

Regulatory Pathways to Net Zero Water: Guidance for Innovative Water Projects in Seattle

Phase II Summary Report
February 2011



TABLE OF CONTENTS

INTRODUCTION	3
Purpose	3
Audience.....	3
Background	4
Process	5
LIVING BUILDING CHALLENGE: Net Zero Water and Ecological Water Flow.....	7
CODES AND REGULATIONS RELATED TO NET ZERO WATER	12
Water Supply: Rainwater Harvesting for Potable Use	12
Greywater Reuse	17
On-Site Wastewater Treatment	19
FUTURE RESEARCH.....	22
WORKSHOP PARTICIPANTS	23
CASE STUDIES	24
Cascadia Center for Sustainable Design and Construction	24
Bertschi School: Living Science Building	26
GLOSSARY	28

INTRODUCTION

the City of Seattle to identify regulatory pathways for Seattle-area projects pursuing net zero water strategies. Net zero water projects are described as those that operate solely within the water budget of their site on an annual basis, meeting all water needs from on-site sources and managing all wastewater and stormwater on-site. Building on the Seattle City Council's 2009 Living Building Pilot Program Ordinance (#123206), this effort brought together public agencies and water utilities at the local and state levels to discuss current codes and gain a shared understanding of regulatory authority, technical viability, and financial costs for building scale water systems. One of the outcomes of that process is this report, which describes obstacles present within current codes, identifies possible alternative pathways for projects seeking approvals, and provides guidance to design teams pursuing the goals of the Living Building ChallengeSM.

This report is not intended to endorse one approach over another as the appropriate scale for managing water resources in Seattle— from larger scale centralized systems to building scale decentralized systems. Instead, it is expected that the initial findings from this process will be used to refine and improve upon a collective understanding of the regulatory implications of Living Buildings and their financial, operational and managerial considerations. In addition, it is expected that the process of designing, permitting, constructing, operating and maintaining Living Buildings developed through the Pilot Program will be an essential part of future discussions.

While the efforts of this project are specific to the City of Seattle, it is intended to serve as a model for other jurisdictions around Washington State and to support the evolution of policies and programs at the national level.

AUDIENCE

Pathways to Net Zero Water is a resource for design teams as well as local and state agencies responsible for approval of water systems. Primary audiences include:

- Water, stormwater and wastewater utilities
- Local and state public health agencies
- Local planning and building permit departments
- Long range planners
- Policy makers
- Environmental agencies
- Building owners and developers
- Architects, engineers and contractors

BACKGROUND

Throughout the United States and globally, communities are facing significant water-related challenges. Water supply and wastewater treatment infrastructure—most of which was designed and built in the early 20th century—is continuing to age and is in need of major overhauls and repair. Each year, surface water and groundwater resources are degraded by combined sewage and stormwater overflows, creating financial burdens for water utilities and their customers. According to the 2009 American Society of Civil Engineers Report Card on our nation’s water and wastewater infrastructure, over \$255 billion is needed to upgrade these systems over the next 5 years.

With growing awareness around these and other challenges, sustainable water use programs, policies and regulations are beginning to emerge. Conventional practices for supplying water have been modified to include extensive demand management programs focused on conserving potable water in residential, commercial and industrial sectors. Likewise, conventional practices for managing stormwater have been augmented by “green infrastructure” approaches that attempt to mimic natural processes such as infiltration, storage and evaporation. More recently, there has been a growing interest in green building standards, such as the Living Building Challenge, that promote on-site water capture and treatment approaches to reduce the need for conveyance to and from centralized facilities. Emerging building and neighborhood scale technologies need to be piloted in order to learn about how they work and their effectiveness in managing water resources. Additional research and analysis is also needed to evaluate how these approaches can complement and be integrated with existing water infrastructure systems to enhance overall resiliency.

SEATTLE LIVING BUILDING PILOT PROGRAM

In December 2009 the Department of Planning and Development launched a pilot program to assist building owners in meeting the requirements of the Living Building Challenge. The Pilot Program allows flexibility in the application of development standards to accommodate innovative technologies or design approaches that might otherwise be discouraged or prohibited.

www.seattle.gov/dpd/GreenBuilding/

Local Context

The Pacific Northwest, with its historic abundance of fresh water, will also face challenges with respect to climate change. Current climate change projections indicate wetter winters and drier summers for the Puget Sound region. These projections reinforce the importance of sustaining aggressive water conservation programs as well as supporting robust stormwater management strategies to reduce sewer overflows and to manage peak winter storm events.

Seattle residents are served by Seattle Public Utilities (SPU) for water supply and King County’s regional utility for wastewater treatment services. Drinking water is sourced from two rivers that originate in the central Cascade mountains. Because of SPU’s aggressive water conservation efforts over the last 30 years, demand for potable water has declined despite a growing population.

Looking forward, participants in the Seattle water supply system have agreed to pursue an additional 15 million gallons per day in water savings through 2030, which is an important aspect of Seattle's climate adaptation strategy.

The City of Seattle actively promotes green building practices and has developed policies and incentives that support water resource protection. For example, the City recently adopted new stormwater codes that require low impact development techniques. Seattle also secured a water right for rainwater harvesting, provides permitting guidance for rainwater harvesting systems and offers rebates and technical assistance for water conservation efforts.

In December 2009, Seattle established a Living Building Pilot Program Ordinance to assist developers seeking to meet the advanced sustainability standards set by the International Living Building Institute's Living Building Challenge . The ordinance identified three purposes for the Pilot Program: 1) stimulate development that meets the goals of the Living Building Challenge and City of Seattle design guidelines; 2) encourage development that will serve as a model for other projects throughout the City and region; and 3) identify barriers to Living Buildings in current codes and processes. The Pilot Program is limited to a period of three years, 2010 through 2012, and a maximum of twelve projects.

In light of these and other efforts, there remain a number of obstacles for Seattle projects that seek net zero water goals — that is, projects seeking to operate within the water budget of their sites by utilizing closed-loop systems that meet human needs while protecting the surrounding ecosystem. As more Seattle-area projects pursue the Living Building Challenge, there is a growing need to clarify the codes and regulations around on-site water management systems, identify regulatory authority and possible obstacles or gaps in the approval process, and learn about the financial and operational performance of buildings constructed through the Pilot Program.

PROCESS

Between December 2009 and October 2010, Cascadia convened a series of three workshops that brought together key staff from the City of Seattle Department of Planning and Development (DPD), Seattle Public Utilities (SPU), King County Wastewater Treatment Division (KC WTD), Seattle/King County Department of Public Health, Washington Department of Ecology (WA DOE) and Washington Department of Health (WA DOH). The Cascadia Center for Sustainable Design and Construction, a Living Building pilot project currently in the design and early permitting phase, served as the case study for exploring pathways for approval of net zero water buildings in Seattle (see case study on page 24).

Attendance at the workshops was limited to regulators, water and wastewater utility representatives, and key members of the Cascadia Center's project team. The primary objective of the workshops was to identify the city, county and state water use, reuse and treatment regulations relevant to a commercial or mixed-use project within the City of Seattle. The Cascadia Center for Sustainable Design and Construction was used as the platform for the discussion, allowing participants to discuss the regulatory pathways the project may seek for approval of its innovative water systems. It was acknowledged that obstacles within the current regulations may be outside the control of the local or state authorities responsible for implementing them and that some solutions will require broader policy changes through legislative efforts.

The workshops were not intended as a forum for any one group to advocate their specific positions on or changes to existing codes and regulations. Rather, the intended outcome was a shared understanding by each agency of the regulations that exist at the various jurisdictional levels and where conflicts or gaps present potential barriers for net zero water projects.

As part of laying the groundwork for discussion, the group agreed on the following shared goals and assumptions:

- All parties are committed to protecting public health and safety. Any solution to addressing current obstacles to net zero water projects must meet or exceed the intent of current regulations in place to protect public health.
- All parties are committed to a sustainable future with respect to our water resources. Solutions must support long-term resiliency of our water systems and address risks from an economic, environmental and social perspective.
- Pilot projects, such as the Cascadia Center for Sustainable Design and Construction, serve as important models for future sustainable development practices in Seattle.

The following sections summarize the findings, potential barriers encountered by project teams, and recommendations and/or opportunities for creating regulatory pathways for net zero water projects in the future.

LIVING BUILDING CHALLENGE: NET ZERO WATER AND ECOLOGICAL WATER FLOW

To frame the exploration of regulatory pathways to achieving net zero water, the standards defined by the Living Building Challenge were chosen because they set high performance goals for water use and discharge. The Living Building Challenge, launched in 2006 and operated by the International Living Building Institute, is a benchmarking standard and certification program that defines the most advanced measures of sustainability in the built environment available today. The Living Building Challenge applies to building and renovation projects at all scales, including infrastructure projects, and is intended as a tool for transforming the way the built environment is conceived, designed and constructed. Additionally, it serves as an advocacy tool, providing a platform for design teams and regulatory agencies to define codes and policies to support more sustainable development practices.



**LIVING
BUILDING
CHALLENGE™**

The Living Building Challenge is comprised of seven performance areas, or 'Petals': site, water, energy, health, materials, equity and beauty. Petals are subdivided into a total of twenty Imperatives, or mandatory requirements. The intent of the Water Petal is to realign how people use water, to redefine 'waste' in the built environment, and to ensure that water is respected as a precious resource.

There are two requirements of the Living Building Challenge Water Petal:

Imperative 5: Net Zero Water

One hundred percent of occupants' water use must come from captured precipitation or closed loop water systems that account for downstream ecosystem impact and that are appropriately purified without the use of chemicals.

Imperative 6: Ecological Water Flow

One hundred percent of stormwater and building water discharge must be managed on-site to feed the project's internal water demands or released onto adjacent sites for management through acceptable natural time-scale surface flow, groundwater recharge, agricultural use or adjacent building needs.

Building and development projects seeking to meet these imperatives are fundamentally different from conventional projects in their approach to sourcing water, using and re-using water in both interior and exterior applications, and treating water prior to outflow off the building site or into the environment.



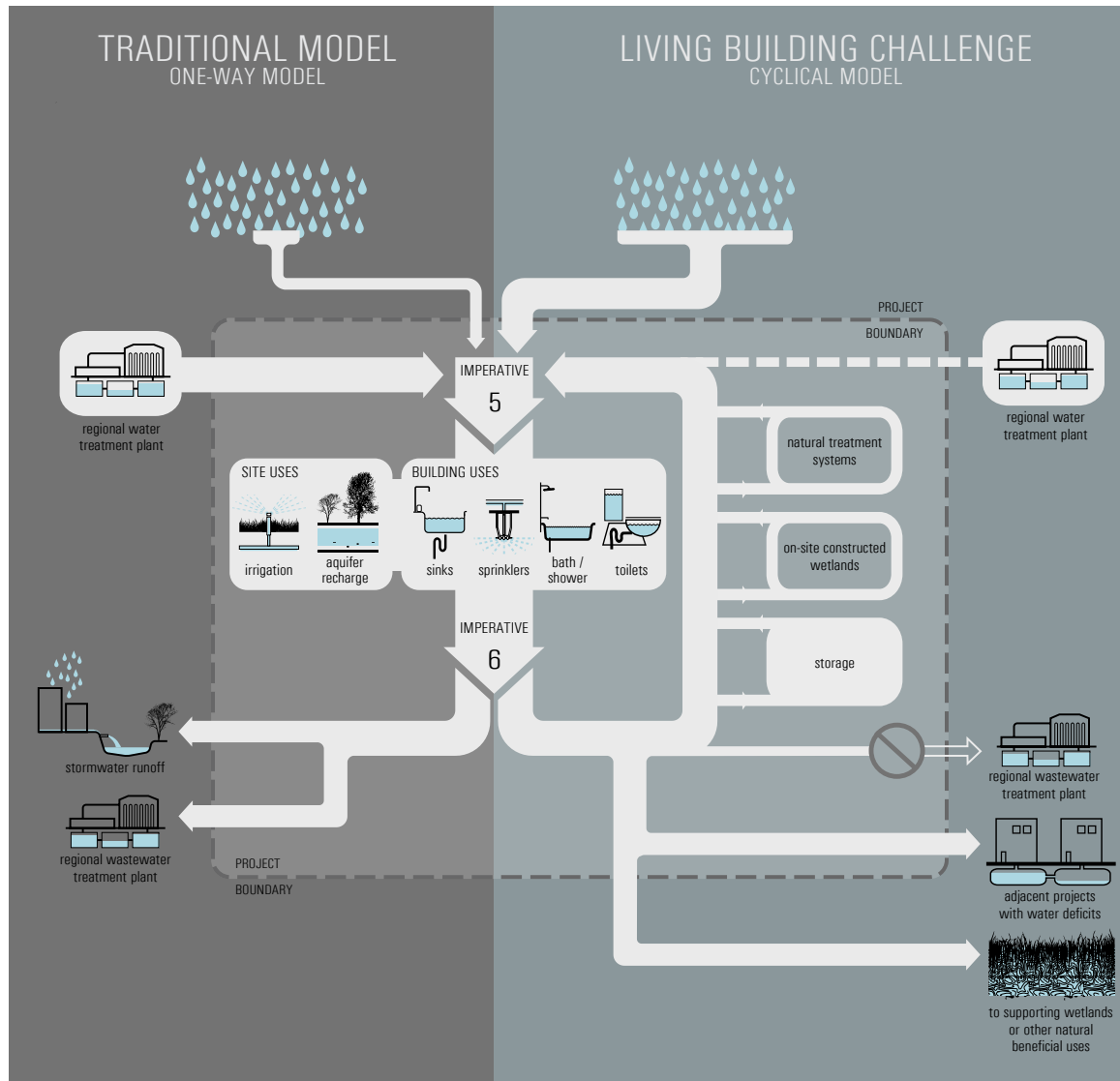
The first two certified Living Buildings in the United States, The Omega Center for Sustainable Living in Rhinebeck, NY (above left) and Tyson Research Center’s Living Learning Center in Eureka, MO (above right) utilize different strategies to manage water and waste on-site. The Omega Center collects wastewater from the surrounding campus and treats it on-site through an eco-machine and constructed wetlands. Tyson’s potable water is provided by a chemical-free rainwater harvesting system. The project includes composting toilets and a sub-surface constructed wetland to treat greywater. Images courtesy of BNIM Architects and Clivus Multrum.

Figure 1 on the following page demonstrates these differences. Traditional models rely solely on regional potable water supply for all water uses and regional facilities for treatment of all stormwater and wastewater leaving a project site. In contrast, Living Building projects seeking net zero water and ecological water flow goals source their water through rooftop harvested precipitation, groundwater, surface water, stormwater, and/or on-site reclaimed water sources.

Regionally supplied water is allowed only for potable supply to sinks, faucets and showers where local health regulations require it, and only if an appeal has first been filed to the appropriate agency. However, it is not permitted for any other use including irrigation, toilet flushing and equipment.

Figure 2 shows possible design paths to meet the requirements of the Living Building Challenge. Design teams often utilize two different methodologies in their approach to net zero water strategies, either a treatment and reuse route or a waterless/composting fixture route. The

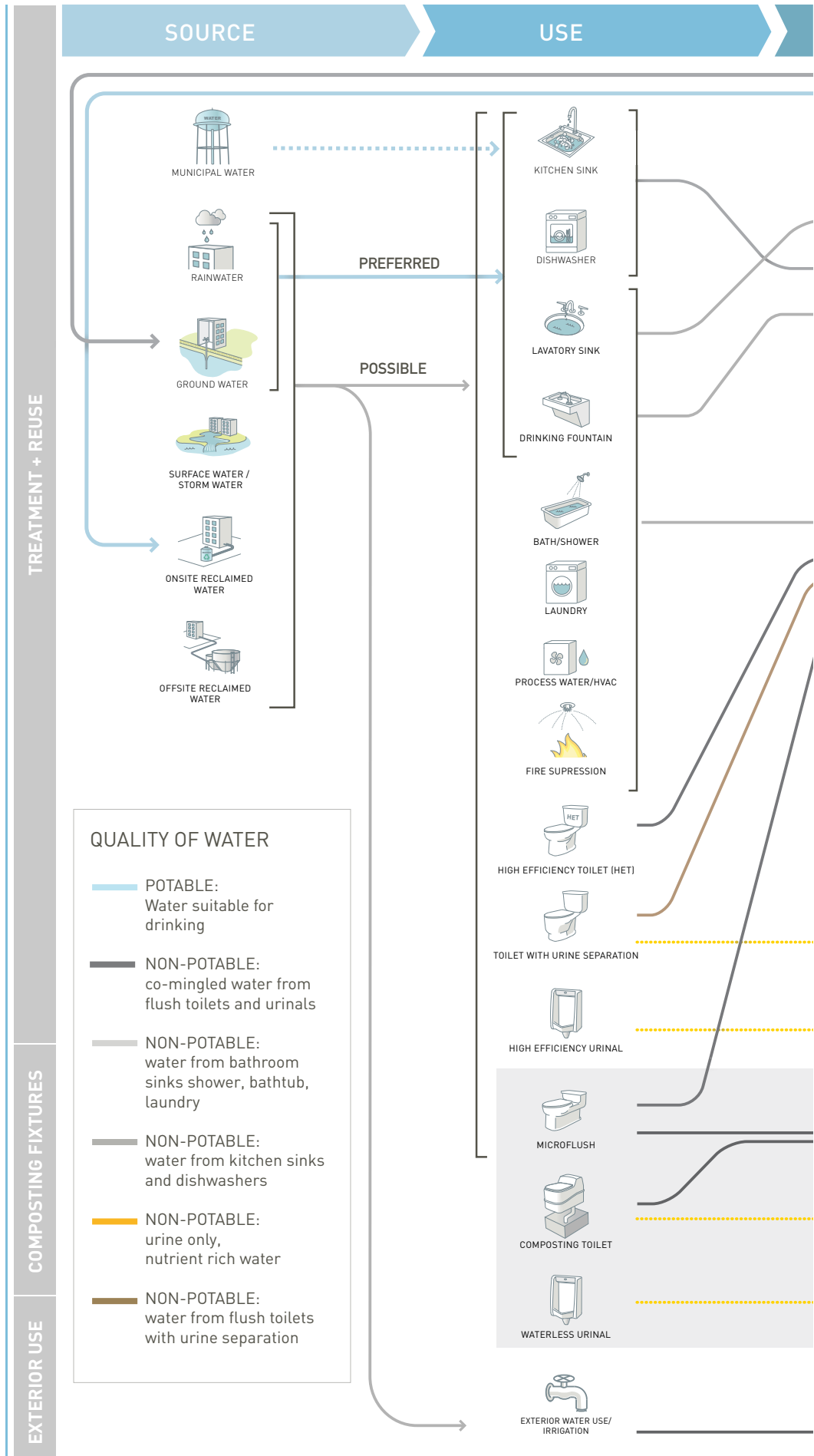
FIGURE 1. TRADITIONAL VERSUS CLOSED LOOP WATER SYSTEMS

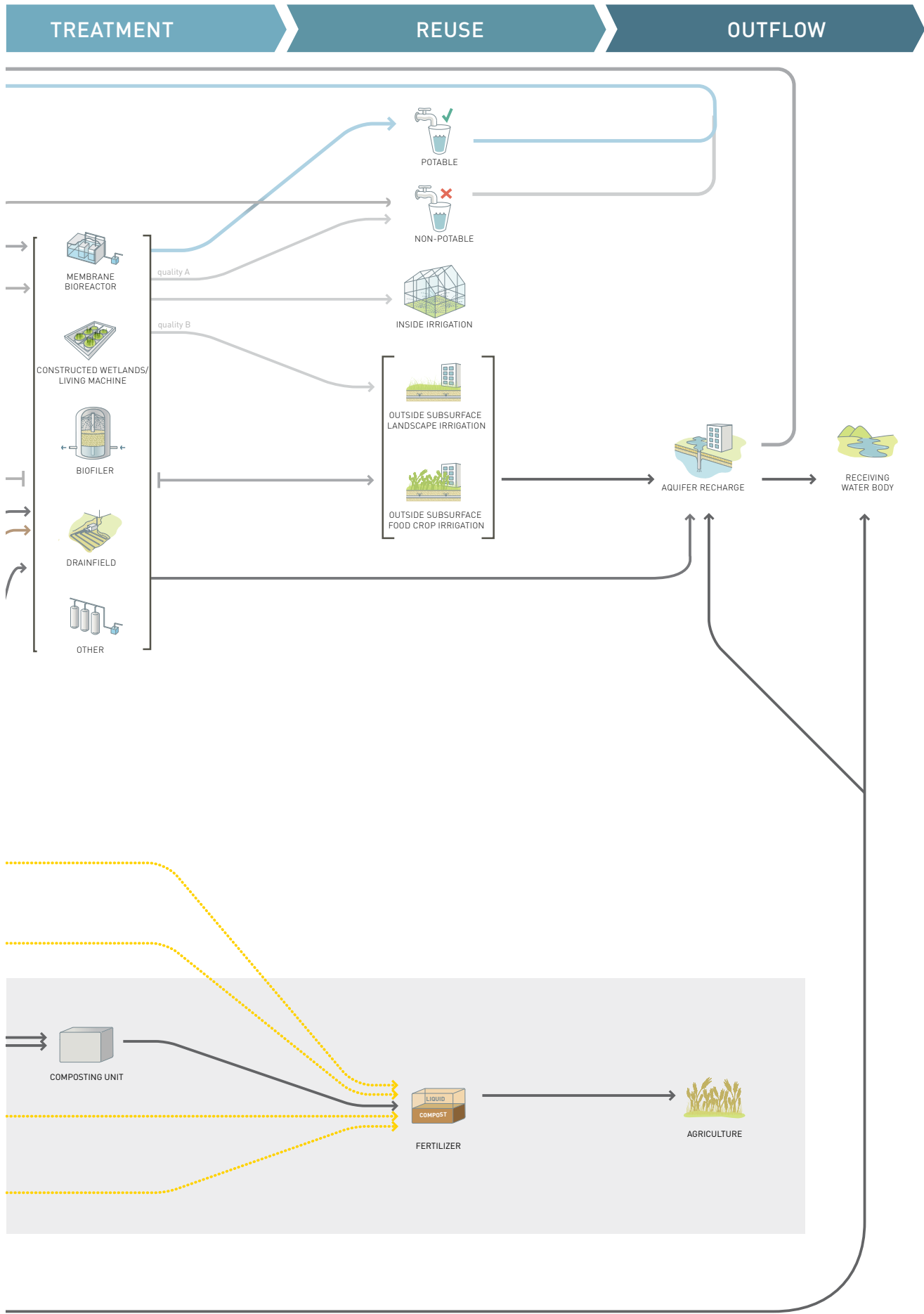


Living Building Challenge projects utilize closed-loop water systems, sourcing water through captured precipitation and other onsite methods. Water is treated for reuse, onsite discharge or routed to adjacent sites for beneficial use. Image courtesy of The Miller Hull Partnership, LLC.

former utilizes storage and treatment systems to collect water from its point of use and to process it to a level of treatment appropriate for its reuse application or prior to discharge. The latter route seeks to minimize water demand and the need for on-site treatment by utilizing waterless and composting fixtures for toilets and urinals. This route provides opportunities to reclaim nutrients otherwise diluted by water and offers a variety of ways in which the remaining greywater can be reused on-site, with or without treatment. The most appropriate pathway for any Living Building project is contingent upon careful analysis and investigation of climate, site conditions, building occupancy and use.

FIGURE 2. DESIGN PATHWAYS TO NET ZERO WATER





CODES AND REGULATIONS RELATED TO NET ZERO WATER

WATER SUPPLY: RAINWATER HARVESTING FOR POTABLE USE

CURRENT CODES

Regulations		Comments
Seattle / King County Board of Health Code (BOH)		
12.32.010	Requires connection to an existing public water supply	BOH 12.36.010 Conditions for a waiver: not to conflict with WAC and Federal Safe Drinking Water Act.
Washington Administrative Code (WAC)		
246-290	Group A Public Water System Regulations	Includes initial design, ongoing operational, monitoring and response requirements for larger systems. Also reflects Federal Safe Drinking Water Act requirements.
246-291	Group B Public Water System Regulations	Requirements for smaller public systems. King County does not have a Group B water program.
246-292	Water Works Operator Certification	Water Works Operator Certification Certified operator must be in charge of day-to-day operations.
246-293	Water System Coordination Act	Applies to most of King County, outside of the City of Seattle.
246-295	Satellite System Management Agency	
Code of Federal Regulations (CFR)		
Title 40 Parts 141 and 143	Federal Safe Drinking Water Act Requirements	Group A water systems must comply with Federal drinking water laws and are subject to regulation by EPA.

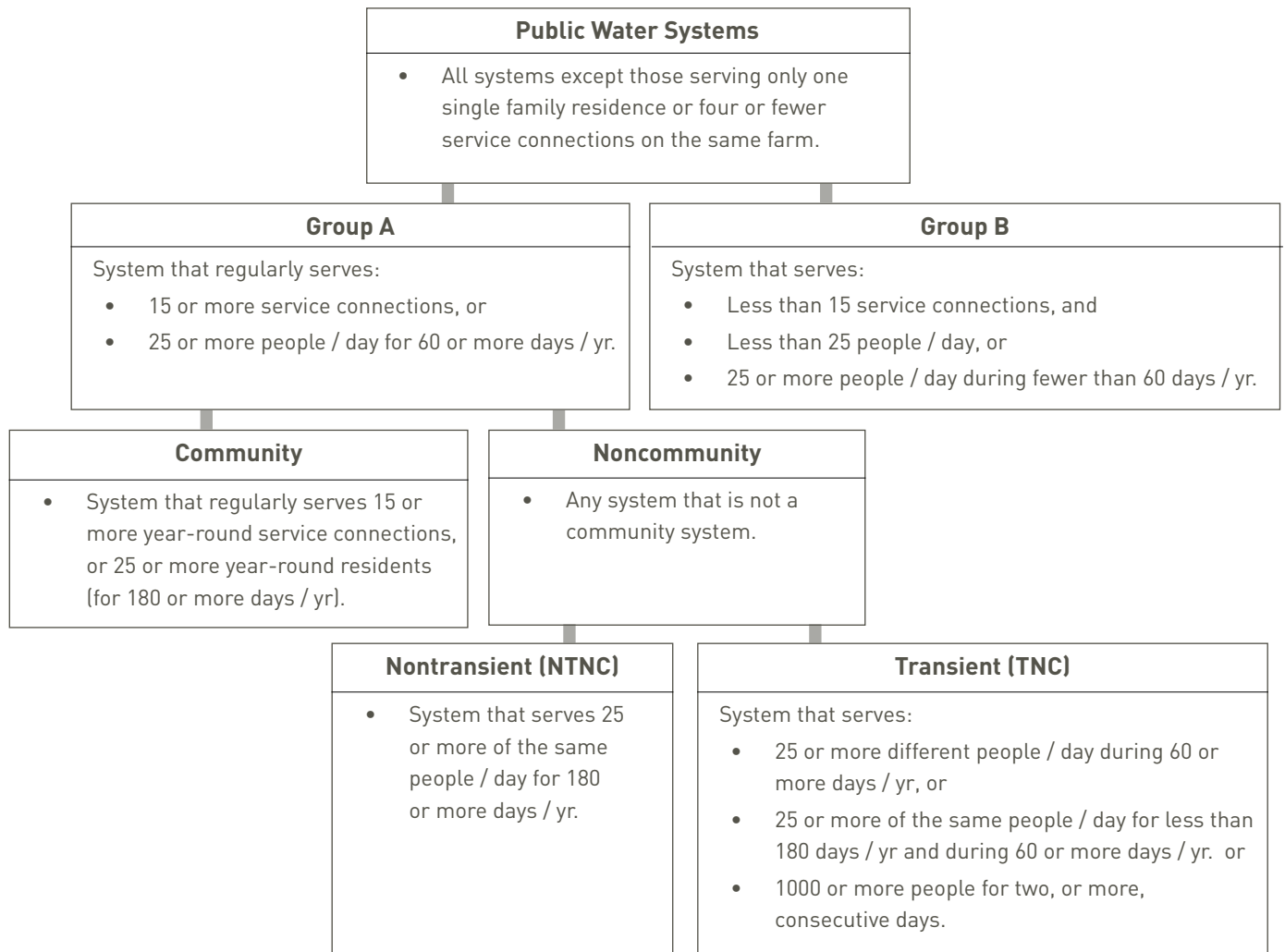
FINDINGS

For commercial and multifamily buildings seeking to meet potable water needs through captured precipitation, regulatory authority lies with the Washington State Department of Health (WA DOH). Currently, these types of systems are permitted as a new public water supply and fall under

the state’s regulations for Group A or Group B water systems depending on their size. Group A systems are those that have 15 or more service connections or serve 25 or more people per day. Group B water systems serve fewer than 15 connections and fewer than 25 people per day.

Group A water systems are subject to federal, state and local regulations related to safe drinking water. For a new Group A public water supply system proposed within the service area of an existing Group A system, WA DOH requires the concurrence of the local water utility as a condition of approval. Under Group A regulations, a certified operator is required for daily operations including monitoring and reporting, and for maintaining a continual safe drinking water supply. In addition, any local ordinances pertaining to drinking water standards must also be met, such as Seattle’s requirement for fluoridation of water supply.

FIGURE 3. PUBLIC WATER SUPPLY SYSTEMS IN WASHINGTON STATE



RAINWATER FOR POTABLE USE APPROVED FOR RESIDENTIAL BUILDINGS

While outside the scope of this effort, Seattle/King County Public Health recently defined standards for residents of detached single family dwellings and townhomes choosing to harvest rainwater for potable uses on their properties. The provisions are spelled out in Health Document Code Method #10-004. Rainwater treated for potable purposes is only permitted for use within the dwelling unit from which it is captured and it cannot be the sole source of water supply to the home.

While existing Group A drinking water regulations do allow rainwater as a source of supply, these types of systems are generally not approved for smaller Group B systems. Because of the potential for contamination by animals and wind-borne agents, WA DOH classifies rainwater capture systems as a surface water source subject to standard surface water treatment requirements. Treatment requirements include filtration, continuous disinfection and a chlorine residual at the entrance to the distribution system.

BARRIERS

Current regulations for new public water supply systems are not intended for building scale systems within areas that already have a public water supply available. As such, building owners seeking approval to create a new public water supply will likely encounter regulatory requirements and financial obstacles. Building owners also take on much greater liability and risk associated with maintaining and operating the water system. The eight major steps necessary for approval of a new proposed Group A water system are outlined in the text box on the next page.

Projects pursuing the Living Building Challenge must purify captured precipitation without the use of chemicals, posing debate around the federal and state treatment regulations that require chlorine disinfection. For a rainwater harvesting system supplying potable water to a building, an appeal to the state board of health would be necessary for approval of an alternative disinfection method. However, current regulations do not allow any variances for the surface water treatment requirement. Additionally, there is no precedent for such an appeal and state regulators are reluctant to advocate for one, stating that there is an absence of compelling factors.

Currently, the pathway identified for approving a building scale potable rainwater harvesting system in Seattle involve their installation solely as a redundant system to the existing public water supply. One Living Building project under construction in the City has elected to install but not hook up the necessary rainwater harvesting infrastructure for potable use in anticipation of future regulatory changes.

Washington State Department of Health has identified additional barriers or issues that merit further discussion. These include:

- Issues associated with creating new water supply systems inside the service area of existing water systems including the rationale for new systems, the selection of source and treatment alternatives and the State's interest in reducing the proliferation of new supply systems;
- Identification by a building owner of the cost of operating and maintaining on-site systems over an extended period of time; and
- The conflict between the Living Building Challenge prohibition of using chemicals for water treatment and federal requirements (enforced by state agencies) for the use of chlorine in Group A water systems.

OPPORTUNITIES + RECOMMENDATIONS

Alternative Pathways for Disinfection

Based on feedback and discussion at the workshops, the need for finding common ground at the local and state level on the rationale behind the Living Building Challenge requirements for treatment without the use of chlorine was clear. Opportunities exist for public agencies and the design community to work collaboratively on identifying acceptable alternatives that meet or exceed public health protection as prescribed in current codes.

During the process of convening regulatory agencies, two recommendations emerged on possible pathways for re-classification of rainwater as a potable supply source at the building scale.

First, it was identified that the quality of rooftop-harvested rainwater may be quite different from other surface water sources for which the current regulations are intended to address. Re-classification of rainwater as a new supply source by WA DOH is one option for addressing regulatory obstacles to using chlorine disinfection, potentially allowing for new definitions of acceptable disinfection methods for these types of systems.

APPROVAL OF NEW GROUP A WATER SYSTEMS

The following is a list of the major steps for approval of a new Group A water system:

1. Preliminary meeting with WA DOH to define submittal requirements and review roles and responsibilities.
2. Request to Seattle Public Utilities for approval of a new Group A water system within their service area.
3. Submit planning and project engineering documents for WA DOH review and approval. Include justification for creation of new system.
4. Project report review and approval by WA DOH.
5. Submit construction documents/drawings and specifications for WA DOH approval.
6. Construct water system.
7. Once certified, begin water system operation in accordance with operations and management program.
8. Conduct daily operations including reporting to State.

Second, the intent of the regulations is to maintain public health by disinfecting water prior to entering the distribution system and before it comes into contact with the public. When the “distribution system” is merely the plumbing within the building as opposed to large-scale conveyance of municipal water supply, there may be a possibility of re-defining disinfection requirements for building scale systems. Under current regulations, a building scale potable rainwater harvesting system must add chlorine disinfection after leaving the cistern and before entering the interior plumbing lines within the building where it can then be removed through carbon filters at the tap. Opportunities exist to work at the state and federal levels to evaluate alternative disinfection methods for water systems at this scale that may have a lower environmental impact than chlorine. Regardless of the disinfection method proposed, any alternative would need to meet or exceed current public safety standards outlined by the federal regulations.

Operating Entity

At this time, the net zero water system would need to be operated and maintained by a satellite water operations company. Seattle Public Utilities does not operate or provide monitoring services for small-scale Group A water systems within their service provider area. Future opportunities may exist for other entities to provide these services for a fee to building owners.

Pilot Projects

Due to the number of challenges a project may encounter around alternative supply sources, local and state agencies might consider establishing a formal pilot program to define alternative pathways for permitting net zero water projects that meet existing code for potable water. Seattle’s existing Living Building Pilot Program provides an excellent model for establishing political and regulatory support for innovative projects.

GREYWATER REUSE

CURRENT CODES

Regulations		Comments
Uniform Plumbing Code (UPC)		
Chapter 601 and 305.1	Requires potable water to fixtures and connection to public or private sewer	Requires administrative ruling for alternatives
Chapter 16	Graywater Systems	Adopted by WA state
Washington Administrative Code (WAC)		
173-219	Reclaimed Water Use	Draft Department of Ecology Regulations
246-274	Greywater Reuse for Seasonal Subsurface Irrigation	Allows greywater reuse up to 3,500 gallons per day for subsurface irrigation only. A local health jurisdiction must first adopt a program to regulate greywater uses.

FINDINGS

Greywater reuse systems vary widely in their design and discharge applications. There are different ways in which greywater systems are permitted currently and will be permitted in the near future as new draft regulations are adopted.

Residential and commercial scale systems that collect light greywater for reuse inside buildings AND have a traditional discharge connection to a sewer are permitted at the local level through Seattle/King County Public Health. Currently, Public Health utilizes the alternate methods and materials provisions in Chapter 3 of the Uniform Plumbing to approve the reuse of greywater for non-potable purposes. Projects permitted in Seattle are unique in that the City's plumbing and the County's on-site wastewater treatment programs are housed in the same agency and therefore can coordinate on these types of project approvals.

Chapter 16 of the 2009 Uniform Plumbing Code, which has been adopted by Washington State, defines standards for greywater to be reused as toilet and urinal flushing and for other uses. Testing requirements are also identified in the code. In addition, the International Association of Plumbing and Mechanical Officials (IAPMO) new "green supplement" provides provisions for greywater reuse, as will the forthcoming International Code Council's new International Green Construction Code (IgCC).

At the state level, two important rules are under development with respect to how greywater systems may be permitted in the future. WA DOH has developed new greywater regulations for seasonal exterior subsurface irrigation for both residential and commercial buildings.

The new rules have just recently been adopted and will take effect on July 31, 2011.

WAC 173-219, also under development, will provide new regulations for reclaimed water in Washington State. While these regulations are not specifically written for the reclamation and reuse of on-site greywater, state officials indicated that they may provide the pathways for approval of on-site systems that fall outside the regulatory authority of local public health departments. According to the Department of Ecology, concerns raised by stakeholders during the comment period has delayed the filing of the draft reclaimed water rule, which was originally scheduled for adoption at the end of 2010.

BARRIERS

Where greywater will be routed outside the building at the commercial scale, it is currently undefined whether projects will be permitted at the local level under the greywater regulations stated above or the new WA DOH reclaimed water regulations. As both of these are still under development, larger net zero water projects such as the Cascadia Center for Sustainable Design and Construction will be permitted through WA DOH as a Large On-Site Sewage Systems (see the following Wastewater section for applicable codes) in the interim.

OPPORTUNITIES + RECOMMENDATIONS

Provisions for Greywater Reuse Inside Buildings

A number of opportunities exist for greywater reuse in buildings and to develop codes and regulations that provide clear pathways for projects to pursue. Part of the challenge is the fact that there are multiple definitions of greywater since there are various qualities of greywater depending on the source. WA DOH and local health departments should clearly define greywater based on source and identify regulatory provisions for on-site greywater reuse inside commercial and residential buildings. In addition, these entities should develop clear provisions for how state and local regulations overlay UPC requirements.

As the new state regulations come online, further clarification is needed to define whether a project will be permitted under the greywater provisions at local public health departments versus the pending reclaimed water regulations through WA DOH.

ON-SITE WASTEWATER TREATMENT

CURRENT CODES

Regulations		Comments
Seattle Municipal Code (SMC)		
21w.16.040 A	Requires wastewater side sewer connection	
22.206.050 E	Requires flush-type toilets	
Seattle / King County Board of Health Code (BOH)		
13.04.050	Connection to public sewer	
13.52.020	Provisions for composting toilets	
13.52.057	Provisions for subsurface drip irrigation systems	
Washington Administrative Code (WAC)		
173-219	Reclaimed Water Use	Draft regulations
246-272 A	Sewage Technologies	Includes composting toilets
246-272 B	Large On-Site Sewage Systems	

FINDINGS

Seattle Municipal Code 21.16.040 A Subtitle 2 requires all projects within the City to have a side sewer connection. Permitting for on-site wastewater treatment is dictated by the size of the system. For on-site systems with design flows under 3,500 gallons per day, jurisdictional authority lies with Seattle King County Public Health. For larger systems, WA DOH has authority and approval over those with domestic strength design flows between 3,500 to 100,000 gallons per day. Washington State Department of Ecology permits on-site systems greater than 100,000 gallons per day.

A current list of all composting toilet models approved for use in Washington State is available at:

www.doh.wa.gov/ehp/ts/ww/ww-register.pdf

FIGURE 4. REGULATORY OVERSIGHT FOR ON-SITE WASTEWATER TREATMENT SYSTEMS

System Design Flow (gallons per day)	Jurisdiction
0 - 3,500	Local Health Officer
> 3,500 - 100,000	Washington State Department of Health
Above 100,000	Washington State Department of Ecology

Regardless of their size, on-site wastewater treatment systems in urban areas such as the Cascadia Center for Sustainable Design and Construction (which is expected to fall under 3,500 gal/day due to the use of composting toilets) would need to be permitted at the state level under WA DOH's draft water reclamation rules (WAC 173-219) as a private utility OR under the state's current regulations for Large On-Site Sewage Systems (LOSS). All projects permitted under the LOSS regulations require a management entity to provide ongoing testing and monitoring.

King County assesses capacity charges to building projects hooking up to public sewerage. King County Code 28.84.050 and 28.86.160, and RCW 35.52.570 and 36.94.140 determine annual sewer rates and capacity charges. Capacity charges are established based on the number of plumbing fixtures and are collected to finance the cost of the County's wastewater capital improvements.

BARRIERS

Existing regulations in place for on-site wastewater treatment are not applicable for projects in urban areas where a connection to a public sewer exists, presenting obstacles for net zero water projects seeking to treat all of their waste on-site. For the Cascadia Center project, the existing sewer connection is expected to remain in place and be used as a backup overflow. Similar to the issue noted in the rainwater section, the preliminary step requires an agreement between Seattle Public Utilities and the building owner/certified operator to relinquish the utility's requirement to provide primary wastewater service to the building. Likewise, DPD's requirements for flush-type toilets in SMC 22.206.050E would need to be waived.

King County Wastewater Treatment Division requires capacity charges for all sewer connections. While a project without a sewer connection would not encounter any fees from King County, there is no variance process or

APPROVAL OF GREYWATER AND COMPOSTING TOILET SYSTEMS

The following is a list of the major steps for seeking approval for a combined greywater and composting toilet system in Seattle under the state's Large On-Site Sewage System (LOSS) regulations:

1. Complete a LOSS feasibility study with soils/groundwater evaluation.
2. Pre-Design report submittal including project summary, narrative, and site conditions.
3. Pre-Design meeting with WA DOH.
4. Request to Seattle Public Utilities for approval of a LOSS wastewater system within their service area.
5. WA DOH LOSS site review approval.
6. Engineer's report submittal:
 - a. Project documents and design calculations
 - b. Plans and specifications
 - c. Operating and maintenance manual
 - d. Management entity approval
 - e. Certified operator approval
7. WA DOH engineer's report review and comments.
8. Final engineer's report submittal including any additional requested information.
9. Apply for operating permit.
10. WA DOH construction approval.
11. Final WA DOH approval/inspection.
12. WA DOH annual operating permit.

alternative rate structure from the County's capacity charges for projects seeking to install on-site wastewater treatment systems that rely on the County connection solely as a backup emergency connection.

OPPORTUNITIES + RECOMMENDATIONS

On-Site Treatment in Sewered Areas

It is recommended that the City of Seattle Department of Planning and Development (DPD) work with King County to define a variance process establishing requirements for projects seeking to install sewer connections for emergency backup use only. Requirements should include clearly documented and engineered designs that meet the intent of current codes around health and safety, insurance, management and inspection responsibilities for on-site systems, change of ownership, and how wastewater will be handled in the event of on-site system failure. Another option is to define standards that allow projects to be "sewer ready," meaning that they would provide a jacketed internal easement so that a sewer connection could be added at a later date if necessary or desired.

Sewer Fees

It is recommended that King County develop a fee structure that reflects only the need for a backup or emergency connection. King County may look for guidance from municipalities that have instituted innovative fee structures. One example is the City of Portland, which allows for emergency-only connections but charges large use fees in the event that the utility connection is needed.

FUTURE RESEARCH

During the process of this project, a number of important topics were raised that require ongoing research and further discussion.

Benefits and risks to public health and safety.

Current codes and regulations exist to safeguard human health and welfare and to ensure access and availability of clean water supply and wastewater treatment to all people. Further exploration of the benefits and risks of alternative strategies to conventional systems is needed in order to conduct comparative analyses of centralized and decentralized approaches. Opportunities exist for regulatory agencies, utilities, research groups and trade associations to evaluate risks to public health and safety beyond what is currently mandated by codes, including risks associated with climate change, resource depletion, and pollution prevention.

Life cycle cost analysis of net zero water strategies.

Further research is needed to assess the full costs and benefits of on-site systems to determine their economic feasibility for building owners. Consideration for an on-site system's increased costs associated with ongoing operations and maintenance as well as potential increased operating energy costs and capital costs for installation of treatment technologies and/or redundant infrastructure should be evaluated against reduced utility fees in order to fully understand the economic feasibility of these systems.

Occupant behavior around water use.

Net zero water strategies such as rainwater harvesting and greywater reuse systems demand a higher level of occupant attention and ongoing maintenance. Further research is needed to determine how occupant behavior, especially through change of a building's ownership, affects the performance of on-site water systems and how this is addressed on an on-going basis in the permitting of Living Building projects.

Quality and level of wastewater treatment in municipal systems versus on-site systems.

Further research is needed to evaluate the effectiveness and efficiency of achieving higher levels of water quality through on-site treatment systems, and for addressing public health risks such as contamination and pollution at both scales.

Appropriate scale for alternative water supply systems in Seattle.

A number of questions arose around the appropriate scale for Living Building water systems given that Seattle is fortunate to have a primarily gravity-fed and, at present, a resilient source of water supply. Further analysis beyond the scope of this effort is needed to evaluate environmental impacts of alternative systems and the financial, operational and managerial implications for existing water management systems. In addition, research is needed to assess how Living Building systems can be integrated with existing water management systems to improve overall resiliency and economic sustainability.

WORKSHOP PARTICIPANTS

Name	Organization/Department	Title
Joel Sisolak	Cascadia Green Building Council	Advocacy and Outreach Director
Katie Spataro	Cascadia Green Building Council	Research Director
Marin Bjork	Cascadia Green Building Council	Research Manager
Peter Dobrovolny	Seattle Dept. of Planning and Development	Green Building Specialist
Kathleen Petrie	Seattle Dept. of Planning and Development	Green Codes Analyst
Joel Banslaben	Seattle Public Utilities	Sr. Sustainable Strategies Specialist, Green Building
Paul Fleming	Seattle Public Utilities	Manager, Climate & Sustainability Group
Mike Brennan	Seattle Public Utilities	Plan Review Manager
Mark Jaeger	Seattle Public Utilities	Strategic Cross Utility & Interdepartmental Coordination
Keith Hinman	Seattle Public Utilities	Planning and Portfolio Management
Larry Fay	Seattle-King County Public Health	Community Environmental Health Manager
Dave Cantrell	Seattle-King County Public Health	Chief Plumbing Inspector
Sharman Herrin	King County Wastewater Treatment Div.	Government Relations Administrator
Jessie Isreal	King County Wastewater Treatment Div.	Section Manager, Resource Recovery Section
Chris Rogers	Point 32	CEO
Margaret Sprug	The Miller Hull Partnership, LLC	Principal
Scott Wolf	The Miller Hull Partnership, LLC	Partner
Mark Buehrer	2020 ENGINEERING	Founder/Director
Colleen Mitchell	2020 ENGINEERING	Project Engineer
Kurt Unger	WA State Department of Ecology	Water Policy Analyst
Steve Deem	WA State Department of Health	Office of Drinking Water
Ginny Stern	WA State Department of Health	Environmental and Public Health Liaison
Denise Lahmann	WA State Department of Health	Supervisor, LOSS & Reclaimed Water Program
Craig Riley	WA State Department of Health	Program Lead, Water Reclamation & Reuse Program

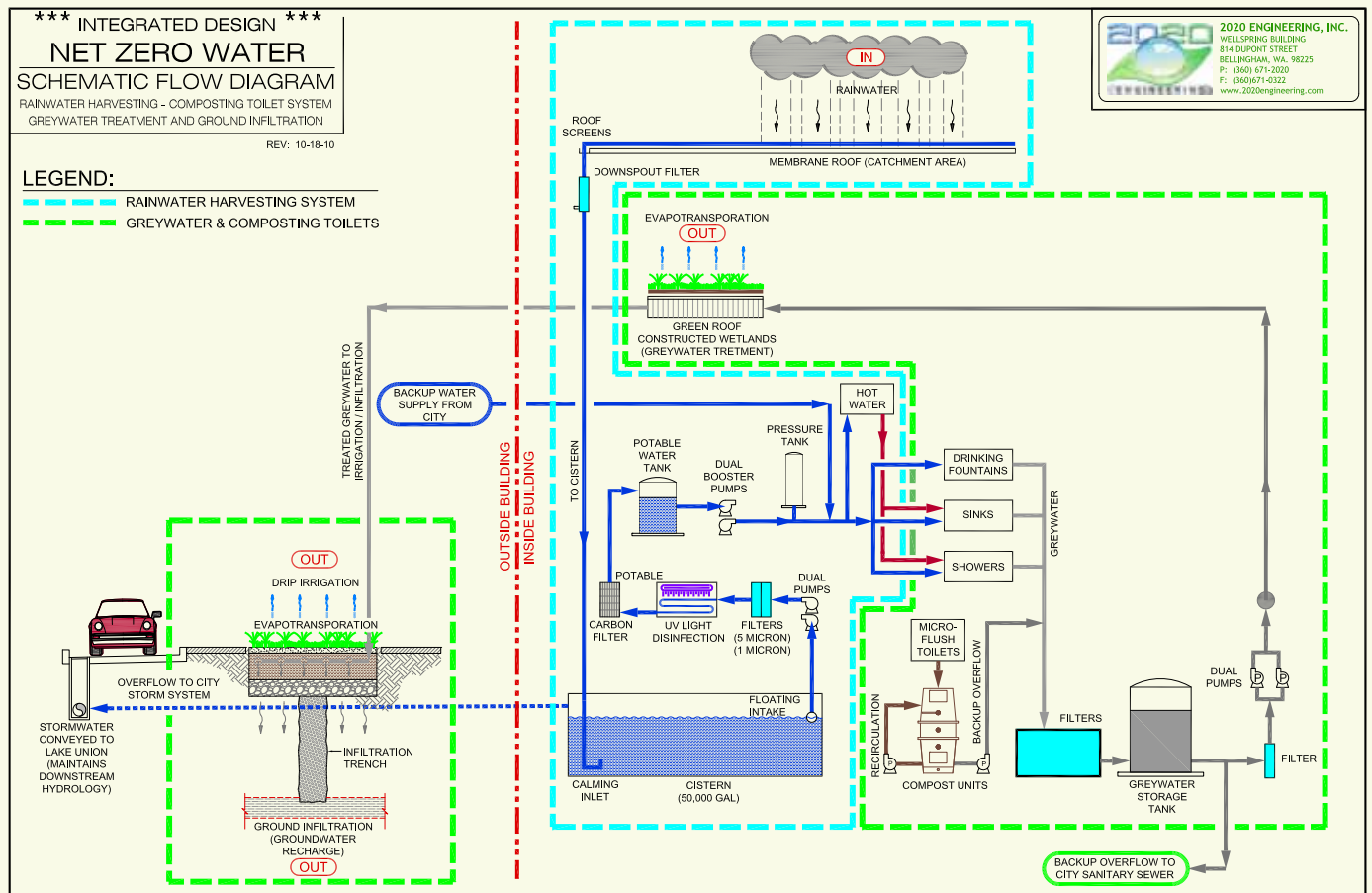
CASCADIA CENTER FOR SUSTAINABLE DESIGN AND CONSTRUCTION

Date Completed: Expected late 2011
Location: Seattle, WA
Building Owner: The Bullitt Foundation
Project Type: Commercial / Office
Project Size: 42,773-sf
Site Area: 10,000-sf
Capacity: 166 daily occupants
System Selected: Phoenix composting unit / constructed wetland

Design Team:
 Point 32, LLC / The Miller | Hull Partnership /
 2020 ENGINEERING / PAE Consulting Engineers /
 The Berger Partnership / Schuchart Construction Co. /
 The University of Washington's Integrated Design Lab

The Bullitt Foundation's Cascadia Center for Sustainable Design and Construction serves as a valuable case study for mapping the regulatory pathways to net zero water within the City of Seattle. The project, currently in the design phase, provides a real-life context for discussing net zero water design goals and the regulatory framework affecting the project.

The six-story, 42,000-sf building, located at the intersection of 15th & Madison in the Central Area and Capitol Hill neighborhoods, will be one of the first to participate in the City of Seattle's Living Building Pilot Program. In addition to the Bullitt Foundation, the building will be occupied by various tenants whose mission is to provide education in the green building and sustainability fields, or are practitioners of green design and construction.



Cascadia Center Net Zero Water Schematic Flow Diagram/ Courtesy of 2020 ENGINEERING



Courtesy of The Miller Hull Partnership, LLC

The design team for the Cascadia Center is evaluating a number of innovative strategies for meeting net zero water goals, such as a rainwater harvesting system to meet 100% of the building's interior water needs, including potable water use. Water will be harvested off the roof area and stored in a large cistern in the basement. Ultraviolet and carbon filter systems are proposed to treat rainwater to reach potable quality without the use of chemicals.

The building includes micro-flush composting toilets on each floor. This greatly reduces the building's overall water use and eliminates the generation of blackwater. All solid wastes from the toilets will be routed to basement composting units. Wastes are then combined with sawdust (or another composting media) in the composting chamber. The units compost the waste into valuable fertilizer which can be applied to agricultural or forest land.

Greywater from sinks and showers will be collected and stored in basement tanks before it is pumped to a vegetated roof located on the third floor of the building.

The 485-sf green roof will serve as the treatment system by utilizing the natural, chemical, physical and biological treatment processes occurring in subsurface wetlands. The roof will contain a 15" depth of gravel-type media to treat the daily estimated greywater flows. Average treated effluent BOD and TSS levels are expected to be <10 mg/L.

The treated greywater will then be discharged from the green roof area to a 1,000-sf landscape area at the ground level located along the sidewalk via a subsurface drip-emitter piping system. The landscape area will have a minimum 18" depth of engineered drainfield soil and the treated greywater will remain below the surface to avoid human contact. An infiltration trench connecting the drainfield and the existing sand layer will be dug to ensure that the treated greywater infiltrates through the engineered drainfield soil layer and into the native soils below, similar to a typical drainfield area.

The integrated system design will provide a "closed loop" water system that meets the intent of the Living Building Challenge water imperatives.

BERTSCHI SCHOOL: LIVING SCIENCE BUILDING

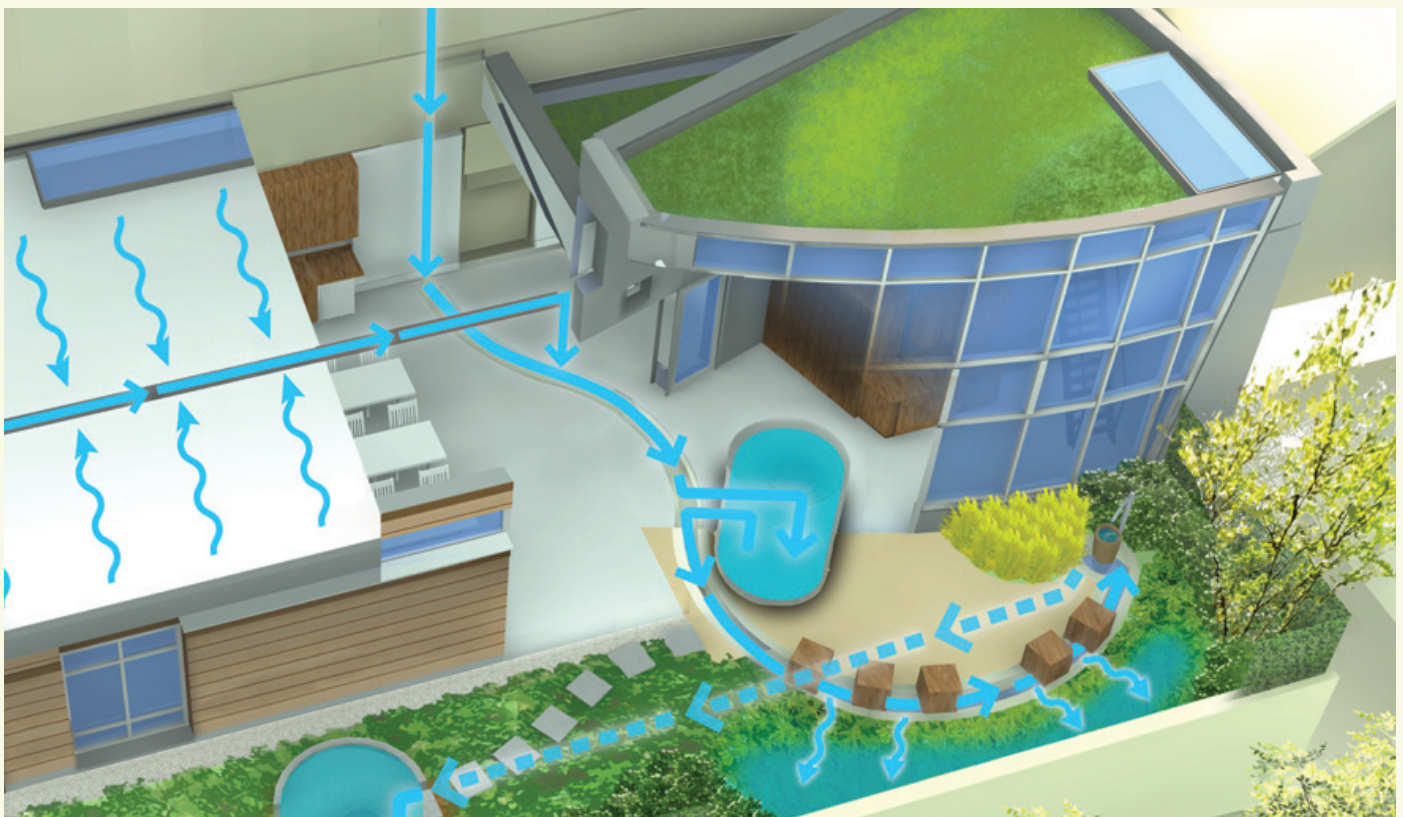
Date Completed: February 2011
Location: Seattle, WA
Owner: The Bertschi School
Project Type: Campus
Project Size: 1,425-sf
Site Area: 3,800-sf
Capacity: 17,500 uses/year
System Selected: Aqua2use, Living Wall, Ekologen Envirolet, FlushSmart

Design Team:

Restorative Design Collective: KMD Architects / 2020 ENGINEERING / GGLO / GeoEngineers / Quantum Consulting Engineers / Rushing / O'Brien and Company / Back To Nature Design LLC / Parsons Public Relations / Skanska

The Living Building Science Classroom at the Bertschi School, a private elementary school located in Seattle's Capitol Hill neighborhood, is slated for completion at the end of January 2011. The school is dedicated to providing students with opportunities to experience cutting-edge sustainable design to reinforce its ethic of cultivating local and global stewardship. The 1,425-sf Living Science Building has been designed to allow students to see and interact with the building's water systems and to observe water use with real-time monitoring equipment.

Striving to meet net zero water goals presented both design and regulatory challenges for the project team. While the building sits on a relatively small site, it has been designed to harvest rainwater for all of its water needs, and to treat and infiltrate all building discharge and stormwater on-site. The integrated system incorporates rainwater harvesting for both interior and exterior uses, composting toilets, and an interior vegetated green wall to evapotranspire treated greywater from the classroom's sinks.



Rainwater is collected from the roof of the building and stored in a 2,500-gal. underground precast concrete cistern painted with a food-grade Xypex waterproofing admixture on the interior walls of the vault. Some of the runoff is channeled through an interior runnel to express the activity level of the water system for students inside the science building. A second underground precast concrete tank provides additional rainwater storage for landscape irrigation. Overflow from the irrigation cistern is directed into rain gardens via an exterior runnel, where water quality is improved as it infiltrates and recharges groundwater on-site.

While the rainwater system is designed to treat and supply potable water to classroom and lavatory sinks, the Seattle/King County Department of Public Health denied approval of the system for potable use. As a result, municipally-supplied water is used within the building to serve these locations. However, the school has elected to install the rainwater filters and ultraviolet disinfection as designed in anticipation of future changes to local and state codes. A simple flip of a valve will allow the classroom to utilize harvested rainwater for all uses as the law allows.

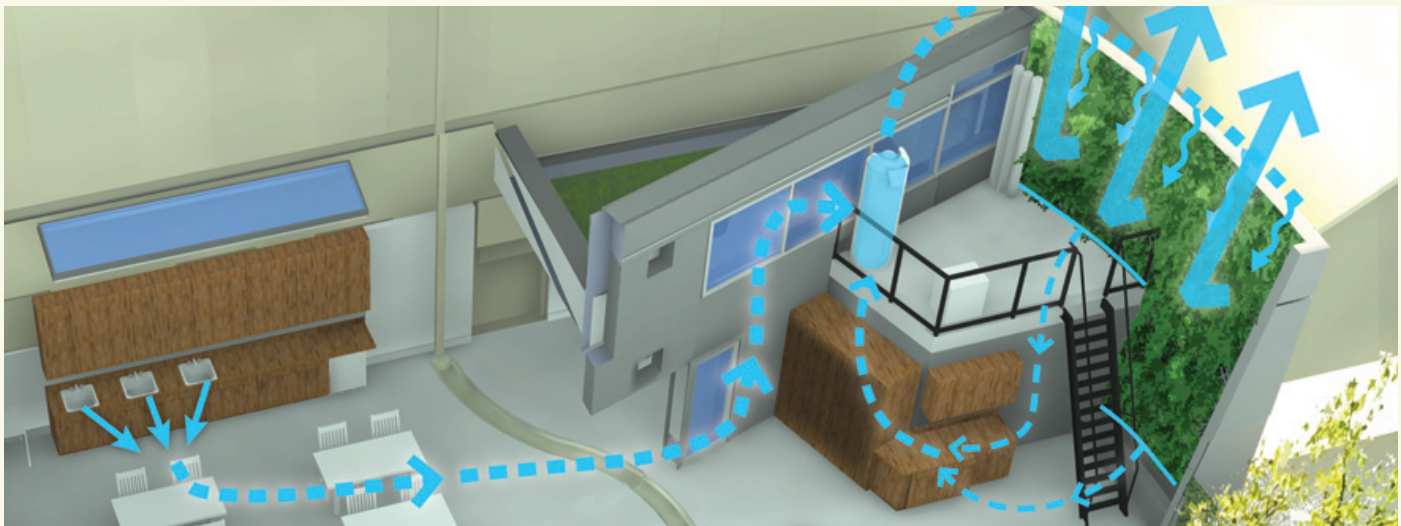
Greywater from the classroom sinks and lavatory is diverted to an Aqua2use storage unit where it is filtered

using a series of progressively denser filters. The lightly treated greywater is then used to irrigate an interior living wall through a subsurface drip irrigation system.

Greywater is eventually evapotranspired by the vegetation. The project team was able to gain approval for the greywater reuse system by installing a conventional overflow to the City's sewer system, allowing the local health department to permit the system through an administrative ruling on the Uniform Plumbing Code.

The Living Science Building eliminates the discharge of blackwater by utilizing a composting toilet system. The Ekologen Envirolet® FlushSmart™ VF™ 750 Double system aerates and pulverizes waste for faster composting-action while only using .05 gal. per flush. A vacuum generator pumps waste to the Y-connector which divides the waste between two tanks for up to 48 uses per day. Composted waste will be harvested about once a year and used on-site to fertilize landscape vegetation.

The greywater, composting toilet, and rainwater catchment systems for the project were all permitted with plumbing permits through Seattle-King County Public Health.



Greywater System (above): Classroom sinks drain to the greywater tank. The Living Wall evapotranspires the greywater via a drip irrigation system. Rainwater System (opposite): The roof rainwater is collected and directed into gutters to an interior runnel before being stored in a large cistern. Overflow from the cistern is released through a runnel to the rain garden where it eventually infiltrates into the ground or temporarily stored in an underground cistern.

Images courtesy of GGLO

GLOSSARY

Blackwater is water containing solid and liquid wastes from toilets and urinals.

Closed loop water systems are ones in which all water used on a project is captured, treated, used/ reused and released within the boundaries of the project site.

Effluent is the out flowing of water from a treatment process discharged into a receiving water body.

Greywater is wastewater discharged from sinks, showers, laundry, drinking fountains, etc., but not including toilets and urinals. Light Greywater is water from bathroom sinks, shower, bathtub, laundry, drinking fountains, and equipment condensate. Dark Greywater is water from kitchen sinks and dishwashers.

Groundwater is a fresh water supply that is located beneath the surface of the ground and is suitable quality for all types of uses.

Group A water systems are public water supply systems that typically have 15 or more service connections or serve 25 or more people per day.

Group B water systems are public water supply systems that serve fewer than 15 connections and fewer than 25 people per day.

Integrated Water Systems Management is an approach to manage potable water, rainwater, stormwater and wastewater holistically as part of watershed planning.

Net zero water projects are those seeking to operate within the water budget of their sites by utilizing closed loop systems that meet human needs while respecting the surrounding ecosystem.

Potable water meets the U.S. EPA's drinking water quality standards and is approved by state and local authorities having jurisdiction as fit for human consumption.

Rainwater is precipitation harvested from roof areas that is collected and stored on-site. With appropriate levels of treatment, rainwater can be reused for a variety of non-potable and potable purposes including drinking, irrigation, washing, and flushing toilets and urinals.

Reclaimed water is wastewater that has been treated to a standard at which it can be safely reused for a specific beneficial purpose such as irrigation or toilet flushing.

Stormwater is precipitation that falls on the ground surfaces of a property. Stormwater runoff flows over the surface of site and into sewer systems or into receiving water bodies.

Surface water is all water open to the atmosphere and subject to surface runoff (i.e., lakes, rivers, streams, etc.).

Wastewater is water that has been used for residential, commercial or industrial uses.

Wastewater treatment is the process of removing or reducing hazards in water and typically includes some of all of the following steps:

Primary treatment – physical treatment process, with or without chemical assistance; some heavy metals removed.

Secondary treatment – a process that removes dissolved and suspended solids by biological treatment and sedimentation; biodegradable organics, volatile organics, some nitrogen and phosphorus removed.

Tertiary treatment – such as filtration, membrane filtration, and detention in lagoons or wetlands; usually combined with coagulation, sedimentation, filtration and disinfection; more removal of nitrogen and phosphorus, dissolved solids and heavy metals.