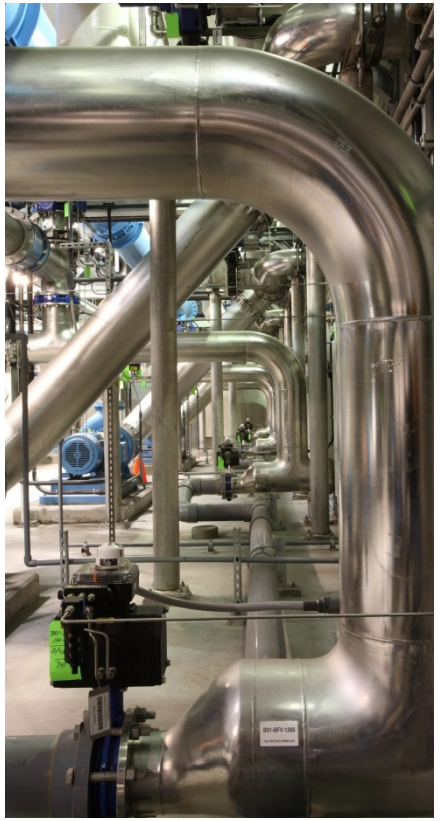
Integrating Onsite Water Reuse with Centralized Treatment Systems

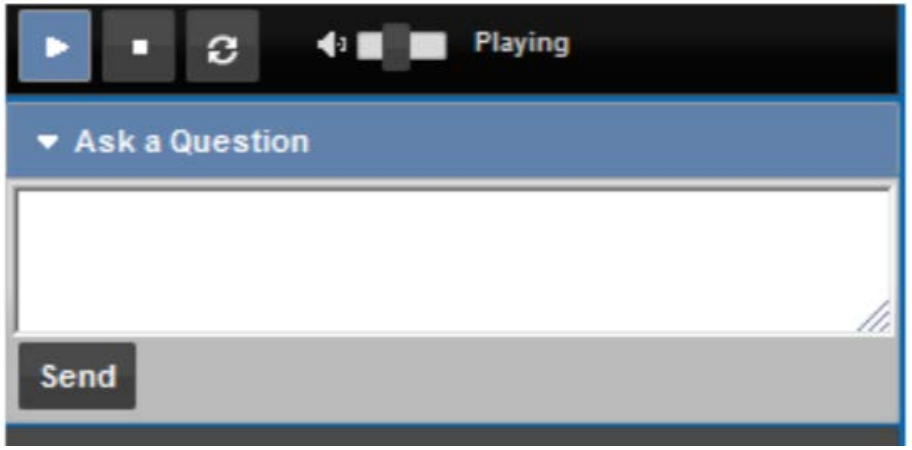
December 19, 2019



WateReuse Webcast Series

A Few Notes Before We Start…

- Today's webcast will be 60 minutes.
- There is one (1) Professional Development Hour (PDH) available for this webcast.
- A PDF of today's presentation will be shared via email
- Please type questions for the presenters into the chat box located on the panel on the left side of your screen.



WATEREUSE

Today's Presenters

Moderator
Mary Ann Dickinson
President & CEO
Alliance for Water Efficiency

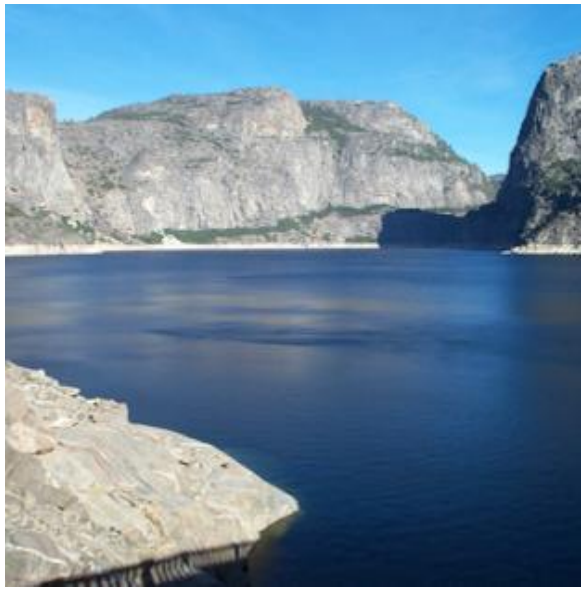
Presenter
Paula Kehoe
Director of Water Resources
San Francisco Public Utilities Commission

WaterReuse

ADVANCING ONSITE WATER REUSE & LESSONS LEARNED

Paula Kehoe
Director of Water Resources
San Francisco Public Utilities Commission
December 19, 2019

San Francisco Public Utilities Commission



Water: delivering high quality water every day to 2.7 million people

Power: generating hydropower and solar power

Wastewater: protecting public health and the environment

Challenges to Future Water Supply Reliability


Drought


Resilience

Aging Infrastructure


New Development


Stormwater Management


In-Stream Flow Needs

OneWaterSF: Moving from a Linear Approach to Integrated Planning and Implementation

Traditional Resource Management

OneWaterSF

San Francisco's Local Water Program

HETCH HETCHY
+ LOCAL WATER
Better together.

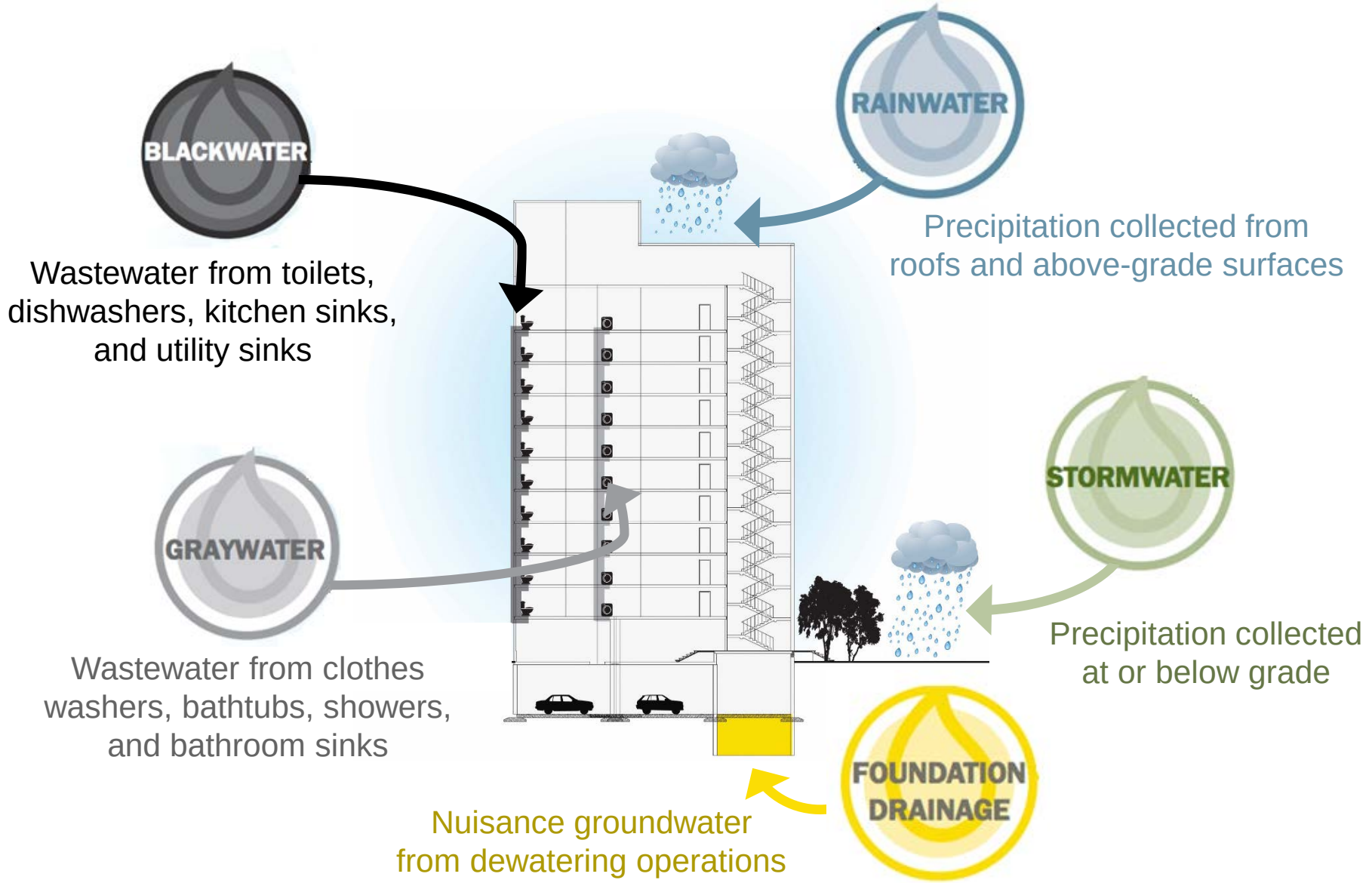
Conservation
Groundwater
Recycled Water
Onsite Water Reuse
Innovations Program

San Francisco knows the importance of diversifying our water portfolio…
To ensure reliability—particularly in the age of climate change—we need
to use every water resource available.

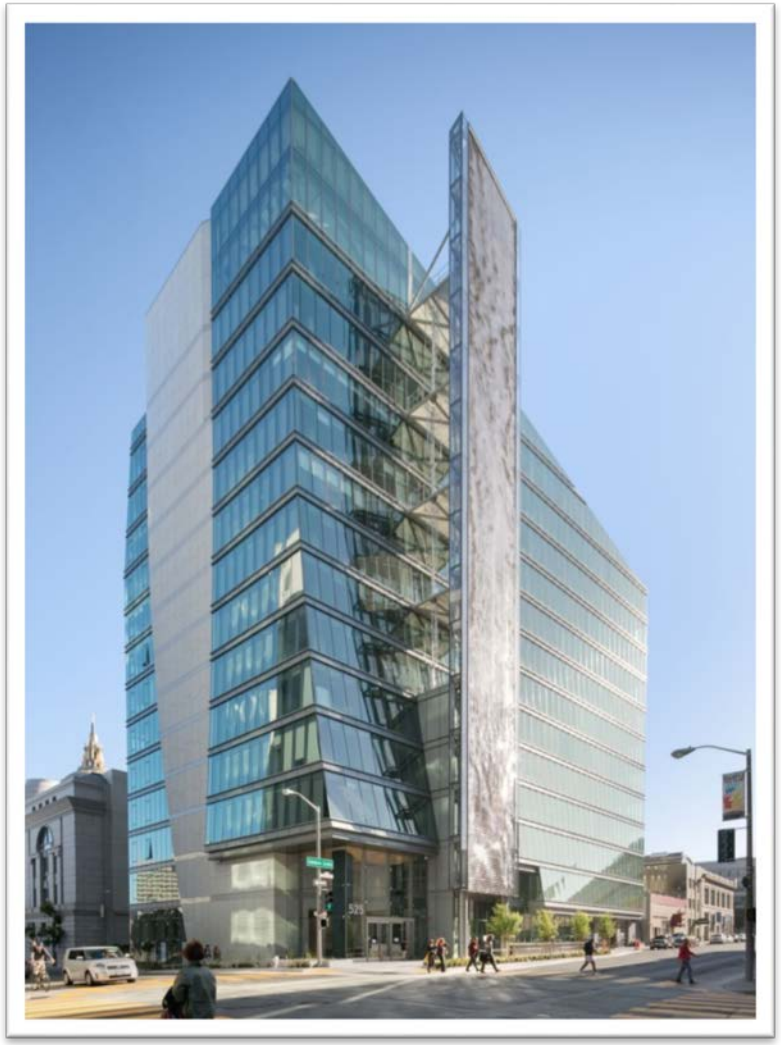
Harlan L. Kelly, Jr., SFPUC General Manager

ONSITE WATER REUSE
PROGRAM IMPLEMENTATION

Buildings Generate Resources, Not Waste



Pioneering Onsite Water Reuse at SFPUC Headquarters

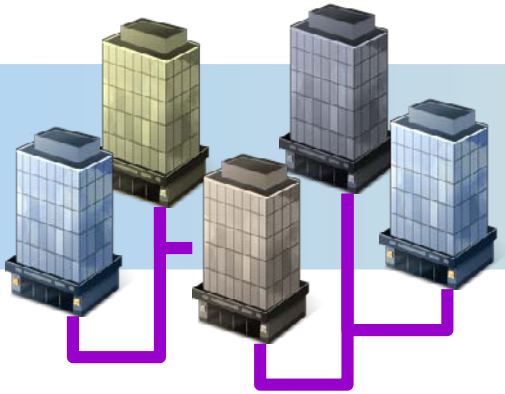


San Francisco's Evolving Onsite Water Reuse Program

2012

Single Building

2013



District-Scale

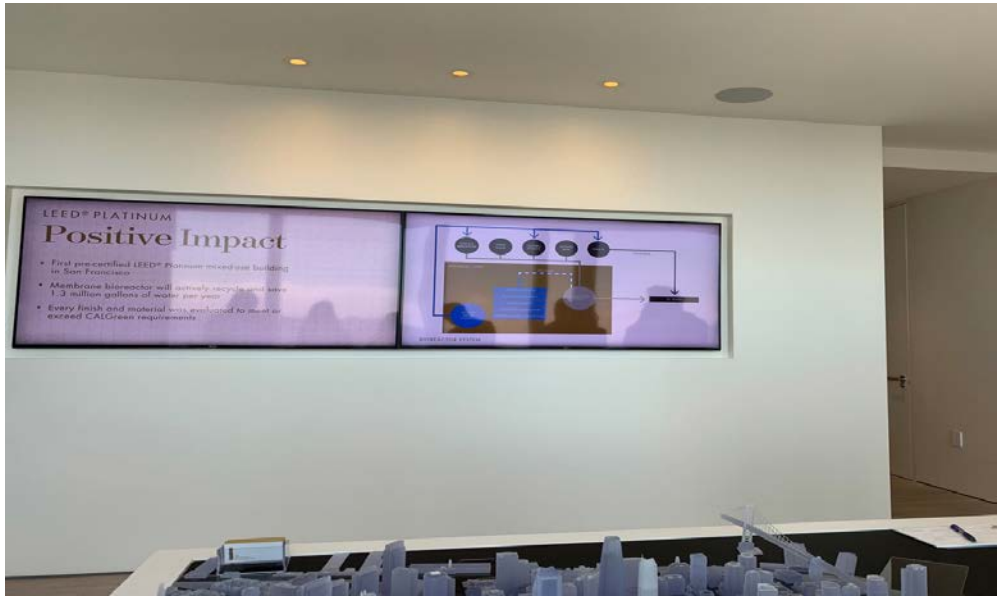
2015

Mandatory for ≥ 250,000 gsf

Source: San Francisco Public Utilities Commission

181 Fremont, San Francisco

Graywater and Rainwater for Flushing and Irrigation
1.3M GPY Potable Offset



Source: Jay Paul Company and Heller Manus Architects

Salesforce Tower, San Francisco

Blackwater for Flushing, Cooling, and Irrigation
7.8M GPY Potable Offset

Source: Aquacell

Moscone Convention Center, San Francisco

Foundation Drainage and Condensate for Flushing, Irrigation, and Street Sweeping
11M GPY Potable Offset

Source: Skidmore, Ownings & Merrill LLP with Mark Cavagnero Associates

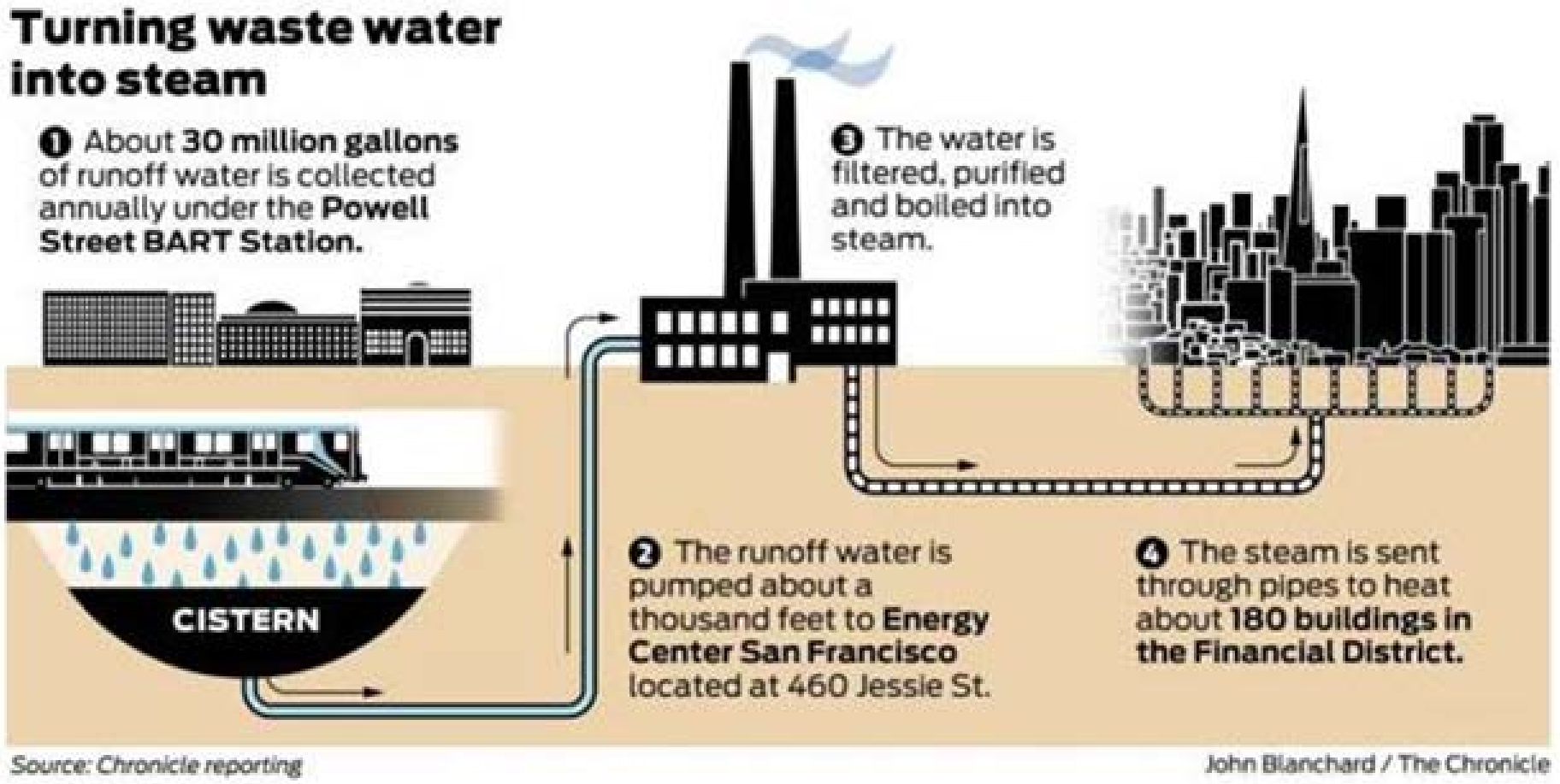
Chase Center, San Francisco

Rainwater, Stormwater, Graywater, and Condensate for Flushing
3.7M GPY Potable Offset

Source: Golden State Warriors

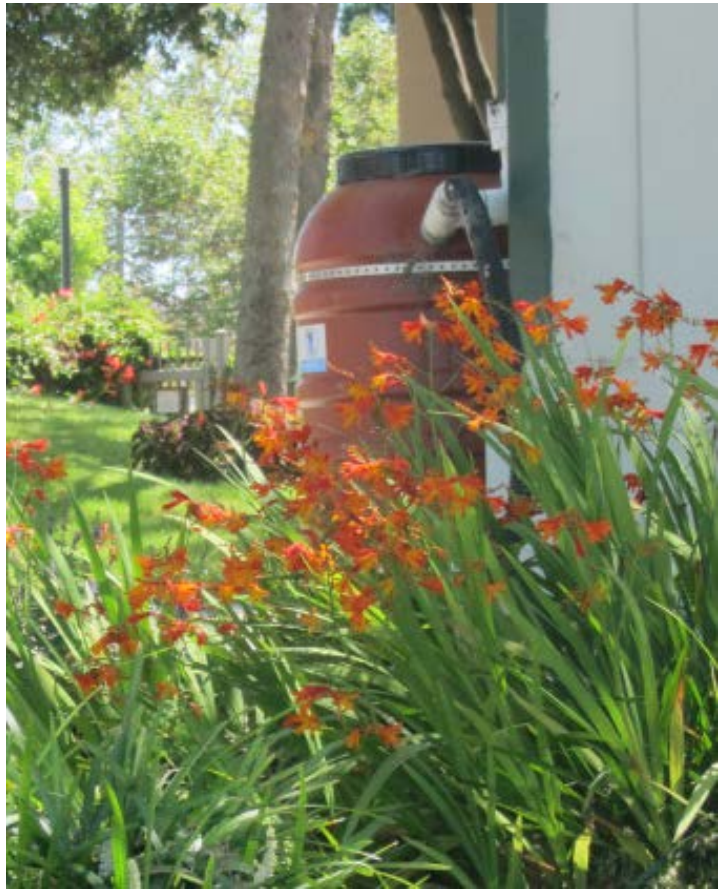
Industrial Reuse

NRG Steam Loop
30M GPY Potable Offset



Source: NRG; San Francisco Public Utilities Commission

Reusing Rainwater & Graywater on a Residential Scale



ONSITE WATER REUSE
SAN FRANCISCO'S LESSONS LEARNED

Onsite Water Reuse
Key Lessons Learned

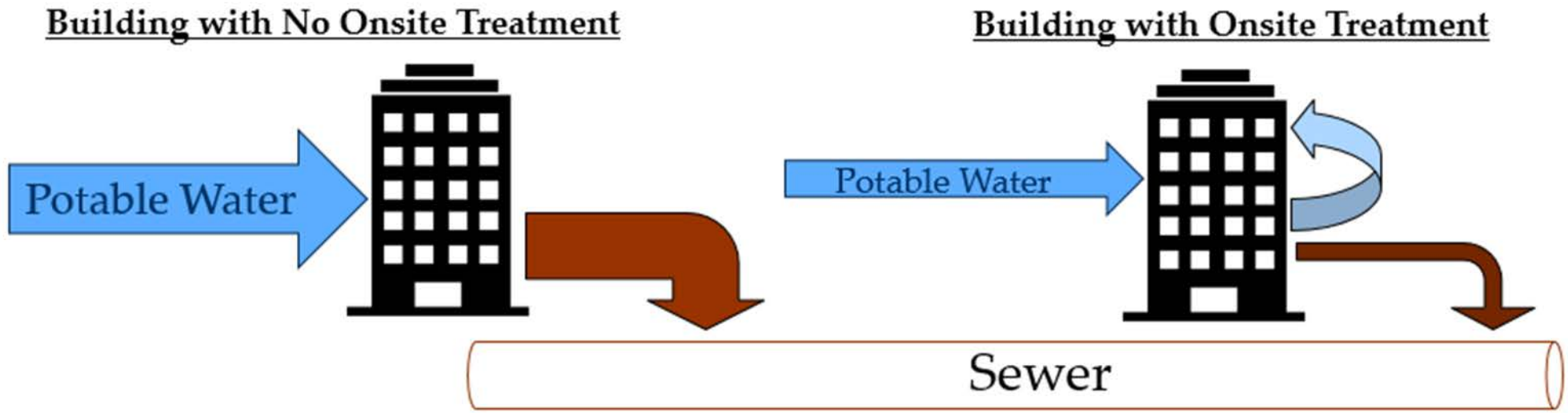
- Program Development
- Water Quality and Treatment Design
- Key Utility Considerations
- Operator Capacity
- Partner with Developers, Vendors and General Public
- Resource Recovery Opportunities

Onsite Water Reuse Lessons Learned
Program Development

- Need for multi-agency collaboration
- Identify roles and responsibilities
- Establishment of rules and regulations
- Identify enforcement measures
- Policy synergies
- Cultural shift

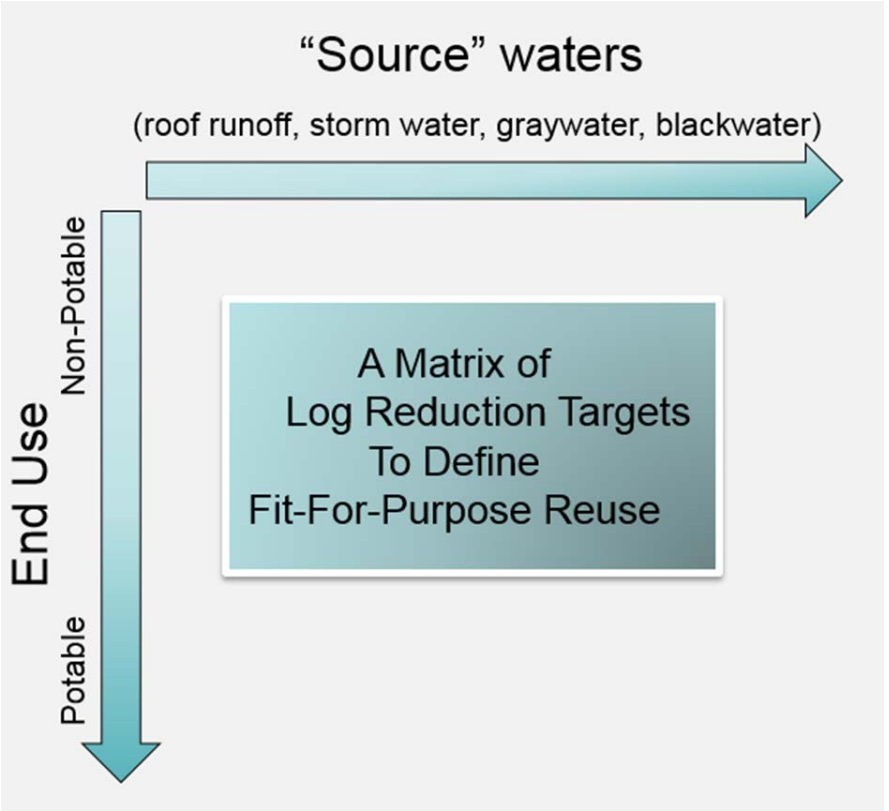
Onsite Water Reuse Lessons Learned
Key Program Elements

- Require connections to municipal water and sewer systems
- Require backflow protection requirements
- Conduct cross-connection test prior to operation



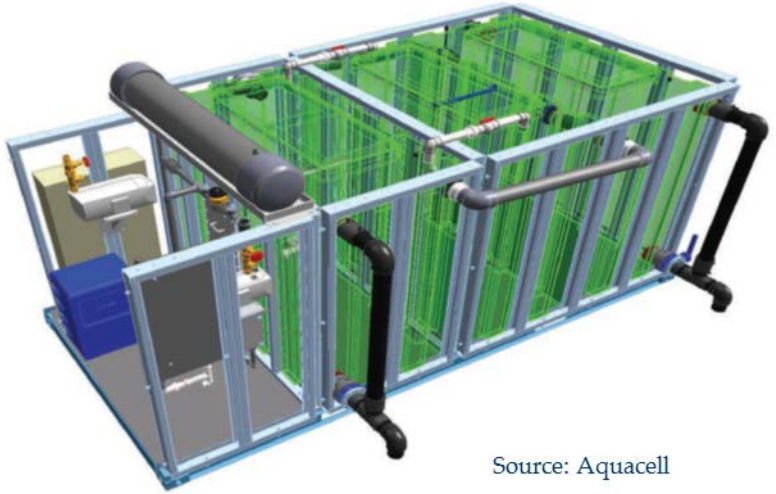
Onsite Water Reuse Lessons Learned
Water Quality and Treatment Design

- CA Plumbing Code limitations
- Protection of public health: risk-based water quality standards
- Design treatment systems to reduce pathogens that can impact public health (protozoa, bacteria, and virus)



Graywater and Blackwater Treatment

- Biological treatment of graywater and blackwater can reduce TSS, turbidity and BOD; improve UV Transmittance; and can reduce ammonia
- Raw graywater BOD can be as high as 600 mg/L
- Consider aesthetics desired for end uses, e.g. toilet flushing



Source: Aquacell

Rainwater Harvesting

- Routing rainwater through a green roof or planter can create issues with color and turbidity
- Tanks and pipes must be properly sealed to prevent mosquito growth
- Plumbing cistern to be able to flush with potable water helps avoid dry season stagnation

Onsite Water Reuse Lessons Learned
Key Utility Considerations

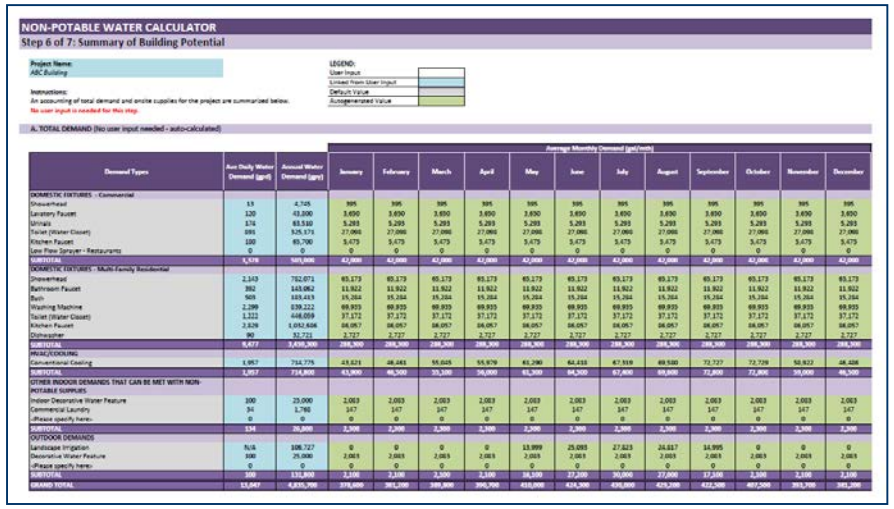
- Wastewater flows and odors
- Revenue impacts
- Capacity charge adjustments
- Excess use charges

Management and Mitigation Approach	✓ Hydraulic modeling used to evaluate impacts ✓ So far, no impacts expected in SF ✓ Alternative strategies available (e.g. flushing, trucking solids)

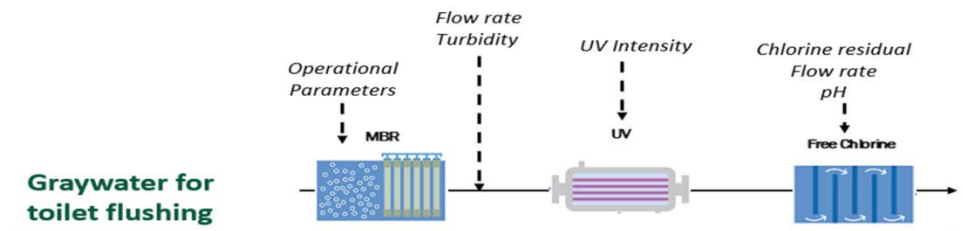
Onsite Water Reuse Lessons Learned
Operator Capacity

- Operators benefit from having experience with both traditional water and wastewater technologies
- Require operators to sign affidavit acknowledging they possess appropriate knowledge, skills, and training
- Early communication is key among operators, project owners, and engineers about ongoing O&M costs and responsibilities

Onsite Water Reuse Lessons Learned
Develop Technical Assistance

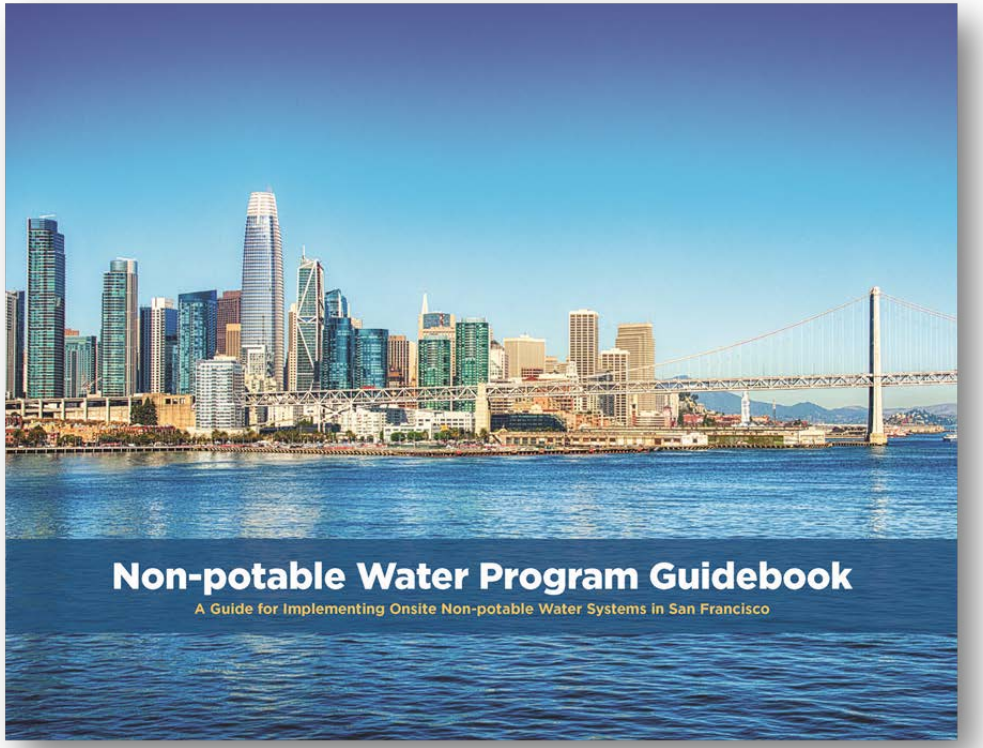

NON-POTABLE WATER CALCULATOR

Step 6 of 7: Summary of Building Potential



Graywater for toilet flushing

Pathogen Credits			
Treatment Process	MBR	UV	Chlorine
Virus	1.5	Up to 6	Up to 5
Protozoa	2	Up to 6	0
Bacteria	4	Up to 6	Up to 5
Ongoing Requirements	Operate within Tier 1 envelope	Online monitoring to confirm validated dose	Demonstrate CT with verified free chlorine residual



Onsite Water Reuse Lessons Learned
Share Learning with Developers and Vendors

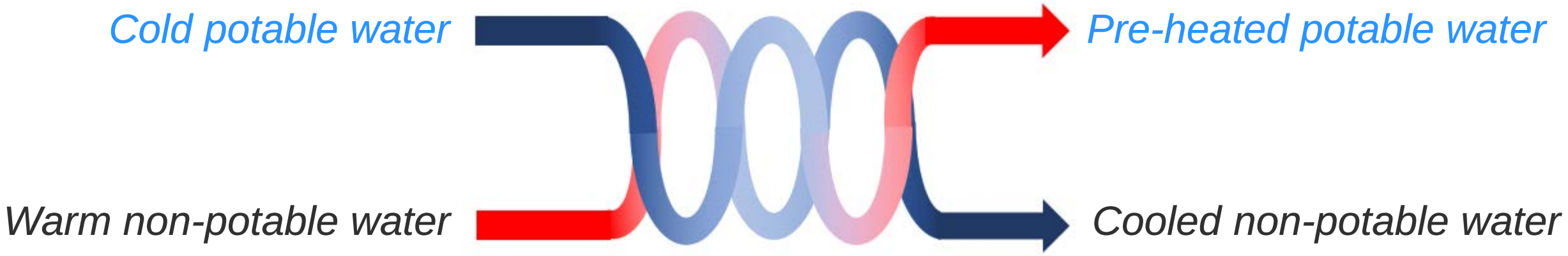
- Encouraging blackwater reuse in commercial buildings as opposed to graywater can achieve significantly higher potable water savings

Onsite Water Reuse Lessons Learned
Public Education

- Signage in bathrooms and common areas is an opportunity to engage occupants and visitors about conserving water with onsite water treatment systems

Onsite Water Reuse Lessons Learned
Resource Recovery Opportunities

Wastewater Heat Recovery:
The extraction of thermal energy from warm wastewater, and subsequent beneficial use of this energy to offset building energy use for applications such as hot water heating or space heating/cooling



Onsite Water Reuse Lessons Learned
Wastewater Heat Recovery

- Potential for heat recovery is greatest in multi-family residential buildings
- Maximizing benefits requires integration with building hot water and/or space heating & cooling systems
- Wastewater heat recovery has synergies with onsite reuse
  - ✓ Onsite water reuse systems will already have EQ tanks that can provide consistent flow to heat recovery system
  - ✓ Heat can be recovered from treated gray or blackwater, meaning less wear and tear on heat recovery equipment from raw wastewater
  - ✓ Heat recovery will cool down treated non-potable water, which can help control Legionella growth in distribution system

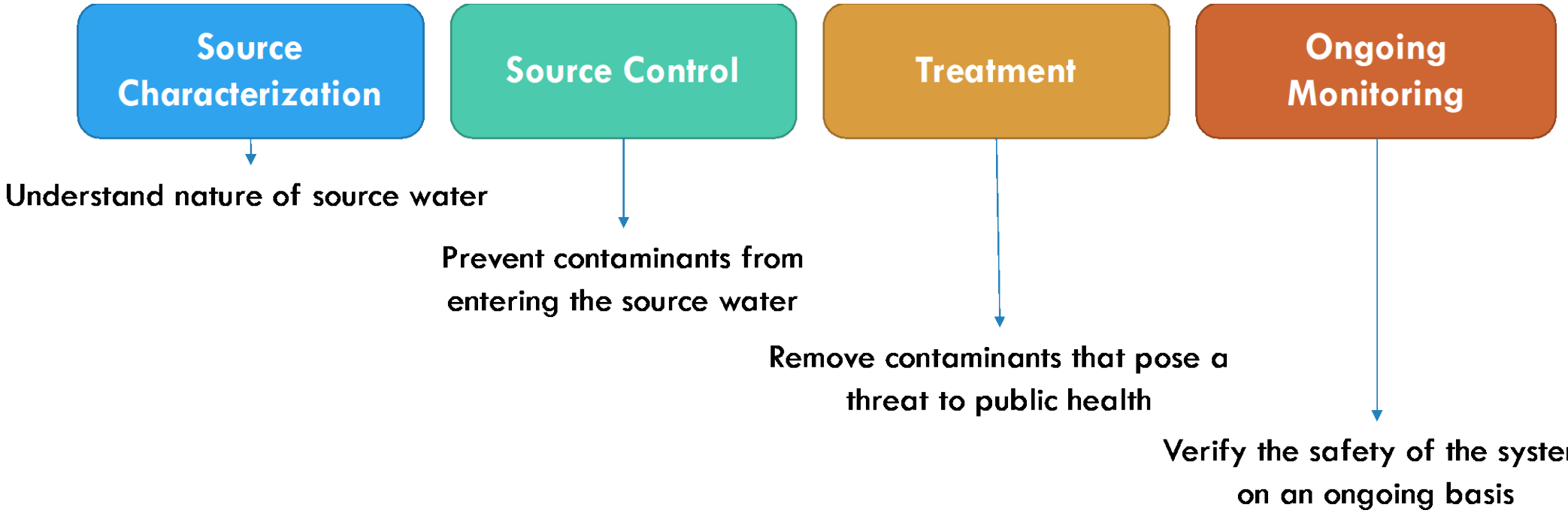
SAN FRANCISCO'S INNOVATIONS PROGRAM

Brewery Process Water Reuse

- Typical brewery can use 5 – 7 gallons of water to produce 1 gallon of beer
- Breweries can collect & treat process water onsite to reduce water footprint
  - Rinsing tanks, bottles, and kegs
  - Floor wash down
  - Cooling towers
  - Beer production
- SFPUC Onsite Water Reuse Grant Program contain guidance on brewery process water reuse

Brewery Process Water Reuse
Need for New Strategy to Protect Public Health

- San Francisco's chemical and pathogen control strategy is based on four key elements to ensure public health protection:

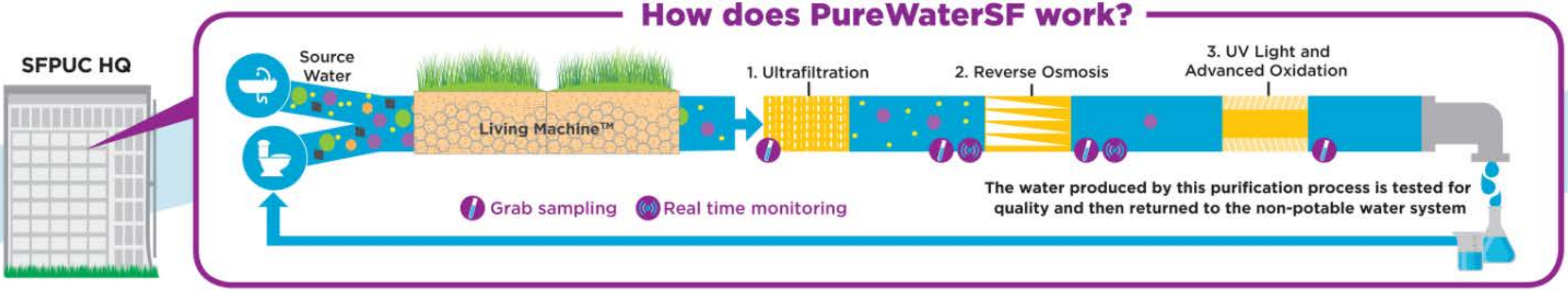


PureWaterSF

Researching Direct Potable Reuse at the Building Scale

Building on our values

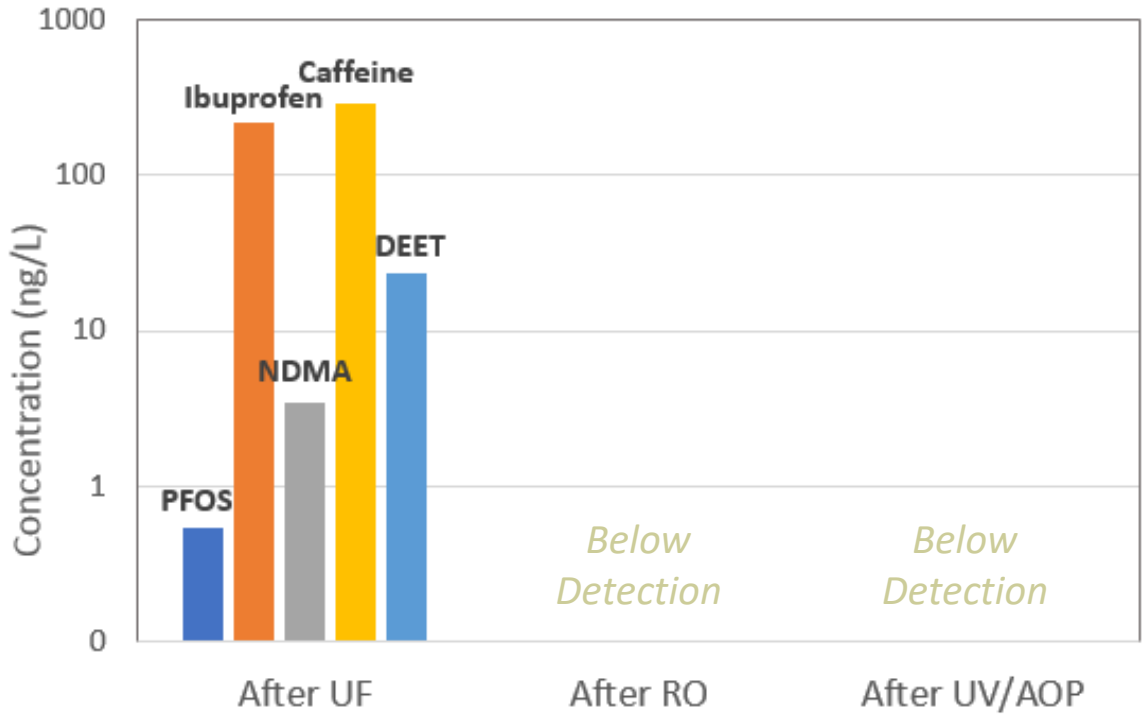
How does PureWaterSF work?



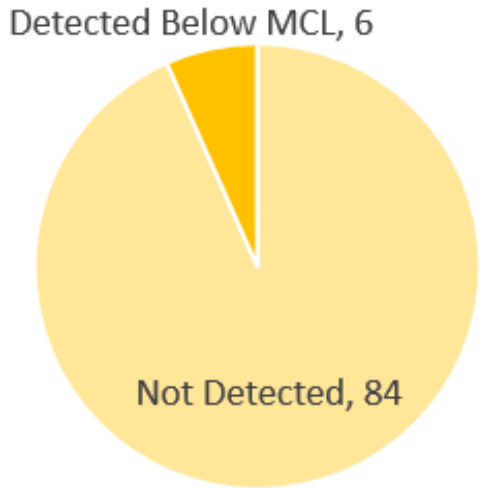
Findings: Water Quality and Treatment Performance

✓ ***>1,300 individual analyses performed***

✓ ***Pharmaceuticals & other CECs are removed well through treatment train***



✓ ***Chemicals are below regulatory limits in finished water***



✓ ***Treatment processes achieved pathogen removal goals***

Atmospheric Water Generation
Additional Opportunity to Produce Water Onsite

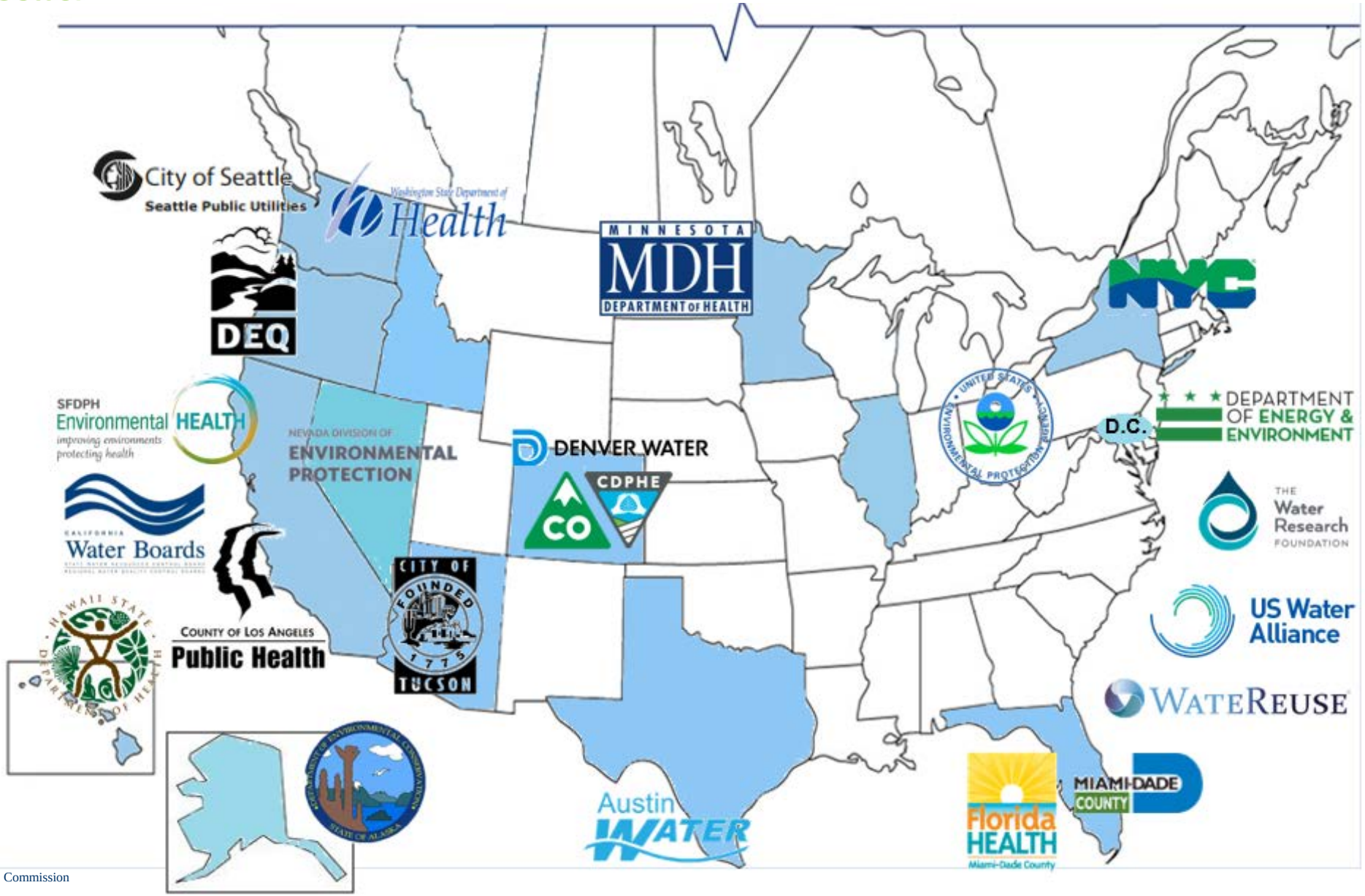
Source: Zero Mass Water

AWG at the Denver Botanic Garden

Hangar 1 Fog Point Vodka made with captured fog

ONSITE WATER REUSE
COLLABORATING ON A NATIONAL LEVEL

National Blue Ribbon Commission for Onsite Non-potable Water Systems



Source: San Francisco Public Utilities Commission

National Blue Ribbon Commission
Address Key Issues

- Create Consistent Water Quality Standards From State to State
- Promote Risk-Based Water Quality Standards
- Encourage Local Oversight and Management Programs
- Forum for Peer to Peer Learning

National Blue Ribbon Commission for Onsite Non-potable Water Systems

Varying Water Quality Standards Across the US

Graywater Use to Flush Toilets						
	BOD_5 ($mg\ L^{-1}$)	TSS ($mg\ L^{-1}$)	Turbidity (NTU)	Total Coliform (cfu/ 100ml)	*E. Coli* (cfu/ 100ml)	Disinfection
California	10	10	2	2.2	2.2	0.5 – 2.5 mg/L residual chlorine
New Mexico	30	30	-	-	200	-
Oregon	10	10	-	-	2.2	-
Georgia	-	-	10	500	100	-
Texas	-	-	-	-	20	-
Massachusetts	10	5	2	-	14	-
Wisconsin	200	5	-	-	-	0.1 – 4 mg L^{-1} residual chlorine
Colorado	10	10	2	-	2.2	0.5 – 2.5 mg/L residual chlorine
Typical Graywater	80 - 380	54 -280	28-1340	$10^{7.2} - 10^{8.8}$	$10^{5.4} - 10^{7.2}$	N/A

Source: Jay Garland, US EPA

Independent Expert Panel

Developed a risk-based water quality approach for onsite non-potable water systems

Pathogen Log Reduction Targets (LRTs)

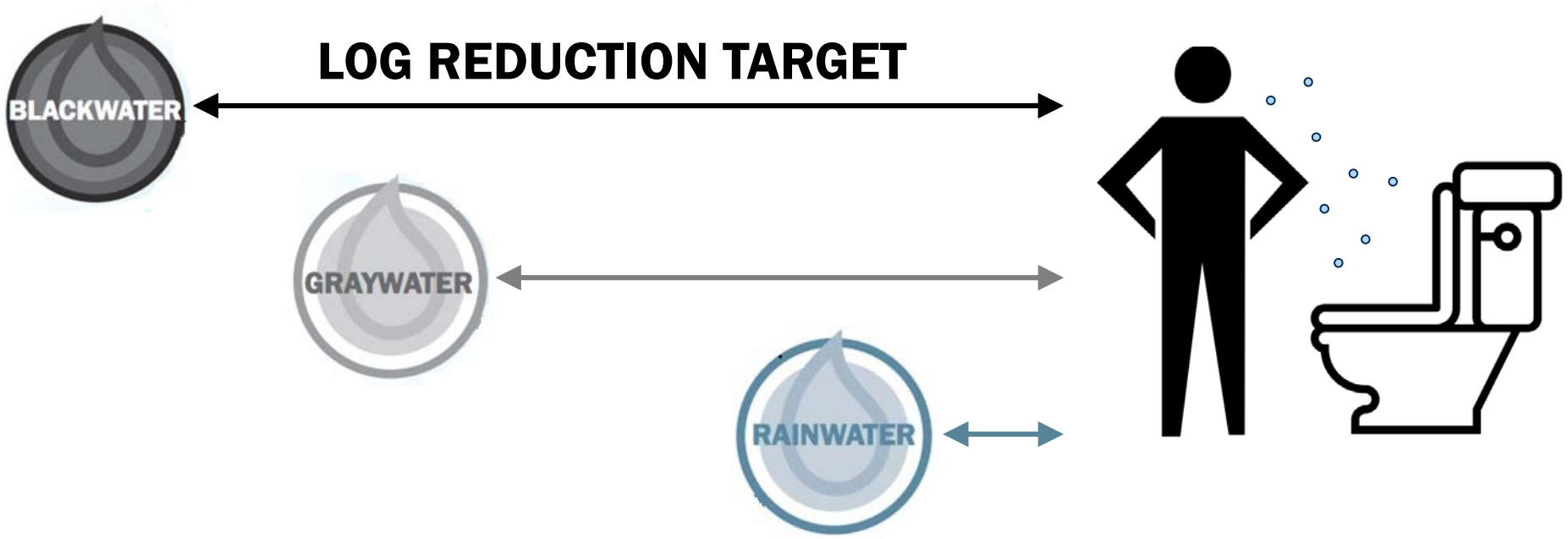
Continuous online monitoring

Treated water quality standards

Pathogen Log Reduction Targets

Source waters have different starting pathogen concentrations

Target safe pathogen level is the same regardless of source water

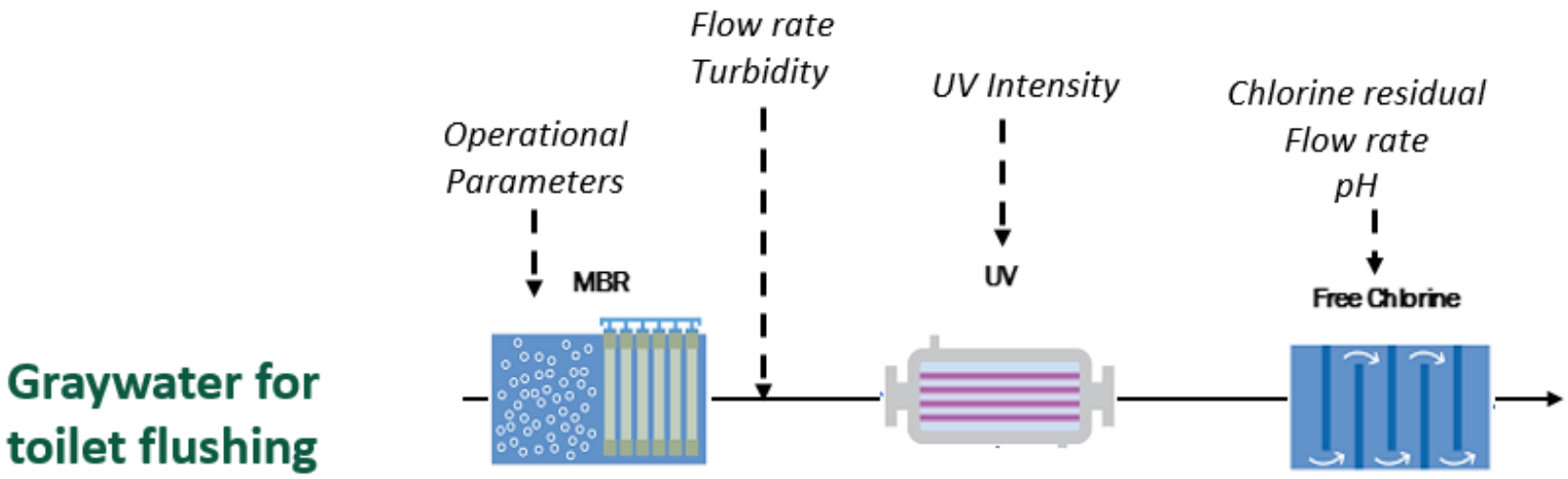


Log reduction target is the difference between the starting point and the safe end point

Pathogen Log Reduction Targets for Various Water Sources & End Uses

	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
Blackwater			
Outdoor use	8.0	7.0	6.0
Indoor use	8.5	7.0	6.0
Graywater			
Outdoor use	5.5	4.5	3.5
Indoor use	6.0	4.5	3.5
Roof Runoff			
Outdoor use	N/A	N/A	3.5
Indoor use	N/A	N/A	3.5
Stormwater			
Outdoor use	3.0	2.5	2.0
Indoor use	3.5	3.5	3.0

Example Graywater System Treatment Train



Pathogen Credits			
Treatment Process	MBR	UV	Chlorine
Virus	1.5	Up to 6	Up to 5
Protozoa	2	Up to 6	0
Bacteria	4	Up to 6	Up to 5
Ongoing Requirements	Operate within Tier 1 envelope	Online monitoring to confirm validated dose	Demonstrate CT with verified free chlorine residual

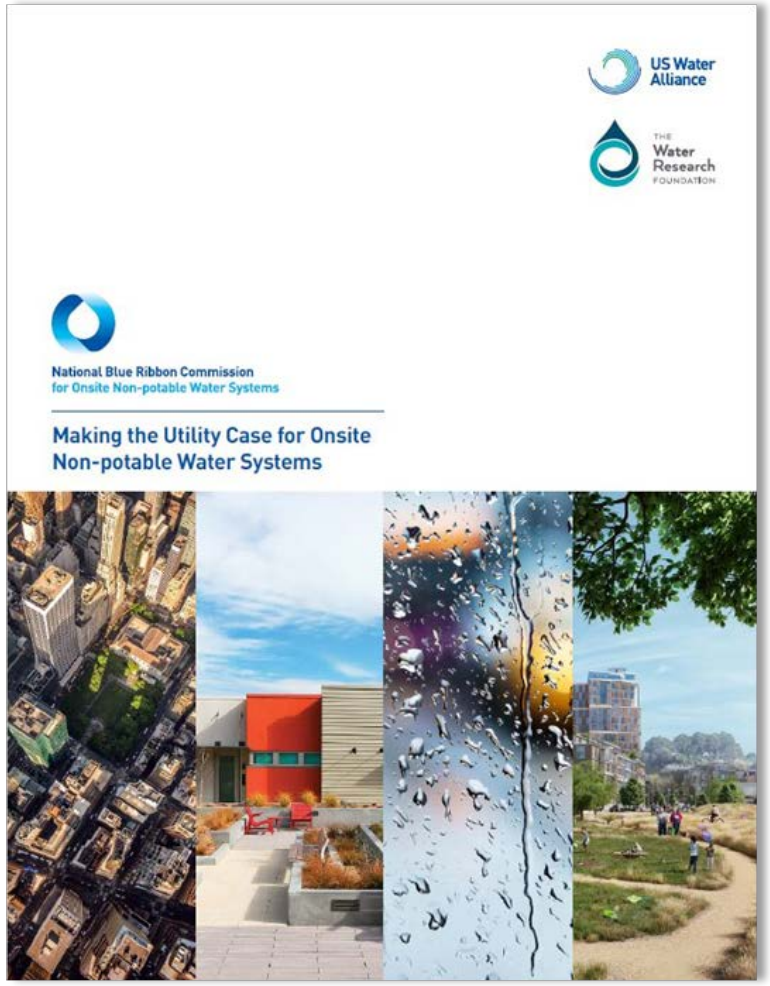
Source: San Francisco Public Utilities Commission

Model Regulations for Consistency Across the US

- San Francisco
- Colorado, Regulation #84
- California SB 966 and Hawaii HB 444
- Minnesota and Washington D.C. Guidelines for Stormwater
- Washington State and Oregon
- Texas and Alaska

Addressing Utility Considerations

- Stretch drinking water supplies
- Assist with stormwater management
- Defer capital investment in large centralized infrastructure
- Potential for lower energy footprint



Source: San Francisco Public Utilities Commission; Jim G. Maloney/Biohabitats, Inc; City of Santa Monica

Utilities Incorporating Onsite Water Systems

SAN FRANCISCO
Mandatory for new development over 250,000 sq ft

DENVER WATER
Blackwater system at new admin building

CITY OF ST. PAUL
District-scale rainwater harvesting system at Allianz Field

AUSTIN WATER
10 mgd from decentralized systems by 2040

SANTA MONICA
Downtown stormwater, groundwater, wastewater reuse by 2020

VANCOUVER
Rainwater harvesting is key water conservation strategy

NEW YORK CITY
Battery Park operating decentralized system since 2003;
Grant program for onsite systems

ANAHEIM
Operating blackwater system for irrigation around City Hall and toilet flushing in Anaheim West Tower

PORTLAND
Hassalo on Eighth recycling blackwater from four downtown city blocks

Source: San Francisco Public Utilities Commission

Tools for Developing Local Oversight and Management Programs

Developing a local program to manage onsite water systems offers a proactive way to increase water resiliency and promote green building practices while protecting public health. The development of a program should follow a sequence of steps and associated actions, which will inform critical decisions regarding the scope, structure, and implementation of the program.

1 **Convene a Working Group**
Establish a small working group to guide the development of the local program.

2 **Select the Types of Alternate Water Sources**
Narrow the specific types of alternate water sources covered in the program.

3 **Identify End Uses**
Classify specific non-potable end uses for your program.

4 **Establish Water Quality Standards**
Establish water quality standards for each alternate water source and/or end use.

5 **Identify and Supplement Local Building Practices**
Integrate your program into local construction requirements and building permit processes.

6 **Establish Monitoring and Reporting Requirements**
Establish water quality monitoring and reporting requirements for ongoing operations.

7 **Prepare an Operating Permit Process**
Establish the permit process for initial and ongoing operations for onsite water systems.

8 **Implement Guidelines and the Program**
Publicize the program to provide clear direction for project sponsors and developers.

9 **Evaluate the Program**
Promote best practices for onsite water systems.

10 **Grow the Program**
Explore opportunities to expand and encourage onsite water systems.

Source: San Francisco Public Utilities Commission

Guidance Manual for Onsite Water Reuse

CHAPTER 1:
Introduction

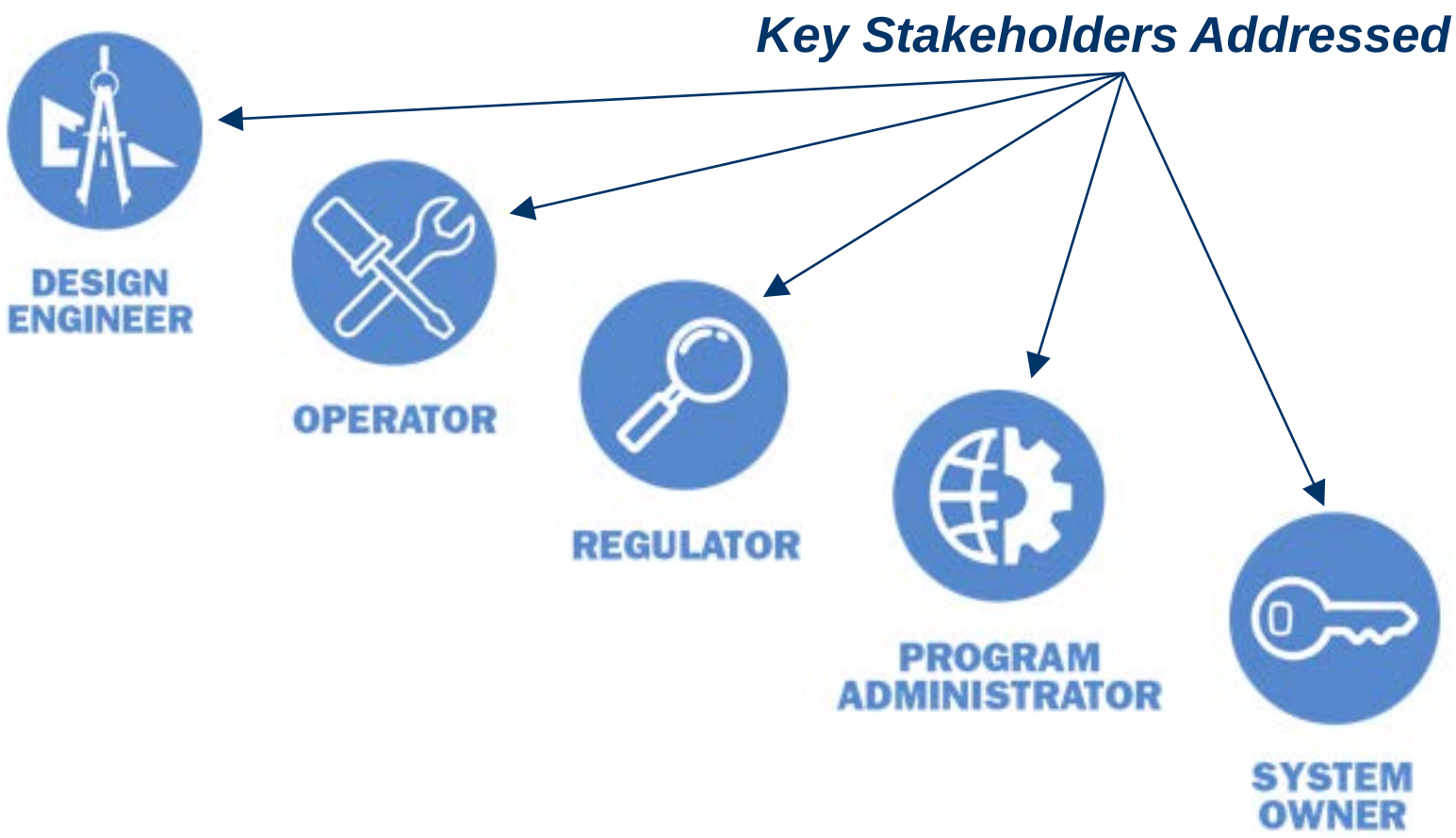
CHAPTER 2:
Public Health Goals

CHAPTER 3:
Treatment Selection and Crediting

CHAPTER 4:
Developing Multiple-Barrier ONWS Systems

CHAPTER 5:
Operations Plan

CHAPTER 6:
Regulatory and Permitting Plan



ANTICIPATED RELEASE EARLY 2020

Guidance Manual for Onsite Reuse
What You Can Expect to Find

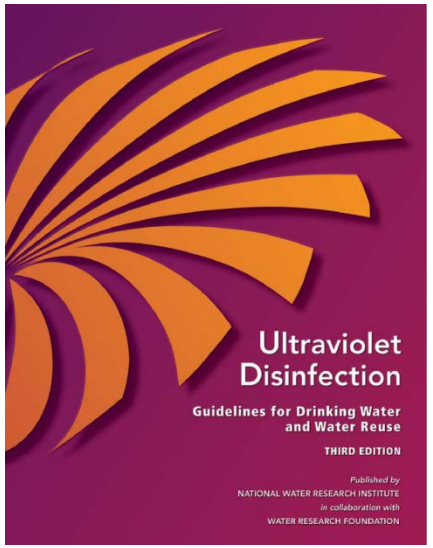
CLEAR DESCRIPTION OF CRITICAL TOPICS

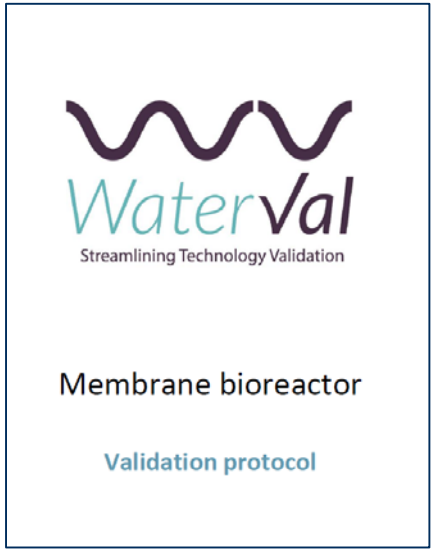
- ✓ **Risk-Based Water Quality Standards**
- ✓ **Basis for Log Reduction Targets**
- ✓ **Pathogen Crediting Frameworks**

	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
Blackwater			
Outdoor use	8.0	7.0	6.0
Indoor use	8.5	7.0	6.0
Graywater			
Outdoor use	5.5	4.5	3.5
Indoor use	6.0	4.5	3.5
Roof Runoff			
Outdoor use	N/A	N/A	3.5
Indoor use	N/A	N/A	3.5
Stormwater			
Outdoor use	3.0	2.5	2.0
Indoor use	3.5	3.5	3.0

Guidance Manual for Onsite Reuse
What You Can Expect to Find

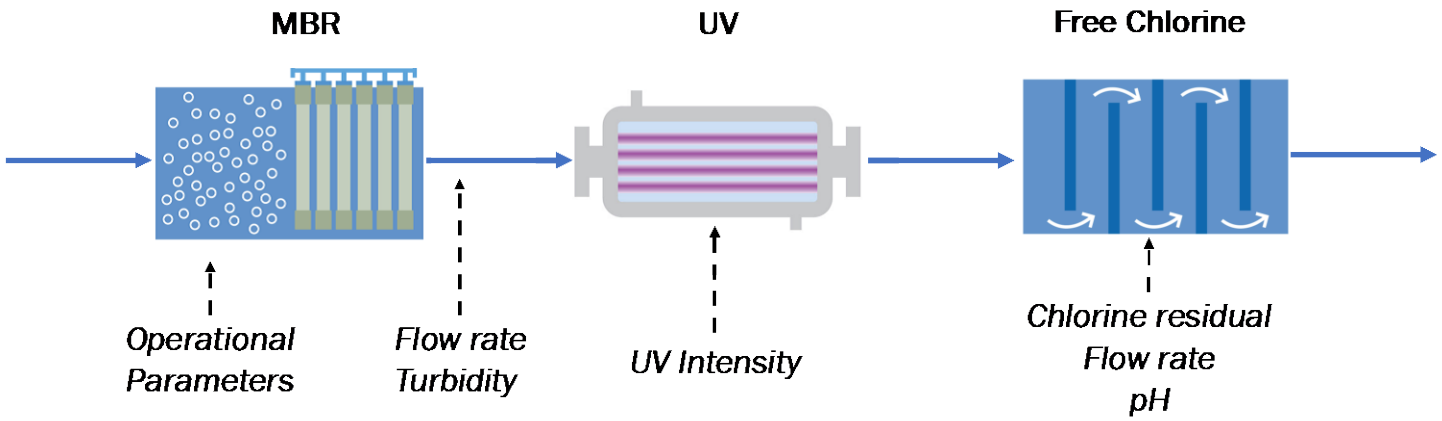
- Overview and detailed discussion of pathogen crediting
- Existing crediting frameworks to streamline implementation
- Online monitoring





EXAMPLE TREATMENT TRAINS

Blackwater Treatment Train



	Unit Process Pathogen Credits			Total Log Removal	LRTs for Blackwater
	MBR	UV	Free Chlorine		
Virus	1.5	3.5	5.0	10.0	8.5
Protozoa	2.0	6.0	0.0	8.0	7.0
Bacteria	4.0	3.5	5.0	12.5	6.0

STAKEHOLDER-SPECIFIC TIPS AND KEY MESSAGES

The **Design Engineer** should evaluate source water quality to determine the size, or combination of sizes, of pretreatment screen to select.

Successful implementation of the Operations Plan will require that that necessary resources—personnel, training, funds, information, infrastructure—are available.

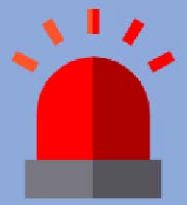
COMMISSIONING AND OPERATIONS GUIDANCE

Example Commissioning Plan Checklist

Commissioning Test Plan Checklist

- ☐ Set up system to ensure all treatment processes receiving pathogen credit can be sampled
- ☐ Ensure treated water can be discharged safely, e.g. to sewer
- ☐ Ensure adequate chemicals and consumables are available
- ☐ Notify relevant agencies about test plan and schedule
- ☐ Verify system controls are effective for ensuring LRT compliance, for example:
  - ☐ *Low UVT alarm*
  - ☐ *Low chlorine residual alarm*
  - ☐ *High turbidity alarm*
  - ☐ *Other critical LRT compliance alarms*
- ☐ Provide results to relevant agencies

Types of System Alarms



LRT Compliance Alarm

Indicates a problem with a unit process's ability to achieve the credited LRT

Water Quality Alarm

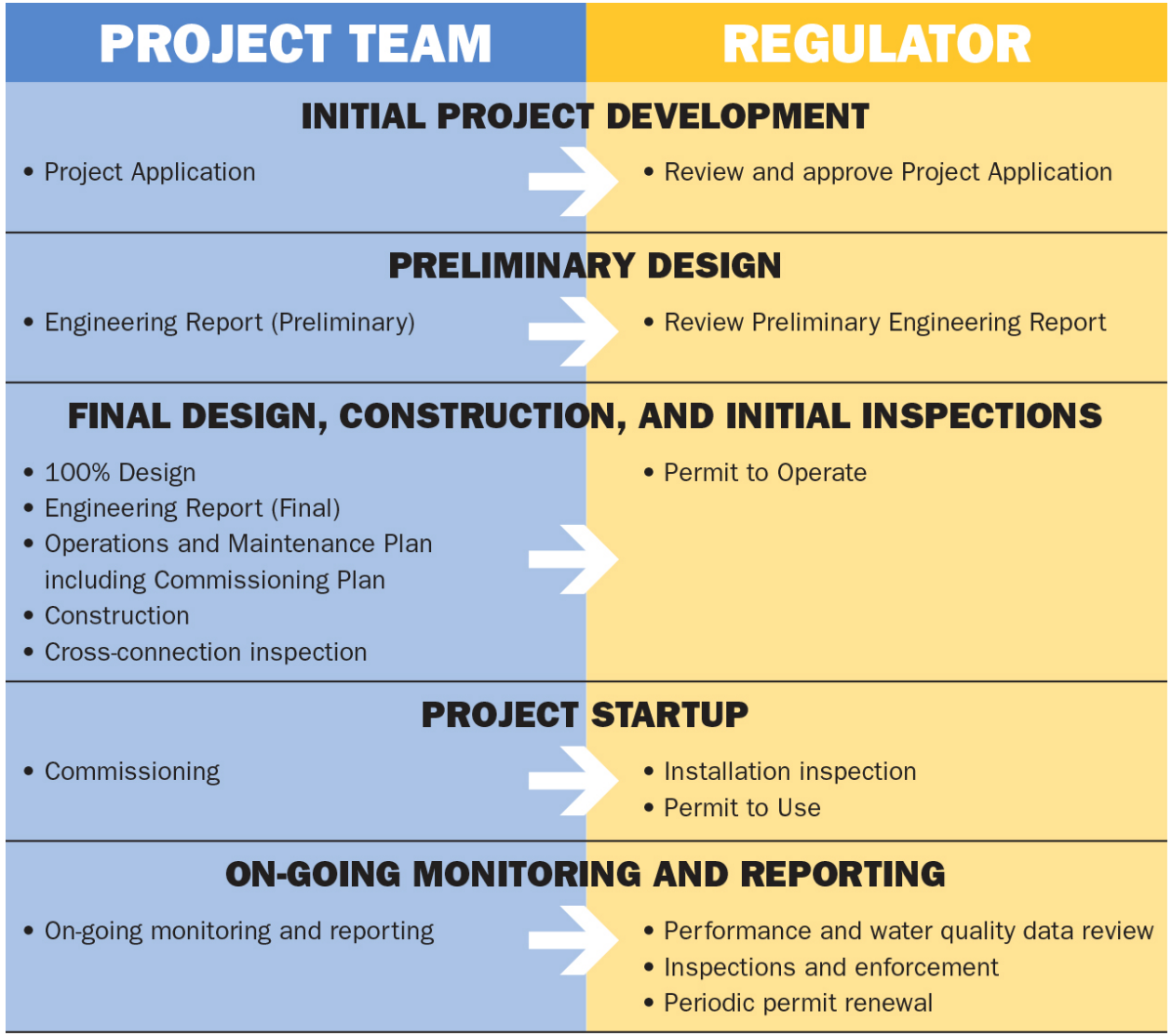
Indicates a problem with unit process or overall treatment train's ability to achieve a water quality target

Operational Alarm

Indicates a problem with a unit process or the overall treatment train's ability to function as designed and continue to produce water

Guidance Manual for Onsite Reuse
What You Can Expect to Find

PROGRAM IMPLEMENTATION AND REGULATORY GUIDANCE



National Blue Ribbon Commission
Future Research Priorities

- Expand risk-based framework to address new sources (e.g. condensate) and end uses (e.g. cooling tower make-up)
- Develop onsite water system operator certificate/certification program
- Develop bacterial log removal crediting frameworks for commonly used treatment processes in onsite water systems
- Define pathogen log removal credits for natural treatment systems (e.g. wetland treatment systems)

Collaboration Leads to New Opportunities

- Consensus among public health regulators and utilities to move towards risk-based approach
- EPA Water Reuse Action Plan highlights fit-for-purpose and national framework for risk-based targets
- Consistent standards nationwide increases market demand and can lead to more cost effective and energy efficient technologies with reduced footprint
- Future activities: pursue funding for research priorities, plumbing codes, NSF, US Green Building Council to align with address risk-based approach

National Blue Ribbon Commission for Onsite Non-potable Water Systems

San Francisco Water Power Sewer

Thank you

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sfwater.org/np
www.watereuse.org/educate/national-blue-ribbon-commission-for-onsite-non-potable-water-systems