US Water Alliance

WATER ENVIRONMENT & REUSE FOUNDATION WE&RF

Water Research Foundation

National Blue Ribbon Commission
for Onsite Non-potable Water Systems

A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems

Preface

Letter from the Chair

One of the most exciting innovations in One Water management is the integration of smaller onsite systems that collect, treat, and reuse water within individual buildings or at the local scale.

The National Blue Ribbon Commission for Onsite Non-potable Water Systems aims to advance the use of onsite non-potable water systems by sharing best practices and fostering a supportive policy and regulatory environment. The commitment and collaboration from three leading national water organizations—the US Water Alliance, the Water Environment & Reuse Foundation, and the Water Research Foundation—demonstrates rising national interest in these systems and the opportunity to come together to forge progress in the field.

As a proven, yet emerging practice, the success of onsite non-potable water systems depends on strong collaboration between municipal utilities and public health agencies to ensure projects protect public health and meet water quality standards. Created by and for utility leaders and state and local public health regulators, this guidebook presents a concrete and actionable framework that states and localities can utilize for regulating and managing onsite non-potable water systems based on best-in-class science and research. Having a consistent policy framework across cities and states is one of the best ways that we can integrate onsite systems in a way that protects public health and meets our water needs. We hope the resources provided in this guidebook will help utilities and regulators forge a path to One Water management in their communities.

Paula Kehoe
Director of Water Resources, San Francisco Public Utilities Commission; *Chair, National Blue Ribbon Commission*

National Blue Ribbon Commission
for Onsite Non-potable Water Systems

About the National Blue Ribbon Commission

The mission of the National Blue Ribbon Commission for Onsite Non-potable Water Systems is to advance best management practices to support the use of onsite non-potable water systems for individual buildings or at the local scale. We are committed to protecting public health and the environment, and sustainably managing water—now and for future generations.

The National Blue Ribbon Commission aims to progress innovative solutions for onsite water management. It is convened by the US Water Alliance, the Water Environment & Reuse Foundation (WE&RF), and the Water Research Foundation (WRF) in 2016 and chaired by the San Francisco Public Utilities Commission (SFPUC).

The Commission is comprised of 33 representatives from municipalities, water utilities, and public health agencies from 11 states and the District of Columbia.

The goals of the Commission are to:

- Serve as a forum for collaboration and knowledge exchange on the policies, best management practices, procedures, and standards for onsite non-potable water systems;
- Craft model policy guidance and frameworks for the management and oversight of onsite non-potable water systems (e.g. water quality criteria, monitoring and reporting requirements, and operational and permitting strategies);
- Develop case making resources for water utilities based on best practices and lessons learned in the design, development, integration, and operation of onsite non-potable water systems; and,
- Identify additional research needs in the field.

List of Commissioners

Chair

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

Commissioners

Scott Abbott
Manager, Environmental Protection Branch, County of Los Angeles Department of Public Health

Anita Anderson
Principal Engineer, Minnesota Department of Health

Julienne Bautista
Environmental Engineer, District of Columbia Department of Energy & Environment

Brian Bernados
Senior Engineer and Technical Specialist, California State Water Resources Control Board

Brian Davis
Senior Engineer, Metropolitan Council Environmental Services

Steve Deem
Regional Engineer, Washington State Department of Health

Ron Doughten
Water Quality Permit Program Manager, Oregon Department of Environmental Quality

Jon Eaton
Superintendent of Utilities, City of Eagan, Minnesota

Jessica Edwards-Brandt
Director of Water Quality & Technology, DC Water

Mamdouh El-Aarag
Environmental Engineer, Wastewater Management, Washington State Department of Health

Samir Elmir
Environmental Administrator, Florida Department of Health, Miami–Dade County

Jay Garland
Division Director, Office of Research and Development US Environmental Protection Agency

Bertha Goldenberg
Assistant Director for Planning and Regulatory Compliance, Miami-Dade Water and Sewer Department

Brian Good
Chief Administrative Officer, Denver Water

Charles Graf
Principal Hydrogeologist, Arizona Department of Environmental Quality

Bret Icenogle
Engineering Section Manager, Water Quality Control Division, Colorado Department of Public Health and Environment

Mark Jaeger
Strategic Advisor, Inter-Governmental and Agency Coordination, Seattle Public Utilities

David Lipsky
Senior Policy Advisor, New York City Department of Environmental Protection

Josina Morita
Commissioner, Metropolitan Water Reclamation District of Greater Chicago

Sina Pruder
Engineering Program Manager, Hawaii State Department of Public Health—Wastewater Branch

Melinda Rho
Manager of Water Quality Regulatory Affairs, Los Angeles Department of Water and Power

Genevieve Salmonson
Compliance Assistance Ombudsman, Hawaii State Department of Public Health

Neal Shapiro
Senior Sustainability Analyst and Watershed Management Program Coordinator, City of Santa Monica, California

Robert Stefani
Environmental Program Coordinator, Austin Water

Wing Tam
Assistant Director of Watershed Programs, LA Sanitation, City of Los Angeles

Jacqueline Taylor
Director, Environmental Protection Branch, County of Los Angeles Department of Public Health

Barry Usagawa
Program Administrator, Water Resources Division, Honolulu Board of Water Supply

Chris Wanner
Director of Operations, Portland Water Bureau

June Weintraub
Manager of Water, Noise, and Medical Cannabis Regulatory Programs, San Francisco Department of Public Health

National Program Partners & Commissioners

Radhika Fox
Chief Executive Officer, US Water Alliance

Melissa Meeker
Chief Executive Officer, Water Environment & Reuse Foundation

Rob Renner
Chief Executive Officer, Water Research Foundation

Acknowledgements

This document would not have been possible without the invaluable contributions of Paula Kehoe and Taylor Chang from the San Francisco Public Utilities Commission. A special thanks to Paula for her leadership in the development of this document.

We also thank Danielle Mayorga from the US Water Alliance for managing the work of the commission and shepherding the development of this report.

Table of Contents

The technical appendix for this guidebook, along with templates for model state regulation, model local ordinance, and model program rules can be downloaded at www.uswateralliance.org/initiatives/commission.

Section 1.
Introduction and Purpose of the Document

Introduction

The National Blue Ribbon Commission was established in 2016 to advance best management practices to support the use of onsite non-potable water systems (ONWS) in individual buildings or at the local scale. This document, *A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems* was developed by the commission due to the growing interest in incorporating onsite non-potable water systems in communities throughout the United States, amidst a lack of existing public health-based standards and a streamlined permitting process. There continue to be institutional barriers to onsite water reuse, as there are no national standards or guidelines for ONWS in the United States, and there is wide variation in existing water quality criteria. This document will help guide states and local jurisdictions in developing and implementing regulations and oversight programs for ONWS that are based on best-in-class science and are protective of public health.

As we develop regulatory approaches, it is important that they are guided by risk-based science. The recommendations in this guidebook utilize the best, most comprehensive research to date for ONWS, as presented in *Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-potable Water Systems* (WE&RF Project No. SWIM10C15, Sharvelle et al., 2017) published by the Water Environment & Reuse Foundation, in partnership with National Water Research Institute (NWRI), the Water Research Foundation (WRF), and the San Francisco Public Utilities Commission (SFPUC).

The research effort led by NWRI convened an expert panel and stakeholder committee to move forward two key goals: (1) the development of recommendations and guidance for treatment requirements for ONWS that ensure public health protection, and 2) the development of a management framework for the appropriate use of onsite treated water for non-potable applications. The risk-based research established water quality and monitoring criteria with a focus on pathogen reduction targets and monitoring regimes. The Expert Panel used a Quantitative Microbial Risk Assessment (QMRA) approach to derive the pathogen reduction targets because this approach is considered the most advanced and protective of public health. The expert panel also established guidance on management and permitting strategies for ONWS.

This guidebook builds upon this extensive research and provides a specific framework and templates for state and local jurisdictions to use as they craft regulations, adopt policies, and develop and implement local programs for ONWS.

Unless otherwise specified, the guidance in this document was determined by the commission. For details on the risk-based framework used to develop this guidance, please refer to Sharvelle et al., 2017.

How to Use This Guidebook

The purpose of this guidebook is to establish a consistent national approach for regulation and management of ONWS. This document is intended for use by state and local public health regulators seeking guidance on establishing water quality criteria for ONWS. This document also provides regulators with various pathways for implementation of management programs for ONWS at the local and/or state level. It is intended to establish a consistent management approach for ONWS that can be transferable from state to state and community to community, while maintaining the flexibility to meet the specific needs and fit within existing structures of a particular locality. We hope the standardized approach presented in this document will provide clarity on the appropriate water quality criteria and technologies for treating water onsite for non-potable purposes, and lead to improved public health protection and increased treatment system reliability.

The document is organized in the following way:

- **Section 2** defines the scope of water sources and appropriate end uses for ONWS in commercial, multi-family, and mixed-use buildings covered in the report.

- **Section 3** outlines the treatment standards for ONWS, informed by risk-based science, and other water quality and design considerations.

- **Section 4** guides regulators in classifying ONWS into management categories, identifying the appropriate level of regulatory oversight, and determining the requirements for the responsible management entity to ensure performance and compliance. This section helps regulators and responsible management entities understand the ownership, complexity, and risks of the particular system.

- **Section 5** lists the key components for oversight and management programs to ensure proper design, construction, and operation of ONWS.

- **Section 6** discusses the policy vehicles for supporting the development and implementation of ONWS across state and local authorities. This section also provides model policy and regulatory documents, including a model state regulation and a model local ordinance, which can be tailored to specific jurisdictions and adopted by local and state officials. This section also describes recommended program rules that are essential for any oversight and management program established by local or state policy.

Section 2.
Alternate Water Sources, End Uses, and Implementation Scale

There is a broad field of practice around water reuse, which can include large-scale recycled and reclaimed water facilities and potable reuse projects. ONWS present a specific strategy for capturing, treating, and using water onsite or in a local context. This section defines the scope of water sources and end uses for ONWS covered in this document.

Alternate Water Sources

Buildings, including commercial and multi-family residential buildings, generate several types of alternate water sources. The most common types of alternate water sources produced by buildings and covered in this document include:

- **Roof Runoff:** precipitation from rain or snowmelt events that is collected directly from a roof surface not subject to frequent public access.
- **Stormwater:** precipitation runoff from rain or snowmelt events that flows over land and/or impervious surfaces (e.g., streets, parking lots, and rooftops). Stormwater includes runoff from roofs with frequent public access.
- **Domestic Wastewater or Blackwater:** wastewater originating from toilets and/or kitchen sources (e.g., kitchen sinks and dishwashers).
- **Graywater:** wastewater collected from non-blackwater sources, such as bathroom sinks, showers, bathtubs, clothes washers, and laundry sinks.

States and/or local jurisdictions can incorporate additional sources of water into regulations as desired. When considering such additional sources, regulators should utilize quantitative microbial risk assessment to relate human health risk with the exposure to microbial hazards in the non-potable water supplies or analogous approaches suitable to their jurisdiction. Details on quantitative microbial risk assessments can be found in Sharvelle et al., 2017.

Non-potable End Uses

Alternate water sources can be used for a variety of non-potable uses within and outside a building. The most common indoor use is toilet and urinal flushing, which can represent approximately 25 percent of the total water demand in a residential building and up to 75 percent of the total water demand in a commercial building. Other potential non-potable water demands include irrigation, cooling/heating applications, process water, and clothes washers. These additional applications can increase the non-potable water demand up to 50 percent for residential buildings and up to 95 percent for commercial buildings.

The non-potable end uses covered in this report include:

- Indoor Use:
  - — Toilet and urinal flushing
  - — Clothes washing
- Unrestricted Irrigation:
  - — Ornamental plant irrigation
  - — Dust suppression

States and/or local jurisdictions can incorporate additional non-potable end uses into regulations as desired. When considering such additional end uses, regulators should utilize quantitative microbial risk assessment to relate human health risk with the exposure to microbial hazards in the non-potable application or analogous approaches suitable to their jurisdiction. Details on quantitative microbial risk assessments can be found in Sharvelle et al., 2017.

Implementation Scale

The alternate water sources and non-potable end uses addressed in this document are limited to ONWS at the following implementation scales:

- Multi-family Buildings
- Commercial Buildings
- Mixed-use Buildings
- District-scale Projects

The document does not address single-family residential dwellings because quantitative microbial risk assessments were not utilized to relate human health risk with exposure to microbial hazards in non-potable water supplies found in single-family residential dwellings. This document also does not address the applicability for centralized reuse systems such as large, municipal recycled water facilities.

Section 3.
Treatment System Standards for Onsite Non-potable Water Systems

The *Risk Based Framework for the Development of Public Health Guidance for Decentralized Non-potable Water Systems* (Sharvelle et al., 2017) established water quality standards, particularly related to the minimum degree of pathogen removal and/or inactivation required for public health protection. Citing pathogens as the greatest concern to human health in ONWS, the report established a risk-based approach to determine pathogen removal and/or inactivation goals. These goals are specified in terms of "log reduction targets," or LRTs, for viruses, protozoa, and bacteria. While this risk-based approach is new for onsite non-potable water systems, the approach is based on widely accepted practices for both drinking water and potable reuse.

Water Treatment Standards

The standard for the treatment of alternate water sources is to meet or exceed the specified log reduction targets (LRTs) for the removal and/or inactivation of pathogens, as indicated in Tables 1 and 2. The LRTs were established to assess the tolerable levels of risk and the concentrations of pathogens in different source waters. Given the involuntary exposure associated with ONWS, the commission recommends using the LRTs to reduce the annual risk of infection to less than 10^{-4} per person per year benchmarks because it is the more stringent risk goal and a protective approach for public health.

Table 1 indicates the LRTs for domestic wastewater or blackwater, graywater, and roof runoff. The LRT for roof runoff was determined assuming no human fecal input and estimated pathogen densities from the likely mass of animal feces present. The LRT for roof runoff is not applicable to private residential use of roof runoff from rain barrels or cisterns for irrigation without treatment.

Table 2 indicates two LRTs for stormwater, based on a 10^{-1} dilution of municipal wastewater and 10^{-3} dilution of municipal wastewater. Municipal wastewater is defined as wastewater collected by municipal treatment facilities which may include non-domestic wastewater sources such as industrial wastewater. These two levels of dilution are based on somewhat limited, and variable measurements of indicators of fecal contamination in stormwater from urban environments. Some contamination is likely (e.g., at least 10^{-3} dilution of municipal wastewater), and as little as 10^{-1} dilution of municipal wastewater is possible with a chronic sewer leak or sewer overflow into stormwater.

Historical wastewater treatment parameters that focused on goals such as BOD / COD reduction, TDS, and nutrient (nitrogen and phosphorus) management may also still be important considerations in determining appropriate treatment steps and performance monitoring. These parameters will depend upon the alternate source water and end use.

Table 1

Log reduction targets for 10^{-4} per person per year benchmarks for ONWS using blackwater, graywater, or roof runoff

Water Use Scenario	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
Domestic Wastewater or Blackwater			
Unrestricted Irrigation	8.0	7.0	6.0
Indoor Use	8.5	7.0	6.0
Graywater			
Unrestricted Irrigation	5.5	4.5	3.5
Indoor Use	6.0	4.5	3.5
Roof runoff			
Unrestricted Irrigation	Not applicable[1]	No data[1]	3.5
Indoor Use	Not applicable[1]	No data[1]	3.5

Notes:

1. States and/or local regulators can define the LRTs for virus and protozoa for roof runoff systems using one of the following suggested options:
   - Assign LRT values based on stormwater LRTs
   - Conduct research on the presence of virus and protozoa in roof runoff and assign LRT values based on research

Source: Adapted from Sharvelle et al., 2017 (Table 3-3, page 26).

Table 2

Log reduction targets for 10^{-4} per person per year benchmarks for ONWS using stormwater

Water Use Scenario	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
Stormwater (10^{-1} dilution)			
Unrestricted Irrigation	5.0	4.5	4.0
Indoor use	5.5	5.5	5.0
Stormwater (10^{-3} dilution)			
Unrestricted Irrigation	3.0	2.5	2.0
Indoor use	3.5	3.5	3.0

Source: Adapted from Sharvelle et al., 2017 (Table 3-3, page 26).

Elements of Pathogen Crediting Frameworks

In order to meet the LRTs for the range of alternate water sources and end uses, treatment processes are designed in series to create an effective treatment train. Common treatment processes include microfiltration (MF), ultrafiltration (UF), membrane biological reactor (MBR), ultraviolet light (UV) disinfection, ozone disinfection, and chlorination. Treatment processes can achieve pathogen credits to meet the LRTs based on accepted pathogen crediting frameworks. Pathogen crediting frameworks generally consist of requirements for validation, field verification, and ongoing monitoring of treatment performance (Sharvelle et al. 2017).

Each aspect is described briefly below:

- **Validation**: detailed technology evaluation study conducted using challenge testing over a wide range of operational conditions, usually conducted at a pilot test facility, but can be done in situ.
- **Field verification**: performance confirmation study conducted using challenge testing, including surrogate microorganisms and/or other non-biological surrogates, usually during startup and commissioning and may be repeated as needed. The need for, duration, and extent of the field verification procedure will depend on characteristics of the ONWS.
- **Continuous verification monitoring**: ongoing confirmation of system performance using sensors for continuous observation of selected parameters, including surrogate parameters that are correlated with pathogen log reduction target requirements.

It is recommended to use technologies that are validated by the manufacturer and approved by the regulator; however if validated technologies are not used, it is recommended that technology validation and field verification (where applicable) be done to ensure that the treatment process can be expected to achieve its pathogen removal and/or inactivation credit. Continuous monitoring is also recommended to demonstrate compliance with influent and effluent water quality standards, dose requirements, and other aspects of a treatment process related to treatment performance. For continuous monitoring, regulators may determine the appropriate parameters (e.g. minimum, maximum, average) to be reported.

Existing Pathogen Crediting Frameworks

The following sections describe the major pathogen crediting frameworks currently in use to credit treatment processes for the removal and/or inactivation of enteric viruses, *Giardia lamblia* cysts, and *Cryptosporidium* oocysts.

Pathogen crediting frameworks for bacteria have not been developed to date. However, it is recommended that bacterial credit be given for certain technologies such as Ultraviolet Disinfection (UV), based on the virus credit that is awarded. It is also recommended that bacterial credit be given for free chlorine disinfection that is equivalent to the virus credit achieved based on the CT framework (see Appendix A) if it is preceded by a membrane filter or MBR that meets turbidity requirements. If UV or free chlorine disinfection are not selected for use in a treatment train or if a treatment train cannot meet the LRTs in Tables 1 and 2, it is recommended that regulators require an adaptive approach to total coliform monitoring to allow a highly performing system to decrease monitoring frequency over time, until further research on bacterial crediting is completed. Additionally, during the commissioning or start-up phase of an ONWS, it is recommended that regulators require total coliform monitoring. This requirement can be eliminated over time, depending on the treatment train, and is up to the discretion of the regulator.

Drinking Water

The concept of pathogen crediting originated in the US Environmental Protection Agency's (EPA) Surface Water Treatment Rule (SWTR). The original rule and subsequent updates lay out pathogen removal and/or inactivation requirements for facilities treating surface waters, specifying minimum log removals for enteric virus, *Giardia lamblia*, and later, in the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), *Cryptosporidium*. To help facilities comply with these rules, the EPA has created guidance manuals for various types of treatment that lay out approaches for demonstrating and receiving pathogen removal and/or inactivation credit. The guidance documents referenced here are listed below.

Ultimate authority for enforcing the surface water treatment rules lies with the states. If a state has not obtained primacy, e.g. primary enforcement responsibility over public water systems, then the responsibility lies with the EPA (EPA, 1991). This document references the California drinking water regulations, contained in the California Code of Regulations, Title 22, Division 4, Chapter 17: Surface Water Treatment (CCR, 2013). Additional guidelines for UV disinfection have been published by NWRI; although these are not regulations, the California Division of Drinking Water (DDW) has endorsed them and acknowledged that future regulations may be based on them (California State Water Resources Control Board Division of Drinking Water, 2014).

EPA Documents

- Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources (1991)
- Disinfection Profiling and Benchmarking Guidance Manual (1999)
- Alternative Disinfectants and Oxidants Guidance Manual (1999)
- Membrane Filtration Guidance Manual (2005)
- Long Term 2 Enhanced Surface Water Treatment Rule (2006)
- Ultraviolet Disinfection Guidance Manual for the Final Long Term Enhanced Surface Water Treatment Rule (2006)
- Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual (2010)

California Documents

- California Code of Regulations, Title 22, Division 4, Chapter 17: Surface Water Treatment (2013)

Additional Documents

- National Water Resources Institute Ultraviolet Disinfection: Guidelines for Drinking Water and Water Reuse, Third Edition (2012)
- Deutsche Vereinigung des Gas und Wassserfaches (DVGW) UV Devices for the Disinfection for Drinking Water Supply (2006)

Potable Reuse

Pathogen crediting frameworks used in potable reuse are generally similar to those used for drinking water. Additional guidance is provided in the California groundwater replenishment regulations.

EPA Documents

- Membrane Filtration Guidance Manual (2005)
- Ultraviolet Disinfection Guidance Manual for the Final Long Term Enhanced Surface Water Treatment Rule (2006)
- Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual (2010)

California Documents

- California Code of Regulations, Title 22, Division 4, Chapter 3: Water Recycling Criteria (2014)
  - Article 5.1: Indirect Potable Reuse: Groundwater Replenishment—Surface Application
  - Article 5.2: Indirect Potable Reuse: Groundwater Replenishment—Subsurface Application

Non-potable Reuse

The primary pathogen framework referenced here is that used for non-potable reuse in California. Additional information is used from Australian guidelines.

California Documents

- California Code of Regulations, Title 22, Division 4, Chapter 3: Water Recycling Criteria (2014)

Additional Documents

- National Water Resources Institute Ultraviolet Disinfection: Guidelines for Drinking Water and Water Reuse, Third Edition (2012)
- Australian Water Recycling Centre of Excellence National Validation Guidelines for Water Recycling: Membrane Bioreactors (2015)

Table 3 provides example pathogen credits for common treatment processes and examples of required supporting information necessary for regulators to evaluate the treatment train. The example pathogen credits are based on the existing pathogen crediting frameworks discussed above.

Table 3
Example Treatment Process Log_{10} Reduction Credits

Treatment Process	Log_{10} Reduction Credits Virus/Protozoa/Bacteria	Example Information to be Included in an Engineering Report
Microfiltration or Ultrafiltration	0/4/0	Manufacturer's informational sheet indicating ability to detect 0.3µm breach
Membrane Biological Reactor (MBR)	1.5/2/4	Operation with the Tier 1 operating envelope as defined in the AWRCE 2016, *Membrane bio-reactor*, WaterVal validation protocol[2]
Reverse Osmosis	Up to 2/2/2	Manufacturer's informational sheet indicating ability to reject sodium chloride. Allow pathogen removal credit with continuous monitoring of either electrical conductivity or total organic carbon
Ultraviolet (UV) Light Disinfection	Up to 6/6/6 (dose dependent)	UV reactor's Validation Report following state-approved procedures[3] or NSF/ANSI 55 Class A validated.
Chlorine Disinfection	Up to 5/0/5 (CT dependent)	Calculations demonstrating log inactivation using CT disinfection, where CT = Concentration of Chlorine x Contact Time
Ozone Disinfection	Up to 4/3/0 (CT dependent)	Calculations demonstrating log inactivation using CT disinfection, where CT = Concentration of Ozone x Contact Time

Notes:

1. The information presented herein is for informational purposes. Specific requirements will be approved by the Director based on details provided by the Project Applicant in the Engineering Report.
2. AWRCE 2016, *Membrane bio-reactor*, WaterVal validation protocol, Australian Water Recycling Center of Excellence, Brisbane.
3. UV log_{10} reduction credits are reactor-specific. UV Validation Reports shall be prepared by a licensed engineer. Validation reports must provide evidence of reactor's ability to reliably and consistently achieve the log_{10} reduction value, including information on the required operating conditions and surrogate parameters that require continuous monitoring. The Validation Report shall document results based on validation testing completed utilizing one of the following:
   a. EPA UV Disinfection Guidance Manual (USEPA 2006),
   b. German UV Devices for the Disinfection for Drinking Water Supply Standard (DVGW 2006), or
   c. NWRI UV Disinfection: Guidelines for Drinking Water and Water Reuse, 3rd edition (NWRI 2012).

   Submitted validation reports must include a letter demonstrating the report has been accepted previously by a state public health official.

Source: San Francisco Department of Public Health Director's Rules and Regulations for the Operation of Alternate Water Source Systems

Water Treatment Monitoring

The recommended standard for pathogen removal and/or inactivation is to continuously monitor using microbial, chemical, or physical indicator(s) or surrogate parameter(s) that verify the performance of each treatment process's ability to achieve its credited pathogen removal and/or inactivation. Credited pathogen removal and/or inactivation is determined based on the surrogate parameter utilized for continuous monitoring. Reporting frequency on the continuous monitoring is up to the discretion of the regulator.

If alternate water sources such as stormwater are collected, treated, and used in an ONWS, the recommended rule is to address the presence of Volatile Organic Compounds (VOCs), if applicable.

Table 4 shows example continuous monitoring methods for common treatment processes.

Table 4
Example Treatment Process Monitoring

Treatment Process	Example Continuous Monitoring Methods
Microfiltration or Ultrafiltration	• Pressure decay test • Effluent Turbidity
Membrane Biological Reactor (MBR)	• Transmembrane Pressure • Effluent Turbidity
Reverse Osmosis	• Total organic content (TOC) • Influent and Effluent Electrical Conductivity
Ultraviolet Light Disinfection	• Influent UV transmittance • Influent turbidity • UV intensity • Flow rate
Chlorine Disinfection	• Chlorine residual (Free/Total) • Flow rate
Ozone Disinfection	• Ozone residual • Flow rate

Source: San Francisco Department of Public Health Director's Rules and Regulations for the Operation of Alternate Water Source Systems.

Water Quality Considerations

The recommended standard for ONWS is to produce non-potable water with an appropriate color that does not contain odors that may create a nuisance. Non-potable water with discoloring related to dye tests used to test for unintended cross-connections is considered acceptable.

Additionally, it is recommended to maintain microbial stability in the distribution system. Initial pathogen control treatment, coupled with proper management in the storage and distribution of waters is recommended to ensure public health protection in ONWS (see Appendix E). To maintain microbial stability in the distribution system, maintaining a free chlorine residual of 0.2 mg/L or a combined chlorine residual of 0.5 mg/L at or near the point of use may be a consideration. The goal of maintaining a residual at these levels is to reduce the risk of both aesthetic issues such as offensive odors, and health issues posed by *Legionella* and other opportunistic pathogens. Considerations for the management of *Legionella* are addressed in Appendix F.

Other recommendations to improve water quality aesthetics include using non-reactive materials of construction in the distribution system, avoiding stagnation, making it convenient to clean storage tanks, flushing the distribution system, and controlling temperature.

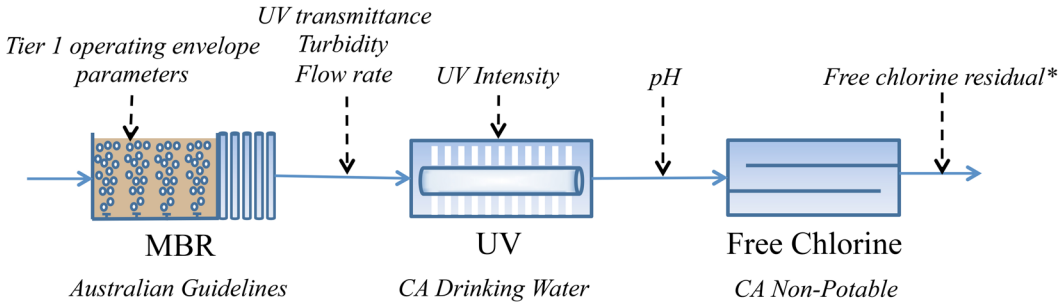
Example Treatment Train

An example blackwater treatment train to achieve the necessary LRTs for indoor use using existing Australian and California pathogen crediting frameworks and the associated monitoring is provided in Figure 1. Figure 1 includes a treatment train with a membrane bioreactor (MBR), UV, and free chlorine. In this train, the MBR receives pathogen credit per the Australian guidelines. The MBR must operate within the Tier 1 operating envelope, with an effluent turbidity ≤ 0.2 NTU. The MBR effluent must be within the validated range of water quality of the UV reactor. The UV reactor (or multiple reactors in series) must provide a UV dose of 80 mJ/cm^2 to receive 3.5-log virus and bacteria credit and 6-log protozoa credit. The remaining virus and bacteria credits are obtained through free chlorine. The chlorine system must provide a CT of no less than 10 mg-min/L, with a verified free chlorine residual. A free chlorine dosing control system is required to ensure that free chlorine residual is maintained even in the presence of ammonia in the feedwater. The example treatment train is based on the health risk assumption of 10^{-4} infections per person per year.

Appendix B contains additional example treatment trains based on existing crediting frameworks along with requirements for validation, field verification, and continuous monitoring.

Figure 1

Example treatment train for ONWS treating blackwater.



	Pathogen Credits			Total	Required
V	1.5	3.5	5	**10**	**8.5**
G	2	6	0	**8**	**7**
C	2	6	0	**8**	**7**
B	4	3.5	5	**12.5**	**6**

Validation & Field Verification Requirements		
Field verification of operation within Tier 1 envelope	Validation for dose of 80 mJ/cm^2 per EPA, NSF, or DVGW	Tracer study or assumed baffling factor of 0.1

Treatment Requirements		
Effluent turbidity ≤ 0.2 NTU Operation within Tier 1 envelope	Influent UVT ≥ minimum validated value for UV reactor UV dose ≥ 80 mJ/cm^2	CT no less than 10 mg-min/L** with verified free chlorine residual

** System must have chlorine dosing control system to ensure free chlorine residual in the presence of ammonia in feedwater*
*** See Maguin et al. (2009), Huitric et al. (2014), Pecson (2016)*

Onsite Non-potable Water System Components

A reliable and safe ONWS requires many components in addition to treatment processes. Critical components typically used in ONWS are listed below. Additional items may be needed depending upon local conditions and regulations.

Alarms and Shutdown Mechanisms: features that result in an automatic system shutdown in the event of an ONWS malfunction.

Backflow Prevention Devices: devices or separation that prevents water from flowing into the potable water system. Air gaps are recommended with make-up water connection in the event the ONWS is not working or unable to meet the LRTs. Consideration may be given to rainwater harvesting systems that do not specify an isolation air-gap at the point of municipally supplied make-up may alternatively specify an isolation Reduced Pressure Principle (RP) at the point of potable make-up to the ONWS.

Bypass: diverts incoming alternate water sources directly to the sewer, bypassing the treatment system.

First Flush Diverter (for ONWS using roof runoff): operates by mechanical float valves or other types of automatic control that diverts a quantity of roof runoff collected from a surface following the onset of a rain event.

Flow Meter: records the collection, treatment, and distribution of water from an ONWS.

Lockable Valves: controls the flow of water from any source originating from another property and lockable valves which can be activated to control the flow of water to any user located at another property.

Monitoring Equipment: demonstrates compliance with influent and effluent water quality standards, dose requirements, and other aspects of a unit process related to treatment performance.

ONWS Identification: includes signage, valve tags, and purple pipe or other appropriate pipe schemes indicating the presence of non-potable water.

Overflow: establishes an overflow connection to the sanitary sewer system with an air gap or other approved backflow prevention device.

Storage Tanks: requires proper ventilation of storage tanks to prevent odors from entering into the building. Requires proper management of storage tanks to prevent growth of *Legionella*. Considerations for the management of *Legionella* addressed in Appendix F.

Additional signage, construction, sizing, piping, and valves requirements that may be applicable to ONWS are found in plumbing codes. The plumbing codes for most communities are modeled after the International Plumbing Code (IPC) or the Uniform Plumbing Code (UPC). The IPC and UPC have been amended by some states to establish their own laws, guidelines, and codes to further refine allowable uses, water quality, and treatment requirements related to ONWS.

Section 4. Owner/Management Considerations

State and local regulators can consider classifying ONWS by Management Categories by referencing Table 5, Table 6, and Figure 2. The Management Categories fit into an example framework intended to guide regulators in identifying the appropriate level of regulatory oversight for ONWS as well as the requirements for a Responsible Management Entity (RME). The RME is responsible for system performance and compliance with the regulating agency's requirements. This process of Management Category classification is not intended to guide the level of treatment necessary for ONWS, but can help both the regulating agency and the RME understand the ownership, complexity, and risk of ONWS.

The Management Category classification is based on the proposed usage characteristics of the ONWS, the number of people it is likely to serve, the complexity of the treatment process, and the likelihood of exposure to human pathogens. As an example, an ONWS classified as low risk has few users, and simple operating processes. For this category, minimal regulatory oversight is required and the regulatory agency's role is to provide education to the RME and issue the permit to operate.

Table 5

Risk Control and Accountability Matrix for the Risk-Based Management Categories

Management Category		
1	**2**	**3**
Low	**Risk characterization**	High
Few users, no public access	**Pathogen risk**	Many users, public access
Simple devices and/or processes	**Process malfunction risk**	Complex devices and/or processes
Regulatory oversight		
System owner is fully responsible and accepts all liability for system performance. Local regulatory authority may provide owner education and registration of system as per their specific regulations.	System owner retains system responsibility and complies with local regulatory authority's additional quality control via a combination of manufacturer approval/certification, O&M manual, installation inspection, system permit, and some degree of performance monitoring.	Prequalified RME accepts all performance responsibility. Regulator qualifies the RME, issues permit, reviews performance report and certifications, performs periodic inspections, and enforces permit compliance.
RME requirements		
Private owner serves as RME and complies with regulatory authority's requirements.	Private owner as RME fully complies with local regulatory authority's requirements.	RME provides financial security, assumes full performance accountability, responsibility for permit compliance, routine reporting, and certification.

Adapted from Sharvelle et al., 2017

Table 6

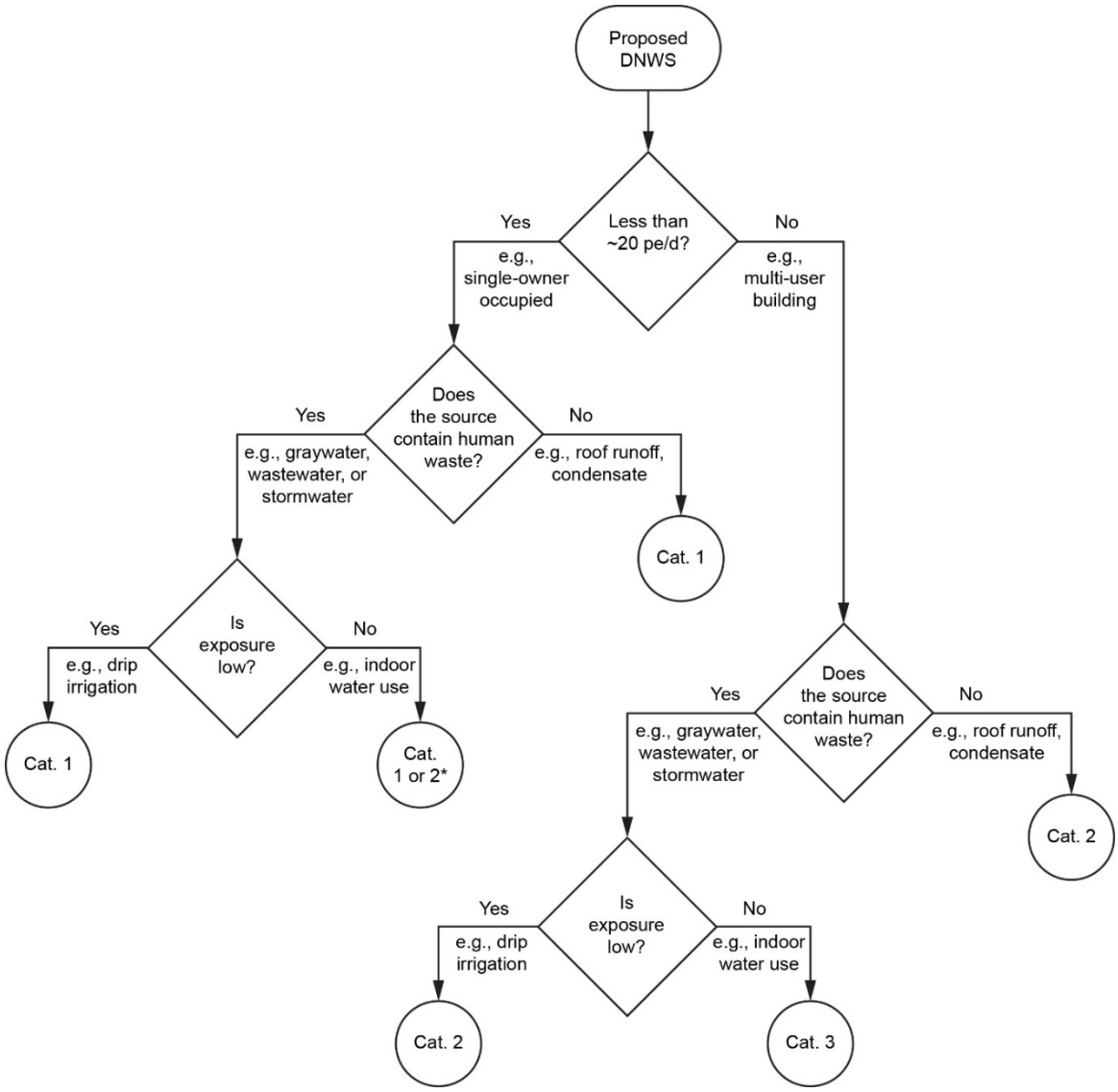
Examples of Risk-Based Considerations for Identifying the Management Category of the ONWS

Example	Number of Persons Exposed	Likelihood of Malfunction	Management Category and Considerations	Health Agency Role
Single-owner occupied system using roof runoff for irrigation	Small user base (<~20 pe/d[1])	Low—low pathogen content—simple process	Low Risk—Building owner serves as the Responsible Management Entity (RME) with full responsibility	Provides educational information to building owners and issues permit
Single-owner occupied system using graywater for toilet flushing and irrigation	Small user base (<~20 pe/d[1])	Moderate—equipment maintenance required	Low Risk—Building owner serves as RME with full responsibility	Requires manufacturer certification of equipment, operation and maintenance (O&M) manual and issues permit
Single-owner occupied system using roof runoff and treated wastewater for toilet flushing, laundry, and subsurface irrigation	Small user base (<~20 pe/d[1])	Considerable—complex equipment requires routine O&M by trained staff	Moderate Risk—Independent registered service agent provides O&M	Registers/licenses service agent, defines reporting of data and issues permit
Multi-user building with roof runoff system for irrigation	Moderate user base (20–100 pe/d[1])	Low—low pathogen content—simple process	Low Risk—Building owner or HOA serves as RME with full responsibility	Registers/licenses service agent, defines performance reporting and issues permit
Multi-user system using treated graywater for toilet flushing and irrigation	Large user base (100–1,000 pe/d[1])	Moderate—equipment and distribution system requires trained O&M staff oversight	High Risk—Qualified full service RME with financial security and routine reporting	Establishes RME qualifications, ensures financial guaranty, requires data reporting, and issues permit
District/multi-user system serving mixed uses, collecting roof runoff and treated wastewater sources for toilet flushing, laundry, cooling, and irrigation	Large user base (100–5,000 pe/d[1])	Significant—Complex process and distribution system requiring skilled O&M	High Risk—Qualified full service RME with financial security and routine reporting	Establishes RME qualifications, ensures financial guaranty, requires data reporting, and issues permit

Adapted from Sharvelle et al., 2017. "pe/d" refers to "people exposed per day."
(Single-owner occupied is defined as a stand-alone building within its own lot occupied by one group of residents.)

Figure 2

Guidance to Specify Management Category



Adapted from Sharvelle et al., 2017. ("pe/d" refers to "people exposed per day" to non-potable water. Single-owner occupied is defined as a stand-alone building within its own lot occupied by one group of residents. Multi-user building is defined as any building that is not a single residence e.g., multi-residential apartment, commercial, mixed use, and others).

*Note: some simply designed single-owner occupied indoor ONWS (e.g., graywater) could be classified as Management Category 1, while others (e.g., wastewater reuse) would be classified as Management Category 2.

Section 5.
Required Elements of Oversight and Management Programs

To ensure ONWS are designed, constructed, and operated to continuously deliver safe water to the end user, oversight and management programs should contain the following requirements listed in Table 7.

Permit Application Report (PAR) Phase

- **Project Application:** provides a basic overview of the proposed treatment of alternate water sources and non-potable end uses. The regulator may elect to charge an initial application fee to account for staff time to review each ONWS application and supporting documentation.
- **Engineering Report:** prepared by licensed engineer and provides detail on design treatment system in order to comply with LRTs listed in Table 1 and/or Table 2 (a sample engineering report is included in Appendix C). The engineering report includes, but is not limited to, continuous monitoring using the pathogenic microorganisms of concern or a microbial, chemical, or physical surrogate parameter(s) that verifies the performance of each treatment process's ability to achieve its credited log reduction (Appendix B provides examples of treatment train and continuous monitoring scenarios).
- **Responsible Management Entity (RME):** provides documentation of the person, corporation, or governmental body that owns or operates an ONWS and has ultimate legal responsibility for the performance of an ONWS.
- **Operations and Maintenance Manual:** provides comprehensive information on ONWS operation, maintenance, and repair.
- **Enforceable Legal Agreement (for district-scale ONWS):** includes an executed legally enforceable agreement for district-scale projects defining the roles and responsibilities of each property owner or entity with regard to the ONWS.

Construction Phase

- **Construction and Plumbing Permits:** includes permits such as plumbing, electrical, and encroachment obtained from the local agency authorizing construction of the ONWS.
- **Construction Certification:** verifies treatment systems were constructed per approved engineering reports. In the event the ONWS differs from an approved Engineering Report, a revised Engineering Report is submitted for approval.
- **Cross-Connection Control Test:** confirms no cross-connection between potable water supply and non-potable systems. Cross-connection control tests are performed during ONWS startup and may be required periodically during operation in accordance with local and/or state plumbing codes and regulations.

Table 7
Requirements of an Oversight and Management Program for ONWS

Permit Application Report	Construction	Operation
• Project Application • Engineering Report • Responsible Management Entity (RME) • Operations and Maintenance Manual • Enforceable Legal Agreement (for district-scale ONWS)	• Construction and Plumbing Permits • Construction Certification • Cross-Connection Control Test • Treatment System Manager Capacity • Proof of Contract with Certified Laboratory • Initial System Startup • Permit to Operate	• Monitoring • Reporting • Record-keeping • Enforcement and Penalties

- **Treatment System Manager Capacity:** consists of a signed affidavit or other documentation that ensures the operator possesses the knowledge, skills, abilities, and training to properly operate the ONWS.

- **Proof of Contract with Certified Laboratory:** consists of verification of contractual arrangement with a laboratory certified to perform water quality analysis.

- **Initial System Start-up:** demonstrates via technology validation and field verification that the treatment processes are capable of achieving a certain amount of pathogen removal and/or inactivation. Results are reported to the local or state agency, when applicable.

- **Permit to Operate:** provides approval to operate an ONWS. Local or state agencies may consider issuing a conditional permit during ONWS start-up and then a final permit once the system has been conditioned. Local or state agencies may also elect to charge an annual license fee to account for staff time to review applicable ongoing ONWS reporting documentation.

Operating Phase

- **Monitoring:** establishes the protocol and schedule for ensuring that regular water quality sampling is conducted, where applicable.

- **Reporting:** sets a schedule for providing ongoing documentation certifying that the ONWS is protective of public health, including reporting on continuous monitoring, annual reporting, malfunction reporting, and notification of change in property ownership.

- **Recordkeeping:** provides records on premises for inspection, including (1) current permit; (2) current treatment system operations and maintenance manual; (3) signed results delivered by the certified laboratory and evidence of chain of custody; (4) continuous monitoring reporting; (5) annual reports; (6) notifications as described in Section 10; (7) a log of calibrations, maintenance, and major changes in operation; and (8) a log of system auto-generated alarms, causes, and corrective actions.

- **Enforcement and Penalties:** establishes protocol for enforcement of rules, such as inspection and notices of violation, suspension and revocation of permits, violations and administrative penalties, and appeal processes.

Section 6.
Model Regulation, Ordinance, and Program Rules

Onsite Non-potable Water System Programs can be developed and implemented through regulation at the state level, an ordinance at the local level, or a combination of the two. Pathways to implementation may look like:

- **States Develop Regulation, Local Authority Implements:** States establish regulation for the treatment, monitoring, and reporting requirements for ONWS. Local authorities establish oversight and management programs by adopting a local ordinance and accompanying rules.
- **States Develop Regulation and Implements:** States establish regulation for the treatment, monitoring, and reporting requirements for ONWS as well as provide oversight and management of ONWS.
- **Local Authority Develops Regulation and Implements:** Local authorities establish a local ordinance to regulate the treatment, monitoring, and reporting requirements for ONWS as well as provide all regulatory oversight.

The appropriate implementation structure will depend on the particular circumstances in each state and locality. The model state regulation and local ordinance that accompany this guidebook are based on the approach that the state develops the regulation and the local authority implements the oversight and management program that complies with the state regulation. However, it should be noted that the local ordinance can also stand alone as sufficient regulation in the absence of a state regulation. At the time of this publication, San Francisco, CA is the only jurisdiction that has developed and implemented a local ordinance to regulate ONWS.

The model program rules that accompany this guidebook should be established alongside a state regulation or local ordinance. The model program rules serve as templates for regulators to modify and adapt to fit the needs of their communities, allowing regulators the flexibility to modify their programs over time. The model program rules provide specific details on implementation of an ONWS program, including ONWS treatment system design criteria, permitting, cross-connection control, reporting, notification, and enforcement procedures for ONWS.

The model state regulation, model local ordinance, and model program rules can be downloaded and amended to fit local needs. To download these templates, visit www.uswateralliance.org/initiatives/commission.

www.uswateralliance.org
@WaterAlliance

www.werf.org
@WERFresearch

www.waterrf.org
@WaterRF