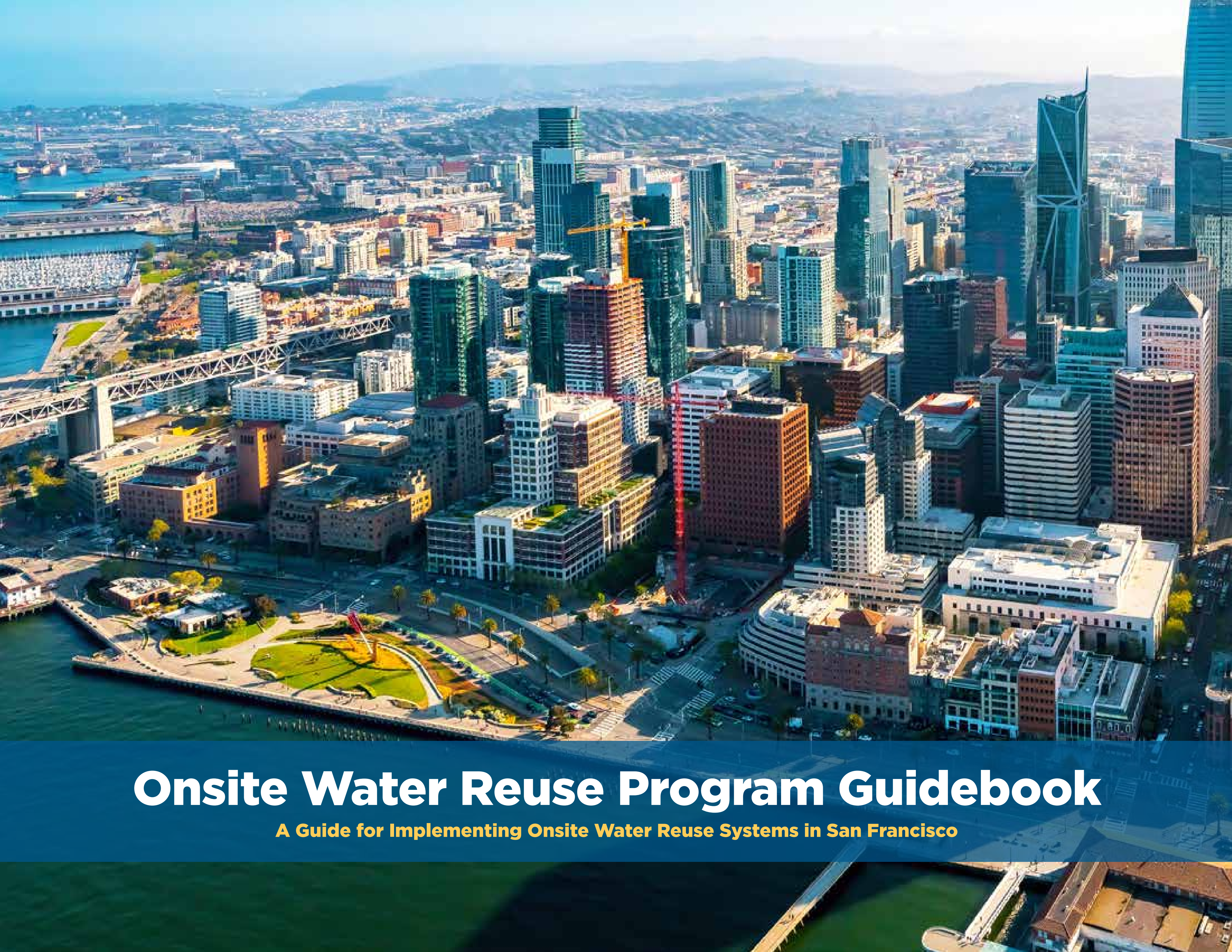


Onsite Water Reuse Program Guidebook

A Guide for Implementing Onsite Water Reuse Systems in San Francisco

San Francisco's Onsite Water Reuse Program

In September 2012, the City and County of San Francisco adopted the Onsite Water Reuse for Commercial, Multi-Family, and Mixed-Use Development Ordinance. Commonly known as the Non-potable Water Ordinance (NPO), it added Article 12C to the San Francisco Health Code, allowing for the collection, treatment, and use of alternate water sources for non-potable uses in buildings. Since 2012, the Non-potable Water Ordinance has been amended to allow for district-scale projects, where two or more parcels can share alternate water sources. In 2015, Article 12C became a mandatory requirement for new development projects of 250,000 square feet or more of gross floor area to install and operate an onsite water reuse system.

Onsite water reuse systems, also referred to as alternate water source systems, provide a myriad of benefits such as reducing potable water use for toilet flushing and irrigation, helping to meet Stormwater Management Ordinance requirements, and helping San Francisco achieve greater water supply resiliency and reliability. The program also supports San Francisco's OneWater approach of matching the right water source to the right use.

This guidebook offers assistance to developers, architects, and design engineers navigating the permitting process and provides tips for successfully designing and implementing onsite water systems. It also outlines the roles and responsibilities of each city agency involved in the approval and permitting process, including the San Francisco Public Utilities Commission-Water Resources Division (SFPUC-WRD), SFPUC Water Quality Division (SFPUC-WQD), San Francisco Department of Public Health-Environmental Health (SFDPH-EH), San Francisco Department of Building Inspection-Plumbing Inspection Division (SFDBI-PID), and San Francisco Public Works (SFPW).

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

San Francisco Department of Building Inspection

Population Health Division
San Francisco Department of Public Health

San Francisco Public Works

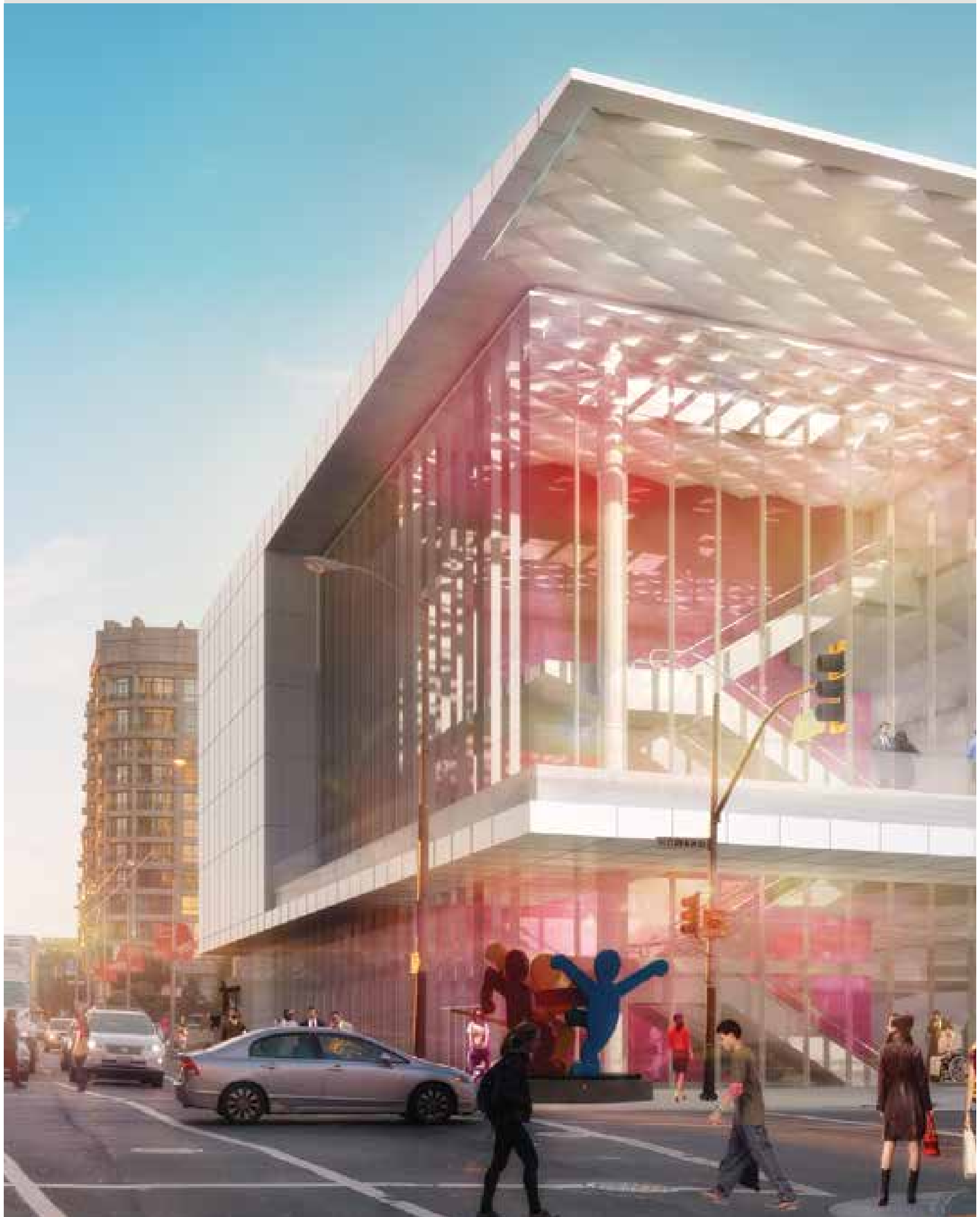
Published: July 2020

Opportunities to Reduce Potable Water Use

Using non-potable water presents an opportunity to reduce potable water demands in multi-family residential, commercial, and mixed-use buildings. In multi-family residential buildings, replacing the demand for toilet and urinal flushing and clothes washing with non-potable water can offset up to 40% of the indoor potable water use; for commercial buildings, using non-potable water for toilet and urinal flushing can offset up to 75% of indoor water use. Additional non-potable water demands include irrigation and cooling towers; meeting these demands with non-potable water can further reduce building potable water demands.

The Whole Foods mixed-use development project located at 38 Dolores Street uses rainwater for subsurface irrigation, reducing potable water for landscaping purposes and to comply with the Stormwater Management Ordinance.

The Moscone Convention Center is operating an innovative onsite water reuse system that collects and treats foundation drainage, rainwater, and condensate to serve demands for toilet flushing, irrigation, and a truck fill station for San Francisco Public Works street cleaning trucks. The project is estimated to offset about 11 million gallons of potable water each year.



Moscone Convention Center (image courtesy of San Francisco Public Works)

Contents

Alternate Water Sources and End Uses

Commercial, mixed-use, and multi-family residential buildings generate several types of alternate water sources. Rainwater, stormwater, foundation drainage, graywater, blackwater, and condensate are the most common types of alternate water sources collected and treated by buildings in San Francisco.

In compliance with the SFDPH-EH Director's Rules and Regulations Regarding the Operation of Alternate Water Source Systems (Rules and Regulations), alternate water sources can be treated and reused to meet the following non-potable end uses:

Indoor uses

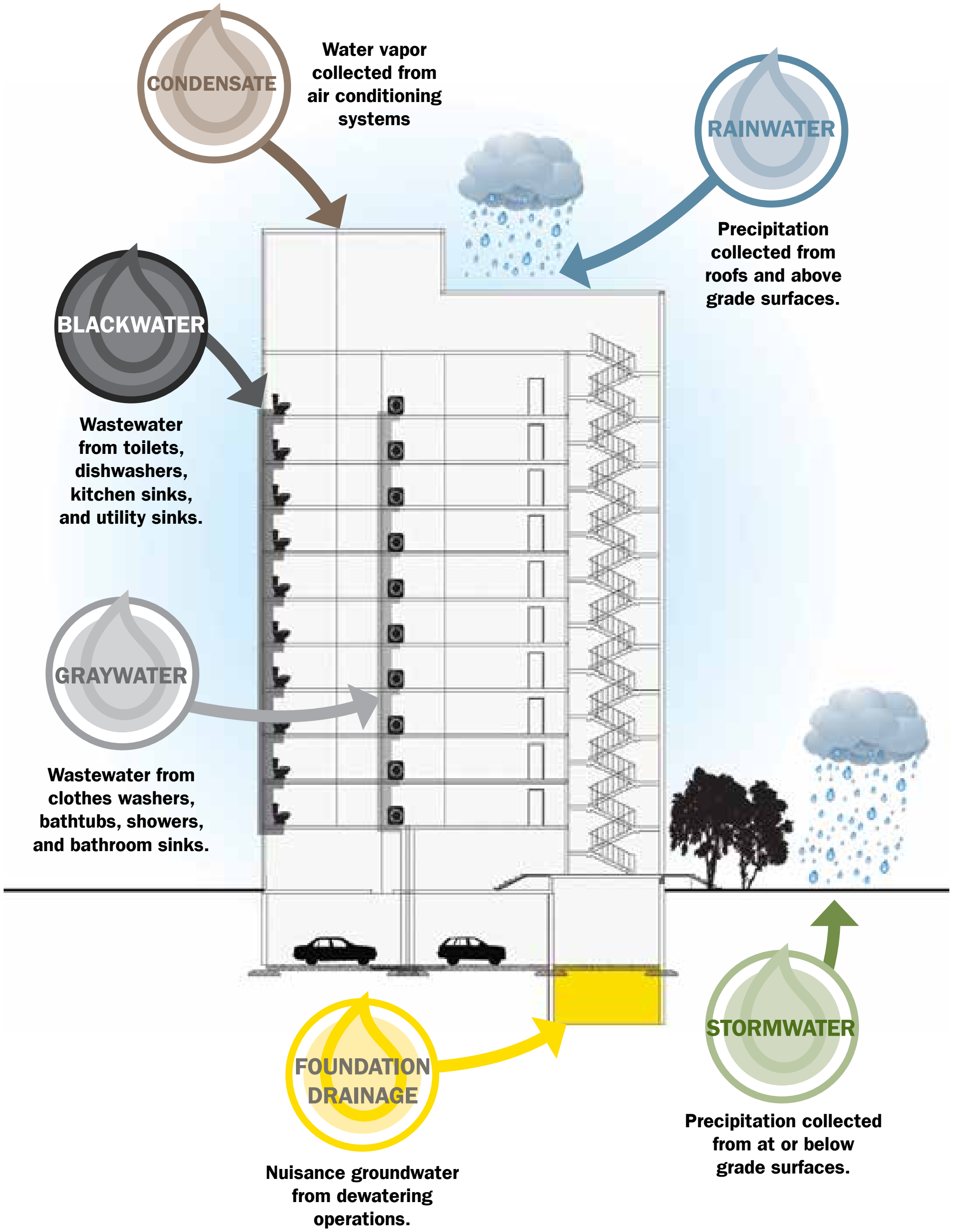
- Toilet and urinal flushing
- Priming drain traps
- Clothes washing

Outdoor uses

- Subsurface irrigation
- Drip or other surface non-spray irrigation
- Spray irrigation
- Decorative fountains and impoundments
- Cooling applications
- Dust control/street cleaning

While the Onsite Water Reuse Program provides a permitting framework for larger commercial, mixed-use, and multi-family developments, the SFPUC also encourages the use of alternate water sources in single-family and two-unit homes through its residential rainwater and graywater programs. For more information, visit **sfwater.org/conservation**.

The SFPUC encourages projects to install onsite water reuse systems by providing grants for up to $1 million. See Page 30 for more information.



Requirements for Onsite Water Reuse Systems

New development projects of 250,000 gross square feet (gsf) or more that were issued a site permit after November 1, 2016, are required to install and operate an onsite water reuse system. The project must meet its toilet and urinal flushing and irrigation demands through the collection, treatment, and use of available graywater, rainwater, and foundation drainage. While not required, projects may use treated blackwater or stormwater if desired and serve other end uses such as clothes washing.

	Projects between 40,000 gsf and 250,000 gsf	Projects over 250,000 gsf and Required to Install an Onsite System
Requirements	Submit water budget calculations to the SPFUC to assess the amount of available graywater, rainwater, and foundation drainage for toilet and urinal flushing and irrigation. Not required to install and operate onsite system, but may choose to do so following 10-step process for successful implementation of an onsite system.	Must use available graywater, rainwater[1], and foundation drainage to meet toilet and urinal flushing and irrigation demands to the extent that: • 100% of these demands are met, or • 100% of available graywater, rainwater, and foundation drainage sources are captured and treated. Projects may also collect, treat, and use blackwater and stormwater. Follow 10-step process for successful implementation of an onsite system.
Subject to SFPUC water use allocation program and excess use charges		✓
Eligibility for water and wastewater capacity charge adjustments	✓	✓
Eligibility for SFPUC grant funding	✓	✓ Above and Beyond projects only, see Page 30 for more information.

[1] For the purposes of NPO compliance, 'available rainwater' is defined as the amount of rainwater that needs to be collected to comply with the SMO

Onsite water reuse projects that are proposing to comply with San Francisco's Stormwater Management Ordinance (SMO) should request joint planning meetings with SFPUC NPO and SMO teams. Email nonpotable@sfwater.org and stormwaterreview@sfwater.org.

At 525 Golden Gate Avenue, the San Francisco Public Utilities Commission installed a Living Machine™ to treat blackwater for toilet and urinal flushing. The system has reduced the use of potable water within the building by approximately 50%.

Living Machine at SFPUC (image courtesy of SFPUC)

10 Steps for Successful Implementation of an Onsite Water Reuse System

1. **Submit a Water Budget Application to SFPUC-WRD**
2. **Submit a Non-potable Implementation Plan to SFPUC-WRD** (district-scale projects only)
3. **Submit Application for Permit to Operate to SFDPH-EH**
4. **Obtain Encroachment Permit from SFPW** (if applicable)
5. **Obtain Plan Check Approval from SFDBI-PID and SFDPH-EH and Complete System Construction**
6. **Conduct a Cross-Connection Test with SFPUC-WQD and Complete Post-Construction Inspection**
7. **Submit Documentation for a Permit to Operate from SFDPH-EH**
8. **Obtain a Permit to Operate from SFDPH-EH**
9. **Operate in Conditional Startup Mode**
10. **Operate in Final Use Mode with SFDPH-EH Approval**

The SFPUC encourages building owners and designers to incorporate wastewater heat recovery with onsite water reuse systems. For more information see Page 31.

STEP 1 Submit a Water Budget Application to SFPUC-WRD

Each project must first prepare a Water Use Calculator and Water Budget Application, both of which can be downloaded at sfwater.org/np. The application provides an overview of the project's onsite water reuse system and the available alternate water supplies and proposed non-potable end uses.

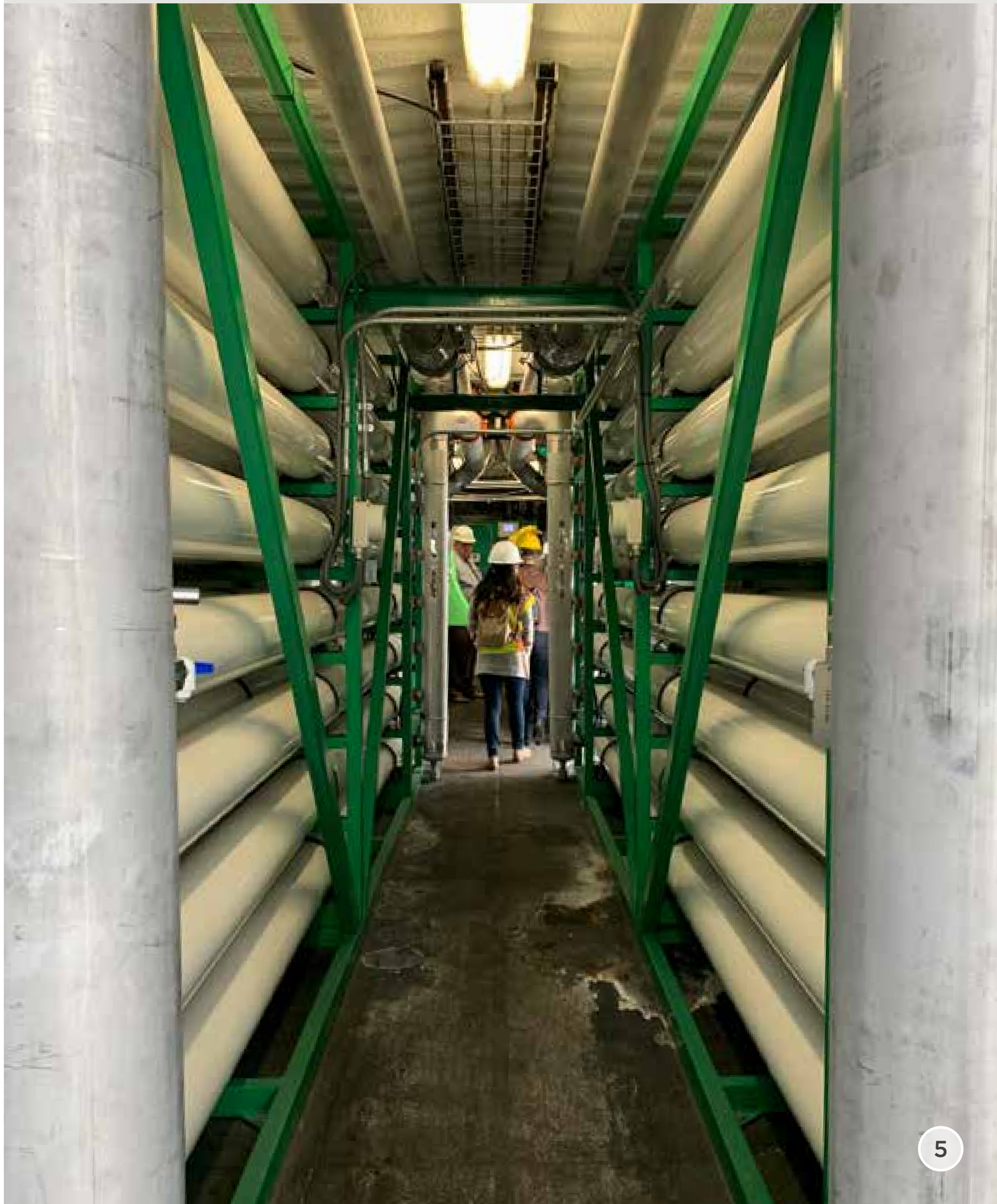
Tips on preparing a Water Budget Application and Water Use Calculator:

- Utilize the Water Use Calculator to fill out the Water Budget Application form. **The calculator is being updated to refine planning-level estimates of alternate water supplies and non-potable demands.**
- The SFPUC will accept Water Use Calculators with modifications made to the calculator's default assumptions for occupancy, fixture flow rates, or others if backup documentation is provided at the time of submittal.
- Re-submit a Water Budget Application form and Water Use Calculator if a project's design changes.

Upon approval of the Water Budget Application, the SFPUC will inform the project on the next steps and notify SFPUC-WQD, SFDPH-EH, SFDBI-PID, and SFPW (if applicable) about the proposed project.

For commercial buildings, collecting, treating, and reusing blackwater onsite can achieve significantly higher water savings than graywater. In addition, projects save on capital costs associated with graywater collection plumbing, as well as water and sewer bills.

Energy Center San Francisco (ECSF) and Bay Area Rapid Transit (BART) partnered on a unique project to reclaim an under-utilized and underground water source. ECSF is reclaiming foundation drainage at the Powell Street BART station, and redirecting it to their District Energy Plant located nearby for use in the downtown San Francisco steam loop. In total, the project is estimated to offset ECSF's annual potable water use by 30 million gallons each year.



Energy Center San Francisco's closed circuit reverse osmosis system (image courtesy of SFPUC)

Mission Rock (image coutesy of Steelblue and San Francisco Giants)

Mission Rock will be a new mixed-use neighborhood at Pier 48 featuring a district-scale blackwater treatment system. The blackwater system is designed to meet all of the demands for toilet and urinal flushing and irrigation and is estimated to offset about 55% of the project's total water demand.

The following are commonly used terms for permitting single building and district-scale onsite water reuse systems.

Permittee: The Person(s) who holds a valid permit granted by SFDPH-EH, and their agents, employees, and others acting at their direction.

Treatment System Manager: The qualified person or entity responsible for the daily management and oversight of the onsite system.

District-scale project: An onsite water reuse system serving two or more parcels, whether under the jurisdiction of one entity or several.

STEP 2 Submit a Non-potable Implementation Plan to SFPUC-WRD (district-scale projects only)

Onsite water reuse systems can be designed for a variety of scales, including a single-building or district. Sharing alternate water sources within a district-scale development project can provide greater efficiencies for onsite water reuse. District-scale projects are subject to additional requirements given the complexity of design, phasing, and implementation.

Step 2 requires district-scale projects to submit a Non-potable Implementation Plan to the SFPUC-WRD. This Plan must be prepared in accordance with the SFPUC's Checklist for the Non-potable Implementation Plan, which includes, but is not limited to:

- Schematic layout of onsite water reuse system components
- Details on the onsite water reuse system
- Estimated potable and non-potable water supplies and demands
- Estimated discharges to the sewer system
- Proposed ownership model and compliance plan
- Phasing for implementation of district-scale project

With approval of the Non-potable Implementation Plan, the project may move forward to obtain additional approvals from SFPUC-WQD, SFDPH-EH, SFDBI-PID, and SFPW. District-scale projects must also execute an enforceable legal agreement that defines the roles and responsibilities of the supplier and user(s). In addition to having a treatment system manager responsible for the district-scale system, each property shall designate a site supervisor to oversee operation and maintenance of their portion of the district-scale project, including distribution and/or collection systems. The site supervisor is also responsible for acting as a liaison between the users of the treated water and the Treatment System Manager and SFDPH-EH.

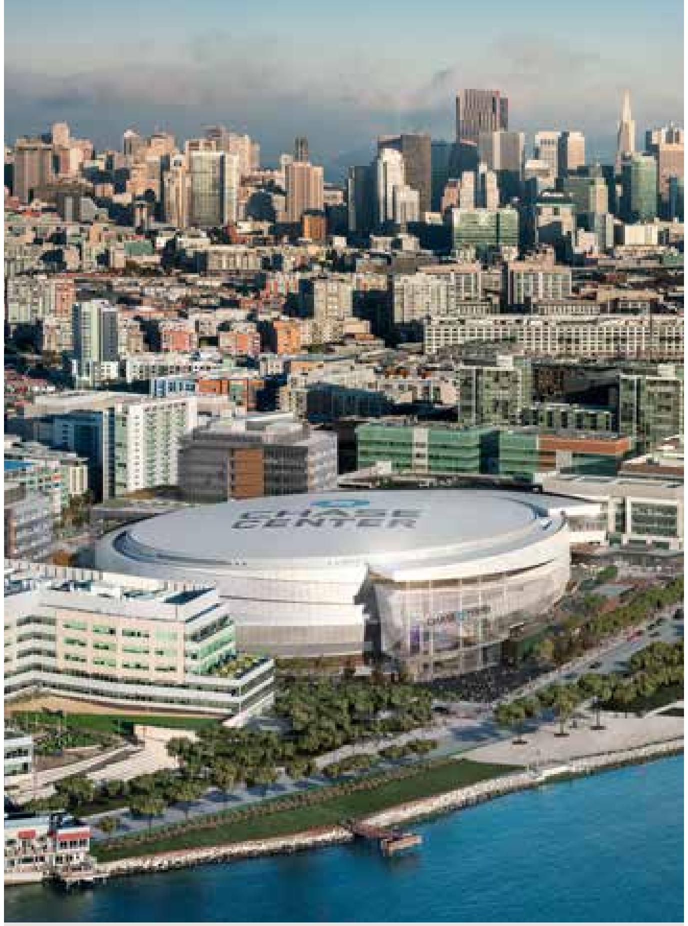
STEP 3 Submit Application for Permit to Operate to SFDPH-EH

All projects must submit to SFDPH-EH the following as described in further detail on SFDPH-EH's website at **sfdph.org/dph/EH/Water/nonPotable**:

- Application for Permit to Operate an Alternate Water Source System
- Appropriate Fee (as shown in the SFDPH-EH schedule of fees)
- Alternate Water Source System Engineering Report (Engineering Report)

Engineering Reports must be prepared by a qualified engineer licensed in CA, following the SFDPH-EH template and include information on the following project elements:

- Alternate water sources collected and treated for non-potable end uses
- Entity or entities involved in the design, treatment, operation, and maintenance of the onsite water reuse system
- Treatment processes used to meet required water quality criteria
- Demonstration of compliance with the pathogen log reduction targets
- Information on operating conditions and continuous online monitoring
- Cross-connection and backflow prevention measures
- Contingency plan and system bypass that will allow the system to divert to the sewer



Chase Center (image courtesy of Golden State Warriors)

Chase Center, the sports and entertainment complex in San Francisco's Mission Bay neighborhood, is designed to collect and treat rainwater, stormwater, graywater, and condensate to supply toilet flushing demands in the arena and two accompanying office buildings. The project is estimated to offset about 3.7 million gallons of potable water annually.

APPLICABILITY: Steps 3-10 do not apply to the following systems constructed in accordance with applicable plumbing codes: (1) Rainwater, Stormwater or Foundation Drainage systems used solely for subsurface irrigation or for surface non-spray irrigation (2) Graywater systems used solely for subsurface irrigation (3) Systems constructed for industrial and closed loop process water reuse

Treatment System Requirements

The Engineering Report is used to document how a project's treatment system complies with the requirements for onsite water reuse systems. This includes detailed information on the treatment processes and how they are used to meet the water quality criteria for allowed alternate water sources and end uses. In addition to the physical and chemical water quality requirements, projects must demonstrate compliance with the pathogen log reduction targets, or LRTs, listed below, which represent the minimum requirements for the removal or inactivation of pathogens including viruses, protozoa, and bacteria.

To meet the LRTs and other water quality requirements, projects should design an effective treatment train which may include the use of common treatment processes such as microfiltration (MF), ultrafiltration (UF), membrane bioreactor (MBR), ultraviolet light (UV) disinfection, and chlorination. The Engineering Report should detail how the treatment train will achieve pathogen reduction credits in order to meet the LRTs, including addressing any validation and ongoing monitoring requirements related to the treatment processes.

SFDPH-EH will review each project's Engineering Report and accept pathogen reduction credits based on established crediting frameworks such as those developed for drinking water, potable reuse, and non-potable reuse. Refer to Pages 16 – 25 for guidance on how to credit common treatment processes, create effective treatment trains to meet the LRTs, and document the validation and ongoing monitoring requirements.

Log Reduction Targets for Onsite Water Reuse Systems

Alternate Water Use Scenario	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
Stormwater or Foundation Drainage			
Outdoor Use	3.0	2.5	2.0
Indoor Use	3.5	3.5	3.0
Rainwater			
Outdoor Use	N/A	N/A	3.5
Indoor Use	N/A	N/A	3.5

The following table provides example pathogen reduction credits for common treatment processes and example information that must be submitted with the project's Engineering Report. Other treatment processes may be used within the treatment train and SFDPH-EH will assess pathogen reduction credits on a case-by-case basis.

Example Treatment Process	Available Pathogen Reduction Credits Virus / Protozoa / Bacteria	Example Information Included in an Engineering Report	Example Continuous Monitoring Methods
Microfiltration or Ultrafiltration	0 / 4 / 0	Description and calculation of how the system defines an acceptable pressure decay test value per the US EPA's Membrane Filtration Guidance Manual to detect 3.0 μm breach	• Daily pressure decay test • Effluent turbidity
Membrane Biological Reactor	1.5 / 2 / 4	Operation within the Tier 1 operating envelope as defined in the AWRCE Membrane bio-reactor, WaterVal validation protocol	• Effluent turbidity
Reverse Osmosis	Up to 2 / 2 / 2	Demonstration of ability to meet salt rejection criteria and a description of surrogate parameter used to calculate pathogen reduction credits	• Influent and effluent total organic carbon (TOC) • Influent and effluent electrical conductivity
Ultraviolet Light Disinfection	Up to 6 / 6 / 6	UV reactor's validation report following US EPA UV Disinfection Guidance Manual or NSF/ANSI 55 Class A validation and demonstration of ability of system to meet criteria to achieve specified UV dose	• UV intensity • Flow rate
Chlorine Disinfection	Up to 5 / 0 / 5	Demonstration of ability to achieve a target CT[1] including description of chlorine contactor, contact time provided, and monitoring of chlorine residual	• Chlorine residual • Flow rate
Ozone Disinfection	Up to 4 / 3 / 4	Demonstration of ability to achieve a target CT[1] including description of ozone contactor, contact time provided, and monitoring of ozone residual	• Ozone residual • Flow rate

[1] CT = disinfectant residual concentration (C) x contact time (T)

SFPUC Headquarters (image courtesy of SFPUC)

Identification and Signage

Onsite water reuse systems and their components must be properly identified and labeled. Non-potable water piping must be purple and labeled as "non-potable" and must include arrows showing direction of flow. All valves on the non-potable water distribution system must be tagged and signage is required on valve access panels and in equipment rooms.

Sites using non-potable water for irrigation must post signs at site entrances, along pathways, or as otherwise determined by SFDBI-PID.

Sites using non-potable water for toilet and urinal flushing must install signage in restrooms. Multi-family residential projects may elect to place tags or signage inside toilet tanks.

STEP 4 Obtain Encroachment Permit from SFPW (if applicable)

Projects installing infrastructure in the public right-of-way (such as a sidewalk or street) must be reviewed by SFPW for potential utility conflicts and issued an encroachment permit. As part of Article 12C, all projects requiring an encroachment permit will be processed as a minor encroachment with no public right-of-way occupancy assessment fee.

For more information on encroachment permit requirements, visit **sfpublicworks.org**.

STEP 5 Obtain Plan Check Approval from SFDBI-PID & SFDPH-EH & Complete System Construction

After approval of the Engineering Report by SFDPH-EH, the project must obtain a building permit from SFDBI-PID to be reviewed by SFDBI-PID and SFDPH-EH. This requires contacting SFDBI-PID to conduct a plumbing plan check to verify that the onsite water reuse system meets the State of California and San Francisco Plumbing Code requirements. For more information, visit **sfdbi.org/plumbinginspection**.

Once the system is constructed, a Construction Certification Letter must be submitted to SFDPH-EH certifying that the onsite water reuse system was installed in accordance with the approved Engineering Report. If system modifications were made during construction, the letter must detail the changes. The Construction Certification Letter must be provided on company letterhead, signed, and stamped by a California licensed engineer.

STEP 6 Conduct a Cross-Connection Test with SFPUC-WQD & Complete Post-Construction Inspection

Cross-Connection Test

Prior to starting up any onsite water reuse system, a cross-connection shutdown test is required to ensure separation between the building's non-potable and potable water systems. The test must be completed by a Certified Cross-Connection Control Specialist from the SFPUC-WQD or other qualified personnel as determined by SFDPH-EH and approved by SFPUC-WQD.

In addition, projects must schedule an onsite inspection of the system with SFDPH-EH for job card sign-off.

Cross-Connection Testing Requirements

	Blackwater System	All other onsite water reuse systems[1]
Before conditional startup[2]	✓	✓
Every four years	✓	
After major plumbing alteration	✓	✓

[1] Cross-connection testing is not required for rainwater harvesting systems serving only outdoor irrigation and system infrastructure is not located within building structure

[2] For new construction, cross-connection test must be performed for building to receive Temporary Certificate of Occupancy (TCO)

While all initial tests must be shutdown tests, the SFPUC may allow pressure differential tests for subsequent tests in fully occupied high-rise buildings. To facilitate the pressure differential test, installation of a connection or fitting downstream of the main isolation valve on both potable and non-potable systems, in each pressure zone if applicable, should be considered during plumbing design and construction.

The Exploratorium treats water from the San Francisco Bay for its heating and cooling system and uses rainwater for toilet and urinal flushing to comply with the Stormwater Management Ordinance.

Exploratorium (image coutesy of Fabrice Florin from Mill Valley, USA / CC BY-SA)

Step 6 Conduct a Cross-Connection Test with SFPUC-WQD & Complete Post-Construction Inspection (continued)

Backflow Prevention

All buildings must have the ability to receive water from the SFPUC in order to serve potable uses and provide make-up water for non-potable end uses. Make-up water must be supplied in a manner that protects the SFPUC's public water system and, if applicable, recycled water system from potential backflow. Properties that have onsite water reuse systems must follow San Francisco backflow prevention requirements listed below, which are consistent with San Francisco Health Code Article 12A and the State of California and San Francisco Plumbing Codes.

Rainwater Harvesting

- Containment reduced pressure principle backflow prevention assembly (RP) located as close as practical to, but in any case within 25 feet downstream of the point of connection to the public water system or water meter
- Isolation RP or isolation air gap at the point of potable make-up to the onsite water reuse system

Blackwater, Graywater, Stormwater, and Foundation Drainage

- Containment RP located as close as practical to, but in any case within 25 feet downstream of the point of connection to the public water system or water meter
- Isolation air gap at the point of potable make-up to the non-potable system

For more information, visit the SFPUC Cross-Connection Control Program website at **sfwater.org/backflow**.

Building owners and construction contractors must ensure every fixture in the building can be tested during the cross-connection shut down test.

STEP 7 Submit Documentation for a Permit to Operate from SFDPH-EH

Once steps 1 through 6 are completed, the project must submit to SFDPH-EH:

- A final operation and maintenance manual
- Proof of a contract with a certified laboratory
- Documentation of an enforceable legal agreement (applicable only to district-scale projects)
- Treatment system manager affidavit

The project must also go to the San Francisco Tax Collector's website at sftreasurer.org to:

- Obtain a Business Account Number
- Pay the license certificate fee to receive the permit to operate (fee must be paid annually)

Treatment System Manager Qualifications:

- Sign affidavit acknowledging sufficient knowledge, skills, abilities, and training
- **Graywater Systems:**
  - Grade 2 Water Treatment Plant or Distribution System Operator
  - Grade II Wastewater Treatment Plant Operator, or
  - Comparable education and/or experience
- **Blackwater Systems:**
  - Grade II Wastewater Treatment Plant Operator, or
  - Comparable education and/or experience

STEP 8 Obtain a Permit to Operate from SFDPH-EH

Once the license fee is paid, SFDPH-EH will issue a permit to operate. At that time, a project should be ready to begin operating the onsite water reuse system in Conditional Startup Mode for 90 days. Requirements for operation in Conditional Startup Mode are covered on Page 14.

38 Dolores Street (image courtesy of BAR Architects)

The Whole Foods mixed-use development located at 38 Dolores uses rainwater for subsurface irrigation, reducing potable water for landscape irrigation and to comply with the Stormwater Management Ordinance.

STEP 9 Operate in Conditional Startup Mode

Operation in Conditional Startup Mode is required for all systems. The requirements are summarized below. **If a project does not complete the requirements for conditional startup within 365 days of the permit issuance, the permit will expire and a new application must be submitted to and approved by SFDPH-EH.** For more information, visit **sfdph.org/dph/EH/Water/Nonpotable**.

Requirements for Conditional Startup Operation of Graywater and Blackwater Systems:

- Verify that log reduction targets are met
- Verify compliance with water quality standards – BOD, TSS, turbidity, and total coliform
- Divert treated water to sewer
- Supply end uses with potable water
- Operate in final plumbing configuration with an approved cross-connection test completed
- Confirm all alarms and diversions work as described in the Engineering Report

Summary of Conditional Startup and Water Quality Sampling Requirements

	Duration of Conditional Startup	Divert to Sewer During Conditional Startup?	Total Coliform Sampling		Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) Sampling	
			Conditional Startup Mode	Final Use Mode	Conditional Startup Mode	Final Use Mode
Rainwater	90 Days	No	Weekly	Monthly	--	--
Stormwater		No	Weekly	Monthly	--	--
Foundation Drainage		No	Weekly	Monthly	--	--
Graywater		Yes	Weekly	Monthly	Weekly	Monthly
Blackwater, indoor use only		Yes	Daily	Daily / 3x per Week[1]	Weekly	Monthly
Blackwater, with outdoor use		Yes	Daily	Daily	Weekly	Monthly

[1] With SFDPH-EH approval, total coliform sampling can be reduced to 3 times per week for blackwater systems serving only indoor uses.

STEP 10 Operate in Final Use Mode with SFDPH-EH Approval

To maintain a valid permit to operate, ongoing monitoring and reporting are required for all onsite water reuse systems to ensure systems are properly working and continuously protecting public health. If a treatment process is being used to achieve log reduction targets, continuous online monitoring of treatment process performance via surrogate parameters is required. Examples of continuous monitoring methods for common treatment processes can be found in the table on Page 9.

Treatment system managers must report monitoring results to SFDPH-EH at the following frequencies:

	Conditional Startup Mode	Final Use Mode
Blackwater Systems	Monthly	Quarterly and Annually[1]
All other onsite water reuse systems	Monthly	Annually[1]

[1] Annual reports must be submitted to SFDPH-EH by January 15th for the previous calendar year.

Lastly, in accordance with the approved operations and maintenance manual, the onsite water reuse system must be regularly inspected and tested to verify that the system is operating correctly, meets permit requirements, and remains physically separated from the potable water system. Backflow prevention assemblies must be tested annually, and cross-connection tests must be conducted in accordance with Article 12A and the SFPUC's Rules & Regulations Governing Water Service, Section G.

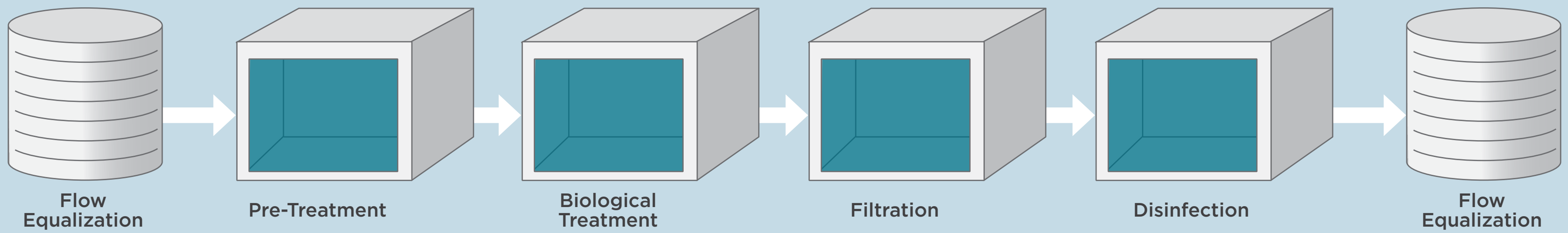
This concludes the 10-step permitting process for San Francisco's Onsite Water Reuse Program.
Detailed information about each permitting step as well as additional guidance and resources can be found at *sfwater.org/np*.

The property owner, design engineer, and daily operations staff should coordinate responsibilities for conditional startup and ongoing operations and maintenance.

Example Onsite Water Reuse Treatment Trains

The following pages provide example treatment trains to illustrate how unit processes can be used to meet the LRTs and other water quality requirements. Also shown are the parameters that must be continuously monitored at critical control points to ensure treatment system performance and demonstrate the ability of each treatment process to achieve the pathogen reduction credits. Treatment trains shown here are for planning purposes only. An engineer licensed in California and experienced in wastewater treatment must prepare the Engineering Report documenting the treatment train and its ability to meet the SFDPH-EH water quality and monitoring requirements. For additional example treatment trains, see the Design and Implementation Tips document at **sfwater.org/np**.

Treatment train selection will depend on project-specific factors such as source water, space constraints, and end uses. Common treatment train elements are shown here.



Considerations for selecting appropriate treatment processes include:

- Source water quality entering the treatment system
- Water quality standards
- Solids management
- Site constraints including footprint and access
- Energy usage
- Economics (both capital and operating costs)
- Aesthetics (i.e. color and odor)
- Ease (or complexity) of operation and maintenance
- Reliability to ensure uptime and production

For additional information, refer to the Onsite Non-potable Water System GUIDANCE MANUAL at sfwater.org/iuws.

Managing BOD

High concentrations of organics will be present in blackwater and many sources of graywater. As a result, biological treatment is required for blackwater and graywater systems to reliably meet the treated water biological oxygen demand (BOD) limit of 25 mg/L. Using biological treatment to reduce BOD and suspended solids will help:

- Improve reliability of pathogen reduction performance in downstream processes such as UV, chlorine, or ozone disinfection
- Increase operational reliability of downstream processes such as membrane filtration, reverse osmosis, or UV disinfection
- Minimize issues with aesthetics (color and odor)
- Minimize regrowth of microorganisms (including Legionella) in the distribution system

The list below provides biological treatment technologies that can reduce BOD in an onsite blackwater or graywater system.

Example Biological Treatment Technologies

- Membrane Biological Reactor
- Engineered Wetland
- Sequencing Batch Reactor
- Moving Bed Biofilm Reactor
- Conventional Activated Sludge
- Biofilter

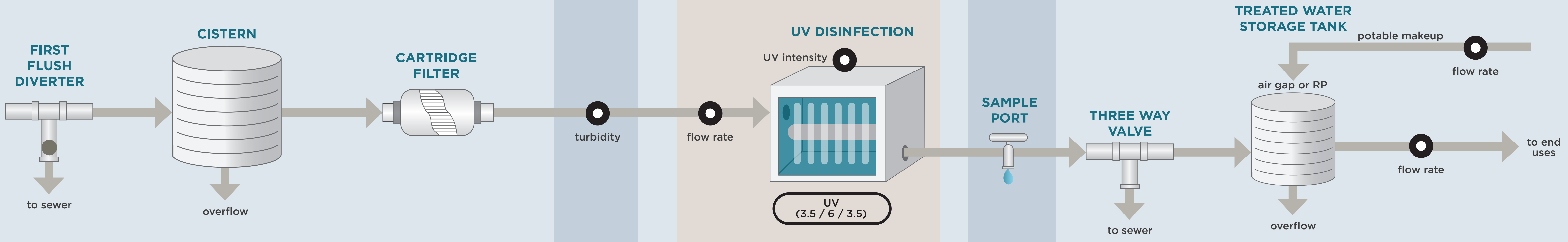
An MBR can provide the dual-benefit of reducing organics concentrations and providing pathogen reduction credit under an existing crediting framework (see example graywater and blackwater treatment trains).

Salesforce Tower

Salesforce Tower, located at 415 Mission Street, is designed to collect and treat blackwater onsite to meet the building's demands for toilet flushing, irrigation, and cooling. The system is estimated to save 7.8 million gallons of water per year, equivalent to roughly 75% of the building's water use.

Example Treatment Trains (continued)

Passive overflow to sewer is required in rainwater cisterns.



Basis for Pathogen Crediting		UV reactor(s) validated[1] for dose > 80 mJ/cm2 UVI > minimum setpoint based on validation Flow within validated range	
Other Water Quality Requirements	Turbidity limits[2]	Influent within validated UVT range	Total coliform limits[3] pH 6 - 10

[1] Validation must be per EPA UVDGM or NSF 55 Class A
[2] Dependent on treatment technology
[3] 7-sample median < 2.2 MPN/100 mL; 30 day max 23 MPN/100 mL; absolute max 240 MPN/100 mL

LEGEND

Online Monitor

Unit Process (V / P / B)

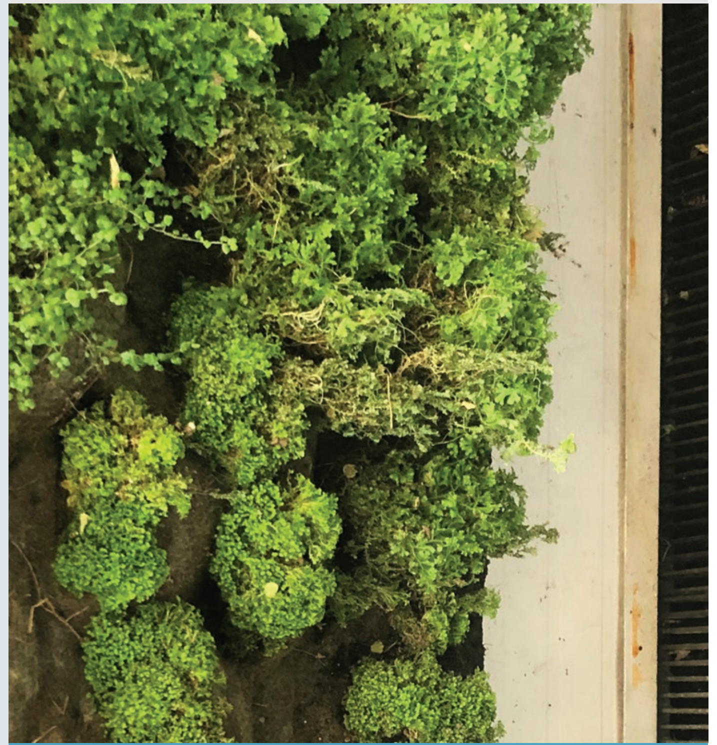
(virus / protozoa / bacteria credit)

In this example, the only specified LRT is for bacteria. In this example, the use of a validated UV reactor can achieve pathogen reduction credits and can meet the LRT for bacteria if it is operated within its validated operating conditions. The inclusion of a cartridge filter upstream of the UV reactor provides pre-treatment to improve the quality of the water prior to disinfection and helps meet the turbidity limits.

Pathogen Crediting Summary

	Required	Total
Virus	N/A	3.5
Protozoa	N/A	6
Bacteria	3.5	3.5

The San Francisco Museum of Modern Art (SFMOMA) integrated a rainwater harvesting system to meet water demands for toilet flushing, cooling tower make-up water, and irrigation of the museum's living wall.

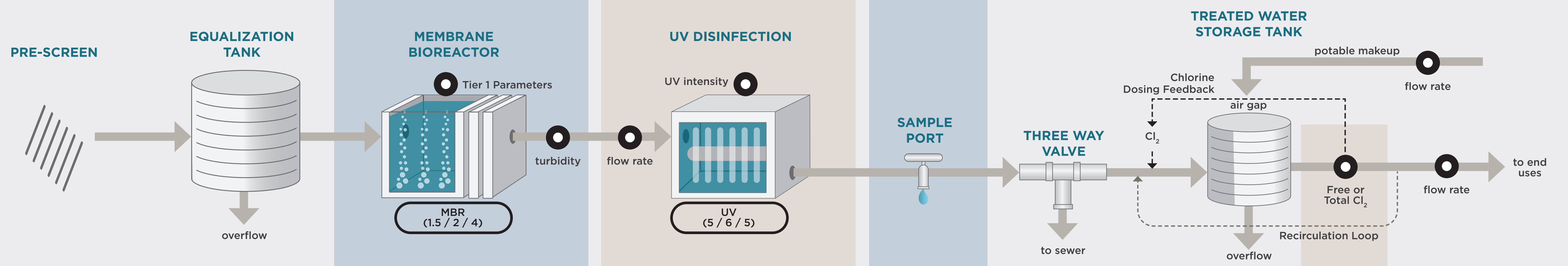


SFMOMA's living wall (image courtesy of SFDPH)

Design Tips for Rainwater Harvesting

- Routing rainwater collection through a rooftop planter or green roof may impact treatment downstream by causing increased turbidity and color issues.
- Consider how to maintain rainwater cisterns in dry months. Example approaches include adding an aerator to the cistern, or plumbing potable water to the cistern to allow for flushing.
- Contact the SMO team for more guidance at stormwaterreview@sfwater.org.

Example Treatment Trains (continued)

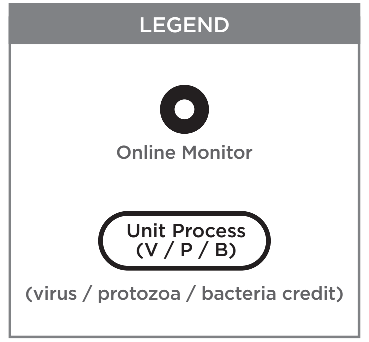


Biological treatment is required for graywater.

	Membrane Bioreactor	UV Disinfection	Sample Port	Treated Water Storage Tank
Basis for Pathogen Crediting	Operation within WaterVal Tier 1 Operating Envelope, including turbidity ≤ 0.2 NTU	UV reactor(s) validated[1] for dose > 120 mJ/cm2 UVI > minimum setpoint based on validation Flow within validated range		
Other Water Quality Requirements		Influent within validated UVT range	BOD < 25 mg/L TSS < 30 mg/L Total coliform limits[2]	Chlorine ≥ 0.5 mg/L pH 6 - 10

[1] Validation must be per EPA UVDGM or NSF 55 Class A

[2] Seven-sample median < 2.2 MPN/100 mL; 30 day max 23 MPN/100 mL; absolute max 240 MPN/100 mL



In this example, the graywater system meets the LRTs for indoor use using MBR and UV:

- MBR: credit for operation within the WaterVal 2017 MBR Validation Protocol Tier 1 operating envelope
- UV: A validated UV system providing a dose of 120 mJ/cm2 can achieve the remaining pathogen credits required (for more information on UV crediting, see Page 24). In this example, the UV Intensity Setpoint method is used to verify UV performance.

The system must also be able to successfully operate during conditional startup (see requirements on Page 13), and provide secondary disinfection with chlorine to maintain protection of the distribution system.

Pathogen Crediting Summary

	Required	Total
Virus	6	6.5
Protozoa	4.5	8
Bacteria	3.5	9

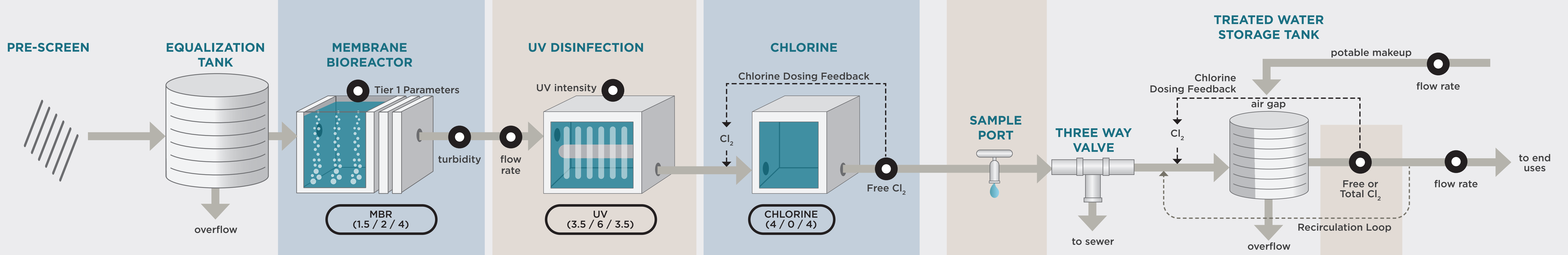
181 Fremont, a mixed-use building in downtown San Francisco, is designed to collect and treat graywater and rainwater to meet the building's non-potable demands for toilet flushing and irrigation. These onsite reuse strategies also help the project comply with the Stormwater Management Ordinance. The project is estimated to save 1.3 million gallons of potable water annually.

181 Fremont, Jay Paul Company, Heller Manus Architects, (image courtesy of Steelblue)

Example Treatment Trains (continued)

BLACKWATER

Biological treatment is required for blackwater.



Basis for Pathogen Crediting	Operation within WaterVal Tier 1 Operating Envelope, including turbidity ≤ 0.2 NTU	UV reactor(s) validated[1] for dose > 80 mJ/cm2 UVI > minimum setpoint based on validation Flow within validated range	Pipeline contactor achieves CT for 4-log virus reduction based on WaterVal CT tables		
Other Water Quality Requirements	Nitrification to remove ammonia	Influent within validated UVT range		BOD < 25 mg/L TSS < 30 mg/L Total coliform limits[2]	Chlorine ≥ 0.5 mg/L pH 6 - 10

[1] Validation must be per EPA UVDGM or NSF 55 Class A

[2] Seven-sample median < 2.2 MPN/100 mL; 30 day max 23 MPN/100 mL; absolute max 240 MPN/100 mL

LEGEND

Online Monitor

Unit Process (V / P / B)

(virus / protozoa / bacteria credit)

In this example, the blackwater system uses an MBR, UV, and free chlorine to meet the LRTs for indoor use (see table below).

- MBR: credit for operation within the WaterVal Tier 1 operating envelope.
- UV: validated UV system providing a dose of 80 mJ/cm2
- Free chlorine disinfection: achieving a CT sufficient for 4-log virus reduction. The system includes a chlorine dosing feedback system to ensure a free chlorine residual in the presence of ammonia in the feedwater.

The system must also be able to successfully operate during conditional startup (see requirements on Page 13), and provide secondary disinfection with chlorine to maintain protection of the distribution system.

Pathogen Crediting Summary

	Required	Total
Virus	8.5	9
Protozoa	7	8
Bacteria	6	11.5

Blackwater Reuse with Wastewater Heat Recovery

The Solaire Building in New York City, a residential high-rise, has an onsite blackwater reuse system designed to treat 25,000 gallons per day. The treated water is reused for toilets, laundry, cooling tower makeup, and irrigation.

The Solaire Building's onsite reuse system was retrofitted with a wastewater heat recovery system that captures heat from treated blackwater and uses that heat in the building's heating system. The wastewater heat recovery system recovers enough heat from blackwater to completely offset the energy used for blackwater treatment. For more information on wastewater heat recovery, see Page 31.

Solaire building, New York City. (image courtesy of Natural Systems Utilities)

Additional Disinfection Guidance: Pathogen Crediting for UV

UV Reactor Validation

To receive pathogen reduction credits, UV reactors must be validated per either:

- NSF/ANSI 55 Class A
- EPA UV Disinfection Guidance Manual

For a list of validated reactors, see **sfwater.org/np**.

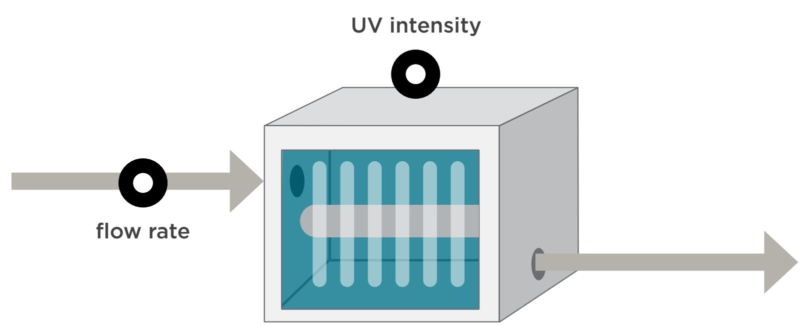
Pathogen Log Reduction Credits for Validated UV Reactors

Validated Dose (mJ/cm²)	Virus	Protozoa	Bacteria
40	2	3	2
80	3.5	6	3.5
120	5	6	5
150	6	6	6

Credits apply for reactors validated using MS2 as the challenge organism.

Monitoring Validated UV Reactors

To receive the pathogen credits, continuous online monitoring is required. The UV intensity setpoint method can be used, which involves monitoring the flow rate and UV intensity and verifying that both parameters are within their specified ranges. Setpoints are based on the operating envelope determined as part of the validation testing and should be provided in the manufacturer's documentation.



With the UV Intensity Setpoint approach, UVT monitoring is not required on the influent to the UV reactor. However, it is critical to consider the likely water quality of the influent in terms of UVT when selecting the appropriate reactor. An MBR-treated blackwater may have a UVT in the 60-75% range; if a reactor was validated only down to a UVT of 80%, the system will fail to meet the UV intensity setpoint and thus the reactor would not be an appropriate choice.

Crediting Framework

Credit based on CT, where:

CT = Cl_2 residual concentration (C) * Contact time (T)
Contact time = average hydraulic residence time * baffling factor

Chlorine Contactor Design Requirements

- All water entering the contactor must be chlorinated prior to entering the contactor
- Chlorine cannot be added in an internal recirculation loop
- Chlorine residual must be measured in the contactor effluent

Free Chlorine Monitoring

If seeking CT credit for free chlorine disinfection, project must provide evidence in the Engineering Report that the free chlorine analyzer selected can distinguish between free and combined chlorine.

Important Consideration: Ammonia

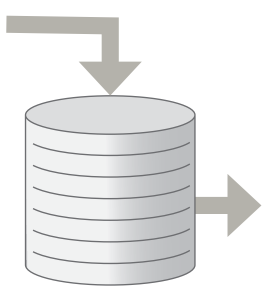
Why is it important?

In blackwater and graywater systems, it presents a challenge for free chlorine disinfection. Ammonia will consume free chlorine and convert it to chloramine, a weaker disinfectant.

How can it be managed?

- Ammonia can be removed through biological treatment via nitrification, i.e. conversion of ammonia to nitrate
- A chlorine dosing control system can be used to breakpoint ammonia and ensure a free chlorine residual
- If ammonia won't be fully removed, consider alternate disinfection for LRT credit, such as UV

Chlorine Contactor Types



Tank Contactor

Default Baffling Factor: 0.1

Pros: Simple design

Cons: Requires larger footprint for same CT, more challenging to control chlorine dosing if tank residence time is long

Pipeline Contactor

Default Baffling Factor: 0.6[1]

Pros: Smaller footprint for same CT because of higher baffling factor, easier control due to faster feedback

Cons: More complex design

[1] Design requirements: Length/diameter (L/D) ratio ≥ 40; Reynold's number ≥ 4,000 (i.e. turbulent flow regime); no expansions/contractions.

Additional Disinfection Guidance: Primary and Secondary Disinfection

Primary Disinfection: used to achieve the pathogen log reduction targets for onsite water reuse systems. Associated with the control of enteric viruses, parasitic protozoa, and enteric bacteria.

Secondary Disinfection: used to maintain a disinfectant residual to prevent contamination as water travels through the distribution system. Provides protection against opportunistic pathogens such as Legionella.

Comparison of pros (+) and cons (−) of common disinfectant options for primary and secondary disinfection.

Disinfection Process	Log Reduction Credit (Primary)	Maintaining Residual in Distribution System (Secondary)	Additional Considerations
Free Chlorine	+ Smaller footprint required for virus credit because of low CTs needed − Not effective against protozoa[1] − Requires dosing control system to maintain residual	+ Effective for controlling biofilm growth − Will need to breakpoint chloramine in potable makeup water to maintain free chlorine residual − Less stable than chloramine	+ Color control
Chloramine	− Requires very large footprint to reach necessary CT values for virus credit − Not effective against protozoa	+ Stable residual + Easy to blend with existing potable makeup + Less reactive with organics, may reduce overall chemical usage − Requires chemical storage & handling of chlorine, ammonia	
UV	+ Effective against virus, protozoa, and bacteria + Relatively simple implementation with pre-validated reactors	− Not suitable as a secondary disinfectant due to lack of residual	
Ozone	+ Effective against virus − Not effective against protozoa[1]	− Not suitable as a secondary disinfectant due to lack of stable residual	+ Color control

[1] The two major groups of parasitic protozoa are Giardia and Cryptosporidium. Both free chlorine and ozone can be effective against Giardia; however, because they are not effective against Cryptosporidium, they have been described here as not effective against protozoa.

Disinfection protects public health in onsite reuse systems. Both primary and secondary disinfection are key components of this protection.

ADDITIONAL CONSIDERATIONS FOR SECONDARY DISINFECTION

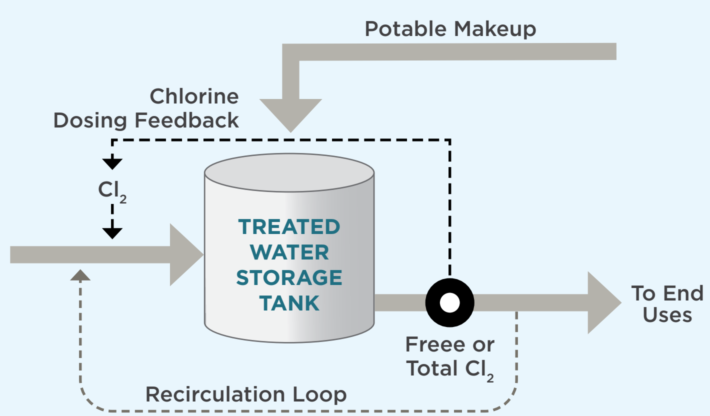
Compatibility of Chlorine and Chloramine

SFPUC potable water has a chloramine residual. This needs to be accounted for in the secondary disinfection design; chloramine reacts with free chlorine in what is called a breakpoint reaction. The net result is an overall lowering of the total chlorine residual. Consider using chloramine as a secondary disinfectant to simplify blending with makeup water and avoid the breakpoint reaction. The two panels on this page illustrate examples of secondary disinfection with free chlorine and chloramine.

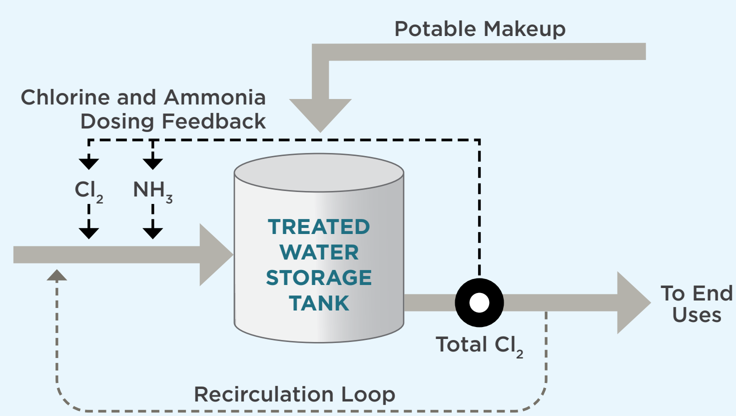
Water Storage and Recirculation

- Because demands may not be constant for these systems, there may be times when water sits in a treated water storage tank (e.g. overnight and weekends in commercial buildings).
- Recirculation is an effective strategy for maintaining the concentration of secondary disinfectant, especially when linked to a disinfectant dosing control system. Such a system would use the chlorine residual measurement to determine whether recirculation and/or changes to chemical dosing are needed to meet the chlorine target (see example treatment trains on pages 20-23).

Secondary Disinfection with Free Chlorine



Secondary Disinfection with Chloramine



Use recirculation for secondary disinfectant control.

Capacity Charge Adjustments for Onsite Water Reuse Systems

The SFPUC assesses a water and wastewater capacity charge prior to the issuance of a project's site permit by SFDBI-PID. One-time water and wastewater capacity charges are designed to provide an equitable mechanism by which development projects that create new or additional demands on San Francisco's water and sewer system can pay their proportional share of the cost for the infrastructure required to serve them.

Understanding that onsite water reuse systems provide many benefits, including reduced potable water use and discharges to the sewer system, the SFPUC has implemented a capacity charge adjustment for development projects with onsite water reuse systems. Effective February 1, 2017, a project with an onsite water reuse system may receive an adjusted water and wastewater capacity charge based on the size of the water meter required to serve only the plumbing fixtures supplied with SFPUC water during normal building operation. This adjustment fairly assesses capacity charges by only charging for the demand placed on SFPUC water and sewer systems.

The example below illustrates the potential savings from an adjusted capacity charge for a new building installing an onsite water reuse system. While the building is still required to install a water meter sized to meet 100% of the building's water demands, the capacity charge is assessed based on the size of the water meter required to serve only the fixtures supplied with SFPUC water during normal building operation. Note that actual cost savings will differ depending on the meter size required for the project.

Example Capacity Charge Adjustment

Building without an onsite water reuse system (assessed using potable and non-potable demands)		**Building with an onsite water reuse system** (assessed using only potable water demands)	
Size of Water Meter Installed	2"	**Size of Water Meter Installed**	2"
Water Capacity Charge for 2" Meter	$10,211	**Water Capacity Charge for 1" Meter**	$3,192
Wastewater Capacity Charge for 2" Meter	$34,744	**Wastewater Capacity Charge for 1" Meter**	$10,857
Total Capacity Charge:	$44,955	**Total Capacity Charge**	$14,049

Capacity Charge Savings: $30,906

India Basin (image courtesy of Build Inc and Steelblue)

Large redevelopment projects such as India Basin are considering district-scale onsite water reuse systems as a sustainable solution to reduce potable water use.

UBER's new office buildings are designed to collect and treat graywater and rainwater separately to meet the building's toilet flushing and irrigation demands. The project is estimated to offset about 700,000 gallons of potable water each year.

UBER Office Building (image courtesy of SHoP Architects)

Onsite Water Reuse Grant Program

Summary

The Onsite Water Reuse Grant Program provides grant funding to encourage retail water users to reduce SFPUC water supply usage by collecting, treating, and using alternate water sources including rainwater, stormwater, condensate, foundation drainage, graywater, and blackwater for non-potable uses such as toilet flushing, irrigation, and cooling tower makeup.

The SFPUC has awarded grants to 6 onsite water reuse projects that will save an estimated 60 million gallons of potable water per year.

The SFPUC's grant program rules and application are posted on **sfwater.org/np**.

Eligible Project Types

Voluntary Projects:

Projects that are installing Onsite Water Systems on a voluntary basis.

Above and Beyond Projects:

Projects that are installing Onsite Water Systems on a mandatory basis in compliance with the Non-potable Water Ordinance (NPO) that go above and beyond Baseline NPO Compliance.

Brewery Process Water Reuse Projects:

Projects that are installing onsite treatment and reuse of brewery process water.

Grant Funding Opportunities

Projects are eligible for grant funding if able to achieve at least one of the following:

Estimated Water Offset (gal/yr for 10 years)	Funding Available
≥ 450,000	Up to $200,000
≥ 1,000,000	Up to $500,000
≥ 3,000,000	Up to $1,000,000

How can projects be eligible for a grant by going Above and Beyond Baseline NPO Compliance?

Example 1:

A project that cannot meet their full toilet and urinal flushing demands with available rainwater, graywater, and foundation drainage could choose to use blackwater and condensate to fully meet toilet and urinal flushing demands.

Example 2:

A project could choose to meet non-potable demands above and beyond Baseline NPO Compliance (toilet and urinal flushing and irrigation), such as for clothes washing and cooling tower make-up.

Wastewater Heat Recovery refers to the extraction of thermal energy from warm wastewater, or treated non-potable water, and subsequent beneficial use of this energy to offset existing energy requirements.

Benefits of Wastewater Heat Recovery

- Integration with onsite water reuse can offset some or all the energy needed for treatment
- Decreased energy costs
- Reduced greenhouse gas emissions and reliance on fossil fuels
- Potential green building certification credits

Wastewater Heat Recovery & Onsite Water Reuse Synergies

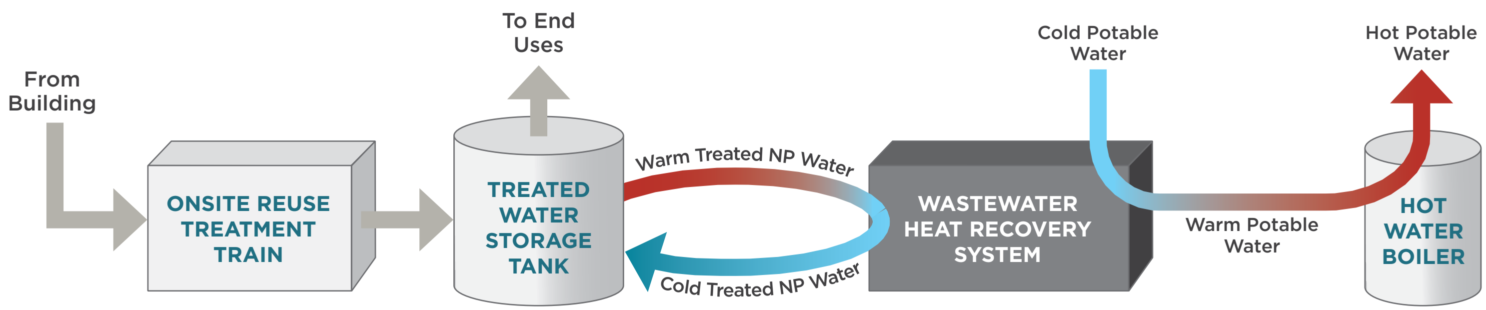
- Onsite water reuse systems will already have equalization tanks available to provide a consistent flow to a wastewater heat recovery system
- Using treated blackwater or graywater from an onsite water reuse system can enable heat recovery from a cleaner stream than raw wastewater, which can result in longer equipment life and less maintenance needed
- Wastewater heat recovery systems cool down the treated non-potable water being sent to toilets and other non-potable end uses in buildings, which can result in improved control of Legionella and other opportunistic pathogens in premise plumbing

Onsite Water Reuse Grant Program Requirements

All projects applying for an Onsite Water Reuse grant must estimate the potential energy offset that can be achieved with wastewater heat recovery in the grant application.

Mixed-use and multi-family buildings are required to implement wastewater heat recovery if applying for an Onsite Water Reuse grant.

Wastewater Heat Recovery & Onsite Water Reuse: Example Configuration



National Blue-Ribbon Commission for Onsite Non-potable Water Systems

The SFPUC has been collaborating with a nation-wide group of utilities and public health agencies since 2014, advancing policies and contributing significant research related to onsite water reuse. In 2016, the SFPUC and the U.S. Water Alliance formalized the partnership and established the National Blue Ribbon Commission for Onsite Non-potable Water Systems. Today, in partnership with the WateReuse Association, U.S. Water Alliance, and Water Research Foundation (WRF), the group is comprised of more than 30 members representing 14 states, the District of Columbia, U.S. Environmental Protection Agency (U.S. EPA), U.S. Army Engineer Research and Development Center, City of Toronto, and City of Vancouver.

Leveraging funding from WRF, the group has made significant research contributions and advanced policies and regulations for onsite water reuse over the years. As a result of the peer exchange, joint policy development, and rigorous research, there has been a shift in the perspective of many participating public health agencies who now have the appropriate framework and tools to develop regulations. California, Colorado, Minnesota, Oregon, Washington, and Hawaii are advancing regulations or policies supporting onsite reuse, while others including Texas and Alaska are considering similar steps forward.

The Blue Ribbon Commission's most recent work includes finalizing a guidance manual and training modules for designing and permitting onsite water systems that meet risk-based public health standards. It targets system designers, regulators, program administrators, owners, and operators to help with capacity building. Additionally, the group is acknowledged as the leading entity supporting the implementation of onsite water reuse systems in the 2020 U.S. EPA's Water Reuse Action Plan.

Resources developed by the Blue Ribbon Commission are listed below and can be found at **sfwater.org/iuws** and **watereuse.org/educate/national-blue-ribbon-commission-for-onsite-non-potable-water-systems**:

- **Guidance Manual for Designing and Permitting Onsite Non-potable Water Systems and Training Modules (2020)**
- **Making the Utility Case for Onsite Non-potable Water Systems (2018)**
- **A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems (2017)**
- **Model State Regulation for Onsite Non-potable Water Programs (2017)**
- **Model Local Ordinance for Onsite Non-potable Water Programs (2017)**
- **Model Program Rules for Onsite Non-potable Water Programs (2017)**
- **Risk-based Framework for the Development of Public Health Guidance for Decentralized Non-potable Water Systems (2017)**
- **Blueprint for Onsite Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems (2014)**

Hassalo on Eighth (image courtesy of Jim G. Maloney/Biohabitats, Inc.)

The National Blue Ribbon Commission visited the Hasslo & 8th Ecodistrict's onsite water recycling in Portland, OR.

Additional Resources

This guidebook serves as a resource to assist with San Francisco's permitting process for onsite water reuse systems. It is not intended as a substitute for a qualified professional completing a comprehensive design process for your specific project. Additional resources for San Francisco's Onsite Water Reuse Program and Stormwater Management Program can be found at **sfwater.org/np** and **sfwater.org/smr,** including:

- **Case Studies of San Francisco Onsite Water Reuse Systems**
- **Onsite Water Reuse Program Factsheet**
- **Onsite Water Reuse System Resources List**
- **San Francisco Department of Public Health Director's Rules and Regulations Regarding the Operation of Alternate Water Source Systems**
- **San Francisco Health Code, Article 12A, Backflow Prevention**
- **San Francisco Health Code, Article 12C, Non-potable Water Ordinance**
- **San Francisco Public Utilities Commission Rules and Regulations Governing Water Service to Customers, Section G, Cross-Connection Control**
- **Stormwater Management Requirements and Guidelines**
- **Synergies for Compliance with the Non-potable Water Ordinance and Stormwater Management Ordinance Guidebook**
- **Water Budget Applications for single buildings and district-scale projects**
- W**ater Use Calculators for single buildings and district-scale projects**
- **Onsite Water Reuse Design and Implementation Tips**
- **Validated UV List**
- **Implementing OneWaterSF: Onsite Reuse Factsheet**
- **Onsite Water Reuse Grant Program Rules and Application**

Grant Program Highlight: Brewery Process Water Reuse

Reusing process water onsite can significantly reduce breweries' water use. To make 1 gallon of beer, the average brewery uses up to 7 gallons of water; with process water reuse, this can be reduced as low as 2 to 3 gallons.

The SFPUC's Onsite Water Reuse Grant Program provides guidelines for breweries looking to reuse process water in a range of applications, including those that may come into contact with the final product, such as final rinses of the interior of bottles.

An example of this is Seismic Brewing Company in Santa Rosa, California. To reduce their water footprint, Seismic Brewing treats and reuses brewery process water onsite for tank rinses and floor washdowns.

Seismic Brewing Company (image courtesy of Ricky Grossmann Photography)

Onsite Water Reuse Program Guidebook