Bullitt Center
Rainwater-to-Potable Water System

February 1, 2019

Introduction

No compound is more central to life on Earth than water. It is literally the stuff of which all living things are made. And yet, as a society people tend to undervalue water. Famously, the moral philosopher and economist Adam Smith described the "diamond-water paradox," where people put an enormous value on diamonds – which serve very little practical purpose – yet give away water almost for free, even though it is necessary for all life.

With the climate changing and population rising, the era of under-valued water is coming to a close, even in a historically water-rich region like Seattle.

At the same time, clean drinking water is arguably the greatest public health triumph in history, and we need to take care when we tinker with it. With global warming bringing huge, inevitable changes in precipitation patterns, and the global population migrating rapidly to cities, we need to make fundamental changes in the way we address potable water—but we need to proceed very carefully.

When the Bullitt Center team committed to achieving the Living Building Challenge, it committed to "Net Positive Water" as one of the goals. Beyond achieving the Challenge, however, the goal of the Bullitt Center is to show people what's possible when a project team tries to do everything right. When it comes to water, this meant exploring the potential to capture and treat rainwater for all purposes in the building, including drinking.

The following white paper summarizes the experience of the Bullitt Center team in designing and implementing the rainwater-to-potable water system that is currently operating in the building.

Before turning to the rainwater-to-potable water system, however, one point is worth emphasizing: The Bullitt Center uses only a fraction of the water typical for an average commercial office building. For example, the average commercial building in the United States uses 20 gallons of water per square foot per year (SOURCE). In contrast, the Bullitt Center uses just one gallon per square foot per year, a 95% reduction in water use. This is due in large part to the composting toilet system, which requires only a few tablespoons of water per use. Because the analysis below – and the value of onsite water treatment – ties to regional water demand, it is important to recognize that if all new commercial buildings used water like the Bullitt Center, existing supplies of water would go much further in meeting future demand, even with significant growth in population.

Lessons Learned

Based on our experience, the Bullitt Center team has identified the following key lessons learned for projects considering rainwater-to-potable water systems:

- **Regulations vary by state.** Before designing a rainwater-to-potable water system, understand the regulatory requirements, which vary by state. While the Safe Drinking Water Act, as administered by the U.S. Environmental Protection Agency (USEPA), sets the overarching regulatory framework, implementation in Washington State is delegated to the state health agency, the Washington State Department of Health (WSDOH), which regulates Group A systems and is also responsible for additional State Board of Health regulations. Group A systems include cities, water districts, and other water systems such as the Bullitt Center. The Bullitt Center is considered a Group A, Non-Transient, Non-Community system because it serves at least 25 people who use the building for at least 180 days per year in a non-residential setting. While USEPA regulations generally govern drinking water in the U.S., regulations, guidance and enforcement can vary by state, so it is important to research and understand the relevant rules before developing a water system plan. For example, most states, including Washington, require National Sanitation Foundation (NSF) certification for every part of the system, although some states do not.

- **Focus on the Water System Plan.** Before installing any part of the water system, it is critical to develop a water system plan with qualified engineers and architects, and to have the plan reviewed and approved by the relevant regulatory authorities. In Washington State, water system plans are required by regulation for all Group A water systems. The plan provides the basis for the regulators to assess the current and future capabilities of the water system, to recommend needed improvements to allow the system to provide water service throughout the planning period (historically six years, but changed to ten years at the start of 2018), and to meet the statutory requirements of the relevant state codes. The Bullitt Center Water System Plan is included in the Appendices.

- **Benefits include stormwater.** While the obvious benefits of a rainwater-to-potable water system include delivery of potable water for drinking, project teams and government officials should not overlook potential benefits tied to stormwater mitigation. For example, in the Bullitt Center, the building engineer can draw down the cistern by releasing water into the storm sewer ahead of a rain event, then use the cistern to store stormwater while it is raining, which can help mitigate peak flows and reduce pollution risks from combined-sewer overflow. At the scale of a single building, the impact is limited. But the potential stormwater benefits could be significant in the future with a system of cisterns controlled by stormwater authorities. Seattle Public Utilities, for example, is exploring just such potential.

- **All new construction should contain a cistern.** Especially in commercial construction, it is common to have under-utilized spaces below ground. In practice, a cistern can be as simple as a concrete-walled room with no doors that can be accessed from above, typically in a basement location. As a result, incremental costs to add a potential future cistern during new construction can be minimal. In contrast, retrofitting a cistern into an existing building can be difficult and expensive, depending on the density of surrounding buildings and existing infrastructure. By adding a cistern to new construction, project teams are keeping options open during the life of the building to add a rainwater-to-potable water system or, at a minimum, stormwater mitigation.

- **Everything that touches water needs NSF certification in Washington.** One objective of the Bullitt Center is to test new ideas, to lower barriers for projects that follow. The rationale for the rainwater-to-potable water system advanced this objective. And one challenge encountered was the fact that every part of the system that contacts rainwater before it reaches the cistern requires NSF certification or, at least, testing to NSF standards prior to use per WSDOH regulation, including the solar array on the roof. Because rainwater first hits the solar panels before dripping onto the roofing membrane and funneling into the downspout that leads to the cistern, the solar array required testing to NSF standards. The concern was valid: To ensure no harmful chemicals leached out of the panels – especially from the anti-reflectant coating on the glass – that would contaminate the treated drinking water. However, the requirement to test to NSF standards for the SunPower panels required a significant investment of time and dollars to achieve. Because of the efforts of the Bullitt Center team, SunPower panels now come with NSF approval for use in water systems.

- **Chlorine is required by the Safe Drinking Water Act.** Chlorine is a hazardous chemical, with derivatives that are included on the International Living Future Institute's materials "Red List" (SOURCE). As a result, the Bullitt Center team explored whether there were other ways to ensure the system delivered safe drinking water without chlorine. However, after significant exploration we learned that chlorine is a statutory requirement. There are no provisions for exceptions to the provisions in the federal Safe Drinking Water Act require a disinfectant residual in the distribution system. All water on the potable side of the system must include a small amount of chlorine to prevent bacterial growth that could harm public health.

  Although chlorine gas can be hazardous, by itself and when combined with numerous organic compounds, there are two compelling reasons why it is a key component of a commercial potable drinking water system. (1) There have been instances where harmful bacteria have entered drinking water supplies "through the back door" (i.e. through shower heads and faucets). So, no matter how clean the water may be when it enters a building's plumbing, it can get contaminated en route to the tap. Chlorine remains in water as it flows through the pipes and it kills any harmful bacteria encountered along the way. The EPA has declared that, up to a concentration of 4 parts per million in water, chlorine poses no health risk to humans. (2) Chlorine (or monochloramine) is required in all public drinking water by the federal Safe Drinking Water Act. Chlorine is commonly credited with virtually eliminating diseases like typhoid fever, cholera and dysentery in the developed world, and regulatory agencies have no authority to grant waivers to its use. If occupants are annoyed by the slight residual taste of chlorine in tap water (just as in water from public water supplies), the chlorine can be effectively removed with inexpensive activated charcoal filters.

Case for Distributed Water Systems

The City of Seattle manages two reservoirs for drinking water on the Tolt and Cedar Rivers. While the City does not foresee a near-term need for additional impoundments, in the long run population growth will increase demand and climate change will decrease supply.

As the climate changes, large parts of the United States will become severely water constrained. Already, water availability is limiting development in Eastern Washington. Coupled with increasing storm severity, risks of wild fire, and other challenges, we expect a growing number of climate migrants to move from areas of greater impact to those of lesser impact. The United Nations estimates that from 2008-2018, more than 22 million people have been displaced globally due to climate-related events (SOURCE). The Pacific Northwest is one of the most attractive locations in the lower-48 states, seen through the lens of climate migration. We expect Seattle's population to increase faster – and to higher levels – than projected by current forecasts as climate impacts in other parts of the country worsen. With growth comes increasing water demand.

Today, it is relatively common for Seattle to face voluntary water constraints on activities such as car washing and lawn watering during dry summer months. Climate change projections for Western Washington can be summarized as drier summers, and warmer and wetter winters (SOURCE). While the two current reservoirs are the most obvious sources of drinking water for Seattle, in reality snowpack in the Cascade Mountains currently holds the lion's share of water used (SOURCE). As this snow turns to rain during warmer winters – at a time when current reservoirs are already at full capacity – water that would currently be stored as snow in the mountains will be lost into the ocean. Functionally, less water will be stored as population continues to grow.

Drier summers, warmer winters, and more people add up to water shortages in the future. Distributed rainwater-to-potable water systems are one part of the solution.

The current economics of water – as described in the "diamond-water paradox" – make investments in full rainwater-to-potable systems difficult to justify financially today. However, in 10-20 years – well within the lifetime of buildings currently being developed – the economics will change as demand grows and usable supply shrinks. In addition, the benefits of distributed systems for stormwater offer very real value. For example, the City of Seattle and King County proposed to spend $1.3 billion on combined sewer overflows – just one part of an expensive stormwater management program (SOURCE).

For these reasons, there is a strong rationale for new construction to include cisterns, which keep options open to install rainwater-to-potable water systems in the future.

Process

The process to design, engineer and develop a rainwater-to-potable water system should follow these steps:

- Step 1 • Engage a qualified engineer and other design professionals
- Step 2 • Understand local regulations and hydrologic system.
- Step 3 • Develop the water system plan.
- Step 4 • Design and engineer the system to the approved plan.
- Step 5 • Provide design plan for regulatory review and approval.
- Step 6 • Install the system.
- Step 7 • Test the system.
- Step 8 • Operate the system.

Challenges Encountered

Achieving approval for the rainwater-to-potable water system has arguably been the most challenging part of the Bullitt Center project. Public health officials take safe drinking water very seriously, for good reason; it is quite likely the most important improvement to human health in the last 100 years.

We offer the following summary of obstacles that were encountered during design, development and approval of the Bullitt Center's system as a way to illuminate areas for future improvements in efficiency:

- **NSF testing for the photovoltaic system.** The objective here was to ensure no harmful chemicals were leached into the drinking water. This is a goal we fully support. However, testing to NSF standards is a lengthy and involved process, requiring testing of new panels and panels that had been exposed to weather for a period of time. Nearly two years were spent negotiating with various parties to get the solar panels into a testing location, and to have the testing conducted. If every type of module produced by the dozens of manufacturers selling solar equipment in the United States needs to be individually approved, the delays and transaction costs will be crippling. Perhaps solar companies can be persuaded (or required) to share this bit of intellectual property and all use the same, most-effective anti-reflectant coating.

- **Installing components ahead of regulatory approval.** Early in the process, several pieces of the system were installed in the building before the Water System Plan and the associated design were approved. In the ultimate design, some of the installed components were not NSF certified and could not be included in the final configuration. If there were a single piece of advice for future projects, it is this: don't install anything until the Water System Plan and system design is approved by the regulatory agency.

- **Efforts to avoid chlorine.** The team worked mightily to receive a variance that would allow the system to operate without chlorine. Motivated by a desire to comply with the Red List, and by the fact that the Chesapeake Bay Foundation's Brock Commons in Virginia was seemingly granted approval to operate a rainwater-to-potable system without chlorine*, the Bullitt Center team tried for several years to identify a work-around that could gain regulatory approval, ultimately taking the request to the head of the U.S. Environmental Protection Agency. In the end, no approval was granted and we added chlorine to the system. The effort to circumvent chlorine requirements took significant time; frayed relationships with regulators; was unwise on its merits; and stood no chance of success.

- **Dearth of NSF-certified products for rainwater catchment.** At the time the Bullitt Center was designed and constructed, there were no Red List compliant roof membrane systems certified under NSF protocol to serve as part of catchment systems. The only NSF-certified membranes were pond liners that were not UV stable. The design instead relied on an NSF-certified Red List compliant coating applied on top of the roof membrane. At the time, most certified coatings were manufactured in the Southeast US and intended for use in the Caribbean. Today there are several new coatings available, but still only two actual NSF-certified membranes. At the Bullitt Center, the decision was made during construction to wait until a regulatory path for approval for potable use was established before the coating was applied.

- **Rooftop planning.** To avoid the need to have NSF-certified HVAC units and also to make sure that routine rooftop maintenance didn't dirty the water, designers for the Bullitt Center located mechanical equipment on a separate roof from the primary catchment area and directed drainage from that area away from the cistern. This design objective – to minimize the amount of equipment and traffic on the catchment area – is an important lesson from the project.

- **A certified operator is required.** For Washington potable water systems, a certified operator is required to monitor and lab test water samples to meet code. Most building engineers are not certified water system operators, so the Bullitt Center outsourced this to a third party to provide a certified operator on a contract basis. The building's regular engineers could become certified, but since they are regularly shifted by the property manager from one building to another, this would be inefficient.

**Note: Ultimately the Brock Commons team relented and the building is currently using chlorine in its rainwater-to-potable water system.*

Conclusion

The goal of the Bullitt Center is to show what's possible and to help lower barriers to high-performance regenerative design for future building projects. To that end, implementing the rainwater-to-potable water system was a valuable experience that was aligned with the main purpose of the project. It is clear that current regulatory approaches to potable water discourage distributed systems, especially in multi-tenant urban infill buildings.

That said, as in nature, systems are most resilient if they can operate independently and also connect into a larger system. For example, higher levels of resilience could be achieved if high-quality water could be produced on site, with the capacity for it to be shared with neighbors during times of surplus or drawn from centralized sources during prolonged droughts. Such a "hybridized" system could be considered in the future to promote resiliency.

In addition, there can be substantial costs associated with operating a rainwater-to-potable water system, largely to treat and maintain the water to meet health regulations, which requires a certified operator to regularly test the system.

Nonetheless, the era of relying only on centralized water systems is coming to an end.

First, moving water long distances (frequently hundreds of miles) requires a huge amount of energy, mostly to operate gigantic pumps. Next, in many places large quantities of water are lost to evaporation when it is sunny and lost to the storm sewer each time it rains. If rain were safely captured on rooftops and used on site, it would help mitigate both peak demands for potable water and stormwater impacts.

Finally, distributed water systems offer a path to resilience. Unlike "brittle" centralized systems that are vulnerable to natural disasters and other system failures, rainwater-to-potable water systems add diversity into the water system, with the potential to continue delivering water even after a cataclysmic event. Especially if coupled with a solar array and backup batteries, a rainwater-to-potable system could operate independently from the larger grid network.

While centralized systems are likely to remain the core strategy for decades to come, the Bullitt Center experience shows that a rainwater-to-potable water system is practicable and will offer many advantages in a future dominated by climate change.

Appendices

1) Bullitt Center Water System Plan

2) Bullitt Center Water System Modifications

3) Bullitt Center Engineering Report



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Bullitt Center Water System Plan

G&O #13607

June 2015

Gray & Osborne, Inc

BULLITT FOUNDATION

KING COUNTY **WASHINGTON**

BULLITT CENTER WATER SYSTEM PLAN

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CHAPTER 1

WATER SYSTEM DESCRIPTION

OBJECTIVE AND INTRODUCTION

The objective of this chapter is to present background information for the Bullitt Foundation's Cascadia Center for Sustainable Design (Bullitt Center, Center) Water System Plan (Plan). The Plan will provide the basis for Washington Department of Health (DOH) Group A water system approval, as well as assess the current and future capabilities of the Bullitt Center's water system, recommend needed improvements to allow the system to provide water service throughout the planning period, and meet the statutory requirements in Chapter 246-290-100 of the Washington Administrative Code (WAC), Chapter 246-293-250 WAC, and Chapter 246-295 WAC.

The chapter presents information on ownership and management of the system, system background data, the existing system facilities inventory, related planning documents, existing and future service areas and characteristics, and service area agreements and policies for the Bullitt Center.

OWNERSHIP AND MANAGEMENT

The Bullitt Center is owned by the Bullitt Foundation. The official name of the water system is the Bullitt Center water system. When DOH approves the Group A status of the water system, an official DOH water system number will be assigned to the water system. Water system plan submittal forms are included in Appendix A.

The Bullitt Center is located at:

1501 East Madison Street
Seattle, Washington 98122

Figure 1-1 shows the location of the Bullitt Center.

TYPE OF OWNERSHIP

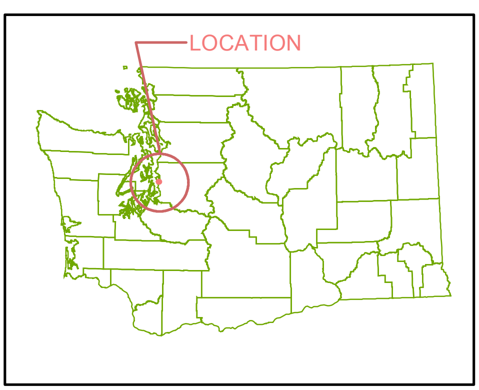
The Bullitt Center water system is owned by the Bullitt Foundation, which is a private, Washington State registered nonprofit corporation dedicated to protecting and restoring the environment in the Pacific Northwest.

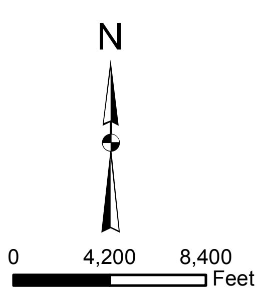
MANAGEMENT STRUCTURE AND DECISION-MAKING PROCEDURES

Because the Bullitt Center will be a Group A water purveyor, it will be required to comply with all of the applicable regulations including those described within this document. Unlike most municipal water purveyors, the Bullitt Center may have more latitude in how it operates and how it meets DOH requirements. The mission of the Bullitt Center as it relates to its water system is summed up by Denis Hayes of the Bullitt Foundation.

> *The Bullitt Center is, at root, a grand experiment. It is pushing the boundaries of numerous technologies that show promise of enhancing sustainability and resilience in the built environment. These include, among other things: constructing the most energy-efficient office building in the United States; meeting all its annual energy requirements from the sunlight that falls on its roof; avoiding more than 260 toxic substances commonly used in office construction; etc. Because some of the Bullitt Center's features are unprecedented, it is also exploring the frontiers of policy and regulation.*
>
> *One of the Bullitt Center's goals is to minimize its water demand—much as it minimized its energy requirements—so that it can be met by the rain that falls on its roof. As with other innovations, this approach may or may not prove to have relevance to the broader society. Few existing buildings can meet all their current energy requirements from incident sunlight. However—even in Seattle—if they generated some of their energy from solar panels, this would increase grid stability, lessen the utility's dependence on distant generators, and provide a measure of self-reliance in the event of natural disasters or other problems. Similarly, by showing that it is possible to meet all its needs for potable water from rain, the Bullitt Center will be placing another arrow in the quiver of water planners facing an uncertain future.*
>
> *For example, the world has entered a period of increasing climate instability. The winter droughts currently ravaging much of America are likely to get much more severe for a very long time before they begin to diminish. With snowpack almost disappearing in California and diminished in the Northwest, water supplies may become severely constrained. Most climate models show regional precipitation continuing but in the form of rain instead of snow. To the extent that buildings capture the abundant rain that falls on their roofs and store it in decentralized cisterns, they can reduce the demands on public drinking water supplies.*
>
> *This is already occurring to some extent with cisterns holding non-potable water for use in irrigation, toilets, etc. The Bullitt Center, here too, is stretching the boundaries and seeking to overcome the technical and regulatory hurdles to meeting all its water needs from rainfall. As best we can tell, there are no insurmountable technical barriers to this, and we hope to win regulatory approval as well.*

Because of the experimental nature of the Bullitt Center and the commitment of the Bullitt Foundation to using rainwater harvesting as its sole domestic water source, some of the approaches normally taken by water systems to address issues in water system





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WATER SYSTEM PLAN
FIGURE 1-1
VICINITY MAP

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UPDATED: 11/26/2014

L:\Bullitt Foundation\13607 Water System Plan\GIS\Figure_1-1.mxd plans may not apply. The water system is not constrained by the usual municipal issues of rate payer sensitivity and local government control in its ability to meet DOH criteria while still meeting its goal of rainwater harvesting.

SYSTEM BACKGROUND

The Bullitt Center is a 50,000 square foot, six-story commercial office building located in the Capitol Hill neighborhood of Seattle. The Center is home to a number of commercial office tenants as well as the building owner, the Bullitt Foundation. Construction on the building began in 2011, and the first occupants were in the building in April of 2013. In addition to the office tenants, the Bullitt Center hosts tours and maintains a public exhibition space to educate and showcase the building's attributes and a number of research projects managed by the University of Washington's Integrated Design Lab.

In addition to collecting all water used on-site, the Bullitt Center is dedicated to meeting net-zero energy use goals. Power is provided by 575 roof-mounted photovoltaic panels that provide 244 kW of power. While still connected to the power grid, the Bullitt Center generates enough power over the course of the year to meet net-zero energy goals on an annual basis. In its first year of operation, the Bullitt Center generated approximately 60 percent more energy than what was consumed.

A copy of the proposed Water Facilities Inventory (WFI) is included in Appendix B. Because the system serves 25 or more people per day for at least 60 days per year, is non-residential (non-community), and serves 25 of the same people for 180 days or more, the system would be classified as a Group A Non-Transient, Non-Community (NTNC) System under WAC 246-290 regulations.

ADJACENT PURVEYORS

The only adjacent purveyor is Seattle Public Utilities (SPU). Because of the experimental nature of the Bullitt Center, SPU has agreed to allow the formation of a new Group A water system within its retail service area. Documentation of the agreement is included in Appendix C.

INVENTORY OF EXISTING FACILITIES

The water system at the Bullitt Center consists of three separate systems, including the potable water system, non-potable water system, and the fire protection system. The potable water system supplies sinks, showers, and dishwashers. The non-potable system is a separate distribution system that supplies the foaming toilets and limited outdoor irrigation.

The following discussion of existing facilities is divided by system. Figure 1-2 shows a schematic of potable and non-potable water systems. While the full water system is awaiting approval from DOH, the building is being served by SPU and the source, treatment, and storage are being used only for non-potable purposes. The following discussion is of all facilities as currently installed and describes intended use and operation.

POTABLE WATER SYSTEM

Roof Collection System

All of the water for the water system will be captured in a roof collection system, which is considered a surface water source. The roof of the Bullitt Center is approximately 6,880 square feet in three segments, all of which are tied to the rainwater collection system via downspouts. The roof membrane is constructed with a Soprema membrane system. At the time of construction, there were limited options for membrane system that met the requirements of the Living Building challenge. The Soprema system has not been approved by the Nation Sanitation Foundation (NSF); however, the Bullitt Center is seeking to obtain approval of the system.

The collected rainwater is piped into a common line and then directed to a vortex filter system. The vortex filter contains a 280 micron filter screen that removes debris from the water stream. A portion of flow is diverted with the debris to the building's stormwater system while the filtered flow is directed to a concrete, rainwater storage cistern located in the basement of the Bullitt Center. The amount of the total flow that is diverted with debris is dependent upon the volumetric flow rate, which is dependent upon the instantaneous rainfall intensity. For rainfall intensities up to 1.2 inches per hour, the filtered fraction is 90 percent or more of the total collected rainwater flow according to manufacturer's literature.

Source Characteristics

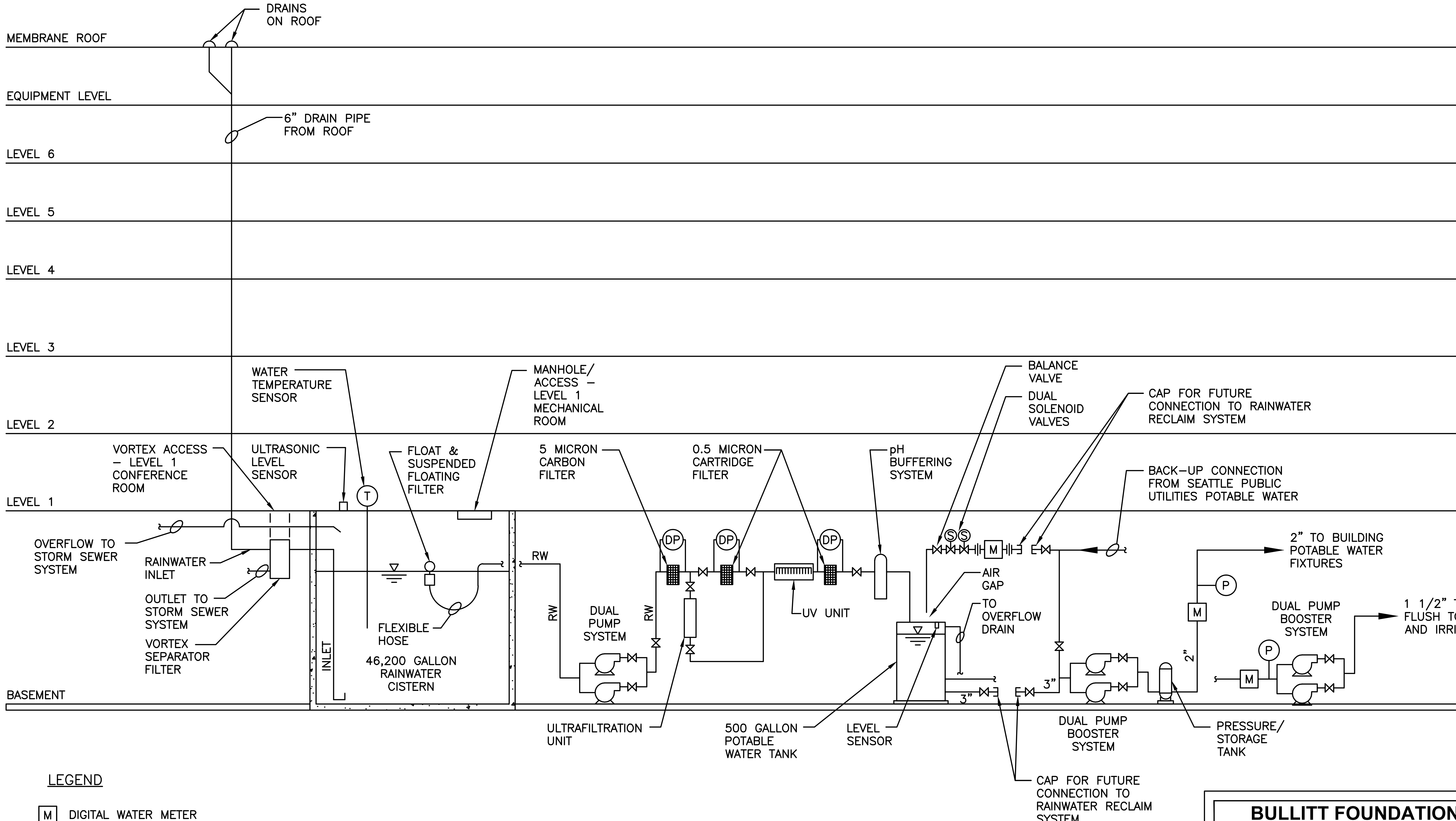
The Bullitt Center's primary source is rainfall. The Seattle area receives 38.39 inches of rainfall per year on average. The lowest historic rainfall year, occurring in 1952, was 23.79 inches of rain. Table 1-1 shows the monthly rainfall for a normal precipitation year and the driest year on record.

TABLE 1-1

Monthly Rainfall Profile, Inches

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Normal Year	5.24	4.23	3.92	2.75	2.03	1.55	0.93	1.16	1.61	3.24	5.67	6.06	38.39
Low Year	4.89	2.46	3.53	2.04	0.98	1.04	0.41	0.70	0.32	1.29	1.11	5.02	23.79

Raw water quality characteristics are discussed in Chapter 3 of this plan. In general, rain water is a high quality source. Any source water quality issues will likely be due to the roof catchment system, such as contaminants from storm debris or birds.



LEGEND

- M — DIGITAL WATER METER
- P — PRESSURE GAUGE
- DP — DIFFERENTIAL PRESSURE GAUGE
- RW — RAW WATER

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WATER SYSTEM PLAN

FIGURE 1-2

WATER SYSTEM SCHEMATIC

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Raw Water Storage

The collected rainwater is stored in a concrete cistern that is incorporated into the building structure in the basement level. According to the as-built drawings, the cistern has an interior footprint of 962 square feet. An overflow pipe to the stormwater system is located 6.41 feet above the cistern floor to allow excess water to escape the cistern. The total volume of the cistern storage is 46,200 gallons.

The cistern is equipped with a level sensor and a temperature sensor.

Treatment and Disinfection

The potable water system for the Bullitt Center will have a treatment system that will treat the water to WAC 246-290 standards and the US Environmental Protection Agency's (EPA) Surface Water Treatment Rule (SWTR). This section describes the system as currently installed. Some modifications are needed to comply with WAC and SWTR standards.

A floating inlet is located in the cistern. The inlet is piped to a dual pump system with an intermediate double check valve for backflow protection.

The first treatment component, a 5-micron cartridge filter. The filter is contained in a plastic housing.

After the cartridge filter, the water is directed through an ultrafiltration membrane (UF) unit. The unit is rated for continuous service at 1.2 gpm for surface water and 3.0 gpm for well water, with intermittent flows of up to 10 gpm. The unit does not carry any NSF certifications.

After UF filtration, the water is treated with UV light. The unit is rated by the manufacturer for 40 mJ/cm^2 at 5.9 gpm for water with UV transmittance greater than 70 percent. The unit is NSF 55 approved.

The next step in treatment is a carbon filter. The unit is rated for particle removal down to 0.5 micron, but its primary purpose is to remove organics that could lead to tastes and odors. The unit is NSF 53 certified for 3.3 log cyst removal (*Giardia*).

At present, the treatment system does not include chlorine for disinfection. An injection port is located after the carbon filter for the addition of a future chlorination system.

The final treatment step is a pH buffering system. The unit is a Culligan filtration system that contains calcium carbonate to adjust pH. The unit is NSF 42 certified.

Chapter 3 includes a discussion and analysis of treatment capacity and regulations, and concludes that the system does not meet DOH requirements. Chlorination for disinfection must be added to provide a detectable residual and also provide inactivation for *Giardia* cysts and viruses. This Plan proposes installing a chlorine injection system.

Treated Water Storage

The treated water is stored in a 500-gallon polyethylene reservoir. Currently, the treated water in the reservoir is used for non-potable purposes. Once the system gains approval and can go online, the tank will be disinfected in order to also be used for potable water.

The tank includes an ultrasonic level sensor that controls the treatment system. Treatment on and off levels are set by the operator. The telemetry system for the tank includes low and high level alarms.

Booster Stations and Distribution System

The potable water system in the Bullitt Center is pumped to the building's distribution system using a skid mounted booster pump assembly. The pump assembly currently pumps water from the Seattle Public Utilities service connection to the distribution system until the rainwater system is approved by the Washington Department of Health. The booster system is composed of two 3-hp, 25-gpm pumps and a 79-gallon expansion pressure tank. The controls are set by pressure and maintain between 65 and 75 psi at the booster station.

The building piping for potable cold and hot water is composed of 1/2-inch to 2-inch plumbing to provide potable service to the tenants on the various floors. The potable system is designed to provide flow for drinking fountains, showers, and sinks. The non-potable system provides water to the foam flush toilets and a small area of limited irrigation outside.

Telemetry and Controls

The water system is controlled and operated automatically by a SCADA system and is monitored by the operator. The automation system human-machine interface (HMI) provides real time and historic data including:

- Cistern level and water temperature
- Day tank level
- Pump status, amps, starts, and run-time
- Treatment component operation status
- Solenoid valve status

System Interties

The Bullitt Center maintains two service connections with SPU, one 2-inch meter that provides fire flow for a sprinkler system and a 5/8-inch meter that is maintained as an emergency source of domestic supply. Both connections are equipped with backflow prevention devices.

Until the Bullitt Center water system is approved by DOH, SPU is providing all potable water for the Center through the emergency domestic connection. After DOH approval, the Bullitt Center intends to curtail its use of SPU water and maintain the service connection as an emergency source.

NON-POTABLE WATER SYSTEM

The non-potable water system serves the foam-flush toilets and the limited amount of outdoor irrigation. The non-potable system is supplied from the treated water storage tank, but is a separate distribution system from the potable system. The system uses a skid mounted booster pump assembly. The booster system is composed of two 3-hp pumps. The controls are set by pressure and maintain between 55 and 65 psi at the booster station.

FIRE PROTECTION WATER SYSTEM

As previously discussed, the Bullitt Center maintains a service and meter with SPU for the fire protection system. As required by City of Seattle codes, the building has a sprinkler system.

RELATED PLANNING DOCUMENTS

- City of Seattle Comprehensive Plan, January 2005 and subsequent amendments, City of Seattle Department of Planning and Development.
- Seattle Public Utilities Water System Plan, July 2012, Seattle Public Utilities.
- Net Zero Water Design Report, July 2011, 2020 Engineering, Inc.

EXISTING AND FUTURE SERVICE AREA

The Bullitt Center water system is intended to serve only the Bullitt Center building. Consequently, its retail service area, both existing and future, is King County parcel 7234600195. The retail service area is approximately 10,000 square feet in size.

Figure 1-3 identifies the service area.

SERVICE AREA POLICIES AND CONDITIONS OF SERVICE

Service area policies are important in guiding the development of a water system. The DOH has established a list of service area policies to be referenced in water system comprehensive plans. Because of the unique nature of the Bullitt Center water system, most service area policies that are considered by water systems do not apply. Table 1-2 lists the type of service area policy, the Bullitt Center's current policies, and the reference source.

TABLE 1-2

Water System Policies

Policy Name	System Policy	Reference
Wholesaling/Wheeling of Water	No wholesaling or wheeling of water	2014 Water System Plan
Annexations	Not applicable	
Direct Connection and Satellite/Remote Systems	No direct connections and no satellite systems	
Design Performance Standards	2012 City of Seattle Plumbing Code	2012 City of Seattle Plumbing Code
Surcharge for Outside Customers	No outside customers	2014 Water System Plan
LID/ULID Formation Outside Corporate Boundaries	Not applicable	
Late-Comer Agreements	Not applicable	
Oversizing	Not applicable	
Cross-Connection Control Program	Cross-connections are unlawful, whether presently existing or hereinafter installed.	
Extension	Not applicable	

COMMERCIAL TENANT POLICIES

The tenant leases include stipulations for water and energy use, and all tenants are required to support the Living Building Challenge. The leases are triple net leases, in which lessees pay a portion of common expenses in addition to the base rent. Water use costs are prorated based on the square footage leased by a tenant.

LEGEND:

- BULLITT CENTER SERVICE AREA
- SEATTLE PUBLIC UTILITES SERVICE AREA

BULLITT FOUNDATION

WATER SYSTEM PLAN
FIGURE 1-3
SERVICE AREA BOUNDARY

Gray & Osborne, Inc.
CONSULTING ENGINEERS

UPDATED: 11/26/2014

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CHAPTER 2

BASIC PLANNING DATA

OBJECTIVE

Basic planning data is an essential component of a Water System Plan. The objective of this chapter is to present basic planning data and water demand forecasts needed to assess the current and future capabilities of the water system. This chapter will provide population analysis, water use data, and develop the water demands, both at present and for the long-term occupation of the facility.

WATER SERVICE AREA POPULATION

Because the water system is designed to serve a discrete building, the ultimate population can be estimated fairly accurately based upon the design building assumptions. The building was first occupied in April 2013 and, at the time of this plan, is not fully occupied.

WAC 246-290 and DOH planning guidelines require that water system plans analyze water use for 6-year and 20-year planning horizons. Because of the unique nature of the Bullitt Center water system, the ultimate design occupancy will be used for the 6 and 20-year planning windows. The design included three classes of water users for the Center, each of which is described below.

Commercial Office Permanent Tenants

The commercial office tenants are the individuals that work in the various firms that occupy the office spaces within the Bullitt Center. The building designers used 170 individuals as full occupancy for the building, with occupants split equally between men and women. The water uses that the designers anticipated are drinking, showers, toilet use, and cleaning.

For water use planning, the designers assumed that on any given weekday, the offices would be occupied by 80 percent of the occupants and on any given weekend, 30 percent of the occupants would be working at the Bullitt Center.

Event Attendees

The Bullitt Center is intended to host events that range from 30 to 100 people. For design purposes, the designers assumed a monthly frequency of events including 22 daily events with 30 people, 10 small events with 50 people, 11 medium events with 80 people, and one event with 100 people. The average daily number of event attendees for design purposes is 98, equally divided between men and women. The anticipated water use during events includes bathroom use, drinking water, dishwashing, and kitchen and service sink use.

Visitor's Center/Energy Lab Visitors

The Bullitt Center maintains a visitor's center on the bottom floor to showcase the building's features and sustainability. For water use analysis, the designers assumed that 100 people, equally divided between men and women, will visit the Center every weekday (22 days per month). The expected water use for visitors is limited to bathroom use and drinking water.

SYSTEM DEMANDS

DESIGN WATER USE

During the design of the building and water system, assumptions were made about occupancy and frequency of use of water fixtures. Table 2-1 summarizes the design assumptions for water use.

TABLE 2-1

Average Weekly Design Use

Usage Category	Number of People	Use per Instance, gal(1)	Instances per Day	Days per Week	Total Use per Week, gal/week
Weekday – Permanent Tenants(2)					
Toilet – Male	68	0.04	1	5	**13.6**
Urinal – Male	68	0	3	5	**0**
Toilet – Female	68	0.04	4	5	**54.4**
Drinking Water/Coffee	136	0.4	1	5	**272**
Kitchen Sink	136	0.33	1	5	**224.4**
Dishwasher	136	0.3	1	5	**204**
Bathroom Sink	136	0.17	1	5	**115.6**
Service Sink	136	0.1	1	5	**68**
Shower	31	3.5	1	5	**542.5**
Weekend - Permanent Tenants(3)					
Toilet – Male	26	0.04	1	2	**2.08**
Urinal – Male	26	0	3	2	**0**
Toilet – Female	26	0.04	4	2	**8.32**
Drinking Water/Coffee	52	0.4	1	2	**41.6**
Kitchen Sink	52	0.33	1	2	**34.32**
Dishwasher	52	0.3	1	2	**31.2**
Bathroom Sink	52	0.17	1	2	**17.68**

TABLE 2-1 – (continued)

Average Weekly Design Use

Usage Category	Number of People	Use per Instance, gal(1)	Instances per Day	Days per Week	Total Use per Week, gal/week
Service Sink	52	0.01	1	2	**1.04**
Shower	12	3.5	1	2	**84**
Event Attendees					
Urinal – Male	49	0	1	5	**0**
Toilet – Female	49	0.04	1	5	**9.8**
Drinking Water/Coffee	98	0.12	1	5	**58.8**
Kitchen Sink	98	0.3	1	5	**147**
Dishwasher	98	0.3	1	5	**147**
Bathroom Sink	98	0.2	1	5	**98**
Service Sink	98	0.2	1	5	**98**
Visitor's Center/Energy Lab Visitors					
Urinal – Male	50	0	1	5	**0**
Toilet – Female	50	0.053	1	5	**13.25**
Drinking Water/Coffee	100	0.12	1	5	**60**
Bathroom Sink	100	0.15	1	5	**75**
Total Weekly Use, gal/week					**2,422**

(1) Water user per event per 2020 Engineering, Inc. report.
(2) Total permanent occupancy is 170 (85 men and 85 women), of which 80 percent are present on a given weekday work day.
(3) Total permanent occupancy is 170 (85 men and 85 women), of which 30 percent are present on a given weekend day.

The data in Table 2-1 shows an average weekly design amount of 2,422 gallons per week or approximately 346 gal/day for average day demand. This corresponds to an annual use of 126,290 gallons per year or 10,524 gallons per month. This amount is approximately 14 gallons per permanent tenant per week for all uses. Because the Bullitt Center has no permanent residents, the per tenant use is an analogous measure to per capita use that municipal systems often use in planning.

Because of the differences between weekdays and weekends and the use of the building, it is useful to also consider the average workday use. If the data in Table 2-1 is assumed for permanent occupants during a workday, as well as event attendees and visitors, the average daily demand is 440 gal/day. For some planning purposes, such as annual use and rainfall sufficiency, the average day demand over the whole week of 346 gal/day is appropriate. For other planning purposes, such as standby storage, the weekday average day use of 440 gal/day is more appropriate.

MAXIMUM DAY

For estimating maximum day, the analysis below assumes that all office workers are present during a normal weekday, that there is a large event with 100 attendees happening, and that 100 visitors will visit the visitor's center. A summary of the design maximum day is included in Table 2-2. The peaking factor for ADD:MDD is 1.51.

TABLE 2-2

Maximum Day Design Use

Usage Category	Number of People	Use per Instance, gal(1)	Instances per Day	Total Use, gal/day
Weekday – Permanent Tenants(2)				
Toilet – Male	85	0.04	1	**3.4**
Urinal – Male	85	0	3	**0**
Toilet – Female	85	0.04	4	**13.6**
Drinking Water/Coffee	170	0.4	1	**68**
Kitchen Sink	170	0.33	1	**56.1**
Dishwasher	170	0.3	1	**51**
Bathroom Sink	170	0.17	1	**28.9**
Service Sink	170	0.1	1	**17**
Shower	40	3.5	1	**140**
Event Attendees				
Urinal – Male	50	0	1	**0**
Toilet – Female	50	0.04	1	**2**
Drinking Water/Coffee	100	0.12	1	**12**
Kitchen Sink	100	0.3	1	**30**
Dishwasher	100	0.3	1	**30**
Bathroom Sink	100	0.2	1	**20**
Service Sink	100	0.2	1	**20**
Visitor's Center/Energy Lab Visitors				
Urinal – Male	50	0	1	**0**
Toilet – Female	50	0.053	1	**2.65**
Drinking Water/Coffee	100	0.12	1	**12**
Bathroom Sink	100	0.15	1	**15**
Total Maximum Day Use, gal/day				**522**

(1) Water user per event per 2020 Engineering, Inc. report.
(2) Total permanent occupancy is 170 (85 men and 85 women), assuming 100 percent are present on maximum day.

PEAK HOURLY DEMAND

Peak hourly demand (PHD), expressed in gallons per minute, is the maximum amount of water use within a service area over a 60-minute period, minus fire flows. PHD cannot be calculated and can only be estimated currently, since usage data is only recorded daily. For a traditional municipal system, PHD would be calculated using equation 5-1 from the DOH *Water System Design Manual.* Equation 5-1 relies on maximum day demand and the number of equivalent residential units within the system. The Bullitt Center system does not conform well to using equivalent residential units as a means of measuring water usage. As a result, an alternative means of estimated PHD has been developed.

Table 2-3 summarizes the estimated peak hour demand. Using Table 2-2 and estimated maximum day usage, PHD assumes that each type of fixture will be used by each user once within the hour, with the exception of the dishwashers and drinking water/coffee. The PHD calculations assume that all 6 dishwashers are running during the peak hour. Drinking water and coffee usage of 0.4 gal/person/day from Table 2-2 has been adjusted to a rate of 0.05 gal/person/hour.

TABLE 2-3

Peak Hour Demand Design Use

Usage Category	Number of People	Use per Instance, gal[1]	Instances during Peak Hour	Peak Hour Use, gal
Weekday – Permanent Tenants[2]				
Toilet – Male	85	0.04	1	**3.4**
Urinal – Male	85	0	1	**0**
Toilet – Female	85	0.04	1	**3.4**
Drinking Water/Coffee	170	0.05	1	**8.5**
Kitchen Sink	170	0.33	1	**56.1**
Dishwasher	NA	4	6	**24**
Bathroom Sink	170	0.17	1	**28.9**
Service Sink	170	0.1	1	**17**
Shower	40	3.5	1	**140**
Event Attendees				
Urinal – Male	50	0	1	**0**
Toilet – Female	50	0.04	1	**2**
Drinking Water/Coffee	100	0.12	1	**12**
Kitchen Sink	100	0.3	1	**30**
Bathroom sink	100	0.2	1	**20**
Service Sink	100	0.2	1	**20**
Visitor's Center/Energy Lab Visitors				
Urinal – Male	50	0	1	**0**

TABLE 2-3 – (continued)

Peak Hour Demand Design Use

Usage Category	Number of People	Use per Instance, gal(1)	Instances during Peak Hour	Peak Hour Use, gal
Toilet – Female	50	0.053	1	**2.65**
Drinking Water/Coffee	100	0.12	1	**12**
Bathroom Sink	100	0.15	1	**15**
Total Peak Hour Demand, gal				**395**
Total Peak Hour Demand, gpm				**6.6**

(1) Water user per event per 2020 Engineering.
(2) Daily use of 0.4 gal/person is divided by 8 hours to 0.05 gal/person/hour.
(3) All six dishwashers are assumed to be operating during the peak hour.

Once the system is approved as a Group A water system, peak hour demand can be better estimated from pump run time data. Peak hour demand will be revisited and revised as part of the next Water System Plan.

PRODUCTION AND CONSUMPTION HISTORY

Typically, water production data is collected from source meters daily, and reported on a daily basis. Water consumption data is currently collected from the Seattle Public Utility meter on a monthly basis. Table 2-4 shows the consumption data based upon SPU billing information. Non-potable water is metered as well, and usage is shown in Table 2-5.

TABLE 2-4

Metered Potable Water Consumption

Month	SPU Service Meter (100 cubic feet)	SPU Fire Service Meter (100 cubic feet)	Total Purchased from SPU (100 cubic feet)	Total Purchased from SPU (Gallons)
2013				
January	16	2(1)	18	13,464
February	8	0	8	5,984
March	60(2)	1(1)	61	45,628
April	10	0	10	7,480
May	8	0	8	5,984
June	10	0	10	7,480
July	9	0	9	6,732

TABLE 2-4 – (continued)

Metered Potable Water Consumption

Month	SPU Service Meter (100 cubic feet)	SPU Fire Service Meter (100 cubic feet)	Total Purchased from SPU (100 cubic feet)	Total Purchased from SPU (Gallons)
August	12	0	12	8,976
September	11	0	11	8,228
October	10	0	10	7,480
November	6	0	6	4,488
December	4	0	4	2,992
Total	**164**	**3**	**167**	**124,916**
2014				
January	5	0	5	3,740
February	5	0	5	3,740
March	4	0	4	2,992
April	4	0	4	2,992
May	5	0	5	3,740
June	6	0	6	4,488
July	16(2)	0	16	11,968
August	8	0	8	5,984
September	5	0	5	3,740
October	5	0	5	3,740
November	5	0	5	3,740
December	5	0	5	3,740
Total	**73**	**0**	**73**	**54,604**

(1) Fire service use for system testing and startup.
(2) Manual system fill.

TABLE 2-5

Metered Non-Potable Water Consumption

Month	Non-Potable Consumption (gal)
2014	
January	580
February	320
March	400
April	500
May	500
June	500
July	600
August	600
September	300
October	415
November	361
December	388
Total	**5,464**

Table 2-4 shows that there was a spike in water use in March 2013 and July 2014. Because the building was not occupied until April 2013, the water use in January through March 2013 was due to construction activities and building commissioning. One of the major water uses during this time was the filling of the 46,200 gallon cistern, an activity that used 7,500 cubic feet of the 8,700 cubic feet in the January through March 2013 period. In addition, potable water from SPU was used until October 2013 to irrigate landscaping on the site in areas that will not be irrigated in the future after landscaping has been established. The July 2014 increase was also due to manual filling of the system.

Table 2-6 shows a comparison of occupancy and water consumption. As the data indicate, the use per tenant has decreased substantially over the period due to startup activities. As indicated above, the cistern was filled in March 2013 and construction and startup activities continued through October 2013. In October 2013, outside irrigation to establish landscaping was curtailed and the November 2013 and subsequent month data better reflect the actual domestic use within the building. After November 2013, the use is below the design use of 14 gallons per tenant per week for all domestic uses.

TABLE 2-6

Comparison of Estimated Occupancy with SPU and Non-Potable Consumption

Month	Estimated Permanent Tenants	SPU Consumption (gal)	SPU Consumption per Permanent Tenant (gal/tenant/mo)	SPU Consumption per Permanent Tenant (gal/tenant/wk)	Non-Potable Consumption (gal)	Non-Pot. Consumption per Permanent Tenant (gal/tenant/mo)	Non-Pot. Consumption per Permanent Tenant (gal/tenant/wk)	Total Consumption per Permanent Tenant (gal/tenant/mo)	Total Consumption per Permanent Tenant (gal/tenant/wk)
2013									
April	28	7,480	267	62.3	Not Available	Not Available	Not Available	267	62.3
May	54	5,984	111	25.0				111	25.0
June	65	7,480	115	26.9				115	26.9
July	68	6,732	99	22.4				99	22.4
August	75	8,976	120	27.0				120	27.0
September	78	8,228	105	24.6				105	24.6
October	80	7,480	94	21.1				94	21.1
November	81	4,488	55	12.9				55	12.9
December	87	2,992	34	7.8				34	7.8
2014									
January	90	3,740	42	9.4	580	6	1.5	48	10.8
February	94	3,740	40	9.9	320	3	0.8	43	10.7
March	96	2,992	31	7.0	400	4	0.9	35	8.0
April	96	2,992	31	7.3	500	5	1.2	36	8.4
May to December	Not Available(1)								

(1) Tenant data not available for May to December.

WATER LOSS

Non-municipal water systems are encouraged to evaluate, manage, and report water loss. This component of the WUE Rule is a variation of the distribution system leakage (DSL) requirement for municipal water systems. DSL is the difference between production and authorized consumption such as metered or other credibly estimated authorized usage. DSL may include physical leaks within the distribution system, billing and accounting errors, and unauthorized usage. The WUE Rule requires that municipal water distribution systems have a leakage rate less than 10 percent of finished water production based on a 3-year rolling average.

Production and consumption are the same amount for the Bullitt Center, as discussed earlier, and thus the standard definition of DSL does not apply. While it is possible that the Bullitt Center may at time experience physical leaks within the system, water loss will likely take the form of system components not performing at the anticipated levels of efficiency, or human misuse of water. The Bullitt Center intends to closely monitor demand and system operation to evaluate if the system is operating as planned and if adjustments to either the physical infrastructure or customer use are needed.

WATER DEMAND PROJECTIONS

An essential component of the Plan is to project water demands during the 6-year and 20-year planning periods, as well as at buildout. As noted above, the three types of demand that are considered in this Plan include average day, maximum day, and peak hour. Average day demand is projected using the permanent tenant population at full occupancy and the design demand of 14 gallons per week per permanent tenant. This equates to 346 gpd or 126,290 gallons per year (170 tenants x 14 gal/week/tenant).

Table 2-2 indicates that the maximum day demand to average day demand ratio is approximately 1.51. Maximum day demand is estimated to be 522 gallons per day, or 0.36 gpm. Table 2-3 shows the estimated peak hour demand of 6.6 gpm at full occupancy. Table 2-7 summarizes design demands for average day, maximum day, and peak hour for the Bullitt Center.

TABLE 2-7

Design Demand at Full Occupancy

Weekday Permanent Tenant Population at Full Occupancy	System Design Consumption		
	Average Day (gpd)	Max Day (gpd)	Peak Hour (gpm)
170	346	522	6.6

CHAPTER 3

WATER SYSTEM ANALYSIS

OBJECTIVE

The objective of this chapter is to determine if the existing system components are capable of supplying sufficient quality and quantity of water to meet existing as well as projected demands. The components that will be analyzed in this chapter are listed as follows:

- System Design Standards
- Water Quality Analysis
- Facility Analysis
- System Deficiencies and Proposed Improvements

SYSTEM DESIGN STANDARDS

Performance and design criteria typically address the sizing and reliability requirements for source, storage, distribution, and fire flow. WAC 246-290 contains general criteria and standards that must be followed in development of public water systems. In addition, Washington State Department of Health (DOH) has published its 2009 Water System Design Manual that provides more specific guidance for water system design. The design standards for the following subjects are discussed in the order shown below:

GENERAL FACILITY STANDARDS

1. Average and Maximum Day Demand
2. Peak Hour Demand
3. Storage Requirements
4. Fire Flow Rate and Duration
5. Minimum System Pressure
6. Minimum Pipe Sizes
7. Backup Power Requirements
8. Valve and Hydrant Spacing
9. Other System Policies

WATER QUALITY STANDARDS

1. Applicable Drinking Water Quality Regulations
2. Existing Drinking Water Quality Standards
3. Anticipated Future Drinking Water Quality Regulations
4. Water Quality Monitoring Schedule

WATER SYSTEM DESIGN AND GENERAL FACILITY STANDARDS

DOH relies on various publications, agencies and the City itself to establish design criteria. The following gives a brief description of two of the most widely recognized performance and design standards.

- WAC 246-290, Group A Public Water Systems, Washington State Board of Health (March 2012).
- Water System Design Manual (WSDM), Washington State Department of Health (DOH) (December 2009).
- International Building Code
- Local codes
- American Water Works Association (AWWA) Standards
- American Society of Civil Engineers (ASCE) Standards
- American Public Works Association (APWA) Standards

Table 3-1 lists the suggested DOH Water System Design Manual guidance and the Center's policies with regard to each standard for general facility requirements.

TABLE 3-1

General Facility Requirements

Standard	DOH Water System Design Manual	Bullitt Center Standard
Average Day and Peak Day Demand	Average day demand should be determined from previous actual water use data. Maximum day demand (MDD) is estimated at approximately 2 times the average day demand if metered data is not available.	Average day demand will be determined from metered production data. Maximum day demand will be determined by examining maximum day production. Currently, an average peaking factor of 1.51 was identified (see Table 2-7).
Peak Hour Demand	Peak hour demand is determined using the following equation: PHD = (MDD/1440)[(C) (N)+F] +18 C = Coefficient from DOH Table 5-1 N = Number of connections, ERUs F = Factor of range from Table 5-1	Peak hour demand is determined by applying a peaking factor of 1.66.

TABLE 3-1 – (continued)

General Facility Requirements

Standard	DOH Water System Design Manual	Bullitt Center Standard
Source	Capacity must be sufficient to meet MDD and replenish fire suppression storage in 72 hours.	Capacity must be sufficient to meet MDD. Fire suppression storage provided by SPU.
Storage	The sum of: • Operational Storage • Equalizing Storage • Standby Storage • Fire Suppression Storage	Refer to storage analysis in Chapter 3.
Minimum System Pressure	The system should be designed to maintain a minimum of 30 psi in the distribution system during peak hour demand and 20 psi under fire flow conditions during MDD.	Same as DOH Water System Design Manual.
Minimum Pipe Sizes	The minimum size for a transmission line shall be determined by hydraulic analysis. The minimum size distribution system line shall not be less than 8 inches in diameter.	Not applicable, no transmission or distribution mains.
Reliability Recommendations	• Two or more sources capable of replenishing fire suppression storage within a 72-hour period. • Sources capable of supplying MDD within an 18-hour period. • Sources must meet ADD with largest source out of service. • Back-up power equipment for pump stations unless there are two independent public power sources. • Provision of multiple storage tanks. • Standby storage equivalent to ADD*2, with a minimum of 200 gpd/ERU. • Low and high level storage alarms. • Looping of distribution mains when feasible. • Pipeline velocities not >8 fps at PHD and not >10 fps during fire flow. • Flushing velocities of a minimum of 2.5 fps for all pipelines.	Same as DOH Water System Design Manual, Chapter 5, when applicable.
Valve and Hydrant Spacing	Sufficient valving should be placed to keep a minimum of customers out of service when water is turned off for maintenance or repair. Fire hydrants on laterals should be provided with their own auxiliary gate valve.	Not applicable.

CONSTRUCTION STANDARDS

Because the system is a building with a completed plumbing system, it is anticipated that there will be no modifications or additions to the system. If modifications or additions occur, they will be done per the City of Seattle Plumbing Code and WAC DOH standards.

WATER QUALITY

Group A public community water systems must comply with the drinking water standards of the federal Safe Drinking Water Act and its amendments. The Washington State Department of Health adopted the federal standards under WAC 246-290, which were updated in 2012. A summary of the water quality standards as they apply to the Bullitt Center is described below.

WATER QUALITY MONITORING REQUIREMENTS AND RESULTS

Bacteriological

Because it serves less than 1,000 people, the Bullitt Center will be required to collect one monthly routine bacteriological sample from a sample tap within the building. Requirements for routine monthly bacteriologic sampling are detailed in WAC 246-290-300. A coliform monitoring plan is included in Appendix D. Sampling will begin once the system is approved and comes online.

Bacteriological testing of raw water from the cistern in 2014 indicated the presence of E. coli in the cistern and total coliforms present in a level too numerous to count. It is likely the source of the coliform bacteria is bird fecal matter on the roof that is entrained in the rainwater catchment system. Treatment and system maintenance and cleaning are discussed elsewhere in this Plan.

Inorganic Chemicals and Physical Characteristics

Existing State law contains maximum contaminant levels (MCLs) for inorganic chemical and physical characteristics. Primary MCLs are based on health effects, and secondary MCLs are based on other factors, including aesthetics. Sampling for inorganics is required every three years, under WAC 246-290. The Bullitt Center's inorganic sampling results from samples collected from the cistern in July and September 2014 are summarized in Table 3-2 along with a comparison of the regulatory MCLs. The water in the cistern at the time of sampling was a mix of rainwater and SPU water. Copies of the inorganic reporting forms are included in Appendix D.

TABLE 3-2

Cistern Inorganic Analysis Results

Parameter	MCL	Cistern Samples July and September 2014
Antimony	0.006 mg/L	0.00047
Arsenic	0.01 mg/L	ND
Barium	2 mg/L	0.00479
Beryllium	0.004 mg/L	ND
Cadmium	0.005 mg/L	ND
Chromium	0.1 mg/L	ND
Copper	1.3 mg/L (1)	0.05433
Cyanide	0.2 mg/L	ND
Fluoride (2)	4.0 mg/L	0.169
Lead	0.015 mg/L (1)	ND
Mercury	0.002 mg/L	ND
Nickel	0.1 mg/L	0.00522
Nitrate	10 mg/L	0.558
Nitrite	1 mg/L	ND
Selenium	0.05 mg/L	ND
Thallium	0.002 mg/L	ND
Chloride	250 mg/L	1.26
Color	15 Color Units	6(3)
Hardness	No recommendation, mg/L as $CaCO_3$	~2(3)
Iron	0.3 mg/L	ND
Manganese	0.05 mg/L	0.00636
Silver	0.1 mg/L	ND
Sulfate	250 mg/L	1.07
Zinc	5.0 mg/L	0.12985
Conductivity	700 umhos/cm	20.7
Total Dissolved Solids	NA	15

(1) Lead and Copper are not regulated as primary or secondary contaminants but rather under the Lead and Copper Rule, which sets an Action Level value as shown.
(2) SPU fluoridates their water.
(3) Analysis performed by Gray & Osborne.

The lab results in Table 3-2 indicate that the cistern water meets all of the inorganic requirements of drinking water regulations. It should be noted that some of the water in the cistern was from Seattle Public Utilities from the original filling of the cistern in April 2013. The presence of fluoride in the water would indicate that SPU water was still present in summer 2014. The 0.169 mg/L value for fluoride from September 2014 would indicate that 16 to 20 percent of the water at the time of the sampling was from SPU given that SPU generally has between 0.8 and 1.0 mg/L fluoride in the water that it delivers.

Volatile Organic Chemicals and Synthetic Organic Chemicals

The State has adopted primary MCLs for a broad class of manufactured organic chemicals. These chemicals are further divided into volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The regulations and monitoring requirements for these chemicals have been established by EPA as listed in Chapter 40 of the Code of Federal Regulations (CFR), Part 141.

Samples taken in July 2014 from the Bullitt Center's cistern were analyzed for VOCs, and SOCs including pesticides and herbicides. Neither herbicides (EPA method 515.4) nor pesticides (EPA method 508.2) were detected in the sample. For the VOC analysis, the only detectable VOC was chloroform at 0.5 µg/L, a concentration well below the MCL of 80 µg/L. It is possible that the chloroform was an artifact of the filling of the cistern with SPU water. Chloroform can be formed when chlorine reacts with organic matter in the water. SPU water typically has approximately 30 µg/L of chloroform and other trihalomethanes, according to the SPU water quality data.

VOC and SOC sampling is required every 3 years unless the requirement is waived by DOH.

Disinfection Byproducts

Disinfection byproducts are formed when organic compounds in the water react with a disinfectant like chlorine to form other compounds, such as trihalomethanes (THMs) or haloacetic acids (HAA5s). These samples must be taken in the distribution system. For the Bullitt Center the samples would be taken within the building at locations such as a kitchen sink tap.

Under the Stage 2 Disinfection Byproduct Rule, NTNC systems serving less than 500 persons are required to take two samples per year for THMs and HAA5s in the distribution system. For the Bullitt Center, these samples would be taken from sample taps in the upper reaches of the building to get samples with the longest residence times. The MCLs for THMs and HAA5s are 80 µg/L and 60 µg/L, respectively.

Lead and Copper

Lead and copper are regulated under the Lead and Copper Rule and are sampled at taps throughout the distribution system. For the Bullitt Center, ten samples will be required for each round of initial sampling since the system will be a NTNC serving between 101 and 500 people. The sample locations will be kitchen and bathroom taps as opposed to hose bibs.

Unlike most contaminants, compliance with the lead and copper rule is not a comparison with a Maximum Contaminant Level but rather a comparison of the 90th percentile value with the lead and copper Action Levels. The levels are 0.015 mg/L and 1.3 mg/L, respectively, for lead and copper. The 90th percentile value will be the second highest value among the ten samples.

The Bullitt Center will be required to perform lead and copper sampling after it begins producing its own water from the treatment system. The water system will be required to perform testing every 6 months.

If after two consecutive 6-month periods of testing where the 90th percentile results are below the Action Level, lead and copper monitoring can be reduced. For the Bullitt Center, reduced monitoring would be five samples with the average of the two highest values counting for the 90th percentile. The sampling frequency would also be reduced to once per year. If the 90th percentile values are all below the Action Levels in three consecutive years of annual sampling, the sampling frequency can be reduced to once per 3 years.

If the Action Level is exceeded by the 90th percentile concentration of either lead or copper, the Bullitt Center will need to optimize the corrosion control system and resample.

FILTRATION SYSTEM MONITORING

The Bullitt Center will be required to monitor the filtration system for various water quality parameters. The type of filtration that the Bullitt Center uses is considered an alternate filtration, the monitoring requirements for which are covered in WAC 246-290-664. A summary of these parameters is included below.

Source Coliform

The Bullitt Center will be required to collect a sample from the cistern prior to any treatment once per month.

Source Turbidity

WAC 246-290-664 (2)(d) indicates that "purveyors using an approved alternate filtration technology may be required to monitor source water turbidity at least once per day on a representative sample as determined by the department." It is likely that a daily turbidity grab sample from the cistern will be required for the Bullitt Center after the system is started up. Because of the unique nature of the cistern, it may be possible to seek a reduced monitoring schedule if it is justified. For example, during drier periods of the year, turbidity monitoring on a weekly basis would likely be sufficient to note any changes in cistern water quality that may affect treatment.

Filtered Water Turbidity

WAC 246-290-664 requires that purveyors using alternate filtration "provide monitoring in accordance with the technology-specific approval conditions determined by the department." The WAC also stipulates that purveyors with alternate technology "may reduce filtered water turbidity monitoring to one grab sample per day with departmental approval" provided that "the purveyor demonstrates to the department's satisfaction that a reduction in monitoring will not endanger the health of the consumers served by the water system." Because alternative systems are approved on a case by case basis, it is difficult to predict the filtered water turbidity monitoring requirements; however, at minimum, one grab sample per day will be required. As an alternative to grab samples, a continuous turbidity analyzer may be used to capture filtered water turbidity any time the system is filtering water.

Disinfection-Inactivation

The chlorine disinfection system will require daily monitoring to ensure at least 1-log *Giardia* and 4-log virus inactivation requirements are met. The inactivation monitoring is supposed to occur during the peak flow period of the day. For the Bullitt Center, the dedicated CT storage will likely be after filtration and before the finished water storage tank. Consequently, the filtration rate, since it is constant, would be used for calculation.

At minimum, the Bullitt Center personnel will need to take pH, temperature, and chlorine residual data after CT storage once per day to calculate inactivation. A chlorine analyzer may be used to continuously monitor chlorine any time filtration is occurring. Most analyzers also monitor temperature and pH.

Disinfection-Residual

Disinfection residuals are measured at two points in the distribution system: at entry to the distribution system and within the distribution system. For small non-community systems, DOH may (or may not) require grab sample monitoring at the entry to the distribution system. For samples in the distribution system, i.e., a sample tap within the building, the WAC stipulates that "the purveyor shall measure the residual disinfection concentration at representative points within the distribution system on a daily basis or as otherwise approved by the Department." At minimum, it is expected that the Bullitt Center will be required to collect one chlorine residual sample each day within the building.

WATER QUALITY MONITORING SCHEDULE

Water quality monitoring is required for regulatory compliance and to identify water system conditions. DOH provides guidelines for inorganic and organic monitoring under WAC 246-290-300, Monitoring Requirements, in which each system is required to prepare a Monitoring Plan that will define monitoring schedules and sample locations.

Table 3-3 lists anticipated water quality monitoring required by State law. Some water quality monitoring requirements for certain contaminants, such as for VOCs and SOCs depend, in part, on the availability of monitoring waivers from DOH.

TABLE 3-3

Anticipated Water Quality Monitoring Parameters and Frequency

Parameter	Sample Location	Frequency
Bacteriological	Distribution System and Cistern	One sample per Month
Turbidity	Cistern	Daily
Turbidity	After Treatment	Daily
Chlorine	After CT storage	Daily
Chlorine	Distribution System	Daily
pH	After CT storage	Daily
Temperature	After CT storage	Daily
Inorganics	Cistern	Every 3 Years
Nitrates	Cistern	Annually
VOCs	Cistern	Every 3 years unless DOH waiver
SOCs	Cistern	Every 3 years unless DOH waiver
Lead and Copper	Distribution System	10 samples every 6 months for two sampling periods; may be reduced to five samples every year and possibly further reduced to five samples once every 3 years
Disinfection Byproducts (THMs and HAA5s)	Distribution System	Two samples per year

SYSTEM ANALYSIS

SOURCE OF SUPPLY ANALYSIS

According to Department of Health 2009 Water System Design Manual, source production capacity must be sufficient to supply maximum day demands. In addition, maximum day and average daily demands must comply with the maximum instantaneous and maximum annual withdrawal limitations of associated water rights.

WATER RIGHTS ANALYSIS

All appropriations of water for public use within Washington State must be made in accordance with existing water rights and the established procedures that govern their implementation and use under Washington Department of Ecology (Ecology) rules. Ecology issued an Interpretive Policy Statement in October 2009 that is summarized in Ecology publication 09-11-026 Focus on Rainwater Interpretive Policy that was updated in October 2013. The policy indicates that a water right is not required for on-site storage and use of rainwater collected from a rooftop. A copy of this policy is included in Appendix E. Ecology may regulate the storage and use of rooftop rainwater harvesting in the future if the impact of future systems are shown to negatively affect instream flows or existing water rights. Even if Ecology were to begin regulating rooftop catchment systems, it is unlikely that the Bullitt Foundation would be affected since it does not impact any instream flows or existing water rights since all stormwater in the area flows through the City of Seattle's stormwater system directly to Lake Union.

SOURCE CAPACITY ANALYSIS

A description of the Bullitt Center's source of supply was presented in Chapter 1. For the Bullitt Center, the capacity of the source that is of fundamental importance is whether the rainwater collection and storage system can provide adequate source for the entire year. Seattle's rainfall pattern concentrates precipitation during the winter months with little moisture during the summer. Consequently, the system must have sufficient cistern storage to provide water during drier periods.

During the design of the Bullitt Center, the annual water use budget was developed to verify source capacity. The design process showed that the rainwater catchment system could provide the annual design use during an average precipitation year. The design analysis assumed some efficiencies for various months for capturing rainfall; i.e., inches of rain on the roof per gallon of cistern water stored.

Table 3-4 shows an annual analysis of rainfall, cistern level, and water use during an average precipitation year. The monthly precipitation totals are averages from the weather records at SeaTac airport kept since 1941. The monthly use of 10,524 gallons was determined in Chapter 2. In addition to indoor uses, the Bullitt Center was designed to use treated rainwater for some limited outdoor irrigation in the summer. The planned irrigation amounts are shown in Table 3-4.

TABLE 3-4

Annual Water Use Balance During Average Precipitation Year

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Average	Total
Assumptions														
Mean Rainfall, in.	5.24	4.23	3.92	2.75	2.03	1.55	0.93	1.16	1.61	3.24	5.67	6.06	3.20	38.39
Collection Efficiency Est.	95%	95%	95%	95%	90%	85%	85%	85%	85%	90%	95%	95%	91%	NA
Gallons collected per SF Roof	3.10	2.50	2.32	1.63	1.14	0.82	0.49	0.61	0.85	1.82	3.36	3.59	1.85	NA
Calculations, gallons														
Beginning Monthly Storage Balance	36,516	46,200	46,200	46,200	45,289	40,954	33,922	24,085	15,272	8,784	9,775	22,351	31,295	NA
Indoor Monthly Water Demand	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	10,524	126,290
Irrigation Demand	0	0	0	1,591	1,646	2,158	2,703	2,517	1,833	990	0	0	1,120	13,438
Total Water Demand	10,524	10,524	10,524	12,115	12,170	12,682	13,227	13,041	12,357	11,514	10,524	10,524	11,644	139,728
Monthly Rainfall Runoff	21,348	17,233	15,970	11,204	7,835	5,650	3,390	4,228	5,869	12,505	23,100	24,689	12,752	153,023
Ending Monthly Storage Balance	46,200	46,200	46,200	45,289	40,954	33,922	24,085	15,272	8,784	9,775	22,351	36,516	31,295	NA
Days of Storage	134	134	134	131	118	98	70	44	25	28	65	106	90	NA

The data in Table 3-4 demonstrate the seasonality of Seattle's precipitation. At the end of September, the cistern level will be at its lowest. As precipitation begins to fall in October and November, the cistern level increases until the cistern is full at the end of February. The cistern remains full until April when precipitation decreases and the cistern level continues to decrease until October. Even at its annual minimum, the amount of water in the cistern is sufficient for 25 days worth of use. This provides a buffer.

Since the intent of the Bullitt Foundation water system is to provide 100 percent of the indoor water use through rainwater capture, it is useful to consider the ability of the capacity of the system during a drought year. In reviewing weather records from Puget Sound locations with periods of records longer than 100 years, the driest year over the past 100 years was 1952, a year in which only 23.8 inches of rain fell at the SeaTac weather station compared to the average 38.4 inches. Table 3-5 is an analysis of the capacity of the water system during the 100 year low precipitation year.

TABLE 3-5

Annual Water Use Balance During 100 Year Low Precipitation Event

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Average	Total
Assumptions														
Mean Rainfall, in.	4.89	2.46	3.53	2.04	0.98	1.04	0.41	0.70	0.32	1.29	1.11	5.02	1.98	23.79
Collection Efficiency	95%	95%	95%	95%	90%	85%	85%	85%	85%	90%	95%	95%	91%	NA
Gallons collected per SF Roof	2.90	1.46	2.09	1.21	0.55	0.55	0.22	0.37	0.17	0.72	0.66	2.97	1.16	NA
Calculations, gallons														
Beginning Monthly Storage Balance	36,516	45,914	45,412	46,200	45,076	39,423	33,779	25,838	18,955	10,686	6,230	1,317	29,612	NA
Indoor Monthly Water Demand(1)	10,524	10,524	10,524	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,707	116,490
Irrigation Demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Water Demand	10,524	10,524	10,524	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,707	116,490
Monthly Rainfall Runoff	19,922	10,022	14,382	8,311	3,782	3,791	1,495	2,552	1,166	4,979	4,522	20,452	7,948	95,377
Ending Monthly Storage Balance	45,914	45,412	46,200	45,076	39,423	33,779	25,838	18,955	10,686	6,230	1,317	12,333	27,597	NA
Days of Storage	142	140	143	139	122	104	80	59	33	19	4	38	85	NA

(1) Indoor water demand includes a 40 percent reduction in shower use.

The data in Table 3-5 use a smaller indoor water use amount of 9,432 gal/week starting in April, which includes a 40 percent reduction in shower use, and it assumes that there is no outdoor irrigation using treated rainwater at all. During a normal precipitation year, the cistern would be full by the end of January, however during the historically driest year, the cistern would not be full until March. This is used as an early indicator that the year would have less rainfall than average, and that additional conservation measures should be enacted, and cistern levels should be closely monitored.

With these assumptions concerning water use reductions, the system is able to provide sufficient water with a minimum cistern volume capable of supporting 4 days worth of use at the end of November. The measures required to meet the assumptions in the drought year will be discussed in Chapter 4 Water Use Efficiency.

The Bullitt Foundation has an intertie with Seattle Public Utilities that it can use if necessary.

TREATMENT SYSTEM PERFORMANCE ANALYSIS

Rainwater catchment is considered surface water and is subject to the Surface Water Treatment Rule (SWTR) as regulated in the Washington Administrative Code (WAC) 246-290. The specific aspects of WAC 246-290 for surface water treatment are summarized below. The system must provide:

> 99 percent (2 log) removal or inactivation of *Cryptospiridium*,
> 99.9 percent (3 log) removal or inactivation of *Giardia* cysts, and
> 99.99 percent (4 log) removal or inactivation of viruses.

The required removal and/or inactivation of those pathogens is typically achieved through a combination of filtration and disinfection. Removal credit for filtration technology is either prescribed by WAC 246-290 for standard filtration technology like conventional and direct rapid sand, slow sand, and diatomaceous earth filtration, or on a case by case basis for alternative forms of filtration, such as membranes, based on DOH review of available performance information such as third party testing. Even if the filtration technology is capable of meeting all of the pathogen removal required, WAC 246-290 requires a minimum of 0.5 log *Giardia* cyst and 2 log virus inactivation by disinfection. The inactivation of viruses by disinfection is significantly easier than the inactivation of *Giardia* cysts. Therefore, systems that can meet the 0.5 log *Giardia* cyst inactivation also easily meet the 2 log virus inactivation requirement.

Inactivation of pathogens by disinfection is determined by calculation involving the disinfectant dose (C) and the time of exposure (T) to determine CT. The required CT times for the required log removals are determined by EPA published tables based upon laboratory studies.

In addition to meeting CT inactivation for pathogens, WAC 246-290 requires that water systems maintain a detectable residual. Consequently, only chemicals, such as chlorine, can be used for disinfection.

Another limitation from WAC 246-290 is that all materials that are in "substantial contact" with the water must have an NSF rating, either NSF 61 for equipment or NSF 60 for chemicals.

The existing treatment system at the Bullitt Center is analyzed below for its ability to meet the WAC 246-290 regulations with deficiencies noted.

5-Micron Carbon Filter

The 5-micron carbon filter provides a pre-filter function for the main filtration system. As such, it is not intended to fulfill the requirements of WAC 246-290 for pathogen removal, but rather is intended to improve the performance of the overall system. Carbon filters can act to remove organic matter that can lead to taste and odor issues.

Ultra-Filtration Membrane Filter

The ultrafiltration (UF) membrane filter is the unit that is intended to provide the required pathogen removal. UF membranes can provide significant pathogen removal including, in some cases, removal efficiencies higher than the WAC requirements.

Because membranes are an alternative technology, the individual installation needs to be approved by DOH either by being on the DOH list of approved units or by being listed under NSF 53, a third party system of verification. The Pentek Freshpoint unit currently installed at the Bullitt Center is not on the DOH list of approved equipment nor is it NSF 53. Consequently, it is not in compliance with WAC 246-290.

Ultraviolet Light Unit

The UV unit is designed to provide disinfection by passing UV radiation through the water sample. The UV inactivates pathogens by reacting with the pathogen DNA to render the pathogens incapable of multiplying. DOH requires that a minimum dosage of 40 mJ/cm^2 be applied for disinfection. The installed unit is nameplate rated for 40 mJ/cm^2.

DOH also requires that the reactor design be verified by third party dosimtery-based testing per DVWG W-294 standards. The existing unit, although NSF 55 compliant, has not been third party tested per DVWG W-294 standards.

0.5-Micron Carbon Filter

The 0.5-micron carbon filter is designed to address pathogen removal and provide organic removal for potential taste and odor problems. The unit is NSF 53 certified to 99.95 percent cyst removal (3.3 log *Giardia* cyst) but Washington DOH will only grant 2 log removal for *Giardia* cysts from a single filter. Although intended to be a single step in a multi-step process, the 0.5-micron filter is the only component of the system that currently meets NSF 53. It alone is providing the required cyst removal per DOH regulations.

pH Buffer

The pH buffer unit is designed to increase the pH of the finished water to make it less corrosive. While not designed to address pathogen removal, the pH buffer does address corrosivity issues that can lead to problems with lead and copper levels, another water quality concern regulated by WAC 246-290.

Disinfection

The existing treatment system does not have a disinfection component that can provide the required residual and the additional 1 log inactivation of *Giardia* cysts. Consequently, the existing treatment system is not in compliance with WAC 246-290 in this regard.

Fluoridation

The City of Seattle passed Ordinance 96931 in 1968 to provide for the fluoridation of the City's municipal water supply. Although the Bullitt Center is located within the City of Seattle, the City Attorney has determined that the ordinance only applies to the City's municipal water supply, and thus the Bullitt Center does not need to fluoridate its water source. A letter from the Seattle City Attorney office outlining this decision is included in Appendix D.

Summary

In short, the existing treatment system does not meet WAC 246-290 for pathogen removal and inactivation. The 0.5-micron carbon filter fulfills the filtration requirement of the SWTR but the means of disinfection are deficient in this regard. The pH buffer unit should provide a regulatory benefit for lead and copper compliance.

The UV and ultra-filtration membrane units are not needed, nor do they meet WAC certification requirements, and thus will not be used for finished water at this time. A chlorine feed system will be installed, along with piping to achieve adequate disinfection contact time.

SOURCE AND TREATMENT SYSTEM HYDRAULIC CAPACITY

The existing treatment system is designed for 1.2 gpm continuous flow with a maximum intermittent flow of 5.9 gpm in both its pumping and treatment capacity. The ultra-filtration (UF) membrane limits continuous flow to 1.2 gpm and the UV system limits maximum flow to 5.9 gpm. At the low end of this range, the system can provide 1,728 gallons per day. This capacity is well above the maximum day requirement determined in Chapter 2 of 522 gallons per day.

As discussed above, the existing treatment system must be modified to meet requirements in WAC 246-290. The recommended modifications include removing the UF membrane and UV unit, and installing a chlorine injection system and CT piping. The volume of CT piping needed is a function of the disinfectant concentration and the treatment plant flow rate. The preliminary CT calculations in this Plan assume a flow rate of 4 gpm, which was calculated by taking into account available space for CT piping and equalizing storage requirements, which are discussed further in this chapter.

STORAGE ANALYSIS

Storage requirements are determined according to the DOH Water System Design Manual, 2009. The storage requirements are based on the sum of the following:

- Operational Storage
- Equalizing Storage
- Standby Storage
- Fire Suppression Storage

Operational Storage

Operational storage is the amount of a storage vessel that is used for providing the controls for filling the vessel. In other words, it is the difference between a full reservoir and the water level that triggers filling the tank. For the Bullitt Center, the operating storage is estimated at 100 gallons for this analysis.

Equalizing Storage

Equalizing storage is typically used to meet diurnal demands that exceed the average daily and peak day demands. The volume of equalizing storage required depends on peak system demands, the magnitude of diurnal water system demand variations, the source production rate, and the mode of system operation. Sufficient equalizing storage must be provided in combination with available water sources and pumping facilities such that peak system demands can be satisfied.

Equalizing storage is calculated using the following equation:

$$V_{ES} = (Q_{PH} - Q_S)150 \text{ minutes}$$

V_{ES} = Equalizing storage component (gallons)
Q_{PH} = Peak hourly demand (gpm)
Q_S = Total source of supply capacity, excluding emergency sources (gpm)

The peak hour demand at the Bullitt Center was estimated for a weekday when the offices are at full occupancy and there is an event with 100 people. The peak hour demand is estimated at 6.6 gpm and the treated water production capacity is calculated at 4 gpm. The flow rate of 4 gpm was selected as the proposed treatment system flow rate, and is based on balancing equalizing storage and contact time needs.

Using the equation described above, the equalization storage required at the Bullitt Center is 387 gallons.

Standby Storage

Standby storage is provided in order to meet demands in the event of a system failure. For the Bullitt Center, standby storage would be used for a power outage or a shutdown of the water treatment system due to a breakdown, contamination in the cistern, or routine maintenance.

Municipal and community systems are required to maintain standby storage adequate for serving the system if the source is out of service, usually twice the average day demand. Non-transient, non-community systems with no permanent residential structures are not required to have standby storage. While maintaining some amount of standby storage is still prudent in the event that the treatment system is not operable and people must still be in the building, the Bullitt Center can use the SPU connection to fill the day tank when needed. As a result, no standby storage is assigned to the day tank.

Fire Suppression Storage

Fire suppression storage is provided to ensure that the volume of water required for fighting fires is available when necessary. Because the Bullitt Center water system does not provide fire flow from its rainwater system, fire suppression storage is not required. The Bullitt Center retains a service connection Seattle Public Utilities for fire suppression service.

Summary

Table 3-6 summarizes the storage analysis for the Bullitt Center.

TABLE 3-6

Storage Capacity Analysis

Storage Component	Gallons
Available Effective Storage	500
Operational Storage	100
Equalizing Storage	387
Standby Storage	0
Total Required Storage	487
Storage Surplus/(Deficit)	13

This analysis indicates that the Bullitt Center has adequate storage to meet design demands.

DISTRIBUTION SYSTEM ANALYSIS

Booster Pumps

The potable water system is supplied by two 25-gpm pumps and one 79-gallon pressure tank. The potable system is a closed system, thus the pumps must be capable of supplying PHD at 30 psi with the largest pump out of service. Peak hour demands have been estimated to be 6.6 gpm at full occupancy. The booster pumps have sufficient capacity to meet PHD.

DOH recommends that pumps be designed to operate for six cycles or less per hour, although higher frequencies are permitted if justified by the pump or motor manufacturer's warranties. At 6.6 gpm, peak hour demand is approximately 395 gallons. If the pressure tank is allowed to drain halfway, the pumps will cycle a total of ten times within the hour. Since the pumps alternate operation, each pump would likely cycle five times per hour, which is within the recommended frequency.

At the current level of occupancy, approximately half of building capacity, building SCADA records indicate that the booster pumps cycle approximately ten cycles per day per pump with most of the cycling occurring within the eight hour workday. This would suggest that each pump currently cycles one to two times per hour.

SCADA records indicate that the non-potable booster pumps have cycled approximately five times per day per pump with most of the cycling occurring within the 8 hour workday. This suggests that each pump cycles approximately once every 90 minutes.

SUMMARY OF SYSTEM DEFICIENCIES

IDENTIFIED SYSTEM DEFICIENCIES

Source

The building capacity and water system has been design to be self contained, and for demands to be able to be met entirely by rainwater. The initial water use data indicates that the current building tenants' water use is within the design considerations. The Bullitt Center will monitor the use of water and the efficiency of rainwater capture after it begins to use rainwater for all of its domestic water to ensure that all design assumptions are valid. However, the existing roof membrane is not currently NSF 61 or NSF P151 certified.

Treatment Hydraulic Capacity

The existing treatment system has surplus hydraulic capacity for the design requirements.

Storage

The existing storage system is sufficient to meet design demands.

Treatment

The existing treatment system is not in compliance with WAC 246-290. The installed UF filter unit is not approved by DOH nor is it NSF listed. The existing 0.5-micron carbon filter is NSF approved and provides a DOH prescribed maximum of 2 log *Giardia* cyst removal.

The existing system does not have a disinfection system that provides a residual nor does it meet the requirements of WAC 246-290 for pathogen inactivation. The Bullitt Center will need to install disinfection that will provide an additional 1 log *Giardia* cyst inactivation and maintain a disinfectant residual in the building piping. Along with a new disinfection system, the Bullitt Center will also have to install CT piping prior to the finished water day tank.

Distribution System

The distribution system, including the two pumps and two pressure tanks, have adequate capacity to provide average day, maximum day, and peak hour demands.

CHAPTER 4

WATER USE EFFICIENCY PROGRAM

A viable water use efficiency plan is a requirement of water system planning. The following chapter presents the Bullitt Center's Water Use Efficiency Program.

WATER USE EFFICIENCY PLANNING REQUIREMENTS

The Washington Legislature passed the Water Use Efficiency Act of 1989 (43.20.230 RCW) which directs the Department of Health (DOH) to develop procedures and guidelines relating to water use efficiency. In response to this mandate, the Department of Ecology (Ecology), the Washington Water Utilities Council, and DOH jointly published a document titled Conservation Planning Requirements (1994). In 2003, the Municipal Water Supply – Efficiency Requirements Act (Municipal Water Law) was passed and amended RCW 90.46 to require additional conservation measures. The Municipal Water Law, among other things, directed DOH to develop the Water Use Efficiency Rule (WUE Rule), which is outlined in the Water Use Efficiency Guidebook and became effective January 22, 2007. These documents provide guidelines and requirements regarding the development and implementation of conservation and efficiency programs for public water systems. Conservation and efficiency programs developed in compliance with these documents are required by DOH as part of water system planning documents and by Ecology as part of a public water system water right application. Conservation must be evaluated and implemented as an alternate source of supply before state agencies approve applications for new or expanded water rights.

The requirements of the WUE differ for municipal and non-municipal water suppliers. The Bullitt Center is considered a non-municipal, non-transient, non-community (NTNC) water system. NTNC systems must fulfill the following WUE related requirements.

- Install production meters;
- Provide monthly and annual water production data by source and consumption data by customer class;
- Provide demand forecast for 6- and 20-year periods with and without efficiency savings;
- Evaluate the affordability and feasibility of a water rate structure that will encourage demand efficiency; and
- Create a water use efficiency program taking into consideration the water supply characteristic and affect from current and future use on the water supply.

As a non-traditional water system, several of the above requirements do not translate to the Bullitt Center's system. The following chapter discusses the requirements as they relate to the Bullitt Center's water system.

DATA COLLECTION AND REPORTING

For conventional water systems, the WUE Rule requires regular collection of metered production and consumption data for the purpose of calculating leakage, forecasting future water demands, indentifying areas for more efficient water use, and other purposes.

The Bullitt Center meters the non-potable water used for toilets and irrigation and the amount of potable treated water produced. Temporary supply from SPU is also currently metered, and the meter will remain in place as an emergency source once the Bullitt Center gains approval of their water system and can begin using only rainwater as their source.

Data collection for the Bullitt Center will vary from conventional systems, since there is no differentiation between production and consumption. The Bullitt Center will report the volume of treated water on a monthly and annual basis.

DEMAND FORECAST

The Bullitt Center's water demands are discussed in Chapter 2. Currently, the Bullitt Center is not at full occupancy; however it is anticipated that it will reach full occupancy within the 6-year planning period. At that point, water demand is projected to remain fairly constant. Fluctuations may be caused by temporary reductions in occupancy if office spaces turn over, or by variations in event attendees and visitors.

At full occupancy, it is projected that the annual demand will be 126,290 gallons, which equates to 346 gpd.

The Bullitt Center's system consists of a single source and a single service, thus production and consumption are the same quantity. These terms can be used interchangeably, along with the term water demand.

RATE STRUCTURE

Water use, along with the use of other utilities, maintenance costs, and insurance, are included in the triple net leases used for each tenant. Water use is billed based on the pro-rated share of usage based on square footage leased per tenant. While receiving supply from SPU, the SPU bill is divided in this manner. When the treatment system comes online and the SPU connection is no longer used, the monthly costs for operating the system will be divided amongst the tenants in the same way.

WATER USE EFFICIENCY PROGRAM

As a non-municipal NTNC water system, the components of the Bullitt Center's WUE program varies some from those required for municipal systems. While DOH has not provided specific program requirements for non-municipal systems, they recommend that the following elements be included.

- Set water saving goals for supply side and demand side to promote water use efficiency;
- Identify water saving measures to meet goals;
- Evaluate, report, and manage water loss;
- Educate customers about WUE;
- Install consumption meters to determine annual usage and customer class data;
- Evaluate WUE program effectiveness over 6 years; and
- Report WUE program success annually to customers.

The following sections address these requirements and discuss the Bullitt Center's WUE program, including a discussion of the water supply characteristics.

WATER SAVING GOALS

As stated in the Bullitt Center's mission statement, "one of the Bullitt Center's goals is to minimize its water demand…so that it can be met by the rain that falls on its roof." Quantitatively, this means keeping potable and irrigation demand to less than approximately 95,377 gallons per year during the driest year, or 153,053 gallons during normal rainfall years.

The entire water system has been designed to meet this goal, from the roof catchment area and cistern capacity, to the size and types of gardens and how much irrigation is needed, to the water fixtures within the building.

WUE MEASURES

The WUE Rule recommends identifying water use efficiency measures to help meet the WUE goals. The Bullitt Center is implementing the following measures as part of the WUE Program.

Source Metering and Meter Calibration

The Bullitt Center meters the non-potable water used for toilets and irrigation and the amount of potable treated water produced. Temporary supply from SPU is also currently metered, and the meter will remain in place as an emergency source once the Bullitt Center gains approval of their water system and can begin using only rainwater as their source. These meters were calibrated during installation, and will be calibrated per the AWWA recommended schedule.

Leak Detection and Water Accounting

One benefit of having a single meter that directly supplies fixtures is that production can be monitored for potential leaks within the system. If a leak is suspected and there are no visible signs of a leak, usage can be tracked using meter data for periods of no authorized use, such as night time when no one is in the building. Any registered usage or demand could indicate a leak and alert system staff to investigate further.

User Education

The Bullitt Center has three types of users: permanent tenants, event attendees, and visitors to the Discovery Commons. Each type of user receives education regarding the mission of the Bullitt Center.

All the firms that occupy the Bullitt Center are required to commit to energy and water budgets as part of the lease to ensure the building meets the Living Building Challenge. Education is a key part of this to ensure that all individual tenants and users adhere to and honor the philosophy of the Bullitt Center.

Transient users, such as event attendees and visitors, receive education on the Bullitt Center's mission and water use goals as well. The Discovery Commons, operated by the University of Washington Center for Integrated Design (CID), includes comprehensive exhibits on all aspects of the Bullitt Center to educate visitors on the basic sustainable systems used in the Bullitt Center. CID also offers tours to the public four days a week, and offers private group and technical tours upon request.

Conservation Rate Structure

As discussed above, the Bullitt Center does not have a traditional rate structure seen in most water systems. Water use is worked into the triple net lease system used for each tenant. As a result, there is no need for a conservation rate structure.

Reclaimed Water

The Bullitt Center has a grey water reclamation system that uses water from sinks and showers to infiltrate into the aquifer. Water and biodegradable soap drains to a 500-gallon storage tank in the basement. From there, up to 500 gpd is pumped to a constructed wetland on the third floor. The constructed wetland consists of several layers of porous gravels and soils, and horsetails. Grey water is recirculated through a series of drip lines, allowing the plants to absorb nutrients. Finally, the excess water is collected and diverted to bioswales on the western side of property. The bioswales are under-laid by 20 vertical feet of gravel, which the water filters down through before entering the water table. According to the Bullitt Center's website, the design engineers estimate that "this catch and slow release of water allows the Bullitt Center to restore 61 percent of the water to the ecosystem either through ground infiltration or evaporation, and mitigate stormwater during and after rain events."

Low Flow Fixtures

All water fixtures in the Bullitt Center are low-flow fixtures. Most notably, the Bullitt Center uses Phoenix Composters with Neptune Foam toilets and Ecourinal ETEU-100 waterless urinals, in addition to low-flow sinks, dishwashers, and showers. Table 4-1 summarizes these fixtures and includes comparison of the low-flow and conventional water use.

TABLE 4-1

Summary of Low-Flow Fixture Water Use

Fixture	Flow rate unit	Bullitt Center Low-Flow Fixture Flow Rate	Conventional Fixture Flow Rate
Toilet	Gal/flush	0.008	1.6
Urinal	Gal/flush	0	1
Kitchen Sink	gpm	2	2.5
Dishwasher	Gal/use	4	18
Bathroom Sink	gpm	0.5	1.5
Service Sink	gpm	2	2.5
Shower	gpm	1	2.5

WATER SUPPLY ANALYSIS

As discussed in Chapter 3, the rainwater source capacity is estimated to be approximately 153,025 gpd on average, and could be as low as approximately 95,380 gpd based on historic rainfall. Average potable demand is estimated at approximately 10,524 gpd, and annual potable demand at approximately 126,290 gpd, which is greater than the minimum historic rainfall during a drought year.

The Bullitt Center will monitor cistern levels throughout the year, along with rainfall, and will use that data to determine if reductions in water use or use of the SPU source is needed. An analysis of water use, cistern levels, and days of storage is included in Chapter 3 for a year with average rainfall and also for the historic low rainfall year. During the normal year, the cistern will be completely full and overflowing additional rainfall in January, February, and March. During the low rainfall year, the cistern will not completely fill until March. Cistern levels during the first several months of the year should be used to help determine if and/or when water use needs to be curtailed in order to maintain adequate storage throughout the year.

If the Bullitt Center opts to reduce water use, the likely areas of conservation would be to eliminate irrigation uses and to reduce shower usage. Table 3-5 shows the annual water balance under the lowest historic rainfall with irrigation use eliminated and shower usage reduced by 40 percent. With these additional conservation measures, the system can still maintain a minimum of 4 days of storage in the cistern.

It must be noted that this water supply analysis is based on the design water usage for the building, and the water use profile may change as real water use data is collected.

WATER LOSS

Non-municipal water systems are encouraged to evaluate, manage, and report water loss. This component of the WUE Rule is a variation of the distribution system leakage (DSL) requirement for municipal water systems. DSL is the difference between production and authorized consumption such as metered or other credibly estimated authorized usage. DSL may include physical leaks within the distribution system, billing and accounting errors, and unauthorized usage. The WUE Rule requires that municipal water distribution systems have a leakage rate less than 10 percent of finished water production based on a 3-year rolling average.

Production and consumption are the same amount for the Bullitt Center, as discussed earlier, and thus the standard definition of DSL does not apply. While it is possible that the Bullitt Center may at time experience physical leaks within the system, water loss will likely take the form of system components not performing at the anticipated levels of efficiency, or human misuse of water. The Bullitt Center intends to closely monitor demand and system operation to evaluate if the system is operating as planned and if adjustments to either the physical infrastructure or customer use are needed.

PROGRAM EVALUATION AND REPORTING

As discussed above, the Bullitt Center will continuously monitor the system and demand to ensure that water demand does not exceed the source capacity in terms of rainfall and cistern storage.

The Bullitt Center reports utility usage in comparison to the energy budget to tenants.

CHAPTER 5

SOURCE WATER PROTECTION

OBJECTIVE

The Bullitt Center relies on rainfall and a roof catchment system, which is considered a surface water source, to meet its water supply needs. To protect water supplies, the Environmental Protection Agency (EPA) and Washington Department of Health (DOH) require public water utilities to develop a source water protection program as a component of its water system plan. The purpose of a source water protection program is to provide local utilities with a proactive program for preventing source water contamination.

WATERSHED CONTROL PROGRAM

In Washington State, water supply systems using a surface water source must develop and implement a watershed control program in order to protect the water supply and the health of water system customers. For a traditional water system, the watershed is typically a large area of land, sometimes with multiple uses, that contributes water to the source. For the Bullitt Center, the watershed is confined to the roof collection system area. The term roof collection system is used interchangeably with the term watershed for the remainder of this chapter.

The objective of this section is to document the Bullitt Center's program for roof collection system control to protect source water quality. This program identifies possible pollutants and contaminants within the collection system that may affect the raw water. Protection and management of the roof collection system can be accomplished through regular maintenance and cleaning of the catchment area, and by developing a protocol for roof access. This chapter has been prepared to fulfill the watershed control program requirements for filtered systems.

REGULATORY REQUIREMENTS

Specific criteria against which the adequacy of source water protection is evaluated is provided in the following regulations:

- WAC 246-290-135 (5), Source Protection
- WAC 246-290-668, Watershed Control, and
- WAC 246-290-678, Reliability for Filtered Systems.

Source Protection

In accordance with WAC 246-290-135, subpart (5), the Bullitt Center's Water System Plan shall include a description of the roof collection system including location and size, hydrology, ownership, and activities that may adversely affect source water quality. It will also include similar discussion on the cistern. The WAC also requires a description of relevant written agreements, monitoring activities, and assessment of water quality.

Watershed Control

In concert with Source Protection, WAC 246-290-668 requires an evaluation of the Bullitt Center's Watershed Control Program at least every 6 years. The program shall describe the watershed and characterize the hydrology. All changes in the watershed over the previous 6 years and that adversely affects source water quality must be described. The purveyor shall also have a monitoring program in place to assess the adequacy of the Watershed Control Program.

Filtered System Reliability

WAC 246-290-678 requires all water systems with filtration technology to provide reliability features. The WAC requires such features as alarm devices to warn of treatment process failures, standby replacement equipment to ensure continuous operation, and redundant filter units.

WATERSHED DESCRIPTIONS AND CHARACTERISTICS

LOCATION AND SIZE

The Bullitt Center's roof collection system encompasses approximately 6,880 square feet in three segments, all of which are tied to the rainwater collection system via downspouts. The roof is coated with a membrane system.

The raw water system also includes a 46,200-gallon cistern in the basement of the Bullitt Center. The cistern can be accessed via a manhole flush with the floor in the building's mechanical room. The mechanical room houses heat pumps, water heaters, and equipment for the geothermal heating and cooling system including the glycol feed tank.

Additionally, the inlet to the cistern includes a vortex filter which can be accessed for maintenance in the conference room on the ground floor. Both the manhole and vortex filter are possible points of entry for contaminants.

HYDROLOGY

Mean annual precipitation to the roof collection system is approximately 38.39 inches per year. The area receives approximately 153,053 gallons of water per year of precipitation.

ROOF COLLECTION SYSTEM AREA OWNERSHIP

The roof collection system is owned by the Bullitt Foundation, along with the rest of the water system and building.

WATERSHED MONITORING

The watershed for the Bullitt Center consists of the roof catchment area and photovoltaic cells, since many of these drain to the roof catchment. The building systems staff person visits the roof monthly to visually inspect the catchment area. The roof access is kept locked and only authorized people within the building have access to it.

The mechanical room is visited daily during the week and is visually inspected for possible leaks that could reach the cistern through the manhole. The vortex filter is inspected monthly.

CONDITIONS AND ACTIVITIES THAT ADVERSELY AFFECT SOURCE WATER QUALITY

The Bullitt Center's roof collection system is susceptible to natural and man-made contaminants from wildlife, plant debris, human access, and HVAC system equipment, which is located within one of the roof sections. These present a potential risk to water quality and water quantity within the watershed.

Wildlife can be a source of contamination to water quality through their feces. Fecal coliforms, when present in sufficient numbers in drinking water, indicate the potential for a number of diseases. The presence of fecal coliforms can be mitigated by chlorinating the water supply. The types of wildlife that could impact the water system include birds and small mammals like squirrels or mice. Plant debris may also enter the collection system if blown onto the roof.

Equipment for the building's HVAC system is located on the roof. Equipment includes air conditioner units, dampers, exhaust and intake fans, and HVAC control panels. Maintenance is sometimes required on the HVAC equipment, requiring building staff, outside contractors, and tools to be brought onto the roof and into the collection system area, which increases the risk of contamination of the water supply.

The cistern water quality may be impacted if there is a spill of any type of liquid in the mechanical room. The manhole is flush with the floor and is not watertight. The vortex filter is the least susceptible point of contamination since it is enclosed normally and not exposed to contaminants unless tampered with by a person.

WATER QUALITY ASSESSMENT

The Washington Department of Health (DOH) classifies source water based on two criteria, vulnerability and susceptibility. Vulnerability is the water source's potential for contamination and is composed of two factors: the physical susceptibility to the infiltration of contaminants and the risk to the source from exposure to contaminants. Susceptibility is determined by conditions that affect the movement of contaminants from the land surface into a water supply. DOH has not yet assigned a classification to the Bullitt Center water source.

As discussed in Chapter 3, raw cistern water testing in 2014 indicated the presence of E. coli and total coliforms present in a level too numerous to count. It is likely the source of the coliform bacteria is bird fecal matter on the roof that is entrained in the rainwater catchment system. Sampling also showed that the cistern water met all IOC, VOC, and SOC requirements. Overall, the rainwater source water will be high quality, with the exception of bacteria from the roof catchment.

CURRENT WATERSHED CONTROL PLAN

Currently, the Bullitt Center has policies and procedures in place to provide protection of the roof catchment area and other access points to the cistern.

ACCESS RESTRICTIONS

The Bullitt Center limits access to the roof catchment area, mechanical room, and vortex filter to only authorized people to reduce the potential for human contamination of the source water. The roof access door, mechanical room door, and access panel door to the vortex filter are all kept locked preventing unauthorized access. Additionally, chains are strung on the roof segmenting much of the catchment area further limiting human access to those areas.

ROOF CATCHMENT MEASURES

In addition to limited access, the Bullitt Center requires that the roof drains be plugged/capped at the roof level when maintenance is being performed on the HVAC system. This prevents any harmful materials from reaching the cistern in the event of a spill or leak during maintenance activities.

The area on the roof directly in front of the door and surrounding the HVAC components that must be checked frequently by building staff are covered with walking mats. The mats limit debris from shoes or tools from reaching the roof drains.

CONTINGENCY PLAN

All Group A public water supply systems must develop a contingency plan in the event that a main source of water is lost due to contamination or by some other unforeseen event. Depending on how much of the system is contaminated, the Bullitt Center has the option of transferring over to Seattle Public Utility water. SPU water can either be used to fill the day tank or can be connected directly to the building distribution piping. As a non-transient, non-community system, the Bullitt Center also has the ability to close down and not allow occupants into the building if the water system becomes contaminated, or to provide an alternate source of potable water for drinking and handwashing.

EMERGENCY RESPONSE

If an emergency concerning the raw water source should occur, such as a spill on the roof or in the mechanical room, or significant contamination by an animal is discovered, the building systems manager should be contacted immediately. Depending on the severity of the contamination, DOH may also need to be contacted.

RECOMMENDED WATERSHED PROTECTION MEASURES

The following is a list of actions the Bullitt Center may consider for additional protection of its watershed.

CISTERN MANHOLE PROTECTION

The manhole to the cistern is located in the building mechanical room and is flush with the floor. It is not watertight, and thus any spilled liquid could enter the cistern through the manhole. It is recommended to keep a mat over the manhole cover to make it more water-tight, and that a spill cleanup kit be stored close by.

SPILL/INCIDENT RESPONSE PROGRAM

Spill response planning is an important element of an emergency management plan and a watershed protection program. Specific response procedures for watershed protection areas must be determined prior to the occurrence of a contamination incident. The information obtained as a result of the susceptibility assessment can be used to determine what types of spill response measures are necessary for the protection of drinking water sources.

Spill control and cleanup kits should be kept on the roof and in the mechanical room. These kits typically include absorbent pads and cloths for cleanup, and socks for isolating a spill. These kits should be well marked and located in a location that is easy to access.

PERIODIC WATERSHED EVALUATION AND UPDATES

The Washington Department of Health requires that water system plans be updated every 6 years. Watershed Control Plans are also required to be updated at within 6 years, and then become an integral part of the Water System Plan. The watershed control plan should describe any changes that have occurred within the watershed since the last update.

CHAPTER 6

OPERATION & MAINTENANCE PROGRAM

OBJECTIVE

The objective of this chapter is to provide an evaluation of the Bullitt Center's operation and maintenance (O&M) program and its ability to assure satisfactory management of the water system operations in accordance with WAC 246-290-100, -300, -310, -320, -440, -480, and -490, and WAC 246-292-020, -050, and -090. The Bullitt Center's O&M program manual and specific component related documentation are maintained by the Bullitt Center for use by operations personnel. This information is considered sensitive information and is not intended for general distribution to the public.

The O&M Program will include the following elements:

- Water System Management and Personnel
- Operator Certification
- System Operation and Control
- Comprehensive Monitoring Plan
- Emergency Response Program
- Safety Procedures
- Cross-Connection Control Program
- Customer Complaint Response Program
- Recordkeeping and Reporting
- O&M Improvements

The following comments are presented as an assessment of the adequacy of each section of the Bullitt Center's operation and management program.

WATER SYSTEM MANAGEMENT AND PERSONNEL

The Bullitt Foundation is the overall manager of the water system, and has contracted out operation of the water system to UniCo, a Seattle-based real estate investor and full-service operating firm. Ultimately, the Bullitt Foundation is responsible for making final decisions regarding system maintenance and improvements, as well as finances and billing. A full-time building system operator, hired through UniCo, completes the day-to-day tasks such as normal system operation, routine and preventive maintenance, water quality monitoring, cross connection control, and field engineering. The Foundation and the UniCo operator share some responsibilities including complaint response, emergency response, and public/press contact.

OPERATOR CERTIFICATION

Minimum public water system staff certification requirements have been enacted by the state legislature. These requirements are contained in Chapter 246-292 of the Washington Administrative Code (WAC), entitled "Waterworks Operator Certification." Water system classification is separated into water treatment plant and distribution classifications.

DOH will assign the final designation to system as either a Class 1 or Class 2 system. Operator certifications for both Class 1 and Class 2 systems are shown in Table 6-1. The distribution system is classified as Class S, which means that the operator must obtain a Water Distribution Specialist (WDS) certification.

TABLE 6-1

Operator Certification Requirements

System Classification	Operator Certification Required
Distribution System: Class S	Water Distribution Specialist (WDS)
Treatment System: Class 1	Basic Treatment Operator (BTO)
Treatment System: Class 2	Water Treatment Plant Operator 2 (WTPO 2)

Table 6-2 summarizes education requirements for the classifications listed in Table 6-1.

TABLE 6-2

Minimum Education and Experience Requirements for Water Works Operator Certifications

Water Works Operator Classification	Certification Level					
	Operator in Training		Level One		Level Two	
	Education	Experience	Education	Experience	Education	Experience
Water Treatment Plant Operator (WTPO)	12 years	3 months	12 years	1 year	12 years	3 years
Water Distribution Specialist (WDS)	12 years	3 months	12 years	1 year	12 years	3 years
Basic Treatment Operator (BTO)	NA	NA	NA	NA	NA	NA

CERTIFIED OPERATOR STAFF

The building operation firm has expressed a commitment to providing a certified operator or operators once the system classification has been designated. An interim contract operator will be hired until such time that regular staff becomes certified.

PROFESSIONAL GROWTH REQUIREMENTS

In order to promote and maintain expertise for the various grades of operator certification, Washington State requires that all certified operators meet professional growth requirements by completing no less than three Continuing Education Units (CEUs) within each 3-year period. Programs sponsored by both Washington Environmental Training Resources Center (WETRC) and the American Water Works Association (AWWA) Pacific Northwest Subsection are the most popular source of CEUs for certified operators in Washington State.

SYSTEM OPERATION AND CONTROL

A schematic of the water system is shown in Figure 1-2. Operation and control of the water system is accomplished mostly manually with some processes automated using telemetry. The system monitors and regulates the flow through the source meters from SPU, monitors the water levels in the cistern and day tank, monitors and controls the status of the raw and finished water booster pumps, and monitors system pressures. This allows the staff to control the operation of these facilities. A description of normal operation of each facility is given in the following sections.

IDENTIFICATION OF MAJOR SYSTEM COMPONENTS

Major system components are shown schematically on Figure 1-2. All facilities are described in Chapter 1 as well. A description of the normal operation of each potable system facility is given in the following sections.

Roof Catchment

The roof catchment is approximately 6,880 square feet in three segments. Water flows by gravity to three separate pairs of roof drain pipes located in the northwest, northeast, and southeast corners of the roof.

Vortex Filter

The collected rainwater is piped into a common line and then directed to a vortex filter system. The vortex filter contains a 280-micron filter screen that removes debris from the water stream. A portion of flow is diverted with the debris to the building's stormwater system while the filtered flow is directed to a concrete, rainwater storage cistern located in the basement of the Bullitt Center.

Cistern

Raw water is stored in a 46,200-gallon concrete cistern incorporated into the building foundation in the basement. The vortex filter stormwater diversion sets the overflow elevation of the cistern. The cistern includes a level sensor and temperature sensor, and floating intake for the treatment system.

Treatment and Disinfection System

The existing treatment system must be modified to meet DOH requirements. The proposed system will retain the 5- and 0.5-micron carbon filters, as well as the pH buffer. A chlorine injector will be installed. The system will turn on and off automatically based on levels in the day tank.

Day Storage Tank

The treated water is stored in a 500-gallon polyethylene reservoir. Once the system gains approval and is operable, the tank will provide equalizing and standby storage to the building. An ultrasonic level sensor in the tank provides automatic call points for the treatment system.

Booster Stations and Distribution System

The potable water system in the Bullitt Center is pumped to the building's distribution system using a skid mounted booster pump assembly. The pump assembly pumps water from the day tank to the distribution system. The potable booster system is composed of two, 3-hp, 25-gpm pumps and one 79-gallon expansion pressure tank. The controls are set by pressure and maintain between 65 and 75 psi at the booster station.

The non-potable system pumps to a separate distribution system that supplies the toilets and a limited amount of outdoor irrigation. The non-potable booster system includes two 3-hp pumps set to maintain between 55 to 65 psi at the pumps.

The building piping for potable cold and hot water is composed of 1/2-inch to 2-inch plumbing to provide potable service to the tenants on the various floors. The potable system is design to provide flow for drinking fountains, showers, and sinks.

Telemetry and Controls

The water system is controlled and operated automatically by a SCADA system and is monitored by the operator. The automation system human-machine interface (HMI) provides real time and historic data including:

- Cistern level and water temperature
- Day tank level

- Pump status, amps, starts, and run-time
- Treatment component operation status
- Solenoid valve status

System Interties

The Bullitt Center maintains two service connections with SPU. A 2-inch connection provides fire flow for a sprinkler system while a 5/8-inch connection is maintained as an emergency source of supply. The fire system meter is always active and will open automatically in the event of a fire. The emergency domestic water source enters the system in the water treatment area in the basement. The source can be used to just fill the day tank or to supply the entire building directly. The inlet is valved off and must be opened manually when needed. In addition to valving, the SPU connection has a removable section of spool that directs water either to the day tank or to the distribution system, and prevents the system being served by both the day tank and pumps and directly by SPU.

Alternative Operation Modes and Circumstances

In the event that sufficient raw water or treated finished water is not available, the Bullitt Center may use SPU water. As discussed previously, the SPU domestic source can be used to just fill the day tank, and have the pumps and pressure tank provide pressure to the system, or it can supply the distribution system directly without the use of the pumps and pressure tank. Both options require manually isolating portions of the existing treatment and pumping system.

ROUTINE SYSTEM OPERATION

The Bullitt Center will perform routine operation of the water system in accordance with the following schedule. It is estimated that the building system operator will spend 8 hour per week performing routine operations of the water system.

TABLE 6-3

Normal Operation Schedule

Daily
Record the following on the DOH Water Treatment Plant Monthly Report: Volume of Water Treated Pounds of Chlorine Used Treatment Rate Raw and Finished Water Turbidity
Record the following on the DOH SWTR Disinfection Monthly Report: Inactivation Ratio Determination Peak Hour Flow

TABLE 6-3 – (continued)

Normal Operation Schedule

Daily
Water Temperature pH Chlorine Residual Contact Time Calculated CT Required CT Inactivation Ratio Disinfection Residual at Distribution System Entry Point Number of Samples Collected Lowest Daily Residual Duration Less than 0.2 mg/L Residual in Distribution System Number of Sites Sampled Number of Samples Residual Not Detected
Inspect and Adjust Chlorination Equipment
Inspect Day Tank for Level
Monthly
Submit the DOH Water Treatment Plant Monthly Report to DOH
Submit the DOH SWTR Disinfection Monthly Report to DOH
Inspect Roof Catchment Area for Contamination and/or Debris and Clean as Necessary
Inspect Vortex Filter for Contamination and/or Debris and Clean as Necessary
Semi-Annually
Inspect Cistern for Contamination and/or Debris and Clean as Necessary
Inspect Day Tank for Contamination and/or Debris and Clean as Necessary
Inspect Pumps and Pressure Tank

Startup and Shutdown Procedures for Each Major System Component

The Bullitt Center water treatment system is design to be operated mostly manually. Procedures for startup and shutdown will be described in detail in the building's Operation and Maintenance Manual.

Meter Reading

The potable water meter is currently read weekly. When the system comes online and is no longer using SPU water, production meters will be read and recorded daily during the work week.

System Performance Evaluation Procedure

Performance of the water treatment plant will be monitored in accordance with WAC 246-290 Part 6: Surface Water Treatment. The following parameters will be monitored daily including residual disinfectant and pH.

PREVENTIVE MAINTENANCE

The most cost effective method for maintaining a water system is to provide routine planned preventative maintenance. Through a planned maintenance program, the optimal level of maintenance activities can be provided for the least total maintenance cost. Preventative maintenance programs involve defining the task to be performed, determining the frequency for each task, and then providing necessary staff to perform the task.

Preventative Maintenance and Inspection Activities

Preventative maintenance is an ongoing effort for the Bullitt Center. However, due to the size and type of system, there is minimal ongoing maintenance needed. The Bullitt Center uses the computer program Building Engines to track inspections, maintenance, and repairs. Records are backed up nightly.

A summary of the preventative maintenance performed is provided in Table 6-4.

TABLE 6-4

Summary of Preventative Maintenance Activities

Facility	Type of Maintenance	Maintenance Schedule
Roof and Drains	Clean catchment area and drains	Annually
Vortex Filter	Flush and clean filter	As Needed
Cistern	Clean tank	As Needed
Treatment Plant Equipment	Repair of instrumentation and metering devices	As Needed
	Repair of chlorine feed system	
	Replace filter cartridges	
Day Tank	Clean tank	As Needed
Pumps	Perform routine maintenance per manufacturer's specifications	Per Manufacturer's Specifications
Pressure Tank	Perform routine maintenance per manufacturer's specifications	Per Manufacturer's Specifications
Meters	Inspect, repair, and replace as necessary	< 2" every 10 to 15 years, 2" to 4" every 3 to 5 years, > 4" every 1 to 3 years

System Operation with Major Components Offline

The Bullitt Center has the ability to supply the entire system using SPU water. The SPU connection can either fill the day tank when needed, or supply the entire system without the use of the day tank, pumps, or pressure tank.

EQUIPMENT, SUPPLIES, AND CHEMICAL LISTING

Manuals and specifications for all equipment within the water system are kept on-site by the building system operator.

The only chemical used in the treatment process will be chlorine. This component has not yet been design, but it is anticipated that a 5.25 percent sodium hyphochlorite solution will be used.

WATER QUALITY MONITORING PLAN AND REGULATORY COMPLIANCE

The Bullitt Center's water quality monitoring schedule is outlined in Chapter 3.

EMERGENCY RESPONSE PROGRAM

The purpose of the Bullitt Center's Emergency Response Plan is to identify possible emergency scenarios and corrective actions that can be taken to restore the water system to normal operation.

EMERGENCY PERSONNEL CALL-UP LIST

Table 6-5 is a water system personnel emergency call list.

TABLE 6-5

Water System Emergency Telephone Numbers

Person/Agency	Telephone Number
Seattle Police	911
King County Sheriff	911
Seattle Fire Department	911
UniCo - Corey Reilly	425-922-0080
UniCo - Bob Minor	206-321-4441
UniCo - Brooke Maura	206-406-9293
UniCo - After Hours Emergency Dispatch	425-462-2100

TABLE 6-5 – (continued)

Water System Emergency Telephone Numbers

Person/Agency	Telephone Number
Bullitt Foundation - Colleen Neely	206-715-2829
Testing Labs: King County Environmental Laboratory	206-684-2300
Testing Lab (Radionuclide): WA Department of Health Lab	206-361-2910
Department of Health Paige Igoe, P.E., NW Regional After Hours Emergency Hotline	253-395-6764 1-877-481-4901
Consulting Engineer Gray & Osborne, Inc.	206-284-0860

NOTIFICATION PROCEDURES

There may be instances in which building occupants must be informed of a water system related emergency. Notification for the Bullitt Center is much less complicated than that for a municipal system. Any emergency can be relayed to building occupants by phone, email, or in person fairly quickly. The immediate response may be to prohibit drinking tap water, washing hands, and running dishwashers.

Bacteriological Presence Detection Procedure

Notification procedures for notifying building occupants and DOH of water quality emergencies are an important component of an emergency response program. The system may occasionally detect positive coliform samples, likely as a result of contamination in the sample taps or improper sampling procedures. However, the persistent detection of coliform in the water supply, particularly E. coli or fecal bacteria, may require shutting down the distribution system, or prohibiting handwashing and drinking from taps. WAC 246-290-320 requires water utilities to follow specific procedures in the event coliform bacteria are detected in the system.

CONTINGENCY OPERATIONAL PLAN

In the event that the Bullitt Center's source water is not available, either due to issues with the source water quality and availability, or problems with the treatment process, the SPU connection can be used to supply the building. If the distribution system has been contaminated, the building can be shut down until the cause is found and corrective actions have been taken to restore the water system.

CROSS-CONNECTION CONTROL (CCC) PROGRAM

A cross connection control program helps to maintain safe water quality by identifying and regulating possible cross connections. A cross-connection is any actual or potential physical connection between a drinking water system and any other non-potable substance (liquid, solid, or gas). Every water system serving the public must develop a CCC program.

For a municipal system, the responsibility of eliminating potential cross connections is only applied to the purveyors system, and the purveyor is not responsible for abatement of cross connections which occur within the customer's premises. Responsibility within the customer's premises fall under the jurisdiction of the local administering authority. In the case of the Bullitt Center, this would be the City of Seattle building officials.

The requirement to develop a CCC program does not apply to the Bullitt Center. However, the Bullitt Foundation and the building operations company maintain the authority to prohibit the installation of potential cross connections without proper protection to the water system. Any future modifications to the water system will be evaluated for the possibility of cross connection, and appropriate backflow control devices will be installed if a possible cross-connection is found to exist.

CUSTOMER COMPLAINT RESPONSE PROGRAM

There have not been any complaints thus far regarding the water system or water quality. The contracted building operations company will receive and address all complaints regarding the water system. Complaints will be logged along with the any corrective actions taken.

RECORD KEEPING AND REPORTING

Water sampling and system maintenance are all recorded by the building system operator. All records are kept electronically on the computer in the electrical room, which also manages many of the building's systems. Records will be kept for the durations required in WAC 246-290-480.

The building system operator will submit all required reports to DOH per the water quality monitoring schedule and treatment plant reporting schedule.

OPERATION & MAINTENANCE IMPROVEMENTS

The Bullitt Center will develop sampling, monitoring, and maintenance schedule once the final water system design achieves approval by DOH.

CHAPTER 7

CAPITAL IMPROVEMENT PROGRAM

OBJECTIVE

The objective of this chapter is to present the Bullitt Center's Capital Improvement Program, which is composed of projects identified and based on deficiencies outlined in Chapter 3. These improvements are required prior to the Center becoming a Group A water system. There are no other identified capital improvements required over the typical 6- and 20-year planning horizons.

Table 7-1 following the project list below provides a summary of the identified capital improvement projects. The project costs shown are intended to be total costs including sales tax and approximately 15-percent project design and administration assuming the Bullitt Foundation procures all of the design services under a single contract (separating the design of each project may lead to slightly higher costs).

RECOMMENDED IMPROVEMENTS

PROJECT 1: NSF ROOF COATING

Schedule: 2015
Cost: $70,000

The Bullitt Center's existing roof membrane is the R Nova Plus product by Soprema, Inc. This membrane is a liquid applied, two layer polyurethane-acrylic coating system that provides waterproofing, high UV resistance and high solar reflectance but does not have NSF certification. Per Department of Health requirements, this rainwater catchment membrane needs to be either NSF 61 or NSF P151 approved. Soprema, Inc. was contacted and have approved the Premium White Elastomeric Roof Coating, #41-300, as manufactured by Uniflex to be applied as a topcoat over the existing R Nova Plus system. The #41-300 roof coating is a 100-percent acrylic polymer that also provides waterproofing, high UV resistance and high solar reflectance and does have NSF P151 certification for rainwater catchment roofing applications. This product will need to be applied over the existing system by installers certified by both manufacturers.

PROJECT 2: CHLORINE FEED SYSTEM

Schedule: 2015
Cost: $27,000

The existing water treatment system at the Bullitt Center will need to be upgraded to provide a disinfectant residual and 1 log *Giardia* cyst inactivation. In discussions with the Bullitt Foundation, the preferred alternative for this disinfection system is a simple chemical feed of 5.25-percent sodium hypochlorite that can be purchased commercially or acquired locally.

The chlorine feed system will consist of a small polypropylene storage tank, a chemical feed pump skid with a backpressure valve and calibration column, and chlorine analyzer.

PROJECT 3: CONTACT TIME (CT) STORAGE

Schedule: 2015
Cost: $10,000

The 1 log *Giardia* cyst inactivation that will be provided by the disinfection system requires a minimum amount of time that the disinfectant will be in contact with the water (fully mixed) before any potable uses. The amount of time required is a function of the concentration of disinfectant in the water, and the temperature and pH of the water and is based on standard tables provided by the EPA.

For the Bullitt Center, it is likely that approximately 300 gallons of additional CT storage will be required (based on a flowrate of 4 gpm, a disinfectant concentration of 0.6 mg/L, a pH of 7.5, and a water temperature of 108 degrees C). This CT storage can be provided with two out-and-back runs of 8-inch HDPE pipe installed on the south wall of the basement floor of the Bullitt Center for a total length of pipe of approximately 120 feet. This location is adjacent to the existing treatment equipment, which is located along the west wall of the basement floor, and has been identified as unused space.

TABLE 7-1

Capital Improvement Schedule

Project No.	Description	Year	Total Project Costs*
1	NSF Roof Coating	2015	$70,000
2	Chlorine Feed System	2015	$27,000
3	Contact Time (CT) Storage	2015	$10,000
2015 Total			**$107,000**

*Total project costs include sales tax and project design and administration.

CHAPTER 8

FINANCIAL PROGRAM

OBJECTIVE

The objective of this chapter is to analyze the Bullitt Center's total costs of providing water service and the ability to cover the costs of operation and maintenance, and ascertain the financial capability to implement the Capital Improvement Plan outlined in Chapter 7.

The Bullitt Center is a unique system in the sense that it is primarily an experimental system. The Bullitt Center is hoping to be classified as a Living Building though the Living Building Challenge. One aspect of which is to produce enough water on-site to meet demands. The water system is meant to highlight high efficiency fixtures and a sustainable overall design. The system has never been intended to be a more cost effective source of water than being supplied by Seattle Public Utilities, which would be significantly less expensive.

CHARGES FOR WATER USE

The Bullitt Center does not meter each tenant, rather water use along with the use of other utilities, maintenance costs, and insurance, are included in the triple net leases used for each tenant. Water use is billed based on the prorated share of usage based on square footage leased per tenant. While receiving supply from SPU, the SPU bill is divided in this manner. When the system is approved and begins producing and supplying potable water and the SPU connection is no longer used, the monthly costs for operating the system will be divided amongst the tenants in the same way.

The Bullitt Center estimates that water operation and service will cost approximately $0.42 per square foot for the first year of full operation. This cost will change annually based on the historic and projected costs of running the water system. Projected costs for the first year of water system operation following approval by DOH are shown in Table 8-1.

TABLE 8-1

Projected Annual Operating Costs

Annual Water System Expenses	Estimated Amount
Water Quality Testing	$2,710
Licensed Operator Oversight and DOH Report Submittal	$7,560
Training by Licensed Operator	$1,680
Consumables – (bleach, carbon filter)	$600
Total	**$12,550**

IMPROVEMENT PROGRAM FINANCING

Chapter 7 summarizes capital improvement projects. The three projects identified are estimated to cost approximately $107,000.

These projects will be funded by the Bullitt Foundation, however the Foundation may choose to factor some of the project costs into rent as well.

FINANCIAL VIABILITY

As described above, the cost of supplying water to tenants is estimated based on projected operating costs. The costs will be passed on to the tenants, and will be adjusted annually as actual operational costs are determined.

Currently, tenants pay $30 per square foot annually to lease space, plus the triple net lease additions. The anticipated water charge of $0.42 per square foot is a small fraction of the total rent. While there is some limit as to what the rental market can sustain, tenants of the Bullitt Center are knowingly paying above market price for the opportunity to work in a ground-breaking sustainable building. This allows more flexibility in adjusting utility rates, and also provides additional incentive for tenants to adhere to the energy and resource use policies within their lease.

APPENDIX A

WSP SUBMITTAL FORMS

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water System Plan Submittal Form

This form must be completed and submitted along with the Water System Plan (WSP). It will expedite review and approval of your WSP. **All water systems should contact their regional planner before developing any planning document for submittal.**

Bullitt Center		Bullitt Foundation
1. Water System Name	PWS ID# or Owner ID#	Water Systems Owner's Name
Colleen Neely	206-715-2829	
Contact Name for Utility	Phone Number	Title
1501 East Madison Street Suite 600	Seattle	WA, 98122
Contact Address	City	State Zip
Russ Porter	206-660-7746	Project Engineer
2. Project Engineer	Phone Number	Title
701 Dexter Ave N, Suite 200	Seattle	WA, 98109
Project Engineer Address	City	State Zip
3. Billing Contact Name (required if not the same as #1)	Billing Phone Number	Billing Fax Number
Billing Address	City	State Zip

4. How many services are presently connected to your system? 1
5. Is your system expanding (seeking to extend service area or increase number of approved connections)? ☐ Yes ☒ No
6. If the number of services is expected to increase, how many *new* connections are proposed in the next six years? ________________
7. If your system is private-for-profit, is it regulated by the State Utilities and Transportation Commission? ☐ Yes ☒ No
8. Is the system located in a Critical Water Supply Service Area (i.e., have a Coordinated Water System Plan)? ☐ Yes ☒ No
9. Is your system a customer of a wholesale water system? ☐ Yes ☒ No
10. Will your system be pursuing additional water rights from the Department of Ecology in the next 20 years? ☐ Yes ☒ No
11. Is your system proposing a new intertie? ☐ Yes ☒ No
12. Do you have projects currently under review by us? ☐ Yes ☒ No
13. Are you requesting distribution main project report and construction document submittal exception and if so, does the WSP contain standard construction specifications for distribution mains? ☐ Yes ☒ No
14. The water system is responsible for sending a copy of the WSP to adjacent utilities for review or a letter notifying them that a copy of the WSP is available for their review and where the review copy is located. Has this been completed? ☒ Yes ☐ No
15. The purveyor is responsible for sending a copy of the WSP to all local governments within the service area (county and city planning departments, etc.). Has this been completed? ☒ Yes ☐ No
16. Are you proposing a change in the place of use of your water right? ☐ Yes ☒ No

If answer to questions 7,8, 11, 14 and/or 15 is "yes," list who you sent the WSP to: Seattle Public Utilities, City of Seattle

Is this plan: ☒ an Initial Submittal ☐ a Revised Submittal

Please enclose the following number of copies of the WSP:

3 copies for Northwest and Southwest Regional Offices **OR 2** copies for Eastern Regional Office (We will send one copy to Ecology)
1 additional copy if you answered "yes" to question 7. 3 Total copies attached

Please return completed form to the Office of Drinking Water regional office checked below.

☒ **Northwest Drinking Water Operations**	☐ **Southwest Drinking Water Operations**	☐ **Eastern Drinking Water Operations**
Department of Health	**Department of Health**	**Department of Health**
20425 72nd Avenue South, Suite 310	**PO Box 47823**	**16201 East Indiana Avenue Suite 1500**
Kent, WA 98032-2358	**Olympia, WA 98504-7823**	**Spokane Valley, WA 99216**
253-395-6750	**360-236-3030**	**509-329-2100**

For people with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).

APPENDIX B

PROPOSED WATER FACILITIES INVENTORY FORM

Washington State Department of Health
Environmental Health Programs
Division of Drinking Water

WATER FACILITIES INVENTORY (WFI) FORM

ONE FORM PER WATER SYSTEM

RETURN TO: Northwest Regional Operations 20425 72nd Ave. S, Suite 310 Kent, WA 98032-2388

1. SYSTEM ID NO.	2. SYSTEM NAME	3. COUNTY	4. GROUP	5. TYPE
	Bullitt Center	King		

6. PRIMARY CONTACT NAME & MAILING ADDRESS	7. OWNER NAME & MAILING ADDRESS	8. Owner Number:
Corey Reilly TITLE: Building Engineer	Bullitt Foundation	
	TITLE: President	
Unico	Denis Hayes	
1215 4th Avenue, Suite 600	1501 East Madison Street Suite 600	
Seattle, WA 98161	Seattle, Washington 98122	
STREET ADDRESS OF PRIMARY CONTACT – IF DIFFERENT FROM ABOVE	STREET ADDRESS OF OWNER - IF DIFFERENT FROM ABOVE	
ATTN	ATTN	
ADDRESS	ADDRESS	
CITY STATE ZIP	CITY STATE ZIP	

9. 24 HOUR PRIMARY CONTACT INFORMATION	10. OWNER CONTACT INFORMATION
Daytime Phone: (206) 576-4100	Daytime Phone: 206-343-0807
Mobile/Cell Phone: (425) 922-0080	Mobile/Cell Phone:
Evening Phone:	Evening Phone:
Fax: E-mail: coreyr@unicoprop.com	Fax 206-343-0822 E-Mail: dhayes@bullitt.org

WAC 246-290-420()) requires that water systems provide 24-hour contact information for emergencies.

11. SATELLITE MANAGEMENT AGENCY – SMA (check only one)

× Not applicable (Skip to #12) Owned and Managed Managed Only Owned Only

SMA NAME:______________________________ SMA Number:____________

12. WATER SYSTEM CHARACTERISTICS (mark ALL that apply)

- Agricultural
- × Commercial / Business
- Day Care
- Food Service/Food Permit
- 1,000 or more person event for 2 or more days per year
- Hospital/Clinic
- Industrial
- Licensed Residential Facility
- Lodging
- Recreational / RV Park
- Residential
- School
- Temporary Farm Worker
- Other (church, fire station, etc.): ______________________

13. WATER SYSTEM OWNERSHIP (mark only one)

Association County Investor Special District
City / Town Federal × Private State

14. STORAGE CAPACITY (gallons)

500

15.	16 SOURCE NAME	17. INTERTIE	18. SOURCE CATEGORY										19. USE			20	21. TREATMENT						22. DEPTH	23.	24. SOURCE LOCATION			
SOURCE NUMBER	LIST UTILITY'S NAME FOR SOURCE AND WELL TAG ID NUMBER. Example: WELL #1 XYZ456 IF SOURCE IS PURCHASED OR INTERTIED, LIST SELLER'S NAME Example: SEATTLE	INTERTIE SYSTEM ID NUMBER	WELL	WELL FIELD	WELL IN A WELLFIELD	SPRING	SPRING FIELD	SPRING IN SPRING FIELD	SEA WATER	SURFACE WATER	RANNEY / INF. GALLERY	OTHER	PERMANENT	SEASONAL	EMERGENCY	SOURCE METERED	NONE	CHLORINATION	FILTRATION	FLUORIDATION	IRRADIATION (UV)	OTHER	(FEET)	CAPACITY (GALLONS PER MINUTE)	1/4, 1/4 SECTION	SECTION NUMBER	TOWNSHIP	RANGE
	Roof Collector											x	x			y			x				NA	NA	NW,NW	33	25	4
	Seattle Public Utilities	77050Y										x			x	y							NA	NA				

	ACTIVE SERVICE CONNECTIONS	DOH USE ONLY! CALCULATED ACTIVE CONNECTIONS	DOH USE ONLY! APPROVED CONNECTIONS
25. SINGLE FAMILY RESIDENCES **(How many of the following do you have?)**			
A. Full Time Single Family Residences (Occupied 180 days or more per year)	0		
B. Part Time Single Family Residences (Occupied less than 180 days per year)	0		
26. MULTI-FAMILY RESIDENTIAL BUILDINGS **(How many of the following do you have?)**			
A. How many Apartment Buildings, Condos, Duplexes, Barracks, and Dormitory Buildings do you have?	0		
B. How many Full Time Residential Living Units / Dwellings are in these Apartment Buildings, Condos, Duplexes, Barracks, and Dorms, that are occupied any 180 days or more per year?	0		
C. How many Part Time Residential Living Units / Dwellings are in these Apartment Buildings, Condos, Duplexes, Barracks, and Dorms that are occupied less than 180 days per year?	0		
27. NON-RESIDENTIAL CONNECTIONS **(How many of the following do you have?)**			
A. Recreational Service Connections (Public Campsites, RV Sites, Spigots, Shower & Toilet facilities etc.)	0		
B. Institutional, Commercial, or Industrial Service Connections (Churches, Businesses, Office Buildings, Factories etc.)	1		
28. TOTAL, ACTIVE SERVICE CONNECTIONS			

29. FULL-TIME RESIDENTIAL POPULATION

A. How many residents are served by this system 180 or more days per year? None

30. PART-TIME RESIDENTIAL POPULATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many part-time residents are present each month?	0	0	0	0	0	0	0	0	0	0	0	0
B. How many days per month are they present?	0	0	0	0	0	0	0	0	0	0	0	0
31. TEMPORARY & TRANSIENT USERS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
A. How many visitors, attendees, travelers, campers, patients or customers have access to the water system each month?	98	98	98	98	98	98	98	98	98	98	98	98
B. How many days per month are they present?	21	21	21	21	21	21	21	21	21	21	21	21
32. REGULAR NON-RESIDENTIAL USERS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
A. Schools, Daycares, or Businesses How many students, daycare children, and / or employees are present each month?	170	170	170	170	170	170	170	170	170	170	170	170
B. How many days per month are they present?	21	21	21	21	21	21	21	21	21	21	21	21

33. ROUTINE COLIFORM SCHEDULE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

34. GROUP B NITRATE SCHEDULE	QUARTERLY	ANNUALLY	ONCE EVERY 3 YEARS

35. Reason for Submitting / Updating this WFI:

☐ No Change ☐ Contact ☐ Owner ☐ Population ☐ Active Services ☐ Activation ☐ Inactivation

☒ Source Change/Approval ☒ Treatment Change/Approval ☒ WSP Approval ☐ Sanitary Survey / SPI

36. I certify that the information stated on this WFI form is correct to the best of my knowledge.

SIGNATURE: ______________________ **PRINT NAME:** ______________________

TITLE / POSITION: ______________________ **DATE:** ______________________

APPENDIX C

SEATTLE PUBLIC UTILITIES AGREEMENT

City of Seattle
Seattle Public Utilities

February 20, 2013

Mr. Chris Rogers
Point32
1650 20th Avenue
Seattle, WA 98122

Subject: The Bullitt Center Request for Creation of Group A Public Water System

Dear Mr. Rogers,

This letter is in response to the request in your letter of January 18, 2013, to allow a new Group A public water system (System) within the retail service area of Seattle Public Utilities (SPU). This System would be located at the Bullitt Center, 1501 E. Madison Street, and serve the commercial building constructed under Seattle Department of Planning and Development (DPD) Project # 3011010 as part of the City's Living Building Pilot program. SPU recognizes that this innovative project is designed to meet the net zero water requirements of the Living Building Challenge. As such, SPU concurs with your request to create a new Group A water system to serve the Bullitt Center, subject to the conditions stated below.

Your request indicates that the future source of supply will be entirely from rainwater captured at the site. Sale or use of water from this new source to areas or property other than the Bullitt Center or King County Parcel No. 723460-0195 shall be prohibited. Additionally, the retail connections to SPU's water system for domestic and fire suppression service shall stay in place after the new System is created. Such retail service connections shall remain subject to SPU's policies, including applicable standard charges, fees and rates.

The owner of the new System shall be responsible for obtaining all necessary approvals and permits for the new System, including, but not limited to, those required by Seattle-King County Department of Public Health for cross-connection control and fluoridation, SPU for cross-connection control, the City of Seattle, King County, and the Washington State Department of Health. The owner shall be solely responsible for constructing, operating and maintaining the System to meet these requirements. SPU has no responsibility for maintaining the System and has no obligation to provide technical or financial assistance for its construction, operations or maintenance.

Should the new Group A public water system fail to maintain its Washington State Operating Permit, the System owner will provide prompt notice to SPU and the property will revert to receiving domestic and fire service entirely from SPU through the retail service connections.

Ray Hoffman, Director
Seattle Public Utilities
700 5th Avenue, Suite 4900
PO Box 34018
Seattle, WA 98124-4018

Tel (206) 684-5851
Fax (206) 684-4631
TDD (206) 233-7241
ray.hoffman@seattle.gov

SPU has no obligation and has no intention to assume operation and maintenance of the System.

Seattle Municipal Code 10.22 requires that fluoride be added to the Seattle water supply under the direction of the Director of the Seattle-King County Department of Public Health and that the source of fluoride be approved by the Washington State Department of Health. To understand more about this requirement, you may contact Dr. Moffett Burgess, Chief of Dental Health, Seattle-King County Public Health. Her phone number is (206) 852-0376.

If you have any additional questions or concerns, you may contact me at dave.hilmoe@seattle.gov or (206) 684-7414.

Sincerely,

David J. Hilmoe

David J. Hilmoe, P.E. BCEE
Drinking Water Director, Seattle Public Utilities

Copy: Steve Deem, Washington State Department of Health
Denis Hayes, Bullitt Foundation

APPENDIX D

WATER QUALITY DOCUMENTATION

COLIFORM MONITORING PLAN (CMP)
for the Small Non-Community Water System

Part A: Water System Information

Name of Water System: Bullitt Center Water System	County: King	System ID Number: **Not yet assigned**
☑ Attach Copy of Current Water Facilities Inventory (WFI) form	Number of Sample Sites Needed to Represent the Distribution System: 1	

Part B: Routine and Repeat Sample Locations

Please select Routine and Repeat sample sites and complete the table below:

Location / Address for <u>Routine</u> Sample Site	Location / Address for <u>Repeat</u> Sample Sites	Sample Locations for <u>Month Following</u> Unsatisfactory Sample(s)
X # 1 – 6th floor kitchen sink	1-1 – 6th floor kitchen sink	1. 6th floor kitchen sink
	1-2 – Treated water reservoir	2. Treated water reservoir
	1-3 – 3rd floor kitchen sink	3. Raw water cistern
	1-4 – Raw water cistern	4. 3rd floor kitchen sink
		5. 5th floor kitchen sink
X #2 – 2nd floor kitchen sink	2-1 – 2nd floor kitchen sink	6. 2nd floor kitchen sink
	2-2 – Treated water reservoir	7. Treated water reservoir
	2-3 – 3rd floor kitchen sink	8. Raw water cistern
	2-4 – Raw water cistern	9. 3rd floor kitchen sink
		10. 5th floor kitchen sink

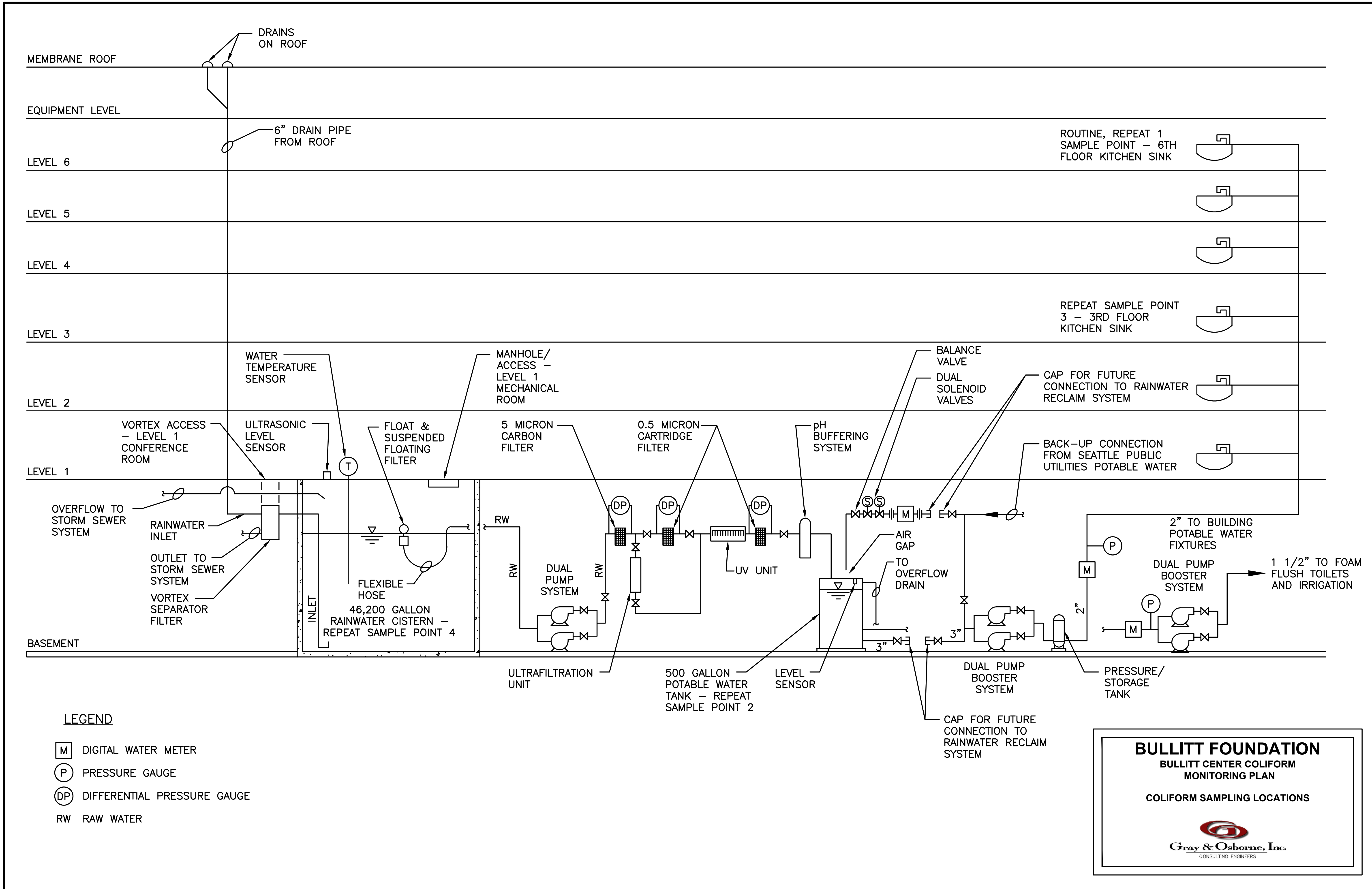
C: Routine Sample Rotation Schedule

Month	Sample Site(s)	Month	Sample Site(s)
January	1	July	1
February	2	August	2
March	1	September	1
April	2	October	2
May	1	November	1
June	2	December	2

☑ D: Attach a simple map of your water system

E: Preparation Information

Name of Plan Preparer: Corinne Travis, P.E.	Position: Consulting engineer, co-author of 2015 Water System Plan, Gray & Osborne, Inc.	Date Plan Completed: April 16, 2015
Daytime Phone Number: ( ) ____ - _______ Evening Phone Number: ( ) ____ - _______	STATE REVIEWER: ___________________________________	DATE REVIEWED: _____ / _____/ _____


DRAINS ON ROOF
MEMBRANE ROOF
EQUIPMENT LEVEL
6" DRAIN PIPE FROM ROOF
LEVEL 6
LEVEL 5
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
BASEMENT
ROUTINE, REPEAT 1 SAMPLE POINT – 6TH FLOOR KITCHEN SINK
REPEAT SAMPLE POINT 3 – 3RD FLOOR KITCHEN SINK
WATER TEMPERATURE SENSOR
MANHOLE/ ACCESS – LEVEL 1 MECHANICAL ROOM
BALANCE VALVE
DUAL SOLENOID VALVES
CAP FOR FUTURE CONNECTION TO RAINWATER RECLAIM SYSTEM
VORTEX ACCESS – LEVEL 1 CONFERENCE ROOM
ULTRASONIC LEVEL SENSOR
FLOAT & SUSPENDED FLOATING FILTER
5 MICRON CARBON FILTER
0.5 MICRON CARTRIDGE FILTER
pH BUFFERING SYSTEM
BACK–UP CONNECTION FROM SEATTLE PUBLIC UTILITIES POTABLE WATER
OVERFLOW TO STORM SEWER SYSTEM
RAINWATER INLET
OUTLET TO STORM SEWER SYSTEM
VORTEX SEPARATOR FILTER
INLET
FLEXIBLE HOSE
46,200 GALLON RAINWATER CISTERN – REPEAT SAMPLE POINT 4
RW
DUAL PUMP SYSTEM
UV UNIT
AIR GAP
TO OVERFLOW DRAIN
2" TO BUILDING POTABLE WATER FIXTURES
DUAL PUMP BOOSTER SYSTEM
1 1/2" TO FOAM FLUSH TOILETS AND IRRIGATION
3"
2"
ULTRAFILTRATION UNIT
500 GALLON POTABLE WATER TANK – REPEAT SAMPLE POINT 2
LEVEL SENSOR
DUAL PUMP BOOSTER SYSTEM
PRESSURE/ STORAGE TANK
CAP FOR FUTURE CONNECTION TO RAINWATER RECLAIM SYSTEM
LEGEND
M DIGITAL WATER METER
P PRESSURE GAUGE
DP DIFFERENTIAL PRESSURE GAUGE
RW RAW WATER
BULLITT FOUNDATION
BULLITT CENTER COLIFORM MONITORING PLAN
COLIFORM SAMPLING LOCATIONS
Gray & Osborne, Inc.
CONSULTING ENGINEERS

Seattle City Attorney
Peter S. Holmes

William C. Foster
Senior Assistant City Attorney
Environmental Protection Section

June 2, 2015

GRAY & OSBORNE, INC.
REC'D - SEATTLE
JUN 04 2015
JOB #____________

Mr. Russ Porter
Grey & Osborne
701 Dexter Avenue North
Suite 200
Seattle, WA 98109

Re: Bullitt Center's Group A Public Water System

Dear Mr. Porter:

I am responding to your request on behalf of the Bullitt Foundation for clarification of the scope of the City's fluoridation ordinance and its relevance to the Bullitt Center's Group A Public Water System.

The City fluoridation Ordinance (Ord. 96931) was passed in 1968 to provide for the fluoridation of the City's municipal water supply. It was amended in 1996 (Ord. 96931) to reflect the creation of Seattle Public Utilities and in 2011 (Ord. 123668) to reflect the newly named Public Health – Seattle & King County. It has been codified at Seattle Municipal Code Section 10.22.010 and reads as follows:

> "A source of fluoridation approved by the Washington State Department of Social and Health Services be added to the Seattle water supply under the rules and regulations of the Washington State Department of Social and Health Services, such addition to be administered by the Director of Seattle Public Utilities under the direction of the Director of Public Health—Seattle & King County."

Under this provision, the Director of Seattle Public Utilities provides for the fluoridation of Seattle's municipal water supply, in a manner that is consistent with the requirements of the State Department of Health and Public Health – Seattle & King County. On its face, Section 10.22.010 does not apply to anything other than Seattle's municipal water supply system. Authority to impose a fluoridation requirement on any other public water system is not to be found in Section 10.22.010.

Very truly yours,

Peter S. Holmes
City Attorney

By:

WILLIAM C. FOSTER
Senior Assistant City Attorney
Environmental Protection Section

WCF:hh

cc: Washington Department of Health
Attn: Bob James
Northwest Drinking Water Operations
20435 72nd AVE S, Suite 200, K17-12
Kent, WA 98032-2358

Washington Department of Health
Attn: Steve Deem
Northwest Drinking Water Operations
20435 72nd AVE S, Suite 200, K17-12
Kent, WA 98032-2358

Public Health – Seattle & King County
Attn: Marguerite Ro
Policy, Community Partnerships and Communications Unit
Chinook Building
401 5th AVE, Suite 1300
Seattle, WA 98104

APPENDIX E

DEPARTMENT OF ECOLOGY INTERPRETIVE POLICY

Focus on Rainwater Interpretive Policy

DEPARTMENT OF ECOLOGY
State of Washington

Water Resources Program **Revised October 2013**

The Department of Ecology (Ecology) has issued an interpretive policy statement clarifying that Washington residents can collect and store rooftop or guzzler collected rainwater for on-site use without having to go through the permit (water right) process of RCW 90.03.

A guzzler is a device used to catch and store rainwater to provide drinking water for wildlife, livestock or birds (see photo, right). They are built to provide adequate drinking water during critical periods of the year where natural watering sources are insufficient.

The new policy brings much needed clarity to rainwater collection that is lacking in the surface water code. Legislation has been introduced annually since 2002 to clarify the 1917 law, but regrettably none of the bills became law.

Rooftop/guzzler rainwater collection policy

The new rainwater policy clarifies that:

- A water right is not required for on-site storage and use of rooftop or guzzler collected rainwater; and
- Ecology may regulate the storage and use of subsequent new rooftop or guzzler collected rainwater harvesting systems if and when the cumulative impact of such new systems are likely to negatively affect instream values or existing water rights.

To qualify as rooftop collected rainwater, the roof collecting the rainwater must be part of a fixed structure above the ground with a primary purpose other than the collection of rainwater for beneficial use.

Monitoring large rainwater collection systems

Ecology is currently working with the State Building Code Council's Plumbing Code Technical Advisory Group (TAG) on amendments to the 2009 Uniform Plumbing Code (UPC). The draft TAG recommendations include a new section on rainwater collection that provides guidance and standards on rainwater systems, and notifies UPC readers of an Ecology registration form. Ecology believes this is a good way to track the larger systems because only the larger systems will involve a plumber familiar with the UPC. Ecology will not be tracking smaller, rain barrel type systems under the new rainwater policy.

Ecology intends to work with local governments involved with building permits associated with larger rainwater collection systems to inform them of this registration process. The department believes this new registration process and tracking system will facilitate an effective way to track the cumulative impact that larger rainwater collection systems may have on streams and groundwater supplies.

For more information

For more information on the Interpretive Policy Statement, please visit Ecology's website or contact Ecology's Water Resources Program at 360-407-6872.

Typical guzzler for small wildlife

For more information on the web

Ecology rainwater collection website: http://www.ecy.wa.gov/programs/wr/hq/rwh.html

Special accommodations

If you need this publication in an alternate format, call the Water Resources Program at 360-407-6872. Persons with hearing loss, call 711 for Washington Relay Service. Persons with a speech disability, call 877-833-6341.

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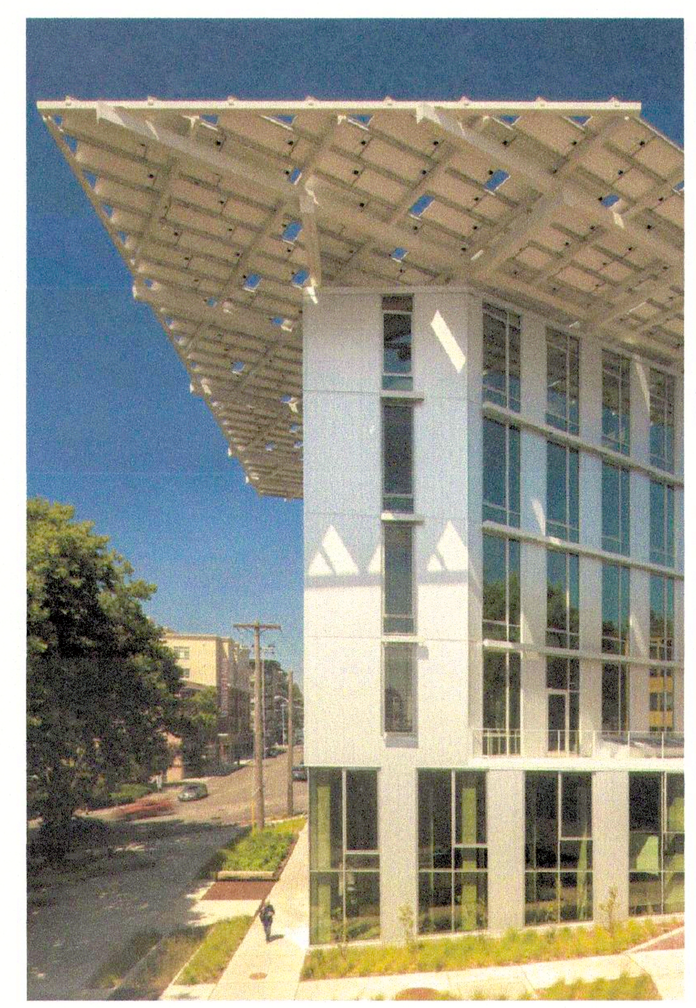
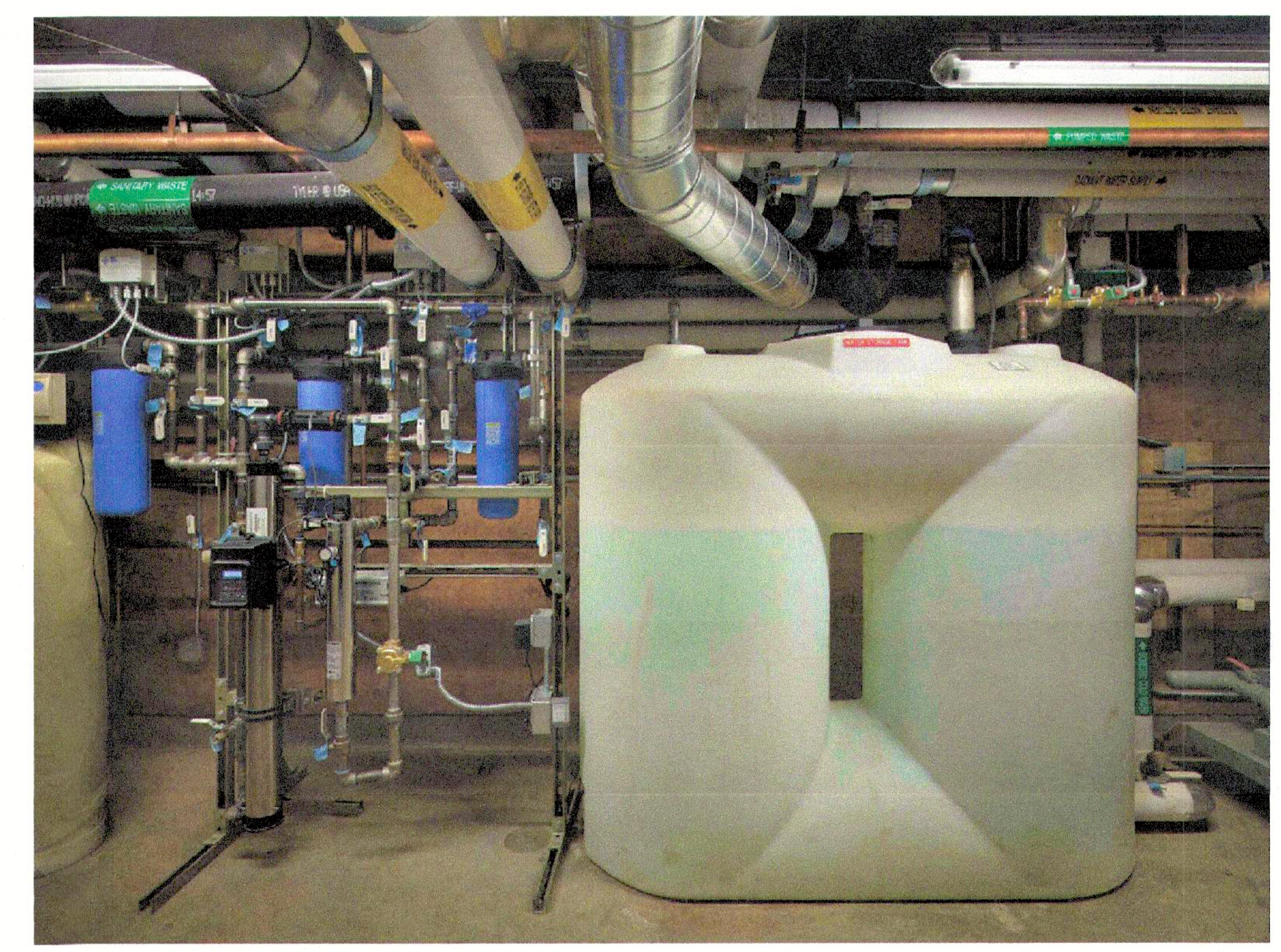
WATER SYSTEM MODIFICATIONS





JUNE 2017

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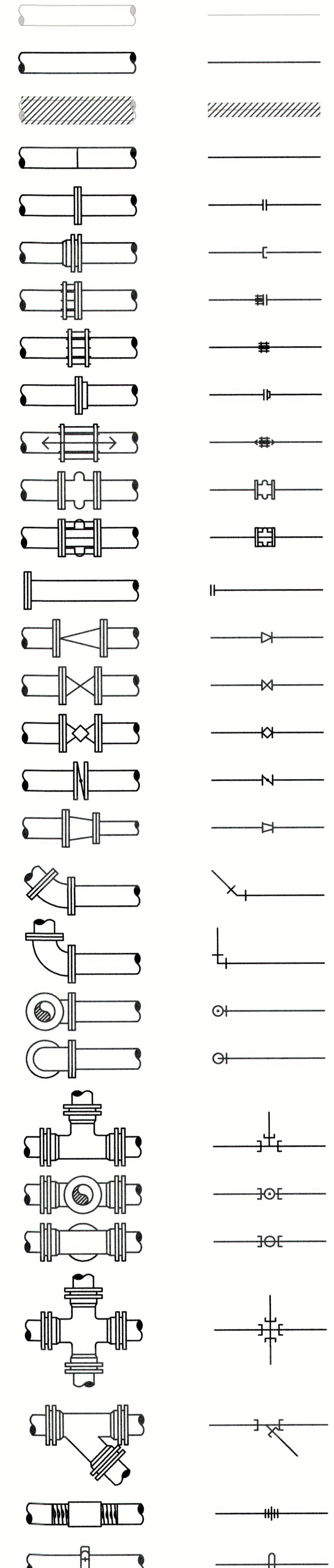
ABBREVIATIONS

@	AT
AB	ANCHOR BOLT
ABON	ABANDONED
ADJ	ADJACENT
ALTN	ALTERNATE
ALUM	ALUMINUM
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
ASPH	ASPHALT
ASSY	ASSEMBLY
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
ATAD	AUTO-THERMOPHILIC AEROBIC DIGESTION
AVG	AVERAGE
AWWA	AMERICAN WATER WORKS ASSOCIATION
BETW	BETWEEN
BF	BOTTOM FACE
BFP	BELT FILTER PRESS
BLD FLG	BLIND FLANGE
BLDG	BUILDING
BM	BEAM
BOD	BIOCHEMICAL OXYGEN DEMAND
BOT	BOTTOM
C	CONDUIT
CAB	CABINET
CB	CATCH BASIN
CEF	CEILING EXHAUST FAN
CFM	CUBIC FEET PER MINUTE
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CENTER LINE
CL	CLOSET
CL	CLASS
CLAR	CLARIFIER
CLG	CEILING
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
CONT JT	CONTROL JOINT
CONV	CONVEYOR
CP	CONCRETE PIPE
CPEP	CORRUGATED POLYETHYLENE PIPE
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CTR	CENTERED
CU FT	CUBIC FEET
CU Y/D	CUBIC YARDS PER DAY
D	DRAIN
DBL	DOUBLE
DI	DUCTILE IRON
DIA	DIAMETER
DISCH	DISCHARGE
DO	DISSOLVED OXYGEN
DN	DOWN
DWG	DRAWING
DWL	DOWEL
E	EAST
EA	EACH
ECC	ECCENTRIC
EF	EACH FACE
EFF	EFFLUENT
EL	ELEVATION
ELEC	ELECTRICAL
ELL	ELBOW
EQ	EQUAL
EXF	EXHAUST FAN
EXP JT	EXPANSION JOINT
EXT	EXTERIOR
EXIST	EXISTING
FAB	FABRICATION
FB	FLAT BAR
FCA	FLANGED COUPLING ADAPTOR
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDN	FOUNDATION
FIG	FIGURE
FIN	FINISH
FL	FLANGE
FLEX	FLEXIBLE
FLR	FLOOR
FR	FIRE RATED
FRP	FIBER REINFORCED POLYESTER
FT	FEET
FTG	FOOTING
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GBT	GRAVITY BELT THICKENER
GEN	GENERAL
GI	GALVANIZED IRON
GLDI	GLASS LINED DUCTILE IRON
GPM	GALLONS PER MINUTE
GV	GATE VALVE
GVL	GRAVEL
H	HEIGHT
HDG	HOT DIP GALVANIZED
HDPE	HIGH DENSITY POLYETHYLENE
HDR	HEADER
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER
HVAC	HEATING, VENTILATING, & AIR CONDITIONING
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
INF	INFLUENT
INSTL	INSTALL
INSUL	INSULATION
INV	INVERT
JT	JOINT
L	LENGTH
L	ANGLE
LAV	LAVATORY
LB	POUNDS
LB/D	POUNDS PER DAY
LF	LINEAR FEET
LR	LONG RADIUS
LT	LIGHT
MAG	MAGNETIC
MATL	MATERIAL
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MG/L	MILLIGRAMS PER LITER
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLSS	MIXED LIQUOR SUSPENDED SOLIDS
MLVSS	MIXED LIQUOR VOLATILE SUSPENDED SOLIDS
MON	MONUMENT
MTL	METAL
N	NORTH
nm	NANOMETER
NO.	NUMBER
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OPNG	OPENING
OPP	OPPOSITE
OSHA	OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
PB	PULL BOX
PE	PLAIN END
PERF	PERFORATED
PL	PROPERTY LINE
PL	PLATE
PLYWD	PLYWOOD
PRV	PRESSURE REDUCING VALVE
PS	PRIMARY SLUDGE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
QT	QUARTER
R	R-VALUE (INSULATION)
R OR RAD	RADIUS
R	RISER
RAS	RETURN ACTIVATED SLUDGE
RCP	REINFORCED CONCRETE PIPE
RDCR	REDUCER
REFR	REFRIGERATOR
REINF	REINFORCE
REQD	REQUIRED
RM	ROOM
S	SOUTH
SC	SCUM
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SECT	SECTION
SF	SUPPLY FAN
SF	SQUARE FEET
SHT	SHEET
SIM	SIMILAR
SL	SLUDGE
SPECS	SPECIFICATIONS
SQ	SQUARE
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
STIF	STIFFENER
STOR	STORAGE
STRUCT	STRUCTURAL
STL	STEEL
SUSP	SUSPENDED
SYMM	SYMMETRICAL
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TC	TOP OF CONCRETE
TDH	TOTAL DYNAMIC HEAD
TEL	TELEPHONE
TEMP	TEMPORARY
TF	TOP FACE
THK	THICK
THRD	THREADED
TOS	TOP OF SLAB
TSS	TOTAL SUSPENDED SOLIDS
TST	TOP OF STEEL
TTD	TOILET TISSUE DISPENSER
TOW	TOP OF WALL
TS	TOTAL SOLIDS
TYP	TYPICAL
UF	UTILITY FAN
UHMW	ULTRA HIGH MOLECULAR WEIGHT
UNO	UNLESS OTHERWISE NOTED
V	VENT
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
VSS	VOLATILE SUSPENDED SOLIDS
VTR	VENT THRU ROOF
W	WIDTH, WEST
W/	WITH
WAS	WASTE ACTIVATED SLUDGE
WCO	WALL CLEANOUT
WD	WOOD
WH	WATER HEATER
W/O	WITHOUT
WR	WASTE RECEPTACLE
WS	WATER STOP
WS	WATER SURFACE
XFMR	TRANSFORMER

PIPING SYMBOLS

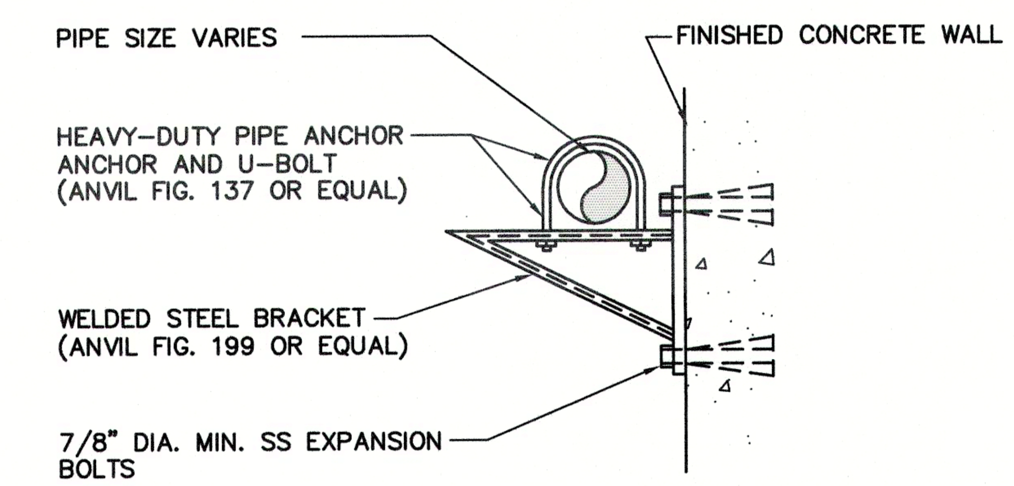
DOUBLE LINE | SINGLE LINE



EXISTING PIPE
NEW PIPE
EXISTING PIPE TO BE REMOVED
WELDED
FLANGED
MECHANICAL JOINT
FLANGED COUPLING ADAPTER
FLEXIBLE COUPLING
ADAPTOR FLANGE
RESTRAINED FLEXIBLE COUPLING
RUBBER EXPANSION JOINT
RESTRAINED RUBBER EXPANSION JOINT
BLIND FLANGE
CHECK VALVE
GATE VALVE
PLUG VALVE
BUTTERFLY VALVE
CONCENTRIC REDUCER
ELBOW, 45°
ELBOW, 90°
ELBOW UP
ELBOW DOWN
TEE
TEE UP
TEE DOWN
CROSS
WYE
SCREWED JOINT
GROOVED COUPLING

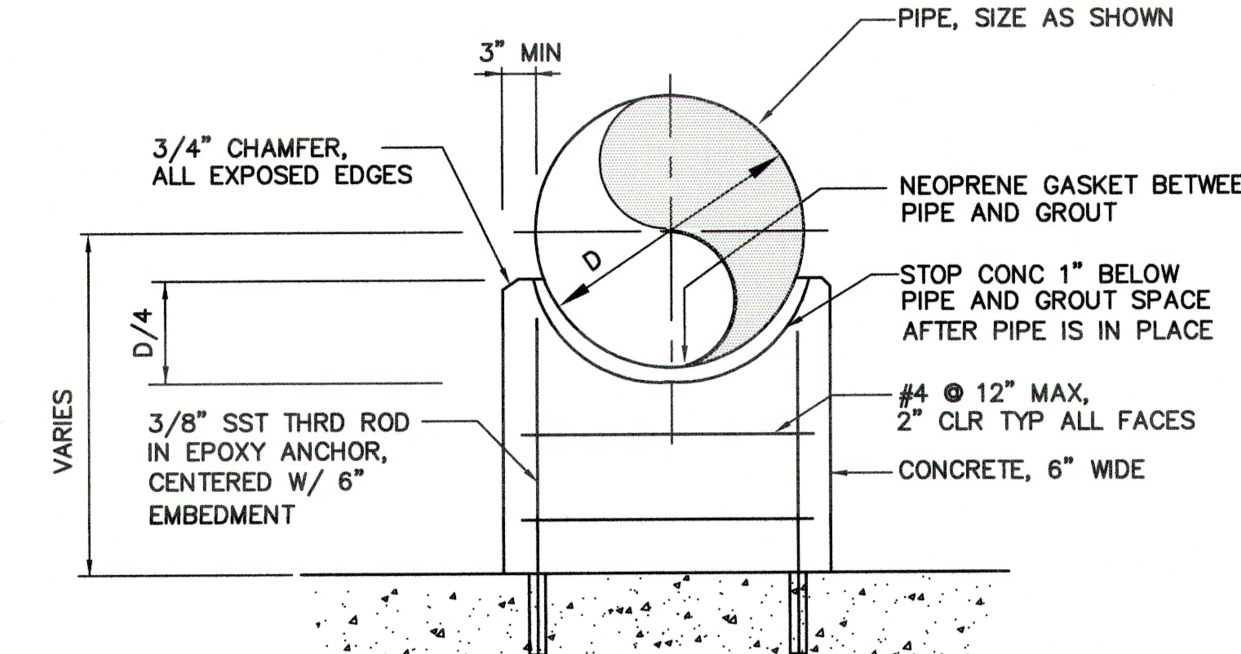
SHEET INDEX

NO.	DESCRIPTION
1	ABBREVIATIONS, SYMBOLS, AND SHEET INDEX
2	PROCESS FLOW DIAGRAMS
3	TREATMENT SYSTEM SCHEMATICS AND DETAILS
4	CHLORINE CONTACT PIPING



NOTE:
1. ALL STEEL NOT STAINLESS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.

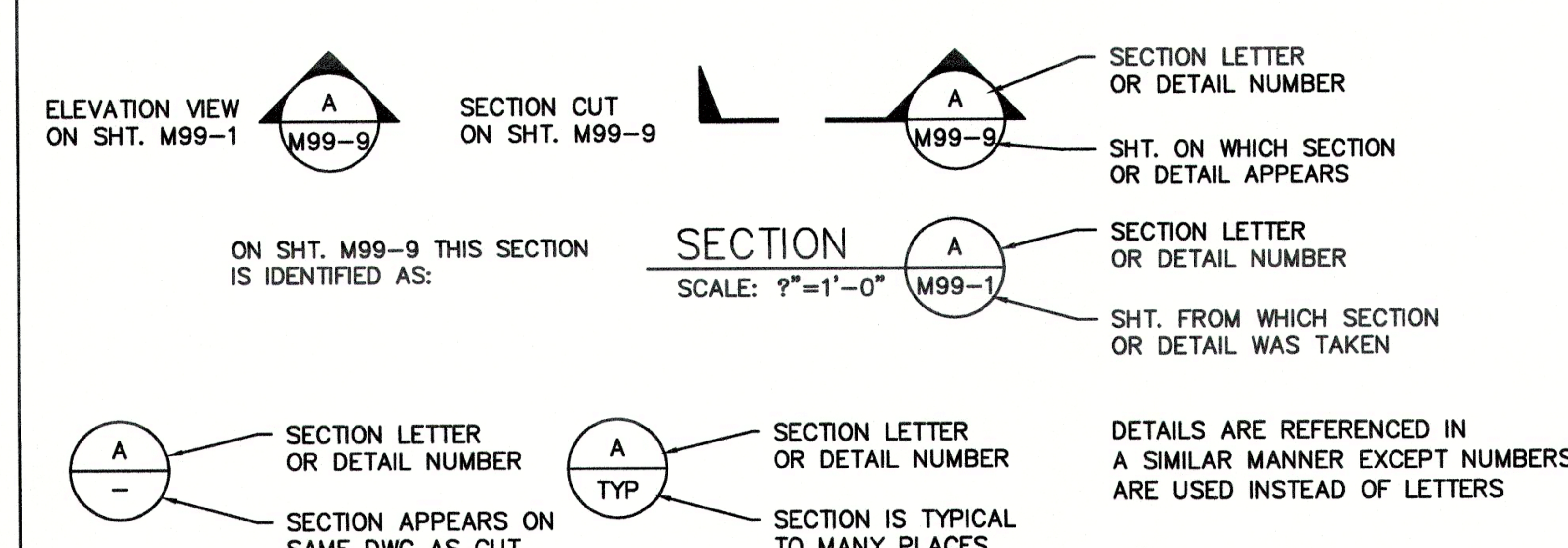
PIPE SUPPORT TYPE A (1/4)
NOT TO SCALE



PIPE SUPPORT TYPE B (2/4)
NOT TO SCALE

EXAMPLE OF SECTION NUMBERING SYSTEM AND PLAN/DRAWING TITLES

FOR DETAILS SUBSTITUTE DETAIL NUMBER FOR SECTION LETTER



DRAWING TITLE IDENTIFICATION : DRAWING TITLE
SCALE: ?"=1'-0"

0 1" 2"
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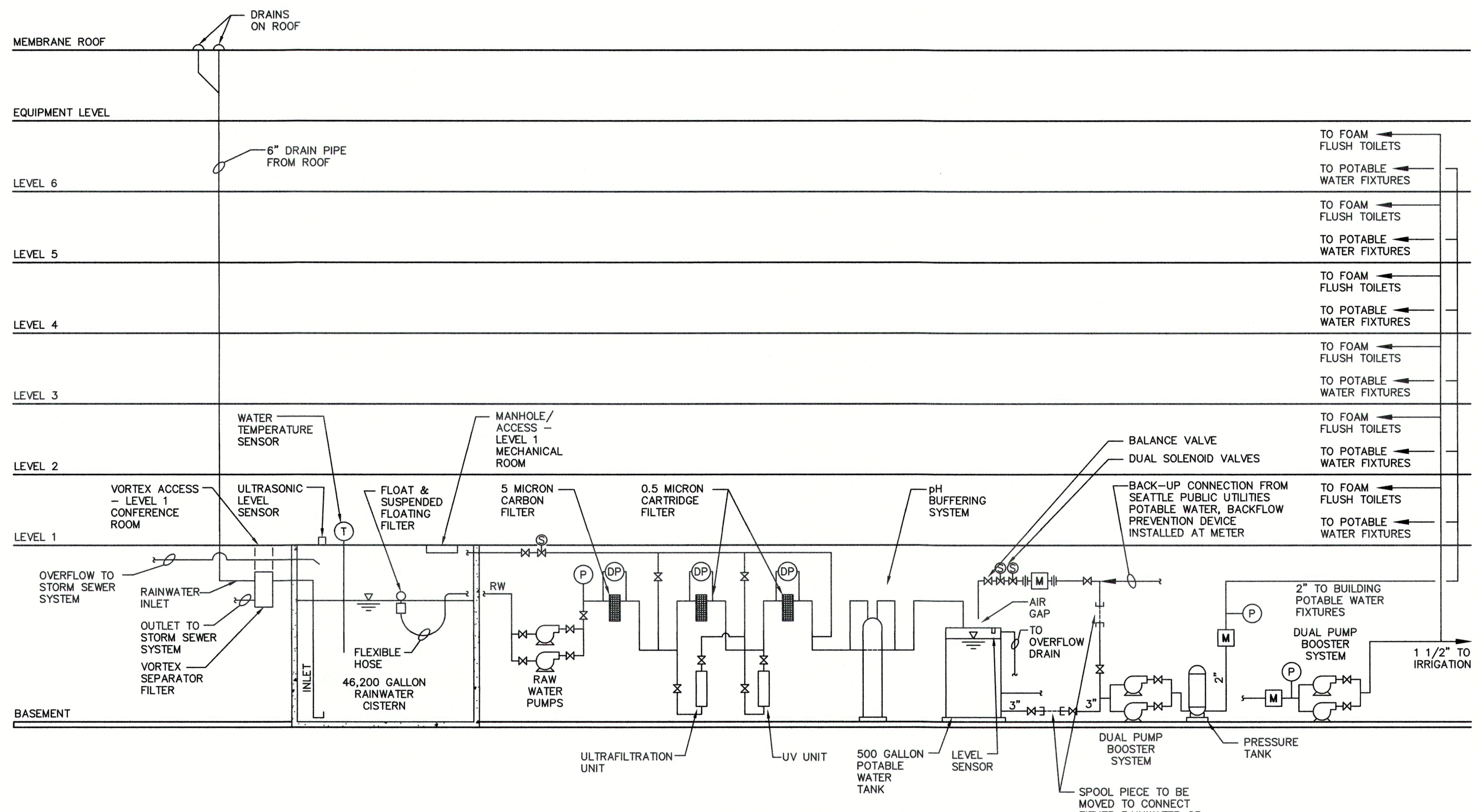
AARON M. PEASE – STATE OF WASHINGTON – 40276 – REGISTERED PROFESSIONAL ENGINEER
RUSSELL L. PORTER – STATE OF WASHINGTON – REGISTERED PROFESSIONAL ENGINEER

BULLITT FOUNDATION
KING COUNTY WASHINGTON

BULLITT CENTER
WATER SYSTEM MODIFICATIONS
ABBREVIATIONS, SYMBOLS, AND SHEET INDEX

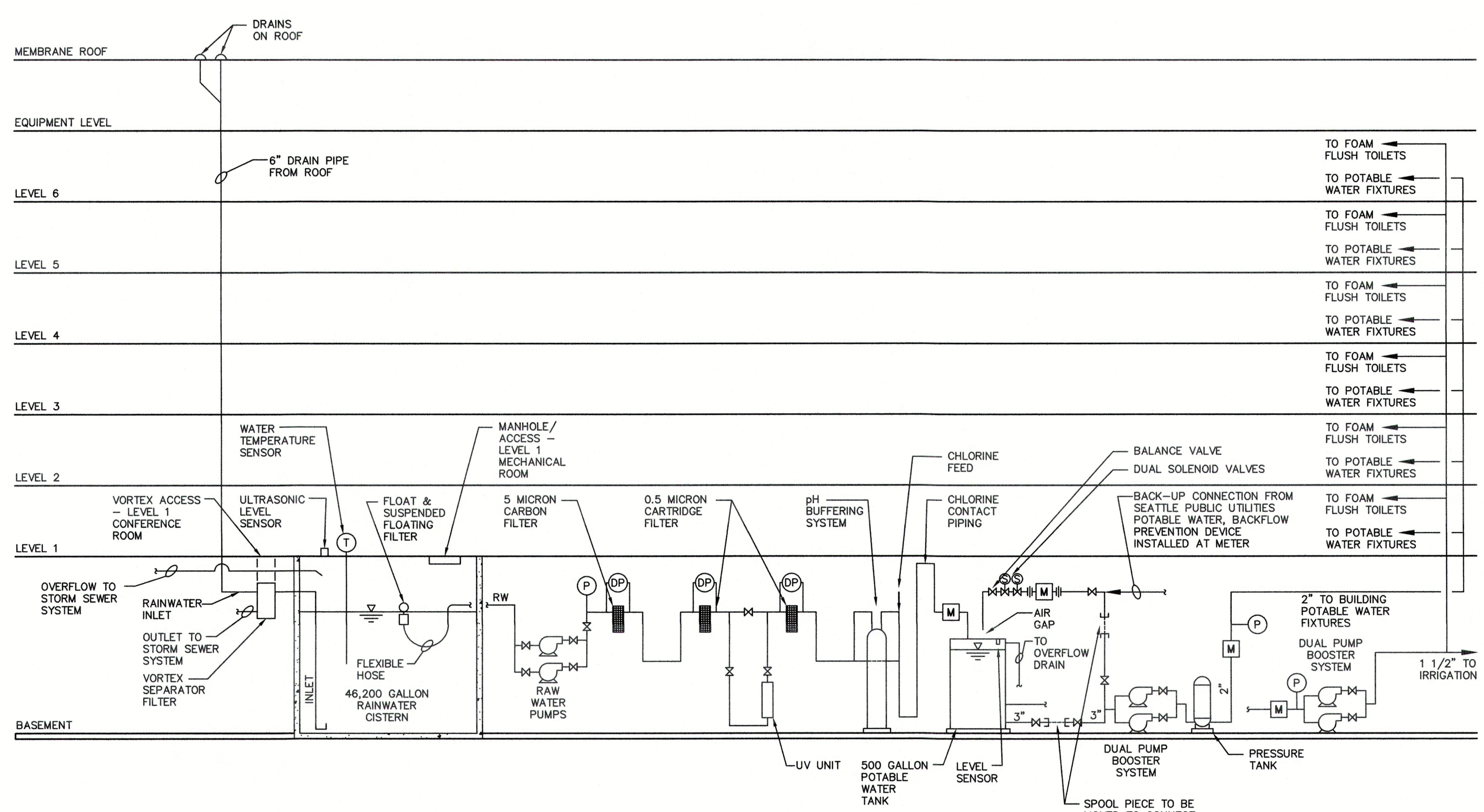
SHEET: 1
OF: 4

JOB NO.: 16454.00
DWG: GSYM-MCH



EXISTING SYSTEM FLOW DIAGRAM

NOT TO SCALE



MODIFIED SYSTEM FLOW DIAGRAM

NOT TO SCALE

LEGEND

- M DIGITAL WATER METER
- P PRESSURE GAUGE
- DP DIFFERENTIAL PRESSURE GAUGE
- RW RAW WATER

DESIGN PARAMETERS

FLOWRATE

FLOWMETER	5/8" POSITIVE DISPLACEMENT SERVICE METER
TREATMENT SYSTEM FLOWRATE	4 GPM

DISINFECTION

DISINFECTANT	SODIUM HYPOCHLORITE
DELIVERED CONCENTRATION	5.25%
DILUTED CONCENTRATION	0.0525% (100:1 DILUTION)
TARGET CHLORINE DOSE	1.2 mg/L

CURRENT DAILY CHLORINE FEED REQUIREMENT (@ 0.0525%)

AVERAGE DAY (346 G)	0.8 GPD
MAXIMUM DAY (522 G)	1.3 GPD

FEED RATE REQUIREMENTS

FEED PUMP NO. 1 (IN USE)	0.58 GPH (36.3 mL/min)
FEED PUMP NO. 2 (SHELF)	0.58 GPH (36.3 mL/min)

INJECTION PUMPS

NUMBER OF PUMPS	2 (1 IN USE; 1 SHELF SPARE)
TYPE	PERISTALTIC
CAPACITY	0 TO 2 GPH MIN.

FEED TANK

NUMBER	1
MATERIAL	POLYETHYLENE
CAPACITY	30 GALLONS

CHLORINE CONTACT

CT REQUIREMENT	44 (pH 7.5, 10°C)
CHLORINE CONCENTRATION	0.8 mg/L
CONTACT TIME REQUIRED	55 MINUTES
12-INCH CT PIPING	38 LF
12-INCH CONTACT TIME @ 4 GPM	53.0 MINUTES
3-INCH CT PIPING	42 LF
3-INCH CONTACT TIME @ 4 GPM	3.9 MINUTES
TOTAL CONTACT TIME	56.9 MINUTES

CONTINUOUS WATER QUALITY MONITORING

CHLORINE/pH ANALYZER

TYPE	AMPEROMETRIC PROBE
SENSITIVITY	±0.01 mg/L
READOUT	DIGITAL SIGNAL FOR REMOTE DATA

GENERAL REQUIREMENTS

1. SHOP, CATALOG, AND OTHER APPROPRIATE DRAWINGS AND INFORMATION SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO FABRICATION OR ORDERING OF ALL EQUIPMENT AND MATERIALS SPECIFIED.
2. THROUGHOUT THE CONSTRUCTION PERIOD, THE CONTRACTOR SHALL MAINTAIN THE CLEANLINESS OF THE SITE AND STRUCTURES IN A MANNER EQUAL TO THE CONDITION OF THE SITE PRIOR TO CONSTRUCTION. PRIOR TO FINAL INSPECTION, REMOVE FROM THE JOBSITE ALL TOOLS, SURPLUS MATERIALS, EQUIPMENT, SCRAP, DEBRIS, AND WASTE, AND CLEAN THE EFFECTED WORK AREA TO A NEW OR BETTER CONDITION.
3. THE CONTRACTOR SHALL MAINTAIN THE OWNER'S ACCESS TO ALL EXISTING, OPERATING EQUIPMENT SUCH THAT THE EQUIPMENT MAY BE SERVICED AND OPERATED.
4. BEFORE BEING PLACED INTO SERVICE, ALL NEW AND MODIFIED POTABLE WATER PIPE AND APPURTENANCES SHALL BE STERILIZED AND A SATISFACTORY BACTERIOLOGICAL REPORT OBTAINED IN CONFORMANCE WITH THE REQUIREMENTS OF THE STATE OF WASHINGTON DEPARTMENT OF HEALTH. IMMEDIATELY PRIOR TO ASSEMBLY, ALL PIPE, FITTINGS, AND APPURTENANCES SHALL BE SWABBED WITH LIQUID HOUSEHOLD BLEACH (FIVE TO SIX PERCENT CHLORINE), AND ONCE COMPLETE, THE SYSTEM SHALL BE FILLED WITH WATER AND BLEACH SUITABLE FOR A CHLORINE CONCENTRATION OF 25 MG/L AND ALLOWED TO SIT FOR A 24-HOUR PERIOD. AFTER THE 24-HOUR STERILIZATION PERIOD HAS ELAPSED, SAMPLE(S) SHALL BE COLLECTED AND SENT TO A DOH APPROVED LABORATORY FOR BACTERIOLOGICAL TESTING.
5. HDPE PIPE SHALL BE IRON PIPE SIZE, PE 4710 HDPE PIPE CONFORMING TO ASTM F714. ALL HARDWARE SHALL BE TYPE 316 STAINLESS STEEL.
6. COPPER PIPE SHALL BE HARD DRAWN PIPE WITH WROUGHT FITTINGS CONFORMING TO ASTM B88 USING LEAD-FREE SILVER SOLDER.
7. STAINLESS STEEL PIPE SHALL BE TYPE 316, SCHEDULE 40 WITH THREADED FITTINGS TO MATCH EXISTING.

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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No.	REVISION	DATE	APPD
1	REVISED CHLORINE SAMPLE LOCATION	06/17	AMP

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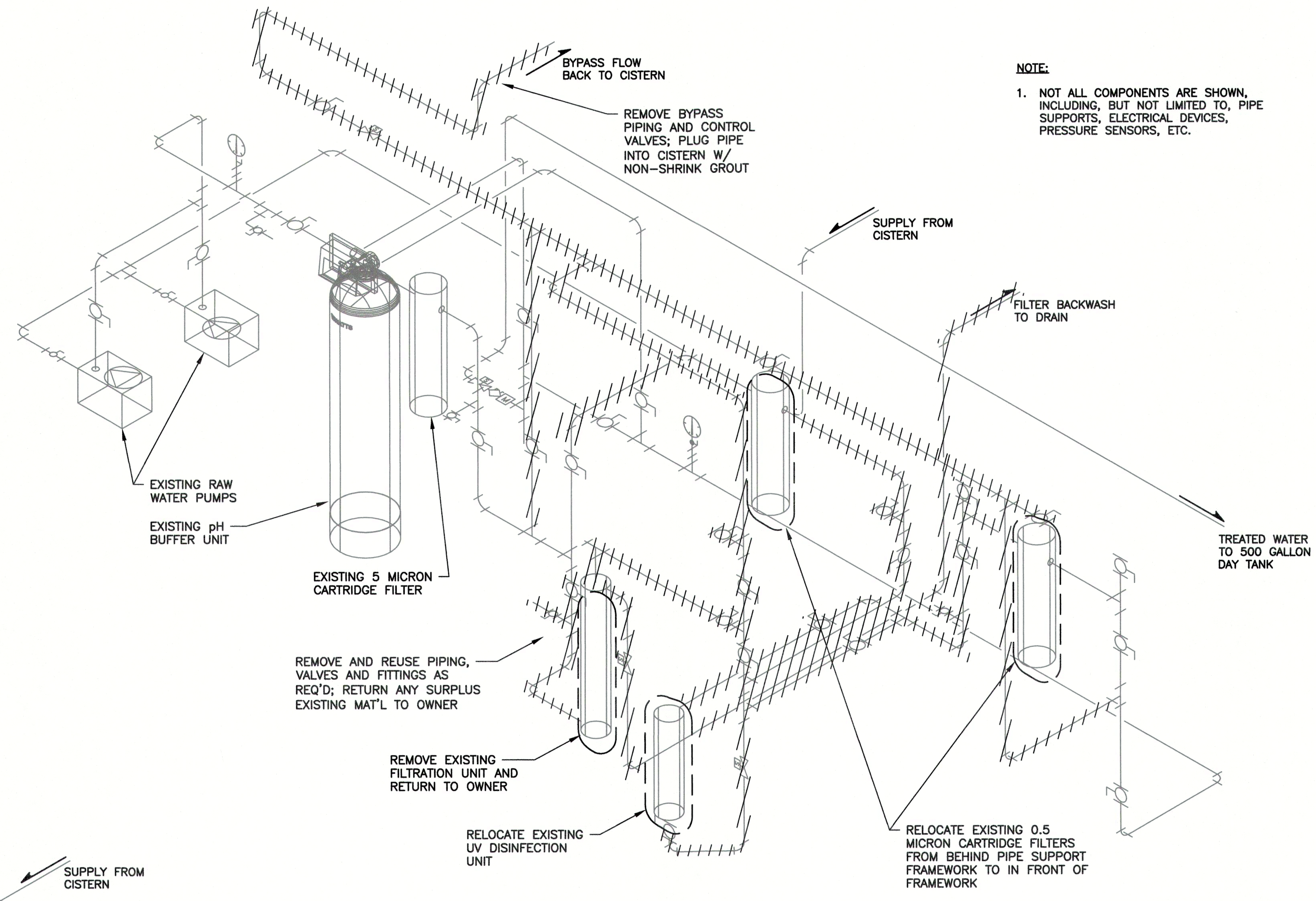
WATER SYSTEM MODIFICATIONS
PROCESS FLOW DIAGRAMS

SHEET: 2
OF: 4
JOB NO.: 16454.00
DWG: FLOW DIAG

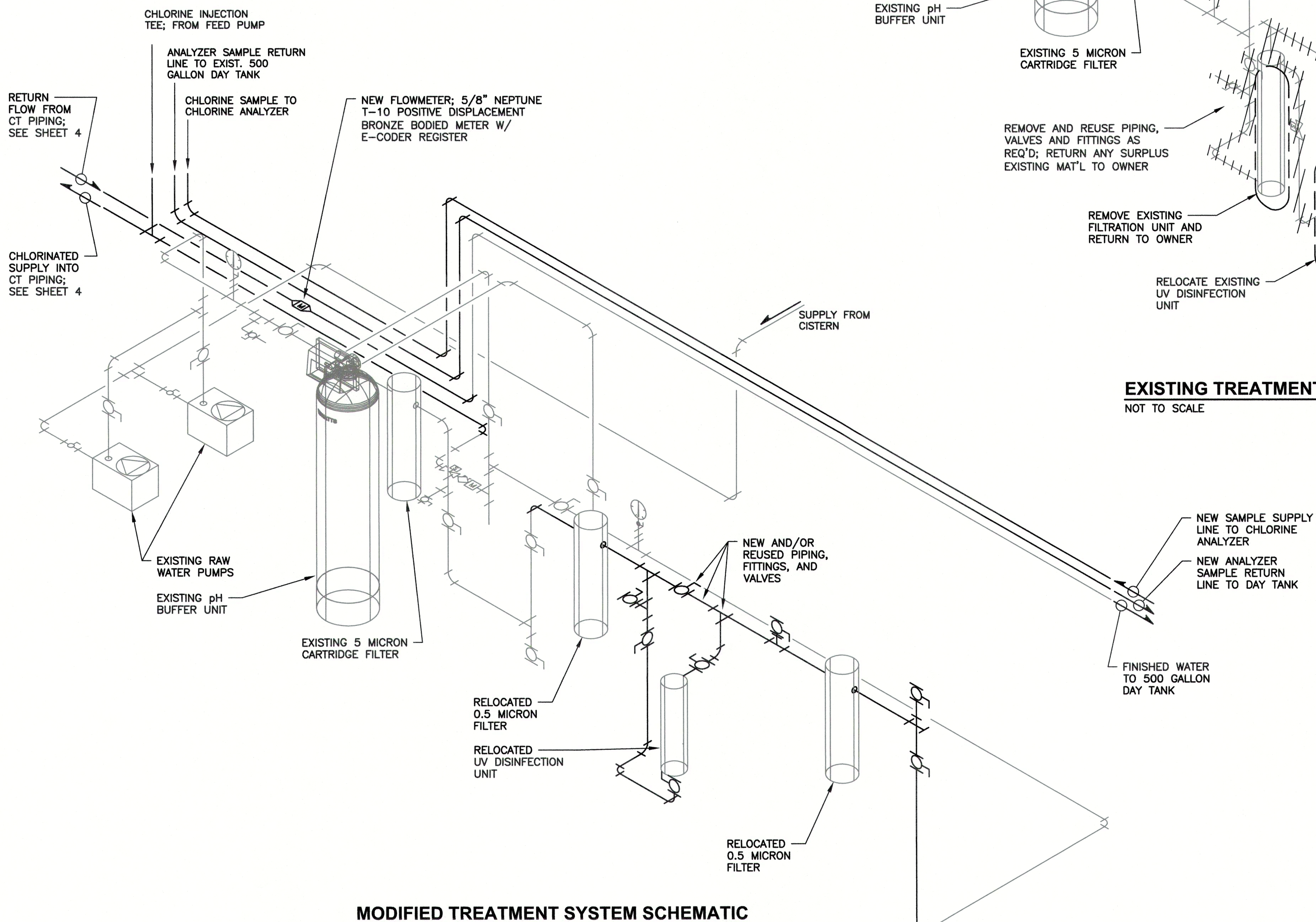


NOTE:

1. NOT ALL COMPONENTS ARE SHOWN, INCLUDING, BUT NOT LIMITED TO, PIPE SUPPORTS, ELECTRICAL DEVICES, PRESSURE SENSORS, ETC.

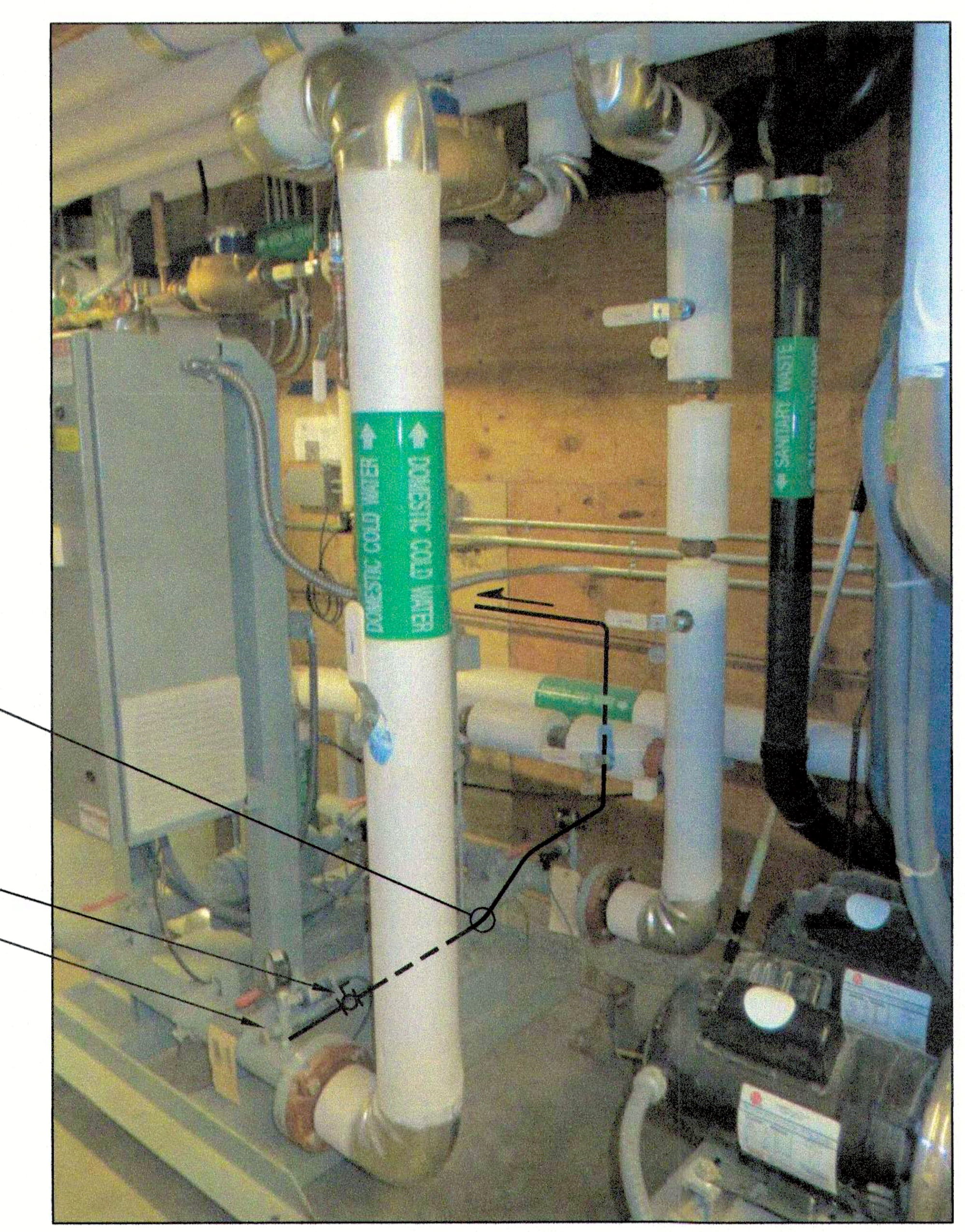
EXISTING TREATMENT SYSTEM SCHEMATIC

NOT TO SCALE



MODIFIED TREATMENT SYSTEM SCHEMATIC

NOT TO SCALE



CHLORINE ANALYZER SAMPLE LOCATION

NOT TO SCALE

0 1" 2"

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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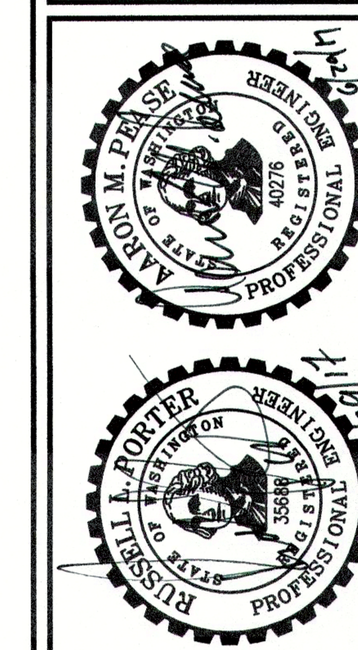
APPROVED: RLP

No.	REVISION	DATE	APPD
1	REVISED CHLORINE SAMPLE LOCATION	06/17	AMP



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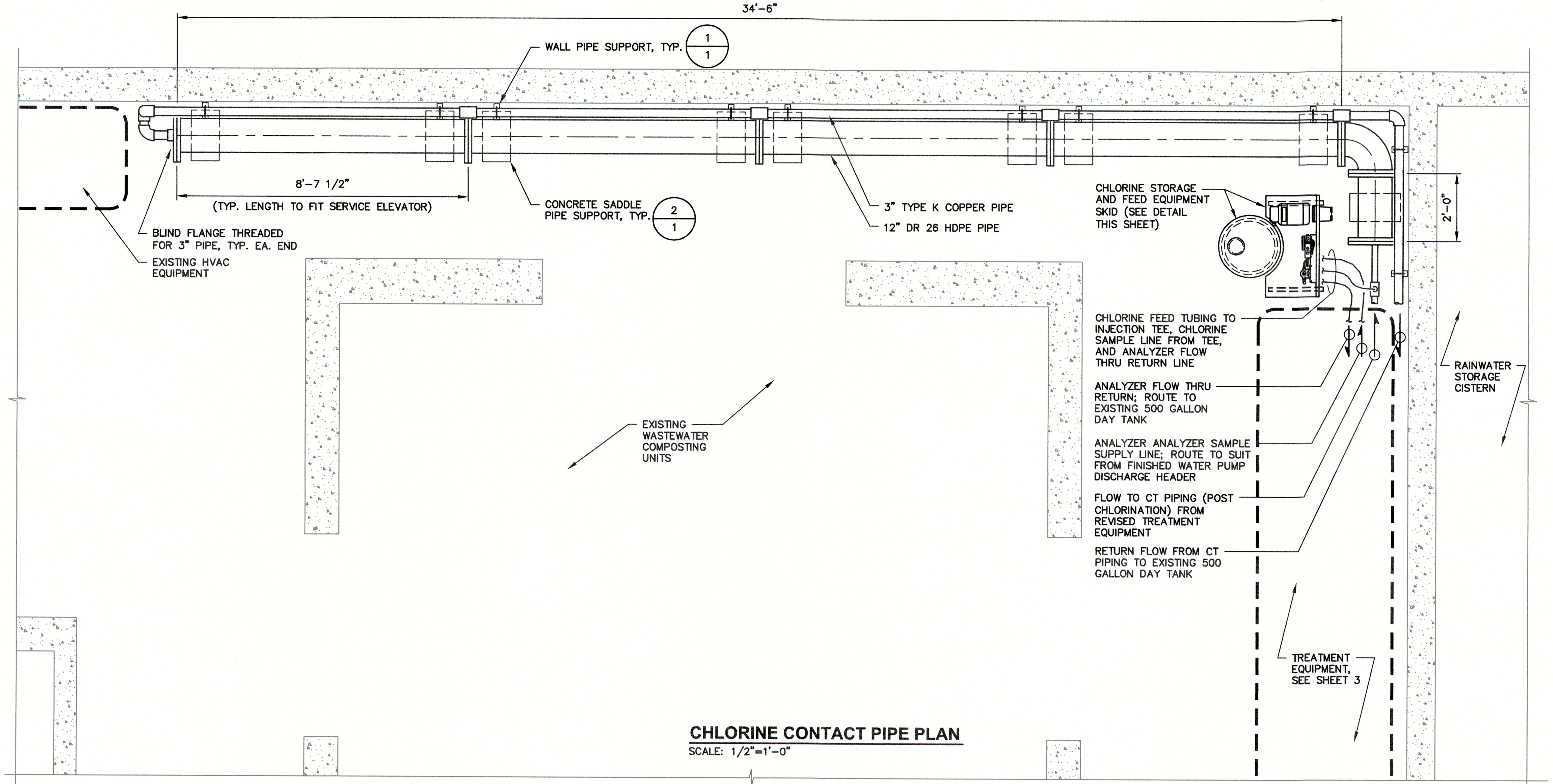
KING COUNTY WASHINGTON

BULLITT CENTER
WATER SYSTEM MODIFICATIONS
TREATMENT SYSTEM SCHEMATICS

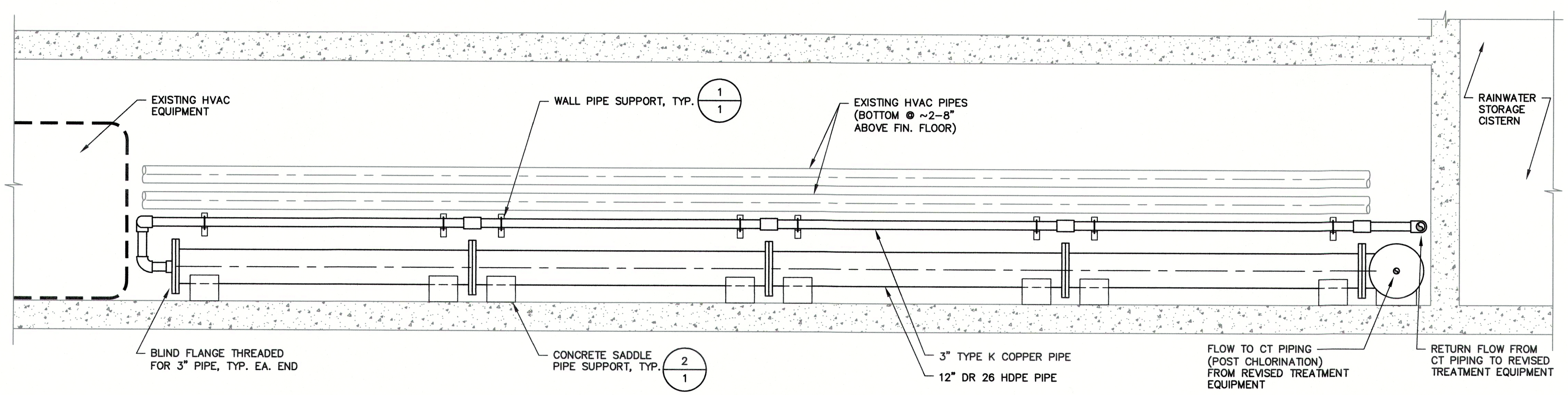
SHEET: 3
OF: 4

JOB NO.: 16454.00
DWG: TRTMNT



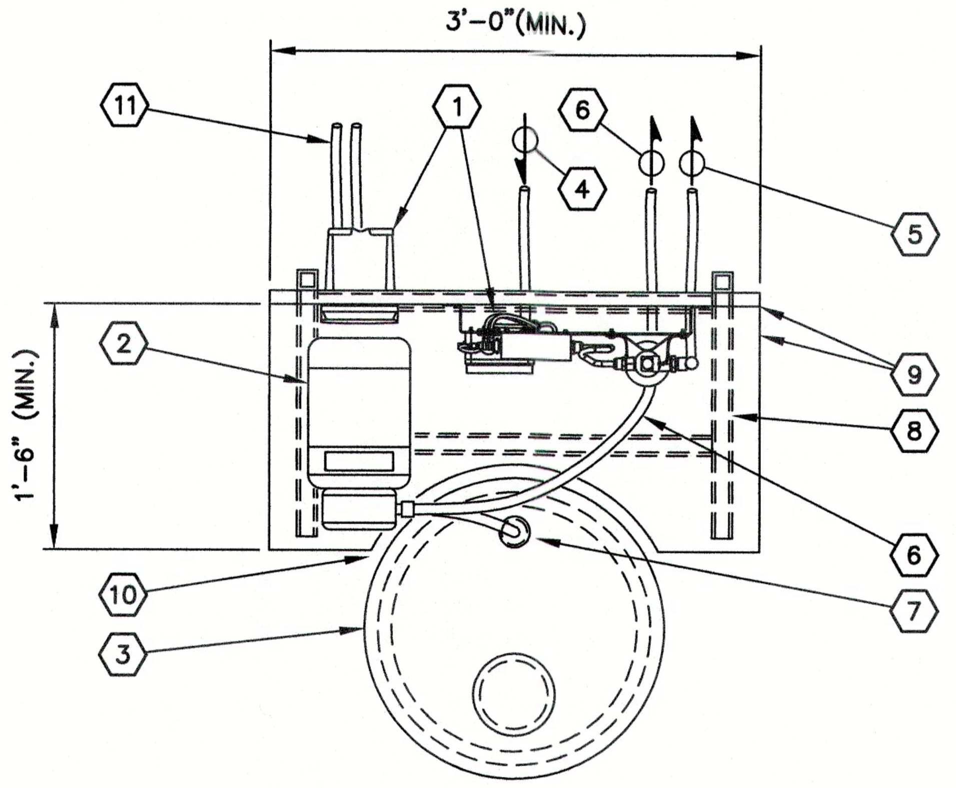
CHLORINE CONTACT PIPE PLAN

SCALE: 1/2"=1'-0"

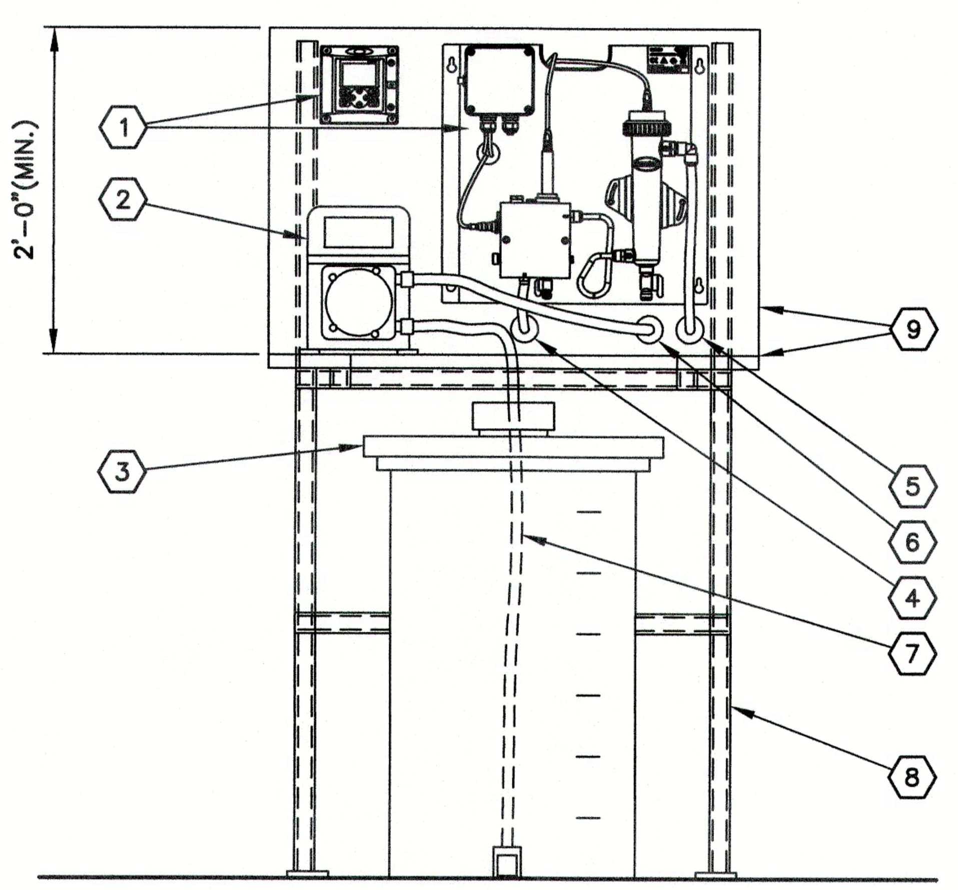


CHLORINE CONTACT PIPE ELEVATION

SCALE: 1/2"=1'-0"



PLAN



ELEVATION

LEGEND

DESCRIPTION

1. CHLORINE ANALYZER; HACH CLT10 sc PANEL WITH sc200 CONTROLLER AND pH SENSOR
2. PERISTALTIC FEED PUMP; BLUE-WHITE INDUSTRIES FLE-PRO A2 METERING PUMP W/ EXTERNAL CONTROL AND 41 GPD CAPACITY
3. CHLORINE STORAGE TANK; SNYDER INDUSTRIES 35 GALLON VERTICAL TANK, SERIES "ASM TK"
4. 1/4" TUBING; SAMPLE LINE IN TO CHLORINE ANALYZER
5. 1/2" TUBING; FLOW THRU SAMPLE RETURN LINE; ROUTE INTO EXISTING 500 GALLON DAY TANK
6. 3/8" TUBING; CHLORINE FEED LINE TO CT PIPING
7. 3/8" TUBING; CHLORINE SUCTION LINE THRU TANK BULKHEAD FITTING W/ SUCTION STRAINER @ BOTTOM OF TANK
8. PUMP AND ANALYZER STAND; FABRICATE FROM 1" SQR. TUBING, HOT DIP GALVANIZED AFTER FABRICATION; 316 SS HARDWARE AS REQ'D
9. 1" THK. HDPE SHELF AND BACK PANEL; FASTEN W/ 316 SS HARDWARE
10. RADIUS SHELF 1" LARGER THAN TANK O.D.
11. POWER AND COMMUNICATIONS CIRCUITS; EXTEND 120V RECEPTACLE TO BEHIND PUMP STAND TO POWER THE ANALYZER AND THE FEED PUMP; ROUTE NEW 3/4" RIGID GALVANIZED METALLIC CONDUIT FROM PUMP STAND TO EXISTING FACILITY CONTROL PANELS; COMMUNICATION CIRCUIT SHALL INCLUDE A MINIMUM OF 8 #14 AWG XHHW-2 CONDUCTORS; COORDINATE W/ EXISTING BUILDING INTEGRATOR FOR CONNECTIONS WITHIN PANEL

CHLORINE STORAGE AND FEED SYSTEM

SCALE: 1"=1'-0"

0 1" 2"
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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1	REVISED CHLORINE SAMPLE LOCATION	06/17	AMP

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KING COUNTY WASHINGTON

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WATER SYSTEM MODIFICATIONS
CHLORINE CONTACT PIPING

SHEET: 4
OF: 4

JOB NO.: 16454.00
DWG: CT PIPING

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BULLITT FOUNDATION

KING COUNTY WASHINGTON

BULLITT CENTER WATER TREATMENT SYSTEM ENGINEERING REPORT

G&O #16454
MARCH 2017

Gray & Osborne, Inc.
CONSULTING ENGINEERS

BULLITT FOUNDATION

KING COUNTY **WASHINGTON**

BULLITT CENTER WATER TREATMENT SYSTEM
ENGINEERING REPORT

RUSSELL L. PORTER
STATE OF WASHINGTON
35688
REGISTERED
PROFESSIONAL ENGINEER

G&O #16454
MARCH 2017

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE OF CONTENTS

LIST OF TABLES

OBJECTIVE

The objective of this report is to provide a description of the water treatment system proposed at the Bullitt Center. The system is composed of existing equipment plus some new components added to bring the system into compliance with water quality regulations.

TREATMENT SYSTEM PERFORMANCE AND DESIGN

Rainwater catchment is considered surface water and is subject to the Surface Water Treatment Rule (SWTR) as regulated in the Washington Administrative Code (WAC) 246-290. The specific aspects of WAC 246-290 for surface water treatment are summarized below. The system must provide:

- 99 percent (2-log) removal or inactivation of *Cryptospiridium*,
- 99.9 percent (3-log) removal or inactivation of *Giardia* cysts, and
- 99.99 percent (4-log) removal or inactivation of viruses.

The required removal and/or inactivation of those pathogens is typically achieved through a combination of filtration and disinfection. Removal credit for filtration technology is either prescribed by WAC 246-290 for standard filtration technology like conventional and direct rapid sand, slow sand, and diatomaceous earth filtration, or on a case-by-case basis for alternative forms of filtration, such as membranes, based on DOH review of available performance information such as third-party testing. Even if the filtration technology is capable of meeting all of the pathogen removal required, WAC 246-290 requires a minimum of 0.5-log *Giardia* cyst and 2-log virus inactivation by disinfection. The inactivation of viruses by disinfection is significantly easier than the inactivation of *Giardia* cysts. Therefore, systems that can meet the 0.5-log *Giardia* cyst inactivation also easily meet the 2-log virus inactivation requirement.

Inactivation of pathogens by disinfection is determined by calculation involving the disinfectant dose (C) and the time of exposure (T) to determine CT. The required CT times for the required log removals are determined by EPA-published tables based upon laboratory studies.

In addition to meeting CT inactivation for pathogens, WAC 246-290 requires that water systems maintain a detectable residual. Consequently, chemicals such as chlorine are typically used for pathogen inactivation and to provide a residual.

Another limitation from WAC 246-290 is that all materials that are in "substantial contact" with the water must have an NSF rating.

The proposed treatment system components at the Bullitt Center are itemized below and noted for compliance meeting the WAC 246-290 regulations.

5-MICRON CARBON FILTER

The existing 5-micron carbon filter provides a pre-filter function for the main filtration system. As such, it is not intended to fulfill the requirements of WAC 246-290 for pathogen removal, but rather is intended to improve the performance of the overall system. Carbon filters can act to remove organic matter that can lead to taste and odor issues. The unit is NSF 42 approved.

The manufacturer's literature indicates that the unit will have 5.5 psi of head loss at 5 gpm so the unit should have a lower head loss at the design flow rate of 4 gpm. The manufacturer also indicates that the unit should have a life of 40,000 gallons or more. The actual lifetime of the unit in the Bullitt Center application will be determined through use, but the differential pressure will be monitored and, at minimum, when the differential pressure begins to appreciably increase, the cartridge will be replaced.

0.5-MICRON CARBON FILTER

The existing 0.5-micron carbon filter is designed to address pathogen removal and provide organic removal for potential taste and odor problems. The unit is NSF 53 certified to 99.95 percent cyst removal (3.3-log *Giardia*, *Cryptosporidium* cyst), but Washington DOH will only grant 2-log removal for cysts from a single filter. It will provide the required cyst removal per DOH regulations. The unit is NSF 53 approved.

The testing information on the unit available from WQA indicates that the flow for the NSF cyst compliance testing was 25 gpm, a rate much higher than the design flow of 4 gpm for the Bullitt Center. The manufacturer's information for the unit indicates the clean bed pressure drop to be 4 psi at 4 gpm and the anticipated lifespan of the carbon for taste and odor removal is greater than 50,000 gallons, but there is no information on cyst removal. Consequently, the replacement will be based upon an appreciable increase in the differential pressure or if the filter produces water approaching or exceeding the 1.0 NTU standard. For initial operation, cartridge replacement based upon differential pressure will be targeted when the differential pressure has increased by 2 psi. At minimum, filter cartridges will be replaced every 50,000 gallons. The actual parameters will be determined during the commissioning phase of operation described below.

ULTRAVIOLET LIGHT UNIT

The existing UV unit is designed to provide disinfection by passing UV radiation through the water sample. The UV inactivates pathogens by reacting with the pathogen DNA to render the pathogens incapable of multiplying. DOH requires that a minimum dosage of 40 mJ/cm^2 be applied for disinfection. The installed unit is nameplate rated for 40 mJ/cm^2.

DOH also requires that the reactor design be verified by third-party dosimetry-based testing per DVWG W-294 standards. The existing unit, although NSF 55 compliant, has not been third-party tested per DVWG W-294 standards.

Because of the lack of DVWG verification, it is not practical to include the UV unit in treating the water for compliance with regulations; however, its use is not detrimental to the system. Bullitt Center staff have indicated an interest in keeping the unit as an additional treatment step for operational, if not regulatory, redundancy. The unit will be plumbed into the proposed system with a bypass allowing for it to be taken offline and bypassed if it is not in use.

pH CONDITIONING UNIT

The existing pH conditioning unit is designed to increase the pH of the finished water to make it less corrosive. While not designed to address pathogen removal, the pH buffer does address corrosivity issues that can lead to problems with lead and copper levels, another water quality concern regulated by WAC 246-290. The pH unit uses a proprietary calcite media that is NSF 42 certified to increase pH and alkalinity. The unit itself is NSF 61.

DISINFECTION

The existing treatment system does not have a disinfection component that can provide the required residual and the additional 1-log inactivation of *Giardia* cysts. Consequently, the proposed treatment system includes the construction of a sodium hypochlorite injection system and contact piping to provide the required contact time.

The system is designed to provide 57 minutes of contact time for the design flow of 4.0 gpm. Assuming a minimum chlorine concentration of 0.8 mg/L, the design CT is 46 mg min/L. Per the EPA SWTR Guidance Manual CT table, the required CT for pH 7.5, T = 10 degrees Celsius, and 0.8 mg/L chlorine is 44 mg min/L. Given the design parameters, the anticipated inactivation ratio is 1.0 at minimum. Should a higher CT be required due to temperature or pH changes, the chlorine dose can be increased.

If additional CT is required, the day tank system could also be used. The tank is an unbaffled, door tank that would likely have a baffling efficiency of 0.1 or possibly 0.2. The actual baffling efficiency could be determined by performing a tracer study. The level in the tank is monitored using an ultrasonic level indicator and it is recorded in the SCADA system. The maximum instantaneous demand would need to be used for the calculation of the contact time but both the potable and non-potable systems have meters that are monitored by SCADA so that information should be available. The chlorine concentration leaving the day tank would also need to be monitored. Because obtaining credit for the day tank is more complex from an operating standpoint relative to the dedicated CT piping with its constant flow, the initial plan is to try to attain the requisite inactivation with the CT piping only.

SUMMARY

In short, the existing treatment system does not meet WAC 246-290 for pathogen removal and inactivation as it is currently configured. The 0.5-micron carbon filter fulfills the filtration requirement of the SWTR, but the means of disinfection are deficient in this regard. With the addition of the proposed disinfection system, the SWTR requirements should be fulfilled. In addition, the pH buffer unit should provide a regulatory benefit for lead and copper compliance. A summary of the inactivation credits for the proposed system is included in Table 1.

TABLE 1

Summary of Inactivation Credits for the Proposed Treatment System

Treatment Component	***Giardia*** **Inactivation**	***Crypto*** **Inactivation**	**Virus Inactivation**
5-micron Filter	0-log	0-log	0-log
0.5-micron Carbon Filter	2-log	2-log	0-log
UV Light	0-log	0-log	0-log
pH Conditioner	0-log	0-log	0-log
Disinfection	1-log	0-log	4-log+
Total Inactivation	**3-log**	**2-log**	**4-log**

TREATMENT SYSTEM MONITORING

The Bullitt Center will be required to monitor the filtration system for various water quality parameters. The type of filtration that the Bullitt Center uses is considered an alternate filtration, the monitoring requirements for which are covered in WAC 246-290-664. A summary of these parameters is included below.

FLOWS AND PRESSURES

The proposed treatment system will include a finished water flow meter that will be used to verify the flow rate through the plant and record the daily production. The meter is a standard residential-style meter with an LCD display for both flow rate and totalizer.

The existing facility has differential pressure transducers that monitor the pressure both upstream and downstream of each cartridge filter unit. These will be reused for the proposed filter scheme. The differential pressure transducers will be used to determine when sufficient head loss has occurred to warrant filter cartridge replacement.

SOURCE COLIFORM

The Bullitt Center will collect a sample from the cistern prior to any treatment once per month. Samples for coliform will be analyzed at a commercial laboratory.

SOURCE TURBIDITY

WAC 246-290-664 (2)(d) indicates that "purveyors using an approved alternate filtration technology may be required to monitor source water turbidity at least once per day on a representative sample as determined by the department." Initially, a daily turbidity grab sample from the cistern will be proposed for the Bullitt Center after the system is started up. Because of the unique nature of the cistern, it may be possible to seek a reduced monitoring schedule if it is justified. For example, during drier periods of the year, turbidity monitoring on a weekly basis would likely be sufficient to note any changes in cistern water quality that may affect treatment.

The grab sample will be analyzed using a handheld unit such as a HACH 2100Q (EPA Method 180.1).

FILTERED WATER TURBIDITY

WAC 246-290-664 requires that purveyors using alternate filtration "provide monitoring in accordance with the technology-specific approval conditions determined by the department." The WAC also stipulates that purveyors with alternate technology "may reduce filtered water turbidity monitoring to one grab sample per day with departmental approval" provided that "the purveyor demonstrates to the department's satisfaction that a reduction in monitoring will not endanger the health of the consumers served by the water system." Because alternative systems are approved on a case-by-case basis, it is difficult to predict the filtered water turbidity monitoring requirements; however, at minimum, one grab sample per day during filter operation is proposed.

It is anticipated that the turbidity requirements for the cartridge filter will be similar to those listed for slow sand filtration or diatomaceous earth filtration. Those WAC requirements stipulate that 95 percent of the samples in a given month are below 1.0 NTU and no sample exceeds 5.0 NTU.

The grab sample will be analyzed using a handheld unit such as a HACH 2100Q (EPA Method 180.1).

DISINFECTION-INACTIVATION

The chlorine disinfection system will require daily monitoring to ensure at least 1-log cyst and 4-log virus inactivation requirements are met. The inactivation monitoring is supposed to occur during the peak flow period of the day. For the Bullitt Center, the dedicated CT storage will be after filtration and before the finished water storage tank.

Consequently, the filtration rate would be used for calculation since it is constant. The proposed system will include a residential-style flow meter with a digital readout for recording flow rate and a totalizer.

The disinfection/inactivation system's performance will be determined based upon providing an inactivation ratio of 1.0 as determined by comparing the measured CT value at a given time against the required CT value from SWTR.

The proposed instrumentation includes a HACH CLT10 (EPA Method 334.0) that will continuously measure free chlorine, pH, and temperature and relay that information to the building SCADA system.

DISINFECTION-RESIDUAL

Disinfection residuals are measured at two points in the distribution system: at entry to the distribution system and within the distribution system. For small non-community systems, DOH may (or may not) require grab sample monitoring at the entry to the distribution system. For samples in the distribution system, i.e., a sample tap within the building, the WAC stipulates that "the purveyor shall measure the residual disinfection concentration at representative points within the distribution system on a daily basis or as otherwise approved by the Department." Initially, one grab sample per day is proposed at the entry to distribution system as well as at a tap within the building distribution system and it will be analyzed with an approved chlorine residual monitoring device such as the HACH DR900 (SM 4500-Cl-G).

To determine compliance, the chlorine concentration will need to be a 0.2 mg/L minimum at entry to distribution system and 0.2 mg/L within the distribution system.

WATER QUALITY MONITORING SCHEDULE

Water quality monitoring is required for regulatory compliance and to identify water system conditions. DOH provides guidelines for inorganic and organic monitoring under WAC 246-290-300, Monitoring Requirements, in which each system is required to prepare a Monitoring Plan that will define monitoring schedules and sample locations.

Table 2 lists anticipated water quality monitoring required by state law. Some water quality monitoring requirements for certain contaminants, such as for VOCs and SOCs depend, in part, on the availability of monitoring waivers from DOH.

TABLE 2

Anticipated Water Quality Monitoring Parameters and Frequency

Parameter	Sample Location	Frequency
Bacteriological	Distribution System and Cistern	One sample per Month
Turbidity	Cistern	Daily
Turbidity	After Treatment	Daily
Chlorine	After CT storage	Continuous
Chlorine	Entry to Distribution	Daily
Chlorine	Distribution System	Daily
pH	After CT storage	Continuous
Temperature	After CT storage	Continuous
Inorganics	Cistern	Every 3 Years
Nitrates	Cistern	Annually
VOCs	Cistern	Every 3 Years unless DOH waiver
SOCs	Cistern	Every 3 Years unless DOH waiver
Lead and Copper	Distribution System	10 samples every 6 Months for two sampling periods; may be reduced to 5 samples every Year and possibly further reduced to 5 samples once every 3 Years
Disinfection Byproducts (THMs and HAA5s)	Distribution System	Two samples per Year

WATER SYSTEM STARTUP AND COMMISSIONING

Because of the unique nature of the rainwater collection system, a phased startup schedule is proposed to ensure that the system works in compliance with water quality regulations prior to providing water for human use. Initially, the treatment system will be used only for the non-potable portion of the water system. By providing water for non-potable use, the treatment system can be tested and its efficacy verified prior to providing water for human consumption.

A trial period of 2 months, minimum, is proposed during which the rainwater system will provide water for the non-potable system while the potable uses will still be provided by the SPU meter. During the trial period, the water quality monitoring of the treatment system will begin. If the water quality data indicates that the system is providing adequate treatment to comply with water quality regulations after the trial period, the system will be modified to include providing water for both potable and non-potable demands. At that point, the SPU connection will be decommissioned and the system will be considered fully operational.

During the initial period of operation, the Bullitt Center will contract with a DOH-licensed operator until the building operator can become licensed. The contracted operator will provide some initial training to the building operator, oversee day-to-day monitoring, and prepare the monthly reports.