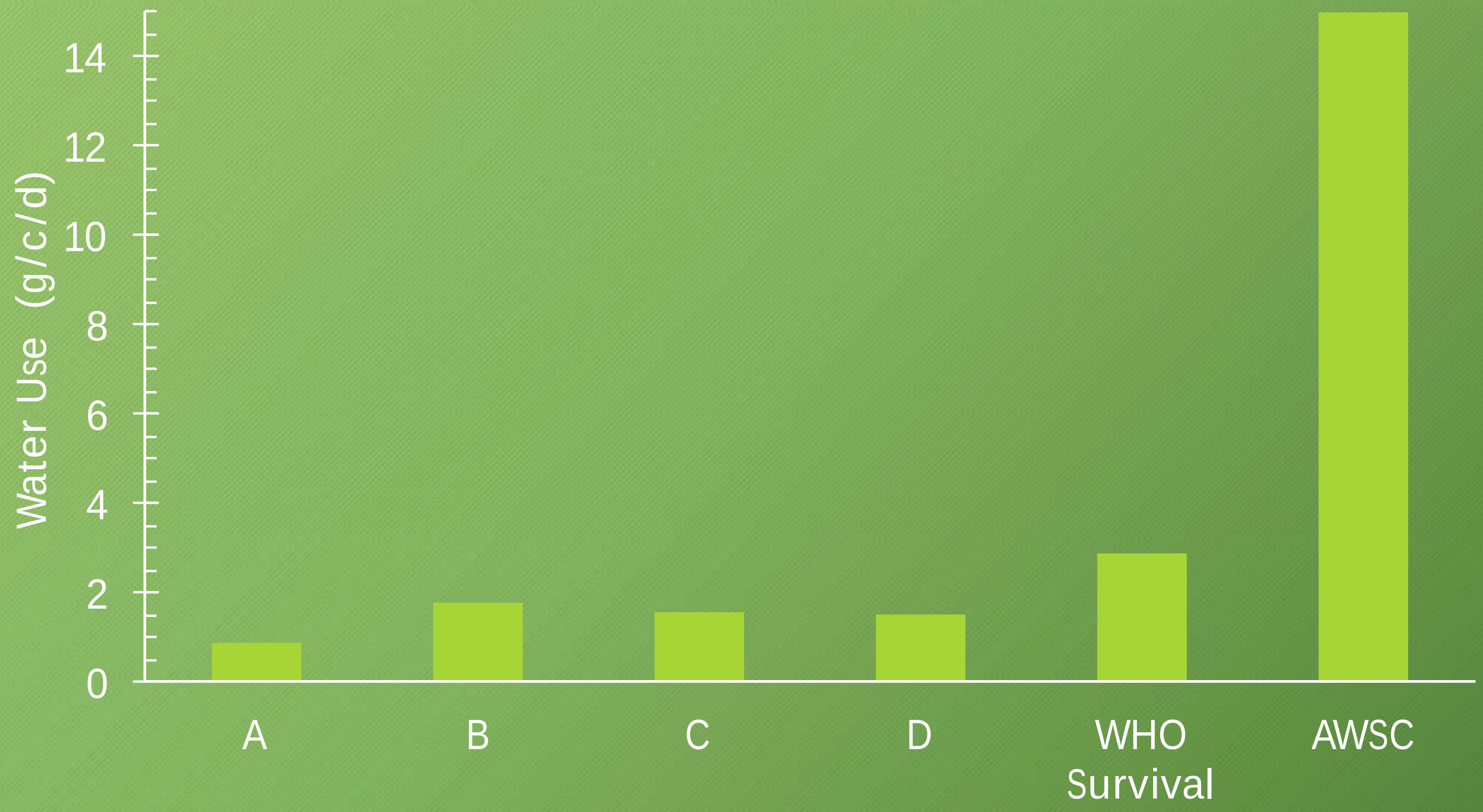
GV Jones & Associates, Inc.
WATER AND WASTEWATER PROCESS ENGINEERS

MWH®

SOUTHERN NEVADA WATER AUTHORITY®

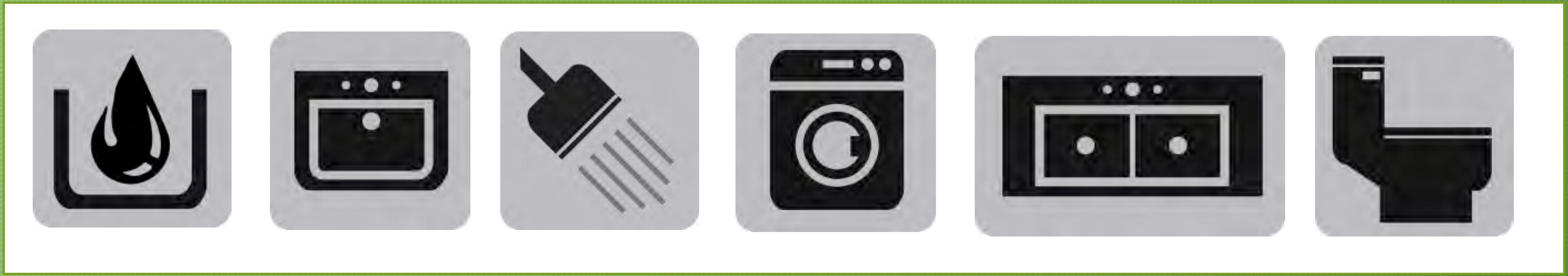
The Situation

http://www.who.int/water_sanitation_health/publications/2011/WHO_TN_09_How_much_water_is_needed.pdf?ua=1
Thomas et al., (2016) Impact of providing in-home water service on the rates of infectious diseases: results from four communities in Western Alaska. *Journal of Water & Health* p.132

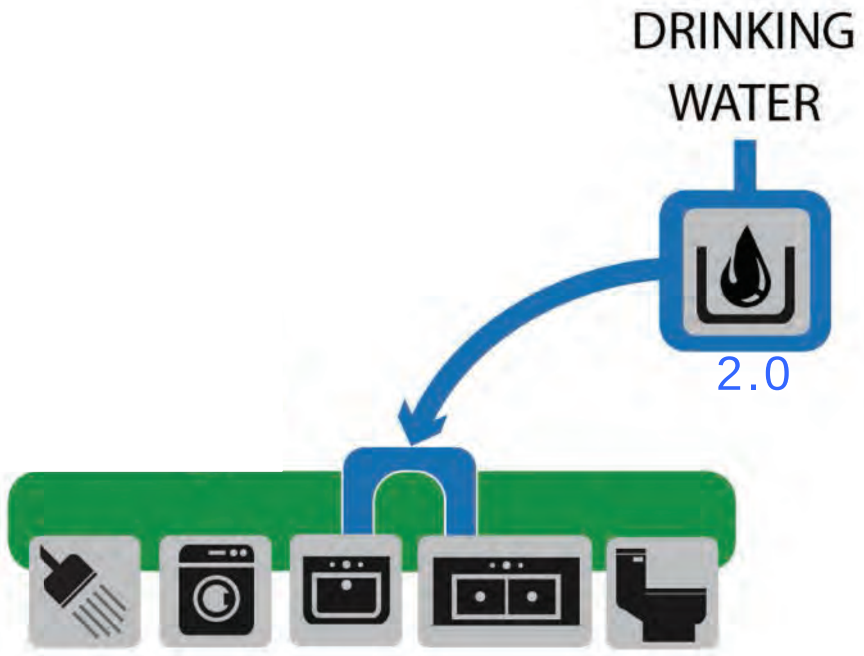


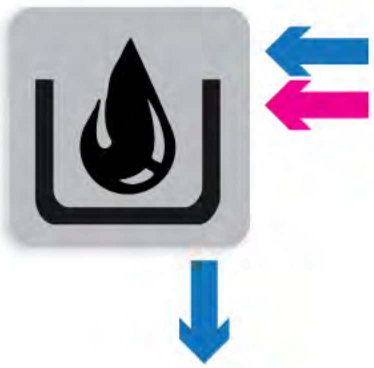
Our Modules

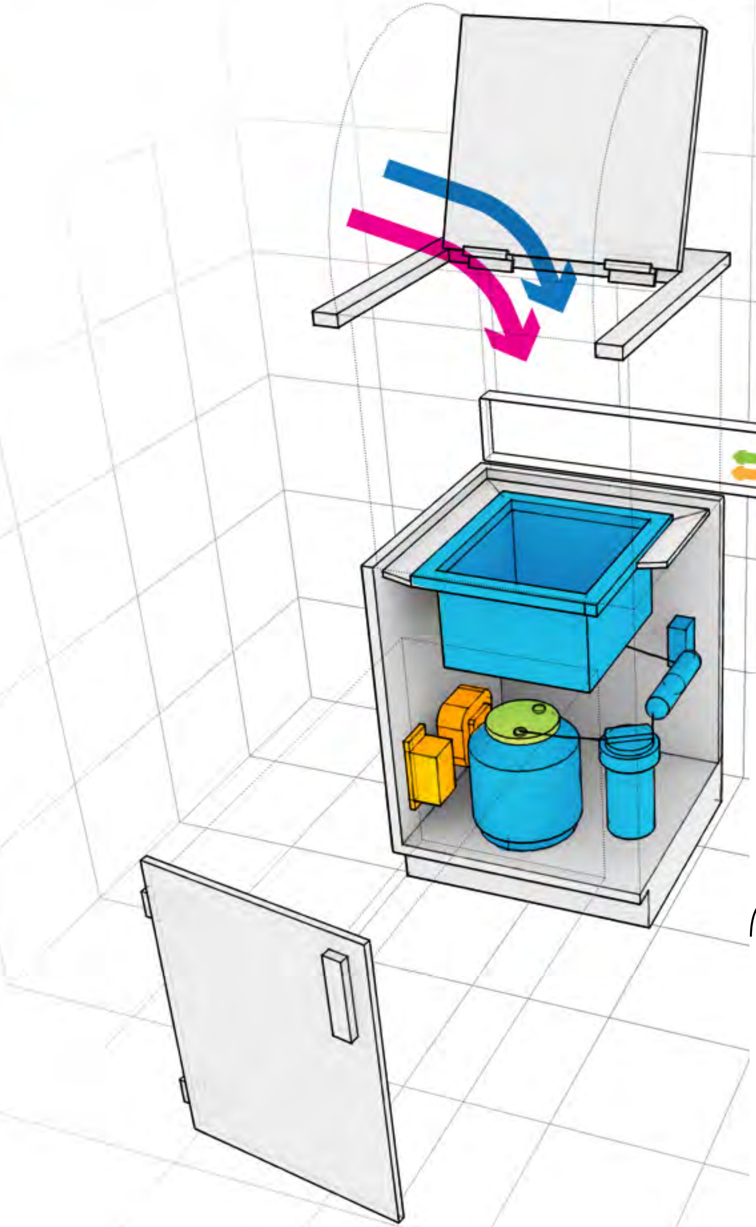
In-Home Modules



Core Module

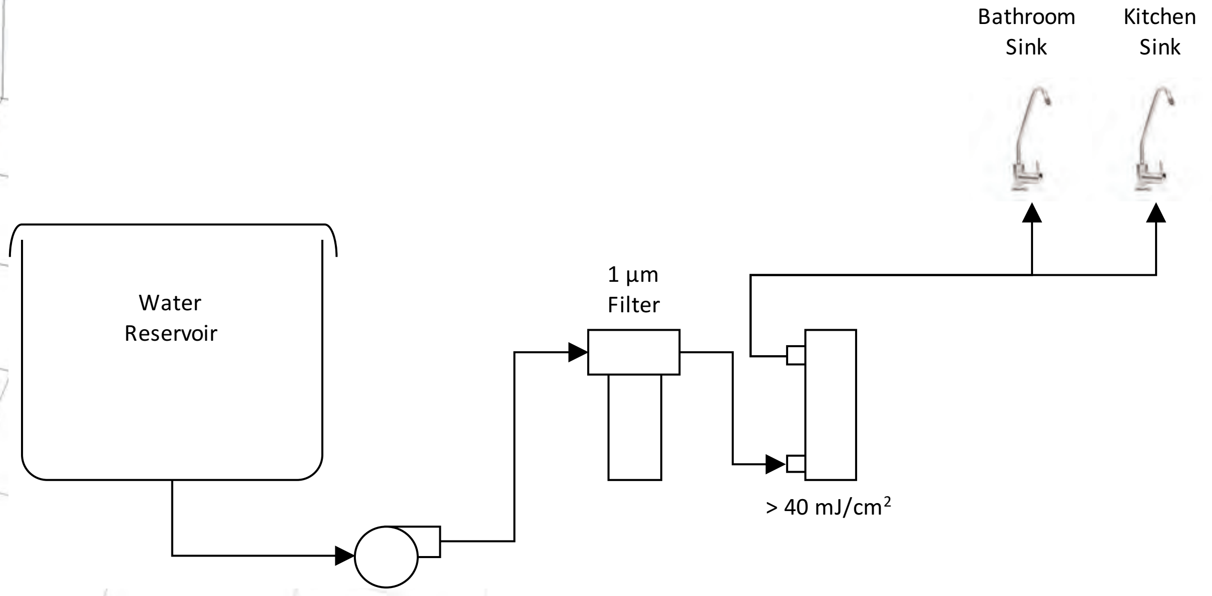

DRINKING
WATER
2.0

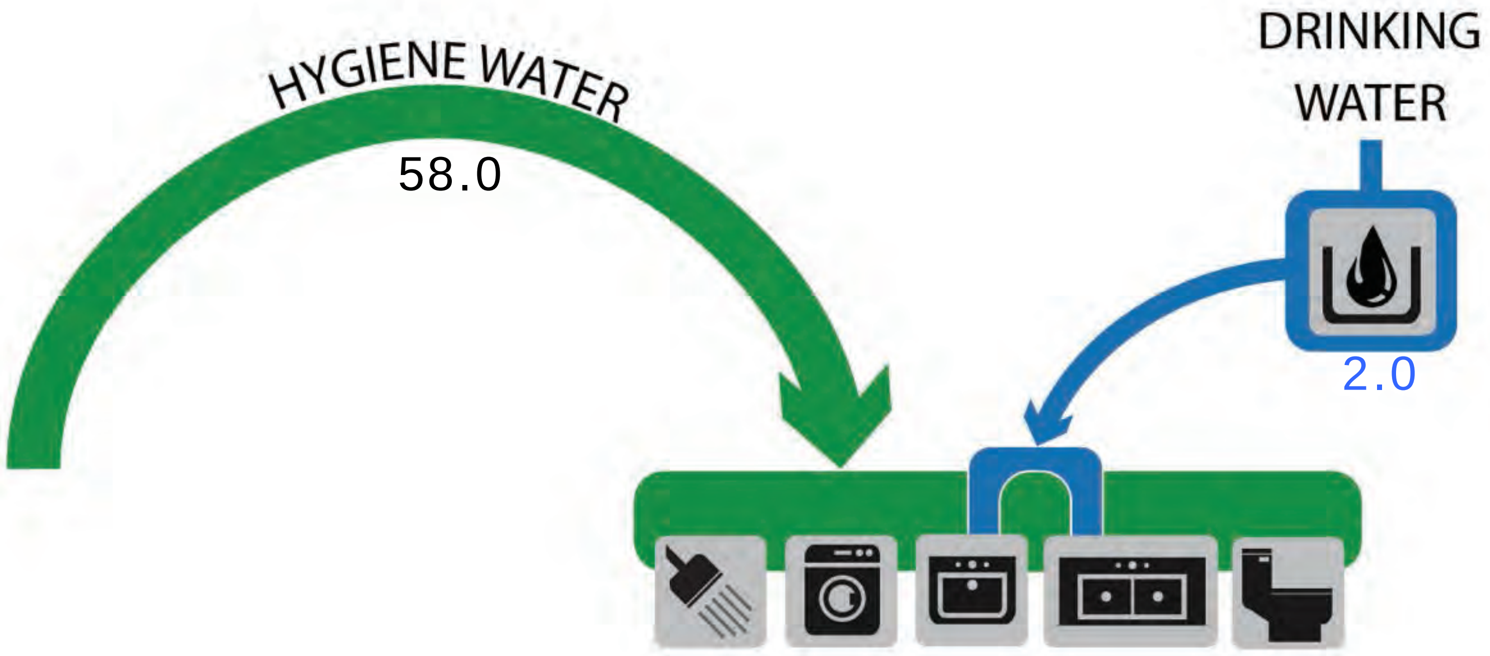




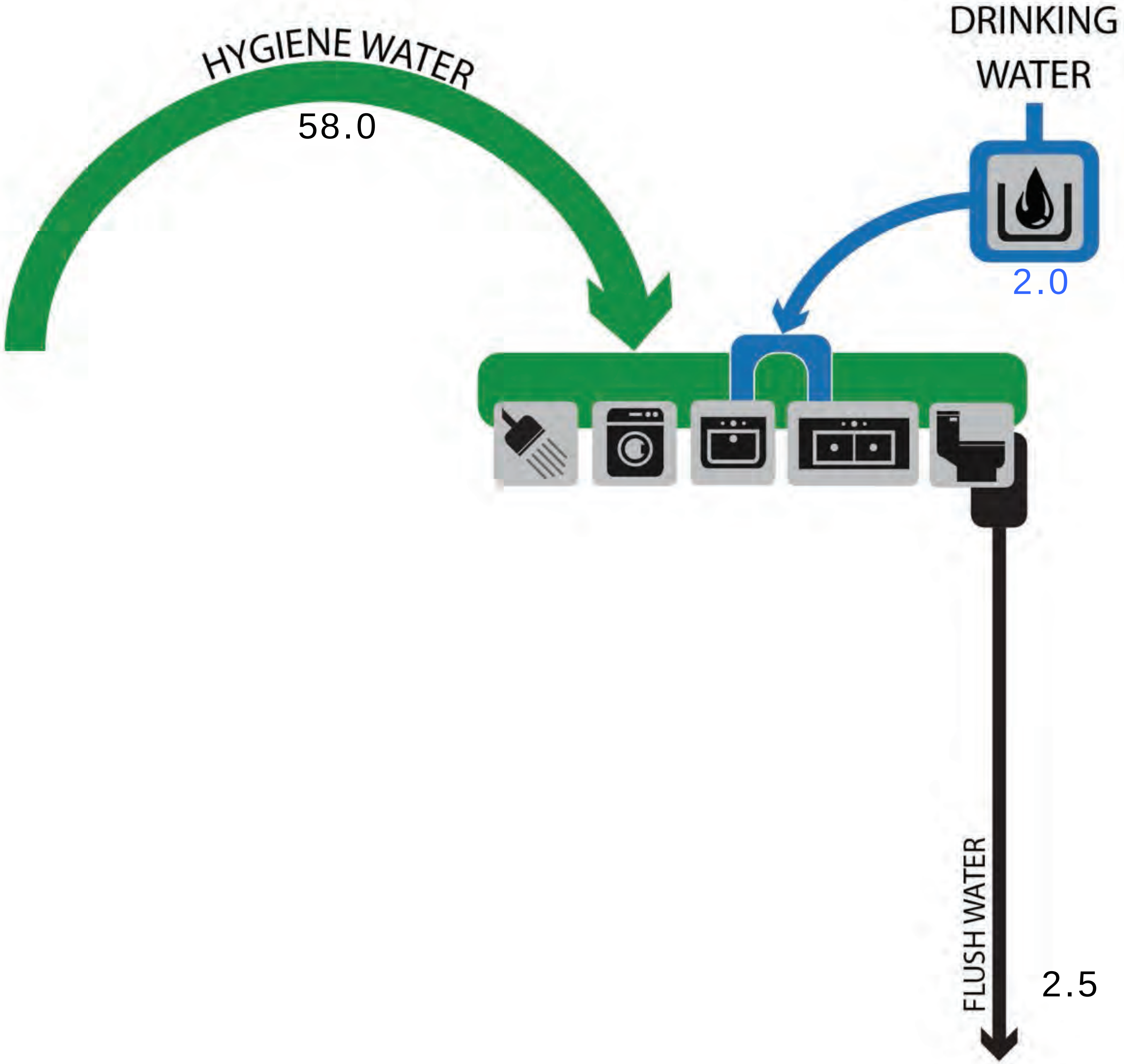
COLOR KEY

- COMPRESSED AIR
- CONTROLS AND POWER
- NATURAL WATER
- WASHETERIA (DRINKING) WATER
- TREATED NON-POTABLE WATER
- GREYWATER
- LIQUID BLACKWATER
- TREATED LIQUID BLACKWATER
- HAULED BLACKWATER





HYGIENE WATER
58.0
DRINKING
WATER
2.0



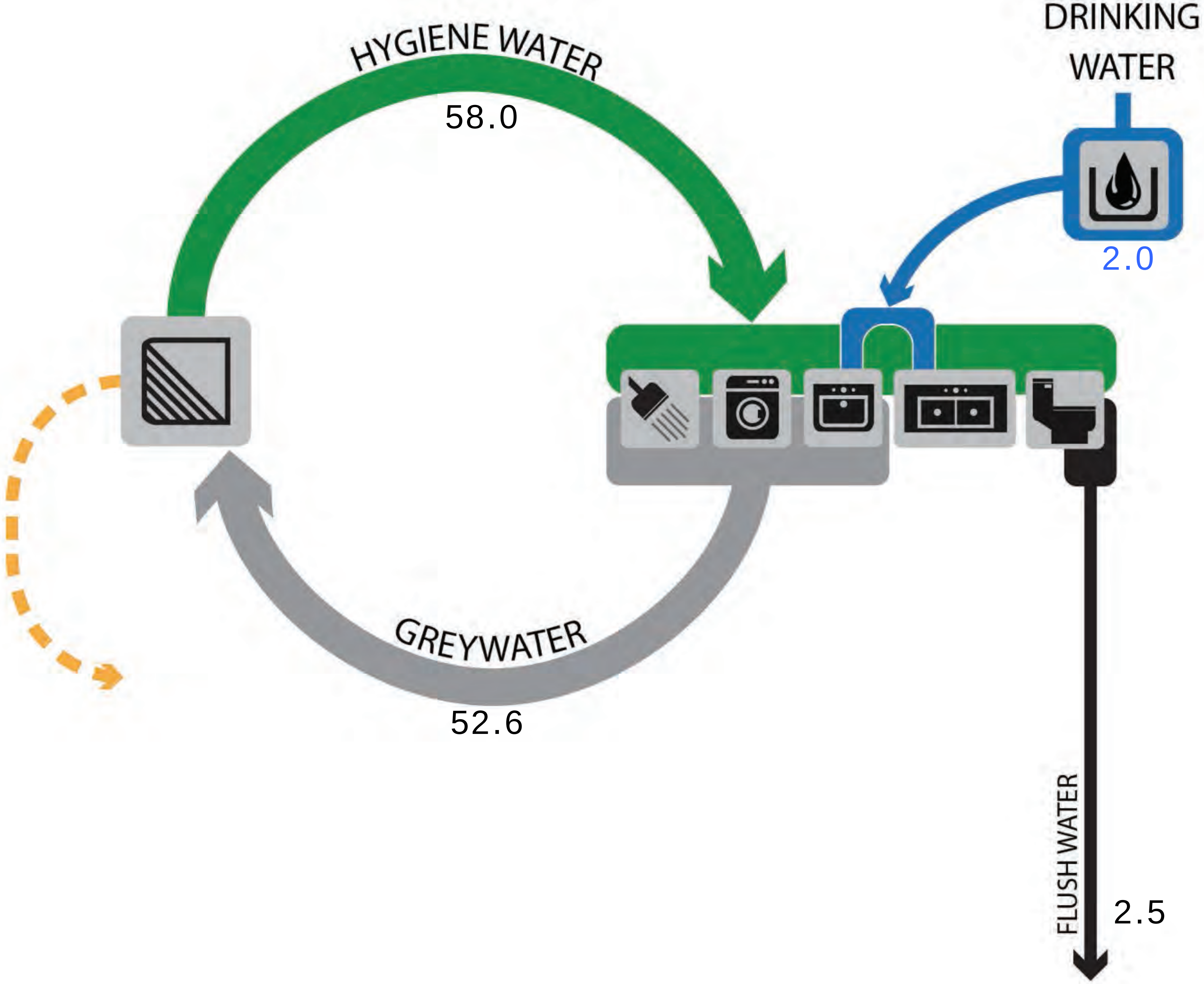
HYGIENE WATER
58.0
DRINKING WATER
2.0
FLUSH WATER
2.5

Enabled by a Separating Toilet

Wostman EcoFlush Separating Toilet

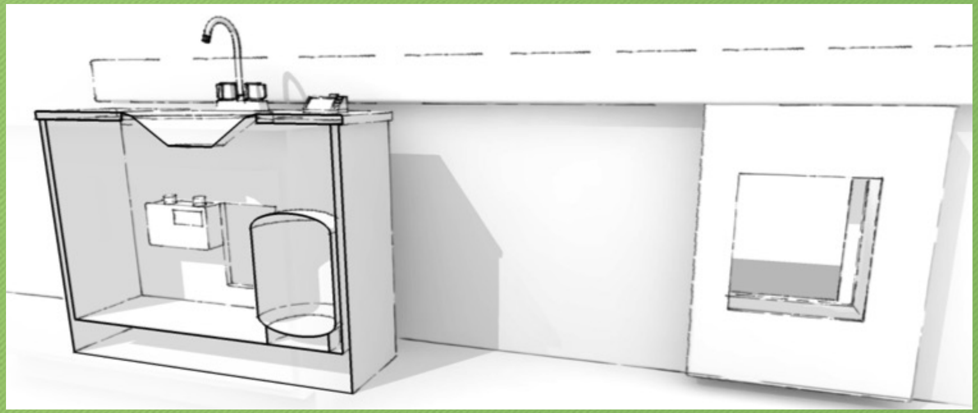
0.05 gal per urine flush

0.66 gal per full flush

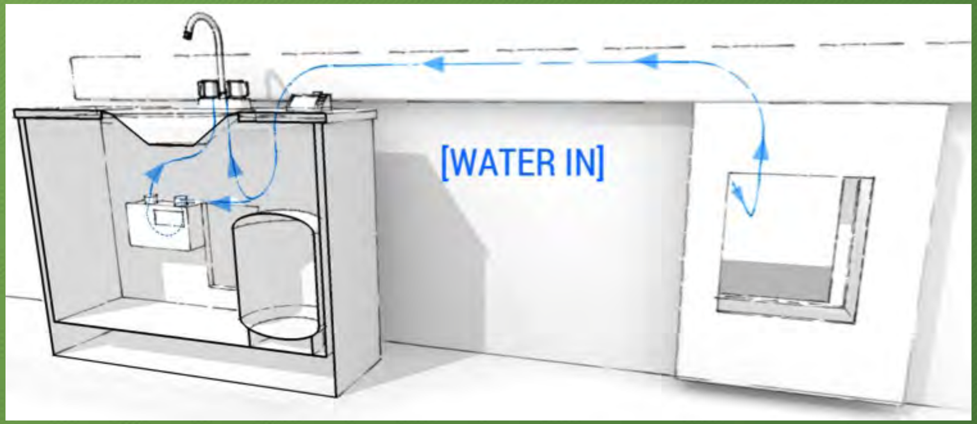


HYGIENE WATER
58.0
DRINKING
WATER
2.0
GREYWATER
52.6
FLUSH WATER
2.5

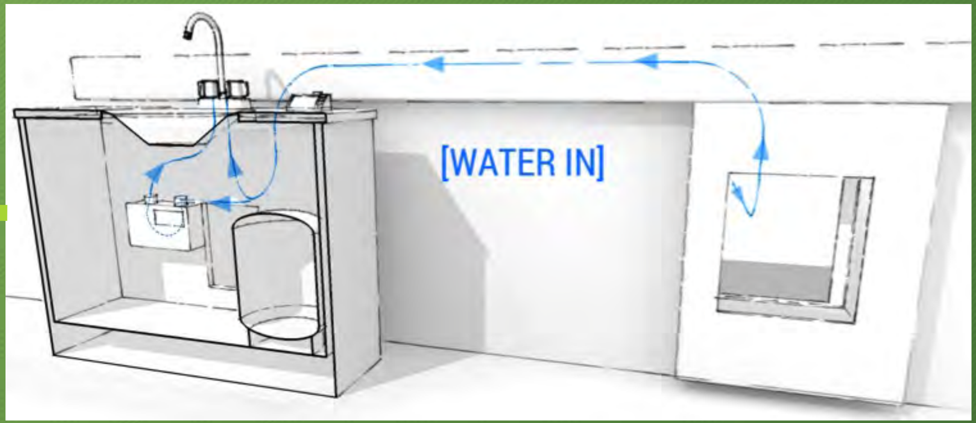
Where we were… End of Phase 2



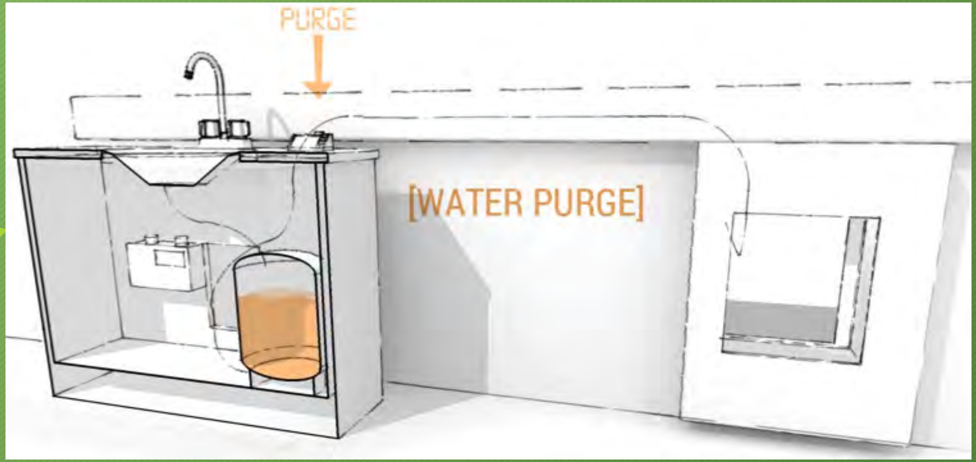
Air Driven Plumbing



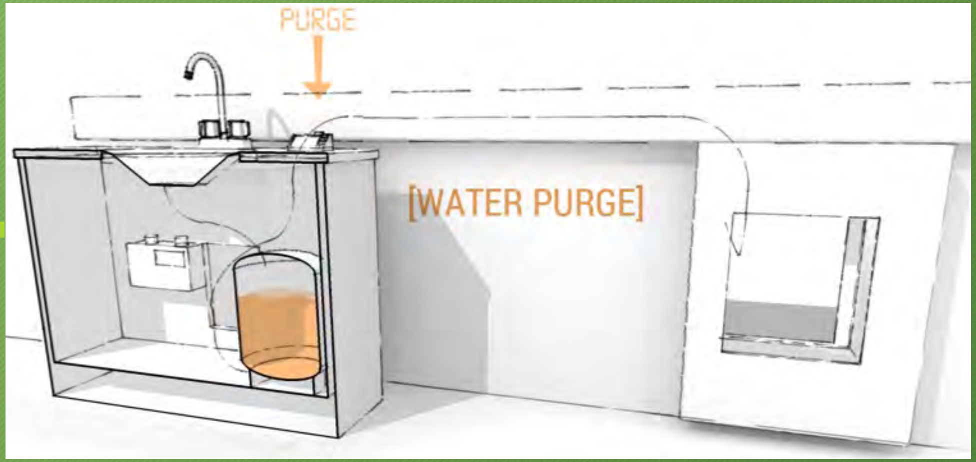
Where we were… End of Phase 2



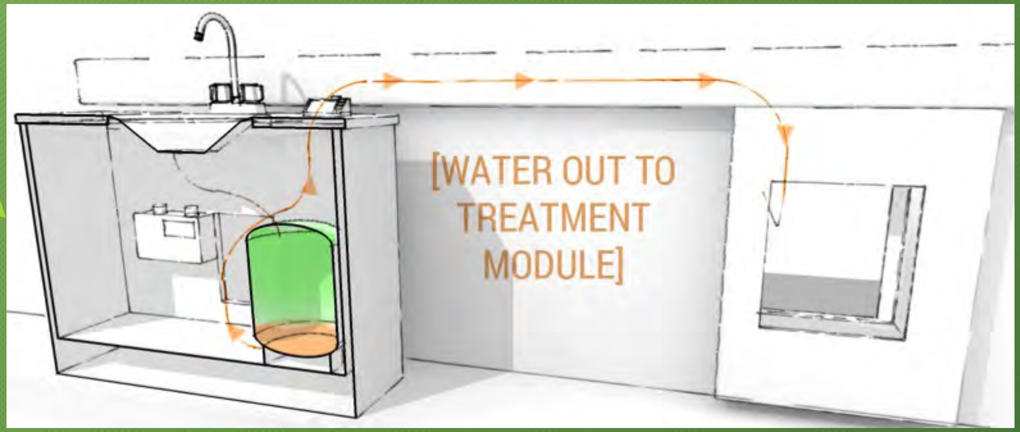
Innovation &Modularity
Air Driven Plumbing
Pre-Visit #2 - Design



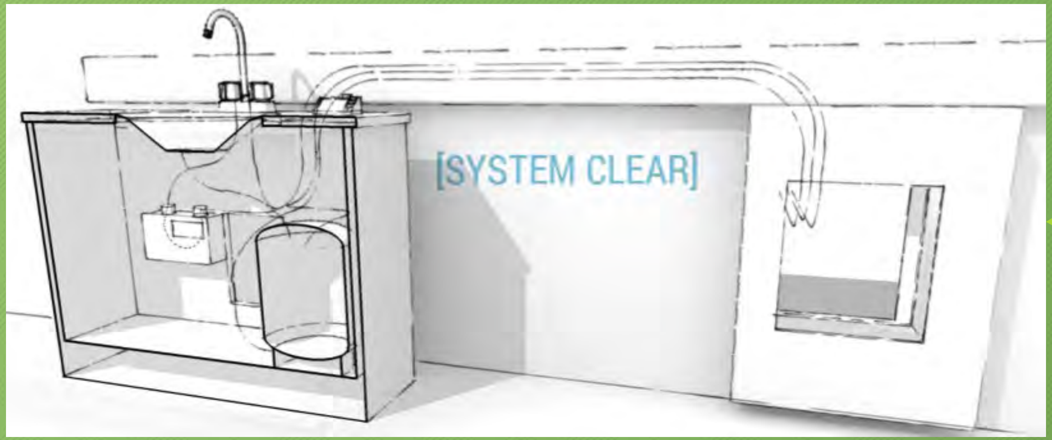
Innovation &Modularity
Air Driven Plumbing
Pre-Visit #2 - Design

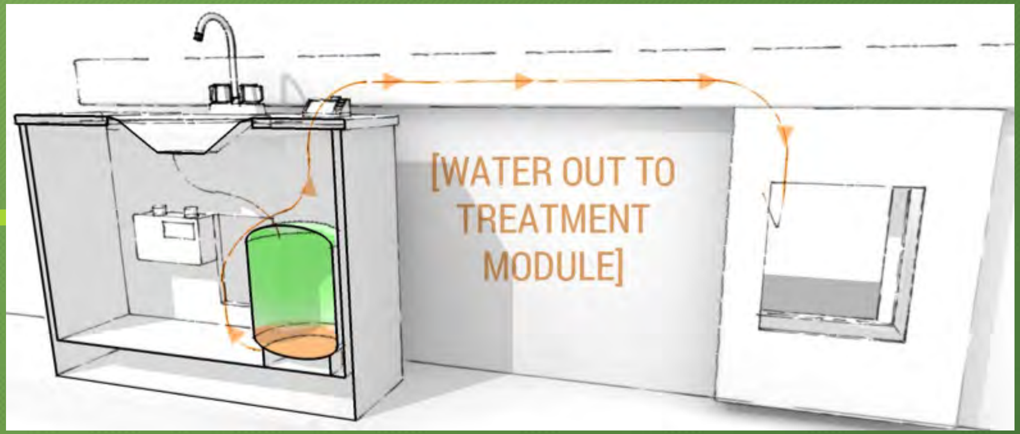


Innovation &Modularity
Air Driven Plumbing
Pre-Visit #2 - Design



Where we were… End of Phase 2



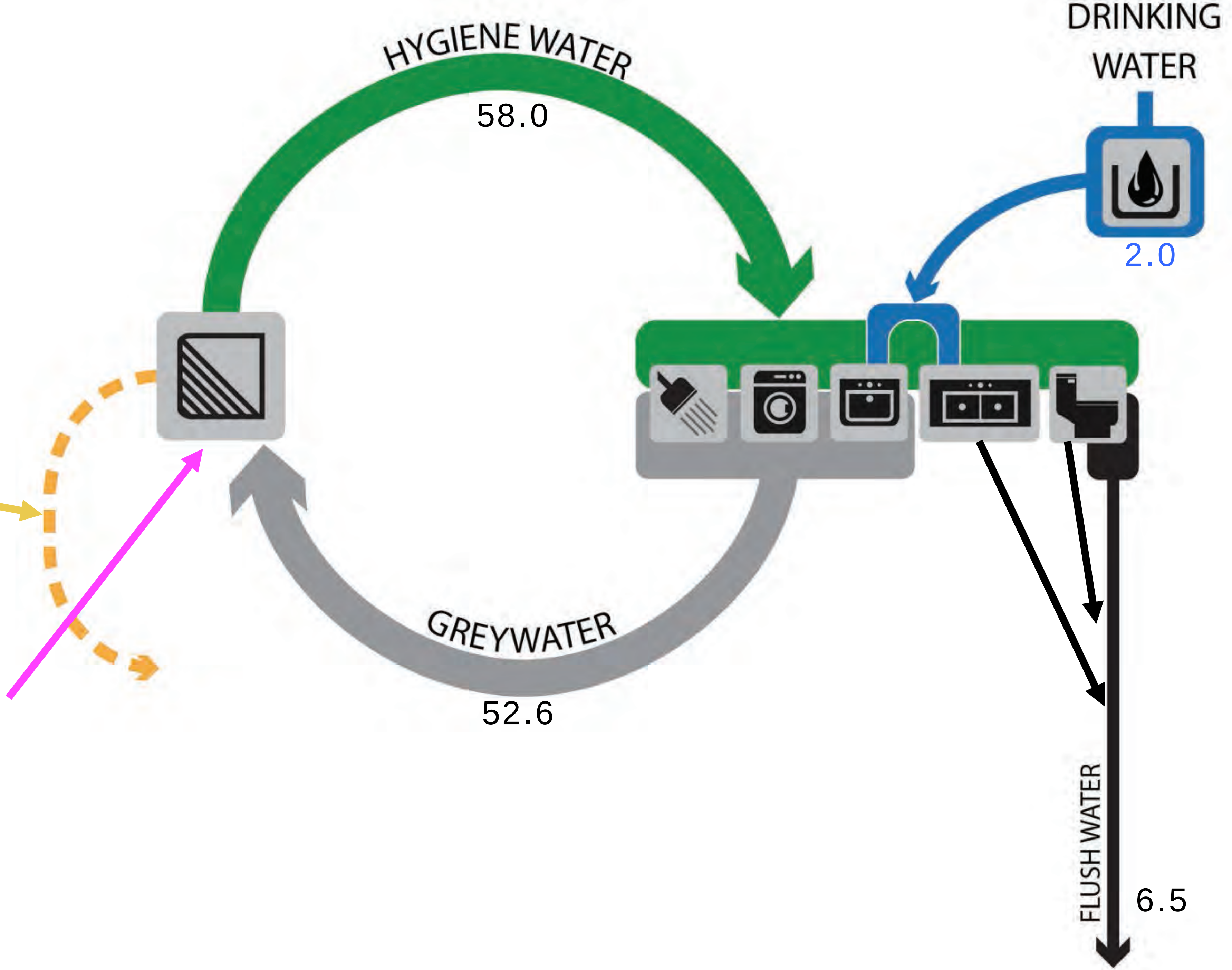


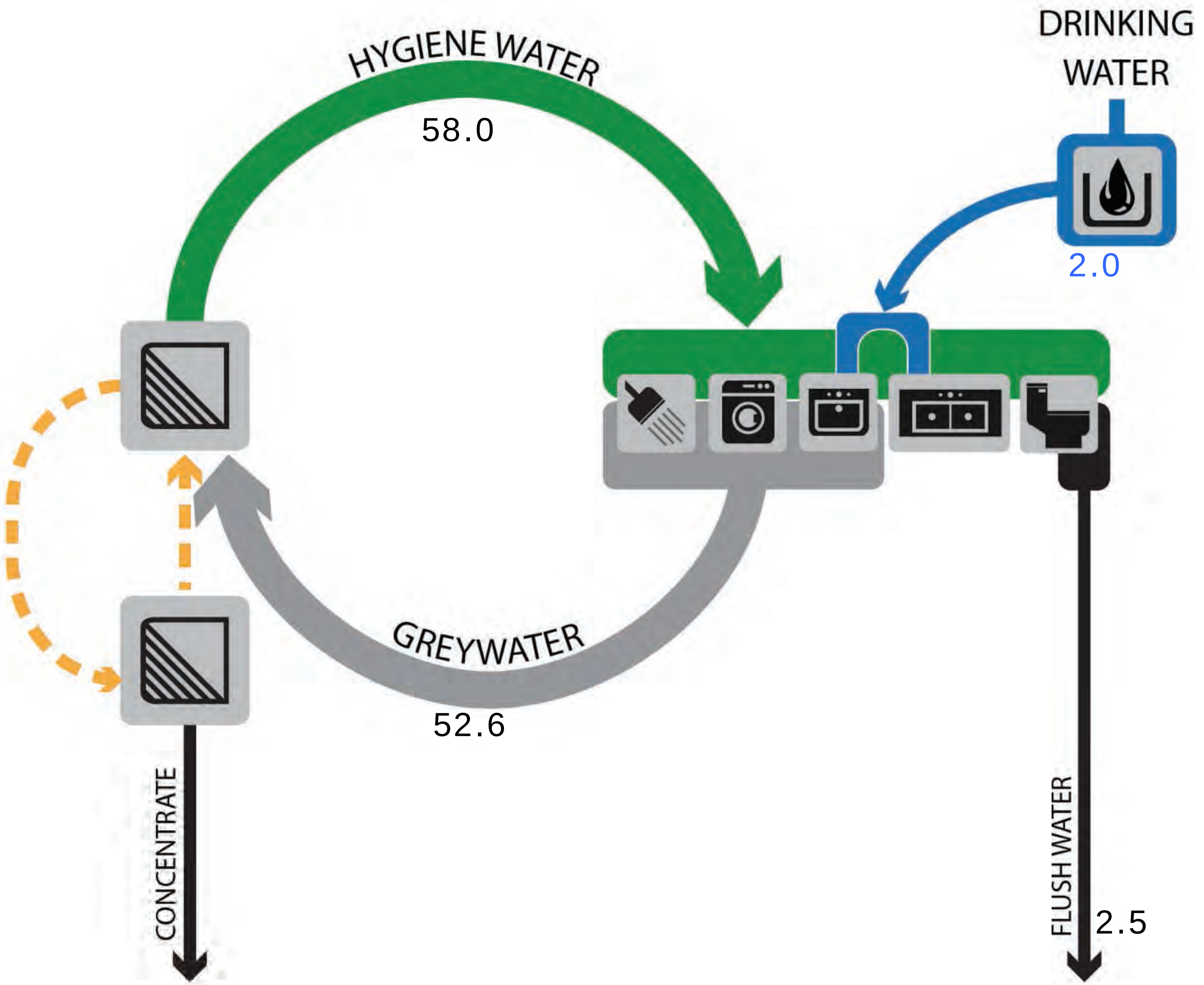
If we stopped here:

INPUT
Drinking Water
2 gpd

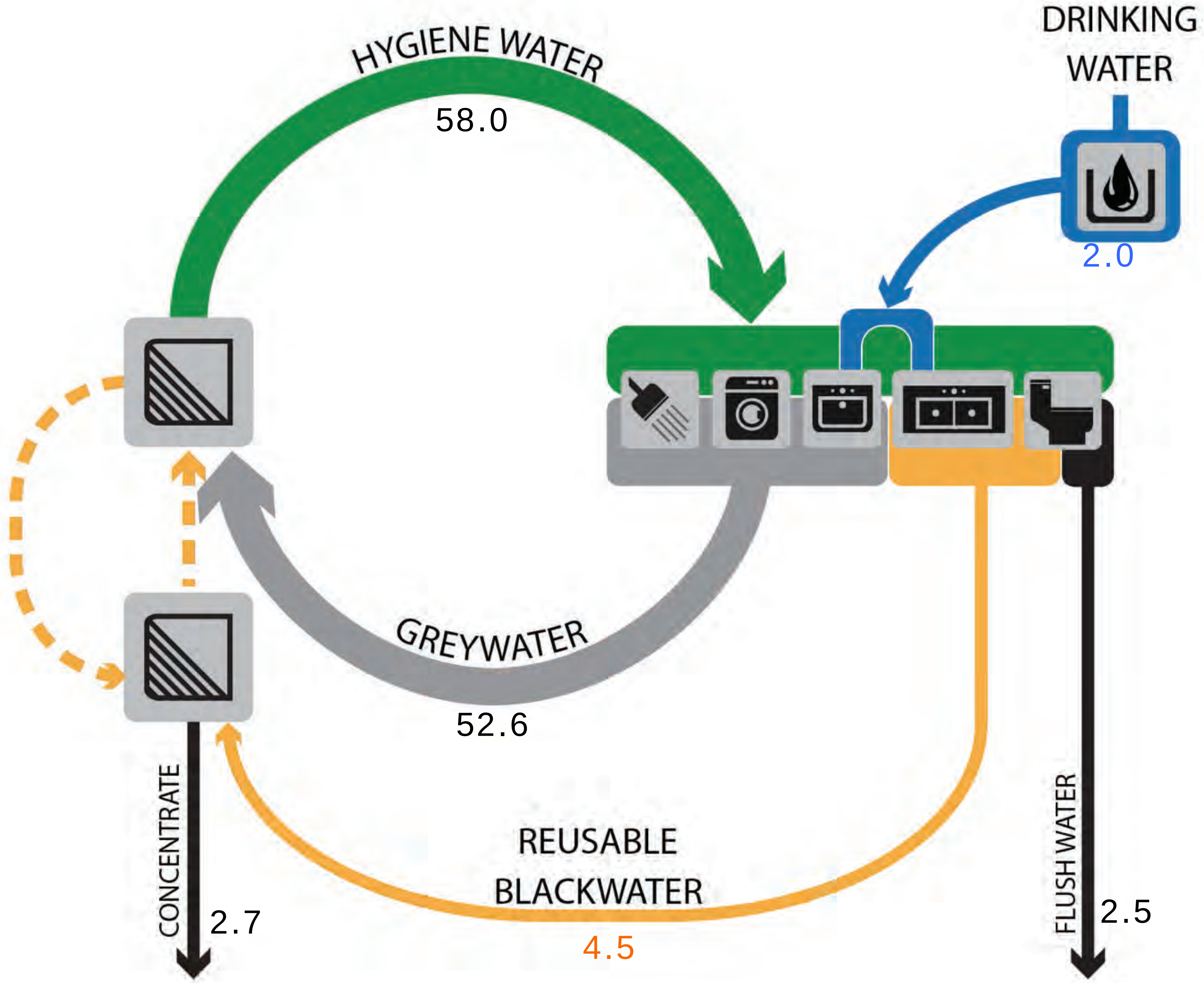
HAULED
Toilet+Kitchen Sink
7.0 gpd
Concentrate
6.4 gpd
=======
12.9 gpd
(includes ~1 gpd of urine)

INPUT
Replacement Water
11.9 gpd





HYGIENE WATER
58.0
DRINKING WATER
2.0
GREYWATER
52.6
CONCENTRATE
FLUSH WATER
2.5

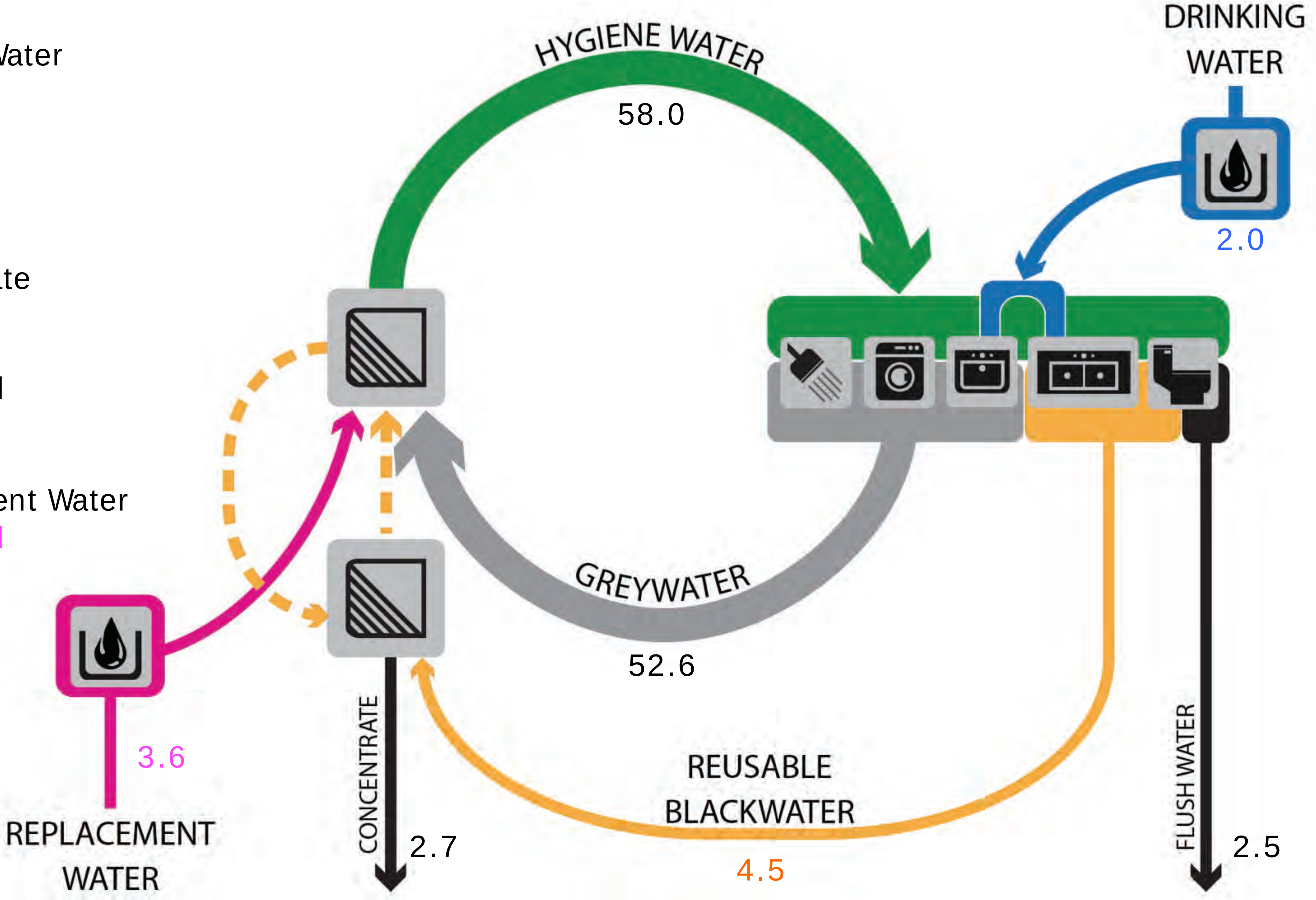


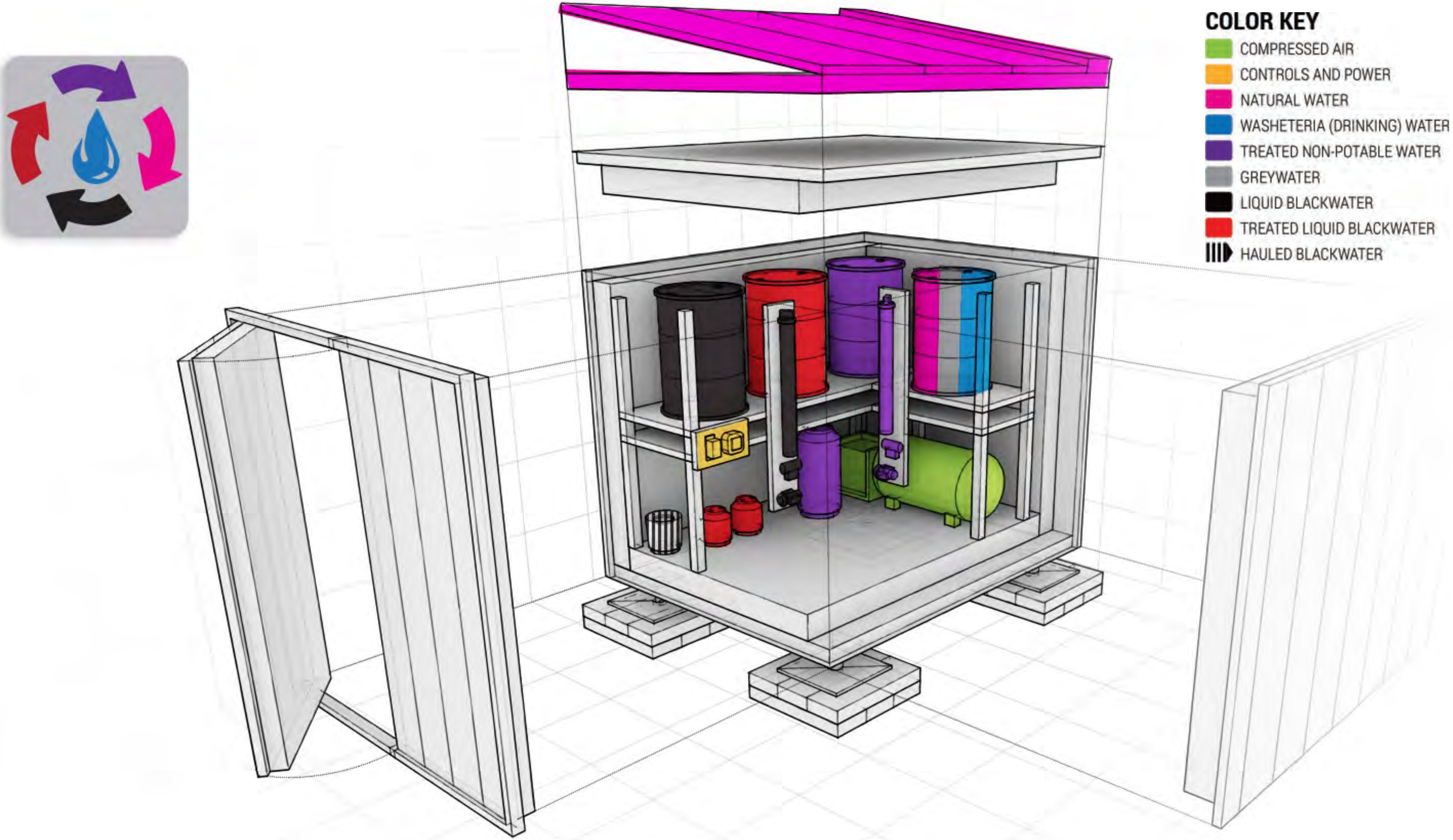
HYGIENE WATER
58.0
DRINKING
WATER
2.0
GREYWATER
52.6
CONCENTRATE
2.7
REUSABLE
BLACKWATER
4.5
FLUSH WATER
2.5

INPUT
Drinking Water
2 gpd

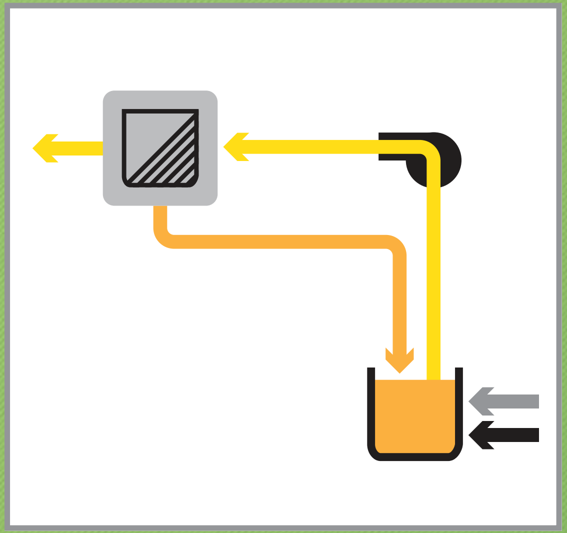
HAULED
Toilet
2.5 gpd
Concentrate
2.7 gpd
=======
5.2 gpd

INPUT
Replacement Water
3.6 gpd

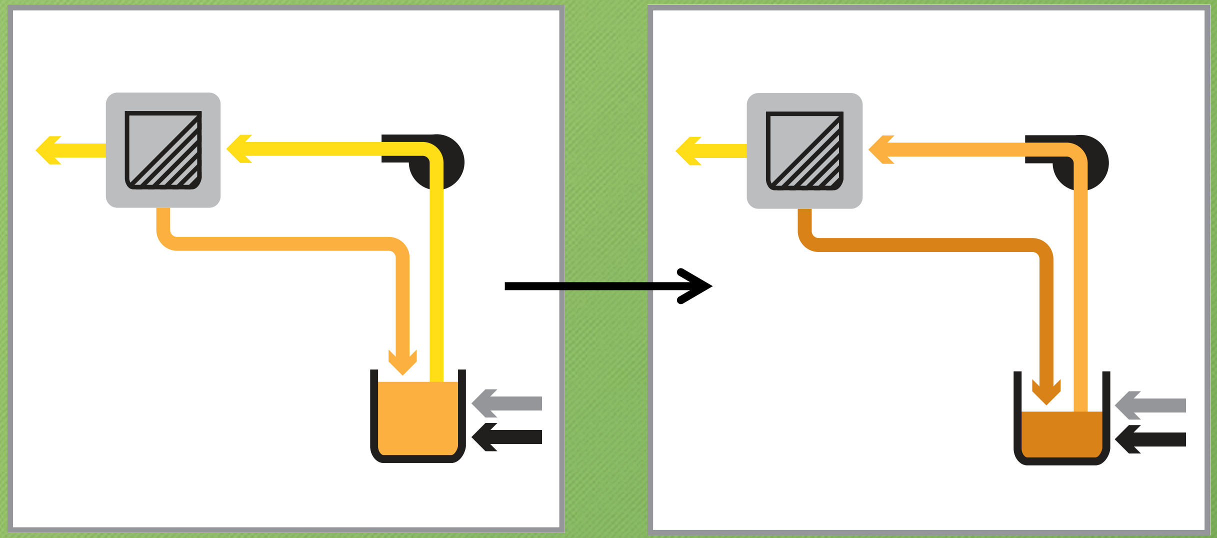



COLOR KEY
COMPRESSED AIR
CONTROLS AND POWER
NATURAL WATER
WASHETERIA (DRINKING) WATER
TREATED NON-POTABLE WATER
GREYWATER
LIQUID BLACKWATER
TREATED LIQUID BLACKWATER
HAULED BLACKWATER

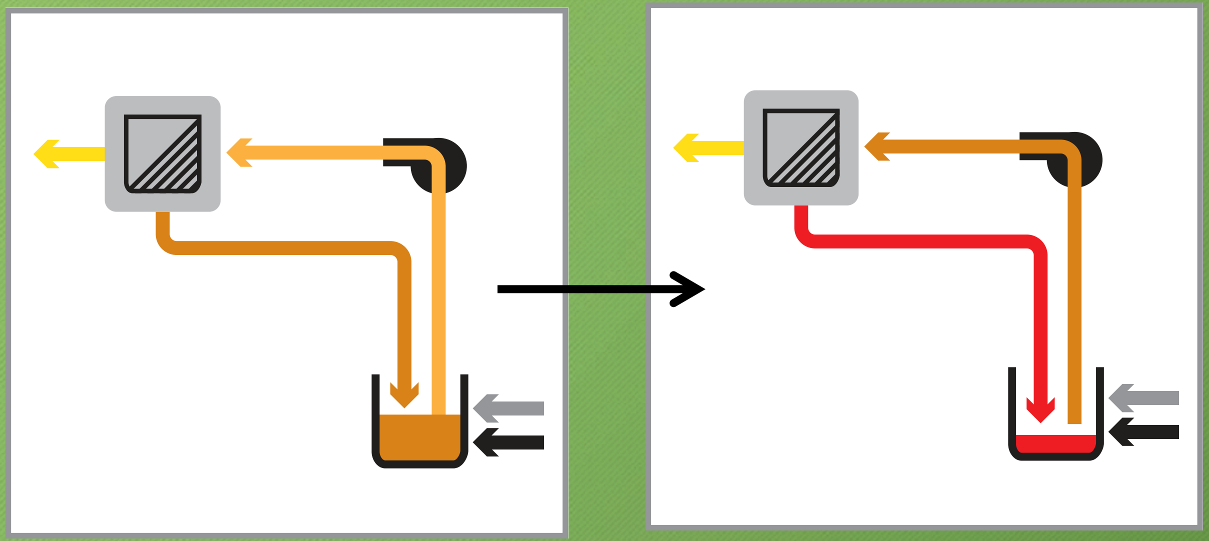
Concentrating Membrane System



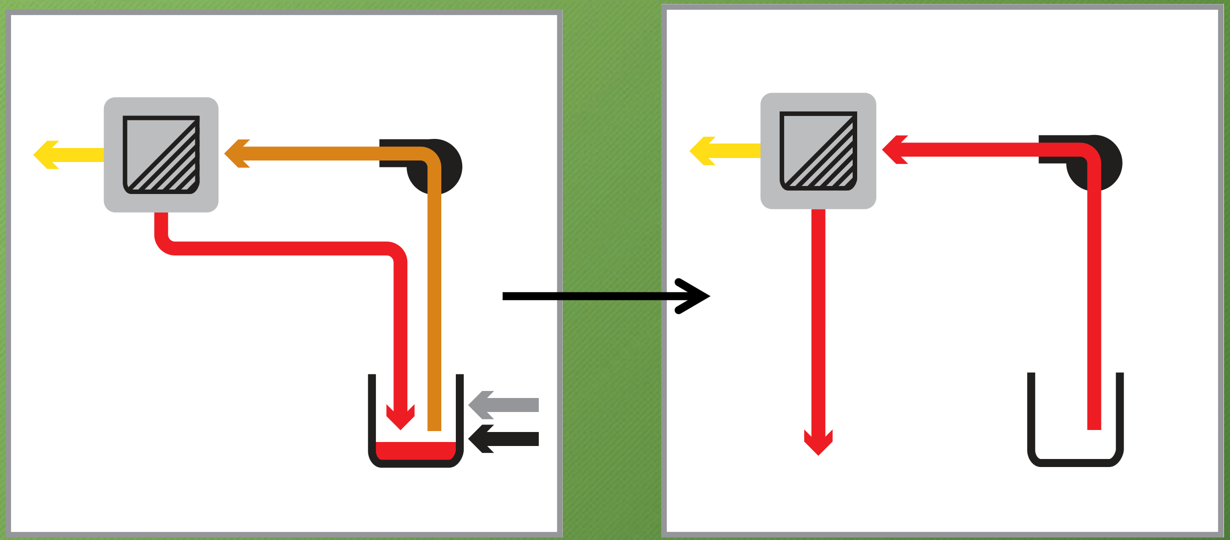
Concentrating Membrane System



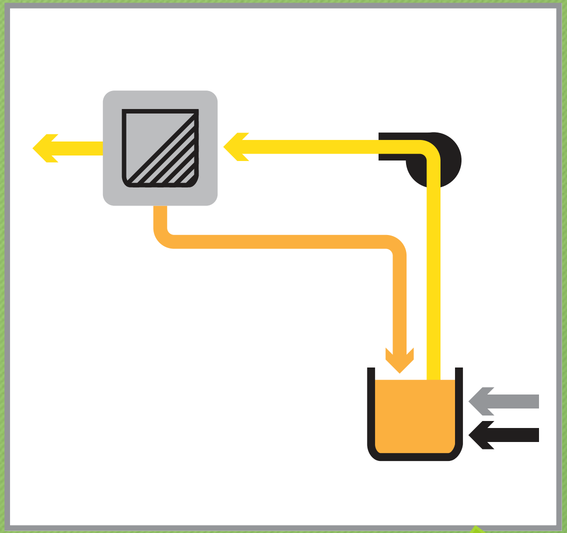
Concentrating Membrane System



Concentrating Membrane System

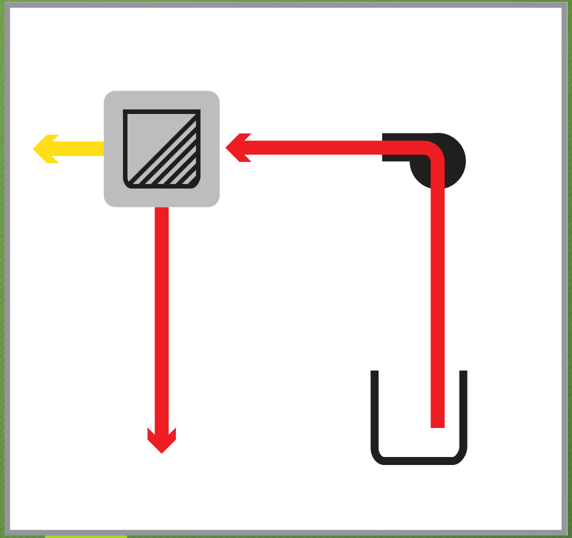


Concentrating Membrane System



Take Away

Single Membrane acts as an Array



Repeat!

System Components

Drinking Water Components

Manufacturer – varies
Filter Type – 1 µm cartridge (2” x 10”)

Disinfection – 40 mJ/cm^2 @ 2.5 gpm

Key Features

Added protection against transportation contamination

Basic pathogen protection against untreated sources

Core Components – In-home Coarse Filters

Manufacturer – varies
Filter 1 Type – 5 μm bag (4” x 10”)
Filter 2 Type – 1 μm cartridge (2” x 10”)

Key Features

- Associated with each fixture for modularity
- Accessible in-home

Core Components - Membrane

Manufacturer - Hydranatautics - HYDRACoRe70pHT
Membrane Type - Nanofiltration
Size - 4040
Material - Sulfonated Polyethersulfone
Pore Size - 750 Dalton

Key Features
- Chlorine Tolerant
- Fouling resistant

Core Component – UV Disinfection

<u>Manufacturer</u> – Viqua (a sister company to TrojanUV)
<u>Model</u>– 2x Pro20
<u>Rating</u> – 4 log virus @15 gpm (i.e. 186 mJ/cm^2 @ 15 gpm)

<u>Key Features</u>

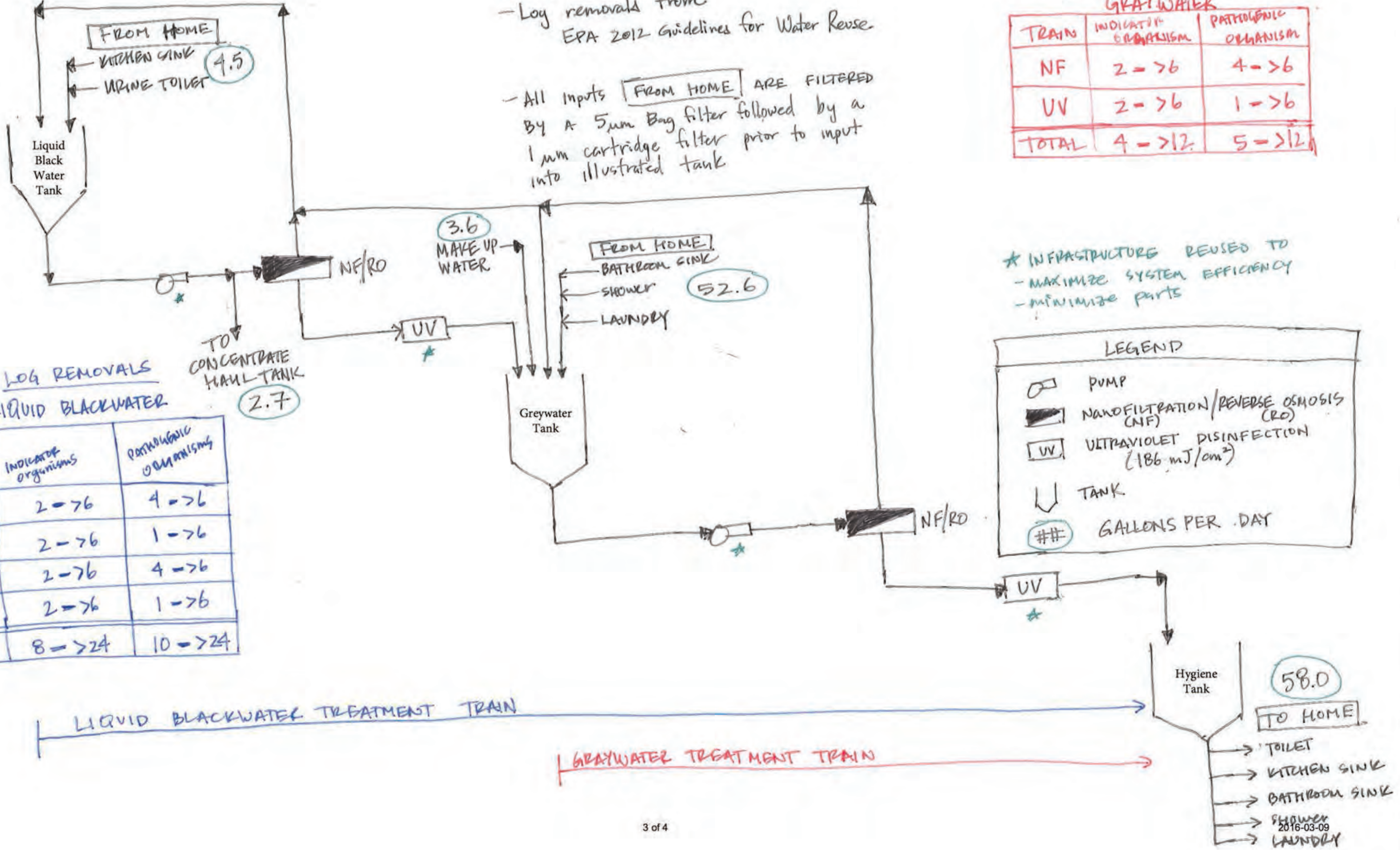
Validated at UVTs down to 80%
In operation only during water production
Provision of AMPLE factor of safety
+ possible photolytic oxidation

Images from viqua.com

Updated by Dotson 3/8/2016

- Log removals from EPA 2012 Guidelines for Water Reuse

- All inputs FROM HOME are filtered by a 5 μm Bag filter followed by a 1 μm cartridge filter prior to input into illustrated tank



★ INFRASTRUCTURE REUSED TO
- MAXIMIZE SYSTEM EFFICIENCY
- MINIMIZE PARTS

LEGEND

- PUMP
- NANOFILTRATION (NF) / REVERSE OSMOSIS (RO)
- UV — ULTRAVIOLET DISINFECTION (186 mJ/cm²)
- TANK
- ## — GALLONS PER DAY

LOG REMOVALS
GRAYWATER

TRAIN	INDICATOR ORGANISM	PATHOGENIC ORGANISM
NF	2 → >6	4 → >6
UV	2 → >6	1 → >6
TOTAL	4 → >12	5 → >12

LOG REMOVALS
LIQUID BLACKWATER

TRAIN	INDICATOR organisms	PATHOGENIC ORGANISMS
NF	2 → >6	4 → >6
UV	2 → >6	1 → >6
NF	2 → >6	4 → >6
UV	2 → >6	1 → >6
TOTAL	8 → >24	10 → >24

2016-03-09

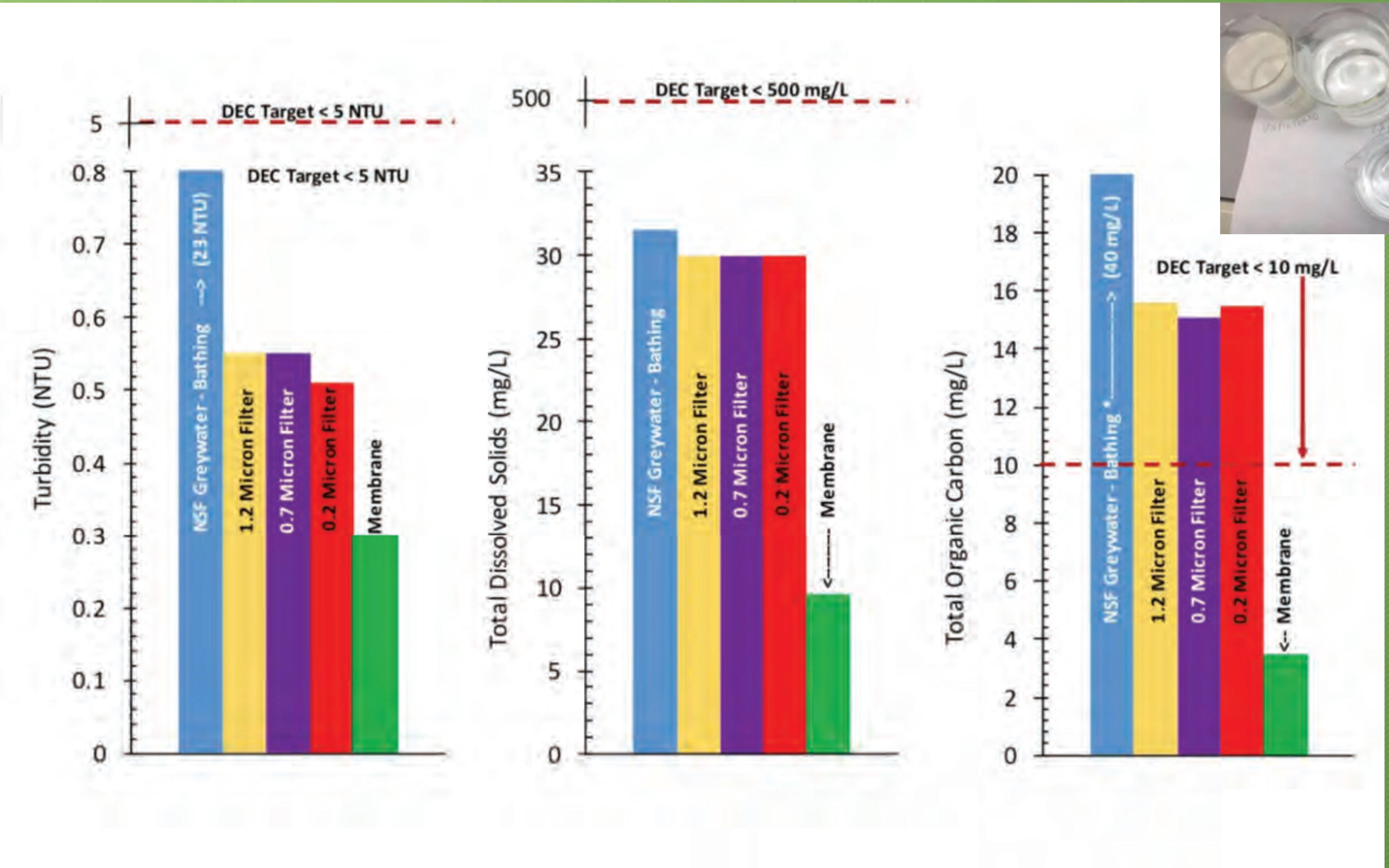
Preliminary Testing & Prototypes

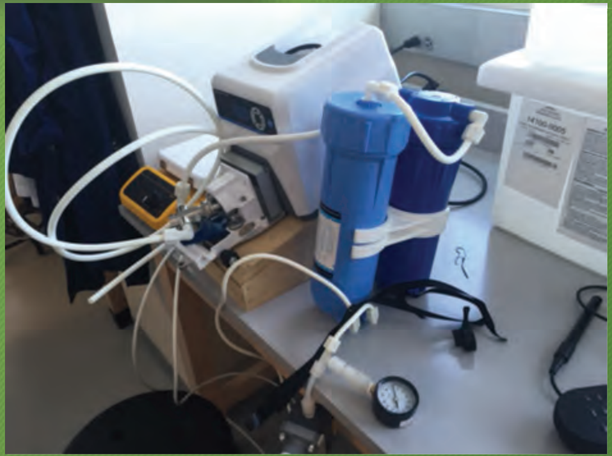
Daily Operation –Waters

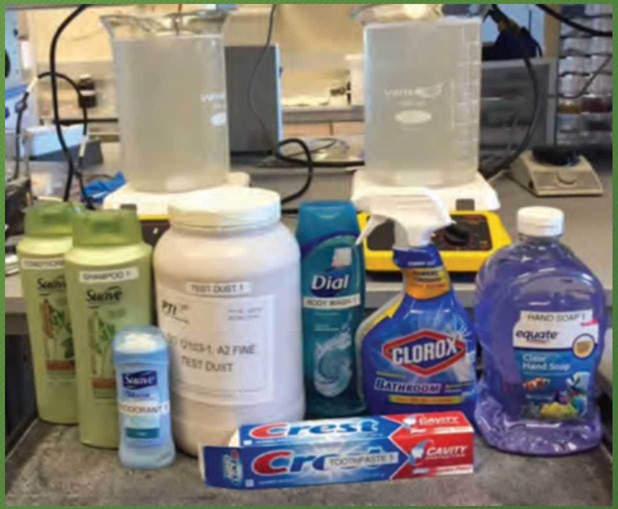
- *Synthetic Waters*
- NSF 350 – Bathing Water
  - Bathroom Sink & Shower
- NSF 350 - Laundry Water
  - Washing Machine
- UAA Kitchen Wastewater
- Synthetic Urine
  - Every Toilet Flush
- Synthetic Fecal Material
  - Full Flush

- *Source Waters*
- Local Tap Water (EIB Faucet)
- Rain Water
- Fork of Chester Creek (near EIB)

Bench-Scale RO – NSF 350 Bathing Water

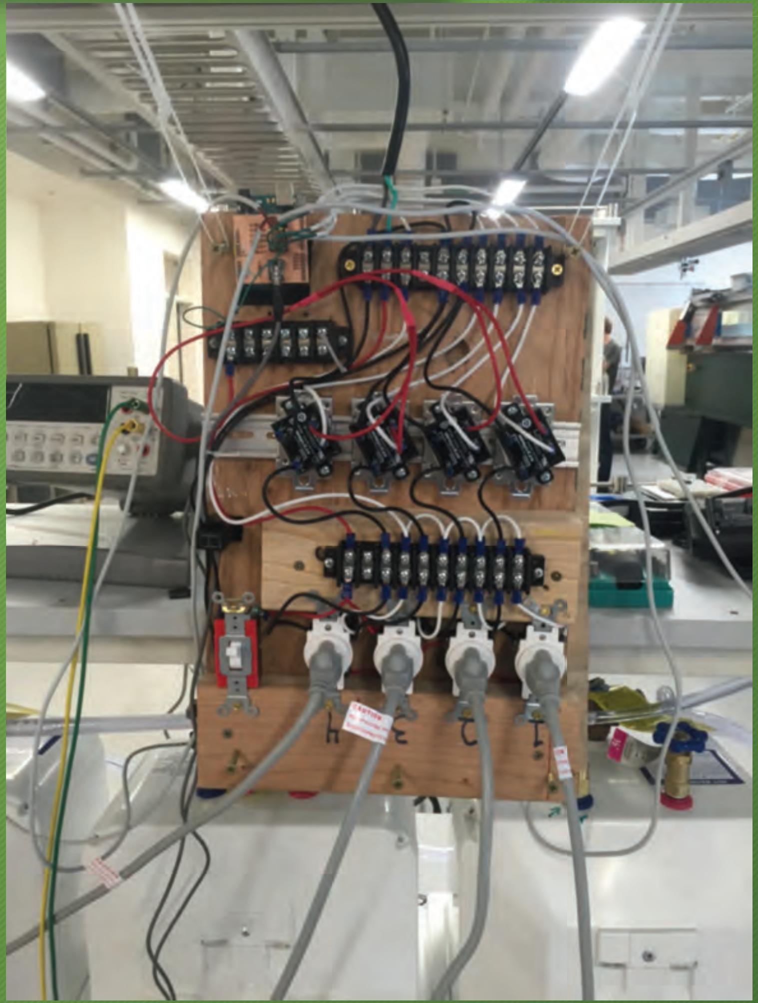






Prototype Construction – Water Heater Loads

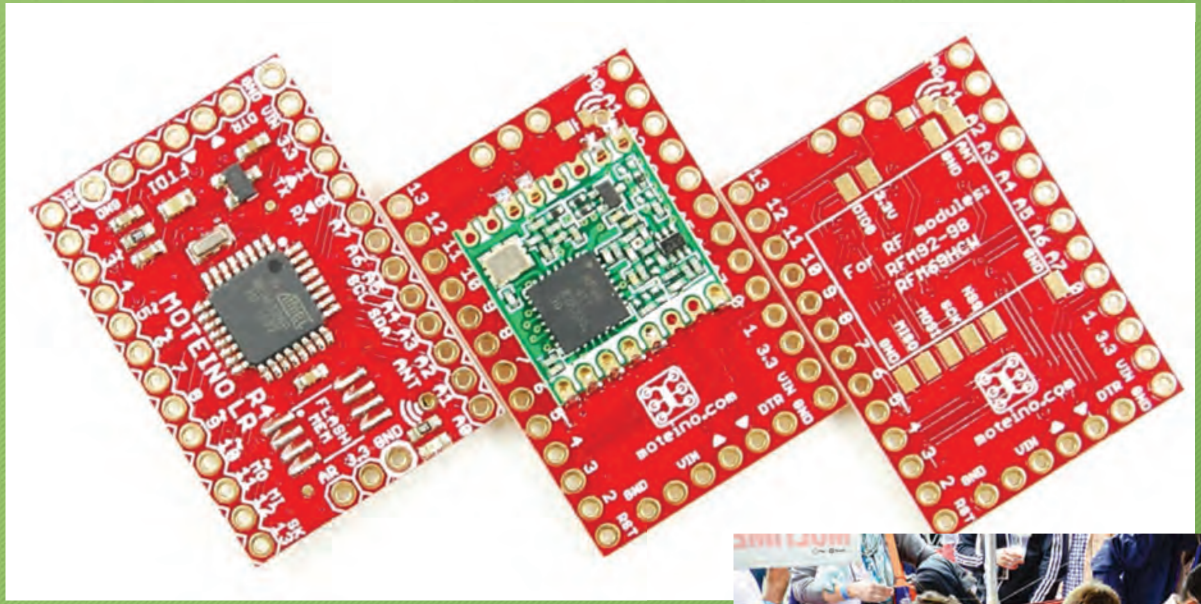
- Goal to minimize
  - total household electrical load
  - time to receive hot water at fixture
- Side-effect
  - Limit extended showers

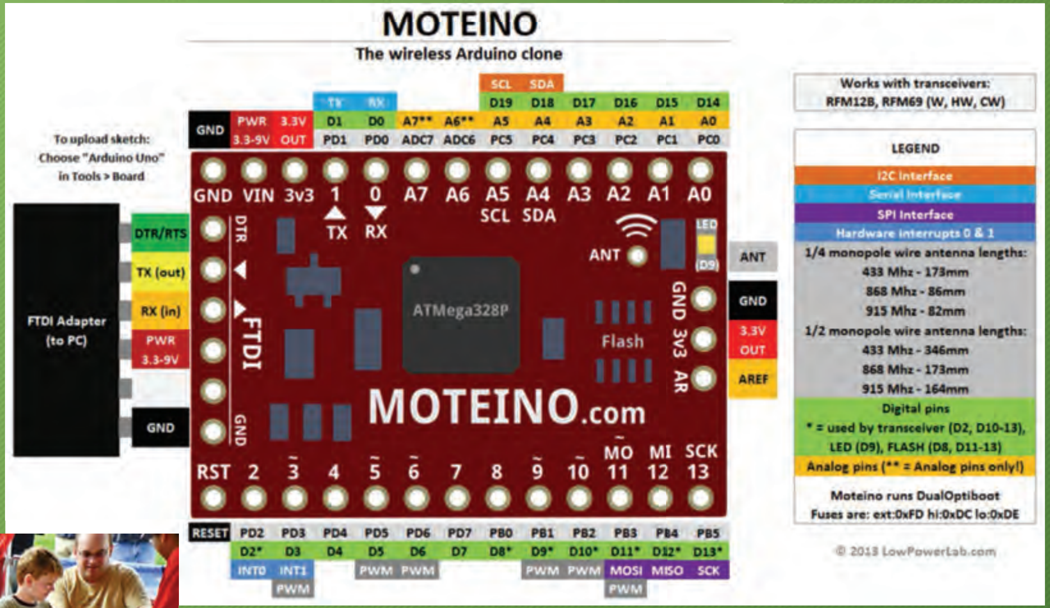


More insight into upcoming demonstration

Automated Operation – The Brains

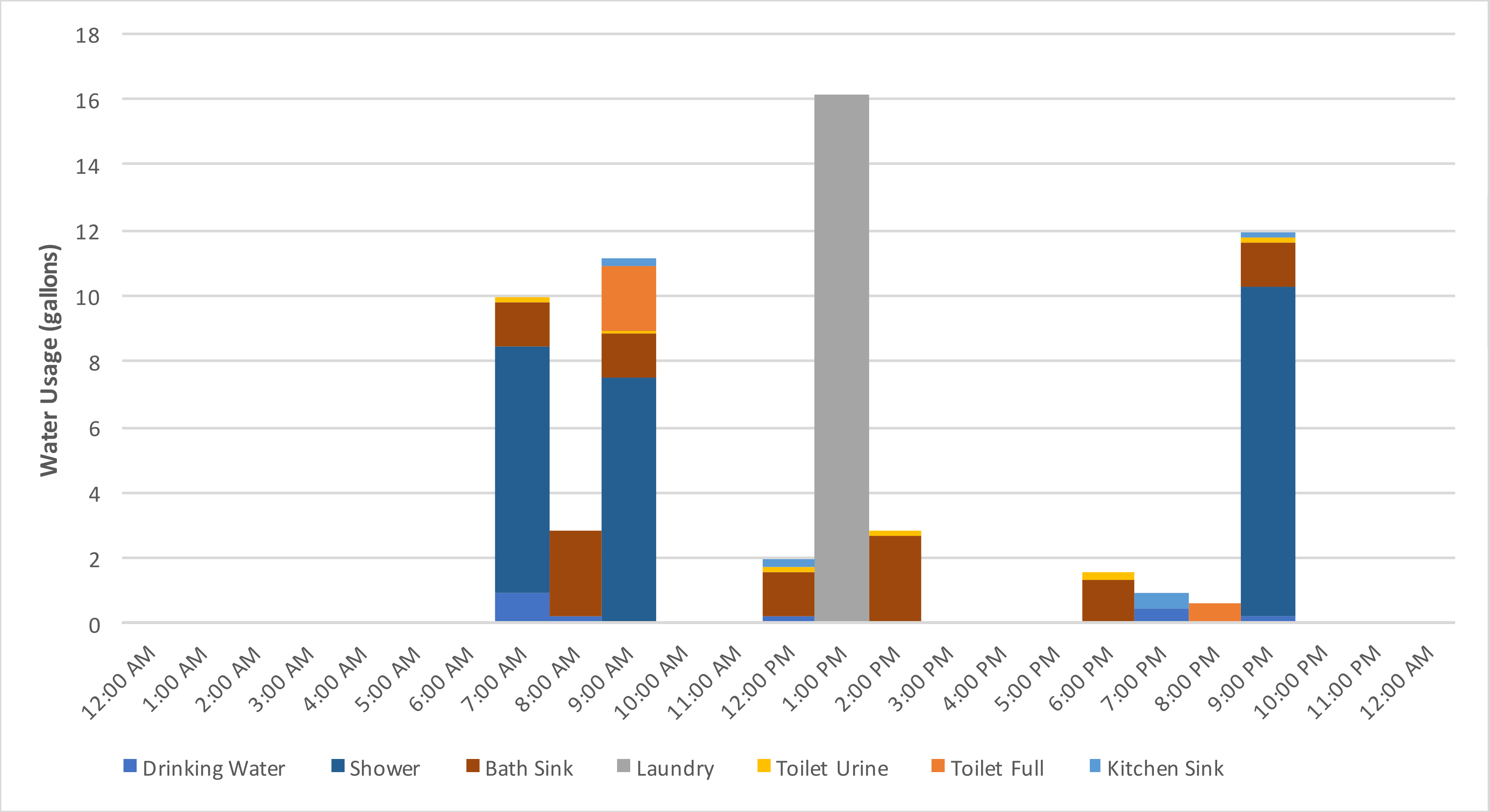
Images from Lowpowerlabs.com





http://technical.ly/baltimore/wp-content/uploads/sites/3/2013/03/Screen-shot-2013-03-04-at-1.30.39-PM.png

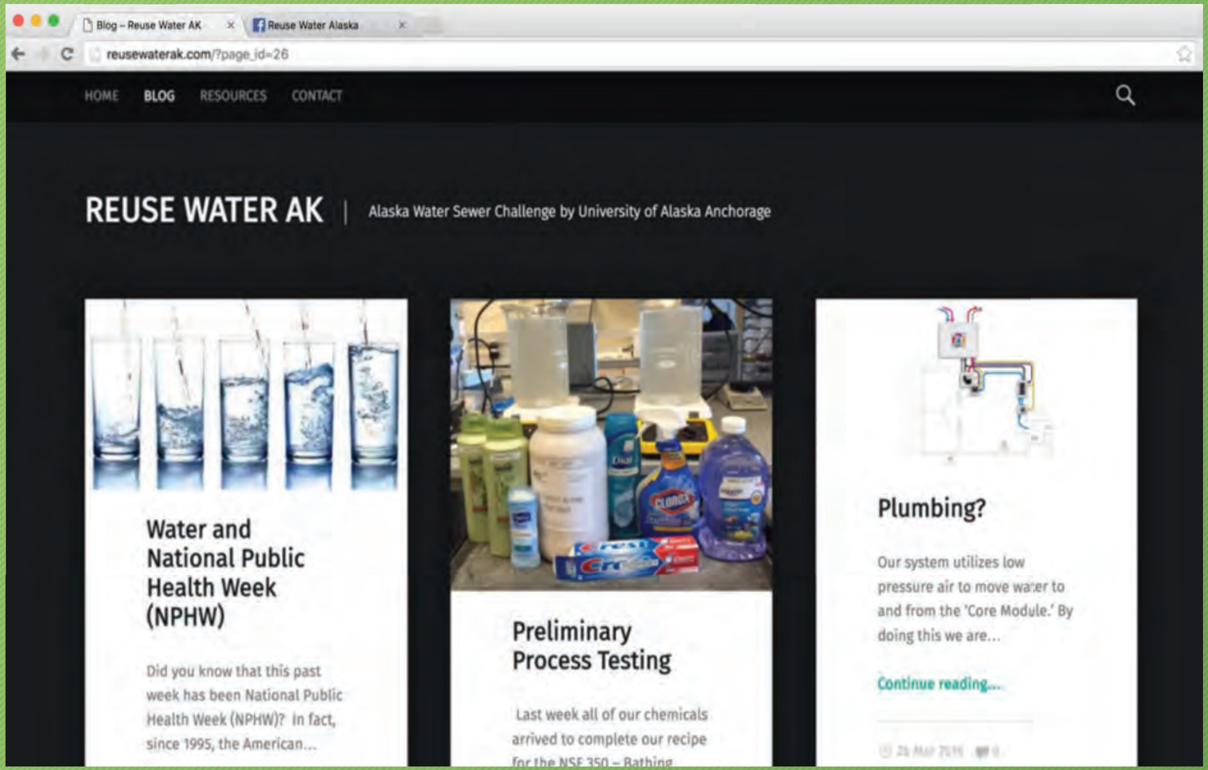
Daily Operation – Regular Loading



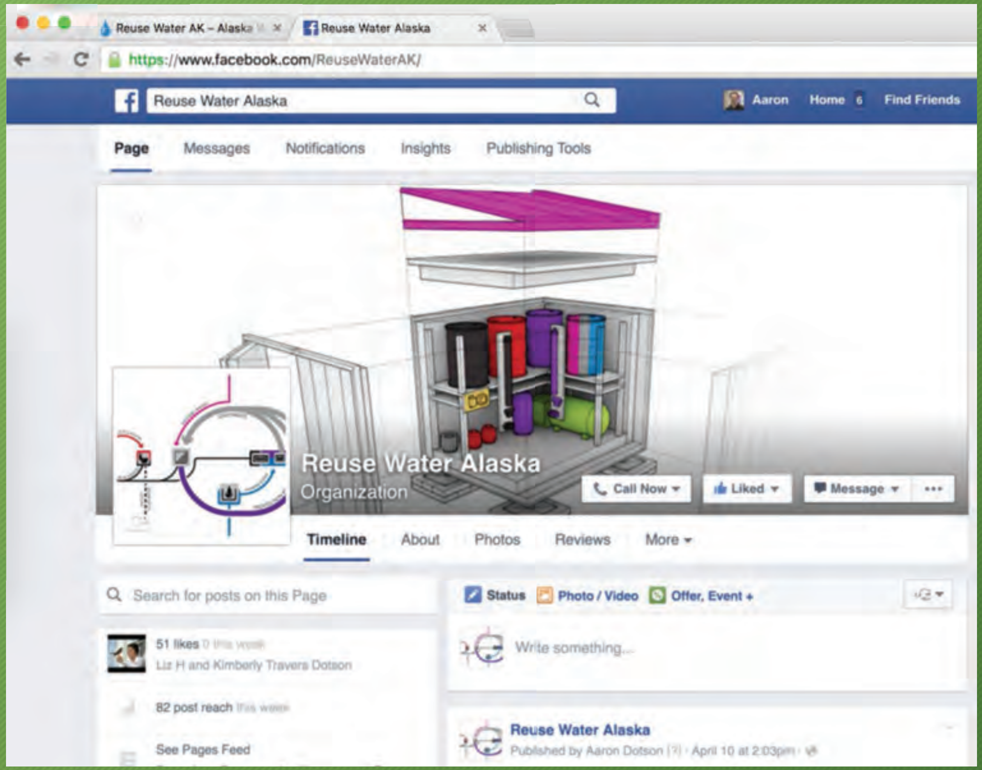
- Based on actual use potential
- Simulate fixture use to match contractual loadings

How to keep track of our project

- http://ReuseWaterAK.com



- http://facebook.com/ReuseWaterAK



Thanks for Listening!

Aaron D. Dotson
Associate Professor
College of Engineering
University of Alaska Anchorage

addotson@uaa.alaska.edu
907-786-6041

YKHC Greywater Recycling Project

Brian Lefferts
Bob White

YUKON-KUSKOKWIM HEALTH CORPORATION

Dump the Bucket
It's Time.

Presentation Overview

- Project overview
  - Design assumptions
  - Testing schedule
- Four systems
  - Closed loop concept
  - Selection rationale
  - Operations by system
- Challenges

Design Assumptions

- Water use for YK Delta village homes served with haul systems
  - Based on goal (21 gallons/person/day)
- Household size/crowding taken into account
  - Based on 6 people/home
- Expected sanitary events (showers, flushes, handwashing) calculated based on household size
  - Limited water + more sanitary events = more concentrated greywater

Household Water Allocation per Home (6 persons)

Purpose	Water Use/ Event (gal)	Events/ Week	Water Use/ Week (gal)	Notes
Handwashing (t)	0.33	210	69	5 events/day/person
Handwashing (other)	0.33	84	28	3 events/day/person
Toilet flushes	1.6	126	202	5 flushes/day/person
Laundry	25	6	150	Estimate loads/week
Shower (low flow)	14	24	336	7 min shower @ 2 gpm
Cleaning Water	5	7	35	Dishwasher (4gpd) Other 1 g/d
Cooking /drinking	1.5	42	63	~2 gal/person/day
			883	

883 @ 7 days/week = 126/day

Bathing Source Water (AM & PM: M-F)

Componentsa	Amount/100 L		Amount/ Event	Events/ week	Challenge Water Dose/Week	Challenge Water Dose/Day	Challenge Water Dose/Shift	
body wash with moisturizer	30	g	11.01	24	264.24	37.75	18.87	g
toothpaste	3	g	1.00	84	84.00	12.00	6.00	g
deodorant	2	g	0.74	24	17.76	2.54	1.27	g
shampoo	19	g	7.10	24	170.40	24.34	12.17	g
conditioner	21	g	7.76	24	186.24	26.61	13.30	g
lactic acid	3	g	1.09		53.55	7.65	3.83	g
secondary effluent	2	L	0.73		35.70	5.10	2.55	L
bath cleaner	10	g	2.00	1	2.00	0.29	0.14	g
liquid hand soap	23	g	2.65	294	779.10	111.30	55.65	g
test dust	10	g			178.50	25.50	12.75	g
Water		gal			472	67.43	33.71	gal

Laundry Source Water (PM: M, Th)

Components	Amount/100 L		Amount/event	Events/ week	Challenge Water Dose/Week	Challenge Water Dose/Load	Challenge Water Dose/Shift	
liquid laundry detergent (2X)	40	mL	37.80	6	226.80	37.80	113.40	mL
test dust	10	g	9.45	6	56.70	9.45	28.35	g
secondary effluent	2	L	1.89	6	11.34	1.89	5.67	L
liquid laundry fabric softener	21	mL	19.85	6	119.07	19.85	59.54	mL
Na2SO4	4	g	3.78	6	22.68	3.78	11.34	g
NaHCO3	2	g	1.89	6	11.34	1.89	5.67	g
Na2PO4	4	g	3.78	6	22.68	3.78	11.34	g
Water		gal	25	6	150.00	25.00	75.00	gal

Testing

- Testing schedule initially based on NSF guidelines
- Adjusted based on project needs
  - Added additional testing to ensure safety
  - Ex. Nitrates
- What effluent criteria should be used?

Testing

- Daily/weekly testing
  - BOD, CBOD
  - TSS, pH, temperature, turbidity
  - Total coliforms, E. *coli*
  - Disinfectant residual (UV)
  - NO2, NO3, iron, TKN, phosphorous
  - Chemical oxygen demand
  - Total organic carbon
  - Surfactants, fats/oils/grease
- Greywater components
  - Bathing source water
    - Body wash, toothpaste, deodorant, shampoo, conditioner, hand soap
    - Secondary effluent
    - Lactic acid, bath cleaner, test dust
  - Laundry source water
    - Laundry detergent, fabric softener
    - Secondary effluent
    - Sodium sulfate, sodium bicarbonate, disodium phosphate, test dust

Greywater Lab Sample Schedule

Parameter	Sample type	Sample location		Week day collection				
		Raw influent	Treated effluent	M*	T	W	Th*	F
Biochemical Oxygen Demand (BOD_5)	24-h comp	X					L - PM	B - AM
Carbonaceous BOD ($CBOD_5$)	24-h comp		X				B - AM	L - AM
Total suspended solids (TSS)	24-h comp	X			B - AM		L - PM	
Total suspended solids (TSS)	24-h comp		X	B - AM		B - AM		L - AM
pH	Grab	X			B - AM		L - PM	
pH	Grab		X	B - AM		B - AM		L - AM
temperature (°C)	Grab	X			B - AM		L - PM	
Total coliforms & E. coli	Grab	X			B - AM		L - PM	
Total coliforms & E. coli	Grab	X			B - AM			
Total coliforms & E. coli	Grab		X	B - AM	L - AM		B - AM	
Total coliforms & E. coli	Grab		X	B - AM	L - AM		B - AM	
Turbidity	24-h comp	X			B - AM		L - PM	
Turbidity	24-h comp		X	B - AM		B - AM		L - AM
Disinfectant[1] (System 1)	24-h comp		X	B - AM		B - AM		L - AM
Nitrite (NO_2)	24-h comp	X		L - PM	B - AM			
Nitrite (NO_2)	24-h comp		X	B - AM	L - AM			
Iron	24-h comp	X		L - PM	B - AM			
Iron	24-h comp		X	B - AM	L - AM			
Nitrate (NO_3)	24-h comp	X		L - PM	B - AM			
Nitrate (NO_3)	24-h comp		X	B - AM	L - AM			
Total Kjeldahl nitrogen (TKN)	24-h comp	X		L - PM	B - AM			
Total Kjeldahl nitrogen (TKN)	24-h comp		X	B - AM	L - AM			
Total phosphorous (P)	24-h comp	X					L - PM	B - AM
Total phosphorous (P)	24-h comp		X				B - AM	L - AM
Chemical oxygen demand (COD)	24-h comp	X		X				
Total organic carbon (TOC)	24-h comp	X		X				
Surfactants	24-h comp	X					X	
Fats, oil and grease	24-h comp	X			X		X	
SAR	24-h comp	X						
SAR	24-h comp		X					

* Laundry source water is added on Monday & Thursday PM shifts.

[1] If the treatment system introduces a disinfectant; the disinfectant shall be measured in the effluent sample. The sample type shall be 24-h composite except when the disinfectant is not stable for 24-h, in which case grab samples shall be collected.

Reactor

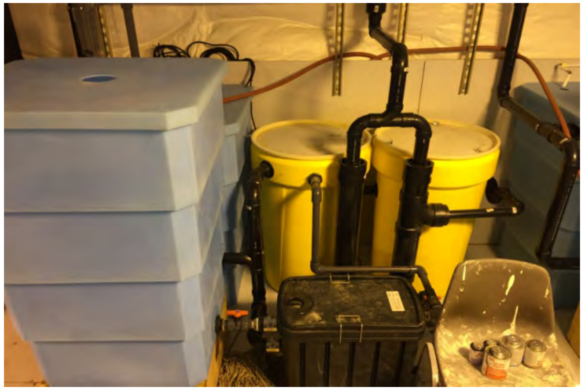
Closed Loop Concept

General Layout

- 130-gallon "dirty water" mix tank
- Motorized valve on a time controlling flow
- Diverter pre-filtration (Aqua2Use)
- Treatment system
- 130-gallon finished water tank

Selection Rationale

System 1: YKHC-OEHE



System 2: BioMicrobics

System 3: Aqua2Use

System 4: WiseWater

Operations by System – YKHC-OEHE

Operations by System – BioMicrobics

Operations by System – Aqua2Use

Operations by System – WiseWater

Challenges

- Non-standard US pipe sizes
- Dirty water feed rate
- GWDD pre-filter level control break in
- High feed rate through filtration units

Challenges

- Soap overfeeds
- Soap building up through closed loops
- Foam passing through vent lines
- Foam fractioning
- Biologic foam control
  - Dye
- Membrane plugging due to biofilm

Quyana to the project supporters!

How to Talk about Water

(A Facilitated Discussion)

Guy Carpenter, PE
Vice President, Carollo Engineers

AWWMA 56th Annual Conference
April 20, 2016

Engineers...Working Wonders With Water®

Water: Nature's Amazing Renewable Resource

Do we make water decisions based on FACT or FEAR?

Are we doing a good job of describing the Science of Water?

Do we use language and imagery that create Confidence and Understanding about water?

Overview

- Water is complex/so is the human mind
- Perception influences our decisions
  - Water and stigma
  - Expert and lay views
  - Inadequacies of public consultation *(without scientific literacy)*
- Resources & examples

A lack of knowledge about water is the single largest barrier to sustainable water management

We *all* use water!

...to wash away our dirt—
ourselves, food, dishes, clothes

...to quench our thirst

...to transport our personal waste

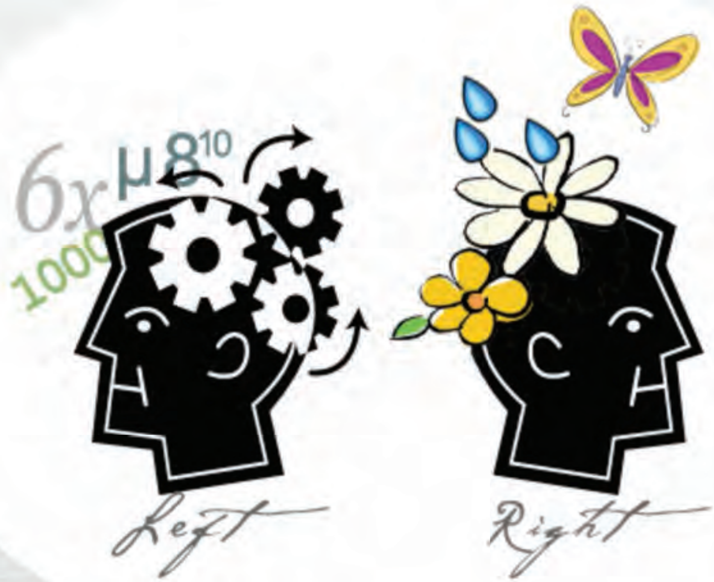
We *all* rely on water for many purposes…

...for nourishment

...for nature

...for life!

Because we NEED water we must use language and imagery that creates a broader and deeper understanding



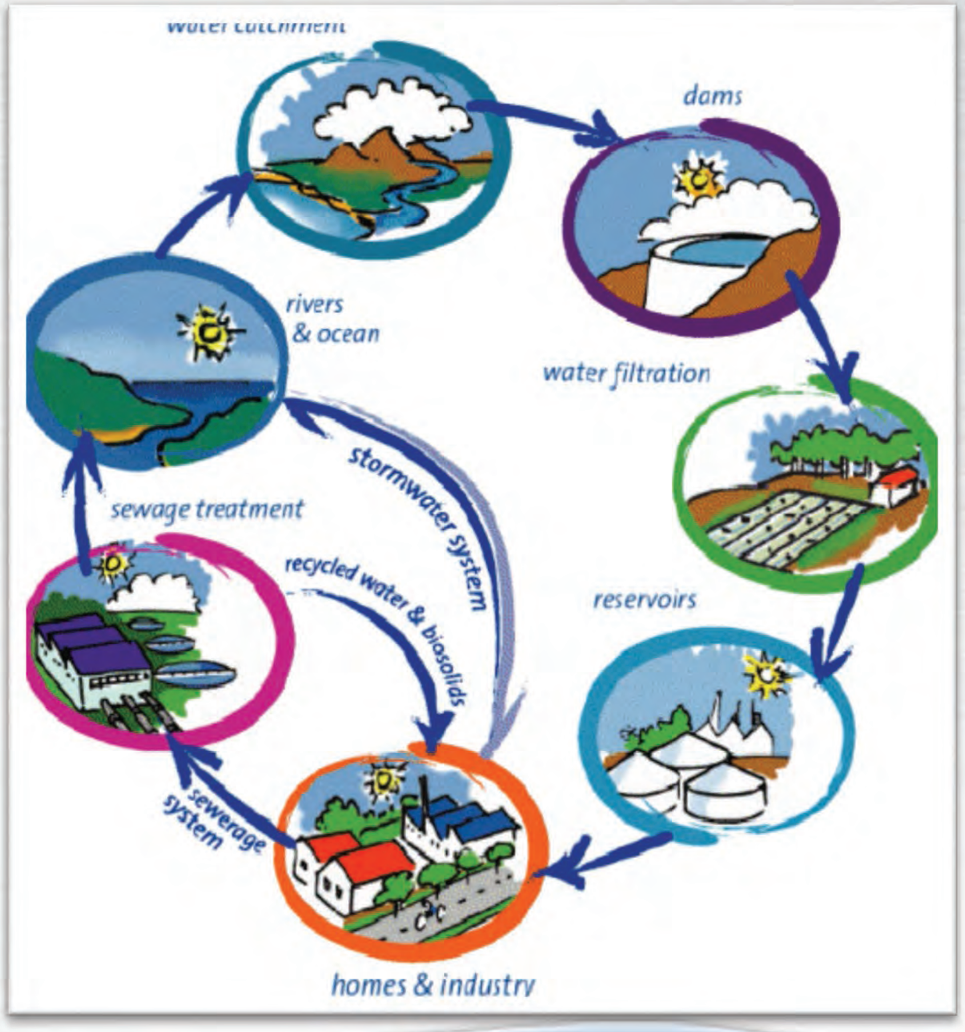
We need to explain how we manage and treat water using science, clear language, and real-life examples

…"Secondary treated effluent"

"Endocrine Disrupting Compounds"…

…"maximum contaminant level"

An accurate understanding of The Water Cycle (both natural and urban) can overcome negative perceptions related to water.



WE HAVE THE SAME AMOUNT OF WATER ON EARTH TODAY AS WE DID 3 BILLION YEARS AGO. Water moves in a continuous process called the water cycle. Unfortunately, the water cycle doesn’t always return water to where we need it.

The Water Cycle naturally contains "dirt"

- As water moves through its cycle, it collects other molecules
- Every time we come in contact with water, we add molecules to it
- About half of the water that comes into our homes ends up at the wastewater treatment plant
- Wastewater is mostly water— a 55-gallon drum contains only about 1 tablespoon of other molecules

Water molecules *attract* elements from life

Everything we put into water is co-mingled with the water molecules

- Organic molecules
- Inorganic molecules
- Micro-organisms—bacteria, viruses, parasites
- Fine particles

Water molecules themselves are not changed by the things we add to it!
Our challenge is to take the other things out of water

We treat water…

so what's the

Problem?

Perceptions have impact

We say that water is “dirty” when chemicals attach themselves to it as it moves through The Water Cycle.

- Wastewater
- Sewage water
- Treated wastewater
- Treated sewage water

Contagion mentality: Once contaminated, always contaminated

As scientists, we have to remind ourselves that <u>feelings</u> AND <u>facts</u> matter

... there can also be strong, spiritual references and connectedness to water, particularly among native people groups.






Risk Perception Summary

- We are sometimes irrational and react to our ***perception*** of risk rather than to the risk itself
- We are generally more accepting of risks that:
  - **We *voluntarily expose ourselves to*—**as opposed to those over which we have no control
  - **Are *natural*—** as opposed to human made
  - **Are *familiar*—** as opposed to unfamiliar
  - **Are *well-defined*—** as opposed to uncertain
  - **We have *good understanding of*—** as opposed to our fear of the unknown

The process of stigmatization affects:

- Our capacity to absorb factual information is blocked by negative associations of "dirty" water

- The negative associations *(based on FEAR rather than FACT!)* scare us!

What's the Solution?

Engineering technology and science can remove the chemicals and micro-organisms in water…

… and negative associations and fears can be reframed by creating a better understanding of water.

What's the Solution?

Understanding the different levels of water quality—and the treatment that creates it—can help us manage supplies and demands.

We need to match the "right" water with the right need.

What's the benefit of enhanced understanding?

- We will be less likely to remove solutions from our water supply toolkit
- We will be more motivated to find sustainable solutions
- We will be able to discuss benefits and consequences

Consider the importance of TRUST. If a utility, city, or regulatory agency doesn’t have trust, no form of phasing images or presentation is likely to be successful.

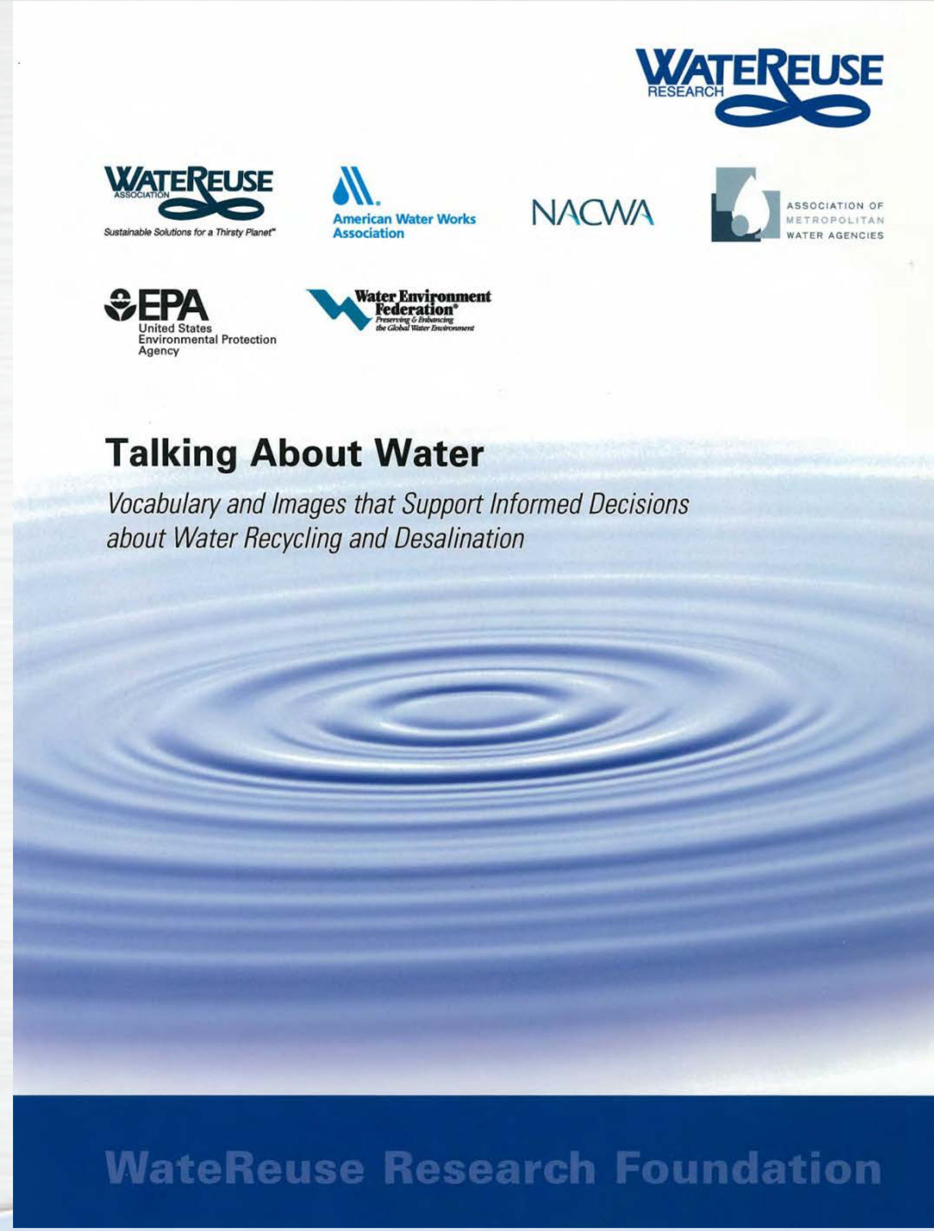
- It’s easier to destroy it than to create it
- Negative events outweigh positive events
- Positive events are often fuzzy
- Sources of bad news are more credible than sources of good news
- Risk is easier to demonstrate

The Words We Use Really Do Matter

Number one impediment to any water reuse project is public perception

Can't talk to public in the same way we do to each other

http://www.watereuse.org/product/07-03



From someone who's been there…

I'd say that the biggest concept to consider when we work with indigenous populations is respect for the environment and the concepts of holistically approaching water management. We tend to stress the "integratedness" of water in our lives and the need to respect those resources.

Additionally, I would say that every community is different so water words that work in some locations do not work in others. Every effort should be made to work with the local community to identify what would be most appealing in terms of terminology, instead of using terms that have worked well in other regions.

~Dr. Channah Rock, UofA

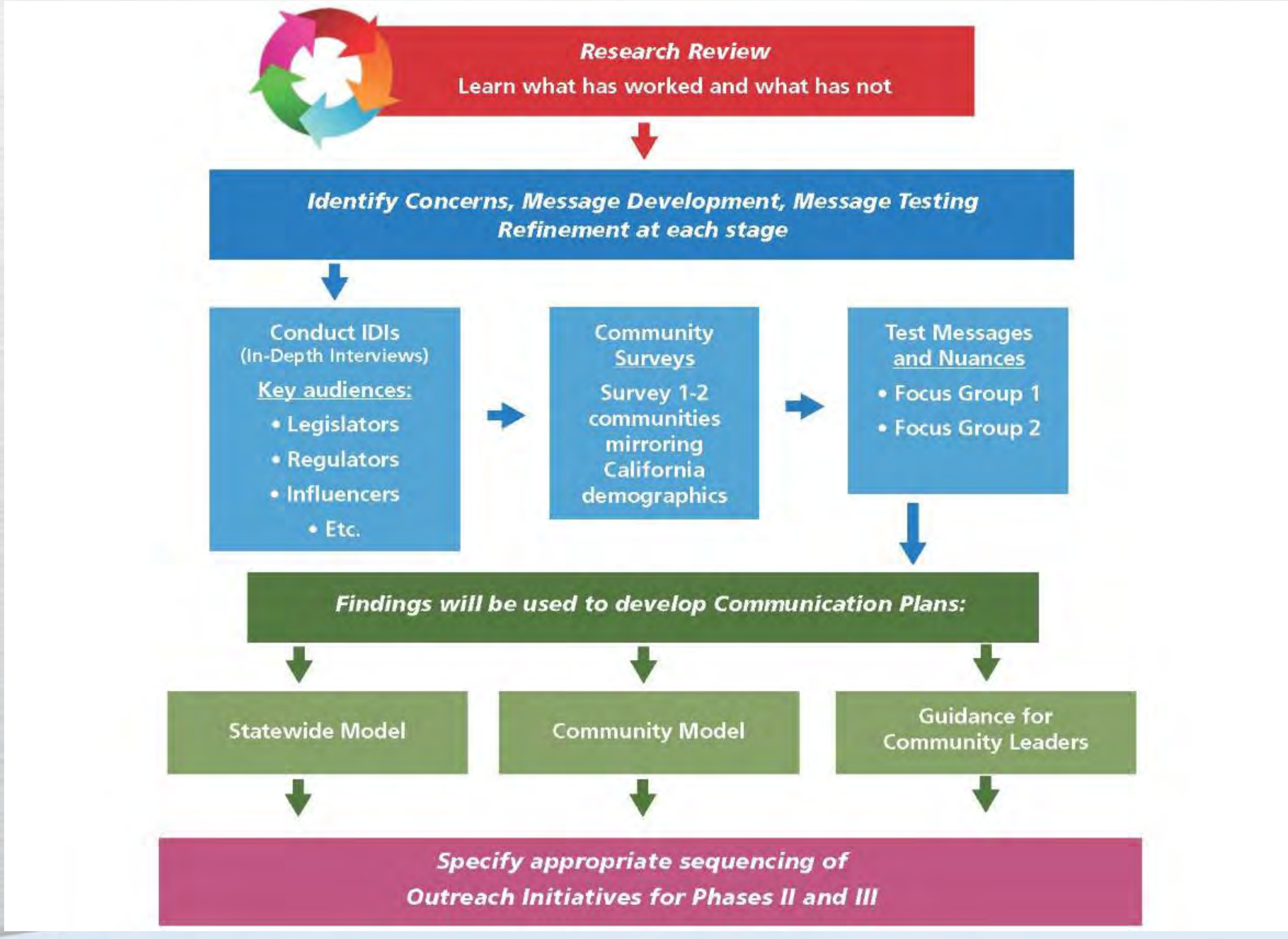
Foundation led activities to foster public acceptance

WHAT HAVE WE LEARNED ABOUT WHAT PEOPLE THINK ABOUT POTABLE REUSE AND HOW DOES IT APPLY TO ON-SITE REUSE IN ALASKA?

Challenges to Water Reuse Acceptance

- The belief that additional water supply sources are not needed
- The perception that water supply deficiencies can be solved solely with conservation
- The lack of public understanding of potable reuse processes and the associated science
- The perception that potable reuse is not safe
- The sometimes distracting or uncomfortable feelings toward the source of the water
- Lack of understanding of the limiting factors associated with other water supplies (energy demand, greenhouse gas (GHG) emissions, cost, and limited availability)

WRRF 13-02 Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse



Getting Ready for Public Engagement

- Develop the potable reuse “project story”
- Develop key messages that tell the story in terms understandable to a non-technical audience.
- Identify key community leaders and the groups they represent and engage, continually

Stakeholder and Public Outreach Structured for Success

- Stakeholder Engagement
- Defined Purpose and Need
- Consistent Message
- Alignment with Technical Program
- Consistent and Sustained Communication

Sample of tools being made available

WATEREUSE

Potable Reuse Summary

Commonly Referred to as Purified Water

Multiple Benefits of Purified Water

Safe, reliable water supply
Potable reuse uses proven technology to purify recycled water to provide a safe water source. Multiple treatment methods separate pollutants, producing water that is cleaner than most bottled water.

Sustainable water supply option
Potable reuse provides a sustainable and cost-competitive water supply option using less energy than many other options.

Environmental benefits
Potable reuse allows us to leave more water in rivers, lakes and streams for fish, plants and wildlife, while reducing discharges to these water bodies and the ocean.

Drought proof
Potable reuse is a drought-proof water supply. It can help ensure safe, sustainable water now and into the future.

Responsive to weather variability
Potable reuse is part of a diversified water portfolio and is independent of climate or weather.

Understanding Potable Reuse — A Key Part of Our Water Supply Solutions

Numerous regions of the world are experiencing drought and resulting lack of water supplies. While using purified water for drinking is not new, innovative projects in Australia, Texas, California and elsewhere are living examples of advanced purification practices being used to increase scarce water supplies.

Water Reuse Happens Naturally

The term "potable" water means "suitable for drinking." Water reuse, including potable reuse, happens naturally all over our planet — on rivers and water bodies everywhere. If your community is downstream from another, chances are you are reusing its water and likewise communities downstream from you are most likely reusing your water.

Reused or recycled water is water used more than one time before it passes back into the natural water cycle. It is wastewater, including sewage, which has been treated or purified to a level that allows for reuse for beneficial purposes.

Potable Reuse — Direct and Indirect

Potable reuse refers to water meeting all federal and state drinking water standards and is safe for human consumption. Potable reuse may be created by indirect potable reuse (IPR) or direct potable reuse (DPR).

To Learn More

WateReuse is a nonprofit organization wh and efficient uses of high-quality, locally p the betterment of society and the environ and outreach, research, and membership. communities are facing water supply chal drought, depletion and contamination of single source of supply. To learn more, visit

Excerpted from WRRF-13-02 Model Communication Plans for Increasing Awareness and Fostering Acceptance

WATEREUSE

Draft Your Message Plan

— ESSENTIAL —

Water Terminology for Potable Reuse

The messages here introduce new terminology for potable reuse — namely, "**advanced purified water**" or "**purified water**." This reflects the preferred terminology from the focus groups and telephone surveys conducted in the WRRF-13-02 project. **The research clearly demonstrates that "potable reuse" and "direct potable reuse" are not understood by the mainstream population and that, even when explained, they do not resonate well.**

We reference direct potable reuse (DPR) and indirect potable reuse (IPR) as "potable reuse." This is fine when talking among those in your agency and industry, but the public neither recognizes nor understands the term — we will substitute with "purified water" from here forward.

WateReuse Research Foundation created a glossary "simple enough to understand, but technical enough to trust," which can be found at www.watereuse.org/information-resources/about-water-reuse/glossary-1.

The glossary can help explain water recycling. Research recommends terms such as "treated wastewater"

Get Ready for Public Engagement

Carefully craft your community's project story

At a minimum, answer the following questions about potable reuse:

1. What is potable reuse?
2. Where does it fit in our water supply portfolio?
3. Why is the potable reuse project needed?
4. What purpose will it serve?
5. How safe is the water?
6. How will it be monitored to ensure safety?
7. How much will it cost?
8. When will it be implemented?

Messaging Tips

Develop key messages in terms understandable to a non-technical audience and avoid jargon.

Create a standard community presentation and train spokespeople to present and respond to general and specific questions.

Identify key community leaders and groups and build a mailing database for distribution of e-mail or direct mail updates.

Create easy-to-understand infographics that describe the treatment process, how

can help improve technological literacy.

Effective messaging is not enough. According to by Dr. Paul Slovic in *The Feeling of Risk: New Perspectives on Risk Perception*, 2010, information must also convey emotion or feeling to be meaningful.

Goals of Messaging

The goal of messages included here is to provide coordinated, consistent, effective communication ideas about the role and importance of potable reuse that can be uniformly used with a variety of stakeholders, from children to parents and health professionals to business interests. There are three basic objectives:

- to identify messages that help to create public understanding of water use, treatment, and potable reuse in a water cycle context;
- establish messages in the context of your water agency's mission;
- establish common terminology and approaches that resonate with the public and broaden acceptance for potable reuse projects.

Messages presented herein are not designed to convince a stakeholder to make a particular decision. Rather, these messages facilitate exploration of ideas and possibili-

WATEREUSE

Key Messages

Top Three Key Messages

Potable reuse provides a safe, reliable and sustainable drinking water supply.

Using advanced purified water is good for the environment.

Potable reuse provides a locally controlled, drought-proof water supply.

Key Messages Explained

Potable reuse, or purified water as described below, uses advanced, multi-stage treatment to provide a safe, reliable and sustainable drinking water supply.

Here are some tested and useful message bullets :

- Proven engineered treatment processes are used to purify water to a level that is safe to drink
- Purifying water is a "multi-barrier process" designed to separate water from pollutants.
- There are various treatment processes to accomplish this objective.
- Purified water is tested, in real-time, with online sensors and will be strictly monitored by the Department of Health.
- Purified water will comply with or exceed strict state and federal drinking water standards.
- The purification process produces water that is more pure than most bottled waters.
- Purified water is currently used to supplement drinking water in many communities in the United States and around the world. There have been no problems from using purified water to augment drinking water supplies.

At times it may be advantageous to include a more detailed description of the advanced technological processes used to purify recycled water. In such instances, the following language is an example of how to describe the microfiltration/reverse osmosis/ultraviolet light treatment train:

- The water first goes through microfiltration, a pretreatment process, where water is pumped through tubes filled with tiny membranes. Each membrane is made up of hollow fibers, perforated with holes 1/300th the width of a human hair! As the water moves through the tubes, solids and bacteria are caught in the fibers.
- The water then goes through reverse osmosis where it's forced through membranes that remove salt and microorganisms, including viruses, bacteria and most chemicals of emerging concern.
- Now the water is very clean, but one more step ensures its safety: exposing the water to ultraviolet light to cause any remaining organic molecules to break down.

Using advanced purified water is good for the environment.

The more recycled water we use for whatever purpose we use it, the less we have to take out of rivers, streams and our scarce groundwater supplies. This is good for rivers and streams and the fish, plants and wildlife that rely upon them.

We all recycle as often as we can — glass, plastic, paper and even yard waste, which is the right thing to do. For the same reason, we should recycle and reuse as much of our limited water supplies as we possibly can — water is too valuable to be used just once.

Excerpted from WRRF-13-02 Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse | www.watereuse.org

WateReuse

Communication and Outreach Tools

Building Trust — Why Tools are Needed

Since public acceptance of potable reuse is one of the primary challenges facing this source of water supply, developing clear and informative tools will help gain acceptance and build trust in your community for your project.

Develop Informational Materials

The following are strategies for developing informational materials:

- Make available easy-to-understand materials highlighting key messages appropriate for target audiences and provide them in print and electronic formats; consider using QR codes and social media platform strategies;
- Develop materials tailored to the interests of specific audiences;
- Ensure all materials are responsive to multicultural, multiethnic, and age-specific audiences; translate key items into other languages as needed;
- Consistently update all materials (both electronic and print) to make sure designated audiences, including agency employees, have timely and accurate materials;
- Link to other places that provide information about purified water projects.

Menu of Informational Materials and Tools

Collaterals

- Purified water fact sheet
- Purified water FAQ
- Pocket brochure
- Bill inserts
- Posters and banners
- Materials for children
- White papers
- Template articles

Web and Digital

- Website
- Presentations
- E-newsletter
- Program DVD
- Quarterly videos

Libraries and Databases

- Graphics "catalog"
- Quote/Cite bank
- Mailing list
- Centralized internal information station

Other

- Learning/visitor's center at the advanced water treatment facility
- Key messages card
- Supporter/comment cards

Speakers Bureau

- Detailed information on *Strategies & Activities for Creating Your Speakers Bureau* are available at www.waterreuse.

For more detailed and helpful information on each of these bulleted items see section 5.10 of the WRRF 13-02 report.

Sample Timeline on reverse

Excerpted from WRRF-13-02 Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse | www.watereuse.org

Spring 2015 – Water Reuse Solutions

WateReuse

Understanding Potable Reuse

A Key Part of Our Water Supply Solutions

Potable Reuse Education — Sharing Solutions to Water Supply Challenges

Numerous regions of the world are experiencing drought and resulting lack of water supplies. While using purified water for drinking is not new, innovative projects in Australia, Texas, California and elsewhere are currently providing advanced water purification to increase water supplies. These projects can serve as models for other states and municipalities.

WateReuse provides countries, states, municipalities and water districts with information and tools that can lead to establishment of Direct Potable Reuse (DPR) or Indirect Potable Reuse (IPR) projects that are both sustainable and protective of public health. As new water supply options, DPR projects treat wastewater, including sewer water, that has been cleaned for return to the environment and actually further clean or purify it to meet all drinking water standards. This purified water is regulated by water quality and health officials and implemented by water utilities in a safe, cost-effective and environmentally responsible manner. Uses may include purifying water to distilled quality for industrial processes, as well as for drinking. IPR projects add the step of passing the highly treated water through an environmental buffer, such as a groundwater aquifer or surface water reservoir.

Since 2012, two Texas cities (see page 3) have been operating the nation's first DPR plants. Likewise, in 2012, California has embarked on an awareness effort to help establish DPR as a water supply option. The ongoing effort is to address the regulatory, scientific, technical, and attitudinal issues surrounding potable reuse projects. This is being accomplished through funding of independent and rigorous scientific research and communicating findings and data through public outreach and awareness programs.

WateReuse is sharing solutions and best practices from 26 independent research projects, made with investments of over $11.5 million, to evaluate and demonstrate the feasibility of DPR. The research revolves around developing a robust monitoring and redundant water purification system. These projects will help inform other communities and governments moving forward when considering a range of potable reuse projects.

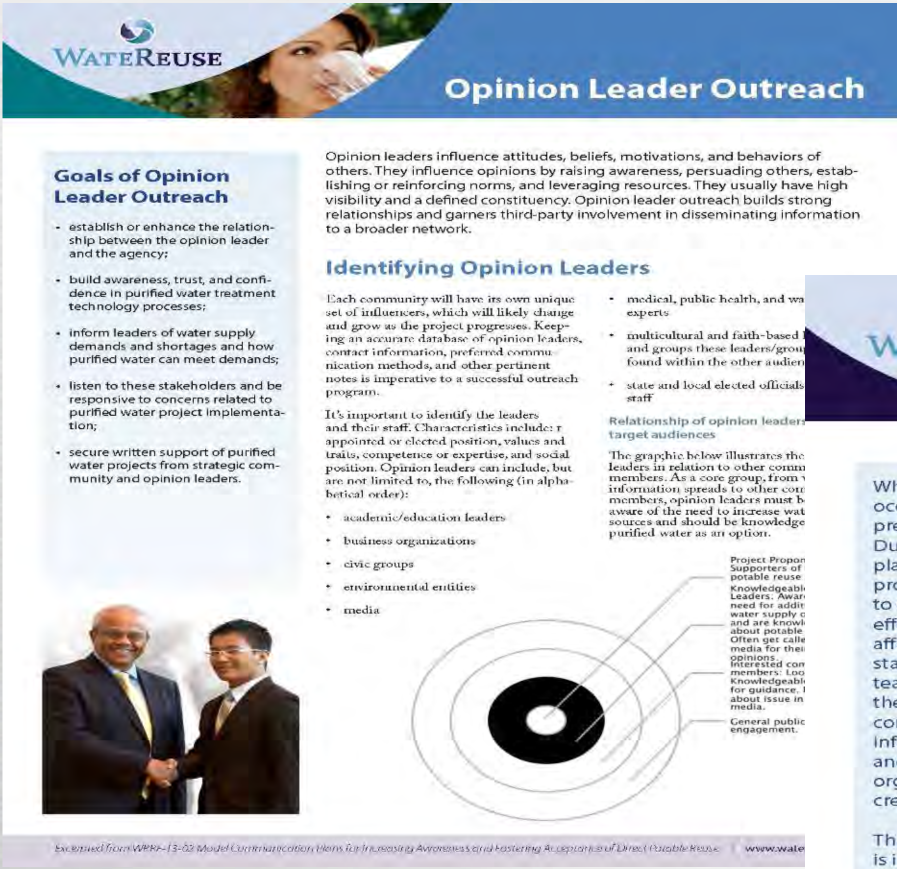
Wichita Falls' DPR Project went online July 9, 2014 following extensive testing by the City of Wichita Falls and the Texas Commission on Environmental Quality (TCEQ). Shown here is one of their clarifiers.

What is Potable Reuse?

Potable reuse refers to purified water you can drink. It's highly treated to meet or exceed federal and state drinking water standards and is safe for human consumption. How potable reused water is delivered determines if it is called Indirect Potable Reuse (IPR) or Direct Potable Reuse (DPR).

Indirect Potable Reuse means the water is delivered to you indirectly. After it is purified, the reused water blends with other supplies and/or sits a while in some sort of man-made or natural storage before it gets delivered to a pipeline that leads to a drinking water plant or distribution system. That storage could be a groundwater basin or a surface water reservoir.

Direct Potable Reuse means the purified water is put directly into pipelines that go to a drinking water plant or distribution system. Direct potable reuse may occur with or without "engineered storage" such as underground or above ground tanks.



WATEREUSE

Opinion Leader Outreach

Goals of Opinion Leader Outreach

- establish or enhance the relationship between the opinion leader and the agency;
- build awareness, trust, and confidence in purified water treatment technology processes;
- inform leaders of water supply demands and shortages and how purified water can meet demands;
- listen to these stakeholders and be responsive to concerns related to purified water project implementation;
- secure written support of purified water projects from strategic community and opinion leaders.

Opinion leaders influence attitudes, beliefs, motivations, and behaviors of others. They influence opinions by raising awareness, persuading others, establishing or reinforcing norms, and leveraging resources. They usually have high visibility and a defined constituency. Opinion leader outreach builds strong relationships and garners third-party involvement in disseminating information to a broader network.

Identifying Opinion Leaders

Each community will have its own unique set of influencers, which will likely change and grow as the project progresses. Keeping an accurate database of opinion leaders, contact information, preferred communication methods, and other pertinent notes is imperative to a successful outreach program.

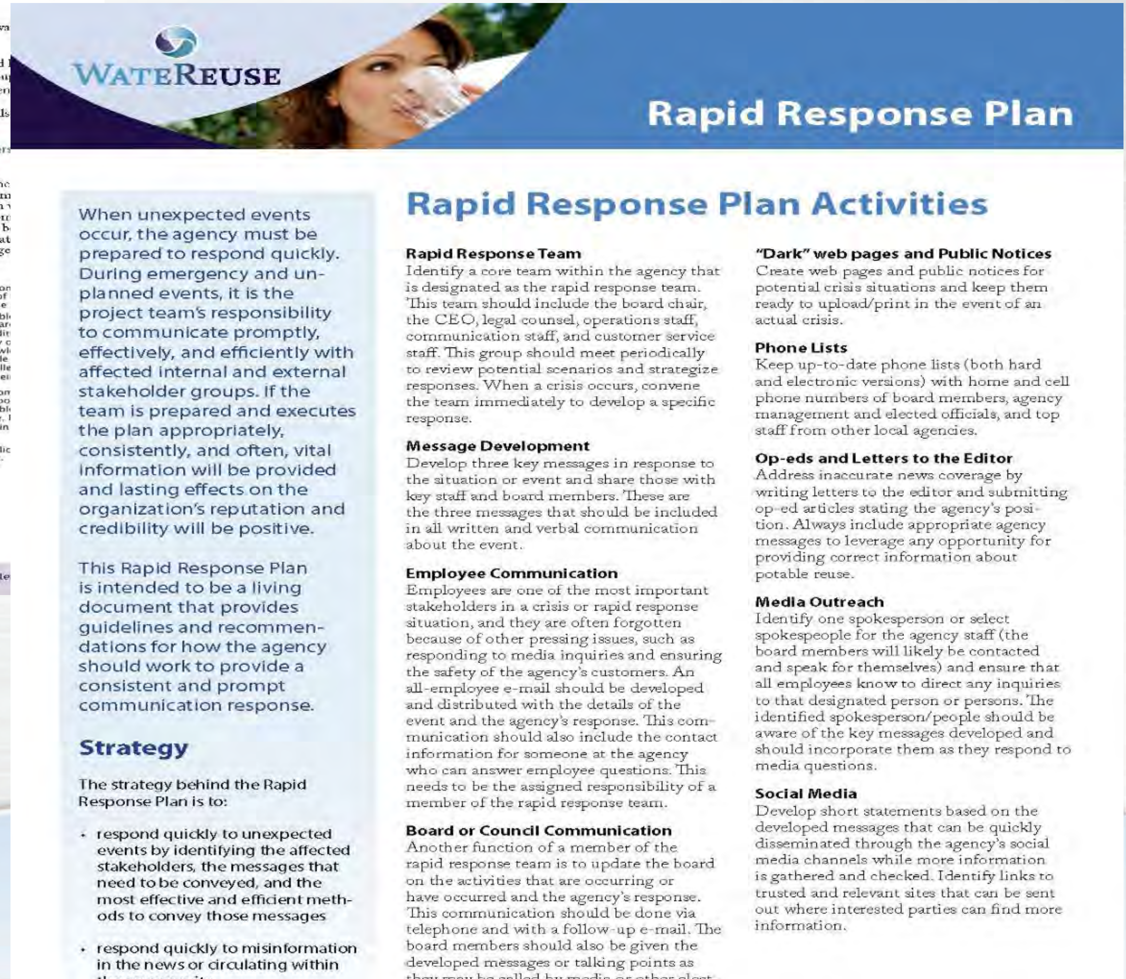
It's important to identify the leaders and their staff. Characteristics include: r appointed or elected position, values and traits, competence or expertise, and social position. Opinion leaders can include, but are not limited to, the following (in alphabetical order):

- academic/education leaders
- business organizations
- civic groups
- environmental entities
- media
- medical, public health, and wa experts
- multicultural and faith-based l and groups these leaders/grou found within the other audien
- state and local elected officials staff

Relationship of opinion leaders target audiences

The graphic below illustrates the leaders in relation to other comm members. As a core group, from information spreads to other com members, opinion leaders must b aware of the need to increase wat sources and should be knowledge purified water as an option.

Excerpted from WRRF-13-02 Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse | www.wate



WATEREUSE

Rapid Response Plan

When unexpected events occur, the agency must be prepared to respond quickly. During emergency and unplanned events, it is the project team's responsibility to communicate promptly, effectively, and efficiently with affected internal and external stakeholder groups. If the team is prepared and executes the plan appropriately, consistently, and often, vital information will be provided and lasting effects on the organization's reputation and credibility will be positive.

This Rapid Response Plan is intended to be a living document that provides guidelines and recommendations for how the agency should work to provide a consistent and prompt communication response.

Strategy

The strategy behind the Rapid Response Plan is to:

- respond quickly to unexpected events by identifying the affected stakeholders, the messages that need to be conveyed, and the most effective and efficient methods to convey those messages
- respond quickly to misinformation in the news or circulating within

Rapid Response Plan Activities

Rapid Response Team
Identify a core team within the agency that is designated as the rapid response team. This team should include the board chair, the CEO, legal counsel, operations staff, communication staff, and customer service staff. This group should meet periodically to review potential scenarios and strategize responses. When a crisis occurs, convene the team immediately to develop a specific response.

Message Development
Develop three key messages in response to the situation or event and share those with key staff and board members. These are the three messages that should be included in all written and verbal communication about the event.

Employee Communication
Employees are one of the most important stakeholders in a crisis or rapid response situation, and they are often forgotten because of other pressing issues, such as responding to media inquiries and ensuring the safety of the agency's customers. An all-employee e-mail should be developed and distributed with the details of the event and the agency's response. This communication should also include the contact information for someone at the agency who can answer employee questions. This needs to be the assigned responsibility of a member of the rapid response team.

Board or Council Communication
Another function of a member of the rapid response team is to update the board on the activities that are occurring or have occurred and the agency's response. This communication should be done via telephone and with a follow-up e-mail. The board members should also be given the developed messages or talking points as

"Dark" web pages and Public Notices
Create web pages and public notices for potential crisis situations and keep them ready to upload/print in the event of an actual crisis.

Phone Lists
Keep up-to-date phone lists (both hard and electronic versions) with home and cell phone numbers of board members, agency management and elected officials, and top staff from other local agencies.

Op-eds and Letters to the Editor
Address inaccurate news coverage by writing letters to the editor and submitting op-ed articles stating the agency's position. Always include appropriate agency messages to leverage any opportunity for providing correct information about potable reuse.

Media Outreach
Identify one spokesperson or select spokespeople for the agency staff (the board members will likely be contacted and speak for themselves) and ensure that all employees know to direct any inquiries to that designated person or persons. The identified spokesperson/people should be aware of the key messages developed and should incorporate them as they respond to media questions.

Social Media
Develop short statements based on the developed messages that can be quickly disseminated through the agency's social media channels while more information is gathered and checked. Identify links to trusted and relevant sites that can be sent out where interested parties can find more information.

Facilitated Discussion

Water:
Nature's Amazing Reuseable Resource