CITY OF BAINBRIDGE ISLAND

WATER SYSTEM PLAN

CITY REVIEW DRAFT

November 2015

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CITY OF BAINBRIDGE ISLAND

WATER SYSTEM PLAN

2015

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with the assistance of
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CITY OF BAINBRIDGE ISLAND

WATER SYSTEM PLAN

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ACRONYMS & ABBREVIATIONS

AC	asbestos cement
ac-ft/yr	acre-feet per year
ADD	average day demand
AL	action level
ASR	aquifer storage and recovery
AWWA	American Waterworks Association
BPS	booster pump station
Bureau	Washington State Survey and Rating Bureau
CAS	central archive server
CCL4	Contaminant Candidate List
CCCP	Cross Connection Control Program
CCR	Consumer Confidence Report
CCCS	Cross Connection Control Specialist
CDX	central data exchange
CEU	Continuing Education Units
CIP	capital improvements plan
City	City of Bainbridge Island
CMMS	Computerized Maintenance Management System
CT	contact time
DBPR	Disinfection Byproducts Rule
DI	ductile iron
DNS	Determination of Non-Significance
DOH	Washington State Department of Health
DSL	distribution system leakage
Ecology	Department of Ecology
ENR	Engineering New Report
EOP	Emergency Operation Plan
ERU	equivalent residential unit
°F	Fahrenheit
FTE	full time equivalent
ft/s	feet per second
GI	galvanized iron
GIS	Geographical Information System
gpd	gallons per day

gpm	gallons per minute
GUI	graphical user interface
GWR	Groundwater Rule
HAA5	halocetic acids
HGL	hydraulic grade lines
HOB	Head of Bay
HPDE	high density polythylene
IC	Incident Command
IDSE	Initial Distribution System Evaluation
IOCs	inorganic chemical and physical characteristics
KPUD	Kitsap Public Utility District
LAA	Local Administrative Authority
LCD	Lead and Copper Rule
LID	Local Improvement District
LRAAs	locational running annual averages
MCGL	maximum contaminant level goal
MCL	maximum contaminant levels
MDD	maximum day demand
MFL	million fibers/liter
MFR	multi-family residential
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
MRDL	Maximum Residual Disinfectant Level
msl	mean sea level
MTU	master telemetry unit
NAS	National Academy of Sciences
O&M	operation and maintenance
PCD	Planning and Community Development Department
pCi/L	picocuries per liter
PHD	peak hour demand
Plan	Water System Plan
PLC	programmable logic controller
ppd	pounds per day
ppm	parts per million

PRV	pressure reducing valve
PSE	Puget Sound Energy
psi	pounds per square inch
PVC	percent polyvinyl chloride
RAA	running annual average
RCW	Revised Code of Washington
Rockaway Beach	Rockaway Beach Water System
RTCR	Revised Total Coliform Rule
RTU	remote terminal units
RWSA	retail water service area
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SFR	single-family residential
SMP	Standard Monitoring Program
SOCs	Synthetic Organic Chemicals
SSS	System-Specific Study
TCR	Total Coliform Rule
THM	trihalomethanes
TNIS	telephone network interface
UCMR4	Unregulated Contaminant Monitoring Rule
USEPA	United States Environmental Protection Agency
VFD	variable frequency drive
VOC	volatile organic chemicals
WAC	Washington Administrative Code
WDM-2	Level 2 Water Distribution Manager
WFI	Water Facilities Inventory
WHPA	wellhead protection areas
Winslow	Winslow Water System
WPRs	Water Plant Reports
WQMS	*Water Quality Monitoring Schedule*
WSP	Water System Plan
WUE	water use efficiency
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

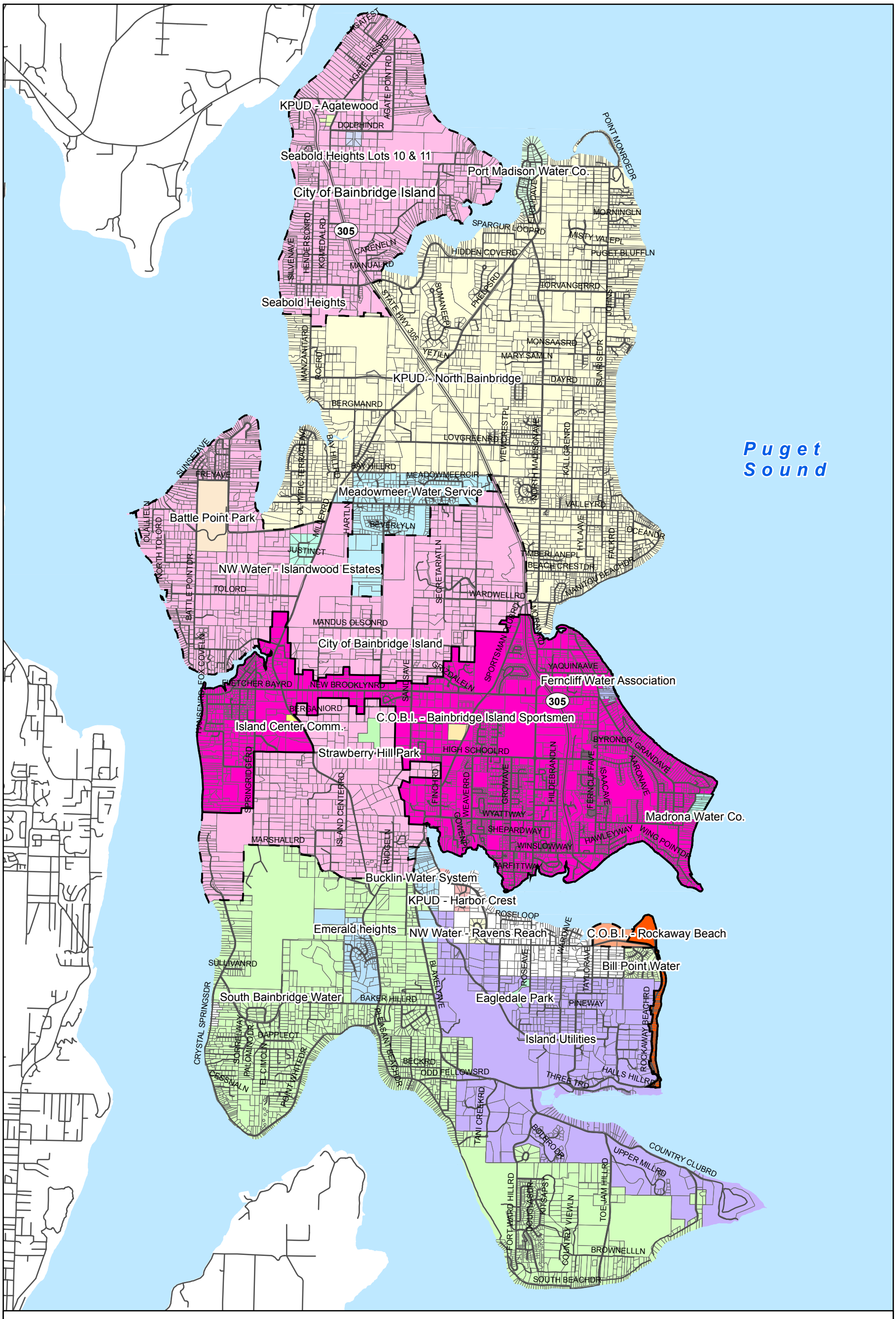
ES.1 INTRODUCTION

This Water System Plan (Plan) has been prepared to update the 2005 *City of Bainbridge Island Winslow Water System Plan* and the 2012 *Winslow Water System Limited Plan Update* in accordance with Washington Administrative Code (WAC) 246-290-100 and the Washington State Department of Health (DOH) requirements. The City of Bainbridge Island (City) owns and operates two separate water systems, the Winslow Water System (Winslow) and the Rockaway Beach Water System (Rockaway Beach). This Plan documents and evaluates both of the City's water systems.

ES.2 BASIS OF PLANNING

Chapter 2 provides an overview of the City, including a discussion of its water service providers, the history of the City and its water systems, the physical features of the island, and the land use within the City's water systems. The policies in place to guide the management and extension of the Winslow and Rockaway Beach water systems are also summarized in this chapter. This chapter serves as the framework on which to base the demographic and system analyses performed to evaluate the ability of the systems to serve future customers.

The citizens of Bainbridge Island are provided water by many different water purveyors of both Group A and Group B water systems. The boundaries of the various water purveyors and the retail water service area (RWSA) boundaries of the two systems owned and operated by the City are shown in Figure ES.1. The future RWSA boundaries are consistent with the areas designated to the City in the *Kitsap County Coordinated Water System Plan*. The RWSA boundary from the 2012 *Winslow Water System Plan Update* was revised and a new Winslow RWSA boundary was delineated as part of the development of this Plan. The Rockaway Beach RWSA was defined to encompass all existing customers, all parcels with a binding water service commitment, and all parcels along Rockaway Beach that are within the South Island Sewer Study Area as defined in the City's 2014 General Sewer Plan.



Legend

- Winslow RWSA
- Rockaway Beach RWSA
- Future Winslow RWSA
- Future Rockaway Beach RWSA
- Roads
- Parcels
- Water Body

N

0 0.55 1.1 Miles

Figure ES. 1
RWSA Boundaries and Adjacent Water Utilities
Water System Plan
City of Bainbridge Island

ES.3 DEMAND PROJECTIONS

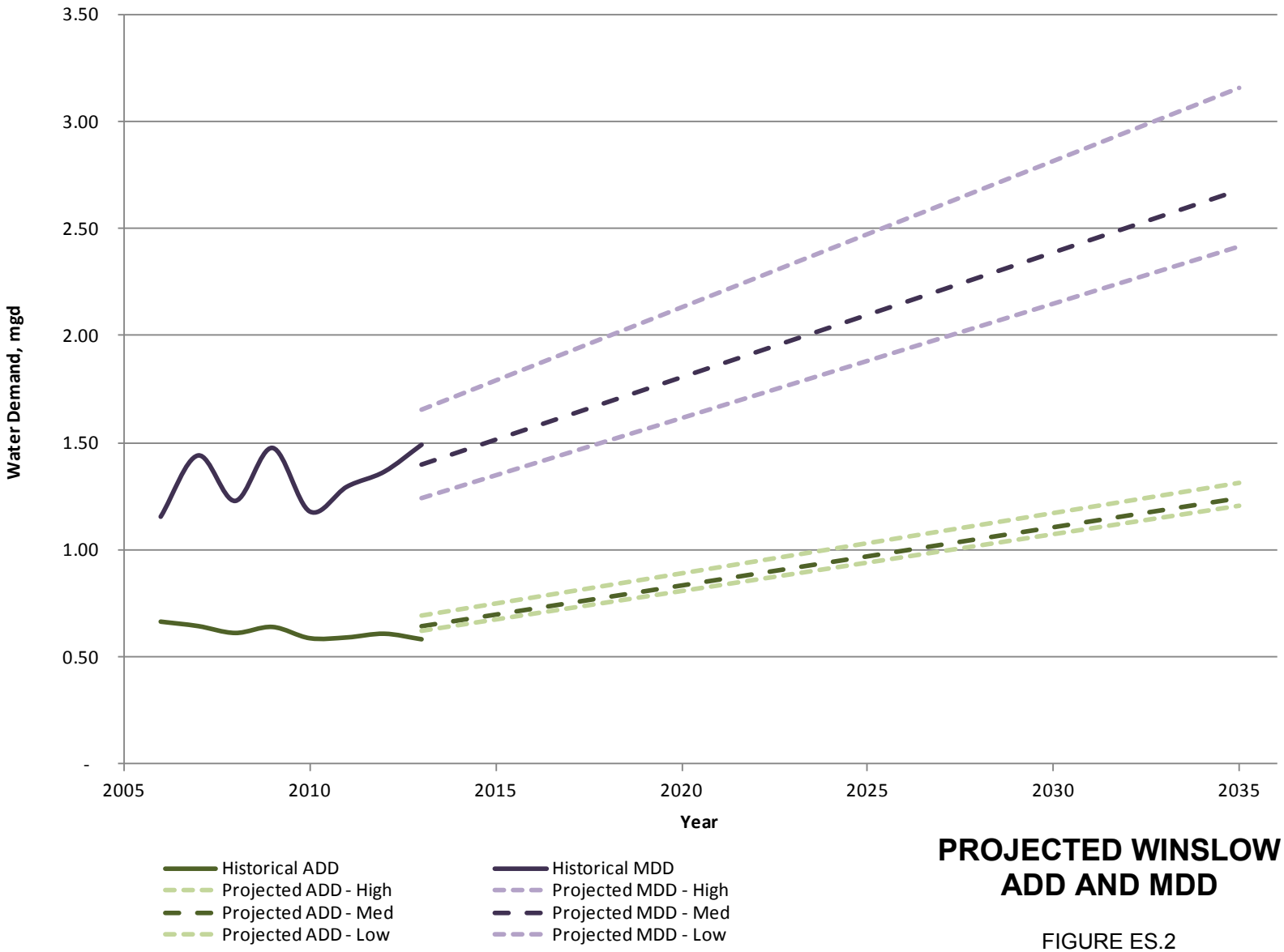
Historical water production and consumption trends for the Winslow and Rockaway Beach water systems are presented in Chapter 3 as well as high, medium, and low water demand forecasts for the RWSAs for the six-, ten-, and 20-year planning periods. These demand projections are the foundation to evaluating the capability of the water systems in meeting future water service requirements.

Demand within the Winslow RWSA is anticipated to increase as a result of three growth elements. First, vacant parcels within the Winslow RWSA are expected to be developed. Second, the City is anticipating redevelopment within Winslow's downtown core. And third, the City wants to be prepared to connect all of the parcels within the RWSA to the water system within the 20-year planning period. The Rockaway Beach demand projections assume that all 78 single-family homes within the RWSA will be connected to the water system within the 20-year planning period.

In 2013, the Winslow had an average day demand (ADD) of 0.59 million gallons per day (mgd) and a maximum day demand (MDD) on July 10th of 1.49 mgd. Single-family households consume nearly 50 percent of the water supplied by the Winslow Water System. Multi-family households consume about 15 percent, and other users such as commercial, government, and irrigation consume approximately 35 percent.

The average Winslow single-family household consumes 152 gallons per day (gpd). This is the equivalent residential unit (ERU) planning value. Rockaway Beach customers have an ERU value of 203 gpd.

The medium demand projections for Winslow predict an ADD of 1.24 mgd if the entire RWSA is connected in 2035. The medium demand projections for Rockaway Beach predict an ADD of 18,800 gpd in 2035. The low, medium, and high demand projections for each water system are presented in Figure ES.2 and Figure ES.3.



PROJECTED WINSLOW ADD AND MDD

FIGURE ES.2

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

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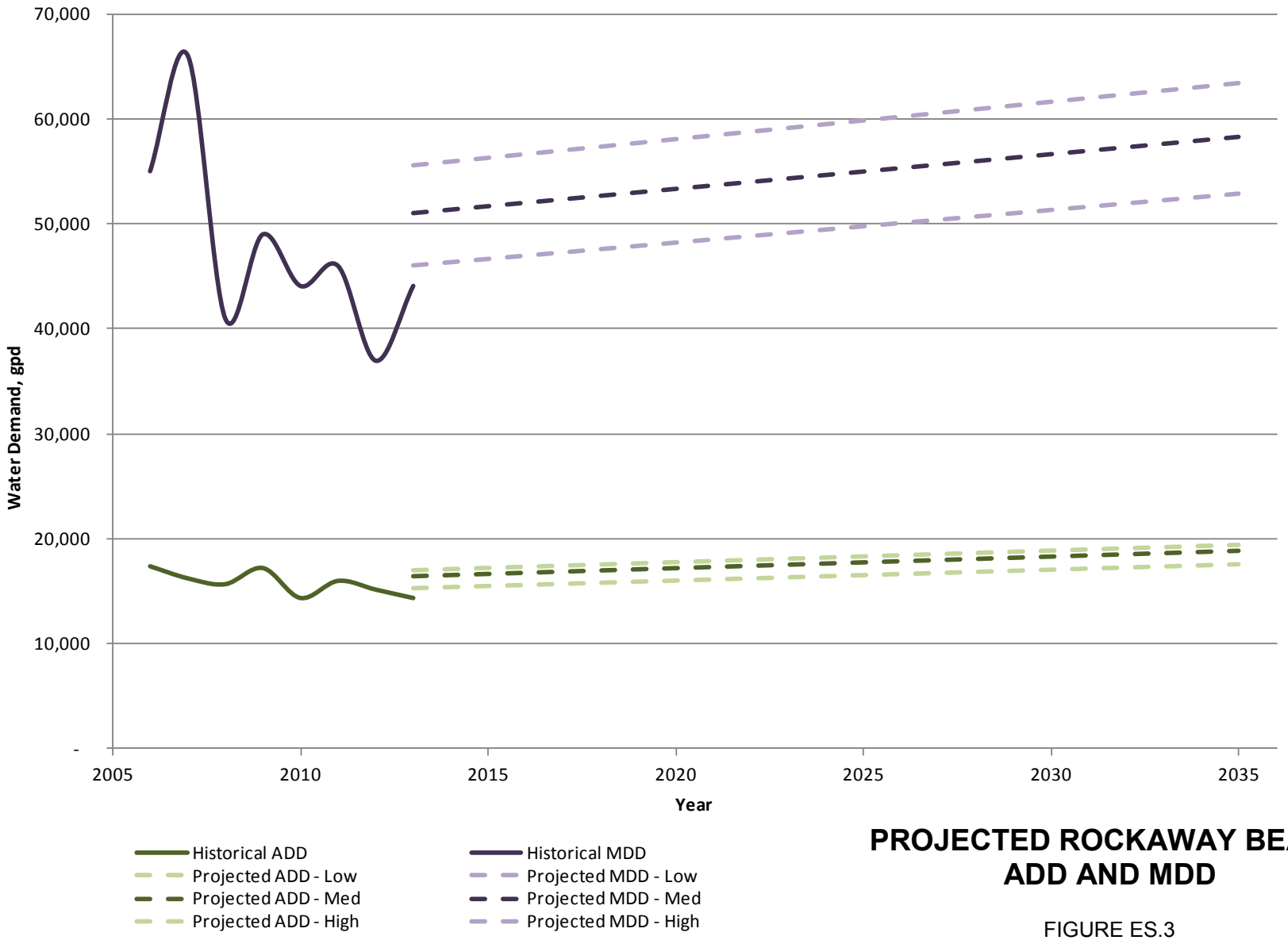

PROJECTED ROCKAWAY BEACH ADD AND MDD

FIGURE ES.3

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

carollo

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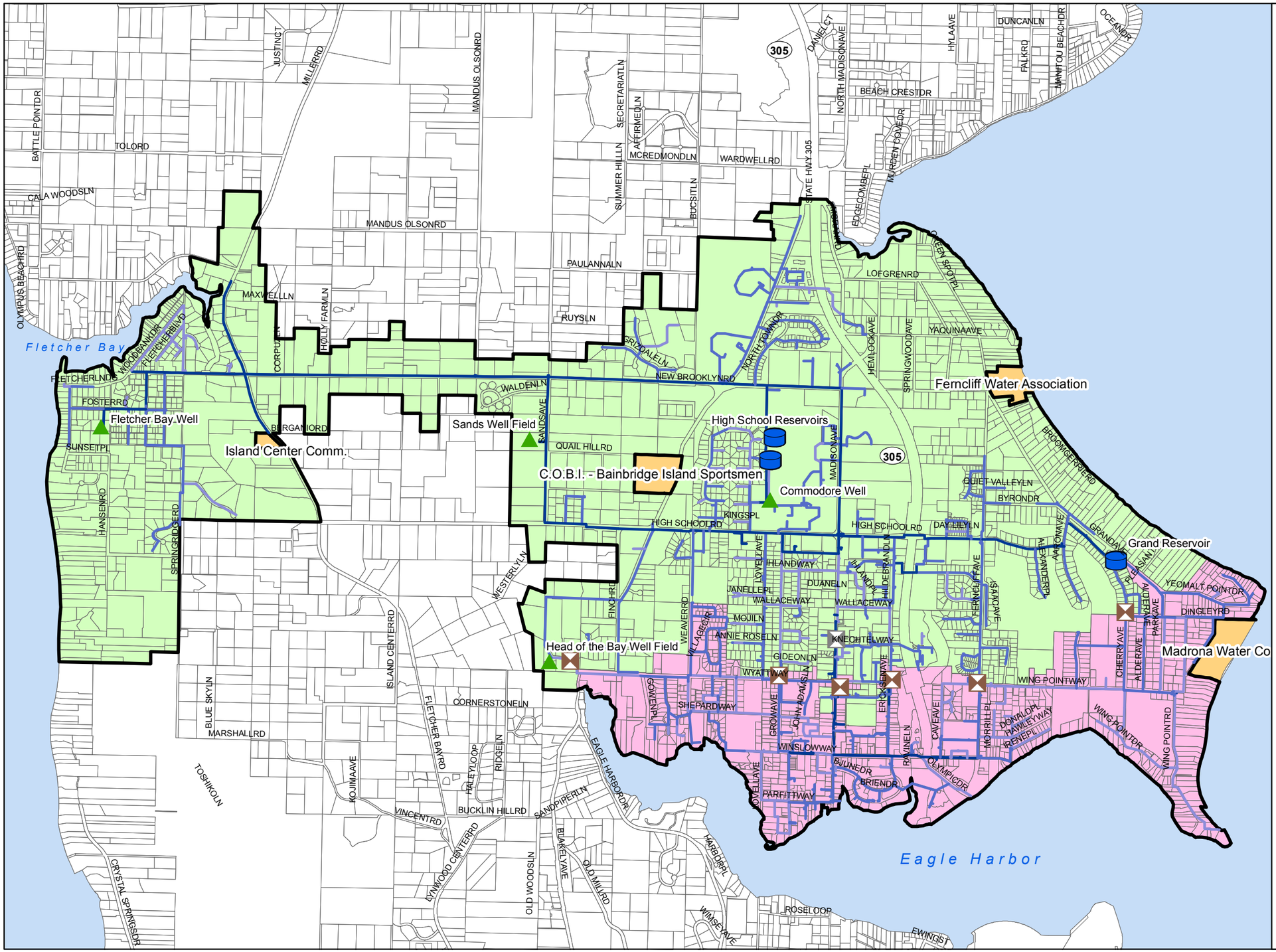
ES.4 EXISTING SYSTEM

The Winslow Water System, shown in Figure ES.4 serves water to customers in the historic Winslow and Fletcher Bay areas. The system consists of a High Pressure Zone and a Low Pressure Zone. The source of supply for the water system is groundwater supplied by eleven active wells located at four well sites: Head of the Bay, Sands Avenue, Fletcher Bay, and Commodore. At each well site the water is treated with chlorine and fluoride before being pumped into the High Pressure Zone distribution system to supply customers and fill the two active storage reservoirs near the high school. The Low Pressure Zone is served by six active pressure reducing valve (PRV) stations. Storage is provided by the two High School Reservoirs in the High Zone with a total capacity of 2.5 million gallons (MG). A third reservoir, the Grand Reservoir, is out-of-service at this time. The High School Reservoirs supply the High Zone by gravity when the wells are not operating. The distribution system is well looped. The wells draw from three separate aquifers. The DOH has determined eight of the eleven wells have a low risk of contamination while the remaining three have a moderate or high risk of contamination. A wellhead protection plan and an active cross-connection control program help protect the water system from contamination. The water system has sufficient water rights to last well into the future. The current limiting source capacity of the water system is approximately 1,750 gpm or 2.52 mgd. This is the supply capacity of the system's well sites with the smaller of the two Sands booster pumps pumping.

The Rockaway Beach Water System serves customers along Rockaway Beach Drive NE on the south side of Eagle harbor. The system consists of the Taylor Avenue Well, a treatment facility, the Creosote Reservoir, and distribution system, the locations of which are shown in Figure ES.5. The system is monitored and controlled by a telemetry system that is headquartered at the Winslow Wastewater Treatment Plant. The well site is called to operate based on the level of the Creosote Reservoir. Once started, the well, treatment facility, and reservoir operate as an integrated system and is controlled by a local programmable logic controller (PLC). The well level is continuously monitored. The well site is equipped with a generator receptacle and manual transfer switch to provide backup power during power outages, and key facilities have intrusion alarms to provide site security. The capacity of the Taylor Avenue well is approximately 43 gpm.



Legend

- PRV
- PRV (Out of Service)
- Reservoir
- Reservoir (Out of Service)
- Well Field

Pipe Network

Diameter

- 6" and Smaller
- 8"
- 10" and Larger
- Winslow RWSA Boundary
- Water Body
- Other Water Purveyors
- Parcels

Pressure Zone

- Low
- High

N

0 1,700 3,400 Feet

Figure ES. 4
Winslow Water System Map
Water System Plan
City of Bainbridge Island

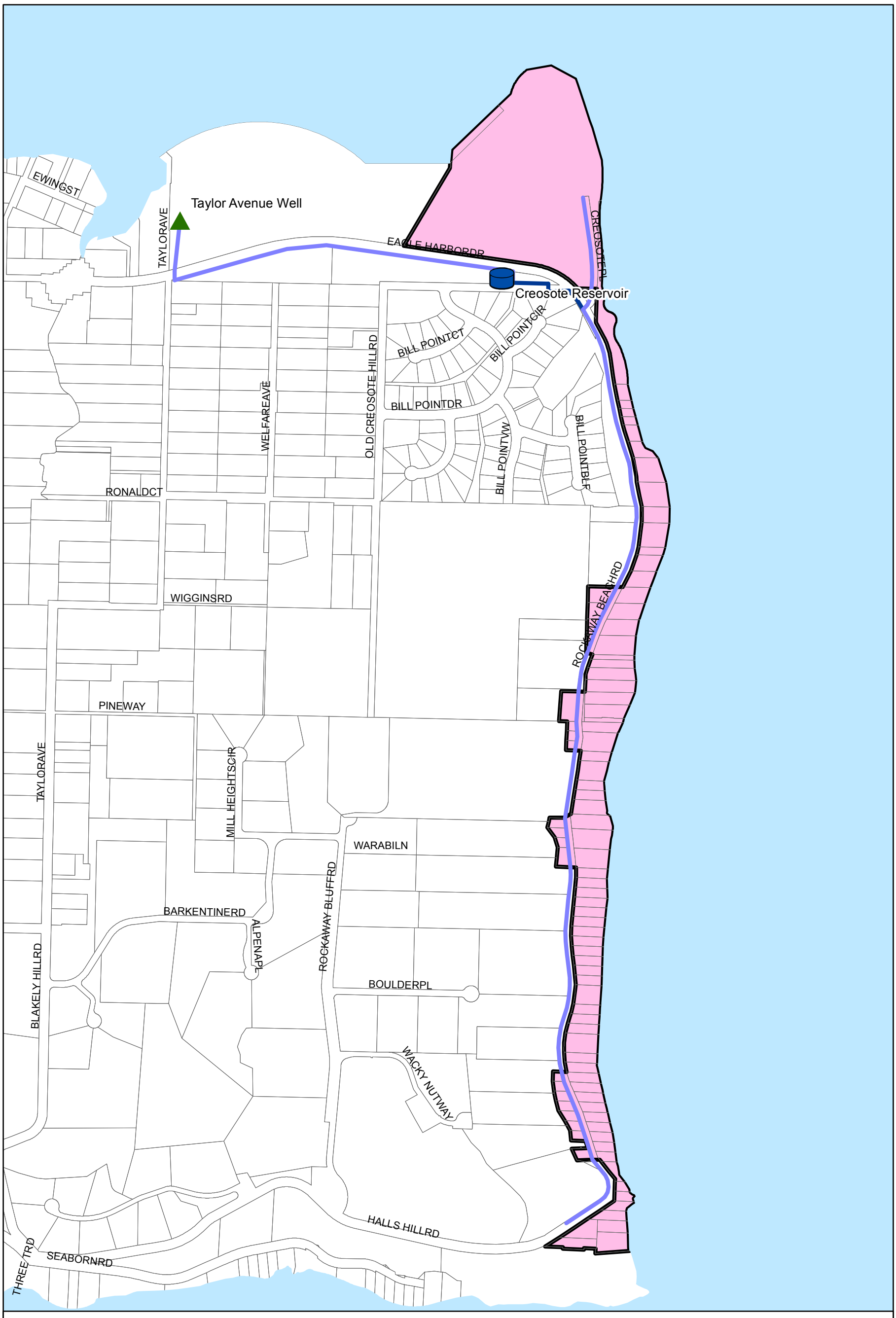


Figure ES. 5
Rockaway Beach Water System Map
Water System Plan
City of Bainbridge Island

ES.5 WATER RESOURCE MANAGEMENT AND WATER USE EFFICIENCY

Chapter 5 reviews the water rights and supply capacities of the City's supply sources and compares them to required supply based on future demand projections and the City's supply reliability criteria. The medium demand projection scenario presented in Chapter 3 is used for the supply analysis.

This chapter also summarizes the City's Water Resource Management Plan, Wellhead Protection Program, and water use efficiency (WUE) goals.

1.5.1 Supply Analysis

Each supply and pumping criterion is evaluated based on the Winslow Water System's instantaneous yield, well capacity, and well site capacity. The definitions of these three supply capacity concepts are:

- **Instantaneous Yield:** The size of the instantaneous water right for a well site, or the maximum safe yield for the well site, whichever is lower. The instantaneous yield for the Winslow Water System is 2,170 gpm.
- **Well Capacity:** The well pump capacity of a well site, or the instantaneous yield for the well site, whichever is lower. Well capacity is the amount of water that the City is able to withdraw safely from its aquifers with existing well pumps. The well capacity of the Winslow Water System is 1,870 gpm.
- **Well Site Capacity:** The limiting capacity of a well site. Well site capacity of a well site is the well capacity, or the booster pump capacity, whichever is lower. The well site capacity of the Winslow Water System is 1,810 gpm.

The City's water system well and booster pump station (BPS) capacities were evaluated against the following four criteria:

1. **Criterion 1** – **Reliable MDD Supply.** Reliable sources are capable of supplying MDD within a 24-hour period.
2. **Criterion 2** – **ADD Supply with Largest Source Removed.** Reliable sources are capable of supplying ADD with the largest source out-of-service.
3. **Criterion 3** – **Fire Storage Replenishment.** Sources are capable of supplying MDD and replenishing fire suppression storage in 72 hours.
4. **Criterion 4** – **Firm Booster Pump MDD Supply.** Booster pumps are capable of supplying MDD of the water system with firm, reliable capacity.

The Winslow Water System has adequate water rights to meet future demands within the planning period (through 2035). Figure ES.6 shows that the City's total annual water rights, including those that are not currently operated, exceed even the City's highest projected

ADD through the planning period. Figure ES.7 compares Winslow's instantaneous supply capacities to the MDD projections. While supply capacities are sufficient to meet demand as well as the City's reliability criteria through 2025, as demands approach 2035 projection levels, additional well capacity and booster pump capacity will need to be obtained to satisfy the reliability criteria.

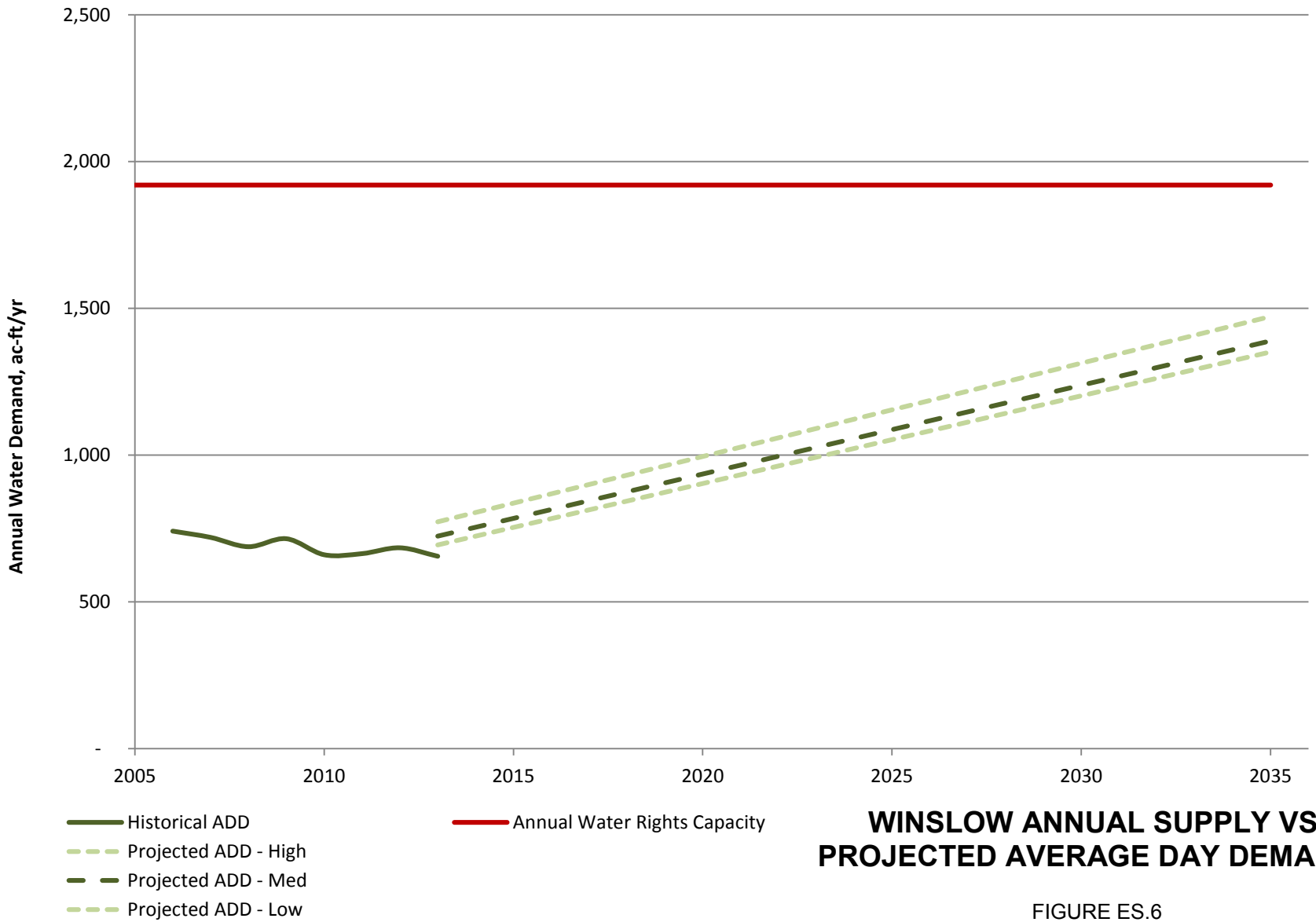
The single Rockaway Beach well, Taylor Avenue Well, does not satisfy the City's supply reliability criteria. The City needs to consider additional supply sources for Rockaway Beach. As shown in Figure ES.8, 2007 MDD exceeded the Taylor Avenue Well pumping capacity. Although MDD has been significantly lower in recent years, MDD is projected to approach the Taylor Avenue Well capacity by 2035. Figure ES.8 also compares ADD and MDD to annual and instantaneous withdrawal water rights. Rockaway Beach water rights are sufficient to supply ADD and MDD. However, as explained in detail in Chapter 5, the well pumping capacity and water rights are not sufficient to comply with the City's supply reliability criteria.

In order to improve the reliability of Rockaway Beach supply and meet all of the City's supply criteria, the City has the following five options:

1. Acquire an adjacent utility with excess water supply.
2. Construct an intertie and buy water from an adjacent utility.
3. Drill a new 80-gpm well to utilize the full Taylor Avenue water right.
4. Acquire an additional well and water rights.
5. Construct a transmission main that connects Rockaway Beach to the Winslow Water System.

1.5.2 Distribution System Leakage

Winslow distribution system leakage (DSL) data for the period 2006 to 2013 have averaged 4.7 percent and are on a downward trend. Rockaway Beach DSL data for the period 2006 to 2013 have averaged 8.6 percent and are also on a downward trend.



WINSLOW ANNUAL SUPPLY VS. PROJECTED AVERAGE DAY DEMANDS

FIGURE ES.6

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

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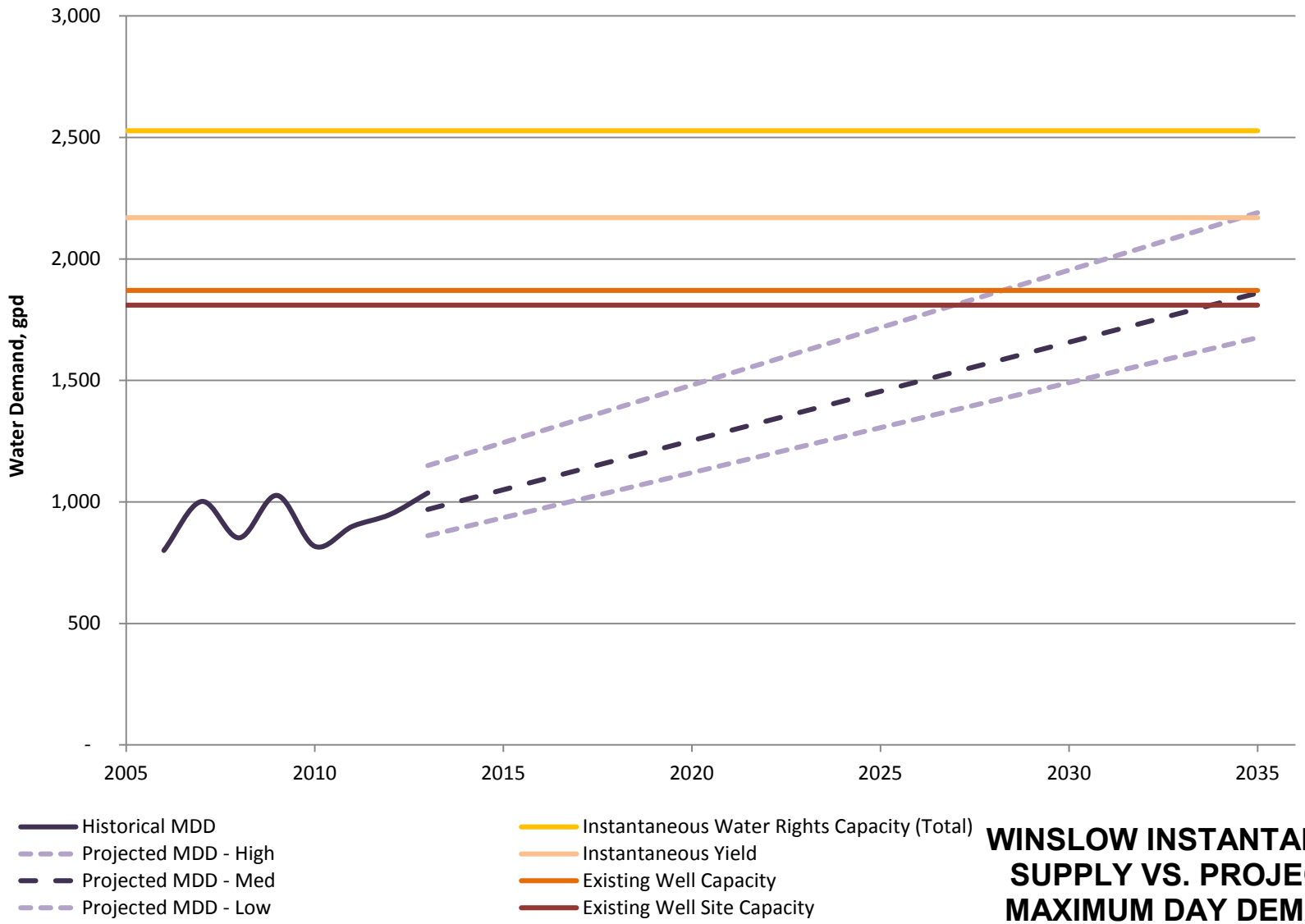

WINSLOW INSTANTANEOUS SUPPLY VS. PROJECTED MAXIMUM DAY DEMANDS

FIGURE ES.7

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

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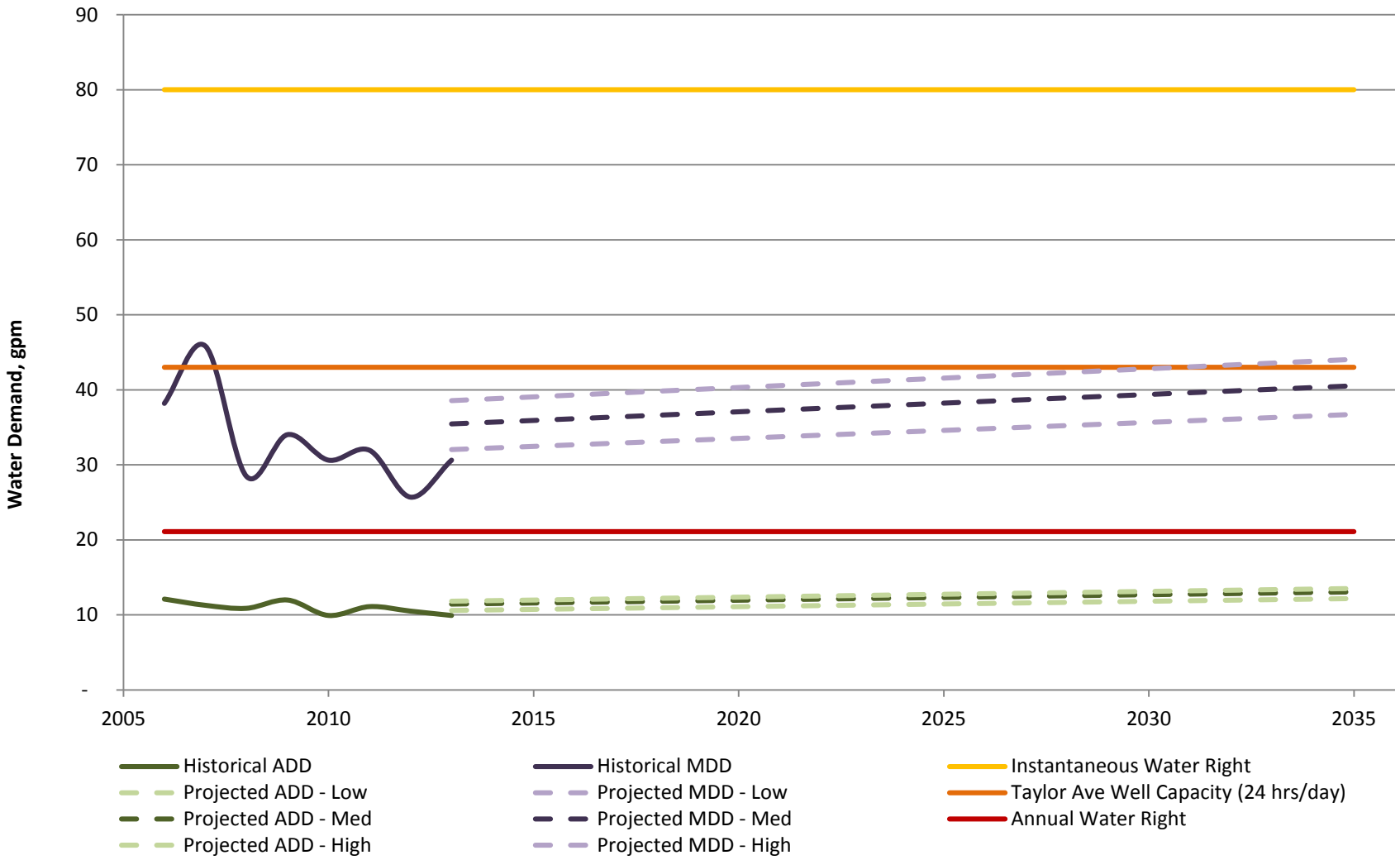


ROCKAWAY BEACH SUPPLY CAPACITY VS. PROJECTED DEMANDS

FIGURE ES.8

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

1.5.3 Water Use Efficiency Goals

For the Winslow Water System, the City's WUE goals for the planning period are:

- To maintain DSL levels under 4.7 percent, which is the historical average between 2006 and 2013, and
- To reduce the water system's ERU value by one percent annually until reaching a value of 135 gpd/ERU.

The City's WUE goals for the Rockaway Beach Water System are:

- To maintain DSL levels under 7.8 percent, which is the 25th percentile value between 2006 and 2013, and
- To achieve one percent annual reduction in the system's ERU value.

These WUE goals are represented by the low demand projection scenarios for Winslow and Rockaway Beach presented Chapter 3.

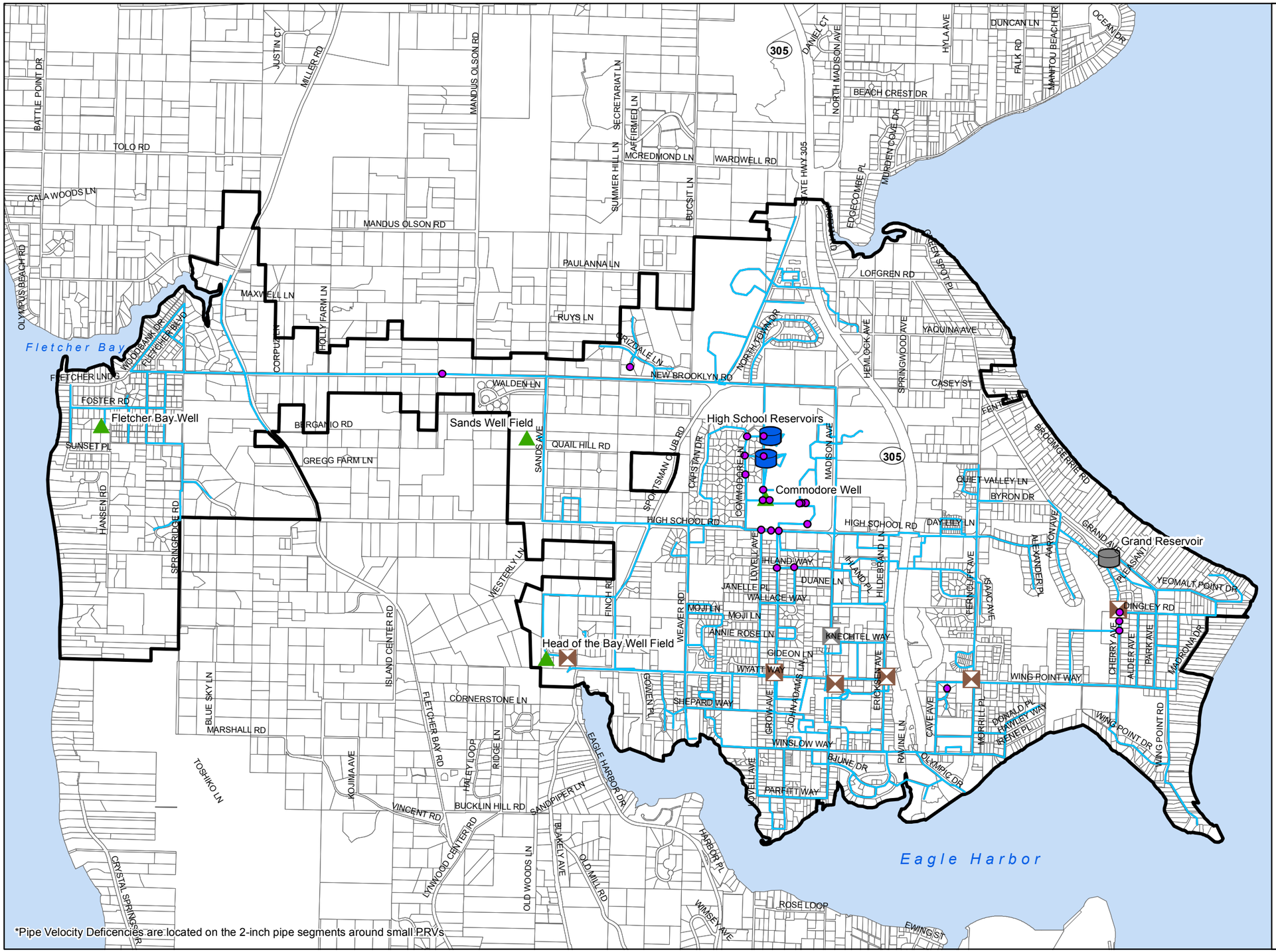
ES.6 SYSTEM ANALYSIS

The Winslow and Rockaway Beach Water Systems were evaluated for their ability to meet the City's reliability criteria under future conditions. The medium demand projection scenario was used for these evaluations. Each water system was evaluated for the capacity of its storage facilities. In addition, the Winslow distribution system was evaluated for capacity deficiencies using the City's updated hydraulic model.

In year 2021 Winslow has a storage deficit due to new high elevation customers along New Brooklyn Rd. Winslow's pressure and fire flow deficiencies are shown in Figure ES.9 and Figure ES.10, respectively.

Many pipeline upsize and new pipe installation projects are recommended to ensure required fire flows are available to all hydrants in Winslow. Rezoning parts of the High Pressure Zone to a higher 405-HGL zone is recommended to resolve Winslow storage, pressure, and fire flow deficiencies. Additional operational changes are also recommended for Winslow. All recommended improvements are shown in Figure ES.11.

Rockaway Beach requires additional storage capacity. It is recommended that the City look into connecting to the Winslow Water System, acquiring an adjacent utility with surplus supply and storage, or connecting to an adjacent utility in order to buy supply and lease storage.



*Pipe Velocity Deficencies are located on the 2-inch pipe segments around small PRVs

Legend

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Water Pipelines
- Winslow RWSA Boundary
- Water Body
- Parcels

Pressure and Velocity Criteria not Met

- Pressure Less than 30 psi
- Velocity Greater than 8 fps

Figure ES.9
Low Pressure Nodes during 2035 PHD without Improvements
Water System Plan
City of Bainbridge Island

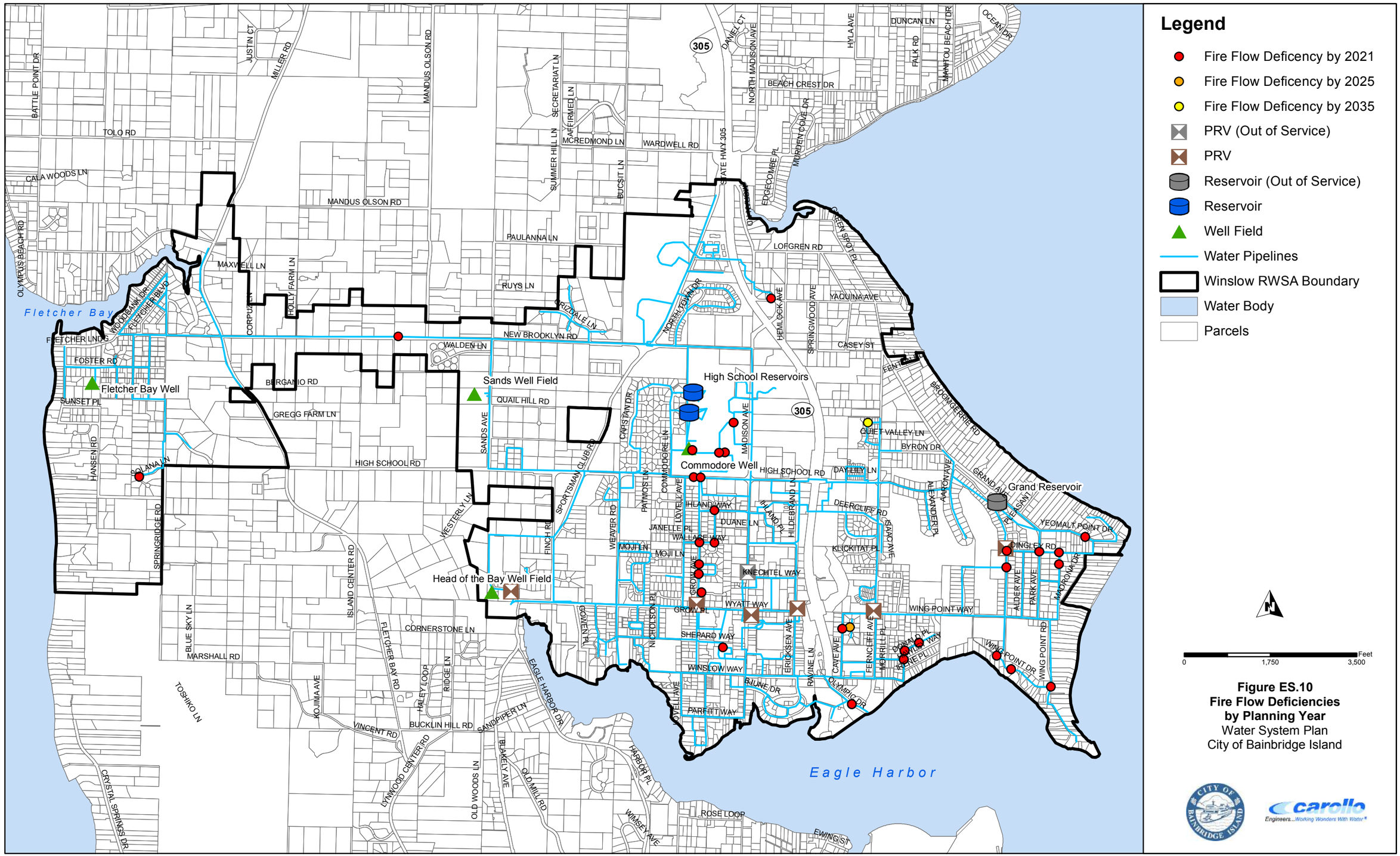


Figure ES.10
Fire Flow Deficiencies by Planning Year
Water System Plan
City of Bainbridge Island

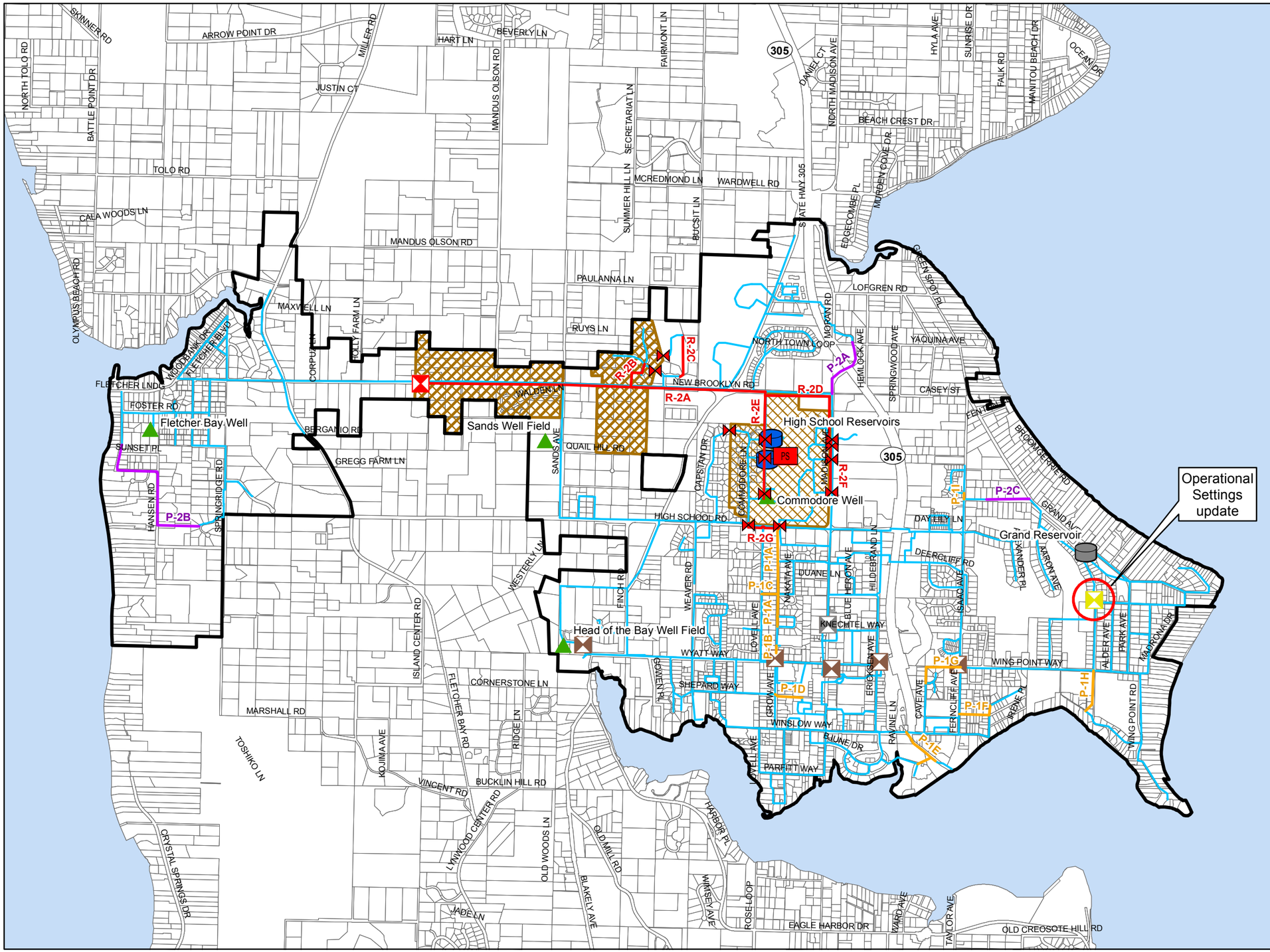


Figure ES.11
Recommended Improvements
Water System Plan
City of Bainbridge Island

ES.7 WATER QUALITY

The Winslow and Rockaway Beach Water Systems are defined as Group A – Public Community Water Systems. Group A water systems must comply with the drinking water standards of the federal Safe Drinking Water Act (SDWA) and its amendments, as regulated by the United States Environmental Protection Agency (USEPA) and adopted by the DOH under WAC 246-290.

This chapter provides the following information:

- Overview of the Winslow and Rockaway Beach Water Systems.
- Description of current drinking water quality regulations.
- Summary of current monitoring programs.
- Review of the City's compliance with water quality regulations.
- Summary of anticipated future regulations.
- Recommendations.

The City's water systems are in compliance with all water quality monitoring regulations. All of the City's sources meet primary maximum contaminant levels (MCLs). However, some sources have exceeded MCLs for secondary contaminants. The sodium levels at the Sands Avenue wells exceed the 20 milligrams per liter (mg/L) EPA level of concern as well as the color MCL. Two of the Head of the Bay wells and the Commodore Well tested higher than the manganese MCL during April 2015 field tests. It is recommended that the City review manganese treatment options for the Head of the Bay and Commodore wells.

ES.8 OPERATION AND MAINTENANCE

The City has a Manager-Council form of government. The City Manager oversees management of the Public Works Department and the Water Utility through the Public Works Director. The Water Utility is operated as a utility enterprise under the direction of the Public Works Director. Policy and planning oversight and input are provided by the Utility Advisory Committee comprised of a group of citizen volunteers.

Throughout the City, the Public Works Department coordinates with other departments and work groups for key Wastewater Utility support services. These services are performed by positions that have multiple areas of responsibility and only a portion of each position is funded by the utility. Together these support services amount to 4.8 full time equivalent (FTE) positions.

The majority of routine operation and maintenance (O&M) activities are performed by the Public Works Department O&M Division. These activities are described in Chapter 8 -

O&M. A list of items being implemented to improve the function of the current O&M program are also presented in Chapter 8.

ES.9 CAPITAL IMPROVEMENTS PLAN

The recommended supply, storage, pipeline, and the other general projects are compiled into a comprehensive capital improvements plan (CIP) for the water utility. The purpose of the CIP is to provide the City with a guideline for planning and budgeting for the future of its water systems. The CIP consists of schedule and cost estimates for the recommended improvements. Project phasing is described as either Short-term (2016 through 2021), Mid-term (2022-2025) or Long-term (2026-2035). A map of the pipeline replacement projects that are included in the CIP is presented in Figure ES.12.

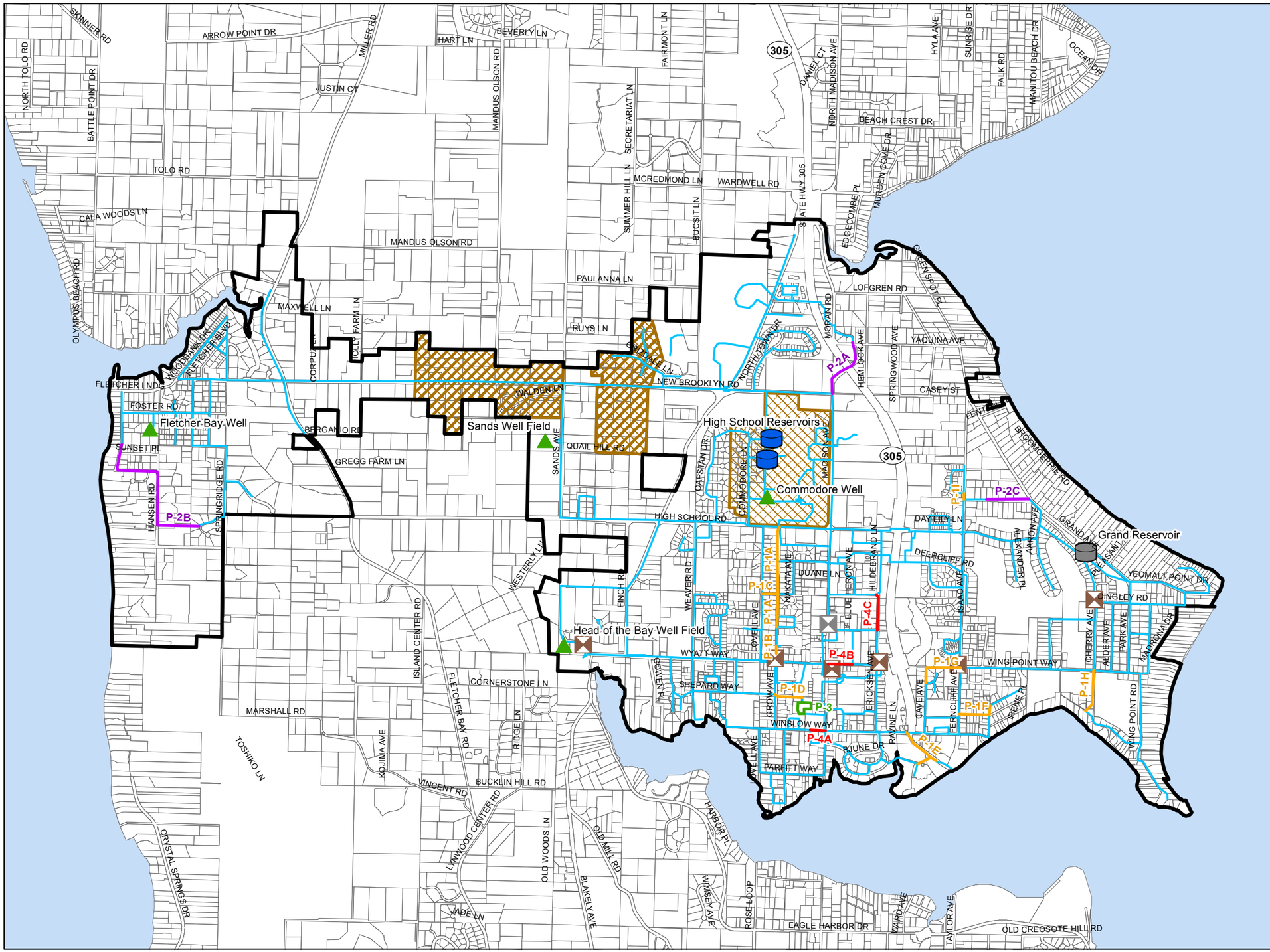
Recommended projects have been assigned a project name associated with the type of project. The following abbreviations were used:

- □P□= Pipeline
- □W□= Well Site/Supply
- □S□= Storage
- "HE" = High Elevation Fire Flow
- □G□= General

Identification for Rockaway Beach projects are prefixed by "RB". Chapter 9 presents cost estimating assumptions, the final recommended projects and programs, and a summary of the final CIP.

The total Water CIP cost over the next 20 years is □12,101,000, which equates to □605,000 annually, as presented in Table ES.1. Of the total cost, □4,224,000 is budgeted for the Short-term Phase, □3,535,000 is budgeted for the Mid-term Phase, and □4,342,000 is budgeted for the Long-term Phase.

The Water CIP is split into six categories: pipeline, well site/supply, storage, high elevation fire flow, Rockaway Beach, and general. Throughout the 20-year planning period, □2,931,000 (24 percent) is budgeted for pipeline projects, □2,370,000 (20 percent) is budgeted for well site/supply projects, □550,000 (5 percent) is budgeted for storage projects, □950,000 (8 percent) is budgeted for high elevation fire flow projects, □4,100,000 (34 percent) is budgeted for Rockaway Beach Projects, and □1,200,000 (10 percent) is budgeted for general projects.



Legend

Proposed System Improvements

- P-1
- P-2
- P-3
- P-4
- High Elevation Customers

Existing System

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Water Pipelines
- Winslow RWSA Boundary
- Water Body
- Parcels

N

0 1,900 3,800 Feet

Figure ES.12
Pipeline Capital Improvement Projects
Water System Plan
City of Bainbridge Island

carollo
Engineers...Working Wonders With Water®

Table ES.1 Capital Improvements Plan
Water System Plan
City of Bainbridge Island

Project ID	Description	Total Capital Cost ($)	Capital Improvement Phasing		
			Short-Term (2016-2022)	Mid-Term (2022-2025)	Long-Term (2026-2035)
Pipe Projects					
P-1	Winslow Pipeline Upsize Projects	$1,705,000			$1,705,000
P-2	Winslow Pipeline Installation Projects	$622,000			$622,000
P-3	Shepherd Way Pipeline Improvement Project	$267,000	$267,000		
P-4	Winslow Core Fire Flow Improvement Projects	$337,000	$337,000		$1,683,000
Total		**$2,931,000**	**$604,000**	**-**	**$2,327,000**
Well Site Projects					
W-1	Winslow Water Quality Analysis	$50,000	$50,000		
W-2	Winslow Water Treatment Improvements	$500,000	$500,000		
W-3	Head of the Bay Emergency Generator	$100,000	$100,000		
W-4	Chlorine Generator Upgrades	$180,000		$180,000	
W-5	Winslow Supply Options Evaluation	$40,000			$40,000
W-6	Winslow Well and Booster Pump Improvements	$1,500,000			$1,500,000
Total		**$2,370,000**	**$650,000**	**$180,000**	**$1,540,000**
Storage Projects					
S-1	Winslow Tank Structural/Integrity Analysis	$50,000	$50,000		
S-2	Winslow Storage Improvements	$500,000	$500,000		
Total		**$550,000**	**$550,000**	**-**	**-**

Table ES.1 Capital Improvements Plan
Water System Plan
City of Bainbridge Island

Project ID	Description	Total Capital Cost ($)	Capital Improvement Phasing		
			Short-Term (2016-2022)	Mid-Term (2022-2025)	Long-Term (2026-2035)
Rezone Projects					
HE-1	Winslow High Elevation Fire Flow Evaluation	□50,000	□50,000		
HE-2	Winslow High Elevation Fire Flow Improvement Implementation	□900,000	□900,000		
Total		**$950,000**	**$950,000**	**-**	**-**
Rockaway Beach Projects					
RB-1	Rockaway Beach Supply and Storage Eval.	□100,000	□100,000		
RB-2	Rockaway Beach Supply and Storage Improv.	□4,000,000	□1,000,000	□3,000,000	
Total		**$4,100,000**	**$1,100,000**	**$3,000,000**	**-**
General Projects					
G-1	Water System Plan Updates	□250,000		□125,000	□125,000
G-2	SCADA Improvements	□550,000	□250,000	□150,000	□150,000
G-3	Meter Replacement	□400,000	□120,000	□80,000	□200,000
Total		**$1,200,000**	**$370,000**	**$355,000**	**$475,000**
All CIP Projects					
Total Cost		**$12,101,000**	**$4,224,000**	**$3,535,000**	**$4,342,000**
Annual Cost		**$605,000**	**$704,000**	**$884,000**	**$434,000**

Notes:
(1) All cost estimates in 2015 dollars.

ES.10 FINANCIAL ANALYSIS

The last chapter of the Plan presents the financial program, including financial history, outstanding debt, fees and charges, and capital improvement funding. A preliminary six-year plan was developed to fund the capital improvements recommended in the CIP.

The City has adequate revenues from water rates and system facility charges to meet the expected operating costs of the water system. However, significant capital projects are projected to be implemented in the next six years, which will require the utility to use reserves to fund these projects.

Chapter 1

INTRODUCTION

1.1 PURPOSE

In accordance with Washington Administrative Code (WAC) 246-290-100 and the Washington State Department of Health (DOH), water system plans need to be updated every six years to reflect the current conditions of the water system. This Water System Plan (Plan) has been prepared to update the 2005 *City of Bainbridge Island Winslow Water System Plan* and the 2012 *Winslow Water System Limited Water System Plan Update*. The City of Bainbridge Island (City) owns and operates two separate water systems. The system name on record with DOH for the larger of the two water systems is City of Bainbridge Island. Within this Plan this water system will be referred to as the Winslow Water System. The other water system owned and operated by the City is on record as Rockaway Beach Water. This system will be identified throughout the Plan as the Rockaway Beach Water System This Plan documents the status of both of the City's existing water systems and analyzes the future water systems' needs.

1.2 SCOPE AND AUTHORIZATION

Recognizing the importance of planning, developing, and financing water system facilities to provide reliable service for the existing customers and to serve anticipated growth, the City initiated the preparation of this Plan. In 2014, the City selected the Carollo Engineers team to develop this Plan, in accordance with applicable rules and regulations governing planning for water utility systems.

The objectives of the Plan include:

- Develop a basis of planning for the City's water systems by establishing the service area goals and policies and by identifying the retail water service area (RWSA) boundaries for the Winslow and Rockaway Beach Water Systems.
- Perform a demographic analysis summarizing the household, employment, and land use projections for the Winslow and Rockaway Beach RWSAs.
- Develop accurate demand projections for the Winslow and Rockaway Beach RWSAs.
- Describe and inventory the City's existing Winslow and Rockaway Beach Water Systems.
- Ensure efficient use of available water resources.
- Analyze the water systems for their ability to meet future water demands and system requirements, ensuring reliable service and high quality drinking water is delivered to future City customers during all conditions of operation.

- Document the City's current water system operation and maintenance (O&M) program.
- Develop a Capital Improvements Plan (CIP) for water system improvements.

1.3 PLAN ORGANIZATION

The Plan contains 10 chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters of this Plan are organized as follows:

Chapter 2 – Basis of Planning provides a history of Bainbridge Island and the Winslow and Rockaway Beach Water Systems, outlines the policies and criteria governing the water systems and presents maps of the RWSA boundaries, existing land use and future land use for the Winslow and Rockaway Beach Water Systems.

Chapter 3 – Demand Projections explains the demographic analysis performed to estimate growth rates within each RWSA and establishes demand projections for both systems.

Chapter 4 – Existing System describes the Winslow and Rockaway Beach Water Systems in detail.

Chapter 5 – Water Resource Management and Water Use Efficiency includes an overview of the City's water supplies, water rights, water resource management plan, and water use efficiency (WUE) plan. This chapter also presents an analysis of the capability of the City's water supplies to meet future needs.

Chapter 6 – System Analysis presents results of the pumping capacity, storage, fire flow, and distribution system pressure analyses performed for the City's water facilities.

Chapter 7 – Water Quality provides an overview of the City's water treatment facilities.

Chapter 8 – Operation and Maintenance describes the management, operation, maintenance, and emergency response program of the water system.

Chapter 9 – Capital Improvements Plan outlines a schedule and budget for recommended water system improvements that are required to meet future condition and capacity limitations.

Chapter 10 – Financial Analysis presents a summary of the financing requirements that are necessary to implement the CIP.

1.4 LOCATION

Bainbridge Island is a city within Kitsap County, Washington as well as the name of the 28 square mile island on which the City is situated. It is located in Puget Sound east of the Kitsap Peninsula and west of Seattle. The cities nearest to Bainbridge Island include Poulsbo, which is accessible to the northwest by bridge, and Seattle to the east, which is accessible by ferry. Figure 1.1 shows the vicinity of Bainbridge Island.

1.5 AUTHORITY AND MANAGEMENT

The Winslow Water System, which is located on the north side of Eagle Harbor on Bainbridge Island, is owned and operated by the City. The DOH water system identification number for the Winslow Water System is 97650 and the system name on record is City of Bainbridge Island. A copy of the Water Facilities Inventory (WFI) Report is included in Appendix D.

The Rockaway Beach Water System is located south of Eagle Harbor on the east side of Bainbridge Island. The water system was originally owned and operated by the Rockaway Beach Water Association. The City took ownership of the Rockaway Beach Water System in 1996. This system is separate from the Winslow Water System with a DOH water system identification number of 73450 and DOH water system name of Rockaway Beach Water. A copy of the most recent WFI Report is included in Appendix D.

The City has a Council/Manager form of government. The Public Works Director is Mr. Barry Loveless, P.E.

The City's current mailing address is:

City of Bainbridge Island
280 Madison Avenue North
Bainbridge Island, Washington 98110-1812

1.6 RELATED PLANS AND STUDIES

Various previous planning and engineering studies conducted by the City have been reviewed while developing this Plan. A list of relevant planning and engineering studies is presented below.

- City of Bainbridge Island. 2012. *Winslow Water System Limited Water System Plan Update*.
- RH2 Engineering. 2007. *Winslow Water System Plan Storage Analysis Update*.
- Robinson, Noble and Saltbush. 2005. *Winslow Water System Water Resource Management Plan*.
- City of Bainbridge Island. 2004. *Comprehensive Plan*.

- City of Bainbridge Island. 2006. *Winslow Master Plan*.
- Robinson & Noble, Inc. 2003. *City of Bainbridge Island Wellhead Protection Program*.
- Robinson, Noble and Saltbush. 2002. *City of Bainbridge Island Water Rights Analysis*.
- R.W. Beck. 1996. *Rockaway Beach Water System Plan.*
- City of Bainbridge Island. 2012. *Taylor Avenue Well Planning Evaluation*.

1.7 APPROVAL PROCESS

This Plan is required to meet state, county, and local requirements. It complies with the requirements of the DOH as set forth in the WAC 246-290-100. The City will submit this Plan to DOH, Kitsap County, and adjacent utilities during part of the agency review process. The Adopting Resolution will be included in Appendix A, upon Plan approval by the City Council. See Appendix B for Comment Letters.

1.8 ENVIRONMENTAL ASSESSMENT

A SEPA Checklist has been prepared for this Plan. The City has determined this Plan does not have probable significant adverse impacts on the environment and has issued a Determination of Non-Significance (DNS) under WAC 197-11-340 (2). It is anticipated that many of the projects proposed within the Plan will require subsequent project specific environmental review and SEPA Checklists as part of their preliminary and final design process. The SEPA Checklist and DNS are included in Appendix C.

1.9 ACKNOWLEDGEMENTS

Carollo Engineers would like to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan:

- Barry Loveless, Public Works Director.
- Christian Munter, Project Manager.
- Charles Krumheuer, Public Works Manager for Operations and Maintenance.
- Cami Apfelbeck, Water Resources Specialist.
- Jennifer Sutton, Special Project Planner for Department of Planning and Community Development.
- Katharine Cook, Planning Director.
- Ellen Schroer, Director of Finance.

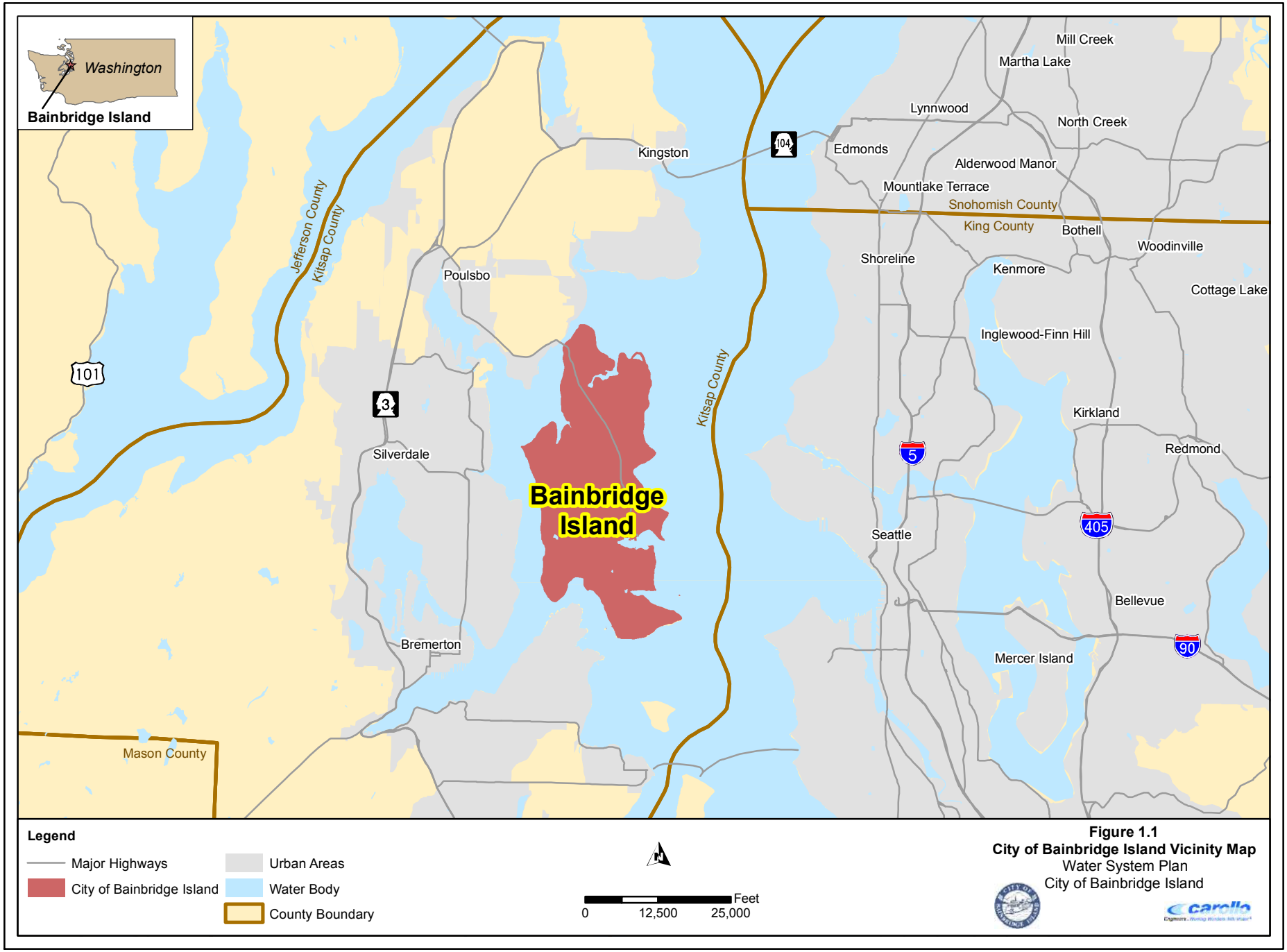


Figure 1.1
City of Bainbridge Island Vicinity Map
Water System Plan
City of Bainbridge Island

Chapter 2

BASIS OF PLANNING

2.1 INTRODUCTION

This chapter provides an overview of the City of Bainbridge Island (City), including a discussion of its water service providers, the history of the City and its water systems, the physical features of the island, and the land use within the City's water systems. The policies in place to guide the management and extension of the Winslow and Rockaway Beach water systems are also summarized in this chapter. This chapter serves as the framework on which to base the demographic and system analyses performed to evaluate the ability of the systems to serve future customers.

2.2 WATER SERVICE PROVIDERS

The City maintains two separate water systems: 1) the Winslow Water System; and 2) the Rockaway Beach Water System. However, water is provided to the citizens of the City of Bainbridge Island by many different water purveyors in both Group A and Group B water systems. Group A water systems serve 15 or more service connections or 25 or more people per day for 60 or more days per year. Group B water systems serve less than 15 service connection and less than 25 people per day or 25 or more people per day during fewer than 60 days per year. The largest water purveyors on the island include the Kitsap Public Utility District (KPUD), Meadowmeer Water Service, South Bainbridge Water, and Island Utilities. Most of the City's citizens are supplied by wells. The boundaries of all the water purveyors on the island are shown in Figure 2.1. This map corresponds to the purveyor boundaries as delineated in the *Kitsap County Coordinated Water System Plan*.

2.2.1 Current and Future RWSA

Figure 2.1 shows the City's current and future retail water service area (RWSA) boundaries for the Winslow and Rockaway Beach Water Systems. The future RWSA boundaries are consistent with the areas designated to the City in the *Kitsap County Coordinated Water System Plan.* The RWSA boundary from the 2012 Winslow Water System Water System Plan Update was revised and a new current Winslow RWSA boundary was delineated as part of development of this Plan. The current Winslow RWSA encompasses all of the customers currently served by the Winslow Water System, all of the parcels with binding water service commitments, the entire Winslow Sewer Study Area as defined in the 2014 General Sewer Plan, all of the Parcels within the RWSA boundary as presented in the 2012 Water System Plan, all parcels adjacent to existing City pipelines, and an area of parcels south of Fletcher Bay that are anticipated to be served within the 20-year planning period. The current Winslow RWSA covers approximately 4.5 square miles. The Rockaway Beach current RWSA encompasses all existing customers, all parcels with a binding water service commitment, and all parcels along Rockaway Beach that are within the South Island Sewer

Study Area as defined in the 2014 General Sewer Plan. The Rockaway Beach current RWSA includes approximately 0.08 square miles.

2.3 OVERVIEW OF BAINBRIDGE ISLAND

2.3.1 History of the City

In 1872 Captain George Vancouver anchored off the southern tip of Bainbridge Island while exploring the Puget Sound. Later in 1841 U.S. Navy Lieutenant Charles Wilkes visited the island while surveying Puget Sound and named the island after Commodore William Bainbridge. Bainbridge Island was ceded to the U.S. government in 1855 by the Suquamish tribe by the Treaty of Point Elliott, which was signed by Chief Sealth. Washington became a territory in 1853 and Kitsap County, named after another chief of the Suquamish, was formed with its county seat at Port Madison, on the northern shore of Bainbridge Island.

The main industries on the island in the late 1800s were logging and ship building. Port Blakely on the island was home to the world's largest saw mill. In the early 1900s the U.S. army built Fort Ward on the southern tip of the island to provide coastal defense for the Puget Sound Naval Shipyard in Bremerton.

The shipyard at Port Blakely was moved to Eagle Harbor in 1902 and the community there became known as Winslow. Winslow incorporated in 1947 and developed water and sewer systems, becoming the urban center of Bainbridge Island. In 1991, Winslow annexed the rest of Bainbridge Island and changed its name to the City of Bainbridge Island.

2.3.2 History of the Winslow Water System

The Winslow Water System was originally constructed to serve the City of Winslow on Bainbridge Island, which was incorporated in 1947. The water system was originally supplied by a number of small wells that were eventually abandoned due to poor water quality, low production, or failure.

In 1972 the Winslow Water System was supplied by six wells and a small surface water diversion at the Head of the Bay (HOB). The wells included three at the HOB, and the Weaver-Wyatt, Weaver-Shepard, and Wing Point wells. The Weaver wells included treatment to remove sulfur from the water. Storage for the water system consisted of two 150,000-gallon reservoirs, one located at Knechtel Way and the other at High School Road and Lovell Avenue.

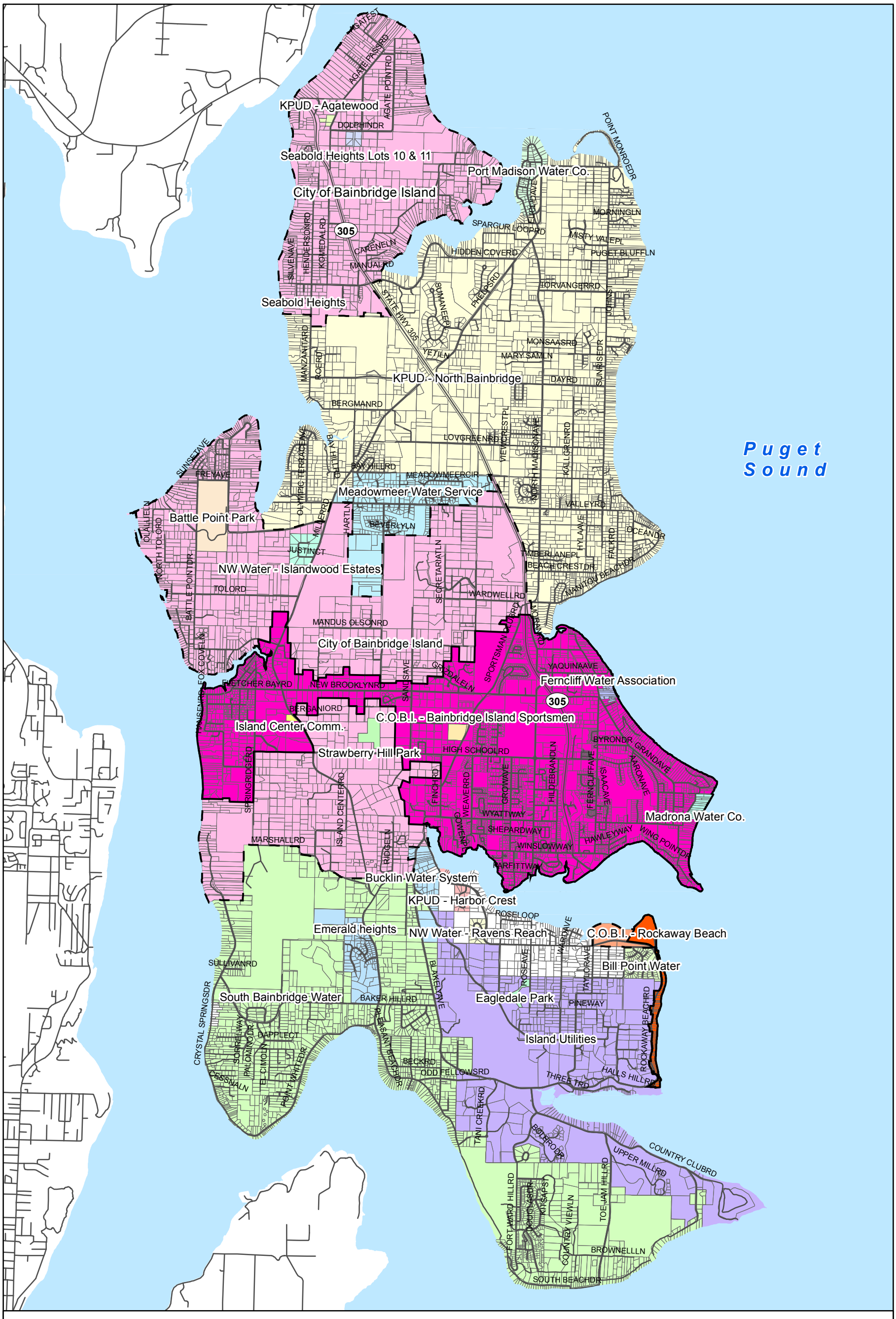


Figure 2.1
RWSA Boundaries and Adjacent Water Utilities
Water System Plan
City of Bainbridge Island

The distribution system was divided into two pressure zones separated by an east-west line roughly even with Knechtel Way. The system included booster pumps located at the HOB and Weaver well sites, Wing Point Country Club, and one in the distribution system at Grow Avenue and Gideon Lane. The 1972 Water System Plan completed by Roats Engineering described the water system as having a deficient source of supply, inadequate storage capacity, and a substandard distribution system. The plan provided a number of recommendations for improvement that, due to economics, mainly focused on supply and storage.

In 1973, the 1.0 million gallon (MG) reservoir was constructed in the high zone. The reservoir was located near the high school between High School Road and New Brooklyn Road. The project included a new transmission main from the HOB well site to the reservoir. As part of the construction, the high zone pressure boundary was adjusted and the 150,000-gallon reservoir located at High School Road and Lovell Avenue was taken out of service.

In 1976 the Weaver-Shepard well 1 failed and the replacement well 1R was drilled. At that time, six wells were providing all of the supply for the water system and the surface water diversion at the HOB was no longer in use. The Grow Avenue and Gideon Lane booster pump had been taken out of service and the distribution system had two nonfunctioning pressure reducing valve (PRV) stations. The water system did not have standby power or emergency back-up pumps in case of a power failure. The 1976 Water System Plan completed by Horton Dennis and Associates noted a number of water system deficiencies; however the recommendations focused mainly on supply and distribution system improvements.

The Fletcher Bay well was constructed by the Kitsap Public Utility District (KPUD) in 1978 and connected to the Winslow Water System in 1979. This high production well, capable of 400 gpm, was operated under a joint use agreement between the KPUD and the City. In 1983, the HOB wells 4 and 5 were constructed. Around 1980 the Knechtel reservoir was raised 12 feet, giving it a total capacity of about 200,000 gallons, and a 300,000 gallon reservoir was constructed at Grand Avenue and Park Avenue to serve the southeastern portion of the low pressure zone. During this same time frame, two PRV stations were constructed between the high zone and low zone. One station was located near Madison Avenue and Knechtel Way and the other located near Ericksen Avenue and Knechtel Way.

By 1985 the main source of supply for the Winslow Water System was five wells at the HOB and the KPUD Fletcher Bay well. Use of the Weaver-Wyatt, Weaver-Shepard, and Wing Point wells had been discontinued, and the distribution system had grown to about 20 miles of water main. The 1985 Water System Plan completed by Kramer, Chin, and Mayo, Inc. made a number of recommendations for improvement related to supply, storage, and distribution.

In 1988 the last well was drilled at the HOB well site. The Sands Avenue well 1 was drilled in 1989 and Sands Avenue well 2 was drilled in 1990. Sands Avenue well 2 was placed in service in 1995. The Fletcher Bay well and Fletcher Bay distribution system were purchased from the KPUD in 1994. The 1.5 MG high zone reservoir was constructed in 1989 and around 1993 two additional PRV stations were constructed, one at Grow Avenue and Wyatt Way and one at Cherry Avenue. In 1995 the telemetry system was designed and constructed to provide monitoring and control of the water system. The 1995 Water System Plan completed by RW Beck recommended distribution system improvements to replace undersized mains and the construction of additional storage.

In 1996, following the development of the water system plan, the Commodore well and school distribution system was acquired by the City and integrated into the Winslow Water System. Over the course of the next several years, a number of major water main improvements were made. In 1998 the Ferncliff Avenue water main was replaced with an 8-inch line and a new PRV station constructed. Also in 1998 the Winslow Way East water main was replaced with a 12-inch line. From 1999 to 2000 a number of water main improvements were made on Madison Avenue and the Madison and Madrona PRV station was constructed in 2000 to replace the Madison and Knechtel PRV station, which was subsequently taken offline. In 2002 the High School water main was replaced with a 12-inch line. In 2003 the Ericksen Avenue water main was replaced with a 10-inch line and a new PRV station constructed to replace Ericksen and Wyatt PRV station.

Between 1999 and 2002 the Winslow Water System began to experience water quality challenges. There were a number of coliform detections and high turbidity episodes in the distribution system. In a 2002 study of the water system, it was determined that both the Knechtel Way and Grand Avenue low zone reservoirs had very limited usable storage. Development in the low zone had grown to the point where the overflow elevations of the reservoirs were too low to provide adequate pressures. Attempts to hold low zone storage at the elevation necessary to provide acceptable pressure caused poor reservoir turnover and contributed to water quality problems. In order to improve water pressure and water quality, both the Knechtel Way and Grand Avenue reservoirs were taken offline in 2003, an additional PRV was installed at the HOB well site, and the six PRV stations were adjusted to provide service to the low zone from the high zone.

In addition to these changes, several operational improvements were made. The operational set points of the High School high zone reservoirs were widened, well site chlorine residuals were increased, dedicated coliform sampling stations were installed, contractor construction controls were stepped up, and unidirectional distribution system flushing procedures were initiated.

As a result of recommendations made in the 2006 Water System Plan completed by Gray and Osborne, Inc., many upgrades were made to the water system. For instance, the pressure reducing station valves were rebuilt. Sands Avenue well 1 was rehabilitated and the well pump replaced. Sands Avenue booster pump 2 was replaced and the telemetry

controls upgraded. Five wells at the HOB well site were rehabilitated and the well pumps replaced. A new booster pump, chlorine generator, electrical system, and telemetry controls were installed. The Fletcher Bay well was rehabilitated, a new chlorine generator installed, and the well pump, booster pump, and controls were replaced. The Weaver well dispensing station was upgraded and relocated to the Sands Avenue well site. Then the Weaver and Wing Point wells were converted to water level monitoring wells. The telemetry system headquarters was relocated to the Winslow Wastewater Treatment Plant. The City also made safety improvement at 1 million gallon High School Reservoir and upsized water mains in the system.

Before its next Water System Plan Update was due, the City requested a two-year water system plan extension. Washington State Department of Health (DOH) granted this extension on the condition that a Limited Water System Plan Update be developed in 2012. Between 2012 and 2014, no major capital investment projects for the Winslow Water System related to storage or production were undertaken. Capital investment was limited to delivery of the following projects:

- Fletcher Bay Control Building Improvements were completed in the summer of 2013 and included:
  - Performed minor interior electrical work and painting.
  - Replaced exterior doors, siding, gutters, and structure painting.
  - Installed secondary containment for the sodium hypochlorite holding tanks.
- Madison Avenue Water Main Upgrade and Replacement was completed during summer of 2013 and included:
  - Abandoned approximately 1,260 lineal feet of 6-inch asbestos cement water main and replacement with 12-inch ductile iron water main from about 300 feet south of High School Road to 200 feet south of Wallace Way.
- HOB Telemetry Upgrade was completed during spring of 2013 and included:
  - Installed water level transducers in wells 2, 3, and 5 and integration into the telemetry system.

2.3.3 History of the Rockaway Beach Water System

The City acquired the Rockaway Beach Water System in 1996 and operates it separately from the Winslow Water System. The system was originally owned and operated by the Rockaway Beach Water Association and supplied by two artesian wells located within the Wyckoff industrial complex, which became a US Environmental Protection Agency (USEPA) superfund site. In 1993 Local Improvement District (LID) 17 was formed to improve the Rockaway Beach Water System.

The Taylor Avenue Well was completed in 1994 to replace the original supply wells, which were decommissioned in May 1995. The Creosote Reservoir and a new main along

Rockaway Beach Road were constructed in 1996. An iron and manganese removal system was installed at the Taylor Avenue Well House in 2002, and the well pump was replaced in 2003.

2.3.4 Physical Features

This section describes the unique physical features within the City's water service areas including watersheds, water bodies, climate, and topography.

2.3.4.1 Surface Waters

The Bainbridge Island surface water system consists of natural and constructed drainages that eventually discharge to the marine waters of Puget Sound. Approximately sixty individual streams, both perennial and seasonal, exist across the whole island. The Winslow RWSA is bordered by the Puget Sound in the south and west and bordered by Fletcher bay to the east. There are nine streams within the Winslow RWSA that all flow from the north to the south into the Puget Sound. Another three streams flow through the Winslow RWSA into Fletcher Bay. One major stream flows through the Rockaway Beach RWSA and into Puget Sound. The streams of Bainbridge Island are shown on Figure 2.2.

2.3.4.2 Watersheds

Bainbridge Island consists of twelve distinct watersheds that have been created by geologic and geomorphologic processes. The watersheds are: Agate Passage, Port Madison, Sunrise, Murden Cove, North Eagle Harbor, Blakely Harbor, South Beach, Pleasant Beach, Gazzam Lake, Fletcher Bay, and Manzanita Bay. Figure 2.2 shows the locations of the island's watersheds. The Winslow RWSA is located within four of these watersheds: Murden Cove, North Eagle Harbor, Fletcher Bay, and Gazzam Lake. The Rockaway Beach RWSA lies within the Eagledale and Blake Harbor Watershed.

2.3.4.3 Topography

Bainbridge Island is surrounded by the waters of Puget Sound. The topography within the Island is dominated by gently rolling hills, with cliffs along some coastal areas. Bainbridge Island ranges in elevation from sea level to approximately 425 feet above mean sea level (msl). In the Winslow RWSA elevations range from sea level to approximately 250 feet above sea level. The Rockaway Beach RWSA consists of beachfront property at sea level adjacent to steep hillsides. Figure 2.2 shows the general topography of Bainbridge Island.

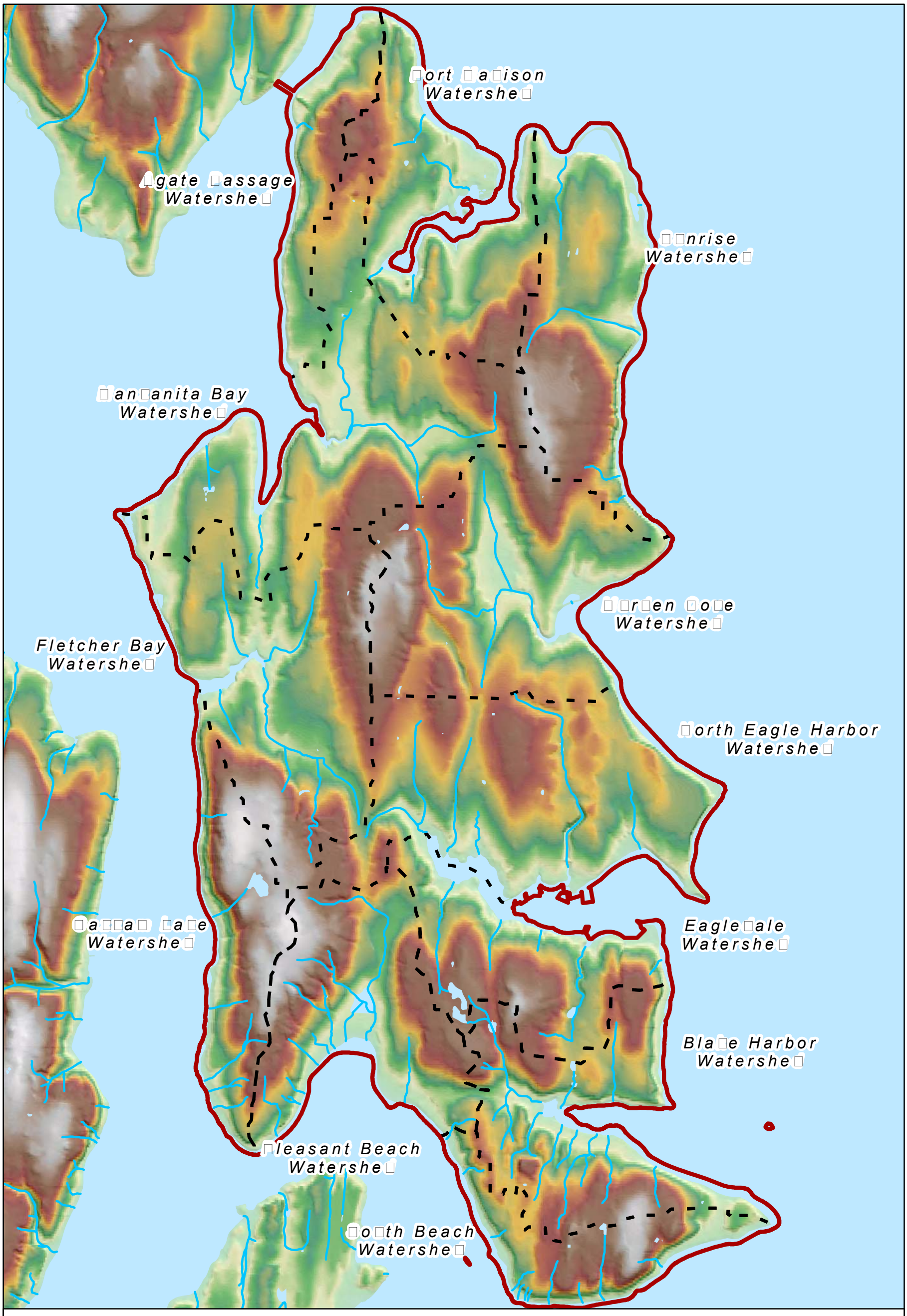


Figure 2.2
Bainbridge Island Physical Features
Water System Plan
City of Bainbridge Island

2.3.4.4 Climate

Bainbridge Island is characterized by a mild, marine climate. Table 2.1 summarizes the maximum and minimum monthly temperatures as well as the average monthly precipitation. January is the coldest month, with an average high temperature of 44.9 degrees Fahrenheit (°F) and an average low temperature of 33.7 °F. December is the wettest month, with an average of 6.5 inches of precipitation. August is the hottest month, with an average high temperature of 75.2 °F and an average low temperature of 51.8 °F. Approximately 70 percent of the annual rainfall occurs between October and April, with an average annual rainfall of 34.2 inches.

Table 2.1 Bainbridge Island Temperature and Rainfall Statistics
General Sewer Plan
City of Bainbridge Island

Month	Average Maximum Temperature (ºF)	Average Minimum Temperature (ºF)	Average Monthly Rainfall (inches)
January	44.9	33.7	5.3
February	48.3	34.9	3.8
March	53.5	37.3	3.6
April	60.1	40.7	1.9
May	65.5	44.6	1.3
June	70.5	49.2	1.6
July	75.1	51.9	0.6
August	75.2	51.8	0.7
September	69	49.1	1.6
October	60.8	44.7	2.8
November	52.2	39.2	4.6
December	47	36.6	6.5
Annual	**60.2**	**42.8**	**34.2**

Notes:
Source: http://www.bainbridgeisland.com/historical-weather

2.4 LAND USE

Land use designations and regulations provide important information for projecting future water demand.

2.4.1.1 Existing Land Use

Maps of the City's existing land use within the Winslow and Rockaway Beach RWSAs were developed with data from Kitsap County and verified by the City's planning department.

Existing land use for Winslow and Rockaway Beach parcels that are currently served by the City are shown in Figure 2.3 and Figure 2.4, respectively.

Parcels were organized into nine land use categories including:

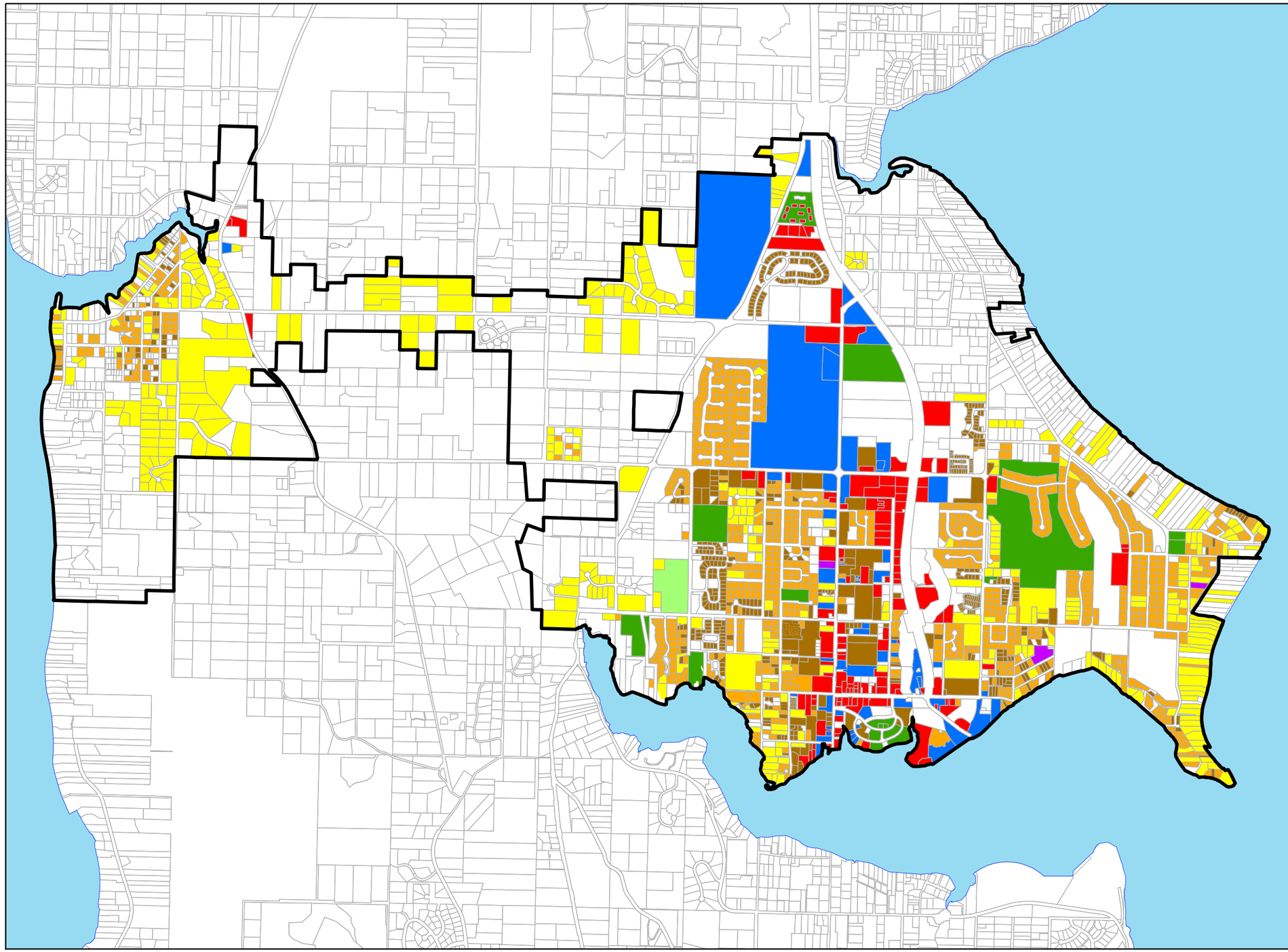
- Low Density Residential.
- Medium Density Residential.
- High Density Residential.
- Commercial.
- Utilities.
- Public.
- Parks/Open Space.
- Agriculture.
- Vacant.

Low density residential includes parcels with two units per acre or less. Medium density residential consists of parcels with two to 4.3 units per acre. All parcels with more than 4.3 units per acre are considered high density residential. Commercial land use consists of parcels occupied by businesses. The utilities land use category consists of facilities related to drinking water, wastewater, and electricity services. The public category includes publicly owned parcels such as schools, libraries, and city offices, as well as quasi-public facilities such as churches.

The Winslow RWSA is characterized by mostly low and medium density residential parcels with a downtown core dominated by commercial and high density residential development. The Rockaway Beach RWSA consists of single family residences and open space including Pritchard Park, the location of the former Wyckoff industrial complex.

2.4.1.2 Future Land Use

Future land use designations were developed with the guidance of the City's Department of Planning & Community Development. The future land use designations represent the maximum build-out foreseeable by year 2035. It is assumed that all parcels within the Winslow and Rockaway Beach RWSAs will be served by the City by the end of the 20-year planning period. Many of the low and medium density residential neighborhoods within the RWSAs are not expected to redevelop, an assumption that is consistent with the General Sewer Plan growth assumptions. The development and redevelopment is expected to occur in Winslow's downtown core. The City's policies encourage mixed use redevelopment.



Legend

- Winslow RWSA Boundary
- Water Body
- Parcels

Existing Land Use - Served by City Water

- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Commercial
- Agriculture
- Public
- Utilities
- Parks/Open Space

N

0 625 1,250 2,500 Feet

Figure 2.3
Winslow Existing Land Use of Parcels Served by City
Water System Plan
City of Bainbridge Island

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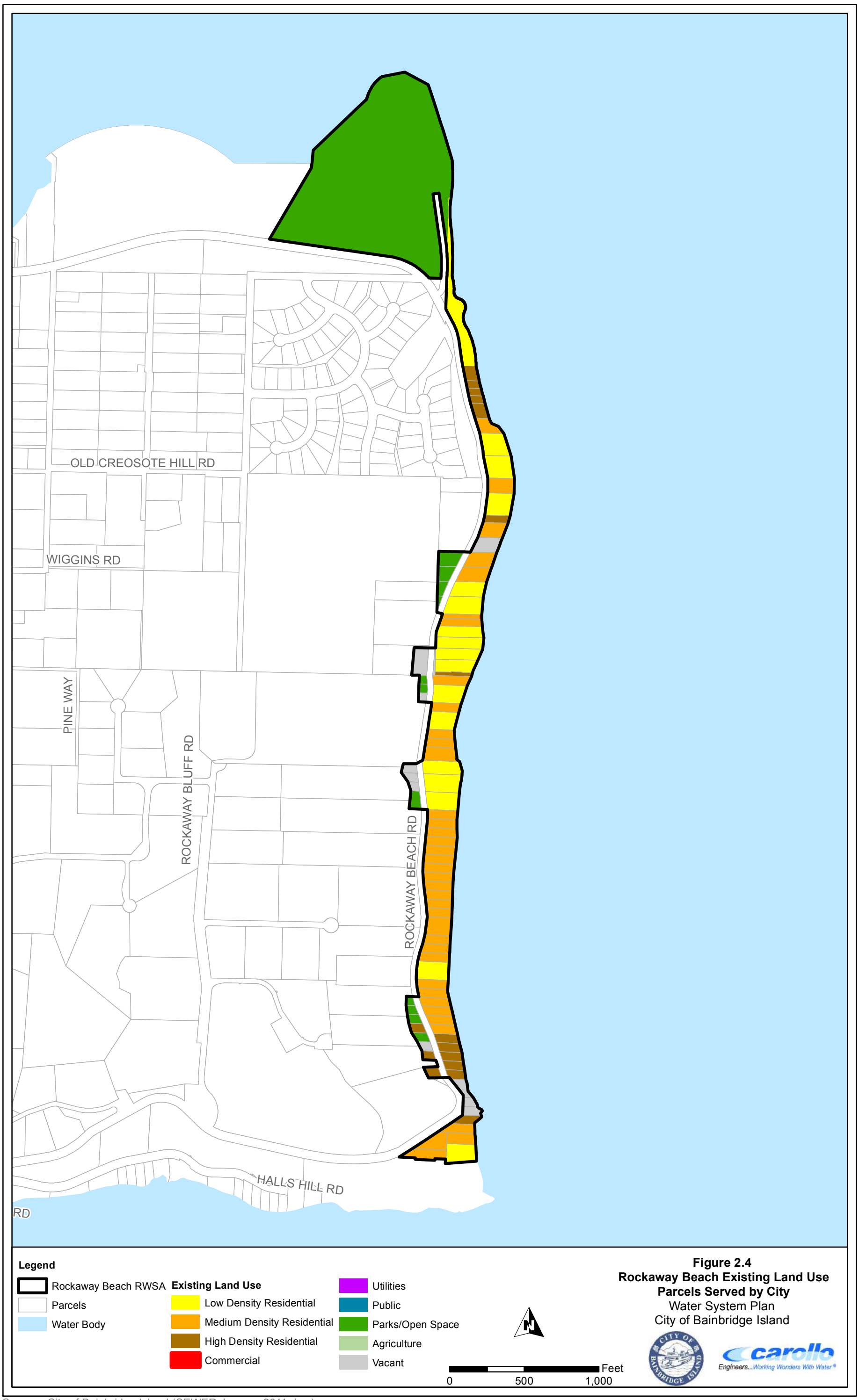


Figure 2.4
Rockaway Beach Existing Land Use
Parcels Served by City
Water System Plan
City of Bainbridge Island

Source: City of Bainbridge Island (SEWER January 2011.dwg)

Thus, the future land use categories used in this Plan are the same as the existing land use categories with the addition of a mixed use category, defined as parcels containing both commercial and high density residential units. The future land use maps for the Winslow and Rockaway Beach RWSAs are shown in Figure 2.5 and Figure 2.6, respectively.

2.5 POLICIES AND CRITERIA

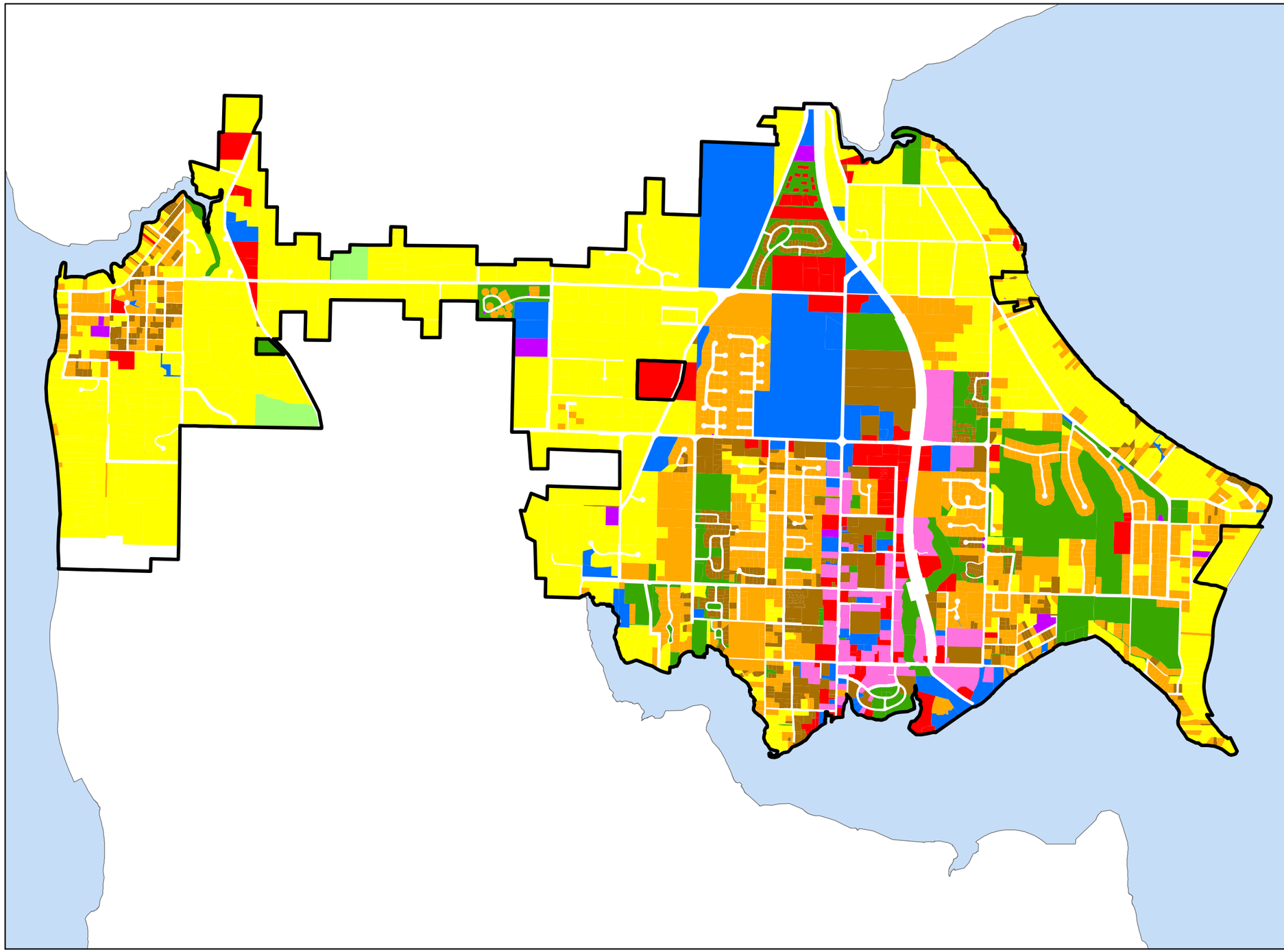
The City is responsible for managing and operating its water system in accordance with all known local, state, and federal regulations. To best manage the system and comply with regulations, the City has adopted water system policies and criteria. These policies guide the development and financing of the infrastructure required to provide water service, and document the City's commitments to current water system customers as well as those considering service from the City. The following sections outline the City's policies and design criteria that are relevant to water system planning. Existing policies are listed in Tables 2.2 through 2.6. Proposed Policies are listed at the bottom of each table. These policies and criteria guide the planning process throughout this Water System Plan.

The policies and criteria are organized into the following categories:

- Water service and service extensions.
- System reliability.
- Fire protection.
- Agency Coordination.
- Design criteria and facilities.
- Financial Policies.

2.5.1 Water Service and Service Extensions

Table 2.2 summarizes the existing and proposed policies regarding the water service area and extension of water service to additional properties. The City is committed to serving customers within its RWSA in accordance with established policies.



Legend

Winslow RWSA Boundary

Future Land Use

- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Mixed-use
- Commercial
- Agriculture
- Utilities
- Public
- Parks/Open Space
- Parcels
- Water Body

N

0 625 1,250 2,500 Feet

Figure 2.5
Winslow Future Land Use
Water System Plan
City of Bainbridge Island

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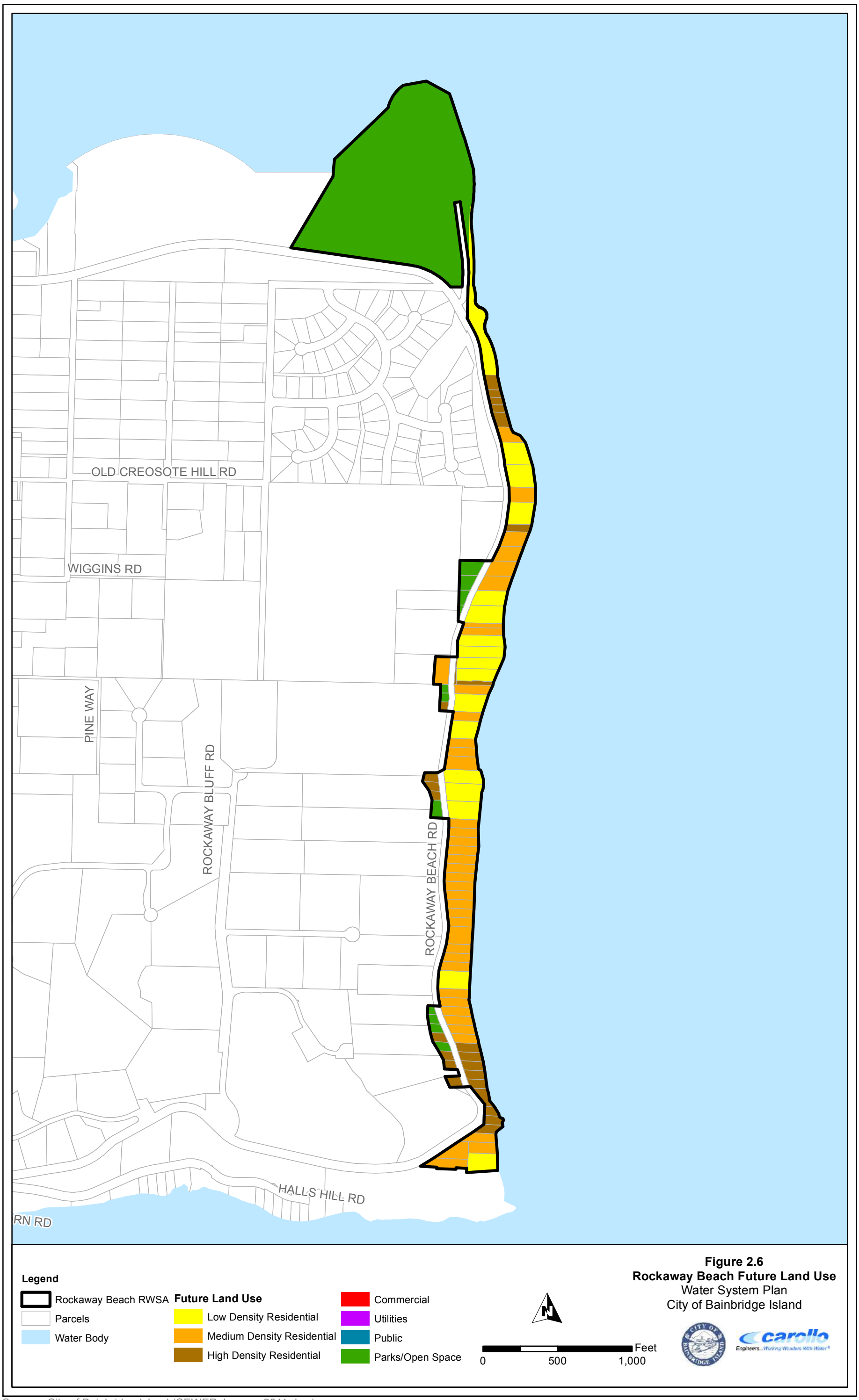


Figure 2.6
Rockaway Beach Future Land Use
Water System Plan
City of Bainbridge Island

Source: City of Bainbridge Island (SEWER January 2011.dwg)

Table 2.2	Water Service and Service Extension Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Late-Comer Agreements	An owner desiring to enter into a latecomer reimbursement agreement, for streets or utilities, shall submit to the public works department an application for latecomer reimbursement, on a form prepared by the public works department an application for latecomer reimbursement, on a form prepared by the public works director, with the application for utility extension agreement. The owner also shall submit a latecomer application fee in an amount established by resolution. The owner also shall pay any processing charges established by resolution. Upon compliance with this chapter, an owner who constructs utility improvements pursuant to a utility extension agreement shall receive latecomer reimbursement from owners of real property abutting the utility improvements who: • Did not contribute, in whole or in part, to the original cost of the utility improvements; • Are within the reimbursement area that is established under this chapter; • Have been assessed a reimbursement charge under this chapter; and • Within 15 years after the execution of the latecomer reimbursement agreement, either connect such real property to the water or sewer improvements or use the storm water improvements.	Bainbridge Municipal Code 13.32
Oversizing	If main extension sizing required by the public works director exceeds the minimum allowable extension pipe sizing for the project, the city, acting by and through the public works director, shall reimburse the developer installing the oversized main the differential cost in materials and installation for the greater pipe size. Prior to the installation of the main extension subject to oversizing reimbursement, the developer shall provide the public works director with certified bids for the cost of minimum allowable extension pipe size as installed and the greater pipe size required by the public works director as installed for review and approval by the public works director to determine the differential cost. Additionally, the oversizing reimbursement section may be applied to those situations where the public works director requests an additional length of pipe to be constructed beyond the minimum allowable pipe length required by the project. The city, acting by and through the public works director, shall reimburse the developer for the differential cost of the pipe oversizing within 60 days of the final acceptance of the installed main extension.	Bainbridge Municipal Code 13.18.030

Table 2.2	Water Service and Service Extension Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Extension Policy	If extension of an existing water main is required, the owner shall contract with the city or a licensed bonded contractor to have the extension constructed. The owner shall be required to enter into a developer agreement with the city for such main extension. Any and all extensions four inches or greater to the city water main system shall be constructed using ductile iron pipe, class 50 or better. If the city constructs the extension, the owner shall pay the actual cost of the extension plus 25 percent for the city's engineering, inspection, and overhead.	Bainbridge Municipal Code 13.08.030
Extension Policy	Whenever water, sewer and storm drainage mains are extended, main extensions shall also be extended along or through the property being served by the extension so that utility service can be provided to other properties beyond the property being served. The specific location of the extension through or along the property shall be determined by the city at the time of application and shall conform to the city's water, sewer, and storm and surface water system plans for the area where the property is located. Generally, main extensions shall be required along the full frontage of rights-of-way adjacent to the property being developed and served by the main extension and may also be required through the property being developed to that utility service can be provided to other properties not fronting the right-of-way.	Bainbridge Municipal Code 13.08.010
Looping Policy	Water lines shall be extended full width of property to be served. Looped connections may be required to maintain continuity in the system.	COBI Design & Construction Standards & Specifications Section 10-15
Direct Connection and Remote System Policy	The owner of property within the City's present or future water service area as identified in the City's comprehensive plan requiring water service shall not be allowed to install a well if a distance from the property to an existing water main, with capacity to serve the property, is 300 feet or less. The owner of the property shall apply to the City for water service, extend the water main, install hydrants, and connect the property to the City's water system in accordance with this title.	Bainbridge Municipal Code 13.08.050
Retail Water Service Area	The Winslow Water System RWSA is entirely within the City of Bainbridge Island water purveyor area as delineated by the Kitsap County Coordinated Water System Plan. The RWSA encompasses the area where the City has existing distribution mains and where distribution mains can be extended in a reasonable timeframe.	Proposed New Policy
Duty to Serve	The City's goal is to provide water service to all customers within the City's retail water service area in a timely and reasonable manner consistent with applicable City policies, ordinances, Washington Department of Health rules and guidelines, and applicable federal, state and local laws and plans.	Proposed New Policy

Table 2.2	Water Service and Service Extension Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Assumption of Adjacent Systems within City Limit	The City may assume the operation of a water district or private water system within the City limit, at the water system's request, if the following conditions are met and subject to approval of City of Bainbridge Island City Council: 1. The district or private system is adjacent to or within the City's current or future RWSA as identified in the City's comprehensive plan. 2. The district's or private system's facilities meet the City's performance criteria and engineering standards, or a plan is in place to assure that they will be brought up to City standards without adversely impacting City's existing customers financially or with regard to level of service. 3. The assumption of the district or private system is permitted by State law. 4. The City shall require the district or private system to transfer the ownership of its water supply sources and associated water rights to the City. Water rights must be successfully transferred to the City and approved for municipal water use by the State Department of Ecology prior to commitment from the City for water service.	Proposed New Policy

2.5.2 System Reliability

The following table summarizes the existing policies regarding system reliability.

Table 2.3	System Reliability Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Supply	Reliable sources capable of supplying MDD within a 24-hour period	
Supply	Reliable sources capable of supplying ADD with largest source out of service.	
Supply	Sources capable of supplying MDD and replenishing fire suppression storage in 72 hours.	DOH Water System Design manual, Ch. 7
Pumping	Booster pumps capable of supplying MDD with firm, reliable capacity.	
Piping	Looping of distribution mains when feasible.	
Velocity	Pipeline velocities not > 8 fps at PHD.	
Velocity	Flushing velocities of 2.5 fps for all pipelines.	

2.5.3 Fire Protection Policies

The City's fire protection standards are listed below.

Table 2.4	Fire Protection Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Fire Flow Standard	One and two-family dwellings: 1,000 gpm for 1 hour. Other occupancies: As stated in Appendix B Table B105.1 of the currently adopted fire code in BIMC 20.04.110 with a minimum of 1,500 gpm for 1 hour.	Bainbridge Island Municipal Code 13.10.065

2.5.4 Agency Coordination

The City currently has no formal policies pertaining to coordination with neighboring jurisdictions and other agencies. Wholesaling and wheeling of water does not apply to the City's water system.

2.5.5 Design Criteria and Standards

Current design criteria policies are outlined in Table 2.5. These policies are an important foundation for evaluation of water system facilities. The City's Design and Construction Standards and Specifications are included in Appendix E.

Table 2.5	Design Criteria Policies and Facilities Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Storage	The sum of: Operational Storage: Volume sufficient to prevent pump recycling, Equalizing Storage: VES = (QPH – QS) * 150 minutes Standby Storage: VSS = 2 days * (QADD – (QS – QL) * 1440 minutes/day) Fire Suppression Storage: VFSS = NFF * T QPH = Peak hour demand, gpm QADD = Average day demand, gpd QS = Capacity of all sources, excluding emergency sources, gpm QL = Capacity of largest source, gpm NFF = Needed fire flow, gpm T = Fire flow duration, min	DOH Water System Design Manual, Ch. 9
Minimum System Pressure	The system should be designed to maintain an minimum of 30 psi in the distribution system under peak hour demand and 20 psi under fire flow conditions during MDD.	DOH Water System Design Manual, Ch. 8

Table 2.5	Design Criteria Policies and Facilities Policies Water System Plan City of Bainbridge Island	
Subject	**Policy**	**Source**
Minimum Pipe Sizes	The diameter of a transmission line shall be determined by hydraulic analysis. The minimum size distribution system line shall not be less than 6-inches in diameter.	DOH Water System Design Manual, Ch. 8
Cross-Connection Control Program	Cross-connections declared in this chapter to be unlawful, whether presently existing or hereinafter installed, and/or services requiring backflow prevention devices and/or unlawful use or operation of a private water supply system served by the city public water supply are public nuisances, and, in addition to any other provisions of this code or the ordinances of the city of Bainbridge island on abatement of public nuisances, shall be subject to abatement in accordance with the following procedure: In the event that the city engineer or his designee determines that a nuisance as herein provided does exist, written notice shall be sent to the person in whose name the water service is established under the records of the city of Bainbridge Island, or alternatively, a copy of such written notice shall be posted on the premises served. The notice shall provide that the nuisance described herein shall be corrected within 30 days of the date the notice is mailed or posted on the premises. In the event the nuisance is not abated within the prescribed time, water service to the premises shall be discontinued. In the event that the nuisance, it the opinion of the city engineer, or his designated representative, presents an immediate danger of contamination to the public water supply, service from the city water supply system to the premises may be terminated without prior notice; provided, however, notice will be posted on the premises in the manner heretofore provided at the time the service is terminated.	Bainbridge Municipal Code 13.20

2.5.6 Financial Policies

The City currently has many financial policies related to the water system. These include user fees, water system development charges, fees pertaining to extensions, and policies regarding operating fund balances available for the utility system. The City's financial policies are described in Chapter 10.

DEMAND PROJECTIONS

3.1 INTRODUCTION

This chapter presents historical water production and consumption trends for the Winslow Water System (Winslow) and Rockaway Beach Water System (Rockaway Beach) as well as water demand forecasts for the retail water service areas (RWSAs) for the six-, ten-, and 20-year planning periods. Projecting a realistic future water demand is necessary for evaluating the capability of the water systems in meeting future water service requirements, planning for infrastructure projects, and securing adequate water supply. Future water demands are used as input conditions for the analyses of the water systems that are used to develop the Capital Improvement Program (CIP).

3.2 WINSLOW DEMAND PROJECTIONS

3.2.1 Demographic Analysis

Demand within the Winslow RWSA is anticipated to increase as a result of three growth elements. First, vacant parcels within the Winslow RWSA are expected to be developed within the 20-year planning period, and will require water service from the City. Second, the City is anticipating redevelopment to occur within Winslow's downtown core. City policies encourage existing residential and commercial parcels to be redeveloped as mixed-use development, which consists of a mixture of commercial and high-density residential units within the same parcel. The third growth element for the Winslow Water System is the connection of existing residences and businesses that are currently served by private wells or community water systems.

Figures 2.3 and 2.5 in Chapter 2 are maps that show the existing and future customers and land use within the Winslow RWSA. The total number of acres within the Winslow RWSA is 2,588, while the total acreage of the existing Winslow Water System customers amounts to 1,277 acres. This indicates that there is great potential for growth within the 20-year planning period. In order for the City to evaluate its ability to serve the entire Winslow RWSA, the demand projections presented in this chapter were developed under the assumption that the City will serve all of the parcels within the RWSA by 2035. Table 3.1 shows the number of acres currently served for each land use type and the total number of acres within the RWSA of each land use type. Existing and future served acreage was used to develop growth rates for single-family, multi-family, and non-residential water demand. The last column in Table 3.2 shows which growth category each land use type was assigned to for development of demographic growth rates.

The number of single-family residences connected to the Winslow Water System is anticipated to grow by approximately 4.0 percent annually during the 20-year planning

period. Multi-family residences served by the City are anticipated to increase by 2.9 percent annually. Non-residential growth within the Winslow RWSA is projected to be 1.7 percent annually within the planning period. These growth rates were derived from the City's future land use assumptions within the Winslow RWSA, which are consistent with regional planning and the Growth Management Act.

Table 3.1 RWSA Acreage Served by City Water
Water System Plan
City of Bainbridge Island

Connection Type	Existing Served Acreage (acres)	RWSA Acreage (acres)	Growth Category
Low-Density Residential	392	1,172	Single-family
Medium-Density Residential	302	457	Single-family
High-Density Residential	151	200	Multi-family
Mixed-use	0	86	Multi-family & Non-residential
Commercial	113	140	Non-residential
Agriculture	12	21	Non-residential
Utilities	4	15	Non-residential
Public	203	236	Non-residential
Parks/Open Space	101	262	Non-residential
Total Acreage	**1,277**	**2,588**	

Table 3.2 Projected Growth Rates
Water System Plan
City of Bainbridge Island

Growth Category	Annual Growth Rate (2013 – 2034)
Single-family	4.0
Multi-family	2.9
Non-residential	1.7

3.2.2 Historical Connections, Production, and Consumption

Historical connections, production, and consumption data were obtained from the City records for the years 2006 through 2013. The historical demand data were evaluated to characterize the water use of the City's customers. Several key demand parameters were generated from the data: typical water use per customer class, typical water use per connection for each customer class, typical water use per equivalent residential unit (ERU),

peaking factors, and distribution system leakage (DSL). These parameters were used as the basis of future demand projections.

3.2.2.1 Historical Service Connections

The City divides its customers into six billing categories, which are as follows:

- Single-family Residential (SFR)
- Multi-family Residential (MFR)
- Commercial
- Government
- Irrigation
- Other

The number of connections in each customer class for the years 2006 through 2013 is summarized in Table 3.3. Connections correlating to the City's top ten largest consumers in 2013 are tallied separately under the row Large Consumers. The connections of the Large Consumers were subtracted from the total number of connections for each of the categories to which they belong to generate the total connections by customer class tallies shown in Table 3.3. The total number of connections has risen only slightly between 2006 and 2013 from 2,261 to 2,387, which corresponds to 0.8 percent annually. The majority of customers are SFR and commercial.

Table 3.3 Historical Service Connections - Winslow Water System Plan City of Bainbridge Island

	Number of Connections by Year							
Connection Type	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Residential								
Single-family	1,893	1,911	1,927	1,928	1,938	1,935	1,968	1,989
Multi-family	86	90	91	90	89	90	90	90
Non-Residential								
Commercial	186	197	202	205	206	204	206	205
Government	25	25	26	26	26	26	26	26
Irrigation	56	58	58	59	59	60	62	62
Other	7	5	5	5	5	5	5	5
Large Consumers	8	9	9	9	10	10	10	10
Total Connections	**2,261**	**2,295**	**2,318**	**2,322**	**2,333**	**2,330**	**2,367**	**2,387**

3.2.2.2 Historical Water Production

The Winslow Water System is supplied by four different well fields: Fletcher Bay, Sands, Head of Bay (HOB), and Commodore. Most of the water supply is provided by the Sands Well Field followed by the Fletcher Bay and HOB well fields. In recent years, very little supply has been pumped from the Commodore Well. As is shown in Table 3.4, total production has been generally decreasing since 2006, even as the number of connections has been increasing. During this period, there was an average annual decrease in water consumption of 1.7 percent. These historical production volumes correspond to the average day demand (ADD) and maximum day demands (MDD) presented in Table 3.5. Although ADD has decreased, MDD has not, resulting in an increasing ADD to MDD peaking factor.

Table 3.4 Historical Annual Water Production by Source (MG) - Winslow Water System Plan City of Bainbridge Island

Well Field	2006	2007	2008	2009	2010	2011	2012	2013	Average
Fletcher Bay	62.6	102.2	93.0	64.9	73.2	60.1	54.7	55.3	
Sands	132.7	104.3	103.2	97.1	76.5	96.1	91.6	101.6	
HOB	44.9	27.5	27.6	70.4	65.7	60.5	76.8	56.9	
Commodore	1.3	0.7	0.6	0.8	0.1	0.0	0.0	0.0	
Total Production	242	235	224	233	215	217	223	214	225

Table 3.5 Historical ADD and MDD - Winslow Water System Plan City of Bainbridge Island

	2006	2007	2008	2009	2010	2011	2012	2013	Average
Average Day Demand (mgd)	0.66	0.64	0.61	0.64	0.59	0.59	0.61	0.59	0.62
Maximum Day Demand (mgd)	1.15	1.44	1.23	1.48	1.18	1.30	1.37	1.49	1.33
Date of MDD	7/26	7/11	7/25	7/31	7/22	8/26	8/31	7/10	
MDD/ADD Peaking Factor	1.74	2.24	2.00	2.32	1.99	2.18	2.24	2.55	2.16

3.2.2.3 Historical Water Consumption

The City's historical annual water consumption by customer class for the years 2006 to 2013 is presented in Table 3.6. Consumption of the City's top ten large consumers was considered independently from the customer categories and appears in a separate row in

Table 3.6. During this period, there has been an overall decrease in water consumption. Even as the number of SFR connections continues to rise, as shown in Table 3.3, overall SFR consumption has decreased significantly. Total consumption of other customer classes has remained fairly steady during this time period.

Other Authorized Use, as it appears in Table 3.6, includes unmetered water used by the City for activities such as annual water main flushing, new water main construction flushing, fire flow testing, and maintenance activities such as clear well cleaning. Although Other Authorized Use is not metered, it is tracked and estimated by the City. Other Authorized Use in the Winslow Water System accounts for approximately one percent of total consumption.

The City's ten largest consumers are a mixture of MFR, commercial, government, irrigation and other customer connections. Historical consumption for these connections are shown in Table 3.7 from largest consumer to lowest for years 2006 through 2013. The maximum and minimum historical consumption for each connection is also shown in the last two columns of Table 3.7.

3.2.3 Distribution System Leakage

Distribution system leakage (DSL) is equal to total production minus total authorized consumption. Total production equals metered source water production. Total authorized water consumption is the volume of water authorized for use by the water system. This includes both authorized metered consumption as well as authorized, tracked, and estimated consumption. Metered consumption is tracked through customer service meters. Other Authorized Uses are tracked and estimated based on flow and duration of use.

All water that is not authorized consumption is considered DSL. DSL includes both apparent and real losses. Apparent losses include water theft, meter inaccuracies, meter reading errors, and data collection errors. Real losses are physical losses from the distribution system including reservoir overflows, water main breaks, and water main leaks.

Table 3.8 shows total water production, authorized consumption, and DSL for the period of 2006 through 2013. As shown, DSL ranged from a high of 7.5 percent in 2012 to a low of 3.3 percent in 2010, not including the negative DSL value reported for year 2013. This erroneous result is likely due to the change in timing of when well meters are read compared to when customer meters are read. The average DSL of the Winslow Water System between 2006 and 2012 is 5.6 percent, with a 2012 three-year rolling average of 4.7 percent. This meets the Washington State Department of Health (DOH) target of DSL less than 10 percent on a three-year rolling average.

Table 3.6 Historical Water Consumption by Customer Class - Winslow Water System Plan City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013
Residential								
Single Family (gpd)	329,725	305,641	291,536	308,418	274,953	273,272	272,194	290,628
Multi-Family (gpd)	89,170	94,562	92,234	95,980	95,453	98,287	90,965	95,607
Non-residential								
Commercial (gpd)	94,100	90,664	88,746	92,004	96,482	90,832	87,666	94,799
Government (gpd)	16,787	16,569	15,138	18,684	18,651	15,802	12,316	14,407
Irrigation (gpd)	31,937	32,605	27,176	32,695	23,856	24,758	27,317	25,735
Other (gpd)	1,574	1,609	1,131	1,314	1,320	1,514	1,051	1,486
Large Consumers (gpd)	52,255	55,573	52,626	54,297	54,792	60,375	66,060	66,875
Other Authorized Use (gpd)	2,740	2,740	3,001	3,412	5,477	8,232	6,334	6,269
Total Authorized Consumption (gpd)	**618,288**	**599,961**	**571,587**	**606,802**	**570,983**	**573,072**	**563,904**	**595,805**

Table 3.7 Historical Water Consumption by Ten Largest Consumers - Winslow Water System Plan City of Bainbridge Island

Customer Account / Year	Customer Category	Consumption (gpd) 2006	2007	2008	2009	2010	2011	2012	2013	Maximum Historical Consumption (gpd)	Minimum Historical Consumption (gpd)
Bainbridge Island Parks and Recreation District	Gov	10,536	11,193	10,511	10,193	9,790	10,212	10,158	10,706	11,193	9,790
Island Health Center	Comm	12,068	10,607	5,923	5,529	6,570	7,250	10,820	10,042	12,068	5,529
Harbor Square HOA	MFR		7,886	10,146	10,566	8,978	8,630	9,417	9,740	10,566	7,886
Bainbridge Island School District Irrigation	Irrigation					2,926	4,060	7,753	5,912	7,753	2,926
Islander Residents Assoc.	MFR	4,525	4,240	5,445	4,334	3,959	5,181	5,213	5,886	5,886	3,959
Safeway Inc	Comm	4,390	3,822	3,287	3,306	4,334	4,756	4,345	5,283	5,283	3,287
Winslow Green	Other	4,726	4,588	3,894	3,750	3,937	4,283	4,369	5,041	5,041	3,750
Bainbridge Island School District	Gov	6,968	5,738	4,611	8,617	6,486	7,716	5,810	5,011	8,617	4,611
Edgewood Villa Associates	MFR	4,836	4,037	4,515	4,543	4,408	4,537	4,340	4,824	4,836	4,037
Wyatt House Retirement Center	Comm	4,207	3,461	4,295	3,457	3,404	3,750	3,834	4,431	4,431	3,404
Total Consumption (gpd)		**52,255**	**55,573**	**52,626**	**54,297**	**54,792**	**60,375**	**66,060**	**66,875**	**75,675**	**49,179**

Table 3.8 Distribution System Leakage - Winslow Water System Plan City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013
Total Production (gpd)	661,833	642,792	612,959	638,838	590,279	593,638	609,642	585,737
Metered Consumption (gpd)	615,548	597,222	568,587	603,390	565,506	564,840	557,569	589,537
Estimated Other Authorized Use (gpd)	2,740	2,740	3,001	3,412	5,477	8,232	6,334	6,269
Authorized Consumption (gpd)	618,288	599,961	571,587	606,802	570,983	573,072	563,904	595,805
Distribution System Leakage	43,545	42,830	41,372	32,036	19,296	20,566	45,738	-10,068
Percent Distribution System Leakage	6.6□	6.7□	6.7□	5.0□	3.3□	3.5□	7.5□	-1.7□
3-year Rolling Average DSL			6.7□	6.1□	5.0□	3.9□	4.7□	
2006-2012 Average Annual DSL							5.6□	

3.2.4 Equivalent Residential Units

The concept of equivalent residential units (ERUs) is a way to express water use by non-residential customers as an equivalent number of SFR customers. Water use per ERU is calculated by dividing the total volume of water utilized in the SFR customer class by the total number of active SFR connections. This number defines the average SFR water use per connection. The volume of water used by other customer classes is divided by the average SFR water use to determine the number of ERUs utilized by other customer classes.

Table 3.9 shows the average daily consumption per connection for each customer class for years 2006 through 2013. It also shows the average daily consumption per connection for each customer class during that time period. The average SFR daily consumption volume was 152 gallons. Therefore, the Winslow Water System ERU value is 152 gallons per day (gpd). The average daily SFR consumption has dropped steadily since 2006 when it was 174 gpd to 146 gpd in 2013.

Table 3.9 shows the average number of ERUs per connection for each customer category served by the City. The typical MFR connection consumes 6.9 ERUs, while commercial connections are equivalent to 3.0 ERUs on average. Government and Irrigation connections use 4.1 and 3.2 ERUs, respectively. Consumption of the top ten large consumers is 40.7 ERUs per connection on average.

3.2.5 Projected Water Demand

Low, medium and high water demand projection scenarios were developed for the Winslow Water System based on historical water demand trends and future growth assumptions. The medium demand projection scenario is used for the system analysis described in Chapter 6. The low and high projection scenarios provide a sense of the extent of uncertainty in the demand forecasts.

3.2.5.1 Water Demand Projection Factors

Several factors were utilized to project future average day and maximum day demands. The factors include the ERU value, peaking factor, DSL percentage, Other Authorized Use percentage, and large consumer demand. In addition, the SFR, MFR, and non-residential annual growth rates, as presented in Table 3.2, were used to project future number of water connections of the Winslow Water System. Low, medium, and high values for each these factors were established using the historical data and assumptions for the future. These factors were used to develop low, medium and high water demand forecasts.

Table 3.9 Historical Water Consumption per Connection by Customer Class - Winslow Water System Plan City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013	Average	ERUs per Connection
Residential										
Single-family (gpd/connection)	174	160	151	160	142	141	138	146	152	1.0
Multi-family (gpd/connection)	1,037	1,051	1,014	1,066	1,073	1,092	1,011	1,062	1,051	6.9
Non-residential										
Commercial (gpd/connection)	506	460	439	449	468	445	426	463	457	3.0
Government (gpd/connection)	671	663	582	719	717	608	474	554	624	4.1
Irrigation (gpd/connection)	570	562	469	554	404	413	441	415	478	3.2
Other (gpd/connection)	225	322	226	263	264	303	210	297	264	1.7
Large Consumers (gpd/connection)	6,532	6,175	5,847	6,033	5,479	6,037	6,606	6,688	6,175	40.7

The low demand projection scenario incorporates the City's water use efficiency (WUE) goal. It is anticipated that the consumption of the typical Winslow SFR customer will continue to decline in the future. The City's WUE goal is to decrease SFR daily consumption by 1 percent annually. The City assumes that the minimum ERU value that is feasible to achieve is 135 gpd/ERU. Starting with an ERU value of 152 gpd/ERU, with 1 percent annual reduction, the City will attain an ERU value of 135 gpd/ERU by 2025 and the ERU value will remain constant beyond that. The medium and high demand projection scenarios assume that a constant ERU value of 152 gpd/ERU is maintained into the future.

During the period from 2006 through 2013, the average ADD to MDD peaking factor was 2.16. This value is used for the medium demand projection scenario. The 25th percentile peaking factor value over that time period of 2.00 is used for the low demand projection scenario. The high demand projection scenario assumes a high peaking factor of 2.4 based on what the City expects it may experience in the future.

The rolling three-year DSL for 2012 was 4.7 percent, while the average DSL from 2006 to 2012 was 5.6 percent. The low and medium demand projection scenarios use future DSL of 4.7 percent and 5.6 percent, respectively. The high demand projection scenario uses DOH's maximum acceptable DSL value of 10 percent.

Other Authorized Use is another factor that must be set to predict future demand. In the years evaluated, the Winslow Water System's Other Authorized Use has been around one percent of total production. City staff anticipate this trend to continue. The low demand projection scenario assumes future authorized use to amount to 0.8 percent of total production. The medium demand projection scenario assumes future authorized use to amount to 1.0 percent of total production, and the high demand projection scenario uses 1.2 percent of total production.

Historical data for the top ten consumers of the Winslow Water System was used to predict future consumption. The low demand projection scenario assumes that in future years each of the top ten consumers will consume the amount that was their minimum annual consumption between 2006 and 2013. This is shown in the last column of Table 3.7. The high demand projection scenario assumes that in future years each of the top ten consumers will consume the amount that was their highest annual consumption between 2006 and 2013, which is shown in the second to last column of Table 3.7. The medium demand projection scenario assumes that the 2013 consumption of 66,875 gpd will continue to be consumed annually by the top ten consumers.

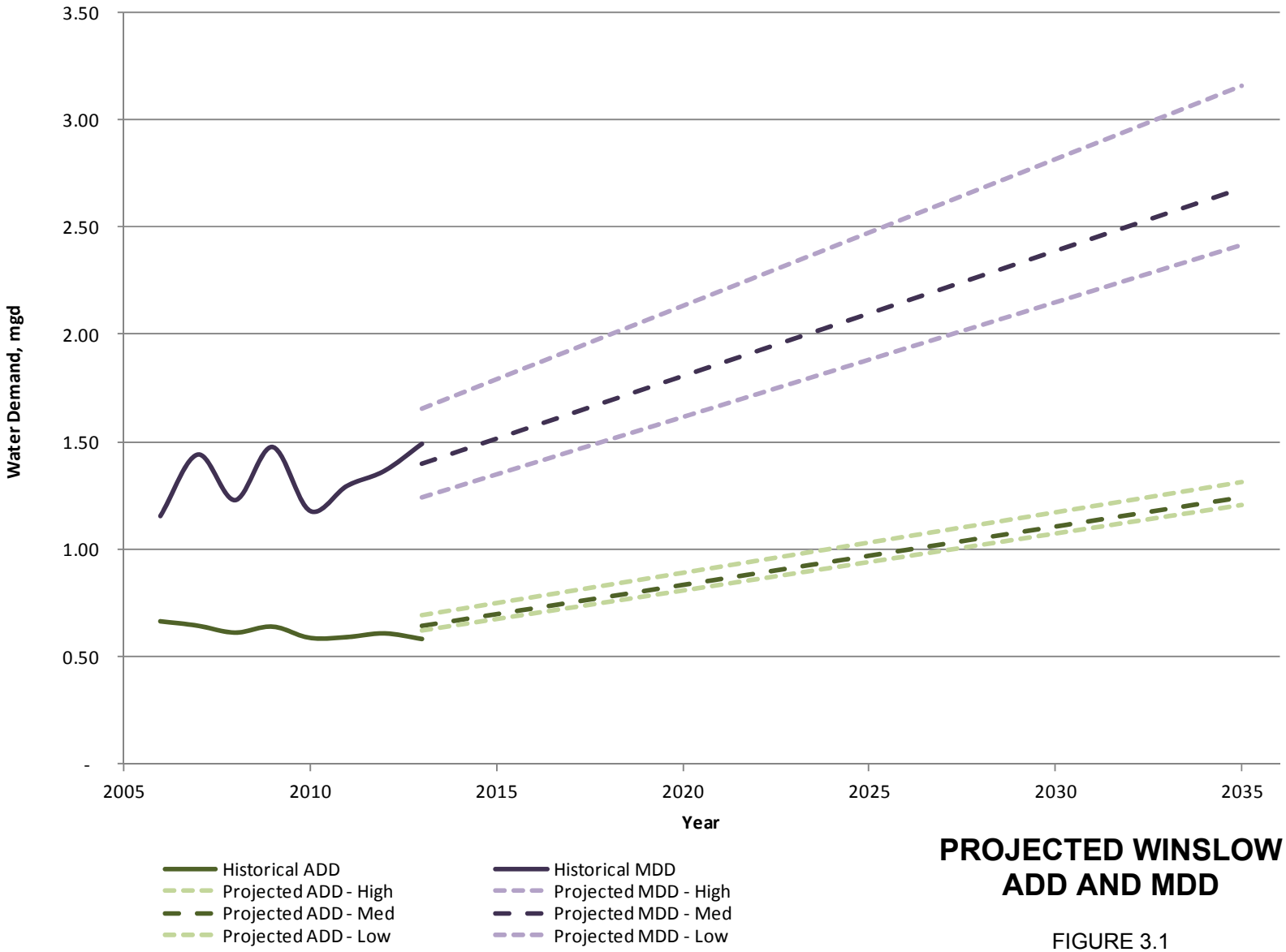
Table 3.10 Water Demand Projection Factors - Winslow Water System Plan City of Bainbridge Island			
	Low	**Medium**	**High**
ERU Value (gpd)	152 to 135	152	152
Peaking Factor	2.00	2.16	2.4
DSL	4.7	5.6	10
Other Authorized Use	0.8	1.0	1.2
Large Consumer Demand (gpd)	49,179	66,875	75,675
SFR Annual Growth Rate	4.0	4.0	4.0
MFR Annual Growth Rate	2.9	2.9	2.9
Non-Residential Annual Growth Rate	1.7	1.7	1.7

3.2.5.2 Projected Average and Maximum Day Demands

To project future demands, the number of connections in each customer category was increased based on their respective annual growth rate as presented in Table 3.10. For example, the number of single-family connections was increased by 4.0 percent annually, while the number of MFR connections was increased by 2.9 percent annually. All of the other connection categories including commercial, government, irrigation and other were increased by the non-residential annual growth rate of 1.7 percent annually.

Next connections for each customer category were converted to consumption volumes in ERUs using the historical ERUs per connection values as presented in Table 3.9. Average day demand projections for each customer class were calculated by converting consumption in ERUs to gpd using the ERU value presented in Table 3.10. Then large user consumption, DSL, and Other Authorized Use was included to establish total ADD projections.

MDD projections were established by multiplying ADD projections by the appropriate ADD to MDD peaking factor for each demand projection scenario as recorded in Table 3.10. ADD and MDD projections for the low, medium, and high demand projection scenarios are presented in Table 3.11 and Figure 3.1. Projections are presented for the 6-year, 10-year, and 20-year planning periods. By 2035, if the entire RWSA is served, MDD is anticipated to range between 2.41 and 3.15 mgd.



PROJECTED WINSLOW ADD AND MDD

FIGURE 3.1

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

carollo

Table 3.11 Demand Projections - Winslow Water System Plan City of Bainbridge Island			
Demand Scenario	**2021**	**2025**	**2035**
ADD (mgd)			
Low	0.83	0.94	1.21
Medium	0.86	0.97	1.24
High	0.92	1.03	1.31
MDD (mgd)			
Low	1.67	1.88	2.41
Medium	1.86	2.09	2.68
High	2.20	2.47	3.15

3.3 ROCKAWAY BEACH DEMAND PROJECTIONS

3.3.1 DEMOGRAPHIC ANALYSIS

The Rockaway Beach RWSA contains single-family residences as well as Pritchard Park, the former Wyckoff Superfund Site. In 2013, 68 single family residences were served by the City. There are a total of 78 single-family parcels within the RWSA that could be served by the City within the 20-year planning period.

3.3.2 Historical Connections, Production, and Consumption

Historical connections, production, and consumption data for the Rockaway Beach Water System were obtained from City records for the years 2006 through 2013. The historical demand data were evaluated to characterize the unique water use of the City's Rockaway Beach customers. From historical data, several key demand parameters were generated including the typical water use per ERU, typical water use per customer class, typical Other Authorized Use, and DSL. These parameters were used as the basis of future demand projections.

3.3.2.1 Historical Service Connections

The Rockaway Beach Water System serves four types of customers:

- SFR.
- Commercial.
- Government.
- Irrigation.

The majority of customers in the Rockaway Beach Water System are SFRs. Each of the non-residential categories have one connection that is active some years and inactive in others. Historical service connections for the Rockaway Beach Water System is located in Table 3.12.

Table 3.12	Historical Service Connections - Rockaway Beach Water System Plan City of Bainbridge Island							
	Number of Connections by Year							
Connection Type	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Residential								
Single-family	68	69	69	69	68	67	68	68
Non-Residential								
Commercial	0	0	1	1	1	1	1	1
Government	1	1	1	1	0	0	1	1
Irrigation	0	0	0	0	0	1	0	1
Total Connections	**69**	**70**	**71**	**71**	**69**	**69**	**70**	**71**

3.3.2.2 Historical Water Production

The Rockaway Beach Water System is supplied solely by the Taylor Avenue Well. From 2006 to 2013, annual production has averaged 5.77 million gallons (MG) as shown in Table 3.13. While ADD has remained fairly consistent during this time period, MDD has varied dramatically. Year 2007 had a particularly high MDD with an ADD to MDD peaking factor of 4.06 as shown in Table 3.13. The minimum peaking factor during this time period was 2.45 with an average of 3.02.

Table 3.13	Historical Water Production - Rockaway Beach Water System Plan City of Bainbridge Island								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	Average
Annual Production (MG)	6.37	5.93	5.74	6.30	5.22	5.84	5.54	5.22	5.77
Average Day Demand (gpd)	17,000	16,000	16,000	17,000	14,000	16,000	15,000	14,000	16,000
Maximum Day Demand (gpd)	55,000	66,000	41,000	49,000	44,000	46,000	37,000	44,000	48,000
Date of MDD	7/25	7/12	8/5	8/25	7/20	8/11	8/31	8/7	
MDD/ADD Peaking Factor	3.15	4.06	2.62	2.84	3.08	2.88	2.45	3.08	3.02

3.3.2.3 Historical Water Consumption

The Rockaway Beach historical annual water consumption for each customer class for the years 2006 to 2013 is presented in Table 3.14. During this period, water consumption has

remained fairly steady. SFR accounts have a total average consumption of approximately 13,000 gpd. The non-residential connections account for a very small portion of total demand in the Rockaway Beach Water System. During the period shown, the highest annual commercial consumption was 35 gpd in 2009, the highest annual government or irrigation consumption was 350 gpd in 2011.

3.3.3 Distribution System Leakage

DSL was calculated for Rockaway Beach using the same methodology as Winslow. Table 3.15 shows total water production, authorized consumption, and DSL for the period of 2006 through 2013. DSL ranged from a high of 11.2 percent in 2007 to a low of 5.6 percent in 2013. During this time period, DSL has averaged 8.6 percent for the Rockaway Beach Water System. The Rockaway Beach System has maintained a three-year rolling average DSL below the DOH threshold of 10 percent.

3.3.4 Equivalent Residential Units

The ERU value for Rockaway Beach was calculated using the same methodology as that used for Winslow. Table 3.16 shows the daily consumption per connection for each customer class for years 2006 through 2013. The average SFR daily consumption volume during that period was 203 gallons, while the 75th percentile value was 209 gallons. The average daily SFR consumption has remained fairly steady in the Rockaway Beach RWSA since 2006. Historically the non-residential connections, which are associated with minimal water use at Pritchard Park, have accounted for less than two ERUs each.

3.3.5 Projected Water Demand

Low, medium and high water demand projections were developed for the Rockaway Beach Water System based on historical water demand trends.

3.3.5.1 Water Demand Projection Factors

Several factors were utilized to project future average day and maximum day demands. The factors include the ERU value, peaking factor, DSL percentage, and Other Authorized Use percentage. It was assumed that all 78 SFR parcels within the RWSA would be served by 2035.

As described above in the Winslow Water System section, the City's WUE goal of decreasing SFR daily consumption by 1 percent annually applies to Rockaway Beach as well. Starting at an ERU value of 203 gpd/ERU, with 1 percent annual reduction, the City's goal is to attain an ERU value of 162 gpd/ERU by 2035. The low demand projections scenario incorporates the City's conservation goal. The medium and high demand projections assume a constant ERU value of 209 gpd/ERU, which corresponds to the 75th percentile SFR connection consumption value between 2006 and 2013.

Table 3.14 Historical Water Consumption by Customer Class - Rockaway Beach Water System Plan City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013
Residential								
Single Family (gpd)	15,497	13,726	13,376	15,032	12,599	13,851	13,374	13,210
Non-residential								
Commercial (gpd)	0	0	31	35	18	33	23	31
Government (gpd)	47	236	168	314	0	0	0	0
Irrigation (gpd)	0	0	0	0	0	350	0	0
Other Authorized Use (gpd)	524	472	423	479	613	422	305	254
Total Consumption (gpd)	**16,068**	**14,434**	**13,998**	**15,859**	**13,231**	**14,657**	**13,702**	**13,494**

Table 3.15 Distribution System Leakage - Rockaway Beach
Water System Plan
City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013
Total Production (gpd)	17,438	16,247	15,669	17,262	14,300	15,995	15,131	14,296
Metered Consumption (gpd)	15,544	13,962	13,575	15,380	12,618	14,235	13,396	13,241
Estimated Other Authorized Use (gpd)	524	472	423	479	613	422	305	254
Authorized Consumption (gpd)	16,068	14,434	13,998	15,859	13,231	14,657	13,702	13,494
Distribution System Leakage	1,371	1,812	1,672	1,402	1,069	1,338	1,430	802
Percent Distribution System Leakage	7.9□	11.2□	10.7□	8.1□	7.5□	8.4□	9.4□	5.6□
3-year Rolling Average DSL			9.9□	10.0□	8.8□	8.0□	8.4□	7.8□
2006 -2013 Average Annual DSL								8.6□

Table 3.16 Historical Water Consumption per Connection by Customer Class - Rockaway Beach Water System Plan City of Bainbridge Island

Year	2006	2007	2008	2009	2010	2011	2012	2013	Average	ERUs per Connection
Residential										
Single Family (gpd)	227	199	194	219	185	206	197	194	203	1.0
Non-residential										
Commercial (gpd)			31	35	18	33	23	31	28	0.1
Government (gpd)	47	236	168	314					191	0.9
Irrigation (gpd)						350			350	1.7

During the historical period evaluated, the average ADD to MDD peaking factor was 3.02. This value is used for the low demand projection scenario. Because the City has seen some very high peaking factors in the past for the Rockaway Beach Water System, the 75th percentile peaking factor value of 3.10 is used for the medium demand projection scenario. The high demand projection scenario assumes a high peaking factor of 3.26 based on what the City anticipates it can expect to see occasionally in the future.

The average DSL between 2006 and 2013 was 8.6 percent. The low demand projection scenario uses the 25th percentile DSL value of 7.8 percent for the future. The medium demand scenario uses future DSL of 8.6 percent. The high demand projection scenario uses the DOH maximum reasonable DSL value of 10 percent.

In the past several years, the Rockaway Beach Water System's Other Authorized Use has varied from 1.8 percent to 4.3 percent of total production. The low demand projection scenario assumes future authorized use to amount to 1.8 percent of total production. The medium demand projection scenario assumes future authorized use to amount to 2.8 percent of total demand, which was the average between 2006 and 2013, and 4.3 percent is assumed for the high demand projection scenario.

Because non-residential consumption has been such a small portion of overall consumption for the Rockaway Beach Water System, and no new future non-residential connections are anticipated, non-residential consumption is not anticipated to increase in the future. The low demand projection scenario assumes 2013 non-residential consumption levels continue into the future. The medium and high demand projection scenarios assume the historical maximum consumption for commercial and irrigation is used in the future. According to City staff, the government, commercial, and irrigation connections correspond to water use at the Superfund site and Pritchard Park irrigation and usually only one account has been active in any given year. Therefore, only the larger irrigation and no government consumption is used in the demand projections.

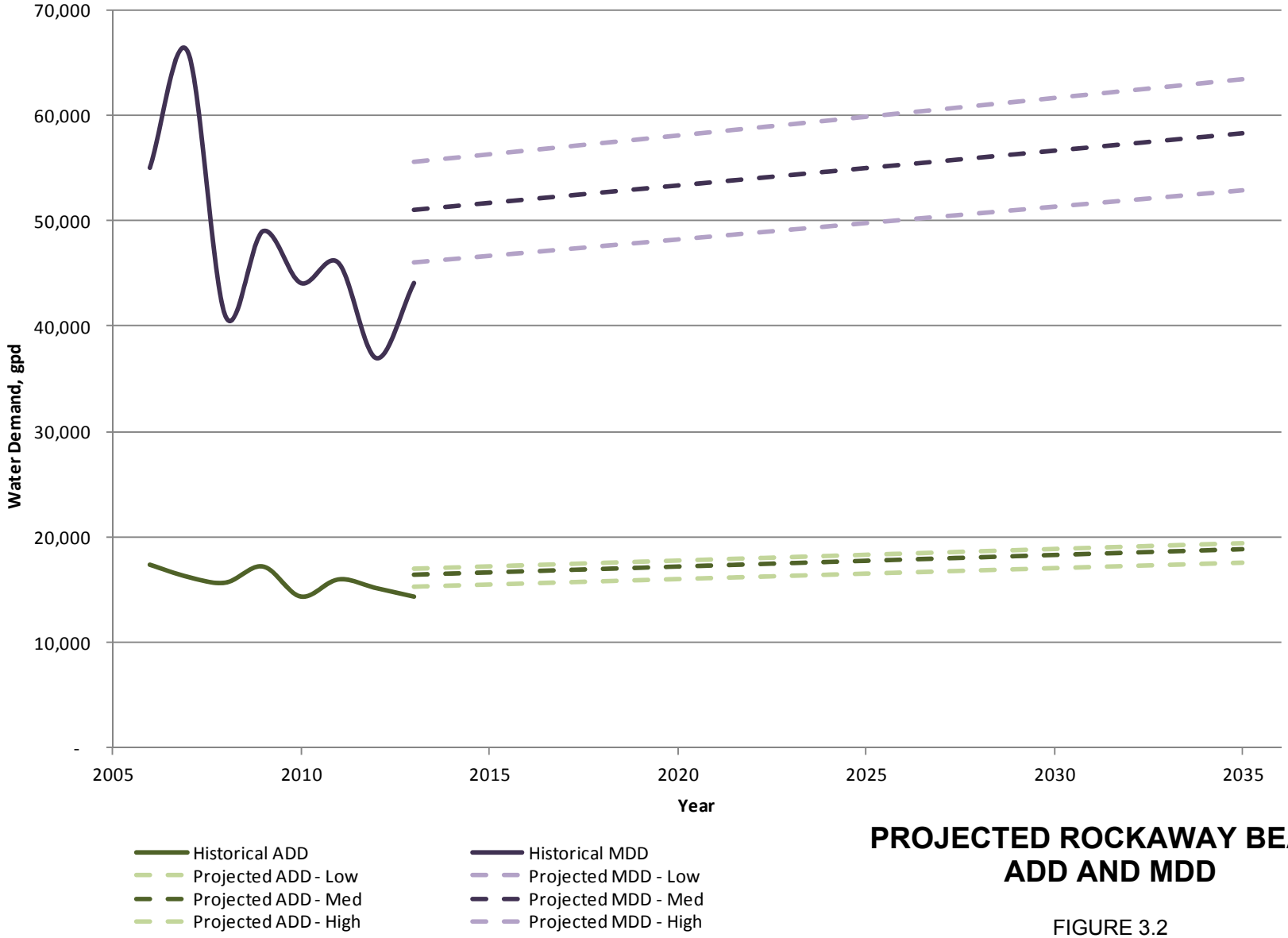
3.3.5.2 Projected Average and Maximum Day Demands

To project future demands, the number of SFR connections were grown steadily to a maximum of 78 connections in 2035. Next SFR connections were converted to consumption volumes in gallons per day using the ERU values presented in Table 3.17. Finally, non-residential consumption, DSL, and Other Authorized Use was included to establish total ADD projections.

Table 3.17 Water Demand Projection Factors - Rockaway Beach Water System Plan City of Bainbridge Island			
	Low	**Medium**	**High**
ERU Value (gpd)	203 to 162	209	209
Peaking Factor	3.02	3.10	3.26
DSL	7.8	8.6	10
Other Authorized Use	1.8	2.8	4.3
Build-out SFR Connections	78	78	78
Commercial Demand	31	35	35
Government Demand	0	0	0
Irrigation Demand	0	350	350

MDD projections were established by multiplying ADD projections by the appropriate ADD to MDD peaking factor for each demand projection scenario as shown in Table 3.17. ADD and MDD projections for the low, medium, and high demand projection scenarios are presented in Table 3.18 and Figure 3.2. Projections are presented for the 6-year, 10-year, and 20-year planning periods. By 2035, MDD is anticipated to range between 52,900 and 63,500 gpd.

Table 3.18 Demand Projections - Rockaway Beach Water System Plan City of Bainbridge Island			
Demand Scenario	**2021**	**2025**	**2035**
ADD (gpd)			
Low	16,100	16,500	17,500
Medium	17,300	17,800	18,800
High	17,900	18,400	19,500
MDD (gpd)			
Low	48,600	49,800	52,900
Medium	53,700	55,000	58,400
High	58,400	59,900	63,500



PROJECTED ROCKAWAY BEACH ADD AND MDD

FIGURE 3.2

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

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pw://Carollo/Documents/Client/WA/Bainbridge Island/9555A00/Deliverables/Chapter 03/Fig_03_02.docx

EXISTING SYSTEM

4.1 INTRODUCTION

This chapter describes in detail the existing facilities associated with both the Winslow Water System (Winslow) and Rockaway Beach Water System (Rockaway Beach) including wells, treatment facilities, storage facilities, pressure reducing valve stations, distribution pipe networks, meters, and telemetry and control systems.

4.2 WINSLOW WATER SYSTEM

The Winslow Water System, shown in Figure 4.1 serves water to customers in the historic Winslow and Fletcher Bay areas. The system consists of a High Pressure Zone and a Low Pressure Zone. The source of supply for the water system is groundwater supplied by eleven active wells located at four well sites. At each well site the water is treated with chlorine and fluoride before being pumped into the High Pressure Zone distribution system to supply customers and fill storage reservoirs. The Low Pressure Zone is served by six active pressure reducing valve (PRV) stations. Storage is provided by the two High School Reservoirs in the High Zone with a total capacity of 2.5 million gallons (MG). A third reservoir, the Grand Reservoir, is out of service at this time. The High School Reservoirs supply the High Zone by gravity when the wells are not operating. The distribution system is well looped. The wells draw from three separate aquifers. The Washington State Department of Health (DOH) has determined eight of the eleven wells have a low risk of contamination while the remaining three have a moderate or high risk of contamination. A wellhead protection plan and an active cross-connection control program help protect the water system from contamination. The water system has sufficient water rights to last well into the future.

All of the active well sites have intrusion alarms and are fenced to provide site security. Each active well site is equipped with a generator receptacle and manual transfer switch to provide backup power during power outages. The water system facilities include two mobile generators capable of operating the largest well sites. These mobile units are normally staged at the Sands Avenue and Fletcher Bay well sites; however they can be moved to provide backup power to any well site necessary.

There is continuous water level monitoring at seven wells. Installation of water level transducers at three Head of the Bay (HOB) wells took place since the 2012 Winslow Water System Limited Water System Plan (WSP) Update. Two of the largest well sites include multiple wells and booster pumps that can easily be reconfigured to adjust to unforeseen conditions. The current limiting source capacity of the water system is approximately 1,750 gallons per minute (gpm), as was also reported in the Winslow Water System 2012 Limited WSP Update.

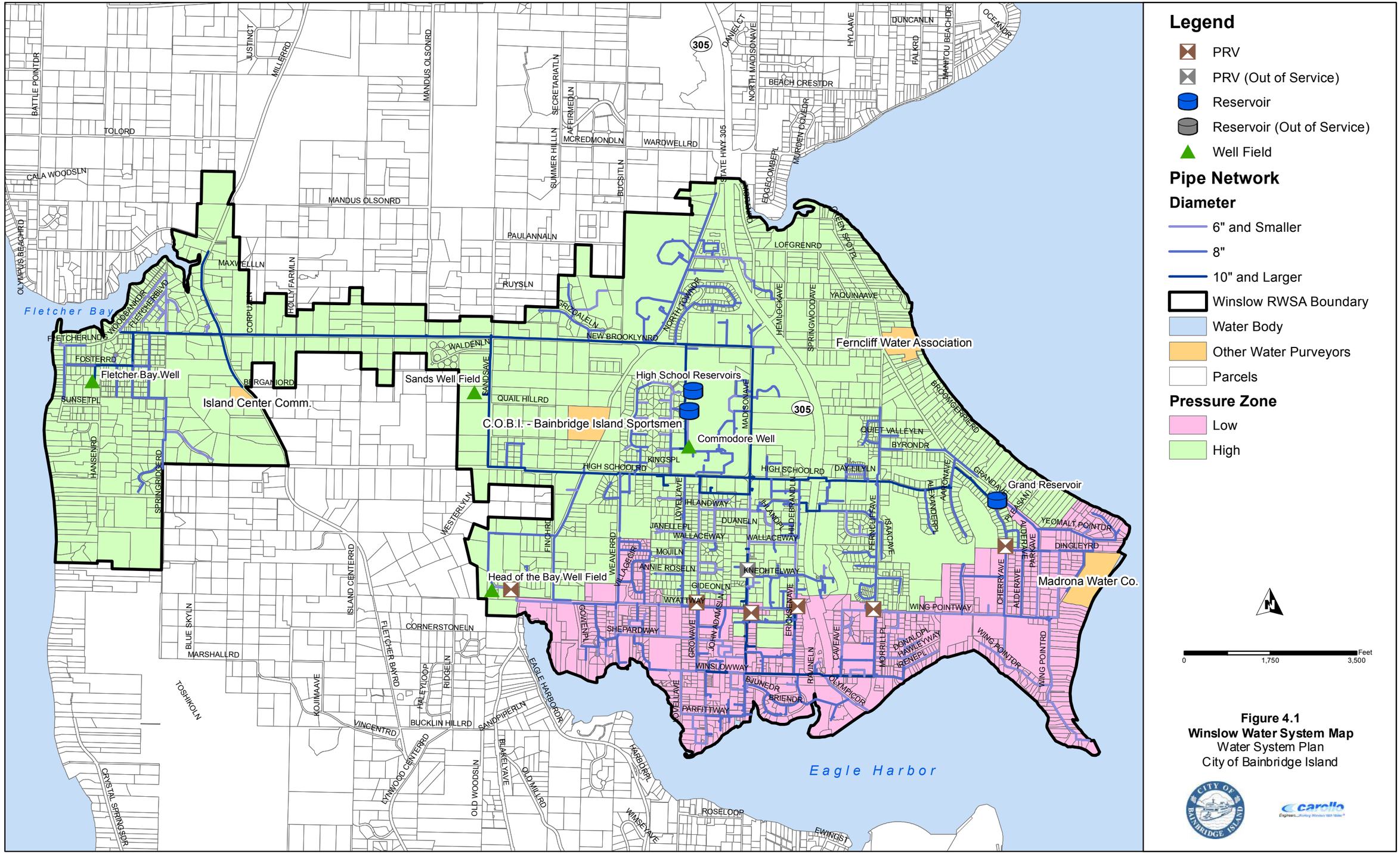


Figure 4.1
Winslow Water System Map
Water System Plan
City of Bainbridge Island

This is the supply capacity of the system's well sites with the smaller of the two Sands booster pumps pumping. The system consists of a robust and reliable source of supply with considerable redundancy to meet unforeseen conditions and changing demands.

The water system is monitored and controlled by a telemetry system that is headquartered at the Winslow Wastewater Treatment Plant. The well sites are selected to operate based on the daily production requirements, well sustainability, and aquifer management requirements. They are called to operate based on the level of the High School reservoirs. Once started each well site operates as an integrated system and is controlled by a local programmable logic computer (PLC). A description of the Winslow Water System facilities is provided in the following sections. Figure 4.1 is a schematic of the water system that shows key system facilities including wells, reservoirs, and pressure zones.

4.2.1 Well Sites

4.2.1.1 Head of the Bay Well Site

The HOB Well Site currently provides about 25 percent of the supply for the Winslow Water System. The well site has seven active wells that tap the Sea Level aquifer. Five of the wells have a low susceptibility rating, while two wells have a moderate or high susceptibility rating. The wells do not have a history of exceeding any primary water quality maximum contaminant levels (MCLs), however some wells exceed the secondary MCL for manganese, sodium, and color. To date, customer concerns have not warranted the installation of treatment for these secondary contaminants. This issue is reevaluated on a regular basis.

The well site is signaled to operate by the level of the High School reservoirs. Once started the site operates as an integrated system by a local PLC based on the level of the onsite intermediate reservoir. The wells can flow freely under artesian pressure or be pumped by the well pumps. The wells discharge into a 10,000-gallon intermediate reservoir adjacent to the control building. From the intermediate reservoir, one of two booster pumps transfers water to the high zone distribution system at Finch and Sportsman Club Roads.

The output of the well pumps ranges from 30 to 250 gpm. Booster pump 1 is a variable frequency drive (VFD) controlled pump to an output of 600 gpm. Booster pump 2 is a fixed rate pump with a capacity of 300 gpm. The well site is configured to operate through the PLC by selecting the desired wells and booster pump.

When the VFD controlled booster pump is part of the setup, the system operates automatically in the following manner: when the well site is signaled to operate, the selected well pumps start and pump into the intermediate reservoir. When the level rises to the setpoint, the booster pump starts and pumps into the distribution system. The booster pump modulates to pace the output of the well pumps. VFD controlled chemical feed pumps provide chemical treatment by injecting chlorine and fluoride into the pump discharge.

When the system is signaled to stop, the well pumps shut off, and the booster pump draws down the intermediate reservoir and then shuts off.

When the fixed rate booster pump is part of the control set up, the system operates automatically in a similar manner except wells or booster pumps cycle on and off as necessary to maintain the level in the intermediate reservoir. Normally the output of the wells is closely matched to the output of the booster pump to keep motor cycle rates within acceptable limits.

Even when the well site is not called to operate by the High School reservoirs, the wells flow under artesian pressure to fill the intermediate reservoir. Once the intermediate reservoir is full, the system operates automatically in a manner similar to that described above. The selected booster pump starts, draws down the level of the intermediate reservoir, and stops. These uninitiated pump cycles rarely produce more than 20,000 gallons per day (gpd) and do not cause overflow of the High School reservoirs.

The HOB is the oldest well site currently in operation. Over the years, several wells have been drilled, redeveloped, and decommissioned at this location. The control building has been reconfigured numerous times. The HOB wells that are still active were constructed between 1967 and 1988.

Wells 1, 2, and 3 at HOB were drilled in 1967, 1971, and 1974, respectively. The control building was expanded, new booster pumps installed, and the 10,000-gallon intermediate reservoir constructed in 1973. The facility included a 100-gpm sand filter to treat a surface water diversion from Cooper Creek until it was decommissioned around 1974. Wells 4 and 5 were drilled and a gas chlorinator installed at the well site in 1983. Well 6 was added in 1985 and Well 1A was drilled in 1988.

The gas chlorination system was replaced with a sodium hypochlorite chlorination system and a fluoride saturator installed to provide fluoridation in 1993. A telemetry system was installed in 1995 to provide monitoring and control of the well site. The low zone booster pumps were removed and the high zone booster pumps replaced with units capable of 250 gpm in 1997. The chlorination system was upgraded with a Chlortech B-Series chlorine generator in 1998. The well site was fenced in 2002 and the chlorine generator was replaced with a Chlortech MTC-36 unit in 2007. The Head of the Bay chlorine generator will need to be replaced again during the 20-year planning period.

Wells 1A, 3, 4, and 6 were rehabilitated and the well pumps replaced in 2005. As part of the project a wellfield test was conducted that determined the maximum safe yield from the site was 500 gpm. In order to take full advantage of the well site capacity, the control building was renovated in 2008. The 250-gpm booster pump 1 was replaced with a VFD controlled pump rated at 630 gpm. The building piping, flow meter, valves, telemetry controls, and electrical system were replaced. A generator receptacle and manual transfer switch were installed and secondary containment for the sodium hypochlorite holding tanks was

constructed. The City plans to install an emergency generator at the site within the next few years.

Wells 2 and 5 were rehabilitated and the well pumps replaced in 2011. That same year the well site piping was rerouted to pass over Cooper Creek and the pipe size increased to maximize well pump efficiency. A telemetry upgrade was completed in 2013 that included installation of water level transducers in Wells 2, 3, and 5.

The limiting capacity of this well site is currently based on the maximum safe yield of the wellfield of 500 gpm. This site is important to long-term aquifer management. The City of Bainbridge Island Winslow Water System Water Resource Management Plan (Robinson, Noble & Saltbush, Inc., 2005) recommended that the site, because it taps the sea level aquifer, be used as the main source of supply in the winter months to allow the Fletcher Bay aquifer a period of recovery from peak summer production.

4.2.1.2 Fletcher Bay Avenue Well Site

The Fletcher Bay Well Site currently provides about 25 percent of the supply for the Winslow Water System. The site has a single well that taps the Fletcher Bay aquifer. The well has a low susceptibility rating and the well level is continuously monitored through the telemetry system. The water quality is good and does not have a history of exceeding primary or secondary MCL. To provide backup power, a mobile emergency generator capable of operating the entire system is normally stationed at the site.

The well site is signaled to operate by the level of the High School reservoirs. Once started it operates as an integrated system by a local PLC based on the level of the clearwell. The well discharge is treated with chlorine and fluoride by fixed rate feed pumps before entering the 15,000-gallon clearwell located beneath the control building. From the clearwell a single booster pump pumps to the high zone distribution system at Foster Road.

When the well site is signaled to operate, the well pump starts and is controlled by a VFD to about 600 gpm. When the clearwell is full the booster pump starts and pumps to the distribution system at a rate of approximately 585 gpm. Over time, the output of the well pump overcomes the output of the booster pump and the well cycles off. When the clearwell pumps down the well pump restarts and the cycle repeats until the well site is signaled to stop. At that time the well pump shuts off and the booster pump draws down the clearwell and then shuts off. Because the well and booster pump flow rates are closely matched, the motor cycle rates are kept well within acceptable limits. Based on the booster pump output the limiting capacity of the well site is approximately 585 gpm.

The Fletcher Bay Well Site was originally developed by Kitsap Public Utility District (KPUD). The well was drilled in 1978 and the control building constructed in 1979. The Fletcher Bay area distribution system was improved and connected to the Winslow Water System in 1979. The gas chlorination system was replaced with a sodium hypochlorite chlorination system and a fluoride saturator installed to provide fluoridation in 1993. After several years

of joint use, under a contractual agreement between the City and KPUD, the well site and the Fletcher Bay distribution system was purchased by the City and fully integrated into the Winslow Water System in 1994. The chlorination system was upgraded with a Chlortech B-Series chlorine generator in 1998 and this system was replaced with a Chlortech T-36 chlorine generator in 2004. The chlorine generator will be replaced again within this Plan's 20-year planning period.

A telemetry system was installed in 1995 to provide monitoring and control of the well site. To facilitate backup power during extended power outages a manual transfer switch and generator receptacle were installed on the control building in 1999. A mobile emergency generator was acquired in 2000 and the well site was fenced in 2002.

Several improvements were made to the site in 2006. The well was rehabilitated and the original 500-gpm submersible well pump was replaced with a 650-gpm unit. The original 500-gpm vertical turbine booster pump was replaced with a 650-gpm unit. As part of these improvements the main electrical control center, flow meter, and mainline valves were replaced. The local PLC and clearwell controls were replaced in 2008. The new well pump failed and was replaced in 2009. Upon investigation, the cause of failure was determined to be water hammer at start-up. To correct this condition a VFD was installed on the well pump in 2011. Minor control building improvements were completed in 2013. On the inside of the structure, electrical improvements were made and the walls painted. On the outside siding, doors, and gutters were replaced and the structure repainted. In addition, secondary containment for the sodium hypochlorite holding tanks was installed.

4.2.1.3 Sands Avenue Well Site

The Sands Avenue well site currently provides about 50 percent of the supply for the Winslow Water System. The site has two wells that tap the Fletcher Bay aquifer and the well levels are continuously monitored through the telemetry system. A mobile emergency generator capable of operating the entire system is normally stationed at the site. The wells have low susceptibility ratings and do not have a history of exceeding primary or secondary water quality MCLs, however sodium levels have surpassed the EPA level of concern.

The well site is signaled to operate by the level of the High School reservoirs. Once started the site operates as an integrated system by a local PLC based on the level of the clearwell. The discharge from the wells is treated with chlorine and fluoride by fixed rate feed pumps before it enters the 20,000-gallon clearwell located beneath the control building. From the clearwell a booster pump transfers water to the high zone distribution system at Sands Avenue.

Sands well 1 has a capacity of 350 gpm and well 2 has a capacity of approximately 380 gpm. The Sands booster pump 1 has a capacity of approximately 615 gpm and booster pump 2 has a capacity of 670 gpm. Under normal operation both wells start and pump to the clearwell when the well site is signaled to operate. When the clearwell is full, operating on an alternating basis, one of two booster pumps starts and pumps to the distribution

system. Over time, the output of the well pumps overcomes the output of the booster pump and the wells cycle off. When the clearwell is pumped down the well pumps restart and the cycle repeats until the well site is signaled to stop. At that time the well pumps shut off and the booster pump draws down the clearwell and then shuts off. Because the well and booster pump flow rates are closely matched, the motor cycle rates are kept well within acceptable limits. Based on the lowest booster pump output the limiting capacity of the well site is 615 gpm.

Development of the Sands Avenue well site began in 1989 when Sands well 1 was constructed. In 1990 Sands well 2 was constructed and the control building completed. Sands well 2 was placed in operation in 1995. The gas chlorination system was replaced with a sodium hypochlorite chlorination system and a fluoride saturator installed to provide fluoridation in 1993. The chlorination system was upgraded in 1998 with the installation of a Chlortech B-Series chlorine generator. This system was replaced with a Chlortech T-36 chlorine generator in 2002 and will require replacement again within the 20-year planning period.

A telemetry system was installed in 1995 to provide monitoring and control of the well site. To facilitate backup power during extended power outages a manual transfer switch and generator receptacle were installed on the control building in 1999. A mobile backup generator was acquired and the well site was fenced in 2002. Booster pump 2 was replaced in 2004. Sands well 1 was redeveloped and the well pump replaced in 2005. The Weaver well water dispensing station was relocated to the site in 2008. That same year the local PLC was upgraded to integrate dispensing station controls and enable remote set up of customer accounts.

4.2.1.4 Commodore Well Site

The Commodore Well Site has a single well that taps a perched aquifer. The well has a high susceptibility rating because of a past volatile organic chemicals (VOC) detection in 1992. The well has elevated manganese levels that exceed the secondary MCL. Although the well is in the active status it is rarely used due to its low capacity of 50 gpm.

The well site is signaled to start by the level of the High School reservoirs and is controlled by the local PLC. The well discharge is treated with chlorine and fluoride. The discharge extends through 700 feet of 4-inch water main before it connects with the high zone near the inlet of the 1.0 MG High School reservoir.

The well was drilled in 1980 for the Bainbridge Island School District. A new control building was constructed for the well and improvements were made to the water system which was owned by the School District. The water system served the school complex between High School Road and New Brooklyn Road. The water system was improved, connected to the Winslow Water System, and transferred to the City in 1996.

4.2.1.5 Weaver Well Site

The Weaver Well Site is part of the original water supply for the City of Winslow. In its history, four wells have been associated with this well site. The Weaver-Shepard wells 1 and 1R are located on City property at the corner of Weaver Road and Shepard Way. The Weaver-Wyatt wells 2 and 3 are located on City property at the corner of Weaver Road and Wyatt Way. Well 1R tapped the Fletcher Bay aquifer and the remaining wells tapped the sea level aquifer. Due to high sulfur content, all the wells required treatment prior to use for potable water supply.

The Weaver-Shepard well 1 was drilled in 1952. The Weaver-Wyatt wells 2 and 3 were drilled and a water treatment system was constructed in 1958. The system consisted of aeration and chlorination to remove sulfur, and booster pumps to pump the treated water into the distribution system. In 1972 when the 1.0 MG High School reservoir was constructed the Weaver system was reconfigured to pump into the low zone distribution system. In 1976 the Weaver-Shepard well 1 failed and was capped but not decommissioned. The Weaver-Shepard well 1R was drilled as a replacement and continued to be used for potable water supply until 1984 when all wells at the site were disconnected from the distribution system.

To provide water for construction purposes and for non-potable public works use, the Weaver-Shepard well 1R was converted into a non-potable water dispensing station in 1986. The Weaver-Wyatt wells 2 and 3 were decommissioned and the dispensing station upgraded with automated controls in 1996. The Weaver-Shepard well 1 was converted to a monitoring well in 2006. The Weaver-Shepard well 1R continued to be used as a dispensing station until 2007, when the structure that housed the controls was partially destroyed by an arson fire. Following that, a new dispensing station was constructed at the Sands Avenue well site in 2008.

Currently, the Weaver-Shepard well 1R has a well pump and motor that is operable but is inactive due to building damage. The Weaver-Shepard well 1 is still available for use as a monitoring well. It is unlikely any of the wells at this location will be brought back in service to use for potable water supply. However, the well site still has value to the water utility in real estate property and water rights assets as well as the benefit of its use as a water level monitoring site.

4.2.1.6 Wing Point Well Site

The Wing Point well is a small 6-inch diameter well that taps a shallow aquifer at a depth of about 40 feet. The well is located on the grounds of the Wing Point Golf Course. By 1985 the output of the well had declined to 15 gpm and its use as a production well was discontinued. It is unlikely this well will ever be brought back in operation; however it is preserved as a water level monitoring site for use as necessary.

4.2.1.7 Clearwells

The Sands, Fletcher Bay, and HOB well sites are signaled to operate by the level of the High School reservoirs. Once started the well sites operate as integrated systems based on the level of the clearwell or intermediate reservoir. Table 4.1 provides a summary of the setpoints. These are general setpoints; redundant float settings are not shown.

Table 4.1 Clearwell Setpoints (feet) - Winslow Water System Plan City of Bainbridge Island

Booster Pump	Low Alarm	Booster Stop	Well Start	Booster Start	Well Stop	High Alarm	Overflow
HOB	6.0	7.5	10.0	16.0	17.0	17.5	18.0
Fletcher Bay	2.2	3.0	3.5	3.5	8.0	8.3	9.5
Sands Avenue	2.2	3.0	3.5	3.5	8.0	8.3	10.0

4.2.1.8 Well Site Booster Pumps

Booster pumps are located at the Sands, Fletcher Bay, and HOB well sites. The booster pumps pump treated water from the clearwells or intermediate reservoir into the distribution system to supply customers and fill the High School reservoirs. The HOB booster pump 1 is controlled by a VFD and the remaining booster pumps use across the line starters. Table 4.2 provides a summary of the booster pump details.

4.2.1.9 Supply Wells

The specific capacity and chloride levels are monitored in the wells on a semiannual basis. The results have shown no unusual trends. The specific capacity of all wells declines over time. In the past ten years, eight of the eleven active wells have been rehabilitated. Depending upon the well, the results of rehabilitation have ranged from modest improvement to significant gain in capacity. Sands well 2 cannot be rehabilitated because a tool broke off and was left in the casing when it was originally drilled. The Commodore well would be difficult to rehabilitate because of limited site access and poor control building design. The HOB well 1 is a low producing well that would not be cost effective to rehabilitate. Table 4.3 provides a summary of the supply well details for the active wells. The information in this table is based on a detailed review of well driller logs and well development reports.

Table 4.2 Booster Pump Specifications - Winslow Water System Plan City of Bainbridge Island

Booster Pump	Year Installed	Pumps From	Pumps To	Design Flow (gpm)	Design TDH (ft)	2014 Test Flow (gpm)	2014 Test TDH (ft)	HP	Variable Speed?	Standby Power Type
HOB Booster 1	2008	HOB Clearwell	High Zone	250	375	300	375	40	No	All Booster Pump Stations are Equipped with a Mobile Emergency Generator Receptacle
HOB Booster 2	1997	HOB Clearwell	High Zone	630	380	600	380	100	Yes	
Fletcher Bay Booster	2006	Fletcher Clearwell	High Zone	600	265	586	265	60	No	
Sands Booster 1	1990	Fletcher Clearwell	High Zone	450	307	616	307	50	No	
Sands Booster 2	2004	Sands Clearwell	High Zone	450	307	670	307	50	No	

Table 4.3	Supply Well Specifications - Winslow Water System Plan City of Bainbridge Island					
Well	**DOH Source**	**Aquifer**	**Depth (ft)**	**Casing-Riser (inches)**	**Year Drilled**	**Last Rehab Year**
HOB Well 1A	S11	Sea Level	144	12/8	1988	2005
HOB Well 1	S01		134	8/6	1967	---
HOB Well 2	S02		130	16/12/9	1971	2011
HOB Well 3	S03		163	6	1974	2005
HOB Well 4	S08		136	8	1983	2005
HOB Well 5	S09		138	8	1983	2011
HOB Well 6	S10		152	8	1985	2005
Fletcher Bay Well	S07	Fletcher Bay	992	12	1978	2006
Sands Avenue Well 1	S12	Fletcher Bay	1,053	8	1989	2005
Sands Avenue Well 2	S13		1,055	10	1990	---
Commodore Well	S14	Perched	264	12/8	1980	---

All of the wells in the water system have submersible pumps. The Fletcher Bay and Commodore well pumps are controlled by VFDs and the remaining well pumps use across the line starters. Pumps were replaced when the wells were rehabilitated. In the past ten years well pumps have been replaced in eight of the eleven active wells. In the past ten years only one well pump has failed unexpectedly. The Fletcher Bay well pump that was installed in 2006 failed and was replaced in 2009. The cause was determined to be water hammer during start-up and the condition was corrected by installing a VFD motor controller. Output of the wells is tested every one to two years. Table 4.4 provides a summary of well pump details for the active wells.

Table 4.4	Well Pump Specifications - Winslow Water System Plan City of Bainbridge Island						
Well Pump	Year Installed	Design		2014 Test		HP	Standby Power Type
		Flow (gpm)	TDH (ft)	Flow (gpm)	TDH (ft)		
HOB Well 1A	2005	138	156	116	156	7.5	All Well Sites are Equipped with a Mobile Emergency Generator Receptacle
HOB Well 1		37		34			
HOB Well 2	2011	206	192	183	192	15	
HOB Well 3	2005	250	150	264	150	15	
HOB Well 4	2005	138	156	83	156	7.5	
HOB Well 5	2011	110	175	125	175	7.5	
HOB Well 6	2005	75	100	86	100	5	
Fletcher Bay Well	2009	600	260	591	260	60	
Sands Avenue Well 1	2005	350		351		40	
Sands Avenue Well 2	1989	360		377		40	
Commodore Well	1995	50		50		7.5	

4.2.1.10 Supply Controls

The City selects which wells will operate based on daily production requirements, equipment operational status, and aquifer management criteria. Individual well site call levels can be set through the telemetry system. Typically, selected wells are called on/off based on the levels in the High School reservoirs. The reservoir levels that call the wells on/off are summarized in Table 4.7.

4.2.2 Treatment

At each well site the water is treated with chlorine and fluoride. The Winslow Water System is currently not required to disinfect, and therefore is not required to provide a contact time (CT) of 6. Chlorine levels are set in order to overcome chlorine demand at each well site and to maintain a minimum residual of 0.1 parts per million (ppm) in the extremities of the distribution system.

Chlorine residuals are monitored daily at operating well sites and weekly at coliform sample sites in the distribution system. Table 4.5 summarizes the target and normal range chlorine residual levels.

Disinfection is accomplished through the use of 0.8 percent sodium hypochlorite. The Sands Avenue, Fletcher Bay, and HOB well sites have onsite chlorine generators each capable of producing 36 pounds of chlorine per day. The Sands Avenue and Fletcher Bay well sites are equipped with Chlortech T-36 units and the HOB well site is equipped with a Chlortech MCT-36 unit. Each onsite chlorine generation system consists of a brine storage tank, a brine pump, a water softener, water heater, sodium hypochlorite production cells, control panel, 0.8 percent sodium hypochlorite storage tanks, sodium hypochlorite feed pump, and secondary containment. At the Commodore well site disinfection is accomplished using the sodium hypochlorite solution produced at the larger well sites.

Fluoridation of the Winslow Water System was initiated in 1992 by City Council Resolution 92-47. In 1993 fluoridation equipment was installed and made operational at all the operating well sites. Fluoridation is accomplished through the use of sodium fluoride and fluoride saturators at each well site. Fluoride residuals are monitored daily at operating well sites and controlled within the range of 0.8 through 1.3 ppm. Check samples are collected and tested by a certified laboratory on a monthly basis. Chlorine and fluoride residuals and check sample results are reported in the DOH Monthly Water Plant Report.

Table 4.5 Chlorine Residual Level Setpoints
Water System Plan
City of Bainbridge Island

Well Site	Target Chlorine Residual Level (ppm)	Normal Chlorine Residual Range (ppm)
HOB	1.6	1.4 – 1 .8
Fletcher Bay	1.8	1.6 – 2.0
Sands Avenue	1.6	1.4 – 1.8
Commodore	1.6	1.4 – 1.8

4.2.3 Storage

The total storage available to the Winslow Water System is provided by the two High School reservoirs. The Grand Reservoir is currently drained and out of service. The active reservoirs are located behind Bainbridge High School between High School Road and New Brooklyn Road. They are of the standpipe design and although they were built with different overflow elevations, because they are hydraulically connected, they have an effective overflow elevation of 334 feet. Together they have a combined capacity of 2.5 MG. The well sites are called to operate based on the reservoir levels through the telemetry system. When the well sites are not operating the reservoirs supply the water system by gravity.

The reservoirs have different base elevations and slightly different overflow elevations. Through physical site surveys, field testing, and record drawing research the as-built dimensions have been determined. Table 4.6 shows the as-built dimensions and other physical characteristics of the two High School reservoirs.

Table 4.6	High School Reservoir Storage Water System Plan City of Bainbridge Island					
Reservoir	**Year Constructed**	**Capacity (gallons)**	**Diameter (ft)**	**Height (ft)**	**Base Elevation (ft)**	**Overflow Elevation (ft)**
1 MG HS Reservoir No. 1	1973	1,003,184	46	80.7	253.3	334.0
1.5 MG HS Reservoir No. 2	1989	1,473,651	53	89.3	246.3	335.6

Both High School reservoirs are designed with a common fill/drain connection. This configuration causes poor water circulation. The water from the wells has a relatively high chlorine demand. These factors can combine to have an adverse effect on water quality. To help maintain water quality, the well site call levels are set to balance reservoir turnover with the requirement to maintain adequate storage at a sufficient level to maintain a minimum of 30 psi at the highest water service elevation of 250 feet.

The reservoirs are hydraulically connected so the lowest overflow elevation of 334 feet in the 1.0 MG reservoir is the controlling high level point. The base elevation of the 1.0 MG reservoir is higher than the 1.5 MG reservoir. In order to simplify operations, the telemetry is set to read both tanks relative to the 1.0 MG reservoir levels. Well sites are called on and off according to the general setpoints summarized in Table 4.7.

Table 4.7	High School Reservoir Setpoints (feet) Water System Plan City of Bainbridge Island					
Well Site	**Low Alarm Probe**	**Well Site Start**	**Well Site Stop**	**High Alarm Probe**	**High Alarm Float**	**Overflow**
First Call	68.5	71.5	79.5	80.0	80.5	81.0
Second Call	68.5	70.5	77.5	80.0	80.5	81.0
Third Call	68.5	69.5	75.5	80.0	80.5	81.0

In 1972 storage for the Winslow Water System was provided by two 150,000 gallon reservoirs, one located at Knechtel Way in the low zone and the other at High School Road and Lovell Avenue in the high zone. In 1973 the 1.0 MG High School reservoir was constructed in the high zone and the pressure zone boundaries adjusted. Because of the boundary adjustment, the 150,000 gallon reservoir located at High School Road and Lovell Avenue no longer had adequate elevation to provide service, so it was taken off line and later demolished. In 1989 the 1.5 MG High School reservoir was constructed in the high zone. Both high zone reservoirs are located near the High School between High School Road and New Brooklyn Road. Around 1980 the Knechtel Way reservoir was raised 12 feet

giving it a total capacity of 200,000 gallons and a 300,000 gallon reservoir was constructed at Grand Avenue and Park Avenue to serve the southeastern portion of low zone. The new overflow elevation was 226 feet. By 2003 development in the low zone had grown to the point where the Knechtel Way and Grand Avenue reservoirs could no longer provide effective storage. Their overflow elevations were not high enough to maintain adequate pressures through gravity. The reservoirs had considerable dead storage that caused poor water circulation and contributed to water quality problems. In order to improve water pressure and water quality, both reservoirs were taken off line in 2003 and the PRV stations adjusted to provide service to the low zone from the high zone. The Knechtel Way reservoir was demolished in 2003 and the Grand Avenue reservoir remains drained and out of service at this time.

In 1993 the 1.0 MG reservoir was drained and painted on the inside and outside. In 2001 the reservoir sustained some damage during the Nisqually earthquake and in 2003 upgrades were completed to bring the reservoir up to seismic standards. In 1996 the 1.5 MG reservoir was drained and inspected. Following the Nisqually earthquake a seismic inspection was performed and it was determined the reservoir met seismic standards. In 2008 the reservoir overflow was extended and in 2009 safety upgrades were completed. Both reservoirs were cleaned and inspected while in service in 1998, 2003, and 2009 using underwater diving services.

It is recommended that the City evaluate the structural integrity of the reservoirs within the next few years.

4.2.4 Pressure Zones and Pressure Reducing Valves

The Winslow Water System is divided into two pressure zones separated by an east-west line roughly even with Wyatt Way. The high zone has a hydraulic gradeline of approximately 334 feet and the low zone has a hydraulic gradeline of approximately 230 feet. All of the wells pump to the high zone distribution system to fill the 1.0 MG High School reservoir and the 1.5 MG High School reservoir. The reservoirs float on the system and provide supply when the wells are not operating.

The low zone is supplied through six active PRV stations. With the exception of the HOB PRV, each station is equipped with a 2-inch low flow pressure reducing valve and a 6-inch or 8-inch high flow pressure reducing/sustaining valve. In addition, each station has a 1-inch PRV set 1 to 2 psi higher than the low flow PRV to maintain a constant flow to the low zone and help maintain chlorine residuals. The downstream PRV pressure settings are adjusted to maintain a minimum pressure of 30 psi at the highest elevation in the low zone.

The HOB PRV was installed in 2003. This is a single 1-inch PRV whose primary function is to improve water circulation and maintain chlorine residual in the southwest quadrant of the low zone. Three PRV stations are equipped with pressure relief valves. Upstream and downstream pressures at the Ericksen and HOB PRV stations are monitored by the

telemetry system. In 1980 the first two modern PRV stations were constructed in the distribution system: one at Madison Avenue and Knechtel Way and one at Ericksen Avenue and Knechtel Way. The PRV at Knechtel and Madison was abandoned in place as part of the Madison water main project in 2013. Around 1993 two additional PRV stations were constructed, one at Grow Avenue and Wyatt Way and one on Cherry Avenue. In 2000 the Madison and Madrona PRV station was constructed and the Madison and Knechtel PRV station was taken off line. In 2003 the Ericksen and Wyatt PRV station was constructed and the Ericksen and Knechtel PRV station was demolished. Currently, the Madison and Knechtel PRV station remains secured and will be removed when the distribution system in the area is upgraded. Table 4.8 provides a summary of the PRV stations.

Table 4.8 Pressure Reducing Valve Stations - Winslow Water System Plan City of Bainbridge Island

Location	Year Installed	Valve Type	Size (inch)	Pressure Settings (psi)			
				Up	Down	Sust.	Relief
HOB	2003	Reducing	1	128	83		
Grow and Wyatt	1993	Reducing	2	76	31		
		Reducing	6	76	26	40	
Madison and Knecktel	2003	Reducing	1-1/2		Closed		
		Reducing	4		Closed		
Ericksen and Wyatt	2003	Reducing	2	78	38		
		Reducing	6	78	33	40	
		Relief	3	33			53
Madison and Madrona	2000	Reducing	2	90	45		
		Reducing	8	90	40	45	
		Relief	2	40			60
Ferncliff Avenue	1998	Reducing	2	84	38		
		Reducing	8	84	33	40	
Cherry Avenue	1993	Reducing	2	75	26		
		Reducing	6	75	21	40	
		Relief	3	26			40

4.2.5 Distribution System

The water distribution system consists of approximately 47 miles of pipe, ranging in size from 2-inch to 12-inch in diameter. The majority of the system is well looped and consists of pipes over 8-inches in diameter. Dead ends are connected, undersized pipes upgraded, and asbestos cement pipes replaced in coordination with road and development upgrade

projects. The make up of pipe materials is approximately 74 percent ductile iron (DI), 17 percent asbestos cement (AC), 7 percent polyvinyl chloride (PVC), 1 percent galvanized iron (GI) , and 1 percent high density polyethylene (HDPE). Table 4.9 provides a summary of the approximate lengths of pipes in the system by diameter.

4.2.6 Meters

The Sands Avenue, HOB, and Commodore well sites have well meters that measure production from individual wells. The Sands Avenue, Fletcher Bay, and HOB well sites have site meters that measure total production of all the wells at each site after treatment. Individual wells have been fully metered since 1996 and well sites have been fully metered since 1986. These meters range in size from 2-inch through 8-inch and have flow rates that range from 30 through 690 gpm.

The meters are tested every 1 to 2 years for accuracy by pumping into and out of clearwells of known dimensions. Regular testing has shown the well site meters tend to over-register production while the individual well meters are typically within the expected range of accuracy.

Prior to replacement in 2008, the HOB well site meter over-registered production by as much as 20 percent. Replacement of some well site meters has improved their overall accuracy, however due to physical limitations for meter installations within the control building they generally over-register production and are not as accurate as the individual well meters. For daily and monthly monitoring purposes the well site meters are used because they are located in the control buildings and do not require confined space entry. The individual well meters are read on a monthly basis for very accurate production reporting including the annual Water Use Efficiency report and the 2012 Winslow Water System WSP Update.

Since 1987 service meters have been in place on all customer service lines. The majority of these meters range from 5/8- x 3/4-inch through 2-inch in size. A small percentage of the service meters range from 2 1/2-inch through 4-inch in size. To reduce labor and meter reading errors service meters were fully converted to touch read by 2001. From 2006 to 2008 small service meters were standardized and in 2009 the upgrade of the larger meters began.

Customer service meter final reads, scheduled shut-offs, and leak checks are performed twice weekly. Service meters are read and shut-offs for non-payment are performed on a two month cycle. Service meter replacements are triggered through service order investigations, high/low meter exception reports, monthly meter data analysis, and programmatic meter replacement. The City specifies a quality service meter.

Table 4.9 Water Distribution Pipe Inventory - Winslow
Water System Plan
City of Bainbridge Island

Pipe Diameter	DI	AC	PVC	GI	HDPE	Approximate Lineal Feet	Percentage of System
Less than 4-inch	506		1,864	2,851	532	5,752.9	2□
4-inch	7,631	16,877	398		778	25,683	10□
6-inch	7,385	19,636	8,460			35,482	14□
8-inch	127,207	3,599	4,465			135,270	54□
10-inch	4,388	1,606	2,464			8,458	3□
12-inch	38,177	1,693				39,870	16□
Total	185,294	43,411	17,651	2,851	1,309	250,516	
Percentage of System	74□	17□	7□	1□	1□		

Experience of larger utilities with active meter calibration and replacement programs indicates the life span of these meters can last as long as 25 years and still provide accurate service. Because of the costs involved, programmatic meter replacement is a long-term process that must balance program costs with budget constraints. Over the years the utility has balanced these constraints to maintain respectable progress in this area.

4.3 ROCKAWAY BEACH WATER SYSTEM

The Rockaway Beach Water System serves customers along Rockaway Beach Drive NE on the south side of Eagle harbor. The system consists of a supply well, treatment facility, storage reservoir, and distribution system, the locations of which are shown in Figure 4.2. The system is monitored and controlled by a telemetry system that is headquartered at the Winslow Wastewater Treatment Plant. The well site is called to operate based on the level of the Creosote Reservoir. Once started, the well, treatment facility, and reservoir operate as an integrated system and is controlled by a local programmable logic controller (PLC). The well level is continuously monitored. The well site is equipped with a generator receptacle and manual transfer switch to provide backup power during power outages, and key facilities have intrusion alarms to provide site security.

The water system was originally owned by the Rockaway Beach Water Association and supplied by two artesian wells. The wells were located within the Wyckoff industrial complex, which was subsequently designated as a US Environmental Protection Agency (USEPA) Superfund site. In 1993, USEPA assumed responsibility for the Superfund site and LID 17 was formed to make improvements to the Rockaway Beach Water System.

Formerly known as the South Eagle Harbor Well, the Taylor Avenue Well is located on a City road end at the north end of Taylor Avenue just west of the Wyckoff Superfund site. The well was completed in March 1994 as the sole source of supply for water system to replace the original supply wells. These wells were decommissioned in May 1995 because of their vulnerability to contamination. The City took ownership of the Rockaway Beach Water System in 1996. An ATEC Iron/Manganese removal system was installed and placed in service in April 2002. The well pump failed and was replaced in January 2003. The road end where the well is located was dedicated as a national historic site and the well building was reconstructed to conform to the historic site in 2009. The water system was originally designed with a well capacity of 80 gpm, however, well production has since declined by over 40 percent. The current well capacity is 43 gpm. Currently, the well would be difficult to rehabilitate because of limited site access related to its reconstruction as a national historic site.

The well is 694 feet deep with a 12-inch casing and a gravel-packed 6-inch screen from 584 feet to 557 feet. The well draws from the Glaciomarine aquifer and has a low susceptibility rating. It does not have a history of exceeding any primary MCLs, however, it does exceed

the secondary MCL for iron and manganese and is required by the DOH to be continuously chlorinated and treated to remove iron and manganese.

When called to operate the well discharges untreated water that travels approximately 2,600 feet through an 8-inch transmission main to a treatment facility located near the intersection of Eagle Harbor Drive and Creosote Hill Road. At the treatment site the water is treated with chlorine and fluoride and then passes through a 70-gpm ATEC iron and manganese removal system before entering the 132,000-gallon Creosote Reservoir.

At the treatment facility, chlorination is accomplished using the sodium hypochlorite solution produced at the larger well sites. Chlorine residuals are monitored daily and the dose is set to support the iron and manganese removal system, provide a CT of 6 minutes, and maintain a minimum residual of 0.1 ppm in the extremities of the distribution system. Iron and manganese levels are tested monthly by a certified lab to monitor treatment performance and the results are reported in the DOH Monthly Water Plant Report.

Fluoridation is accomplished through the use of sodium fluoride. Fluoride residuals are monitored daily and controlled within the range of 0.8 through 1.3 ppm. Check samples are collected and tested by a certified laboratory on a monthly basis. Chlorine and fluoride residuals and check sample results are reported in the DOH Monthly Water Plant Report.

The Creosote Reservoir supplies the water system by gravity. From the reservoir, a 12-inch DI pipeline extends 580 feet to the intersection of Old Creosote Road, Eagle Harbor Drive, and Rockaway Beach Road NE. From there an 8-inch line extends 700 feet north to Pritchard Park and an 8-inch line extends 5,765 fee south to serve residences along Rockaway Beach Road.

As with the Winslow Water System customer, service meter final reads, scheduled shut-offs, and leak checks are performed twice weekly. Service meters are read and shut-offs for non-payment are performed on a two-month cycle. Service meter replacements are triggered through service order investigations, high/low meter exception reports, monthly meter data analysis, and programmatic meter replacement.

Table 4.10 Creosote Reservoir Storage
Water System Plan
City of Bainbridge Island

Reservoir	Year Constructed	Capacity (gallons)	Diameter (ft)	Height (ft)	Base Elevation (ft)	Overflow Elevation (ft)
Creosote	1996	132,000	30	25	111.0	335.0

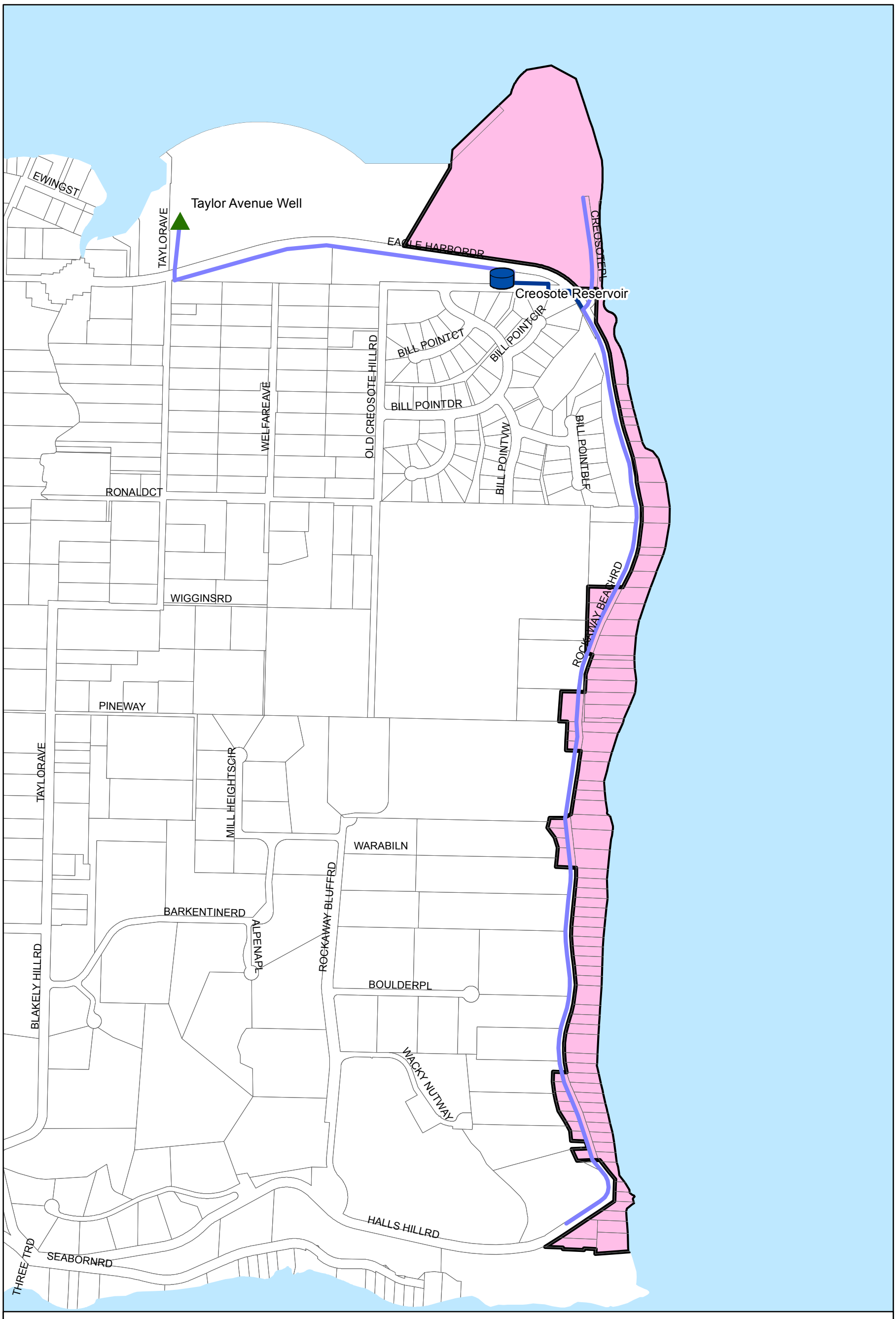


Figure 3.2
Rockaway Beach Water System Map
Water System Plan
City of Bainbridge Island

4.4 TELEMETRY AND CONTROL

The Winslow and Rockaway Beach water systems are monitored and controlled by a Supervisory Control and Data Acquisition (SCADA) system. The system was designed and installed by S&B Inc. in 1995. Monitoring and control of the City water system, sewer system, and wastewater treatment plant is integrated into the system. The SCADA system is housed in a master telemetry unit (MTU) that was originally located on City property at John Nelson Park. In 2006 the MTU was upgraded and relocated to the Winslow Wastewater Treatment Plant. Additional integration and upgrades to the system were accomplished in 2009 as part of the Winslow Wastewater Treatment Plant upgrade.

The SCADA system includes a PLC, graphical user interface (GUI), telephone network interface (TNIS), central archive server (CAS), and autodialer. All the control and alarm logic for the water system is contained in the PLC. The GUI provides an operator interface to understand logic, adjust setpoints, troubleshoot systems, and manage data. In order to communicate with the remote sites, the TNIS provides an interface with leased analog and digital subscriber telephone lines (DSL). The CAS archives and stores data and the autodialer calls out alarm conditions to standby personnel for after-hours emergency response. All well sites, reservoirs, and select PRV stations can be monitored and/or controlled from the MTU at the wastewater treatment plant. In addition, the system can be accessed for monitoring and control at the Public Works Facility through the City network. Typical parameters, conditions, and alarms monitored and controlled include:

- Communications Fail
- Power Fail
- Phase Fail
- Smoke/Fire
- Flood
- Operator in Trouble
- Intrusion
- Voltage
- Water Level
- Low Level
- High Level
- Water Pressure
- Low Pressure
- High Pressure
- Pump Run Time
- Pump Cycles
- Pump Excessive Start Limit
- Pump Failure
- Pump Flow Rate
- Pump Total Volume

In addition to the main SCADA system, S&B Inc. has been responsible for the design and installation of all City water and wastewater control systems since 1995. This relationship has helped establish standards and ensure continuity of systems design. Over the years the SCADA system and remote controls have proven extremely reliable. All software and hardware are designed with reliability and redundancy. The SCADA PLC has a backup system available onsite. Level probes are backed up with floats. Smart controllers are

widely employed and software includes fail safe logic. Over the past ten years long-term interruption of the telephone lines has been rare and in case of communication failure, all remote sites have standalone PLCs that can operate independent of the MCC.

4.5 INTERTIES

The Winslow Water and Rockaway Beach water systems currently have no interties with adjacent purveyors.

4.6 WATER RIGHTS

Existing water rights for the Winslow and Rockaway Beach water systems are summarized in Tables 4.11 and 4.12, respectively. Included in the summary are the water right certificate number, priority date, quantity of instantaneous withdrawal or diversion (Qi), and annual water right (Qa,). The instantaneous right represents the maximum pumping capacity of a well or maximum diversion rate for a spring or surface water source. Annual right represents the total quantity of water that may be withdrawn or diverted during an entire year. Priority date provides a means of ranking water rights as junior or senior based on their date of application to the Department of Ecology (Ecology). Certificates of Water Rights are included in Appendix H.

Information on the Winslow Water System water rights is obtained from The City of Bainbridge Island Water Rights Analysis (2002) and the City of Bainbridge Island Winslow Water System Water Resource Management Plan (2005), both of which were completed by Robinson, Noble & Saltbush, Inc. As shown in Table 4.11, the City has water rights for some sources that are not currently used as sources of supply for the Winslow Water System. These include the Weaver wells, Wing Point well, Fox well, and a surface water right.

The Weaver wells 2 and 3 are no longer in service. Weaver well 1 was used to provide water for construction purposes until 2008 when a new water dispensing station was constructed at the Sands Avenue well site. Based on the indicated locations of the points of withdrawal for the Weaver wells, these wells may have been the original HOB Wells. However, according to the Robinson, Noble & Saltbush reports, it does not appear that the water right certificates 3170-A and 3171-A are assigned to any of the HOB Wells. The water right certificate 3170-A was previously associated with HOB Well 1. However, the Robinson, Noble & Saltbush reports concluded that the well's location and the point of diversion listed under the water right do not correspond with the location of HOB Well No. 1. HOB wells are part of a wellfield and therefore all wells and replacement wells can be pumped under the total available water rights for the HOB wells. As recommended in the Robinson, Noble & Saltbush reports, a wellfield designation from Ecology for the HOB and Sands well fields should be formally requested. This will allow any and all existing wells and

future replacement wells or additional points of withdrawal to be included under the existing water rights.

The Wing Point well was installed to serve the Community of Wing Point. The Fox Well water right is for a well that belonged to the City of Winslow and is located on the John L. Fox property. Neither well is currently used by the Winslow Water System. The surface water diversion water right was one of the original sources of supply for the City of Winslow. The source diverted water from Cooper Creek, which is located near the HOB Wells. This surface water source is no longer used.

Table 4.11 Winslow Water Rights Summary[1]
Water System Plan
City of Bainbridge Island

Source	Well Status	Certificate Number	Priority Date	Instantaneous Withdrawal (gpm)	Annual Withdrawal (acre-ft/yr)[2]
Primary Sources of Supply					
Fletcher Bay Well	Operational	G1-20706C	June 14, 1973	730	1,168
Commodore Well					
Well No. 1	Not Used	C-6025-A	April 8, 1968	20	32
Well No. 2	Operational	G1-23678C	September 15, 1980	120	32 (S)
Sands					
Well No. 1	Operational	G1-25264C	June 29, 1988	300	336 (S)
Well No. 2	Operational	G1-25614P	February 1, 1990	500	564 (S)
HOB					
Wells No. 1 & 2 (Original)	Not Used	C-5597-A	March 21, 1966	55	88 (S)
Wells No. 1 & 2	Operational	C-7410-A	August 18, 1967	300	336
Well No. 3	Operational	G1-22248C	June 28, 1974	75	160
Wells No. 4 & 5	Operational	G1-24349C	July 8, 1983	200	224
Total Permitted Water Rights (Primary Sources of Supply)				**2,300**	**1,920**

Table 4.11 Winslow Water Rights Summary[1]
Water System Plan
City of Bainbridge Island

Source	Well Status	Certificate Number	Priority Date	Instantaneous Withdrawal (gpm)	Annual Withdrawal (acre-ft/yr)[2]
Other City Water Rights					
Lower Weaver	Not Used				
Well No. 1	Not Used	C-3170-A	February 20, 1958	100	160
Wells No. 2 & 3	Not Used	C-3171-A	February 20, 1958	50	80
Wing Point Well	Not Used	C-1011-D	August 1, 1930	7	11
(Same well)	Not Used	C-3786-A	July 16, 1957	13	21
Fox Well	Not Used	C-4786-A	May 21, 1962	30	48 (S)
Surface Water Right	Not Used	C-7943	June 25, 1958	157	253
			Total Permitted Water Rights	**2,657**	**2,445[3]**

Notes:
(1) Source: City of Bainbridge Island Winslow Water System Water Resource Management Plan (Robinson, Noble & Saltbush, 2005).
(2) (S) = Supplemental to existing water rights.
(3) Total does not include supplemental water rights.

Table 4.12 Rockaway Beach Water Rights Summary
Water System Plan
City of Bainbridge Island

Source	Well Status	Certificate Number	Priority Date	Instantaneous Withdrawal (gpm)	Annual Withdrawal (acre-ft/yr)
Primary Sources of Supply					
Taylor Avenue Well	Operational	G1-26704P	June 28, 1992	80	13
			Total Permitted Water Rights	**80**	**13**

Chapter 5

WATER RESOURCE MANAGEMENT AND WATER USE EFFICIENCY

5.1 INTRODUCTION

This chapter reviews the water rights and supply capacities of the City's supply sources and compares them to required supply based on future demand projections and the City's supply reliability criteria. The medium demand projection scenario presented in Chapter 3 is used for the supply analysis.

This chapter also summarizes the City's Water Resource Management Plan, Wellhead Protection Program, and water use efficiency (WUE) goals.

The Winslow Water System (Winslow) has adequate water rights to meet future demands within the planning period (through 2035). While supply capacities are sufficient to meet demand and reliability criteria through 2025, as demands approach 2035 projection levels, additional well capacity and booster pump capacity will need to be obtained.

The single Rockaway Beach well, Taylor Avenue Well, does not satisfy the City's supply reliability criteria. The City needs to consider additional supply sources for the Rockaway Beach Water System (Rockaway Beach).

5.2 WATER SUPPLY ANALYSIS

5.2.1 Winslow

The Winslow Water System has four operational wells sites: Head of the Bay (HOB), Fletcher Bay, Sands, and Commodore. These well sites contain a total of 11 wells and are supplied by three different aquifers.

5.2.1.1 Water Rights Summary

The water rights of the City's operational well sites amount to 2,300 gallons per minute (gpm) of instantaneous withdrawal, and 1,920 acre-feet per year (ac-ft/yr) of annual withdrawal. Although the instantaneous water rights for the Head of the Bay Site amount to 630 gpm, the maximum safe yield of the HOB Well Site is 500 gpm, as described in Chapter 4. Therefore, the maximum available instantaneous withdrawal from the City's active well sites is 2,170 gpm.

The City also has many water rights that are currently not in operation. These water rights are associated with the three Lower Weaver wells, the Wing Point Well, the Fox Well, and a surface water right that served as Winslow's original water source. These groundwater rights that are not associated with the well sites in operation amount to an additional 200

gpm of instantaneous withdrawal and 272 acre-ft/yr of annual withdrawal. The surface water right allows 157 gpm of instantaneous withdrawal and 253 acre-ft/yr.

5.2.1.2 Supply and Pumping Analysis

Each supply and pumping criterion is evaluated based on the Winslow Water System's instantaneous yield, well capacity, and well site capacity. The definitions of these three supply capacity concepts are:

- **Instantaneous Yield:** The size of the instantaneous water right for a well site, or the maximum safe yield for the well site, whichever is lower. The instantaneous yield for the Winslow Water System is 2,170 gpm.
- **Well Capacity:** The well pump capacity of a well site, or the instantaneous yield for the well site, whichever is lower. Well capacity is the amount of water that the City is able to withdraw safely from its aquifers with existing well pumps. The well capacity of the Winslow Water System is 1,870 gpm.
- **Well Site Capacity:** The limiting capacity of a well site. Well site capacity of a well site is the well capacity, or the booster pump capacity, whichever is lower. The well site capacity of the Winslow Water System is 1,810 gpm.

Table 5.1 shows the supply and pumping capacities used to determine the Winslow Water System's instantaneous yield, well capacity, and well site capacity. Well pump and booster pump capacities are the results of pump tests performed by the City in July of 2014.

5.2.1.2.1 *Supply vs. Demand*

The Winslow Water System has enough total instantaneous and annual water rights to meet future water demands and water reliability requirements. However, as demands reach the levels projected for 2035, the City will need to upgrade the pumping capacities of their wells and booster pump stations to meet their reliability goals. Figure 5.1 shows that the City's total annual water rights, including those that are not currently operated, exceed even the City's highest projected average day demands (ADD) through the planning period.

Figure 5.2 compares Winslow's instantaneous supply capacities to the maximum day demand (MDD) projections. Winslow's instantaneous water rights exceed even the highest MDD projections. Instantaneous yield is adequate to supply the medium demand projection scenario through the planning period. Winslow well capacity can also meet 2035 projected MDD. However, the capacity of the City's booster pumps is slightly less than 2035 medium MDD projections.

Table 5.1 Supply and Pumping Capacities
Water System Plan
City of Bainbridge Island

Well Site	Instantaneous Water Right (gpm)	Safe Yield (gpm)	Instantaneous Yield (gpm)	Well Pump Capacity (gpm)	Well Capacity (gpm)	Booster Pump Capacity (gpm)	Well Site Capacity (gpm)
Head of the Bay	630	500	500	890	500	600	500
Fletcher Bay	730	N/A	730	590	590	590	590
Sands	800	N/A	800	730	730	670	670
Commodore	140	N/A	140	50	50	50	50
Non-operational Water Rights	357	NA	NA	NA	NA	NA	NA
Winslow Total	2,657		2,170		1,870		1,810
Taylor Avenue	80	N/A	80	43	43	N/A	43

5.2.1.2.2 *Pumping Criteria*

The Winslow Water System well and booster pump station (BPS) capacities were evaluated against the following four criteria:

1. **Criterion 1** – **Reliable MDD Supply.** Reliable sources are capable of supplying MDD within a 24-hour period.
2. **Criterion 2** – **ADD Supply with Largest Source Removed.** Reliable sources are capable of supplying ADD with the largest source out of service.
3. **Criterion 3** – **Fire Storage Replenishment.** Sources are capable of supplying MDD and replenishing fire suppression storage in 72 hours.
4. **Criterion 4** – **Firm Booster Pump MDD Supply.** Booster pumps are capable of supplying MDD of the water system with firm, reliable capacity.

The requirement of each criterion is compared to the Winslow Water System's instantaneous yield, well capacity, and well site capacity.

5.2.1.2.3 *Criterion 1 - Reliable MDD Supply*

Criterion 1 states:

"Reliable sources are capable of supplying MDD within a 24-hour period."

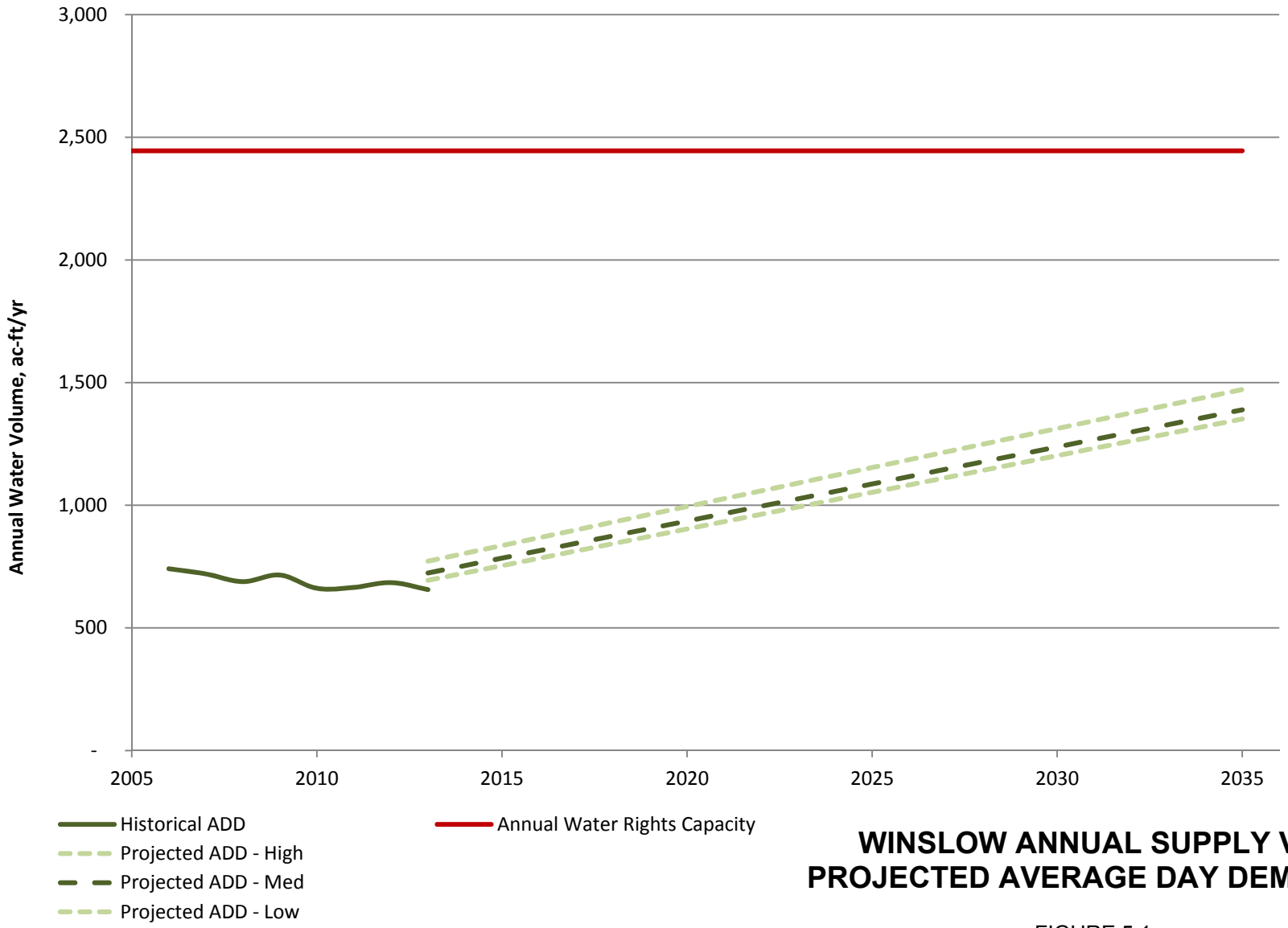
All of the City's wells and booster pumps have back up power supplied by mobile emergency generators. Therefore all of the City's supply is considered reliable.

As shown in Table 5.2, instantaneous yield and well capacity are adequate to supply 2035 MDD. However, by 2035 the well site capacity, which is dictated by the capacity of the booster pumps, is approximately 50 gpm shy of supplying MDD.

Table 5.2 Supply and Pumping Analysis Criterion 1 - Winslow Water System Plan City of Bainbridge Island

	2021	2025	2035
Requirement, MDD (gpm)	1,290	1,450	1,860
Instantaneous Yield (gpm)	2,170	2,170	2,170
Yield Surplus/ (Deficit) (gpm)	**880**	**720**	**310**
Reliable Well Capacity (gpm)	1,870	1,870	1,870
Well Surplus/ (Deficit) (gpm)	**580**	**420**	**10**
Reliable Well Site Capacity (gpm)	1,810	1,810	1,810
Well Site Surplus/ (Deficit) (gpm)	**520**	**360**	**(50)**

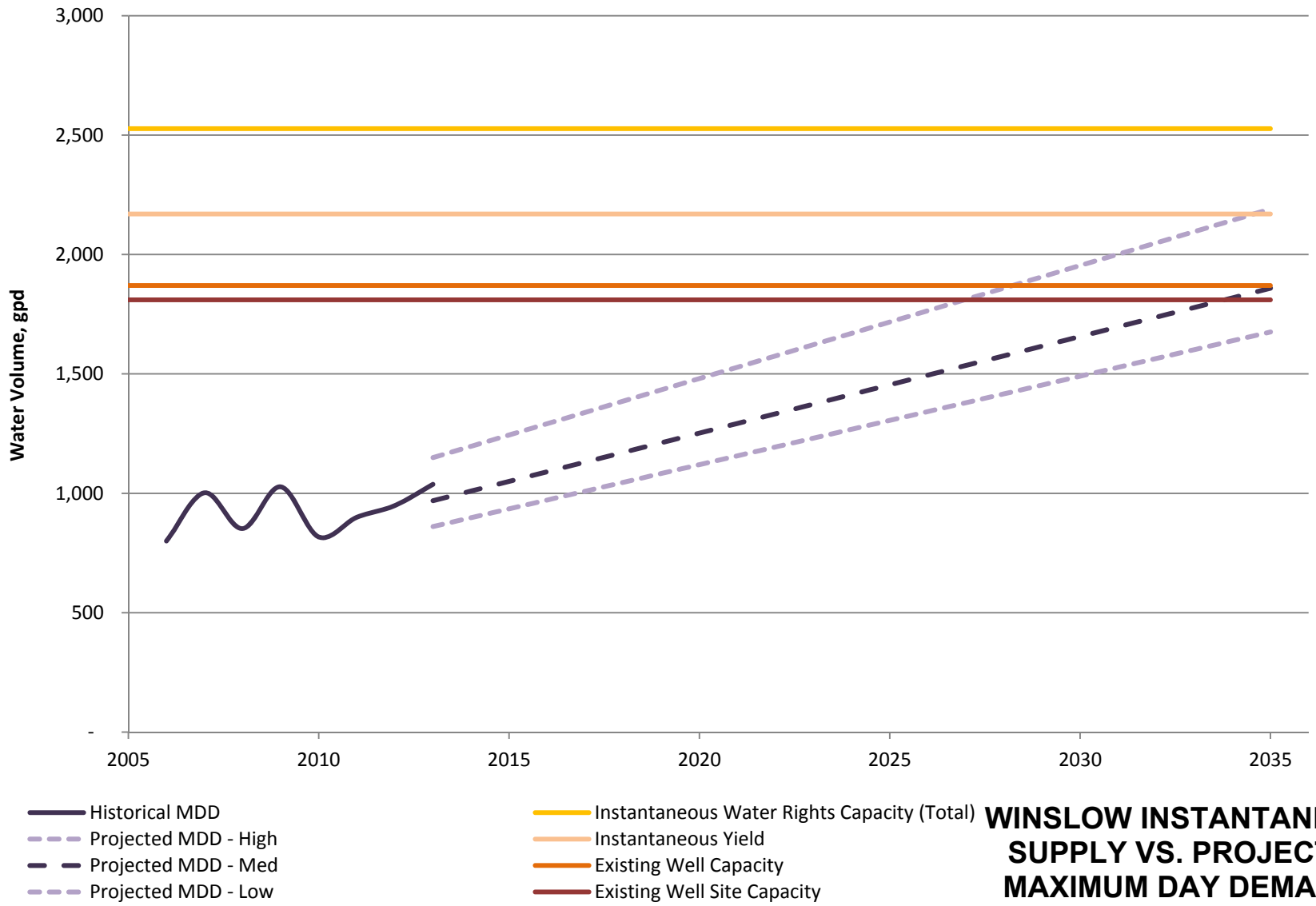
Notes:
(1) All values rounded to the nearest tem gpm.



WINSLOW ANNUAL SUPPLY VS. PROJECTED AVERAGE DAY DEMANDS

FIGURE 5.1

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN



WINSLOW INSTANTANEOUS SUPPLY VS. PROJECTED MAXIMUM DAY DEMANDS

FIGURE 5.2

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

carollo

5.2.1.2.4 *Criterion 2 - ADD Supply with Largest Source Removed*

Criterion 2 states:

"Reliable sources are capable of supplying ADD with the largest source out of service."

The Sands Well Site is the Winslow Water System's largest source with a capacity of 670 gpm. With the Sands Well Site offline, the Winslow Water System still has adequate capacity to meet ADD as shown in Table 5.3.

Table 5.3 Supply and Pumping Analysis Criterion 2 - Winslow Water System Plan City of Bainbridge Island

	2021	2025	2035
Requirement, ADD (gpm)	600	670	860
Instantaneous Yield (gpm)	2,170	2,170	2,170
Largest Source	Sands	Sands	Sands
Yield of Largest Source (gpm)	800	800	800
Firm Supply Capacity (gpm)	1,370	1,370	1,370
Yield Surplus/ (Deficit) (gpm)	**770**	**700**	**510**
Reliable Well Capacity (gpm)	1,870	1,870	1,870
Largest Source	Sands	Sands	Sands
Well Capacity of Largest Source (gpm)	730	730	730
Firm Supply Capacity (gpm)	1,140	1,140	1,140
Well Surplus/ (Deficit) (gpm)	**540**	**470**	**280**
Reliable Well Site Capacity (gpm)	1,810	1,810	1,810
Largest Source	Sands	Sands	Sands
Well Site Capacity of Largest Source (gpm)	670	670	670
Firm Supply Capacity (gpm)	1,140	1,140	1,140
Well Site Surplus/ (Deficit) (gpm)	**540**	**470**	**280**

Notes:
(1) All values rounded to the nearest tem gpm.

5.2.1.2.5 *Criterion 3 - Fire Storage Replenishment*

Criterion 3 states:

"Sources are capable of supplying MDD and replenishing fire suppression storage in 72 hours."

The Winslow Water System meets Criterion 3 through the year 2025. By 2035, however, neither the booster pumps nor the wells have adequate capacity to supply MDD plus the 125 gpm to replenish fire suppression storage. This is shown in Table 5.4.

Instantaneous yield is sufficient for meeting this requirement. As demands approach 2035 projection levels, the City will need to consider increasing well and booster pump capacity to satisfy this criterion.

Table 5.4 Supply and Pumping Analysis Criterion 3 - Winslow Water System Plan City of Bainbridge Island

	2021	2025	2035
Requirement, MDD (gpm)	1,290	1,450	1,860
Fire Storage Volume (gal)	540,000	540,000	540,000
Fire Storage Replenishment Flow (gpm)	130	130	130
Total Requirement (gpm)	**1,420**	**1,580**	**1,990**
Instantaneous Yield (gpm)	2,170	2,170	2,170
Yield Surplus/ (Deficit) (gpm)	**750**	**590**	**180**
Reliable Well Capacity (gpm)	1,870	1,870	1,870
Well Surplus/ (Deficit) (gpm)	**450**	**290**	**(120)**
Reliable Well Site Capacity (gpm)	1,810	1,810	1,810
Well Site Surplus/ (Deficit) (gpm)	**390**	**230**	**(180)**

Notes:
(1) All values rounded to the nearest tem gpm.

5.2.1.2.6 *Criterion 4 - Firm Booster Pump MDD Supply*

Criterion 4 states:

"Booster pumps are capable of supplying MDD of the water system with firm, reliable capacity."

All of the City's booster pumps supply the High Pressure Zone. As mentioned previously, all of the pumps have a reliable emergency supply source. If the largest booster pump, which is the 670-gpm Sands booster pump, is out of service, the booster pump capacity of the system is 1,860 gpm as shown in Table 5.5. The firm, reliable booster pump capacity meets projected 2035 MDD as shown in Table 5.6.

Table 5.5 Firm, Reliable Booster Capacity - Winslow Water System Plan City of Bainbridge Island	
Well Site	**Firm, Reliable Booster Capacity (gpm**
Head of the Bay	600
Fletcher Bay	590
Sands	620
Commodore	50
Total	1,860

Table 5.6 Supply and Pumping Analysis Criterion 4 - Winslow Water System Plan City of Bainbridge Island			
	2021	**2025**	**2035**
Requirement, MDD (gpm)	1,290	1,450	1,860
Firm, Reliable Booster Capacity (gpm)	1,860	1,860	1,860
Total Surplus/ (Deficit) (gpm)	570	410	0

5.2.1.3 Summary and Recommendations

The City's booster pump capacity is not large enough to meet Criteria 1 and 3 for year 2035 projected demands. In addition, the well capacity is not sufficient to supply 2035 MDD while replenishing fire suppression storage. As demands approach 2035 demand projection levels, the City will need to upgrade its well sites, increasing booster pump capacity by at least 180 gpm and well capacity by 120 gpm to satisfy Criterion 3.

None of the operational well sites individually have sufficient water rights or safe yields to provide 180 gpm of additional booster pumping. The City will need to consider upgrading multiple operational well sites and/or developing wells that are currently not used to provide supply reliability for the Winslow Water System.

The configuration of the Commodore Well Site makes rehabilitation difficult. The Commodore Well Site is also not the best candidate for providing additional supply due to high manganese levels. The HOB Well Site wells and booster pumps already exceed the safe yield. This leaves Fletcher Bay and Sands as the well sites to consider for future upgrades. Table 5.7 shows how much well and booster pump capacity could be added to each Well Site before the instantaneous yield of the well site is met.

Table 5.7	Potential Additional Capacity (gpm) Water System Plan City of Bainbridge Island	
Well Site	**Well**	**Booster Pump**
Head of the Bay	0	0
Fletcher Bay	140	140
Sands	70	130
Commodore	90	90

5.2.2 Rockaway Beach

5.2.2.1 Water Rights Summary

The City has only one water right for the Rockaway Beach Water System. The Taylor Avenue Well has an instantaneous withdrawal limit of 80 gpm and an annual withdrawal water right of 34 acre-ft/yr.

5.2.2.2 Supply and Pumping Analysis

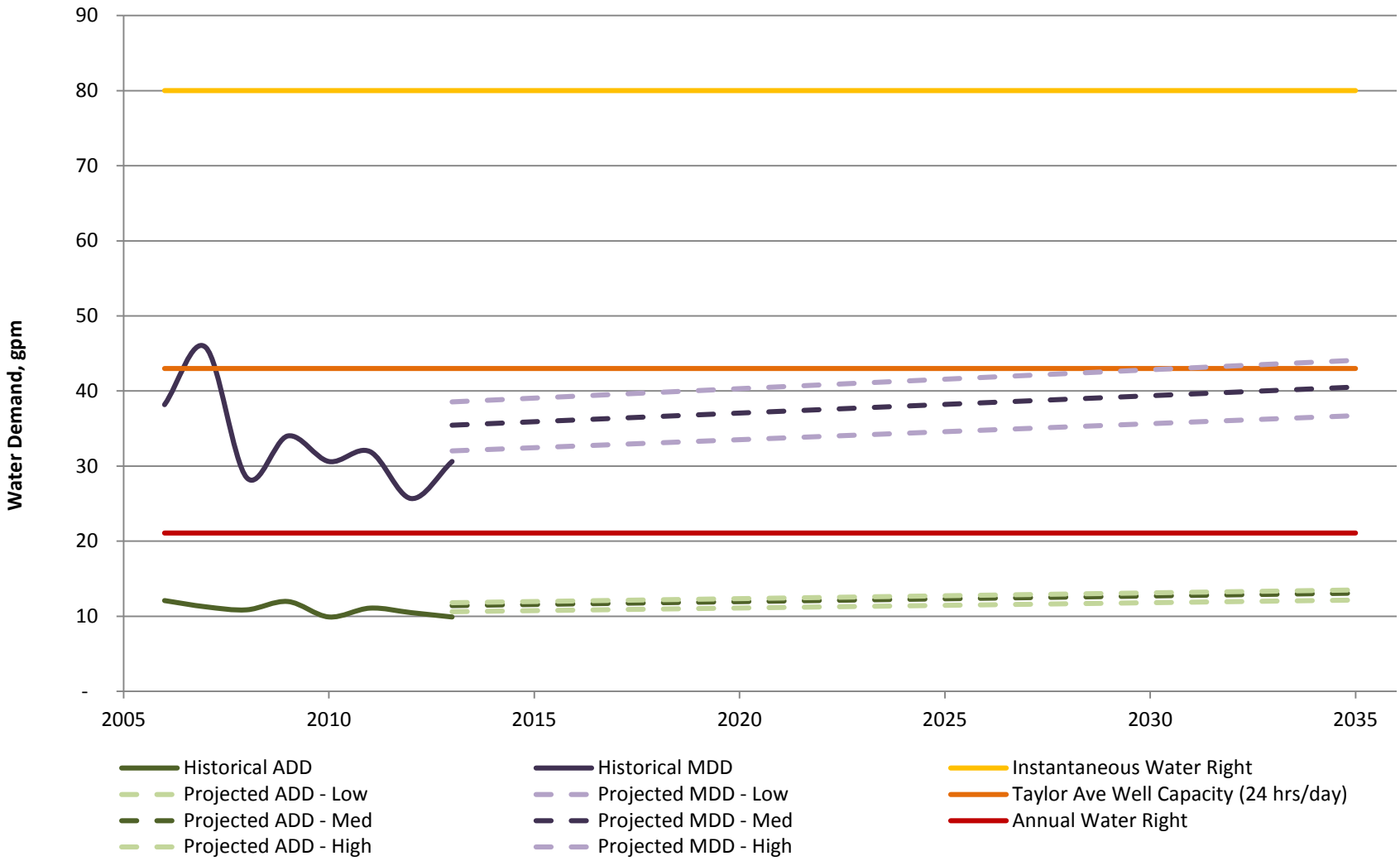
The City is well aware that the supply for the Rockaway Beach Water System, which consists solely of the Taylor Avenue Well, is not as large or reliable as it needs to be to meet the City's supply goals. As shown in Figure 5.3, 2007 MDD exceeded the Taylor Avenue Well pumping capacity. Although MDD has been significantly lower in recent years, MDD is projected to approach the Taylor Avenue Well capacity by 2035. Figure 5.3 also compares ADD and MDD to annual and instantaneous withdrawal water rights. Rockaway Beach water rights are sufficient to supply ADD and MDD. However, as explained in detail below, the well pumping capacity and water rights are not sufficient to comply with the City's supply reliability criteria.

The same supply and pumping criteria that were used to evaluate the Winslow Water System were used to evaluate the Rockaway Beach Water System except that Criterion 4 does not apply to Rockaway Beach because no booster pumps exist in this system.

As shown in Table 5.8, the Taylor Avenue Well is able to satisfy Criterion 1 by supplying MDD within a 24-hour period. The Taylor Avenue Well has a mobile emergency generator receptacle, making it a reliable source.

Because the Taylor Avenue Well is the only source for the Rockaway Beach Water System, the firm capacity of the system is zero. As such, Criterion 2, the capability to supply ADD with firm supply, cannot be met.

Criterion 3 is also not met. The capacity of the Taylor Avenue Well is insufficient to supply MDD while replenishing fire storage within 72 hours. Even the Rockaway Beach instantaneous withdrawal water right of 80 gpm is insufficient to supply the required 82 gpm for MDD and fire storage flow by 2035.



ROCKAWAY BEACH SUPPLY CAPACITY VS. PROJECTED DEMAND

FIGURE 5.3

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

Table 5.8 Rockaway Beach Supply and Pumping Analysis Water System Plan City of Bainbridge Island			
	2021	**2025**	**2035**
Supply			
Water Right Instantaneous Withdrawal (gpm)	80	80	80
Criterion 1 - Reliable Source Capacity (gpm)	43	43	43
Criterion 2 - Firm Source Capacity (gpm)	0	0	0
Criterion 3 - Total Source Capacity (gpm)	43	43	43
Demand Requirements			
Criterion 1 - MDD (gpm)	37	38	41
Criterion 2 - ADD (gpm)	12	12	13
Criterion 3			
Fire Storage Volume (gal)	180,000	180,000	180,000
Fire Storage (FS) Replenishment Flow (gpm)	42	42	42
MDD + FS Flow (gpm)	79	80	82
Surplus/ (Deficit) (gpm)			
Criterion 1	6	5	2
Criterion 2	(12)	(12)	(12)
Criterion 3	(36)	(37)	(39)

5.2.2.3 Summary and Recommendations

Rockaway Beach does not comply with the City's supply reliability criteria. The City could rehab the Taylor Avenue Well to improve supply, however, even if the Taylor Avenue Well could produce its full instantaneous water right, it would not be enough to satisfy Criterion 3. In order to improve the reliability of Rockaway Beach supply and meet all of the City's supply criteria, the City has the following four options:

- Acquire an adjacent utility with excess water supply.
- Construct an intertie and buy water from an adjacent utility.
- Drill a new 80-gpm well to utilize the full Taylor Avenue water right.
- Acquire an additional well and water rights.
- Construct a transmission main that connects Rockaway Beach to the Winslow Water System.

The City is performing a Rockaway Beach supply alternatives feasibility study and is actively pursuing alternative to secure a more productive and reliable supply source for Rockaway Beach in the short-term planning period.

5.3 WATER RESOURCE MANAGEMENT

5.3.1 Winslow Water Resource Management Plan

In 2005 Robinson Noble & Saltbush, Inc. reviewed in detail the City's water sources for the Winslow and Rockaway Beach water systems and prepared a Water Resource Management Plan. This plan, which is included in Appendix G, recommended operational changes and capital projects to improve the capacity and reliability of the City's water sources.

Major recommendations that have been implemented by the City include well redevelopment and well pump replacements of eight of the Head of the Bay, Sands, and Fletcher Bay wells. The Head of the Bay well site has been totally upgraded with new booster pumps, controls, meter, valves, and telemetry. In addition, investigation of the Wyckoff Well as a replacement for the Taylor Avenue Well is underway.

Additional recommendations made in the 2005 Water Resource Management Plan that the City may consider implementing in the future are summarized below.

Well Operation Recommendations:

- Shift winter production from the Sands Avenue and Fletcher Bay well to the Head of the Bay and Commodore wells.

Water Rights Recommendations:

- Consider drilling a new 800-gpm well that is fed from the Fletcher Bay Aquifer.
- Explore partnering with KPUD to develop a new point of withdrawal from the Fletcher Bay Aquifer.

Water Rights Recommendations:

- Obtain wellfield designation from the Department of Ecology for the Head of the Bay and Sands well sites.
- Change water right points of withdrawal from Commodore Well 1, Wing Point wells, and Head of the Bay surface water to another site.

Conservation Recommendations:

- Develop a water budget numerical model and water purveyor coalition.
- Locate additional stormwater retention and infiltration facilities in known recharge areas.
- Consider aquifer storage and recovery (ASR).

5.3.2 Wellhead Protection Program

The City's 2003 Wellhead Protection Plan is in place to protect the City's groundwater resources. It meets the requirements of the federal Safe Drinking Water Act and conforms

to the wellhead protection measures directed by Washington State Department of Health (DOH). The plan is included in Appendix I.

Robinson & Noble, Inc. conducted hydrogeologic assessments for each City well to delineate wellhead protection areas (WHPA). Of the City's 12 wells, only Commodore 2 is above sea level. The other 11 wells are protected from potential surface sources of contamination by several confining layers of low permeability silts, clays, and glacial till (hardpan).

General potential groundwater contamination concerns include:

- Discharge onto the ground surface
- Direct discharge to the subsurface
- Abandoned wells
- Stormwater runoff

The contaminant inventory process identified a total of 122 sites of known or suspected potential contaminants. These were ranked according to four factors: proximity of the potential hazard to the WHPA, type of contamination, straight-line distance from the potential hazard to the nearest production well, and type of contaminated media. The principle known contaminant sources identified in the plan are listed in Table 5.9.

Table 5.9 Principle Known Contaminate Sites on Bainbridge Island Water System Plan City of Bainbridge Island

Name	Contaminate Reference List
Pacific Sound Resources	Superfund Site
Bainbridge Island High School	Leaking Underground Storage Tanks
Jiffy Mart	Leaking Underground Storage Tanks
Village Services, Inc	Leaking Underground Storage Tanks
KC Fire protection District 2	Leaking Underground Storage Tanks
Kitsap Transit Station	Leaking Underground Storage Tanks
Bainbridge Island Landfill	Confirmed or Suspected Contamination Source List
Pacific Coast Hemphill	Confirmed or Suspected Contamination Source List

5.4 WATER USE EFFICIENCY PROGRAM

5.4.1 Water Conservation Achievements

5.4.1.1 Past Water Conservation Goals

Prior to development of this water system plan, the City's most recent water conservation plan for the Winslow Water System was issued in 2004. The conservation goals of that plan were to:

- Educate customers about basic water supply principles,
- Encourage water conservation,
- Increase customers' understanding of water use habits,
- Attain maximum utilization of current water supplies,
- Reduce peak daily, peak monthly, and total annual water consumption,
- Reduce lost and unaccounted for water to below 10 percent, and
- Improve efficiency of water use prior to developing new supplies.

Quantitatively, the City's objective was to realize one percent annual savings due to water conservation. The City has far exceeded this goal. In 2004 the Winslow equivalent residential unit (ERU) consumption value was 205 gpd/ERU, not including unaccounted for water. A one percent annual reduction amounted to reducing the value to 166 gpd/ERU by 2024. The goal was met in 2007 and since 2010 the Winslow ERU value has been below 146 gpd/ERU.

5.4.1.2 Past Distribution System Leakage

Municipal water suppliers must meet a 10 percent or less distribution system leakage (DSL) to comply with the water use efficiency (WUE) standard. Leakage is to be presented both as a percentage and as leakage volume, and based on a rolling three-year average. Table 5.10 presents Winslow DSL data for the period 2006 to 2013. Annual DSL is calculated in both volume and percentage. DSL has averaged 4.7 percent for Winslow and is on a downward trend.

Table 5.11 presents Rockaway Beach DSL data for the period 2006 to 2013. DSL has averaged 8.6 percent over this period and is on a downward trend for Rockaway Beach as well.

Records for both Winslow and Rockaway Beach show unusually high DSL in 2012 and low DSL in 2013. This is due to a change in the timing of data collection. Although the 2012 and 2013 DSL volumes and percentages may not be completely accurate, the rolling 3-year averages for 2013 correctly represent DSL over that 3-year period.

Table 5.10	Winslow Distribution System Leakage Water System Plan City of Bainbridge Island		
Year	**DSL Volume (MG)**	**DSL Percentage**	**Rolling 3-Year Average**
2006	15.9	6.6	
2007	15.6	6.7	
2008	15.1	6.7	6.7
2009	11.7	5.0	6.1
2010	7.0	3.3	5.0
2011	7.5	3.5	3.9
2012	16.7	7.5	4.7
2013	-3.7	-1.7	3.3

Table 5.11	Rockaway Beach Distribution System Leakage Water System Plan City of Bainbridge Island		
Year	**DSL Volume (MG)**	**DSL Percentage**	**Rolling 3-Year Average**
2006	0.50	7.9	
2007	0.66	11.2	
2008	0.61	10.7	9.8
2009	0.51	8.1	9.9
2010	0.69	7.5	8.8
2011	0.49	8.4	8.0
2012	0.52	9.4	8.4
2013	0.29	5.6	7.9

5.4.2 Current Water Use Efficiency Program

5.4.2.1 Water Use Efficiency Goals

For the Winslow Water System, the City's WUE goals for the planning period are:

- To maintain DSL levels under 4.7 percent, which is the historical average between 2006 and 2013, and
- To reduce the water system's ERU value by one percent annually until reaching a value of 135 gpd/ERU.

The City's WUE goals for the Rockaway Beach Water System are:

- To maintain DSL levels under 7.8 percent, which is the 25th percentile value between 2006 and 20123, and
- To achieve one percent annual reduction in the system's ERU value.

These WUE goals are represented by the low demand projection scenarios for Winslow and Rockaway Beach presented Chapter 3.

5.4.2.2 Water Use Efficiency Measures

The City implements various water use efficiency measure consisting of public education, technical assistance, system measures, incentives, and other measures. Details about the City's water use efficiency measures can be found in the City's updated Water Conservation Plan in Appendix J.

5.4.2.3 Projected Water Savings

If the City's WUE goals are met, the Winslow and Rockaway Beach water systems will realize significant water savings. The high demand projection scenarios for Winslow and Rockaway Beach, as presented in Chapter 3, represent forecasted water demands if no conservation measures are taken by the City. Therefore, the predicted water savings as a result of implementing conservation measures can be calculated as the difference between the high demand projection scenarios and the low demand projection scenarios presented in Chapter 3. The annual water savings by 2035 for Winslow is 39 MG. The annual water savings for Rockaway Beach by 2035 is 0.7 MG. This amounts to about 8.2 percent and 10.1 percent annual water savings in Winslow and Rockaway Beach, respectively.

5.5 WATER RECLAMATION OPPORTUNITIES

This section describes water reclamation opportunities for the City to consider implementing in the future. The City's wastewater treatment plant currently does not treat its effluent to water reuse standards.

There are three main types of potential water reuse for the City:

- Irrigation,
- Groundwater recharge, and
- Stream augmentation.

5.5.1 Irrigation

Reclaimed water can be used to irrigate parks, golf courses, and agricultural fields. The most promising potential reclaimed water users for irrigation within Winslow are the Wing Point Golf and Country Club, irrigated parks, and school grounds. Open access landscape irrigation areas must be served Class A reclaimed water. The potential reclaimed water use customers within the vicinity of the Winslow Wastewater Treatment Plant are shown on

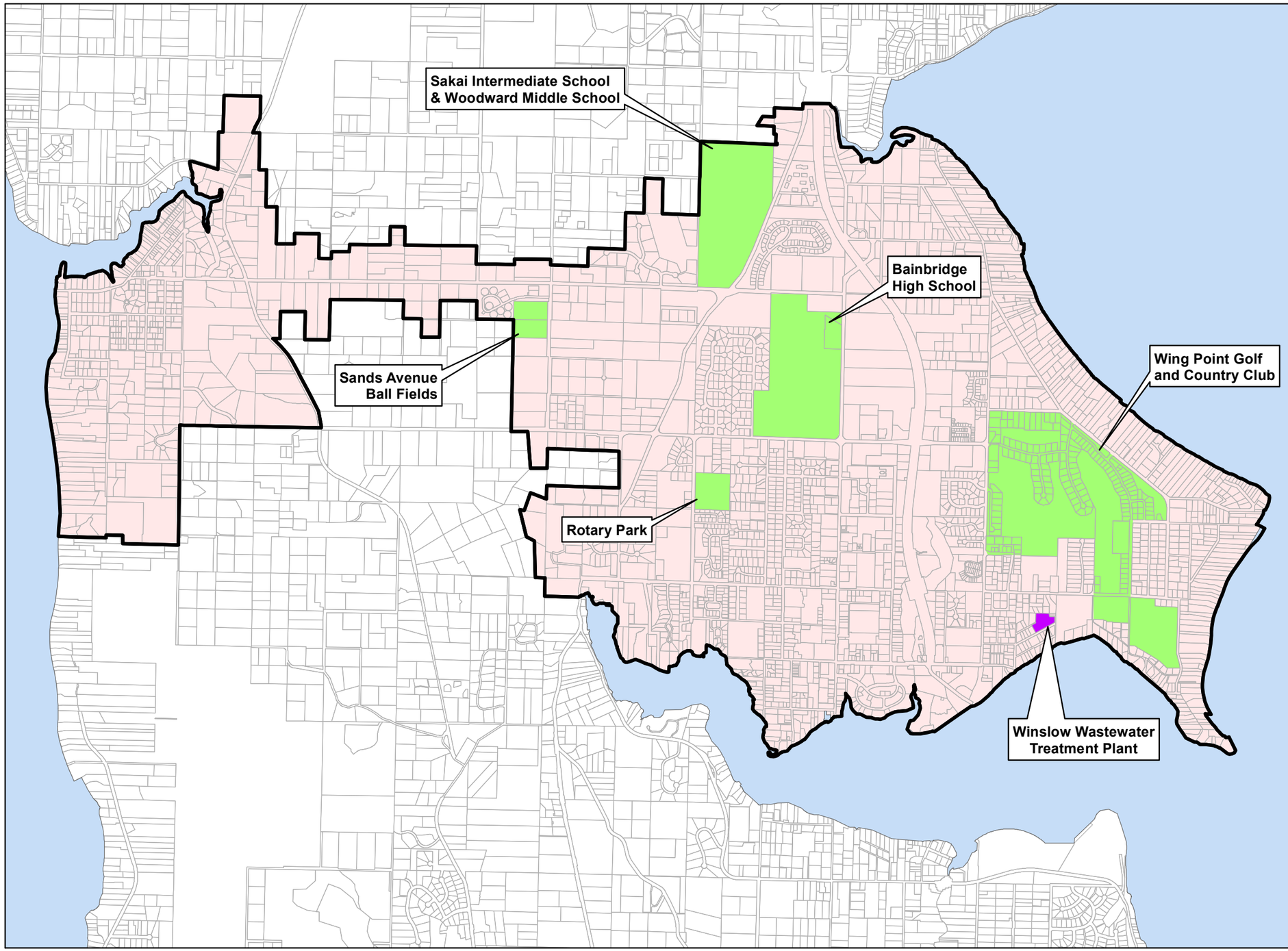
Figure 5.4. Not many parks within the City are currently irrigated, resulting in few reclaimed water use opportunities for the City.

5.5.2 Groundwater Recharge

The City considered groundwater recharge during its most recent wastewater treatment plant upgrade planning process. The analysis at that time indicated that without substantial upgrades in technology, the City's treatment plant could not provide adequate nitrogen removal to meet groundwater standards throughout the colder parts of the year. Additional treatment for nutrient removal such as installing membrane bioreactors, were considered too expensive to be cost effective to provide any benefit to the City from groundwater recharge.

5.5.3 Streamflow Augmentation

Based on the 2012 Washington State Department of Ecology's Water Quality Assessment 303(d) list for non-pollutant impaired streams, there are no streams in the vicinity of the Winslow or Rockaway Beach water systems that could potentially benefit from streamflow augmentation. Consequently, no incentive exists to implement a streamflow augmentation program.



Legend

- Winslow RWSA Boundary
- Water Body
- Parcels
- Potential Reclaimed Water Users
- Wastewater Treatment Plant

N

0 625 1,250 2,500 Feet

Figure 5.4
Potential Reclaimed Water Customers
Water System Plan
City of Bainbridge Island

carollo
Engineers...Working Wonders With Water®

SYSTEM ANALYSIS

6.1 INTRODUCTION

The Winslow Water System (Winslow) and Rockaway Beach Water System (Rockaway Beach) were evaluated for their ability to meet the City's reliability criteria under future conditions. The medium demand projection scenario was used for these evaluations. Each water system was evaluated for the capacity of its storage facilities. In addition, the Winslow distribution system was evaluated for capacity deficiencies using the City's updated hydraulic model. Supply and pumping analyses were also performed for the system. These results are presented in Chapter 5.

This chapter discusses recommendations to eliminate each of the deficiencies identified as part of the system analysis. These recommendations form the basis of the City's capital improvement program outlined in Chapter 9. Many pipeline upsize and new pipe installation projects are recommended to ensure required fire flows are available to all hydrants in Winslow. Rezoning parts of the High Pressure Zone to a higher 405-HGL zone is recommended to resolve Winslow storage, pressure, and fire flow deficiencies. Additional operational changes are also recommended for Winslow.

Rockaway Beach requires additional storage capacity.

6.2 STORAGE ANALYSIS

The City's storage requirements are a function of the City's booster pump operation, water demands, supply capacity, and fire flow requirements. The following sections summarize the available storage of the Winslow and Rockaway Beach water systems, describe the required storage components, and present recommendations to address identified storage deficits.

6.2.1 Storage Components and Governing Criteria

Following the Washington State Department of Health (DOH) storage volume requirements (WAC 246-290-235(3)) and the Water System Design Manual, Chapter 9, the five components of storage listed below and illustrated in Figure 6.1 must be considered for any water system:

1. Operational storage.
2. Equalizing storage.
3. Standby storage.
4. Fire Suppression storage.
5. Dead storage.

Operational and equalizing storage must be available to all customers at a residual pressure of at least 30 pounds per square inch (psi) under peak hour demand (PHD) flow conditions. Standby and fire suppression storage must be available to all customers at a residual pressure of at least 20 psi under maximum day demand (MDD).

Figure 6.1 shows the components of storage required by DOH as well as the hydraulic grade lines (HGL) in a tank that represent the minimum water surface elevations that can supply water at 20 psi or 30 psi to all customers. All tank volumes above the HGL are available storage. Thus there are two blocks of available storage: the volume of storage available to all customers with a pressure of at least 20 psi, and the volume of storage available to all customers at a pressure of at least 30 psi. Dead storage is the volume in the tank that cannot be used to serve the highest customer in the water system with a pressure of at least 20 psi.

6.2.1.1 Operational Storage

Operational storage is the band of storage within each reservoir that is utilized during periods of average demand. It is typically estimated based on the amount each reservoir drops prior to calling on the supply sources, and is measured as the volume of water stored between the pump call-off and pump call-on levels.

6.2.1.2 Equalizing Storage

Equalizing storage is the volume needed to satisfy PHD. It must be available at 30 psi to all service connections. The City's minimum requirements for equalizing storage follow DOH requirements.

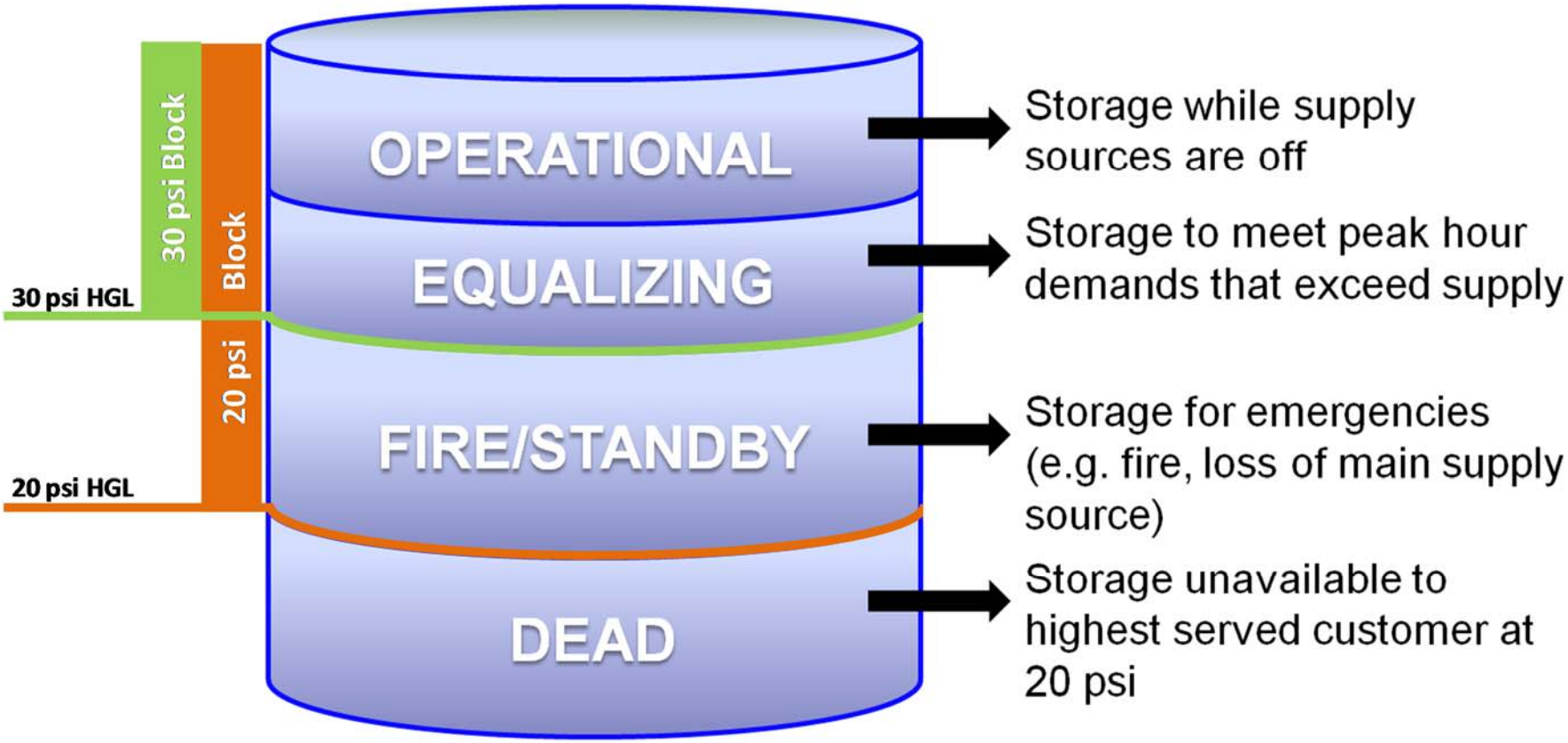
Equalizing storage volume requirements can be calculated using the following equation from the DOH Water System Design Manual:

$$ES = (PHD - Qs)*150 \text{ minutes, but in no case less than zero}$$

Where: ES = Equalizing Storage component, in gallons

PHD = Peak hourly demand, in gpm

Qs = Sum of all installed and active source of supply capacities, except emergency sources of supply, in gpm



STORAGE COMPONENTS

FIGURE 6.1

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

For the storage analysis, PHD is calculated using the following equation from the DOH Water System Design Manual:

$$PHD = (MDD / 1440)(C*N + F) + 18$$

Where: MDD = Maximum Day Demand, gpd/ERU

C = Coefficient Associated with Ranges of ERUs

N = Number of ERUs

F = Factor Associated with Ranges of ERUs

Table 6.1 identifies the appropriate coefficients and factors for use with the above equation.

Table 6.1 Coefficients and Factors for PHD Equation
Water System Plan
City of Bainbridge Island

Number of ERUs (*N*)	*C*	*F*
15-50	3.0	0
51-100	2.5	25
101-250	2.0	75
251-500	1.8	125
> 500	1.6	225

6.2.1.3 Fire Suppression Storage

Storage for emergencies is comprised of fire suppression storage and standby storage. For the City water system, these two components of storage are nested, which means that the volume of storage reserved for emergencies consists of whichever requirement is greater, fire suppression storage or standby storage.

Fire suppression storage is the volume of storage required to deliver fire flows as prescribed by local fire protection authorities, while maintaining a minimum pressure of 20 psi throughout the entire water system. Since a fire can occur at any time during the day, the fire suppression storage must be in addition to the equalizing and operational storage.

The maximum fire flow required for Winslow is 3,000 gpm for a duration of 180 minutes (3 hours) at the high school. This results in a fire suppression storage requirement of 0.54 million gallons (MG). Rockaway Beach serves only single-family homes. The highest required fire flow is 1,500 gpm for 120 minutes (2 hours), which corresponds to a fire suppression storage volume of 0.18 MG. This fire flow requirement was set by the fire department as it is higher than that required for the typical single-family home.

6.2.1.4 Standby Storage

Standby storage is the volume of storage required to supply reasonable system demands during a system emergency, such as disruption of the water supply. Disruptions could be caused by transmission pipeline or equipment failure, power outage, valve failure, or other system interruptions. The computation of emergency/standby storage requirements includes consideration of reasonable system disruptions that can be expected to occur within normal planning contingencies, and does not consider major system emergencies, such as earthquakes that result in shutdown of water supplies and multiple distribution system breaks. These types of emergencies should be covered under emergency system operation planning.

The City's standby storage policy is that the water system should have enough standby storage to supply average day demand (ADD) for two days with the largest well site off-line. For Winslow, the largest well site is Sands. Rockaway Beach only has the Taylor Avenue Well, and therefore no firm capacity. The following equation is used to calculate required standby storage volumes.

$$SS = 2 \text{ days} * (ADD - Q_F)$$

Where: SS = Standby storage volume, in gallons

ADD = Average day demand, in gpd

Q_F = Sum of all supply capacities to the water system, with the largest well site out of service, in gpd

6.2.2 Winslow Storage Analysis

6.2.2.1 Available Storage

Winslow has two storage tanks in service. Both are located near the high school. The tanks have a total storage capacity of 2.47 MG. However, the available storage excluding dead storage is significantly less. The available storage in each operating area is controlled by the elevation of the highest customer in the system and the HGL required to serve that customer with a pressure of at least 20 psi in the case of a fire or other emergency, or 30 psi under normal conditions. Table 6.2 shows the highest service elevation and the amount of available storage meeting the 30 psi and 20 psi requirements.

Table 6.2 Available Storage - Winslow Water System Plan City of Bainbridge Island			
Facility	**High School Reservoir 1**	**High School Reservoir 2**	**Total**
Storage Capacity (gal)	1,000,000	1,470,000	2,470,000
High Service Elevation (ft)	260	260	
Existing Storage Above 30 psi HGL (gal)	33,457	45,257	78,714
Existing Storage Above 20 psi HGL (gal)	319,703	432,452	752,154
Percent of Storage Above 30 psi HGL	3□	3□	3□
Percent of Storage Above 20 psi HGL	32□	29□	30□

Due to high elevation customers along New Brooklyn Road that have been added to the system since the last water system plan update, the percent of storage that is considered available is very low. Only three percent of Winslow storage can serve the highest customer at a pressure of 30 psi; only 30 percent of the storage is above the 20 psi HGL. Therefore, 70 percent of the system's storage is considered dead storage and cannot be counted toward meeting the system's storage requirements.

6.2.2.2 Required Storage

Operational storage volumes for each high school reservoir are shown in Table 6.3. The City uses approximately ten percent of each tank's total storage for operational storage, which is typical for many water utilities.

Table 6.3 Operational Storage - Winslow Water System Plan City of Bainbridge Island			
Facility	**High School Reservoir 1**	**High School Reservoir 2**	**Total**
Geometry	Cylinder	Cylinder	
Storage Capacity (gal)	1,000,000	1,470,000	2,470,000
Operating Band Min (ft)	71.5	71.5	
Operating Band Max (ft)	79.5	79.5	
Operating Volume (gal)	99,133	134,094	233,226
Percent of Total Storage	10□	9□	9□

The storage volumes required by Winslow for each storage component are summarized in Table 6.4 for the planning years 2021, 2025, and 2035. Because the firm capacity of the Winslow wells exceeds ADD, no standby storage is required.

Under total required storage in Table 6.4, volumes are listed for both the 30 psi and 20 psi requirements. The volume required above the 30 psi HGL is the sum of operational and equalizing storage. The volume required above the 20 psi HGL is the sum of operational storage, equalizing storage, and the greater of fire suppression or standby storage.

Table 6.4 Required Storage Components - Winslow
Water System Plan
City of Bainbridge Island

Planning Year	**2021**	**2025**	**2035**
Operational Storage (MG)	0.23	0.23	0.23
Equalizing Storage (MG)	0.13	0.14	0.18
Fire Suppression Storage (MG)	0.54	0.54	0.54
Standby Storage (MG)	0.00	0.00	0.00
Total Required Storage (MG)			
Above 30 psi HGL(1)	0.36	0.38	0.41
Above 20 psi HGL(2)	0.90	0.92	0.95

Notes:
(1) Sum of operational and equalizing storage.
(2) Sum of operational, equalizing, and the greater of fire suppression or standby storage.

6.2.2.3 Available versus Required Storage Comparison

Comparing available storage to required storage shows that by year 2021 Winslow has a storage deficit of 0.28 MG. Table 6.5 compares available storage to required storage for the 30 and 20 psi HGLs and shows the total storage deficit in each planning year. The system has plenty of total storage, but due to the high elevation of some customers served, very little of that total storage is available.

Table 6.5 Storage Analysis - Winslow Water System Plan City of Bainbridge Island			
Planning Year	**2021**	**2025**	**2035**
Total Storage (MG)	**2.47**	**2.47**	**2.47**
Available Storage (MG)			
Above 30 psi HGL	0.08	0.08	0.08
Above 20 psi HGL	0.75	0.75	0.75
Required Storage (MG)			
Above 30 psi HGL	0.36	0.38	0.41
Above 20 psi HGL	0.90	0.92	0.95
Storage Surplus/(Deficit) (MG)			
Above 30 psi HGL	(0.28)	(0.30)	(0.33)
Above 20 psi HGL	(0.15)	(0.16)	(0.20)
Total Surplus/(Deficit) (MG)	**(0.28)**	**(0.30)**	**(0.33)**

6.2.2.4 Storage Recommendations

Rather than construct additional storage, the simplest way to eliminate the Winslow storage deficit is to free up additional available storage by removing the high elevation customers from the High Pressure Zone and creating a new pressure zone at a higher HGL of approximately 405 feet. The new 405 Pressure Zone would include customers around the high school as well as high elevation customers along New Brooklyn Road. Figure 6.2 shows the area recommended to be included in the new 405 Zone.

Table 6.6 shows how much storage would be available if the new 405 Pressure Zone were created.

Table 6.6 Winslow Storage Surplus After Rezone Water System Plan City of Bainbridge Island			
Planning Year	**2021**	**2025**	**2035**
Available Storage (MG)			
Total Storage (MG)	2.47	2.47	2.47
Highest Customer	237	237	237
Above 30 psi HGL	0.75	0.75	0.75
Above 20 psi HGL	1.42	1.42	1.42
Total Surplus (MG)	**0.52**	**0.51**	**0.47**

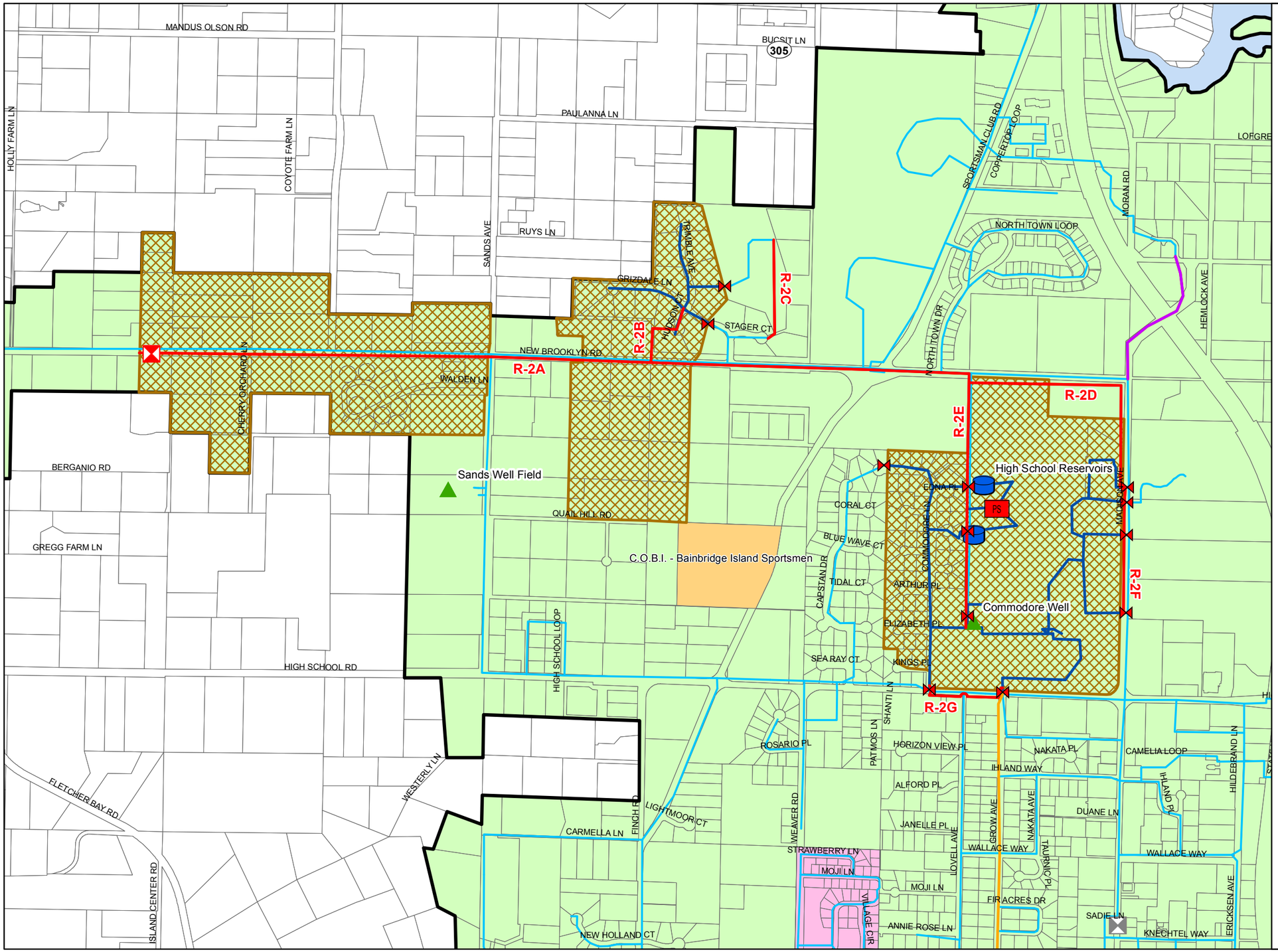


Figure 6.2
Proposed Rezone Project
Water System Plan
City of Bainbridge Island

6.2.3 Rockaway Beach Storage Analysis

6.2.3.1 Available Storage

Rockaway Beach has one storage tank; the Creosote tank has a total storage capacity of 132,000 gallons. The overflow elevation of the tank is 135 feet. With the highest Rockaway Beach customer at an elevation of 100 feet, the system technically has no available storage above the 20 psi HGL. The Creosote Tank cannot serve a customer at an elevation of 100 feet with a pressure of 20 psi. With no available storage, Rockaway Beach clearly faces a storage challenge.

6.2.3.2 Required Storage

The Winslow Water System storage criteria also apply to Rockaway Beach. See Section 6.2.1 for an explanation of how the required volume of each storage component is calculated. The required storage volumes for Rockaway Beach are listed in Table 6.7.

Table 6.7 Required Storage Components - Rockaway Beach
Water System Plan
City of Bainbridge Island

Planning Year	2021	2025	2035
Operational Storage (MG)	0.01	0.01	0.01
Equalizing Storage (MG)	0.01	0.01	0.01
Fire Suppression Storage (MG)	0.18	0.18	0.18
Standby Storage (MG)	0.03	0.04	0.04
Total Required Storage (MG)			
Above 30 psi HGL(1)	0.02	0.02	0.02
Above 20 psi HGL(2)	0.20	0.20	0.20

Notes:
(1) Sum of operational and equalizing storage.
(2) Sum of operational, equalizing, and the greater of fire suppression or standby storage.

6.2.3.3 Available versus Required Storage Comparison

The Rockaway Beach storage deficit is 0.2 MG for all of the planning years. The total volume of the Creosote Tank is 0.13 MG. Therefore, even if all of the volume within the tank were available, Rockaway Beach would still have a storage deficit. Fire suppression storage accounts for the largest required storage component at 0.18 MG and exceeds the size of the Creosote Tank. The storage analysis volumes for Rockaway Beach are listed in Table 6.8.

Table 6.8 Storage Analysis - Rockaway Beach Water System Plan City of Bainbridge Island			
Planning Year	**2021**	**2025**	**2035**
Total Storage (MG)	**0.13**	**0.13**	**0.13**
Available Storage (MG)			
Above 30 psi HGL	0	0	0
Above 20 psi HGL	0	0	0
Required Storage (MG)			
Above 30 psi HGL	0.02	0.02	0.02
Above 20 psi HGL	0.20	0.20	0.20
Storage Surplus/(Deficit) (MG)			
Above 30 psi HGL	(0.02)	(0.02)	(0.02)
Above 20 psi HGL	(0.20)	(0.20)	(0.20)
Total Surplus/(Deficit) (MG)	**(0.20)**	**(0.20)**	**(0.20)**

6.2.3.4 Storage Recommendations

Rockaway Beach requires additional storage of approximately 0.2 MG in the short term planning period. The City has three options:

1. Connect to the Winslow Water System.
2. Connect to an adjacent water system and lease storage capacity.
3. Construct a new storage tank at a higher elevation than the Creosote Tank.

6.3 WINSLOW DISTRIBUTION SYSTEM HYDRAULIC MODEL

The City's hydraulic model was the primary tool for evaluating the Winslow distribution system. The model evaluates how Winslow's water infrastructure handles future demands and verifies that recommended improvements will eliminate system deficiencies. The City does not have a hydraulic model for the Rockaway Beach Water System.

The City's current model was updated and calibrated as part of development of this Plan. The medium demand projection scenario was incorporated into the model for evaluating future conditions of the system in years 2021, 2025, and 2035.

6.3.1 Model Update - Data Collection and Validation

The Winslow hydraulic model was developed and calibrated as part of the City’s 2006 Water System Plan (WSP) Update. The City’s model uses Innovyze H2ONet hydraulic modeling software. This modeling platform is integrated with AutoCAD.

The City's hydraulic model represents the physical and operational characteristics of the water system, and performs calculations to simulate flows in pipes and pressures at nodes. The computer modeling process requires defining pipes, nodes, reservoirs, supply sources, booster pumps, and valves and allocating water demands to the demand nodes.

During development of this Plan, the model was reviewed and updated to match the City's latest Geographical Information System (GIS) infrastructure and distribution system information. The model was also updated with recent infrastructure projects completed since the last WSP update. Discrepancies between the hydraulic model and the latest GIS data provided by the City were resolved by City staff.

The model pipe network was enhanced to include additional important pipes that create loops in the system or pipes that are necessary for the calibration process. Most water mains with diameters equal to or less than 6-inches were not included; the hydraulic model in its updated form remains a skeletonized model.

Model operational setpoints were also confirmed including pressure reducing valve (PRV) settings, well settings, and pump curves.

The updated model contains 391 nodes and 514 pipes. In addition, there are 3 tanks, 5 well sources, and 8 booster pumps.

6.3.1.1 Demand Allocation

The model was also updated with the ADD and MDD of the medium demand projection scenario for planning years 2021, 2025, and 2035. Demands were allocated to each node in the model such that the total water system demand matched the demand projections.

Winslow water system demands were projected by customer class. Each customer class corresponds to a particular land use type. Single-family residential (SFR) demands correspond to low and medium density residential land use. Multi-family residential (MFR) customers correspond to high density residential land use. The commercial customer class corresponds to commercial land use and government customer demands were assigned to public land use. Irrigation customer class demands were allocated proportionally to all non-single family residential areas in the system, except open space. Open spaces were not allocated demands. Distribution system leakage and other authorized use demands were allocated uniformly across the system. Large consumer demands were assigned independently to specific locations to accurately capture the hydraulic impacts of these large demands.

Existing demand per acre factors for each land use type was calculated by dividing the customer class demand by the number of acres currently connected to the water system in the corresponding land use categories. Demands were then spatially distributed to the nodes in the model.

Each node represents the demands from nearby customers, which may include customers from multiple classes. The contributing area of each land use type to each model node on the parcel scale was calculated using GIS. Automated GIS tools initially assigned parcels to each model node. The results of the automated analyses were reviewed and some parcels were reassigned to better represent the source of water for the customers. Then node demand was calculated by multiplying the demand per acre factor by number of acres for each land use type contributing to the node.

Future demand per acre factors were calculated for the demand anticipated in addition to existing demand by 2021, 2025, and 2035. Future demands were allocated on top of existing demands to nodes with the following three types of contributing area:

- Parcels that are currently developed and are expected to connect to the water system in the future,
- Parcels that are currently undeveloped and expected to develop and connect to the water system within the planning period, and
- Connected parcels that are expected to redevelop within the planning period.

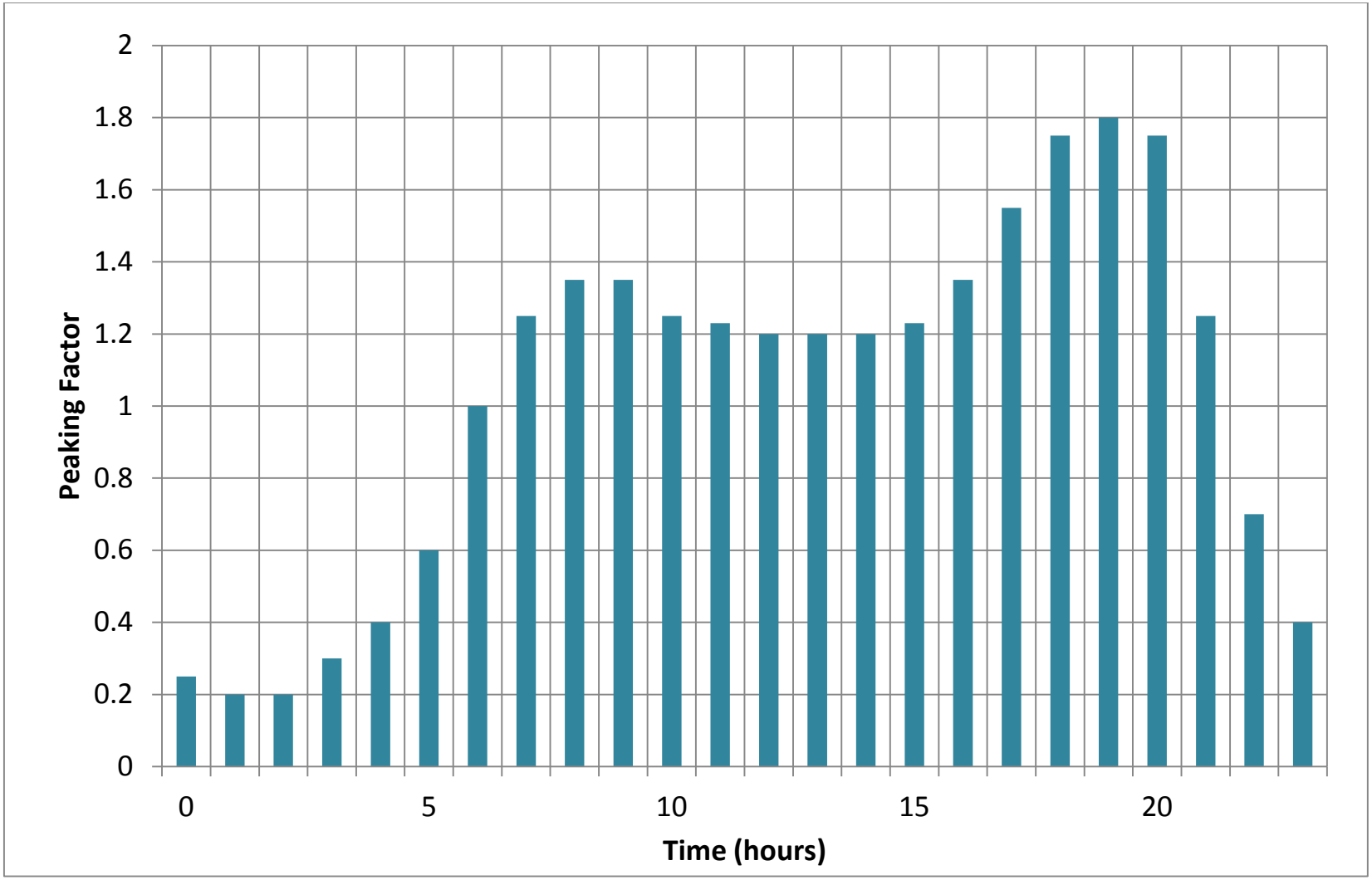
Demands of currently connected parcels that are not expected to redevelop within the planning period did not change for the future scenarios.

6.3.1.2 Diurnal Demand Pattern

Water usage in distribution systems is inherently unsteady due to continuously varying demands. In order for an extended period model simulation to accurately reflect dynamics of the real system, these demand fluctuations must be incorporated into the model. The City uses the AWWA diurnal curve, illustrated in Figure 6.3.

6.3.2 Hydraulic Model Calibration

The purpose of the water system hydraulic model is to estimate, or predict, how the Winslow Water System will respond under a given set of conditions. Calibration of the hydraulic model to measured field conditions is important to establish confidence that the model has sufficient accuracy to base important decisions on the model results. Carollo calibrated the Winslow Water System model against six field fire flow tests. The calibration process considered both the observed system pressures and how the pumps and reservoirs responded to fire flows.



AWWA DIURNAL CURVE

FIGURE 6.3

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

Model calibration is typically achieved by modifying pipeline roughness coefficients until model outputs match field conditions during fire flow tests. Other parameters may be adjusted as well. During average demand conditions, flows are low and the roughness of a pipe causes a relatively small impact on the pressures of a distribution system. However, as the flows increase during high demand days, velocities within pipelines increase and the roughness of a pipe contributes to more head loss and lower pressures. Fire flow tests are useful for assessing a pipelines roughness coefficient because they generate a high velocity in the pipe. The high velocity causes a significant drop in pressure, which can be used to estimate a pipeline's roughness coefficient.

During model calibration the roughness coefficients were adjusted within the acceptable range of 90 < C < 130 for a given pipe material and age and were kept constant across each pressure zone.

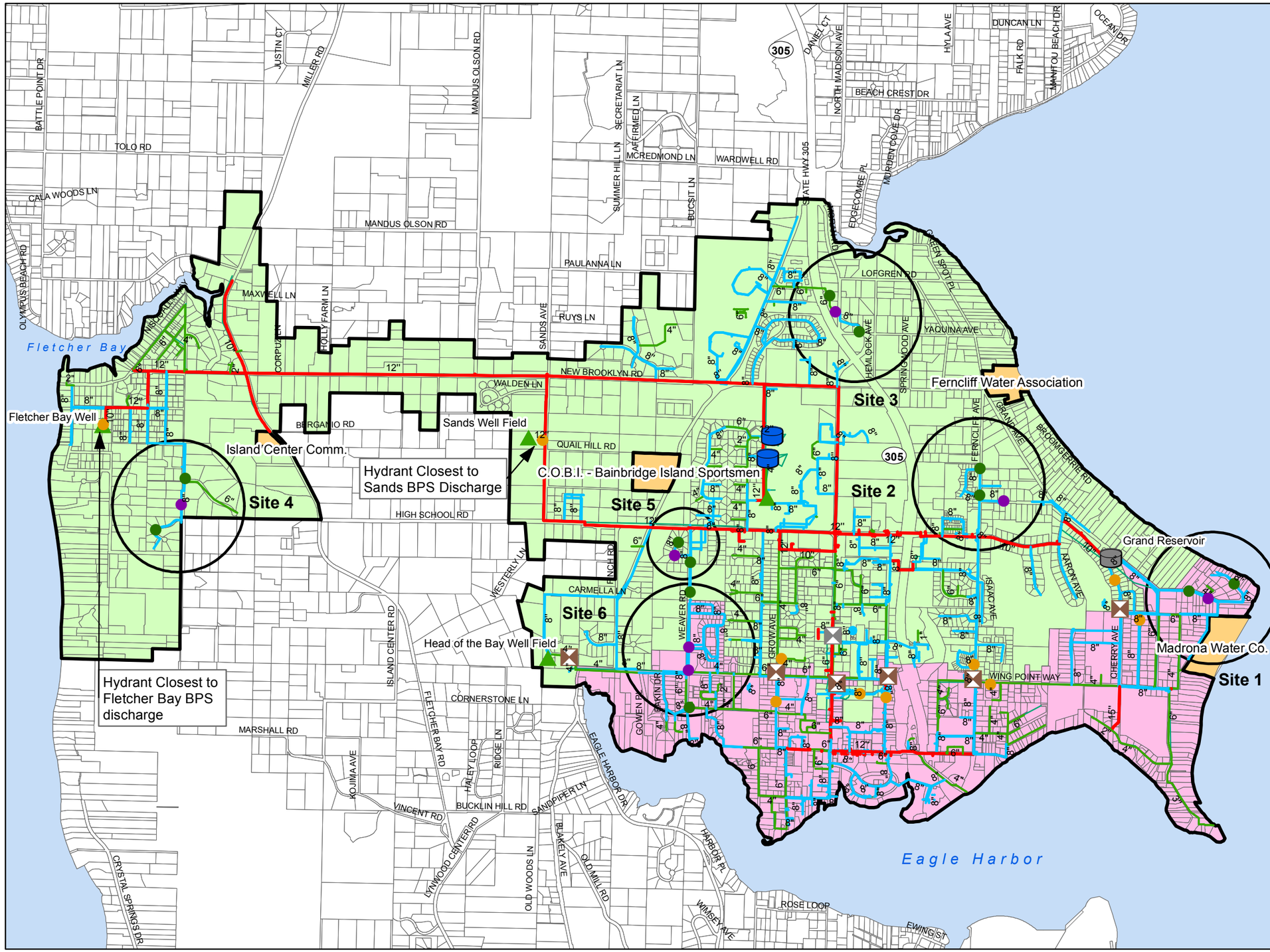
6.3.2.1 Fire Flow Field Testing

City staff conducted six fire flow tests on July 23, 2014 at sites spread throughout the City's Winslow distribution system. The fire flow test locations are shown in Figure 6.4. Each test consisted of one or two flowing hydrants and two pressure hydrants. Test site locations that provided a good representation of system performance throughout the water system were chosen. The fire flow field testing results are included in Appendix F.

6.3.2.2 Calibration Results

Hydraulic models are considered well calibrated if model pressures are within 10 psi or 10 percent of the field measured pressures. The calibration results, which are summarized in Table 6.9, show that there is good correlation between measured pressures and model predicted pressures for all of the fire flow tests, with the exception of the fire flow test at Site 3. Detailed model calibration results are included in Appendix F.

The hydraulic model was not able to match the field residual pressures at Site 3. However, static pressures in the model at both Site 3 pressure hydrants match the field results (within 2.2 psi). The residual pressures were recorded at hydrants along a 1,070-foot 6-inch dead-end pipe and significant headloss is observed in the model, which was not observed in the field. The headloss observed in the field seems low for this type of configuration. Adjusting pipe friction factors within plausible limits does not result in model pressure that match field recordings. The results suggest that the local pipe configuration at Site 3 in the model may not match field conditions.



Legend

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field

Water Pipelines by Diameter

- 6" and Smaller
- 8"
- 10" and Larger
- Winslow RWSA Boundary
- Water Body
- Other Water Purveyors
- Parcels

Pressure Zone

- Low
- High

Flow Test Hydrants

- Flow Hydrant
- Pressure Hydrant
- Pressure Logger

0 1,750 3,500 Feet

Figure 6.4
Fire Flow Calibration Test Sites
Water System Plan
City of Bainbridge Island

Table 6.9 Model Calibration Results Summary
Water System Plan Update
City of Bainbridge Island

Fire Test No.	Hydrant/BO ID	Pressure Zone	Field (Measured) Results			Model Simulated Results		Comparison			
			Hydrant Flow (gpm)	Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)	Difference (psi)		Difference (%)	
								Static	Residual	Static	Residual
Site 1	46-F2	Low	920								
	46-F3	Low		92	80	94	79	-1.9	0.9	-2.1□	1.1□
	46-F1	Low		36	-	40	26	-4.2	-1.0	-11.5□	NA
Site 2	37-F1	High	1,060								
	28-F1	High		66	56	66	55	0.3	1.4	0.4□	2.5□
	37-F2	High		70	60	72	62	-2.2	-2.2	-3.2□	-3.6□
Site 3	9F-1	High	1,060								
	8F-1	High		86	64	88	49	-2.2	15.3	-2.5□	23.8□
	9F-2	High		70	44	72	20	-2.2	23.9	-3.1□	54.3□
Site 4	30-F1	High	1,060								
	30-F2	High		86	70	82	68	4.2	1.6	4.8□	2.2□
	22-F7	High		45	28	43	24	2.3	3.6	5.2□	13.0□
Site 5	41-F1	High	1,330								
	34-F8	High		77	68	79	71	-1.6	-2.8	-2.0□	-4.1□
	41-F2	High		82	76	83	76	-0.7	0.5	-0.9□	0.7□
Site 6	48-F8	Low	1,000								
	48-F2	Low	800								
	41-F6	High		88	85	90	89	-2.5	-3.8	-2.8□	-4.5□
	55-F2	Low		78	54	83	58	-5.3	-3.5	-6.8□	-6.5□

6.3.3 Fire Flows

Fire flow demands were allocated in the hydraulic model based on land use. The City's fire flow requirements are:

- 1,000 gpm for one hour for SFR land use and
- 1,500 gpm for one hour for MFR and non-residential zoning.

City parks without structures and open spaces do not have fire flow requirements. Fire flow demands were only attributed to model nodes serving hydrants and are shown in Figure 6.5.

The City identified one high fire flow location for each pressure zone:

- 3,000 gpm for 3 hours located at the High School in the High Zone and
- 2,500 gpm for 2 hours located at the NE corner of Winslow Way and Madison Avenue in the Low Zone.

These higher fire flow requirement locations are also shown on Figure 6.5.

6.4 WINSLOW DISTRIBUTION SYSTEM ANALYSIS

The updated and calibrated model was used to evaluate the distribution system under future demand conditions. The Winslow distribution system was evaluated against four performance criteria. Areas not meeting the criteria are considered deficient and system improvements are identified to achieve the required level of service.

6.4.1 Evaluation Criteria

The evaluation criteria are from the City's policies and criteria presented in Chapter 2. These policies are at least as stringent as DOH Design Manual and WAC 246-290 requirements. The distribution system was evaluated for the following criteria:

1. **High ADD Pressure.** Maximum recommended pressure is 80 psi during ADD.
2. **Low PHD Pressure.** Minimum allowed pressure is 30 psi during PHD.
3. **High Velocity.** Maximum allowed velocity is 8 feet per second (ft/s) during PHD.
4. **Available Fire Flow.** During fire flow during MDD conditions, system pressures must remain above 20 psi.

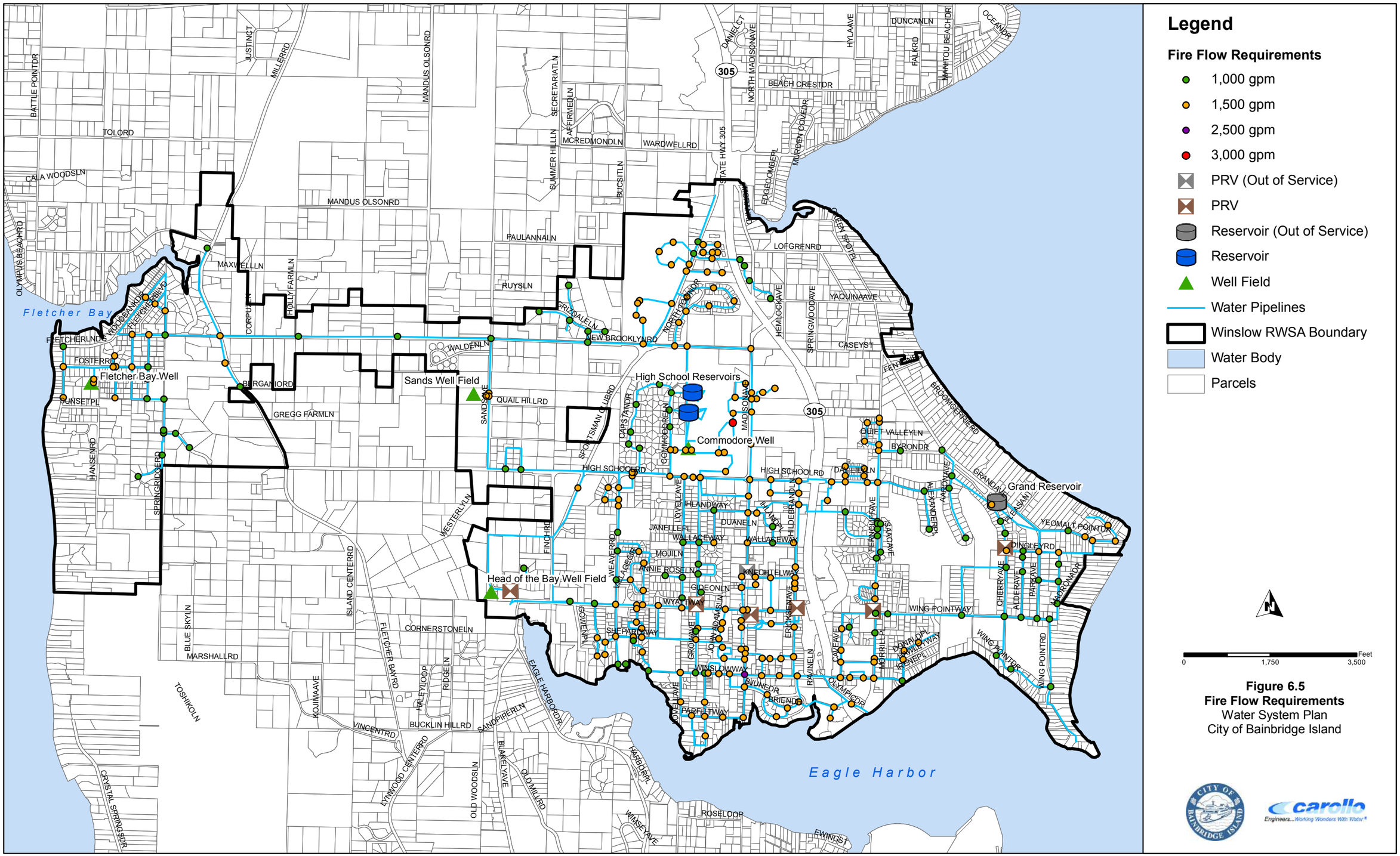


Figure 6.5
Fire Flow Requirements
Water System Plan
City of Bainbridge Island

6.4.2 Identified Deficiencies

6.4.2.1 High ADD Pressure

International plumbing code requires the installation of individual PRVs when the meter pressure exceeds 80 psi. Therefore, 80 psi is the recommended maximum pressure for water system design. The model was run in extended period simulation during ADD to identify the range of pressures typically experienced in the system. Figure 6.6 shows model nodes with pressures above 80 psi during 2021 ADD, which is the planning year where demands will be lowest and therefore pressures will be highest. Deficient nodes under both 2025 ADD and 2035 ADD are the same as those for 2021 ADD.

Areas of high pressure in the system are largely due to topography. Residences along the shoreline in the south and east part of Winslow, as well as customers along the shoreline in Fletcher Bay, experience high pressures.

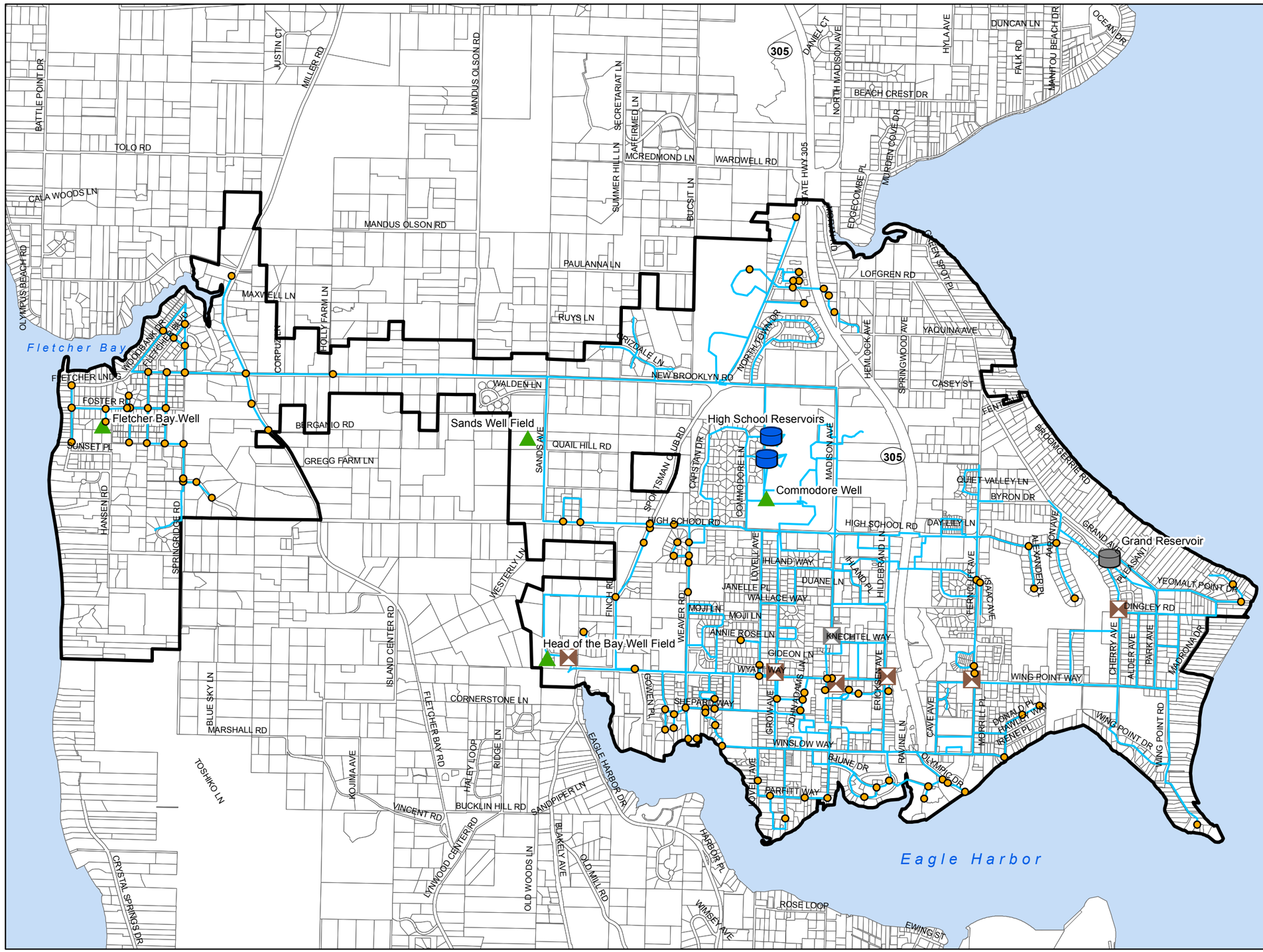
This criterion is a guideline rather than a requirement. The results are provided for the City's information. No improvements are recommended.

6.4.2.2 Low PHD Pressure

PHD conditions were simulated for each planning year to identify areas with operating pressures below 30 psi. Most of the areas of low pressure in the system are located in the highest parts of the system. Three locations did not meet the low pressure criteria of 30 psi starting in 2021:

- The area around the High School reservoirs between NE High School Road, Commodore Lane NW and Madison Avenue N,
- The area downstream of the PRV located at the intersection of Cherry Avenue NE and NE Dingley Road,
- The area along NE New Brooklyn Road east of Sands Avenue NE.

Low pressure nodes under 2025 and 2035 PHD scenarios are the same as those during 2021 PHD. Figure 6.7 illustrates the locations of the areas where pressures drop under 30 psi during PHD in 2035. This is the planning year of highest demand and therefore lowest pressure.



Legend

Nodes Exceeding Pressure Criteria During 2021 ADD

- Greater than 80 psi
- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Water Pipelines
- Winslow RWSA Boundary
- Water Body
- Parcels

0 1,750 3,500 Feet

Figure 6.6
High Pressure Nodes during 2021 ADD without Improvements
Water System Plan
City of Bainbridge Island

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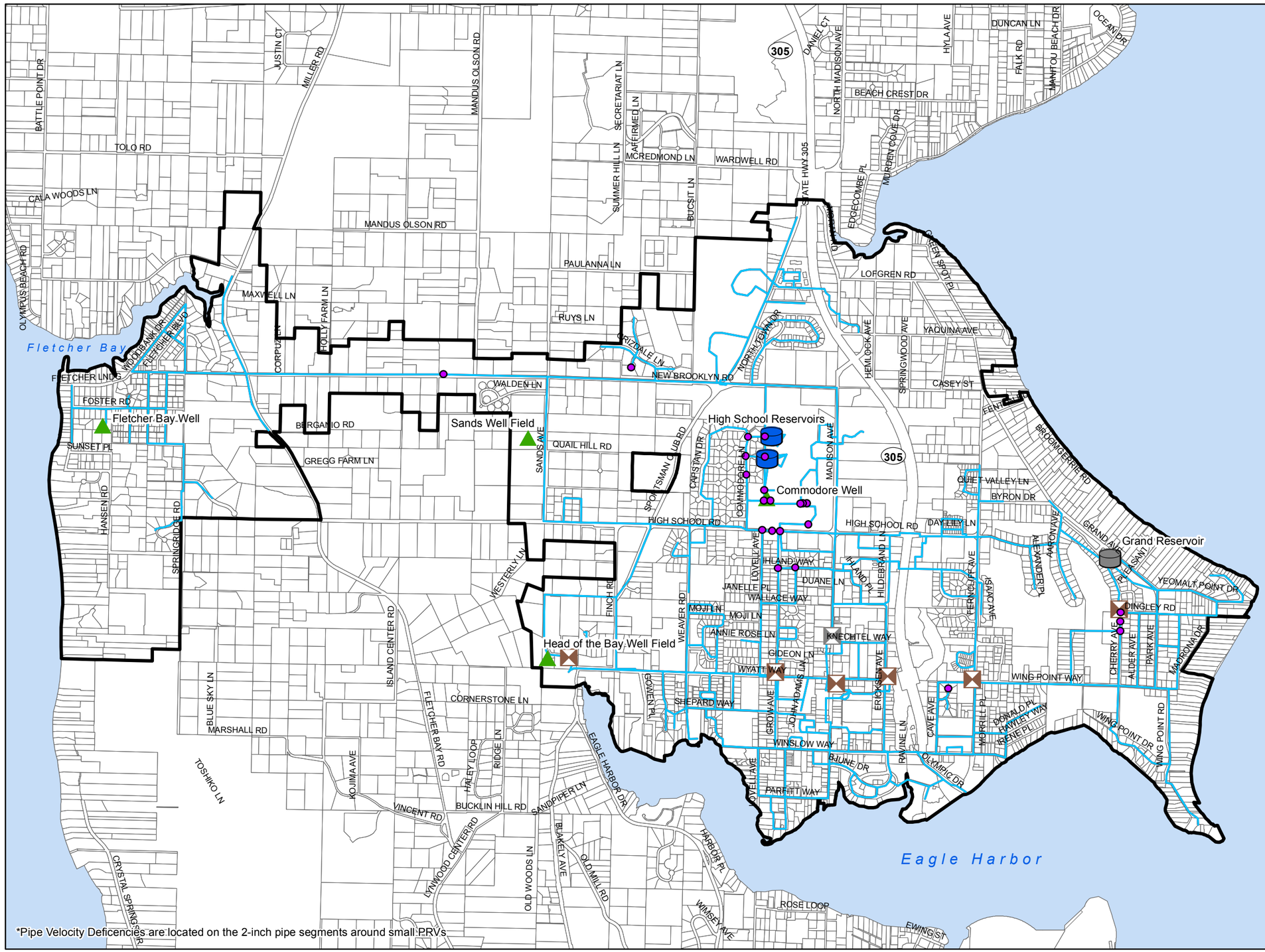


Legend

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Water Pipelines
- Winslow RWSA Boundary
- Water Body
- Parcels

Pressure and Velocity Criteria not Met

- Pressure Less than 30 psi
- Velocity Greater than 8 fps

0 1,750 3,500 Feet

Figure 6.7
Low Pressure Nodes during 2035 PHD without Improvements
Water System Plan
City of Bainbridge Island

6.4.2.3 High Velocity

The City's goal is to maintain velocities under 8 ft/s in distribution pipes during the PHD. No pipes were found to exceed the velocity criteria in any planning year. Therefore, no improvements are recommended.

6.4.2.4 Available Fire Flow

The City criterion requires fire flows to be met while supplying MDD and maintaining 20 psi throughout the distribution system. Fire flows are typically the largest flows a system experiences and often a major factor in pipe sizing and configurations. The hydraulic model was used to systematically simulate a fire at all model nodes representing fire hydrants for each of the planning years. For each of the planning years, deficient nodes that cannot provide required fire flows while maintaining system pressures above 20 psi are shown in Figure 6.8. Fire flow deficiencies by 2021 are shown in red. Fire flow deficiencies that are not expected to appear until 2025 and 2035 are shown in orange and yellow, respectively.

During the fire flow analysis, reservoirs are set at the 20 psi HGL, which is the bottom of the fire suppression storage component. This is often much lower than typical operating levels. Therefore, locations that may have sufficient pressure and flow during annual hydrant testing may be deficient with these lower reservoir levels.

Figure 6.9 shows the ratio of available fire flow to required fire flow, which is referred to as the fire flow ratio. The results are the same for each of the planning years. Locations with sufficient available fire flow (ratio > 1) are not shown on the map. The black dots represent a fire flow ratio between 0.75 and 1, purple dots represent a fire flow ratio between 0.5 and 0.75, orange dots represent a fire flow ratio between 0.5 and 0.25, and red dots represent a fire flow ratio less than 0.25.

6.4.3 Recommended Distribution System Capacity Improvements

Hydraulic analysis showed a number of improvements are required to deliver water that meets the City’s polices and criteria. Improvements include pipe upsizing, new pipe looping, operational setting changes, and adding a new pressure zone. The recommended improvements are shown in Figure 6.2 and Figure 6.10.

Each project requires further site-specific and project level engineering analysis at the time of implementation.

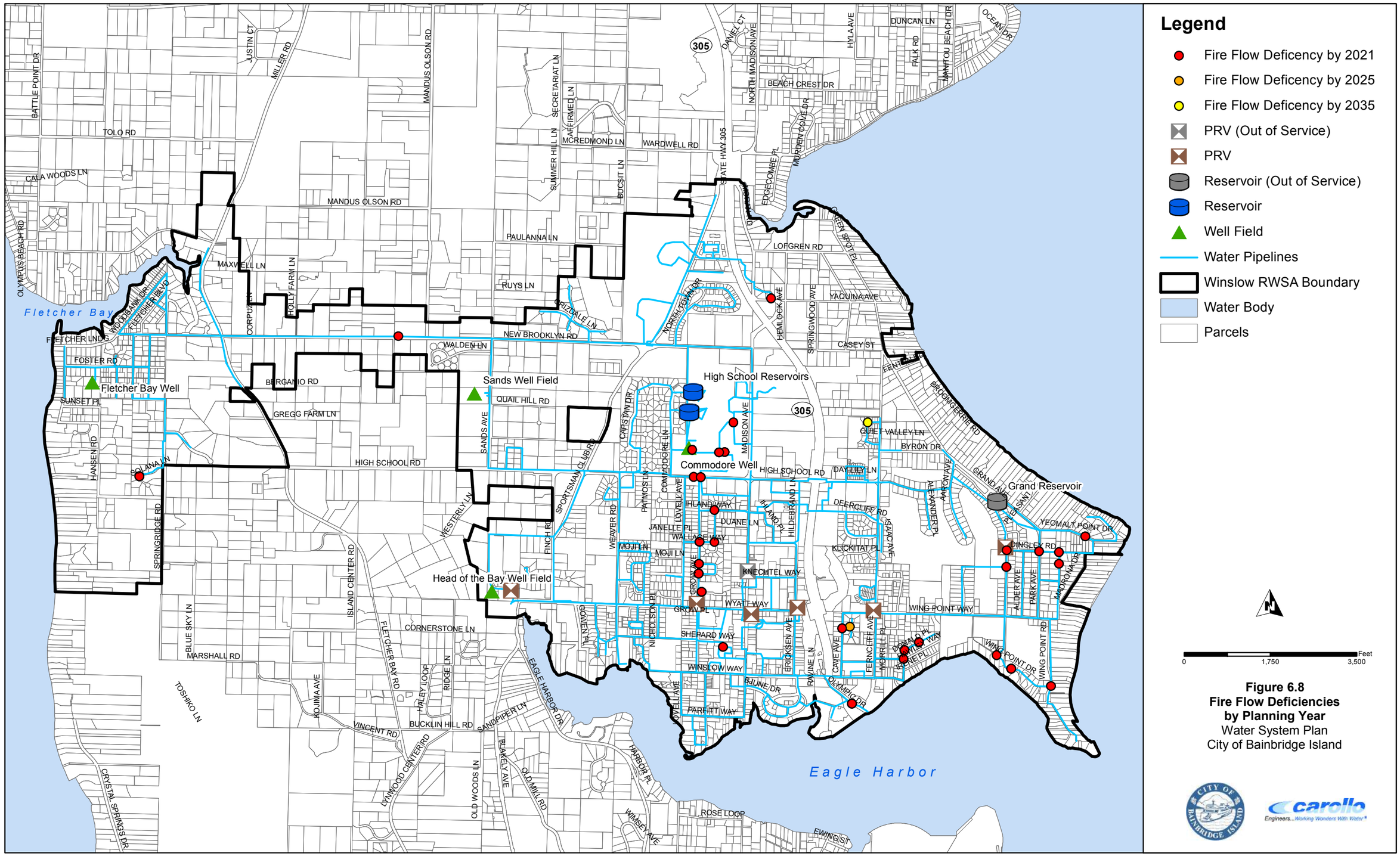


Figure 6.8
Fire Flow Deficiencies by Planning Year
Water System Plan
City of Bainbridge Island

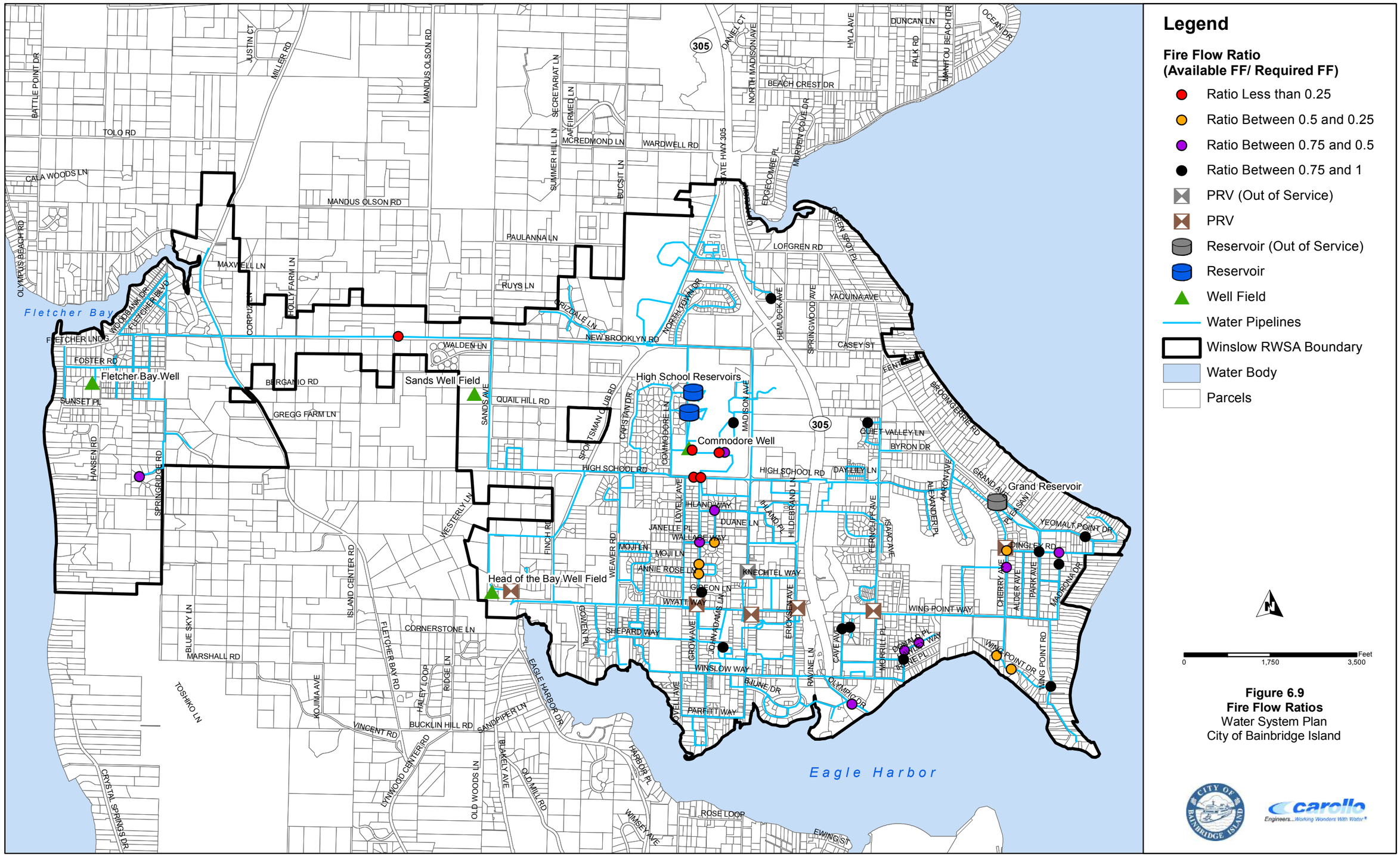
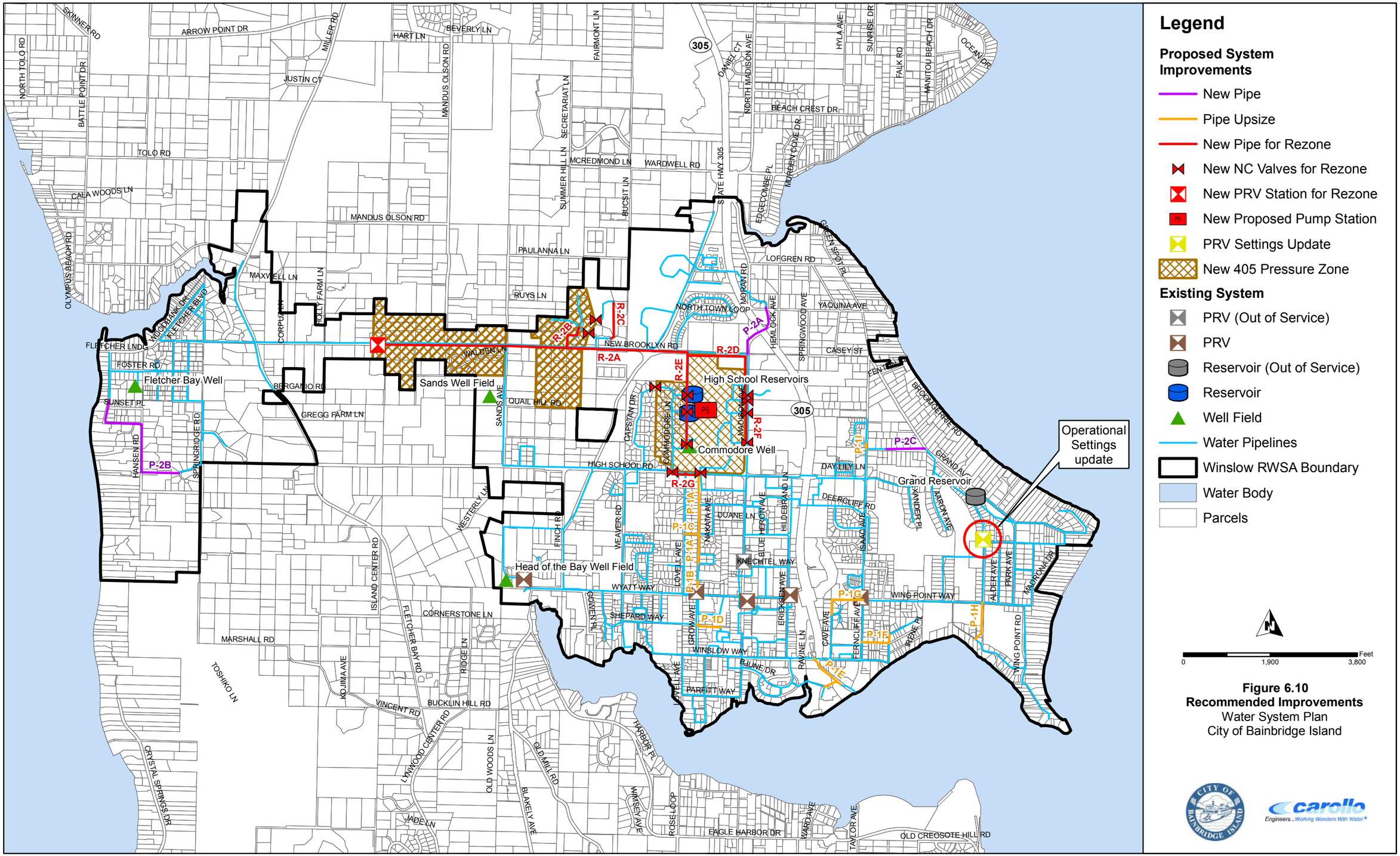


Figure 6.9
Fire Flow Ratios
Water System Plan
City of Bainbridge Island


Legend
Proposed System Improvements
New Pipe
Pipe Upsize
New Pipe for Rezone
New NC Valves for Rezone
New PRV Station for Rezone
New Proposed Pump Station
PRV Settings Update
New 405 Pressure Zone
Existing System
PRV (Out of Service)
PRV
Reservoir (Out of Service)
Reservoir
Well Field
Water Pipelines
Winslow RWSA Boundary
Water Body
Parcels
Operational Settings update
Fletcher Bay Well
Sands Well Field
High School Reservoirs
Commodore Well
Grand Reservoir
Head of the Bay Well Field
R-2A
R-2B
R-2C
R-2D
R-2E
R-2F
R-2G
P-2A
P-2B
P-2C
P-1A
P-1B
P-1C
P-1D
P-1E
P-1F
P-1G
P-1H
P-1I
P-1J
R-1E
PS
305
Feet
0
1,900
3,800
Figure 6.10
Recommended Improvements
Water System Plan
City of Bainbridge Island
carollo
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6.4.3.1 Pipe Upsizing and Looping

Many piping improvements are required to meet fire flow criteria. These projects are summarized below and in Table 6.10. Projects are labeled by project ID on Figure 6.10. Most deficiencies are driven by older 4-inch and 6-inch pipe networks that are undersized to meet modern standards.

The columns used in Table 6.10 refer to the following:

- ID: Each pipe segment is assigned an ID. This is an alphanumeric number that starts with the CIP project number, which is one letter indicating the type of project (P = pipe) and is followed by a number. Lastly the letter indicates the specific pipe segment.
- Type of improvement: Pipe upsize, or new piping.
- Street Description: Street in which the improvement is proposed.
- Ex. Diam.: Diameter of the existing pipeline (in inches).
- New Diam.: Diameter of the proposed pipeline (in inches).
- Length: Estimated length of the proposed pipeline (in feet).
- Planning Period: The planning period within which the project should be undertaken. The short-term planning period is 2015 through 2021. The mid-term planning period is 2022 through 2025. The long-term planning period is 2026 through 2035.

6.4.3.2 Operational Settings

The low pressures and fire flow deficiencies located in the vicinity of the Cherry Avenue PRV can be eliminated by changing the PRV settings. Per the City's input, in this PRV station, PRV 90G-01AS is set at 26 psi and PRV 92DG-01B is set at 21 psi. Raising each PRV in the station by 10 psi would eliminate all pressure and fire deficiencies in the vicinity.

6.4.3.3 Proposed Rezone

As discussed in the sections above, due to high elevation some areas in the system cannot be provided the minimum service pressure of 30 psi, and required fire flow at 20 psi.

Three higher elevation pockets would benefit from the creation of a new pressure zone at an HGL of approximately 405 feet. The new pressure zone would comprise of:

- The area around the high school reservoirs,
- The area along NE New Brooklyn Road east of Sands Avenue NE and west of NE Grizdale Lane, and
- The area along NE New Brooklyn Road west of Sands Avenue NE and east of Holly Farm Lane NE.

Table 6.10 Proposed Pipeline Improvements
Water System Plan
City of Bainbridge Island

ID	Type	Street Description	Length (ft)	Ex. Diam. (inches)	New Diam. (inches)	Planning Period
P-1A	Upsize	Along Grow Ave. NW from NE High School Rd. to 350 ft north of Gideon Ln. NW	1,970	4	8	Short
P-1B	Upsize	Along Grow Ave. NW from Wyatt Way NE to Gideon Ln. NW	150	4	8	Short
P-1C	Upsize	Along Wallace Way NW between Lovell Ave. NW and Grove Ave. NW	320	2	8	Short
P-1D	Upsize	Along Shepard Way NW from Grow Ave. NW to John Adams Ln. NW	550	4	8	Short
P-1E	Upsize	Along Olympic Dr. SE between Winslow Ave E and 370 ft from Olympic Dr. SE dead-end	1,000	4	8	Short
P-1F	Upsize	Along Hawley Way NE between Ferncliff Ave. NE and Eagle Pl. NE and along Eagle Pl. NE between Hawley Way NE and Donald Pl. NE	780	4	8	Short
P-1G	Upsize	Along Wing Point Way NE between Ferncliff Ave NE and Cave Ave NE and along Cave Ave NE between Wing Point Way NE and Kaleetan Pl.	990	6	8	Short
P-1H	Upsize	Along Cherry Ave NE between NE Wing Point Way and NE Wing Point Dr.	850	1.5	8	Short
P-1I	Upsize	Along Ferncliff Ave NE between High School Rd NE and NE Quiet Valley Ln.	120	8	12	Mid
P-4A	New	Along NE Byron Drive between Eleanor Place NE and Grand Avenue NE	840	-	8	Long
P-2A	New	Across State Highway 305 NE from NE Yaquina Ave. to the intersection of NE New Brooklyn Rd. with Madison Ave. N	1,260	-	8	Short
P-2B	New	Along Hansen Rd NE between Solana Ln. NE and NE Sunset Pl.	3,160	-	12	Short
P-2C	New	Along NE Byron Drive between Eleanor Place NE and Grand Avenue NE	840	-	8	Long
Total			**11,990**			

For the areas identified, it is recommended that the City perform a rezone evaluation (Project R-1) to confirm pressure zone boundaries and the required system modifications. Figure 6.2 shows in detail the improvements required to create a new pressure zone. The new pressure zone would require a new pump station with fire flow capacity that would pump from the high school reservoirs. It would also require new PRVs, installation of closed valves to isolate the new pressure zone and new transmission mains for the pressure zone.

Installation of new pipe required for the rezone project is considered project R-2. Individual pipe segments are labeled following the nomenclature R-2A, P-2B, etc. Table 6.11 presents information on each recommended pipe improvement. Pipe segments can be found on Figure 6.2 and Figure 6.10 by segment ID.

Table 6.11 Proposed Rezone Pipeline
Water System Plan
City of Bainbridge Island

ID	Type	Location	Length (ft)	Prop. Diam. (inch)
R-2A	New	Along NE New Brooklyn Road from High School reservoirs to 1,000 ft east of Holly Farm Lane NE	7,270	8
R-2B	New	Along Hudson Ct NE from dead-end to NE New Brooklyn Road	660	8
R-2C	New	Connection between NE Stager Ct Dead-end to NE Laughing Salmon Lane dead-end	850	8
R-2D	New	Along NE New Brooklyn Road and Madison Avenue N from High School reservoirs line to Sakai Village Loop NE	2,090	12
R-2E	New	Parallel to Commodore Lane NW at the High School reservoirs	2,100	12
R-2F	New	Along Madison Avenue N from Sakai Village Loop NE to 720 feet north of High School Road	1,040	12
R-2G	New	Along High School Road from Commodore Lane to Grow Avenue NW	810	12
Total			**14,820**	

6.4.3.4 Result of Project Implementation

When fully implemented, the capital projects listed in Table 6.10 and Table 6.11 will enhance the distribution of water during maximum demand conditions to existing and future customers, and meet the City's service criteria. If all of the recommended distribution system improvements are implemented, the model predicts minimum pressures will be met at all nodes as presented in Figure 6.11, and that adequate fire flow will be available to all hydrants as presented in Figure 6.12.

6.4.4 Future Customer Connection Assumptions

Many areas within the City's RWSA are currently undeveloped or developed but not connected to the water system. As these areas develop, the City will need to expand its existing distribution system to serve these new customers. Planning guidelines for where new transmission mains will need to be routed are shown in Figure 6.13. These pipes are not included as part of the CIP. Each area currently not connected to the City's distribution system should be individually evaluated prior to connection.

A high elevation area exists within the RWSA in the area south of Fletcher Bay. This area cannot be served by the High Zone. A new pressure zone with a pump station and reservoir at an HGL of approximately 460 feet is recommended. The recommended boundaries of the new 460 pressure zone are shown in Figure 6.13.

6.5 SUMMARY OF RECOMMENDATIONS

The recommendations identified for the Winslow and Rockaway Beach water systems are categorized into the following four groups:

- P - Pipe projects
- W - Well site projects
- S - Storage projects
- R - Rezone projects
- RB - Rockaway Beach projects
- G - General projects
- O - Operational changes

Implementation of the pipeline projects will ensure required fire flows and pressures are available to all hydrants in Winslow. Creation of a new 405 Pressure Zone will resolve Winslow storage, pressure, and fire flow deficiencies. Changes to the Cherry Avenue PRV settings will improve water pressure to customers downstream of the PRV.

Rockaway Beach requires additional supply and storage capacity. It is recommended that the City look into connecting to the Winslow Water System, acquiring an adjacent utility with surplus supply and storage, or connecting to an adjacent utility in order to buy supply and lease storage.

When fully implemented, the projects listed in Table 6.12 and Table 6.13 allow the Winslow and Rockaway Beach water systems to meet or exceed all of the City's service policies as well as the criteria of DOH.

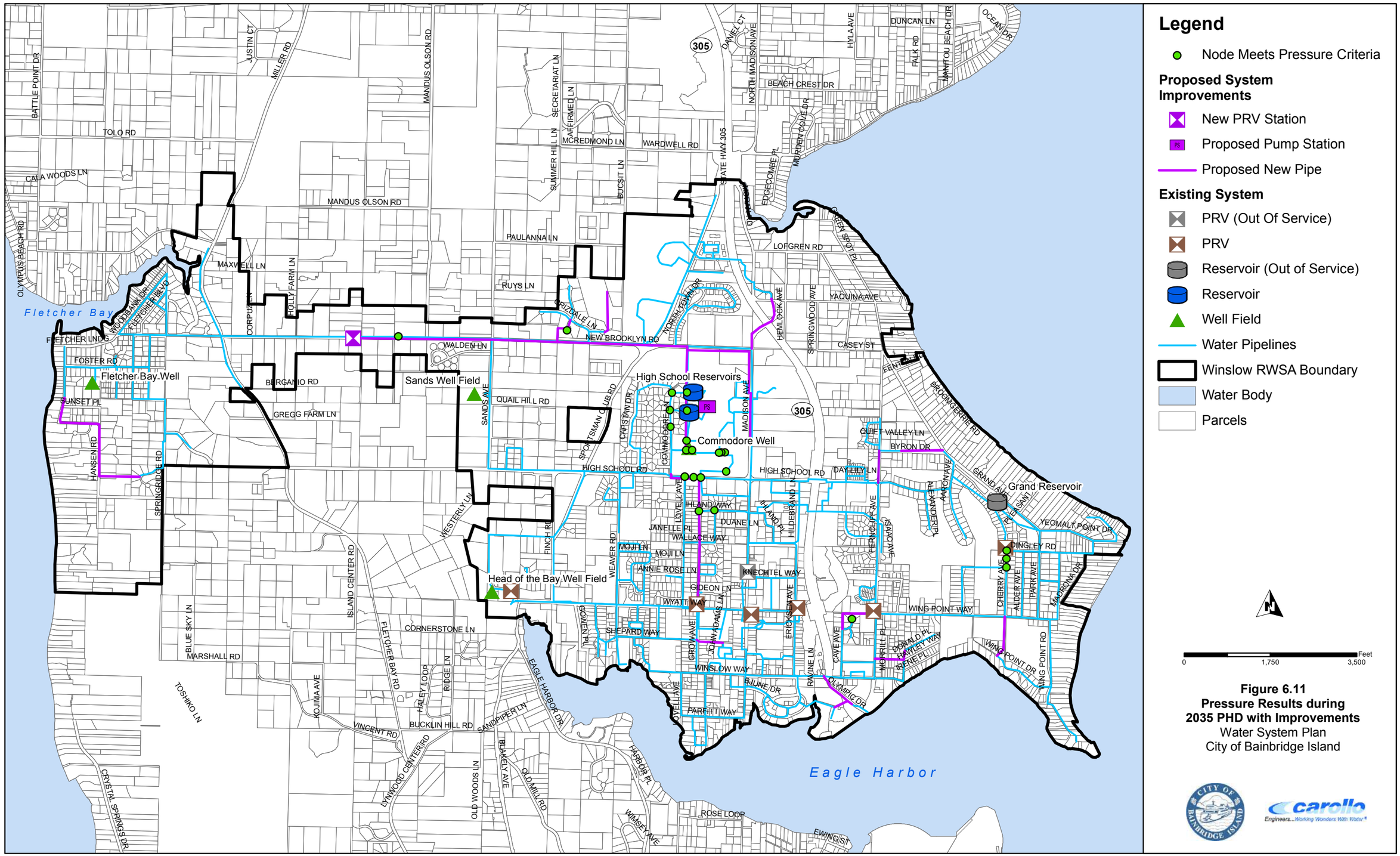


Figure 6.11
Pressure Results during 2035 PHD with Improvements
Water System Plan
City of Bainbridge Island

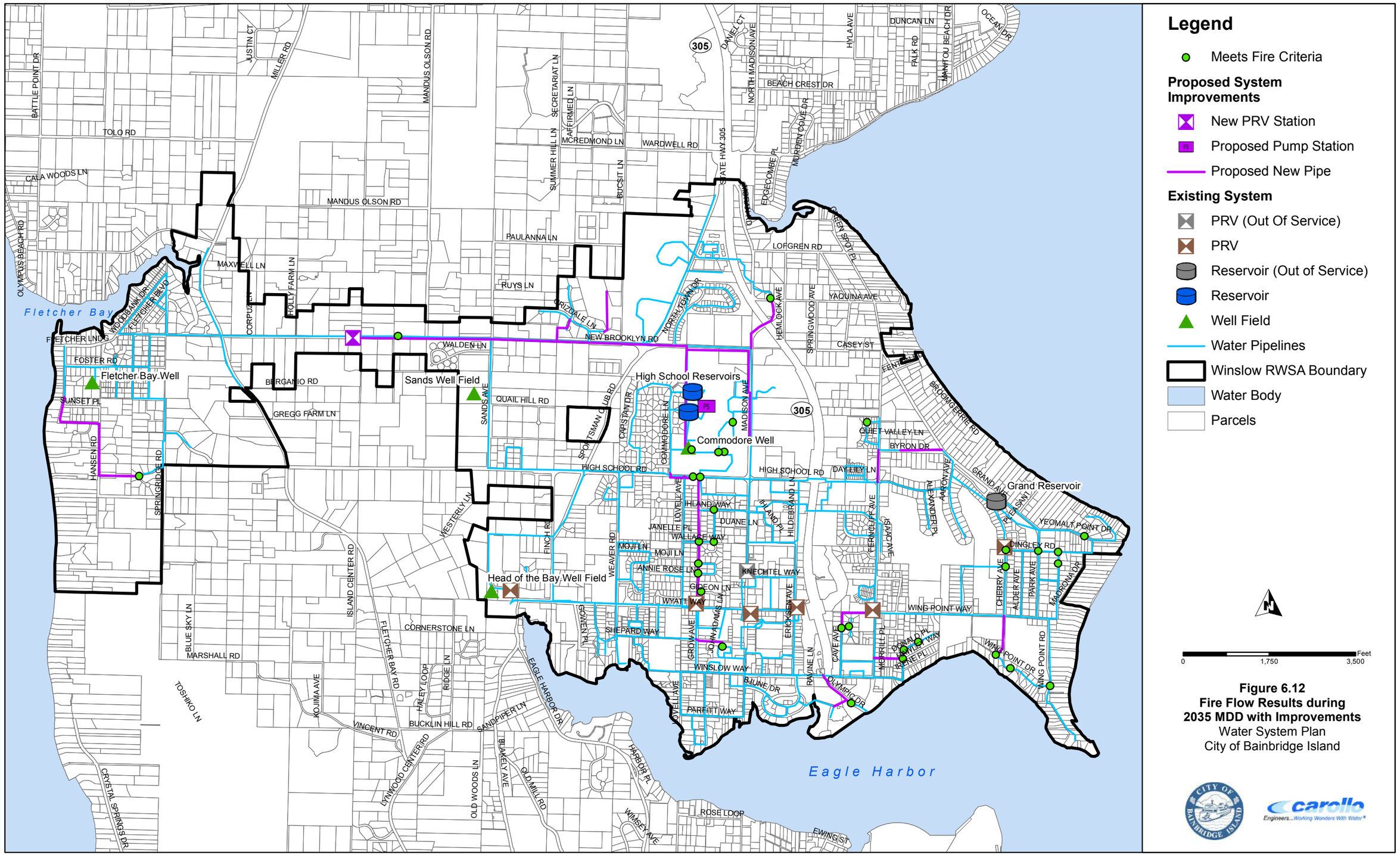
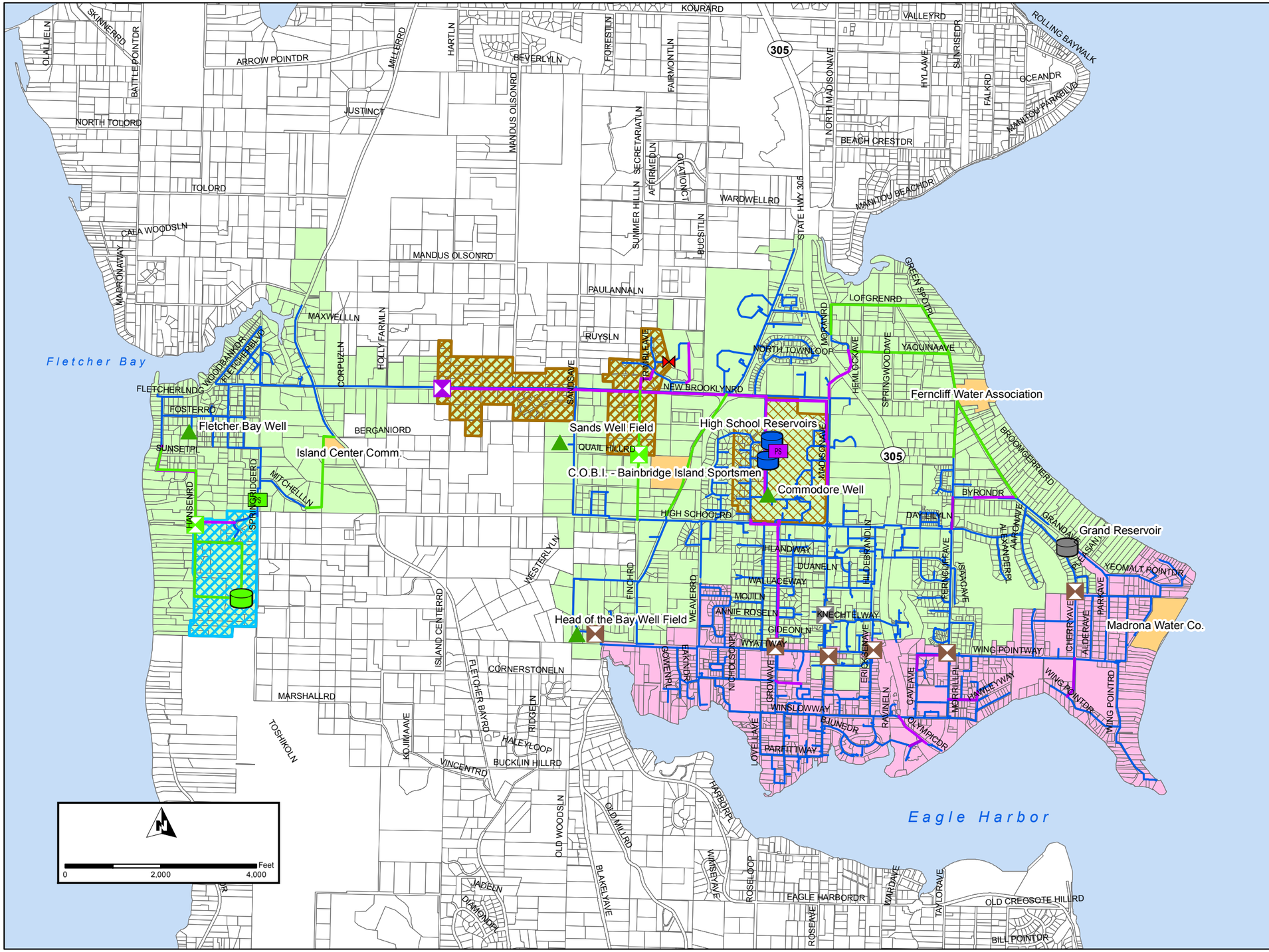


Figure 6.12
Fire Flow Results during 2035 MDD with Improvements
Water System Plan
City of Bainbridge Island



Legend

Future Service Connection Assumptions

- New Reservoir for Future Service Connections
- Proposed Pump Station for New Connections
- New PRV for Future Service Connections
- Proposed New Service Connection

Proposed System Improvements

- New PRV Station
- Proposed Pump Station
- New Pipes

Existing System

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Existing Water Pipelines
- Water Body
- Other Water Purveyors
- Parcels

Pressure Zone

- Low
- High
- New 405 Zone
- New 460 Zone

Figure 6.13
Future Connection Assumptions
Water System Plan
City of Bainbridge Island

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Table 6.12 Winslow Improvement Recommendation Summary Water System Plan City of Bainbridge Island		
CIP ID	**Type**	**Description**
Short-term		
O-1	Operation Change	Raise Cherry Ave PRV settings by 10 psi.
P-1	Capital Improvement	Short-term pipe upsize projects.
R-1	Evaluation	Rezone evaluation.
Mid-term		
P-1	Capital Improvement	Mid-term pipe upsize projects.
R-2	Capital Improvement	Rezone implementation projects including new pipes, pump station, PRVs, and isolation valves.
Long-term		
P-1	Capital Improvement	Long-term pipe upsize projects.
P-2	Capital Improvement	Long-term new pipeline installation projects.
W-5	Evaluation	Evaluation of options for increasing well and booster pump capacity.
W-6	Capital Improvement	Well and booster pump improvements.

Table 6.13 Rockaway Beach Improvement Recommendation Summary Water System Plan City of Bainbridge Island		
CIP ID	**Type**	**Description**
Short-term		
RB-1	Evaluation	Evaluation of options for securing additional supply and storage for Rockaway Beach.
RB-2	Capital Improvement	Supply and storage improvements.

WATER QUALITY

7.1 INTRODUCTION

The Winslow Water System (Winslow) and Rockaway Beach Water System (Rockaway Beach) are defined as Group A – Public Community Water Systems. Group A water systems must comply with the drinking water standards of the federal Safe Drinking Water Act (SDWA) and its amendments, as regulated by the United States Environmental Protection Agency (USEPA) and adopted by the Washington State Department of Health (DOH) under Washington Administrative Code (WAC) 246-290.

This chapter provides the following information:

- Overview of the Winslow and Rockaway Beach Water Systems.
- Description of current drinking water quality regulations.
- Summary of current monitoring programs.
- Review of the City's compliance with water quality regulations.
- Summary of anticipated future regulations.
- Recommendations.

7.2 REGULATORY BACKGROUND

The SDWA of 1974, amended in 1986 and 1996, authorizes the USEPA to establish minimum drinking water quality standards in the United States. These standards are made up of the National Primary Drinking Water Regulations and the National Secondary Drinking Water Regulations. The primary standards set levels for contaminants that may pose a health risk when present in drinking water supplies and are known or anticipated to occur in public water systems. The primary standards cover microorganisms, inorganic chemicals, organic chemicals, and radionuclides.

The USEPA set two limits for each primary contaminant. These limits are established by considering the impact on human health and what is technologically and economically feasible for removal by a treatment facility. The first limit is a health goal, referred to as the maximum contaminant level goal (MCLG). The MCLG is zero for many contaminants.

The second limit is a legally enforceable limit, referred to as the maximum contaminant level (MCL). The MCLs are equal to or higher than the MCLGs. However, most MCLs and MCLGs are the same, except for contaminants that are regulated as carcinogens. The health goals (MCLGs) for these are typically zero because they cause cancer and it is assumed that any amount of exposure may pose some risk of cancer.

Under provisions of the SDWA the USEPA is allowed to delegate primary enforcement responsibility for water quality control to each state. In the State of Washington, the DOH is the agency responsible for implementing and enforcing the drinking water regulations. For the State to maintain primacy under the SDWA, it must adopt drinking water regulations that are at least as stringent as the federal regulations. In meeting these requirements, the State has published drinking water regulations that are contained in WAC 246-290.

Secondary drinking water standards address non-health related contaminants that may cause aesthetic concerns such as taste, odor, and color. The USEPA secondary standards establish recommendations. These secondary standards have been adopted within the WAC. For new community water systems, the DOH requires treatment for secondary MCL exceedances. For other public water systems, the required follow-up action is determined by the DOH based on the degree of consumer acceptance of the water quality and their willingness to bear the cost of meeting the secondary standard.

A summary of key SDWA regulations that apply to the City are shown in Table 7.1 and are divided into those that address source water quality, distribution water quality, and reporting.

7.3 WATER SUPPLY AND TREATMENT

The City's Winslow and Rockaway Beach Water Systems are supplied by groundwater wells that have been determined to not be under the direct influence of surface water. At each well site the water is treated with chorine and fluoride. This treatment is voluntary and not mandated by the DOH. Chlorine treatment provides a disinfectant residual to maintain a barrier against potentially harmful microorganisms and help prevent bacterial regrowth in the distribution systems and storage reservoirs. Fluoride treatment is used as a water additive to promote dental health. Fluoridation is an optional treatment that was voted on and approved for use in city owned water systems by City of Bainbridge Island Council Resolution 92-47.

The Winslow and Rockaway Beach Water Systems are not connected and although they share many similarities and they have some key differences. This section reviews system characteristics as they relate to water quality monitoring. Table 7.2 shows source information.

Table 7.1 Drinking Water Regulations Water System Plan City of Bainbridge Island		
Rule	**Parameters**	**Date**
Source Water Quality		
Groundwater Rule	Fecal indicators in groundwater	Published November 2006 Compliance December 2009
National Primary and Secondary Drinking Water Standards	Bacteriological, IOC, VOC, SOC, Asbestos, Radionuclides, THMs, Lead/Copper	Phases I through V 1987 through 1992
Arsenic Rule	Arsenic	Compliance January 2006
Radionuclide Rule	Radionuclides	Effective December 2003
Unregulated Contaminants Monitoring Rule 3	Various contaminants considered for future regulation	Promulgated April 2012
Distribution System Water Quality		
Total Coliform Rule	Total coliform bacteria	Effective 1990
Revised Total Coliform Rule	Bacteriological	Published February 2013 Compliance April 2016
Lead and Copper Rule	Lead and Copper	Effective 1995
Stage 1 Disinfectants/ Disinfection Byproducts Rule	Trihalomethanes, haloacetic acids, chlorite, bromate, and disinfectant residuals	Compliance 2004
Stage 2 Disinfectants/ Disinfection Byproducts Rule	Trihalomethanes and haloacetic acids	Promulgated January 2006 Compliance 2014
Reporting Requirements		
Consumer Confidence Report Rule	Reporting only	Published August 1998
Public Notification Rule	Reporting only	Promulgated 2000

The Winslow Water System is supplied by eleven active wells that draw from three separate aquifers. The wells are located at four well sites including Fletcher Bay, Sands Avenue, Head of Bay, and Commodore. At each well site the water from the site source(s) is combined and treated before being pumped into the distribution system. The wells do not have a history of exceeding primary MCLs; however, some wells exceed the secondary MCL for manganese. The Winslow Water System was constructed prior to the establishment of some current DOH regulations and is not required to be continuously chlorinated or treated to remove iron and manganese.

Table 7.2 Well Source Information Water System Plan City of Bainbridge Island					
Source Name	**DOH Source**	**Well Depth**	**Susceptibility Rating**	**Well Site**	**Aquifer**
Winslow Water System					
Fletcher Bay Well	S07	992	Low	Fletcher Bay	Fletcher Bay
Sands Avenue 1	S12	1053	Low	Sands Avenue Well Site	Fletcher Bay
Sands Avenue 2	S13	1055	Low		
Head of Bay 1	S01	134	Moderate	Head of Bay Well Site	Sea Level
Head of Bay 2	S02	120	High		
Head of Bay 3	S03	163	Low		
Head of Bay 4	S08	136	Low		
Head of Bay 5	S09	138	Low		
Head of Bay 6	S10	152	Low		
Head of Bay 1A	S11	144	Low		
Commodore Well	S14	264	High	Commodore	Perched
Rockaway Beach Water System					
Taylor Ave Well	S02	694	Moderate	Taylor Ave	Glaciomarine

Because the Winslow Water System is not required to disinfect it is not required to provide a free chlorine concentration times contact time value of six (CT-6). The reservoirs in the water system have a common inlet/outlet connection causing water poor circulation. Chlorine residuals are maintained at relatively high levels at the well sites in order to overcome source water chlorine demand and poor reservoir turnover and maintain a detectable residual in the distribution system.

The Rockaway Beach Water System is supplied by a single active well that draws from the Glaciomarine aquifer. The well does not have a history of exceeding primary MCLs; however it exceeds the secondary MCL for manganese. Raw well water contains manganese in the range of 0.05 to 0.09 milligrams per liter (mg/L) compared to the secondary MCL of 0.05 mg/L. As a condition of water system approval, the DOH requires the system to be treated to remove manganese.

At the Rockaway Beach Water System the well discharge is treated with chlorine and fluoride prior to passing through an ATEC inline pressure filter manganese treatment system. The treatment process uses granular manganese dioxide with a pyrolusite base as the filtration media. Free chlorine in the range of 0.5 to 1.0 mg/L is maintained to optimize the treatment process. After treatment the water enters a reservoir before supplying the distribution system by gravity. The chlorine dose is set to optimize manganese removal, provide a CT value of 6, and maintain a detectable residual in the distribution system. The

storage reservoir is equipped with top fill and bottom drain connections that provide good reservoir circulation and chlorine residual is easily maintained in the distribution system.

7.4 ROUTINE WATER QUALITY MONITORING

The City's treated water sources have routine monitoring requirements necessary to ensure treatment effectiveness, regulatory compliance, and operational control. Treated source water samples are collected at a point downstream of the treatment and prior to the first customer. These samples are regularly tested for free chlorine, fluoride, iron, and manganese water quality parameters. Daily testing is performed by city staff using approved on-site methods and less frequent testing is performed by a state-certified laboratory.

Test results are reported in *Water Plant Reports* and submitted to the DOH within the first ten days of the month following the month in which the samples are collected. Copies of the *Water Plant Report* forms for the Winslow and Rockaway Beach water systems are shown in Appendix K.

Chlorine treatment is accomplished through the use of dilute sodium hypochlorite. In the Winslow Water System free chlorine residuals are monitored each week day at the operating well sites downstream of the treatment and weekly in the distribution system at coliform monitoring sites. In 2014 the chlorine residuals ranged from 1.0 to 2.2 mg/L with an average value of 1.7 mg/L at the well sites and from 0.02 to 1.4 mg/L with an average value of 0.3 mg/L in the distribution system.

At the Rockaway Beach Water System free chlorine residuals are monitored each week day at the well site downstream of the treatment and at the outlet of the storage reservoir and monthly in the distribution system during coliform sample collection. In 2014 the chlorine residuals ranged from 0.7 to 1.2 mg/L with an average value of 1.0 mg/L at the well site and downstream of the reservoir and from 0.6 to 1.1 mg/L with an average value of 0.9 mg/L in the distribution system.

Chlorine test results meet current operational requirements and are consistently well below the Maximum Residual Disinfectant Level (MRDL) of 4.0 mg/L.

Fluoride treatment is accomplished through the use sodium fluoride. Fluoride residuals are monitored each regular work day at all operating well sites and are currently required by regulation to be controlled within the range of 0.8 through 1.3 parts mg/L. For each point of injection a fluoride split-sample is collected on a monthly basis. A portion of the sample is tested by city staff and a portion is tested by a state-certified laboratory. To be within control the state-certified laboratory must determine the test results to be within the range of 0.8 through 1.3 mg/L and not differing by more than 0.30 mg/L from the field test results. In 2014 the Winslow and Rockaway Beach fluoride test results averaged 1.0 mg/L and consistently achieved current compliance standards.

The federal DOH and Human Services has come out with a revised single level of 0.7 mg/L as optimal for fluoride in drinking water. The State Board of Health, which oversees the state's fluoride rule, is developing a revised rule to reflect this new standard. The rule-making process is expected to be complete in early 2016. Until the state rule is updated, the current operating standard range of 0.8 to 1.3 mg/L remains in effect. In order to prepare for a new revised standard the City has begun the process of lowering the fluoride levels as close to 0.8 mg/L as possible.

At the Rockaway Beach Water System iron and manganese samples are collected downstream of the treatment and tested by a state-certified laboratory on a monthly basis. These samples consistently exceed treatment goals and typical results are <0.1 mg/L iron and <0.01 mg/L manganese. Manganese will be discussed further in Section 7.5.3.2.

7.5 COMPLIANCE WATER QUALITY MONITORING

Compliance monitoring samples are collected from the water sources, distribution systems, and customer's taps. The results verify compliance with primary and secondary drinking water standards. The DOH assigns susceptibility ratings for each source based on an assessment of source vulnerability to contamination. Factors considered in this assessment include hydrogeological setting, risk of source exposure to contaminants, and historical water quality monitoring results. City source susceptibility ratings are shown in Table 7.2.

The DOH has the authority to grant monitoring waivers and reduce monitoring requirements for both source and distribution samples and bases eligibility, in part on susceptibility and the historical water quality monitoring results. Depending on the contaminant and minimum monitoring frequencies required by USEPA, waivers can reduce required monitoring frequencies so that no samples, or just fewer samples, must be collected during each 3-year compliance period. Applicable waivers are identified in the following sections.

Each year the DOH prepares a *Water Quality Monitoring Schedule (WQMS)* that defines system specific monitoring requirements including required compliance samples, sampling locations, monitoring waivers, and sample schedules. The City's *2015 WQMSs* are shown in Appendix K and monitoring requirements are summarized in Table 7.3.

Table 7.3 Compliance Water Quality Monitoring Water System Plan City of Bainbridge Island		
Parameter	**Winslow**	**Rockaway**
Source Monitoring		
Nitrate	Standard 1 year	Standard 1 year
Arsenic	Standard 3 yr – Waiver 9 yr	Waiver 9 year
Manganese	Standard 3 yr – Waiver 9 yr	Standard 3 yr
Inorganic Chemical	Waiver 9 year	Waiver 9 year
Volatile Organic Chemical	Standard 3 yr – Waiver 6 yr	Waiver 6 year
Herbicides	Waiver 9 year	Waiver 9 year
Pesticides	Waiver 9 year	Waiver 9 year
Soil Fumigants	Waiver 3 year	Waiver 3 year
Gross Alpha and Radium 228	Standard 3 yr – Standard 6 yr	Standard 6 yr
Distribution System Monitoring		
Total Coliform	Monthly	Monthly
Disinfectant Byproducts	Reduced 1 year	Standard 3 yr
Asbestos	Standard 9 yr	NA
Customer Tap Monitoring		
Lead and Copper	Standard 3 year	Standard 3 year

Compliance source samples are collected at representative locations for each groundwater source after treatment and before entry into the distribution system. The Sands Avenue and Head of Bay well sites each have multiple sources that are combined and treated before entering the distribution system. With DOH approval, source samples for these two well sites are collected as blended samples.

Distribution samples are collected from representative locations according to the *Coliform Monitoring Plan* shown in Appendix L and the *Disinfection Byproducts Monitoring Plan* shown in Appendix M. Lead and copper samples are collected from targeted sites as per DOH monitoring guidance. All compliance water samples are collected, transported, and submitted for analysis by a state-certified laboratory using approved USEPA methods.

The following sections review the Winslow and Rockaway Beach Water System's applicable water quality regulations, regulatory compliance history, and anticipated future regulations. The majority of the review is based on the City's *2015 DOH WQMSs* and water quality data for the period of 2005 through 2014.

7.5.1 Bacteriological

7.5.1.1 Description

Coliform bacteria are a broad group of organisms that are routinely monitored in potable water supplies. They are widely found in the environment and are universally present in large numbers in the feces of warm-blooded mammals. While coliforms themselves are not normally causes of serious illness, they are easy to culture, and their presence is used to indicate that other pathogenic organisms of fecal origin may be present.

Bacterial contamination in a water supply can cause a number of water borne diseases, so these tests are strictly regulated by the DOH. Bacteriological water quality monitoring is regulated as a primary contaminant under the Total Coliform Rule (TCR), the Revised Total Coliform Rule, and the Groundwater Rule (GWR).

7.5.1.2 Total Coliform Rule

The TCR became effective in 1990. The rule requires all public water systems to monitor for the presence of total coliforms in the distribution system at a frequency proportional to the population served. Coliform monitoring samples must be collected from representative locations in the distribution system according to a written plan.

Total coliforms are regulated as a primary contaminant and the MCLG is set at zero. The TCR specifies two types of violations, nonactue MCL and acute MCL. The DOH and water system consumers must be notified if either MCL violation occurs. For the City a violation of bacteriological MCLs occurs during routine sampling when:

- Total coliform is detected in more than one sample in a single month – nonacute MCL
- Total coliform is present in a set of repeat samples collected as a follow-up to a sample with fecal coliform or *Escherichia coli* (*E. coli*) presence – acute MCL
- Fecal coliform or *E. coli* is present in a repeat sample after coliform was detected in the routine sample – acute MCL

7.5.1.2.1 *Total Coliform Monitoring Requirements and Analysis*

The City monitors for bacteriological water quality according to the *Coliform Monitoring Plan* shown in Appendix L. The number of required samples is based on the population as identified in the water systems' *2015 Water Facilities Inventory* reports shown in Appendix D. Currently the City is required to collect ten coliform samples per month from the Winslow Water System and one sample per month from the Rockaway Beach Water System.

These samples are collected from dedicated sample stations at representative locations throughout the distribution systems. The sample sites are regularly rotated and samples are collected on a weekly basis. Eleven sample sites have been designated to represent the Winslow distribution system, including six sites in the high pressure zone and five sites in

the low pressure zone. Three sample sites have been designated to represent the Rockaway Beach distribution system.

During the period of 2005 through 2014 the City collected 942 routine coliform samples from the Winslow Water System and 120 routine coliform samples from the Rockaway Beach Water System. None of the samples tested positive for total coliform. The City has a good coliform monitoring history and is in compliance with bacteriological water quality standards.

7.5.1.3 Groundwater Rule

The USEPA published the GWR in 2006 with compliance required by 2009. The purpose of the rule is to provide increased protection against microbial pathogens in public groundwater water systems. The rule applies to public water systems that serve groundwater including the Winslow and Rockaway Beach Water Systems. The GWR builds on the TCR by identifying additional actions that must be taken when a routine sample tests positive for total coliform, and the sequence of actions that must be taken if any triggered source sample tests positive for fecal indicators.

The GWR is implemented through a strategy that has four primary components that include periodic sanitary surveys, triggered source water monitoring, corrective action for significant deficiencies, and compliance monitoring.

The GWR increases the scope and frequency of sanitary surveys. Under the rule an initial sanitary survey will be conducted on all water systems that serve groundwater to identify significant deficiencies which may make the system susceptible to microbial contamination. After that, sanitary surveys will be scheduled every three years for most water systems and every five years for water systems that provide at least 4-log treatment of viruses or have outstanding performance records, as determined by the DOH.

For groundwater water systems that do not provide 4-log treatment and do not conduct compliance monitoring, source water monitoring is triggered when the system is notified of a total coliform-positive routine sample collected in compliance with the TCR. Under these conditions the system must collect at least one sample, before treatment, from each ground water source that was in use at the time the total coliform-positive sample was collected. The triggered source water sample must be analyzed for the presence of a fecal indicator as specified in the rule.

If the triggered source water sample is fecal indicator-positive, the groundwater water system must either take corrective action, as directed by the DOH, or if corrective action is not required by the DOH and the sample is not invalided by the DOH, the system must conduct additional source water sampling. The DOH can require additional source assessment monitoring and testing for high risk water systems.

Corrective action is required for any groundwater water system with a significant deficiency or evidence of source water fecal contamination. Under these conditions the system must correct all significant deficiencies, provide an alternate source of water, eliminate the source of contamination, or provide treatment that reliably achieves at least 4-log treatment of viruses.

In order not to be subject to triggered source water monitoring, a public water system using groundwater can notify the DOH that it provides at least 4-log treatment of viruses before the first customer. The water system must then begin compliance monitoring designed to show the effectiveness of the treatment process. Water systems that use chemical disinfection and serve more than 3,300 people must continuously monitor disinfectant concentration and must maintain the minimum disinfectant residual concentration determined by the DOH.

7.5.1.3.1 *Groundwater Rule Monitoring Requirements and Analysis*

The Winslow and Rockaway Beach Water System well sites provide disinfection treatment using free chlorine residual combined with unbaffled tanks and/or pipeline plug flow contact time to achieve CT values and virus inactivation. Under the GWR the City is not pursuing compliance monitoring in lieu of triggered source monitoring and chlorine residuals are not continuously monitored at the well sites. The City's *Coliform Monitoring Plan* takes in account the GWR requirements and all wells can be sampled before treatment if source water monitoring is triggered.

The most recent DOH Sanitary Surveys were conducted on June 17, 2010 for the Winslow Water System and on December 8, 2011 for the Rockaway Beach Water System. All of the discrepancies noted during the surveys have been corrected with one exception. At the Rockaway Beach Water System the artesian relief line is not accessible for reconfiguring until the well is taken out of service for rehabilitation. This work has not been scheduled. The Sanitary Survey reports are shown in Appendix K.

Although a detailed analysis to confirm 4-log virus inactivation has not been conducted, available information has been compiled to provide a general review of the effectiveness of the well site disinfection processes. This information is based on the approximate distances from the well sites to the first downstream customers and the average free chlorine residuals at those customer locations. Log inactivation of viruses is based on the USEPA's GWR Contact Time (CT) Calculator. This data is summarized in Table 7.4 with more detailed information provided in the *Well Site Disinfection Efficiency R*eview shown in Appendix K.

Table 7.4 Well Site Disinfection Efficiency Summary Water System Plan City of Bainbridge Island						
Well Site and First Downstream Customer	**Chlorine Residual (C) (mg/L)**	**Peak Flow (GPM)**	**Effective Volume (gal)**	**Contact Time (T) (min)**	**CT (mg/L min)**	**Log Treatment**
Winslow Water System						
Fletcher Bay Well – 5657 Foster Road	1.0	586	1,792	3.1	3.1	3.06
Sands Well Site – 8072 Sands Avenue	1.4	670	7,222	10.8	15.1	15.09
Head of Bay Well Site – 8245 New Holland	1.0	600	8,299	13.8	13.8	13.83
Head of Bay PRV – 7290 Eagle Harbor	1.2	10	65.2	6.5	7.8	7.82
Commodore Well – 1 MG HS Reservoir	1.2	50	457	9.1	11.0	10.96
Rockaway Beach Water System						
Taylor Avenue Well – E. Harbor/Creosote	0.8	105	14,758	141	112.4	112.44

The Winslow and Rockaway Beach Water Systems are voluntarily chlorinated for disinfection purposes. The systems were developed during different periods according to the DOH standards that were in effect at the time. The Rockaway Beach Water System source, storage, and distribution system was totally reconstructed in 1994. The system meets CT-6 and 4-log treatment standards and easily maintains distribution system chlorine residuals above 0.2 mg/L.

The Winslow Water System was constructed before current disinfection standards. With the exception of Fletcher Bay, all of the well sites meet CT-6 and 4-log treatment standards. However, most likely due to poor reservoir turnover, the water system is not able to consistently maintain chlorine residuals above the recommended level of 0.2 mg/L throughout the distribution system.

Despite these limitations the Winslow Water System has a good coliform monitoring record. In the future if the system has difficulty meeting bacteriological regulations or when well site improvements are planned, upgrades to meet current standards will be considered.

7.5.1.4 Revised Total Coliform Rule

The USEPA published the final Revised Total Coliform Rule (RTCR) in February 2013. The RTCR requires public water systems that are vulnerable to microbial contamination, as indicated by monitoring results, to identify and correct any sanitary defects in the distribution system or treatment processes. The DOH is expected to adopt the RTCR in 2015 and public water systems must comply with the rule by April 2016.

The RTCR generally maintains the same basic monitoring structure of the TCR but offers greater public health protection through the reduction of defects that could either provide pathways that allow fecal contamination and/or waterborne pathogens to enter into the distribution system, or could indicate a failure or imminent failure in a barrier that is already in place.

The RTCR eliminates the health goal (MCLG), legal limit (MCL), and non-acute MCL for total coliform. It sets an *E. coli* MCLG of zero and an *E. coli* MCL and a coliform treatment technique based on total coliform and/or *E. coli* monitoring results. Total coliform is used as an indicator of the integrity of the distribution system and *E. coli* as an indicator of the presence of fecal contamination.

The rule requires all water systems to monitor for total coliform and *E. coli* in the distribution system on a regular basis. Total coliform-positive (TC+) samples must be tested for the presence of *E. coli.* Compliance is based on the presence or absence of total coliform and *E. coli* (EC). For the Winslow and Rockaway Beach Water Systems monitoring violations occur under the following situations:

E. coli (EC) MCL violation – when any of the following occurs:

- EC+ repeat sample following a TC+ routine sample
- TC+ repeat sample following an EC+ routine sample
- Failure to take all required repeat samples following an EC+ routine sample
- EC+ repeat sample following a EC+ routine sample

Coliform treatment technique violation – when any of the following occurs:

- Failure to conduct required assessment or corrective action within the specified timeframe
- Failure to correct sanitary defects within state-approved timeframe

Monitoring violation – when any of the following occurs:

- Failure to take every required routine or additional sample in a compliance period
- Failure to analyze for EC following a TC+ routine sample

If the coliform monitoring results show that the water system may be vulnerable to fecal contamination, as indicated by multiple positive results for total coliforms or *E. coli*, the system must conduct an assessment to determine if there are sanitary defects or operational practices that could be causing the contamination.

A Level 1 assessment is intended to be a self-assessment performed by the water system. It is a basic examination of the source water, treatment, storage facilities, distribution system, and relevant operational practices. For the Winslow and Rockaway Beach Water

Systems a Level 1 assessment is triggered if there are two or more total coliform-positive samples in the same month, or the required repeat samples following a total-coliform positive sample are not taken.

A Level 2 assessment is conducted by a technical professional approved by the DOH. The assessment is comprehensive evaluation of the water system, its operational practices, and its monitoring program. The assessment is triggered in response to events that may pose a significant health hazard. For the Winslow and Rockaway Beach Water Systems a Level 2 assessment is triggered if an *E. coli* MCL violation occurs or a second Level 1 assessment is triggered within a rolling 12-month period.

Water systems are required to correct all sanitary defects found during a Level 1 or Level 2 assessment and/or make operational improvements as directed by the DOH.

7.5.1.4.1 *Revised Total Coliform Rule Monitoring Requirements and Analysis*

Once the RTCR is adopted by the DOH the City's *Coliform Monitoring Plan* will be updated to provide the necessary procedures to implement the new requirements.

7.5.2 Consumer Confidence Report

7.5.2.1 Description

The Consumer Confidence Report (CCR) Rule was finalized in August 1998. The CCR is a report on the quality of water that was delivered to consumers during the previous calendar year. The report must contain certain specific elements, but may also contain other information that the water purveyor deems appropriate for public education. Some of the information required in the reports includes the source and type of the drinking water, type of treatment, contaminants that have been detected in the water, potential health effects of the contaminants, identification of the likely source of contamination, and monitoring and reporting violations.

The City is required to distribute the CCR annually to its customers before the 1st of July each year. The City is in compliance with this requirement and copies of the 2014 CCR for the Winslow and Rockaway Beach Water Systems are located in Appendix K.

7.5.3 Inorganic Chemical and Physical Characteristics

7.5.3.1 Description

Inorganic chemical and physical characteristics (IOCs) are regulated as primary and secondary contaminants through the National Primary Drinking Water regulations and WAC 246-290. Many of these contaminants are naturally occurring in the environment and include elemental metals such as mercury and arsenic; non-metallic compounds such as chloride and sulfate; and physical characteristics such as color, total dissolved solids, and specific conductivity. Tables 7.5 and 7.6 show the primary and secondary IOCs included this category.

Table 7.5 Primary Inorganic Chemical and Physical Characteristics
Water System Plan
City of Bainbridge Island

Compound	Primary MCL (mg/L)	Winslow 2015 Detections (mg/L)	Rockaway 2015 Detections (mg/L)
Antimony (Sb)	0.006	ND (1)	ND
Arsenic (As)	0.010	ND – 0.0061	0.0027
Asbestos	7 MFL (2)	ND	-----
Barium (Ba)	2.0	ND	ND
Beryllium (Be)	0.004	ND	ND
Cadmium (Cd)	0.005	ND	ND
Chromium (Cr)	0.1	ND	ND
Copper (Cu)	1.3 (3)	ND	ND
Cyanide (HCN)	0.2	ND	ND
Fluoride (F)	4.0	ND	ND
Lead (Pb)	0.015 (3)	ND	ND
Mercury (Hg)	0.002	ND	ND
Nickel (Ni)	0.1	ND	ND
Nitrate (as N)	10.0	ND – 0.12	0.014
Nitrite (as N)	1.0	ND	ND
Selenium (Se)	0.05	ND	ND
Sodium (Na)	20 (4)	5.77 – 39.6	7.68
Thallium (Tl)	0.002	ND	ND

Notes:
(1) ND = Not detected at or above the SRL.
(2) MFL – Million fibers/liter >10 microns.
(3) Action Level.
(4) EPA level of concern.

Table 7.6 Secondary Inorganic Chemical and Physical Characteristics Water System Plan City of Bainbridge Island			
Compound	**Secondary MCL (mg/L)**	**Winslow 2015 Detections (mg/L)**	**Rockaway 2015 Detections (mg/L)**
Chloride (Cl)	250.0	2.15 – 7.76	4.44
Fluoride (F)	2.0	ND (1)	ND
Iron (Fe)	0.30	ND – 0.153	ND
Manganese (Mn)	0.05	0.022 – 0.161	0.049
Silver (Ag)	0.10	ND	ND
Sulfate (SO4)	250.0	ND	ND
Zinc (Zn)	5.0	ND	ND
Physical Characteristic	**Secondary MCL (mg/L)**	**Winslow 2015 Detections (mg/L)**	**Rockaway 2015 Detections (mg/L)**
Color	15 Color Units	ND – 20	ND
Conductivity	700 umhos/cm	140 – 210	201
TDS	500	-----	-----

Notes:
(1) ND = Not detected.

7.5.3.2 Monitoring Requirements and Analysis

Unless otherwise approved by the DOH, IOCs are collected at representative locations for each groundwater source after treatment and before entry into the distribution system. At the Sands Avenue and Head of the Bay well sites source samples are typically blended to represent several wells at sites.

Dependent upon specific contaminant requirements and previous detections the sampling frequencies for some IOCs vary. The City's groundwater sources have been granted a waiver and the current monitoring schedule requires a complete IOC analysis once every nine years. For most sources arsenic samples are required once every three years. Manganese samples are required once every three years for sources that have tested above the MCL. Nitrate samples are required on an annual basis. Although not required by the *WQMS*, chloride and conductivity samples are tested annually for seawater intrusion aquifer monitoring purposes.

In order to provide the most complete and up to date water quality data for this chapter an IOC analysis was performed on individual City sources in April 2015. With DOH approval these samples were not blended and were collected before treatment. The sources were tested separately to obtain results most representative of each well.

The April 2015 IOC results for samples collected before treatment is consistent with past data for samples collected after treatment for all parameters except for chloride. Before treatment the chloride levels for all wells ranged from 2.15 – 7.76 mg/L in 2015 and after treatment they have historically ranged up to 24 mg/L.

Tables 7.5 and 7.6 compare the primary and secondary MCLs with the range of detections measured at the City's sources in April 2015. The results show both the Winslow and Rockaway Beach Water Systems are in compliance with all primary IOC MCLs. Excluding arsenic, which will be discussed later in this chapter, the only notable exception related to primary IOCs is sodium. The Sands Avenue wells tested up to 39.6 mg/L for sodium. Although there is currently no set MCL for sodium, the USEPA has established a recommended level of 20 mg/L as a level of concern for consumers that may be restricted for daily sodium intake in their diets. Table 7.7 shows primary IOCs detected in the individual well sources in April 2015.

Table 7.7 2015 Primary IOC Detections
Water System Plan
City of Bainbridge Island

Source Name	DOH Source	Arsenic	Nitrate	Sodium
MCL		**0.010 mg/L**	**10.0 mg/L**	**20.0 mg/L(1)**
Winslow Water System				
Fletcher Bay Well	S07	ND	ND	13.7
Sands Avenue 1	S12	0.0045	0.11	39.6
Sands Avenue 2	S13	0.0042	0.12	38.4
Head of Bay 1	S01	0.0042	ND	6.90
Head of Bay 2	S02	0.0045	ND	7.71
Head of Bay 3	S03	0.0048	ND	6.00
Head of Bay 4	S08	0.0061	ND	9.19
Head of Bay 5	S09	0.0045	ND	5.77
Head of Bay 6	S10	0.0049	ND	5.89
Head of Bay 1A	S11	0.0043	ND	6.11
Commodore Well	S14	0.0029	ND	6.69
Rockaway Beach Water System				
Taylor Ave Well	S02	0.0027	0.14	7.68

Notes:
(1) EPA level of concern.

The Rockaway Beach Water System source is treated to remove manganese and the finished water is consistently in compliance with all secondary MCLs. The April 2015 raw water testing before treatment resulted in a manganese level of 0.049 mg/L, which is slightly below the secondary MCL of 0.05 mg/L.

The Winslow Water System sources had some notable exceptions related to secondary MCLs. For manganese, the Head of the Bay wells tested in the range of 0.094 – 0.161 mg/L and the Commodore well tested at 0.052 mg/L compared to the manganese MCL of 0.05 mg/L. For both Sands Avenue wells the physical characteristic color tested at 20 Color Units compared to the secondary MCL of 15 Color Units. Table 7.8 shows secondary IOCs detected in the individual sources in April 2015.

Table 7.8 2015 Secondary IOC Detections
Water System Plan
City of Bainbridge Island

Source Name	DOH Source	Iron	Manganese	Chloride	Conductivity	Color
MCL		**0.3 mg/L**	**0.05 mg/L**	**250 mg/L**	**700 (1)**	**15 (2)**
Winslow Water System						
Fletcher Bay Well	S07	ND	0.034	3.39	185	ND
Sands Avenue 1	S12	ND	0.022	7.76	210	20
Sands Avenue 2	S13	ND	0.026	7.28	203	20
Head of Bay 1	S01	ND	0.099	2.15	145	ND
Head of Bay 2	S02	ND	0.116	3.74	149	ND
Head of Bay 3	S03	ND	0.094	3.52	148	ND
Head of Bay 4	S08	0.153	0.161	4.48	159	ND
Head of Bay 5	S09	ND	0.097	3.07	152	ND
Head of Bay 6	S10	ND	0.100	3.16	145	ND
Head of Bay 1A	S11	ND	0.094	2.71	140	ND
Commodore Well	S14	ND	0.052	3.36	192	ND
Rockaway Beach Water System						
Taylor Ave Well	S02	ND	0.049	4.44	201	ND

Notes:
(1) umhos/cm.
(2) Color Units.

Secondary contaminants have traditionally been viewed as aesthetic concerns that only affect the taste, odor, and color of drinking water. For water systems that existed before current DOH regulations treatment for secondary contaminants is not required unless customer complaints become an issue or directed by the DOH.

A 2015 research study by the Water Research Foundation indicates manganese in drinking water presents a previously unrecognized health risk. The research suggests that MCLG for manganese of less than 0.02 mg/L is a more appropriate target than the current secondary MCL of 0.05 mg/L. The Head of the Bay wells have manganese levels in the range of 0.094 to 0.161 mg/L.

The two main areas of health concern are the neurological effects of manganese and the co-accumulation and subsequent release of regulated metals. The populations at greatest risk are infants, children, and the elderly. Manganese has adverse impact on both the source and distribution system water quality. Biofilm growth and scale in the distribution system can accumulate toxic trace metals and microorganisms that can be released by hydraulic and chemical means. This can result in elevated metals concentrations at the customer tap, coliform occurrence, high chlorine demand, as well as color, taste, and odor problems.

Current manganese research findings are on the radar of the USEPA and the American Waterworks Association (AWWA) supports the inclusion of manganese in the Draft Unregulated Contaminant Monitoring Rule (UCMR4) Contaminant Candidate List (CCL4). Although it is unknown when this research will result in new regulatory requirements, this information will help guide City priorities related to manganese treatment during the capital planning process.

7.5.4 Arsenic

7.5.4.1 Description

Arsenic occurs naturally in the earth's crust. Most arsenic in drinking water comes from natural rock formations. As water flows through these formations, it can dissolve arsenic and carry it into underground aquifers, streams, or rivers that may become drinking water supplies. Arsenic also can come from human activities, such as mining or smelting ores that contain arsenic. In the past, it was used in commercial wood preservatives and agricultural chemicals. Some people who drink water containing arsenic in excess of the MCL over many years could experience skin damage or problems with their circulatory system, and may have an increased risk of getting cancer.

In January 2001, the USEPA promulgated a new standard that requires public water systems to reduce arsenic levels in drinking water. The arsenic rule became effective in January 2006. The rule set and MCLG of arsenic at zero and reduced the MCL from the previous standard of 0.05 mg/L to 0.01 mg/L.

7.5.4.2 Monitoring Requirements and Analysis

Unless otherwise approved by the DOH, arsenic samples are collected at representative locations for each groundwater source after treatment and before entry into the distribution

system. At the Sands Avenue and Head of the Bay well sites source samples are typically blended to represent several wells at sites.

Table 7.5 compares the arsenic MCL of 0.01 mg/L with the range of detections measured at the City's sources in April 2015. Arsenic at the Fletcher Bay well was not detected and the rest of the wells tested in range of 0.0027 through 0.0061 mg/L for arsenic. Table 7.7 shows arsenic levels detected in the individual well sources in April 2015.

Sources that have tested at half the MCL, (0.05 mg/L) or above must test for arsenic once every three years. Sources that test below this level are currently required to be sampled once every nine years. Although some of these results are elevated, they are all below the MCL and therefore in compliance with arsenic monitoring regulations.

Any system that has a sampling point exceed the MCL must increase the monitoring frequency at that sampling point to quarterly. Quarterly sampling must continue until the sample point is reliably and consistently below the MCL. Compliance with the MCL is based on the running annual average of the samples. Systems triggered into increased monitoring will not be considered in violation of the MCL until they have completed one year of quarterly sampling. However, if any sample result will cause the running annual average to exceed the MCL at any sampling point, the system is out of compliance with the MCL immediately.

7.5.5 Asbestos

7.5.5.1 Description

Asbestos is the name for a group of naturally occurring, hydrated silicate minerals with fibrous morphology. Included in this group are chrysolite, corcidolite, amosite, and the fibrous varieties of anthophyllite, tremolit, and actinolite. The most commercially mined asbestos is chrysotile. Asbestos' flexibility, strength, and chemical and heat resistance properties that have adapted it to many uses including building insulation, brake linings, and water pipe. An MCL for asbestos has been set at 7 million fibers/liter (MFL).

7.5.5.2 Monitoring Requirements and Analysis

Asbestos is listed as a primary IOC. Water systems that have greater than 10 percent asbestos cement pipe installed must collect an asbestos sample from the distribution system under conditions where asbestos contamination is most likely to occur once every nine years. Because the Winslow Water System has approximately 20 percent asbestos cement pipe installed an asbestos sample was collected in September 2007. The results were below the detectable limit. The Rockaway Beach Water System does not contain asbestos cement pipe and is not required to sample for this contaminant.

7.5.6 Volatile Organic Chemicals

7.5.6.1 Description

Volatile organic chemicals (VOCs) are a sub-category of the organic chemical group of primary contaminants. They are manufactured, carbon-based chemicals that vaporize quickly at normal temperatures and pressures. VOCs include many hydrocarbons associated with fuels and paint thinners. VOCs are divided into the following groups:

- Regulated VOCs that have been determined to be a significant risk to human health.
- Unregulated VOCs for which the human health risk level has not been established.

The National Primary Drinking Water regulations and WAC 246-290 have established the regulated VOCs (Phase I) and Synthetic Organic Chemicals (SOCs) (Phase II and V). Unregulated Contaminant monitoring is conducted as part of the USEPA Unregulated Contaminant Monitoring program and is discussed later in this chapter. USEPA/State regulated VOCs are shown in Table 7.9.

Table 7.9 Regulated Volatile Organic Chemicals
Water System Plan
City of Bainbridge Island

Compound	MCL (mg/L)	Compound	MCL (mg/L)
1,1,2-Trichloroethane	0.005	Dichloromethane	0.005
1,1-Dichloroethylene	0.007	Ethylbenzene	0.7
1,2,4-Trichlorobenzene	0.07	Ortho-Dichlorobenzene	0.6
1,2-Dichloroethane	0.005	Para-Dichlorobenzene	0.075
1,2-Dichloropropane	0.005	Styrene	0.1
111-Trichloroethane	0.2	Tetrachloroethylene	0.005
Benzene	0.005	Toluene	1
Carbon Tetrachloride	0.005	Trans-1,2-Dichloroethylene	0.1
Chlorobenzene	0.1	Trichloroethylene	0.005
Ethyl Benzene	0.7	Vinyl chloride	0.002
Cis-1,2-Dichloroethylene	0.07	Xylenes	10

7.5.6.2 Monitoring Requirements and Analysis

Unless otherwise approved by the DOH, VOC samples are collected at representative locations for each groundwater source after treatment and before entry into the distribution system. At the Sands Avenue and Head of the Bay well sites source samples are typically blended to represent several wells at sites.

VOC sample testing frequencies for individual sources are dependent upon past detections. All of the City's groundwater sources, except the Winslow Water System's Head of Bay well S02 and Commodore well S14, have been granted a waiver and the current monitoring schedule requires a complete VOC analysis once every six years. Table 7.10 shows VOC monitoring waiver status, required sample frequency, and the most recent year that a sample was collected.

Table 7.10 VOC and SOC Monitoring Schedule
Water System Plan
City of Bainbridge Island

Source Name	DOH Source	Volatile Organic Chemical		Synthetic Organic Chemical	
		Sample Year	Schedule	Sample Year	Schedule
Winslow Water System					
Sands Well 1	S12	2012	Waiver 6-yr	2009	Waiver 9-yr
Sands Well 2	S13	2012	Waiver 6-yr	2009	Waiver 9-yr
Fletcher Bay Well	S07	2012	Waiver 6-yr	2009	Waiver 9-yr
Head of Bay Well 1	S01	2012	Waiver 6-yr	2007	Waiver 9-yr
Head of Bay Well 2	S02	2012	Standard 3-yr	2009	Waiver 9-yr
Head of Bay Well 3	S03	2012	Waiver 6-yr	2009	Waiver 9-yr
Head of Bay Well 4	S08	2012	Waiver 6-yr	2009	Waiver 9-yr
Head of Bay Well 5	S09	2012	Waiver 6-yr	2009	Waiver 9-yr
Head of Bay Well 6	S10	2012	Waiver 6-yr	2009	Waiver 9-yr
Head of Bay Well 1A	S11	2012	Waiver 6-yr	2009	Waiver 9-yr
Commodore Well	S14	2013	Standard 3-yr	2013	Waiver 9-yr
Rockaway Beach Water System					
Taylor Avenue Well	S02	2010	Waiver 6-yr	2012	Waiver 9-yr

A complete VOC analysis is required for the Head of the Bay well S02 and Commodore well S14 once every three years. This increased frequency is required because there were detections for total xylenes in samples tested at these locations in 1998. These detections may have been the result of sampling or laboratory error; however no historical records are available to invalidate the samples. Since that time there have been no xylene detections at these wells.

For the period of 2006 through 2013 there were detections for total trihalomethanes at the Sands, Fletcher Bay, and Commodore wells. These compounds are regulated under the USEPA Disinfection Byproducts program. The detections were below the MCLs and are shown in Table 7.11. The City is in compliance with VOC regulations.

Table 7.11 2015 Regulated VOC Detections Water System Plan City of Bainbridge Island					
Source Name	**DOH Source**	**Year**	**Chloroform**	**Bromo-dichloromethane**	**Total Tri-halomethane**
MCL			**NA**	**NA**	**80 ug/L**
Winslow Water System					
Fletcher Bay Well	S07	2012	2.4	NA	2.4
Sands Avenue 1 Sands Avenue 2	S12 S13	2012	5.6	0.9	6.5
Commodore Well	S14	2010	2.6	NA	2.6

7.5.7 Synthetic Organic Chemicals

7.5.7.1 Description

SOCs are a sub-category of the organic chemical group of primary contaminants. They generally include manufactured chemicals that are not as volatile as VOCs. Of particular concern in this group are herbicides and pesticides such as atrazine, chlordane, and lindane. Regulated SOCs are shown in Table 7.12.

Table 7.12 Regulated Synthetic Organic Chemicals Water System Plan City of Bainbridge Island			
Compound	**MCL (mg/L)**	**Compound**	**MCL (mg/L)**
1,2-Dibrom-3-ochloropropane	0.0002	Endrin	0.002
2,4,5-TP (Silvex)	0.05	Ethylene dibromide	0.00005
2,4-D	0.07	Glyphosate	0.7
Acrylamide	TT	Heptachlor	0.0004
Arochlor	0.002	Heptachlor epoxide	0.0002
Atrazine	0.003	Hexachlorobenzene	0.001
Benzo(a)pyrene (PAHs)	0.0002	Hexachlorocyclopentadiene	0.05
Carbofuran	0.04	Lindane	0.0002
Chlordane	0.002	Methoxychlor	0.04
Dalapon	0.2	Oxamyl (Vydate)	0.2
Di(2-ethylhexyl)adipate	0.4	Pentachlorophenol	0.001
Di(2-ethylhexyl)phthalate	0.006	Picloram	0.5
Dinoseb	0.007	Polychlorinatedbiphenyls	0.0005
Dioxin (2,3,7,8-TCDD)	$3x10^{8}$	Simazine	0.004
Diquat	0.02	Toxaphene	0.003
Endothall	0.1		

7.5.7.2 Monitoring Requirements and Analysis

Unless otherwise approved by the DOH, SOC samples are collected at representative locations for each groundwater source after treatment and before entry into the distribution system. At the Sands Avenue and Head of the Bay well sites source samples are typically blended to represent several wells at sites

All of the City's groundwater sources have been granted a waiver and the current monitoring schedule requires a complete SOC analysis once every nine years. Table 7.10 shows SOC monitoring waiver status, required sample frequency, and the most recent year that a sample was collected. There have been no SOC detections at any City wells and all sources are in compliance with SOC regulations.

7.5.8 Unregulated Contaminants

7.5.8.1 Description

The 1986 amendments to the SDWA require public water systems to monitor for unregulated contaminants every five years. The intent of this program is to gather scientific information on unregulated contaminants to determine if regulations are required to protect human health. Both the 1993 and 1996 amendments to the act added new lists of contaminants, which led USEPA to develop a revised program for monitoring.

The new program became known as the Unregulated Contaminant Monitoring Rule (UCMR 1999). The new UCMR program began in 2001, and produces a new list of unregulated contaminants for monitoring every five years. The UCMR program is now in its third iteration, with UCMR3 finalized in April 2012. Under the UCMR program, USEPA requires large systems to take two sets of samples for unregulated contaminants at six-month intervals. There are two tiers of contaminants; List 1 - Assessment Monitoring, and List 2 - Survey Screening. List 1 contaminants are sampled by all water systems serving over 10,000 people. List 2 contaminants are analyzed using less common analytical techniques, and a portion of the purveyors required to test for List 1 contaminants are randomly selected by USEPA to be required to test for List 2 contaminants.

Under the UCMR, select community water systems are responsible for collecting samples, having them analyzed for specific contaminants by USEPA approved laboratories, ensuring that data are reported to the USEPA central data exchange (CDX) database, and notifying the public of the results.

7.5.8.2 Monitoring Requirements and Analysis

Under the second round of the UCMR, (UCMR2) the Winslow Water System performed Assessment Monitoring for List 1 contaminants. The samples were collected in March and September 2009 at the four well site entry points to the distribution system. The samples were analyzed for two insecticides, five flame retardants, and three explosives. There were no detectable results.

Under the third round of the UCMR, (UCMR3) the Winslow Water System performed Assessment Monitoring for List 1 contaminants. The samples were collected in January and July 2014 at the four well site entry points to the distribution system and at four distribution system maximum residence time locations. The samples were analyzed for 21 List 1 contaminants, consisting of volatile organic compounds, metals, perfluorinated compounds, 1,4-dioxane, and chlorate. There were detections for molybdenum, strontium, vanadium, chlorate, and chromium-6 that will be reported in the 2015 CCR.

The Rockaway Beach Water System is not required to perform UCMR monitoring.

7.5.9 Lead and Copper

7.5.9.1 Description

Lead and copper are heavy metals that may be found in household plumbing materials and water service lines. Promulgated in 1995, the Lead and Copper Rule (LCR) was established to reduce the tap water concentrations of lead and copper that can occur when corrosive source water causes these metals to leach from water meters and plumbing fixtures. The LCR primarily addresses the effects of corrosive water on older plumbing that was installed after 1982 and prior to 1986 when lead solder was banned from use on plumbing fixtures.

Under the LCR lead and copper samples are collected from customers' cold water taps at homes/buildings that are at high risk of lead/copper contamination. The test results are regulated as a primary contaminant. No lead and copper MCLs have been established. Instead, the LCR establishes action level (AL) of 0.015 mg/L for lead and 1.3 mg/L for copper based on the 90th percentile level of tap water sample test results. An AL exceedance is not a violation but can trigger requirements to protect customer health that include water quality parameter monitoring, corrosion control treatment, source water treatment, public education, and lead service line replacement.

7.5.9.2 Monitoring Requirements and Analysis

Based on the requirements of the USEPA Lead and Copper Rule, lead and copper monitoring must be completed for two consecutive six-month monitoring periods. If lead and copper action levels are not exceeded, then the number of samples may be reduced to on-half the original number for three consecutive annual periods. Assuming compliance with the AL is maintained, reduced sampling may continue once every three years thereafter.

Because previous sample results met these requirements the Winslow and Rockaway Beach Water Systems are on a reduced monitoring schedule. Lead and copper monitoring is required once every three years. Thirty samples are required for the Winslow Water System and five samples are required for the Rockaway Beach Water System. These samples are collected by residents from targeted homes/buildings during the months of August and September.

To collect the samples residents are provided with an introductory letter, sampling instructions, certification form, and sample bottle. Following collection the samples are picked up by City staff, the laboratory forms completed, and the samples delivered to the laboratory for analysis. The City distributes about 20 percent more sample kits than required in order to get enough samples to satisfy monitoring requirements. Residents who collect samples receive lead and copper results by letter within thirty days of the City's receipt of the lab results.

A summary of the lead and copper 90th percentile results for the period of 2004 through 2013 is shown in table 7.13. The table shows the lead and copper 90th percentile sample results have been consistently below their ALs and the City is in compliance with this monitoring requirement.

Table 7.13 Lead and Copper 90th Percentile Results
Water System Plan
City of Bainbridge Island

Year	Winslow Water System		Rockaway Water System	
	Lead Detections (mg/L)	Copper Detections (mg/L)	Lead Detections (mg/L)	Copper Detections (mg/L)
MCL	**0.015 mg/L**	**1.3 mg/L**	**0.015 mg/L**	**1.3 mg/L**
2004	0.005	ND	NA	NA
2006	NA	NA	0.002	0.07
2007	0.006	0.18	0.003	0.08
2010	0.005	0.20	0.001	0.08
2013	0.008	0.19	0.001	0.06

7.5.10 Residual Disinfectant

Typical residual disinfectants include chlorine, chloramines, and chlorine dioxide. Disinfection residual protects against bacteriological contamination and helps prevent biofilm growth in the distribution system. Excessive disinfection residual may have adverse effects on public health and influence the formation of disinfection byproducts, which are discussed later in this Chapter. The City voluntarily chlorinates the Winslow and Rockaway Beach Water Systems for disinfection purposes using dilute sodium hypochlorite solution.

7.5.10.1 Monitoring Requirements and Analysis

Chlorine is regulated as a primary contaminant and the MRDL is set at 4.0 mg/L Compliance is based on the running annual average (RAA), computed quarterly, of monthly averages of all samples collected by the system. If the average covering any consecutive four-quarter period exceeds the MRDL, the system is in violation.

The DOH disinfection regulations are currently under review by department. Currently, they require water systems to monitor disinfectant residual at representative points throughout the distribution system once each day, excluding weekends and holidays, and at the same time and location of routine and repeat coliform sample collection. The regulations require a minimum free chlorine residual of 0.2 mg/L, where a sample with HPCs less than 500 cfu/100 mL is assumed to carry the required minimum residual.

The City meets these requirements as previously described in Section 7.4 and outlined in the *Coliform Monitoring Plan* shown in Appendix L. Chlorine residuals are monitored each week day at operating well sites and operational adjustments are made as required to maintain compliance. Distribution chlorine residuals are measured weekly and at the same time and place as routine and repeat coliform samples.

For the period of 2005 through 2014 chlorine residuals ranged from 0.001 to 1.59 mg/L at the Winslow Water System coliform monitoring sampling locations during coliform sample collection. For that same period chlorine residuals ranged from 0.28 to 1.14 mg/L at the Rockaway Beach Water System coliform monitoring sampling locations during coliform sample collection.

7.5.11 Disinfection Byproducts

Disinfection byproducts are regulated as primary contaminants. They are formed in the distribution system when free chlorine reacts with naturally occurring organic substances in water. Some disinfectants and disinfection byproducts have been shown to cause cancer and reproductive effects in lab animals and are suspected to cause bladder cancer and reproductive effects in humans. The Disinfection Byproducts Rule (DBPR) applies to water systems that introduce a disinfectant during any part of the treatment process. The rule is implemented in stages and to improve public health protection by reducing exposure to disinfection byproducts. The portions of the rule that apply to the City are discussed below.

7.5.11.1 Stage 1 DBPR Description

The Stage 1 DBPR became effective in February 1999 and the City water systems had to be in compliance by January 2004. The disinfection by-products regulated under the rule include trihalomethanes (THM) and halocetic acids (HAA5). The four regulated THMs are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. The five regulated HAA5s are monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.

The rule updated and superseded the previous regulations for THM. It reduced the MCL for THMs from the interim level of 0.10 mg/L to 0.080 mg/L and established an MCL for HAA5 of 0.060 mg/L. Under the Stage 1 DBPR compliance with the THM and HAA5 MCLs was based on a system-wide RAA of samples taken in the distribution system. The rule also introduced a MRDL of 4 mg/L for free chlorine, based on a RAA of samples collected concurrent with TCR monitoring.

7.5.11.2 Monitoring Requirements and Analysis

In 2004 the City began Stage 1 DBPR monitoring. To comply with the requirements, THM and HAA5 samples were collected for the Winslow and Rockaway Beach Water Systems during the warmest months of the year at distribution system locations representing the longest detention times. For the Winslow Water System a dual THM and HAA5 sample set was required annually from four distribution system locations. For the Rockaway Beach Water a dual THM and HAA5 sample set was required from a single distribution system location. Since monitoring began the system-wide RAA has been below the MCL for both THM a HAA5. The sample results are shown in Tables 7.14 and 7.15.

Table 7.14 Trihalomethane Monitoring Detections
Water System Plan
City of Bainbridge Island

Year	Winslow Water System				Rockaway Beach Water System
	Miller Bay Road	Yeomalt Point	Shannon Drive	Wood Avenue	
MCL	**80 ug/L**	**80 ug/L**	**80 ug/L**	**80 ug/L**	**80 ug/L**
2004	2.84	3.78	5.84	2.65	ND
2007	18.03	29.40	29.14	31.20	2.59
2010	14.51	33.10	40.40	40.20	8.20
2011	40.90	33.90	30.80	33.50	NA
2012	68.40	41.20	26.90	26.70	NA
2013	28.20	36.50	36.10	35.60	7.40
2014	19.10	32.90	33.10	27.60	6.90

Table 7.15 Haloacetic Acid Monitoring Detections
Water System Plan
City of Bainbridge Island

Year	Winslow Water System				Rockaway Beach Water System
	Miller Bay Road	Yeomalt Point	Shannon Drive	Wood Avenue	
MCL	**60 ug/L**	**60 ug/L**	**60 ug/L**	**60 ug/L**	**60 ug/L**
2004	0.95	ND	1.06	ND	ND
2007	ND	ND	19.72	ND	ND
2010	ND	ND	ND	ND	ND
2011	21.2	4.7	10.7	8.1	ND
2012	24.7	2.4	8	9.4	ND
2013	9.8	1.1	5.2	5.5	ND
2014	10.7	3.2	8.3	6.4	ND

7.5.11.3 Stage 2 DBPR Description

The Stage 2 DBPR was promulgated in January 2006 and the DOH assumed responsibility for the rule in January 2010. The City was required to begin Stage 2 DBPR monitoring in 2014. The goal of the rule is to improve public health protection by eliminating the potential for groups of customers to receive elevated levels of DBPs on a consistent basis.

The Stage 2 DBPR does not add any new contaminants to be monitored and the MCLs for TTHM and HAA5 remain unchanged at 0.080 and 0.060 mg/L, respectively. Key provisions of the rule include:

- Systems must develop an Initial Distribution System Evaluation (IDSE) to identify distribution system locations with high DBP concentrations.
- Systems must develop and implement a Disinfection Byproducts Monitoring Plan.
- Regulatory compliance is based on site-specific locational running annual averages (LRAAs) instead of system-wide RAAs.

The purpose of the IDSE is to identify sample locations for Stage 2 DBPR compliance monitoring that represents distribution system sites with high TTHM and HAA5 levels. There are four options available to satisfy this requirement:

- Standard Monitoring Program (SMP), which involves a 1-year distribution system monitoring effort to determine locations that routinely show high TTHM and HAA5 concentrations.
- System-Specific Study (SSS), based on historical data and a system model.
- 40/30 Waiver, which allows systems with no samples exceeding TTHM and HAA5 concentrations of 40 and 30 µg/L to apply to waive the IDSE requirements.
- Very Small System Waiver, which allows systems that serve under 500 customers with qualifying TTHM and HAA5 data to apply to waive the IDSE requirements.

7.5.11.4 Monitoring Requirements and Analysis

The Winslow Water System was granted a 40/30 Waiver in August 2008 and the Rockaway Beach Water System was granted a Very Small System Waiver in December 2006, therefore no IDSE is required under the Stage 2 DBPR. To comply with Stage 2 DBPR monitoring the City developed a Disinfection Byproducts Monitoring Plan which is shown in Appendix M and began monitoring according to the plan in 2014. Per the plan four sites are monitored in the Winslow Water System and one site is monitored in the Rockaway Beach Water System annually. Monitoring results are shown in Tables 7.14 and 7.15. Since monitoring began the LRAA has been below the MCL for both THM a HAA5 and the City is in compliance with this monitoring requirement.

7.5.12 Radionuclides

7.5.12.1 Description

Radionuclides include radioactive substances that occur as a result of decay of natural and man-made substances. Most radioactivity in groundwater is due to natural causes, but there is also a potential of radionuclide contamination from various industrial and medical processes. Radionuclides are regulated as a primary contaminant. Regulated substances include radium-226, radium-228, uranium, and gross alpha and gross beta particles. In December 2000 the USEPA announced an updated standard for radionuclides which became effective December 2003.

7.5.12.2 Monitoring Requirements and Analysis

Radionuclide samples are collected at representative locations for each groundwater source after treatment and before entry into the distribution system. The Winslow and Rockaway Beach Water Systems are on a standard monitoring schedule and radionuclide sampling is required on a three to six year schedule dependent upon the source.

If gross alpha particle activity is measured at less than, or equal to 5 picocuries per liter (pCi/L) at a confidence level of 95 percent, it is assumed that alpha activity is entirely due to radium 226 and radium 226 does not need to be tested. The alpha activity is then added to the radium 228 activity. If the sum of the alpha activity plus the radium 228 activity is greater than 5 pCi/L, radium 226 activity must be determined for compliance purposes (i.e. radium 226 + radium 228 activity). Uranium needs to be determined only when gross alpha exceeds 15 pCi/L.

Radionuclide MCLs and the range of detections measured at the City's sources for the period of 2001 through 2014 are summarized in table 7.16. The table shows the sample results have been consistently below the MCL and the City is in compliance with this monitoring requirement.

Table 7.16 Radionuclide Monitoring Detections
Water System Plan
City of Bainbridge Island

Radionuclide	MCL	Winslow Detections (pCi/L)	Rockaway Detections (pCi/L)
Gross Alpha Particles	15 pCi/L	-1 – 5.5	-2 – 3.5
Gross Beta Particles	4 millirem/yr	ND	ND
Combined Radium 226 and 228	5 pCi/L	0.4	-----
Uranium	30 ug/L	-----	-----
Radium 226	-----	-0.05	-----
Radium 228	-----	ND – 1.1	ND – 0.4

7.5.12.3 Proposed Radon Rule Description

Radon is a naturally-occurring radioactive gas that may cause cancer, and may be found in drinking water and indoor air. Some people who are exposed to radon in drinking water may have increased risk of getting cancer over the course of their lifetime, especially lung cancer. As required by the 1996 Safe Drinking Water Act, USEPA has developed a proposed regulation to reduce radon in drinking water that has a multimedia mitigation option to reduce radon in indoor air.

The 1996 SDWA Amendments directed USEPA to withdraw the proposed 300 pCi/L MCL for radon and have the National Academy of Sciences (NAS) conduct a risk assessment for radon in drinking water using the best available science. NAS also investigated the health risk reduction and cost analysis for various radon MCLs under consideration.

USEPA issued a Proposed Radon in Drinking Water rule in November 1999. The proposed radon MCL is 300 pCi/L. The proposed alternative radon MCL is 4,000 pCi/L. If the equivalent drinking water level is greater than the proposed MCL, then USEPA has established guidelines for a multi-media radon mitigation program to reduce indoor air radon concentrations. Either the state or the water system must develop and obtain approval of a multi-media radon mitigation program to qualify for the alternative MCL. Water systems using the alternative MCL may be required to state in their CCR that they meet the alternative MCL but not the MCL.

7.6 SUMMARY OF RECOMMENDED IMPROVEMENTS

The City is in compliance with all applicable water quality regulations in both the Winslow and Rockaway Beach Water Systems. The City's water quality monitoring program provides the required monitoring and analysis to maintain safe drinking water. As part of the review of programs, the following recommendations are identified for further consideration.

- Evaluate methods of maintaining low iron, manganese, hydrogen sulfide, arsenic, and disinfection by-product levels.
- Update the Water Facilities Inventory.
- Lower fluoride residuals to 0.8 mg/L to prepare for the revised fluoride standards.
- Conduct compliance monitoring in conformance with the Ground Water Rule.
- Review 4-log treatment requirements during wells site upgrades.
- Reconfigure the Taylor Avenue well artesian relief line identified as a discrepancy in the December 8, 2011 Rockaway Beach Water System Sanitary Survey.
- Update Coliform Monitoring Plan to conform to the Revised TCR.
- Review manganese treatment options for the Head of Bay and Commodore wells.
- Conduct radon source sampling.

OPERATION AND MAINTENANCE

8.1 INTRODUCTION

This chapter provides an overview of the City of Bainbridge Island Water Utility organization, staffing, and operation and maintenance program. This chapter documents existing practices and identifies changes that may improve system operation and maintenance.

8.2 CITY STRUCTURE

The City of Bainbridge Island (City) has a Manager-Council form of government. The City Manager oversees management of the Public Works Department and the Water Utility through the Public Works Director. The Water Utility is operated as a utility enterprise under the direction of the Public Works Director. Policy and planning oversight and input are provided by the Utility Advisory Committee comprised of a group of citizen volunteers.

8.2.1 Departmental Coordination

Throughout the City the Public Works Department coordinates with other departments and work groups for key Water Utility support services. These services are performed by positions that have multiple areas of responsibility and only a portion of each position is funded by the utility. Together these support services amount to 4.8 full time equivalent (FTE) positions and are outlined in this section.

The Executive Department has 0.29 FTEs funded by the Water Utility and is responsible for overall leadership, planning, and policy coordination as well as public information, legal, human resource, and risk management services.

The Planning and Community Development Department (PCD) is funded at 0.08 FTEs by the Water Utility and is responsible to oversee development plan review, permit issuance, inspection of developer extensions, and overall development project management.

The Finance and Administrative Department has 0.95 FTEs funded by the Water Utility and is responsible for customer billing, payment collection, fund activity reporting, budget development, and overall fiscal management.

Within the Finance and Administrative Department the Information Technology Group has 0.17 FTEs funded by the Water Utility and is responsible for information technology network and computer services management as well as CAD mapping and geographic information system development and management.

8.2.2 Public Works Organizational Structure

The Public Works Department is responsible for the city buildings, grounds, streets, water systems, storm sewer systems, sanitary sewer collection systems, and the wastewater treatment plant. The department currently has 37 approved FTE positions spread across two divisions. Under the Public Works Director there are a total of 3.30 FTEs assigned responsibility for planning, design, construction, operation, maintenance, and management of the City's water systems. This consists of 1.39 FTEs in the Engineering Division and 1.91 FTEs in the Operation and Maintenance (O&M) Division.

For all of the positions that support the Water Utility, only a portion of each position is funded by the utility. The current Public Works organization chart is shown in Figure 8.1. Positions with a portion of time assigned to support the Water Utility are shown in blue.

8.2.3 Public Works Departmental Coordination

The Public Works Department Water Utility staffing, responsibilities, and coordination are summarized in this section.

The Engineering Division is responsible for comprehensive water system planning, capital improvement plan (CIP) development, and the design, construction, and inspection of major projects related to the water system. The Engineering Manager oversees the Engineering Division and reports to the Public Works Director.

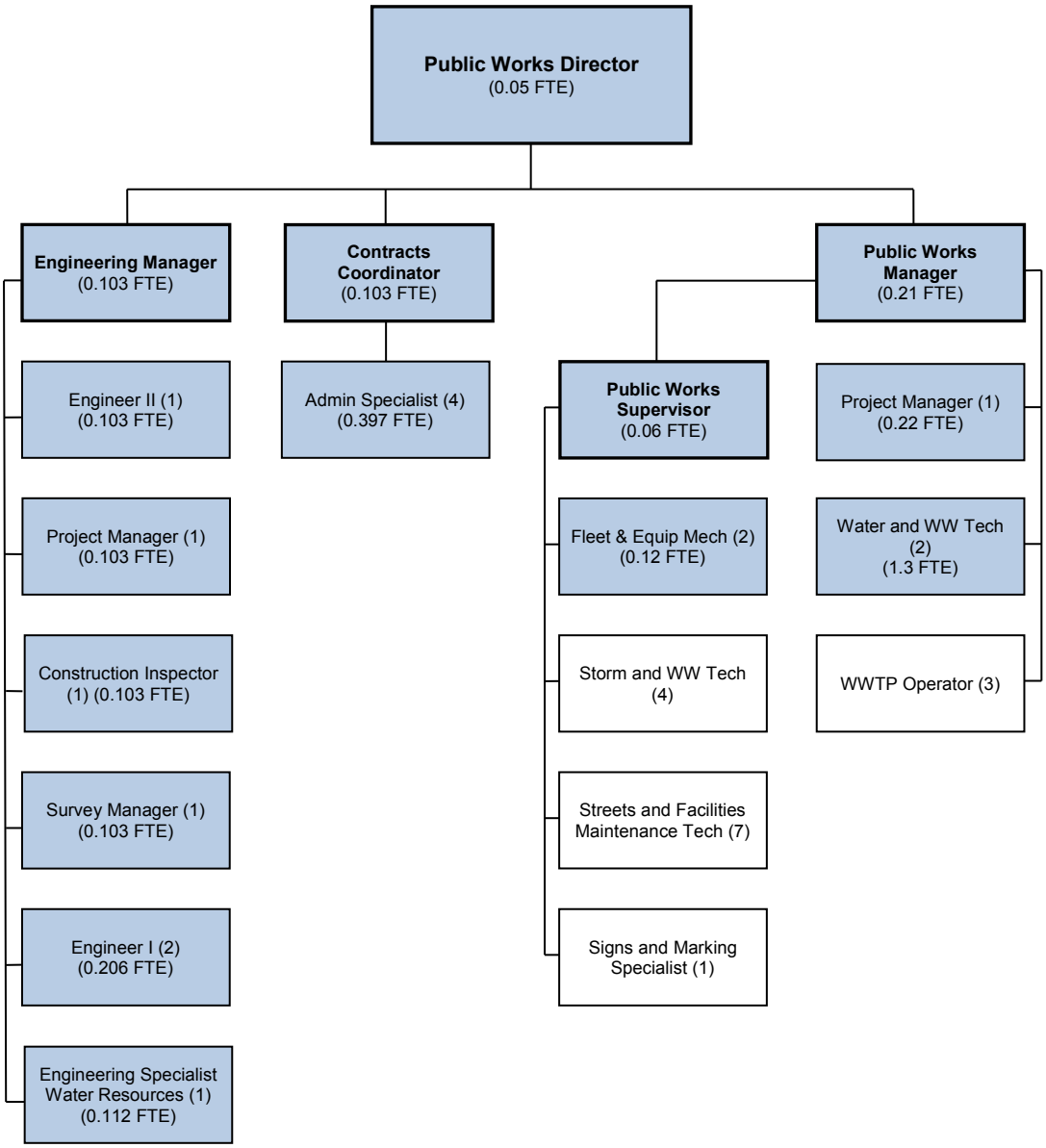
The Administrative Services Group provides capital and operational support including contract coordination, project outreach, purchasing support, work order management, time reporting, and clerical support activities. The Contract Coordinator oversees the Administrative Services Group and reports to the Public Works Director.

The O&M Division is responsible for day to day operations of the wells, pump stations, and water distribution system. The Public Works Manager oversees the division and reports to the Public Works Director. The O&M Division Water Utility responsibilities are organized as outlined in the remainder of this section.

The Water/Wastewater Maintenance Group has both water and wastewater responsibilities. Water responsibilities include water quality monitoring as well as operation, maintenance, and repair. This group also provides customer, development, and capital support activities.

The Operations Project Manager position is responsible for cross connection control, plan review, water availability processing, contract management, equipment procurement, and small capital project delivery.

The Fleet Maintenance Group has responsibilities that cross multiple functional areas including vehicle, equipment, and emergency generator maintenance and repair.



OPERATION AND MAINTENANCE ORGANIZATION STRUCTURE

FIGURE 8.1

CITY OF BAINBRIDGE ISLAND
WATER SYSTEM PLAN

8.3 OPERATOR CERTIFICATION

Under the Washington State Department of Health (DOH), Water Works Operator Certification regulations, WAC 246-292-060 the City is required to have at least one employee certified as a Level 2 Water Distribution Manager (WDM-2) in responsible charge of day to day water system operations. In addition, the City is required by DOH to have at least one employee certified as a Cross Connection Control Specialist (CCCS) to develop and implement the Cross Connection Control Program (CCCP).

The City's certification requirements for Water Utility personnel exceed those mandated by the DOH. The City requires that all O&M personnel with day to day Water Utility responsibilities must hold WDM-2 and CCS certifications. In addition, a number of O&M personnel not directly assigned Water Utility responsibilities hold various DOH certifications. Current certification status of City personnel is shown in Table 8.1.

Table 8.1 Personnel Water Certification
Water System Plan
City of Bainbridge Island

Position	Name	Certification	Cert. No.
Public Works Manager	Charles Krumheuer	WDM 3, CCS	1961
Project Coordinator	Aaron Claiborne	WDM 2, CCS	12104
Water/WW Tech III	Randy Williamson	WDM 2, CCS	7353
Water/WW Tech II	Jerry Kramer	WDM 2, CCS	7327
WW Treatment Plant Operator II	Doug Otte	WDM 2, CCS	6115
WW Treatment Plant Operator II	Delbert Franz	WDM 1	5801
Collection/Storm Tech II	Phillip Mueller	WDS	8184
Collection/Storm Tech II	Chuck Dillon	WDM IT	10465

8.3.1 Professional Growth

In order to maintain DOH certifications, Washington State requires that all certified operators complete not less than three Continuing Education Units (CEU) within each three-year professional growth reporting period. To satisfy this requirement DOH certified personnel attend a wide variety of accredited field specific training on a regular basis.

8.4 OPERATION AND MAINTENANCE PROGRAM

The Winslow Water System is supplied from eleven wells located at four well sites. At each site the water is treated with chlorine and fluoride. From the well sites the water is pumped into the distribution system to supply customers and fill two storage reservoirs. The distribution system is divided into two pressure zones separated by six pressure reducing stations. In 2013 the system supplied 2,387 customers.

The Rockaway Beach Water System is supplied by a single well and reservoir. The well discharge is treated with chlorine and fluoride before passing through a filtration system to remove trace amounts of iron and manganese prior to filling the storage reservoir. From the reservoir the water flows by gravity to supply about 70 service connections.

The Winslow and Rockaway Beach Water Systems are not connected. Although the configuration of the well sites varies the operations, maintenance, and support activities are similar. These activities are planned to balance regulatory requirements, changing priorities, and industry standards with available manpower and budget to maintain a realistic water system operations and maintenance program.

Recurring operation, maintenance, and support activities are performed by the Public Works Department O&M Division. The activities are generally categorized as follows:

- Routine Operations
- Preventive Maintenance and Repairs
- Cross Connection Control
- Capital and Development Project Support
- Emergency Response

8.4.1 Routine Operations

Routine operations are essential activities necessary to maintain Water Utility equipment and systems in good working condition in order to ensure normal system operation and regulatory compliance. These activities are generally performed on a daily, weekly, and monthly frequency. About 49 percent of the division's Water Utility labor is spent on these activities. Key activities are outlined below and routine operations are further summarized in Table 8.2.

- Each regular work day the Supervisory Control and Data Acquisition (SCADA) telemetry system and central archive server (CAS) data is reviewed and anomalies are investigated and corrected as required. Utility locates are performed daily as required.
- Each regular work day the operating well sites are inspected, operational adjustments are made, well site meters are read, supplies are refilled, minor maintenance is performed, and DOH Water Plant Reports (WPRs) are completed.
- Twice weekly customer meter leak checks, final reads, and seasonal shut offs are performed. Each month individual well supply meters are read. Every other month customer meters are read and shut offs for non-payment are made.
- Operational water quality sample collection and testing is performed daily, weekly, and monthly schedule and compliance water quality sample collection and reporting

is performed on a less frequent basis. These activities are summarized in Table 8.3 and further described in Chapter 7.

Table 8.2 Routine Operations
Water System Plan
City of Bainbridge Island

Component	Frequency	Activity
SCADA	Daily	Review water system event and alarm history
		Check levels, flow rates, pressures, and run times
Reservoirs and Water Facilities	Daily	Inspect for signs of intrusion
		Check electrical for loose connections, relays, or burnt wires
		Check heater and ventilation system for proper operation
	Monthly	Inspect and pump out secondary containment tank
Booster and Well Pumps	Daily	Check levels, flow rates, and run times
		Check for unusual sounds, vibration, and odors
		Inspect packing and seals
		Check pipes and fittings for leakage
		Record flow totalizer meter
Chlorination and Fluoridation Systems	Daily	Check for proper operation
		Test chlorine and fluoride residuals
		Check chlorine generator amps and volts
		Check and refill chlorine generator salt as required
		Check and refill sodium hypochlorite as required
		Check chemical feed pump operation
		Record flow totalizer meter
		Complete Water Plant Report
	Monthly	Submit Water Plant Reports to DOH
Distribution and Meters	Daily	Perform utility locates
		Read supply well totalizer meters
	2 month	Read customer meters
		Perform meter shut offs for non-payment
Customer Support	Daily	Investigate customer complaints as required
	Twice Weekly	Perform meter turn ons, shut offs, and leak checks

Table 8.3 Water Quality Monitoring Schedule Water System Plan City of Bainbridge Island		
Parameter	**Location**	**Frequency**
Operational Monitoring		
Chlorine Residual	Operating well sites	Daily
Fluoride Residual	Operating well sites	Daily
Chlorine Residual	Winslow distribution system	Monthly
Fluoride Residual Check Sample	Operating well sites	Monthly
Iron and Manganese	Taylor well site	Monthly
Compliance Monitoring		
Nitrate	Well sources	1 year
Arsenic	Well sources	3 - 9 year
Manganese	Well sources	3 - 9 year
Inorganic Chemical	Well sources	9 year
Volatile Organic Chemical	Well sources	3 - 6 year
Herbicides	Well sources	9 year
Pesticides	Well sources	9 year
Soil Fumigants	Well sources	3 year
Gross Alpha and Radium 228	Well sources	3 - 6 year
Total Coliform	Distribution systems	Monthly
Disinfectant Byproducts	Distribution systems	1 - 3 year
Asbestos	Distribution systems	9 year
Lead and Copper	Customer taps	3 year

8.4.2 Preventive Maintenance and Repairs

Preventive maintenance is necessary to maintain equipment and systems in good working order. These activities are scheduled on a less frequent basis than routine operations. About 14 percent of the division's Water Utility labor is spent on these activities. These activities are summarized in Table 8.4.

Corrective maintenance and repairs are scheduled, non-emergency activities necessary restore or enhance the normal functioning of equipment and systems. About 11 percent of the division's Water Utility labor is spent on these activities. Examples include pump, motor, piping, chlorine generator, meter, emergency generator, vehicle, and controls repair, overhaul, and replacement.

Table 8.4	Preventive Maintenance Water System Plan City of Bainbridge Island	
Component	**Frequency**	**Activity**
Automatic Valve	12 month	Clean screens, adjust controls and test for proper operation Check pipes and fittings for leakage
	72 month	Overhaul main valves and controls
Building	12 month	Inspect screens and vents Check for loose conduits and fasteners Lubricate doors and locks Clean roof and gutters Test backflow preventer
Booster Pump	12 month	Inspect and lubricate bearings Clean motor Inspect and clean clear well as required Check bolts and fasteners Exercise valves
Chlorination	3 month	Inspect and clean chlorine generator power cells
	36 month	Clean hypochlorite storage tanks
Distribution	12 month	Flush system Correct fire hydrant discrepancies
Electrical and SCADA	12 month	Inspect for loose connections, cracked, or burnt wires Clean control cabinet and meg motors Check starter for burnt or degraded contacts Measure amperage readings Clean floats and level transmitter Test telemetry set points and alarms
Emergency Generator	Monthly	Check belts, hoses and fluids Operate and test generator
	12 month	Change fluids
	36 months	Perform load test
Fluoridation	48 month	Inspect and clean fluoride saturator
Grounds	12 month	Inspect, grade, and gravel roadway as required Remove vegetation as required

Table 8.4	Preventive Maintenance (Continued) Water System Plan City of Bainbridge Island	
Component	**Frequency**	**Activity**
Reservoir	6 month	Inspect and clean vents, screens, and gaskets Inspect hatch seal and gasket Inspect ladder, railing, and safety climb
	72 month	Clean and inspect interior Clean and inspect exterior
SCADA	3 month	Inspect remote terminal units (RTU) Inspect and test UPS and back up batteries
Supply Well	12 month	Perform pump test Calculate specific capacity Exercise valves
	36 month	Test flow meter
	120 month	Rehabilitate well and replace pump

8.4.3 Cross Connection Control

The City's CCCP is a combination program that relies upon both in-premise and premise isolation for cross connection control. Currently there are over 1,250 backflow devices being managed under the program. The City's Cross Connection Control Procedure Manual is shown in Appendix N.

In 2010 the City implemented a Backflow Testing Program where participating customers have their backflow devices tested by a City contracted certified backflow tester at a reduced rate and test costs are reimbursed through customer fees. This voluntary program improves customer compliance with testing requirements and reduces program administration costs. Currently about 70 percent of the tracked backflow devices are participating in this program.

The CCCP is managed in accordance with WAC-246-290. The legal authority to implement the program is provided by Bainbridge Island Municipal Code 13.20 and the City's Backflow Assembly Design and Construction drawings 10-160 through 10-167. The program is administered under the Public Works Director's authority as the City water purveyor and is coordinated with the City Building Official as the Local Administrative Authority (LAA). The LAA is part of the PCD.

The primary functions of the program are carried out by the Public Works Operations and Maintenance Division by the City's designated CCCS, the Operations Project Manager position. These functions include survey, inspection, testing, notification, enforcement,

backflow incidence response, public education, and record keeping. Personnel who hold Cross Connection Control Specialist certifications are shown in Table 8.1.

Excluding the Backflow Testing Program, about 8 percent of the division's Water Utility labor is spent on cross connection control activities. The program is augmented with additional General Government funds, amounting to about 10 percent of the division's overall labor, to account for management of in-premise cross connection control activities.

8.4.4 Project Management and Support

These activities fall into two main categories: project management and project support. Combined about 17 percent of the division's Water Utility labor is spent on these activities.

Project management activities include the development, bidding, and management of projects covering procurement, maintenance, and small capital improvements. Examples include vehicle and equipment acquisition; operational projects performed by outside contractors such as reservoir cleaning, backflow testing, and automatic valve maintenance; and capital projects under □100,000.

Project support activities for customer, development, and large capital projects include both administrative and field aspects. Administrative support activities include plan reviews, construction coordination, and the processing of water availability requests including researching information, assessing fees, and issuing responses. Field support activities include performing utility locates and installing meters for construction projects as well as new water main construction inspections, flushing, pressure testing, and bacteria sampling.

8.4.5 Emergency Response

Emergency response refers to unscheduled activities necessary to restore equipment and systems to normal functioning and capacity. It is estimated that less than 1 percent of the division's Water Utility labor is spent on emergency response. Most emergencies are mitigated quickly and follow up, if any, is performed as a corrective maintenance and repair work activity. Examples of emergencies that may occur include acute water quality monitoring violations, water main breaks, pump failures, power failures, wind storms, rain storms, snow storms, earth quakes, fire, burglary, vandalism, terrorism, and transportation system failures.

8.4.5.1 Related Plans

The Coliform Monitoring Plan and Procedures shown in Appendix L outlines actions to be taken in case of a bacteriological water quality emergency. Inorganic and organic water quality emergency actions follow similar response and reporting protocol.

A Vulnerability Assessment and Emergency Response Plan have been prepared that conform to the requirements of the Bioterrorism Act of 2002. The documents contain a vulnerability assessment of the City's water system facilities, a contingency operation plan

for responding to emergency events, a list of water personnel responsible for making decisions during emergency events. These documents contain confidential information that is exempt from public disclosure under the provisions of Revised Code of Washington (RCW) 42.56.210. They are available for review by authorized personnel on a need to know basis.

The City's Emergency Operation Plan (EOP) policies and procedures are currently being reviewed and updated. High level Water Utility emergencies fall under the EOP Incident Command (IC) structure.

8.4.5.2 Reliability and Redundancy Factors

The City's water systems are designed and managed with reliability and redundancy in mind. This philosophy helps to avoid emergencies through early detection and minimize the impact of those emergencies that do occur. Water system reliability and redundancy factors are discussed below.

Emergency Phone List – The City maintains a detailed emergency phone list. The list includes phone numbers for various City offices, engineers, officials for the DOH and Department of Ecology, and various parts suppliers and repair key outside service providers.

Personnel and Equipment – The City maintains a robust fleet of rolling stock, extensive specialized equipment inventory, and a complete stock of critical spare parts. Key personnel are cross-trained, qualified personnel are available at all times, and a standby call back list is maintained for emergencies that occur outside of normal working hours. A list of internal and external emergency contacts is maintained on file. The Water Utility has a fully funded repair and maintenance budget and funds are available for emergency contingencies. During emergencies management personnel are available and during major events the City can call upon a diverse group of professionals throughout the organization.

Supply – The Winslow Water System is supplied from eleven wells located at four well sites that draw from three separate aquifers. Two of the largest well sites are equipped with multiple booster pumps for added flexibility. The Rockaway Beach Water System taps a fourth aquifer. The well meters are tested every three years and the specific capacity and chloride content of the wells is tested on an annual basis. There is continuous water level monitoring at seven wells. The active well sites have locked wellhead enclosures, intrusion alarms, and most are fenced to provide site security.

Storage – Storage for the Winslow Water System is provided by multiple reservoirs. The reservoirs supply the high zone distribution system through a 12-inch loop with adequate sectional valves to isolate either reservoir or loop branch in case of emergency. The distribution system is well looped and the low zone is supplied from six PRV stations. Both the Winslow and Rockaway Beach water systems supply the water systems by gravity when the well sites are not operating.

SCADA – The City's water systems are monitored and controlled by SCADA system designed by S&B Inc. The system allows personnel to adjust set points, troubleshoot systems, and manage data. Communication with remote sites is accomplished through leased analog and digital subscriber telephone lines (DSL). A CAS historian archives and stores data and an autodialer calls out alarm conditions to standby personnel for after-hours emergency response. All well sites, reservoirs, and select PRV stations are monitored and/or controlled through the system. As outlined in Chapter 4 a wide variety of critical parameters are monitored by the SCADA system.

In addition to the SCADA system, S&B Inc. has been responsible for the design and installation of all City water and wastewater control systems since 1995. This relationship has helped establish standards and ensure continuity of systems design. Over the years the SCADA system and remote controls have proven extremely reliable. All software and hardware are designed with reliability and redundancy. The SCADA has a backup system available on-site. Level probes are backed up with floats. Smart controllers are widely employed and software includes fail safe logic. Over the past ten years long term interruption of the telephone lines has been rare and in case of communication failures, all remote sites have standalone controls that can operate independent of the main SCADA system. During emergencies, technical support is available around-the-clock.

Power Grid – The five well sites are served by different portions of the power grid. It is rare when all well sites are affected for a long period of time during a power outage. Puget Sound Energy (PSE) has the ability to provide primary power supply from different substations and to reroute power through distribution switches. PSE considers the Water Utility a priority customer and the City is notified in advance of all scheduled power outages. During major outages and large scale power distribution outages the City coordinates directly with the PSE substation supervisor.

Emergency Power Supply – Typically during widespread power outages water consumption decreases; however, if necessary, the Water Utility has three mobile generators capable of operating the key well sites. The mobile generators can be located at any well site providing an additional degree of flexibility. Every well site is equipped with a generator receptacle and manual transfer switch.

Water Quality – Over the past ten years the City's water systems have had a solid history of good water quality. Disinfection is provided at each well site and a detectable residual is maintained in the distribution system. Construction activities are well monitored and the use of fire hydrants for temporary water supply is severely limited. The water system has an active cross connection control program that is well coordinated with the LAA to provide both premise and in-premise protection.

8.4.5.3 Emergency Call-out Procedures

Water Utility emergencies and alarms are normally reported through the SCADA telemetry system or by telephone from the public. During normal working hours the telemetry system is continuously monitored at the City's Wastewater Treatment Plant (WWTP) and system alarms are routed for response by wastewater plant personnel. Emergencies reported by the public are reported to the O&M front desk and the appropriate personnel are dispatched to respond.

As part of the SCADA telemetry system an automated dialer system reports water system alarms that occur outside of normal working hours. This system calls standby personnel, based on a prioritized employee telephone list, until it receives a response. The on-call employee is designated to be the first to receive after-hours emergency calls and alarms.

Other water system emergencies that are reported outside normal working hours are routed through the Kitsap County 911 emergency response system. Using an emergency call-out list the 911 emergency operator is able to contact standby personnel. As outlined above, the primary responder to those after-hours calls is the on-call employee. Water Utility personnel are trained to respond to system alarms or emergencies. The contacted employee assesses the situation and then responds in accordance with established procedures.

8.5 SAFETY PROGRAM

In addition to professional certifications required by specific job classifications, the City requires that all O&M personnel hold the following core licenses and certifications: Commercial Driver License, Forklift Operator, First Aid/CPR, and Traffic Control Flagger.

The O&M Division has a written Accident Prevention Plan and an active safety program. Hazard communication, hearing conservation, confined space entry, fall protection, lockout/tag out, traffic control, and trenching safety standards are strictly adhered to. Workplace injuries and near misses are investigated and reviewed. Monthly safety meetings are conducted to discuss workplace hazards and proper safety procedures. Safety training is regularly provided on a wide variety of topics. Recently completed training is summarized below.

- Active Shooter
- Backhoe Safety
- Blood Borne Pathogens
- Bucket Truck Safety
- CDL Pre-trip Inspection
- Chain Saw Safety
- Compressed Gas Safety
- Confined Space Entry
- Defensive Driving
- Electrical Safety
- Fall Protection
- Hand and Power Tool Safety
- Hazard Communication
- Hearing Conservation

- High Voltage Safety
- Hearing Conservation
- Hearing Conservation
- Job Safety Analysis
- Lab Safety
- Lifting and Rigging
- Lock Out/Tag Out
- Personal Protective Equipment
- Slips, Trips, and Falls
- Preventing Strains and Sprains
- Respiratory Protection
- Spill Prevention and Control
- Trenching and Excavation
- Waste Management

8.6 RECORD KEEPING

Throughout the City a wide variety of Water Utility records are maintained. The Finance and Administrative Department maintains utility billing, customer account, and financial records. Human Resources maintains personnel and risk management records. PCD maintains building and development records. Information Technology maintains information system and GIS records. The Public Works Engineering Division maintains capital project, construction, study, survey, easement, and right of way records.

The O&M Division maintains water availability application, service installation, and inspection records. Building and development projects are tracked through an integrated land use software system. Safety, training, certification, and fleet maintenance records are maintained and incident reports document major events and emergencies.

Operational records covering supply, distribution, and storage are routinely maintained. Key regulatory information covering customer complaints, water production, water consumption, water quality sampling, and cross connection control is kept on file. Critical data and events covering levels, flow rates, pressures, cycles, and alarms are archived through the telemetry system CAS historian.

DOH reports are maintained on file. Water Plant Reports covering chlorination and fluoridation are submitted to the DOH monthly. CCCS, WUE, and Consumer Confidence reports are submitted to the DOH annually. Water Facilities Inventory and Sanitary Survey reports are kept on file.

All work performed by the division is organized, documented, and tracked through a Computerized Maintenance Management System (CMMS). The CMMS is integrated with the City financial software and labor charged to work orders is linked to the budget through daily time and attendance entry.

8.7 FUTURE OPERATION AND MAINTENANCE NEEDS

The following items for implementation to improve the function of the current operation and maintenance program:

- Improve maintenance, project close out, and GIS coordination practices to ensure timely GIS updates and comprehensive map records.

- Update the Emergency Response Plan.
- Review the distribution of labor across the various work units for opportunities for improvement.
- Establish a succession plan and mentoring program.

CAPITAL IMPROVEMENTS PLAN

9.1 INTRODUCTION

This chapter combines the City of Bainbridge Island's (City's) supply, storage, pipeline, and other general projects that were recommended in the previous chapters and presents a comprehensive capital improvements plan (CIP) for the water system. The purpose of the CIP is to provide the City with a guideline for planning and budgeting of its water system. The CIP consists of schedule and cost estimates for the recommended improvements. Project phasing is described as either Short-term (2016 through 2021), Mid-term (2022-2025), or Long-term (2026-2035).

Recommended projects have been assigned a project name associated with the type of project. The following abbreviations were used:

- P = Pipeline
- W = Well Site/Supply
- S = Storage
- "HE" = High Elevation Fire Flow
- G = General

Identification for Rockaway Beach Water System projects are prefixed by "RB". The following sections present cost estimating assumptions, the final recommended projects and programs, and a summary of the final CIP.

9.2 COST ESTIMATING ASSUMPTIONS

9.2.1 Cost Estimate Level

The CIP cost estimates presented in this chapter are Class 4 estimates. Class 4 estimates are budget level estimates. Actual costs may vary from these estimates by -15 to +30 . These costs were determined based on the City's perception of current conditions at the project locations.

All costs are in 2015 dollars. The Engineering New Report (ENR) U.S. 20-city Construction Cost Index for July 2015 is 10037. The estimates are subject to change as the project design matures. Cost of labor, materials, equipment may vary in the future.

9.2.2 Pipeline Unit Costs

Pipeline unit cost assumptions are shown in Table 9.1. These costs were developed from recent construction costs of various water pipelines. To be conservative, these unit costs

assume open-trench construction in improved areas. If trenchless construction is possible for some projects, the cost estimates may need to be modified. Costs include pavement cutting, excavation, hauling, shoring, pipe materials and installation, backfill material and installation, and pavement replacement. The unit costs are for typical field conditions with construction in stable soil at a depth ranging between 8 to 10 feet. These costs are total project cost; they include 30 percent contingency, 10 percent general conditions, 15 percent general contractor overhead, and 20 percent engineering/legal/administration costs.

Table 9.1 Pipeline Unit Costs
Water System Plan
City of Bainbridge Island

Pipe Size (Inches)	Pipeline Unit Cost ($/Linear Foot)[1]
6	276
8	296
10	316
12	335
16	414
20	434
24	533

Notes:
(1) Pipeline unit costs include 30 Contingency, 10 General Conditions, 15 General Contractor Overhead, and 20 Engineering/Legal/Admin.

9.3 PIPELINE PROJECTS

The pipeline projects recommended to be completed during the planning period are listed in Table 9.2 and shown on Figure 9.1. Each pipeline CIP item is described below.

9.3.1 P-1: Winslow Pipeline Improvement Projects

Nine pipe segments throughout the Winslow Water System are recommended to be upsized as a result of the system analysis to provide the required fire flow capacity. These pipe segments are listed as P-1A through P-1I in Table 9.2 and shown on Figure 9.1.

The City is in the process of implementing Project P-1E, which consists of upgrading pipeline along Olympic Drive. Therefore the cost of this project is not included in the CIP.

Table 9.2 Pipeline Improvement Projects
Water System Plan
City of Bainbridge Island

Segment	Type	Length (LF)	Existing Diameter (inch)	New Diameter (inches)	Planning Period
P-1A	Upsize	1,970	4	8	Long-term
P-1B	Upsize	150	4	8	Long-term
P-1C	Upsize	320	2	8	Long-term
P-1D	Upsize	550	4	8	Long-term
P-1E	Upsize	1,000	4	8	Long-term
P-1F	Upsize	780	4	8	Long-term
P-1G	Upsize	990	6	8	Long-term
P-1H	Upsize	850	1.5	8	Long-term
P-1I	Upsize	120	8	12	Long-term
P-2A	New	1,260	-	8	Long-term
P-2B	New	3,160	-	12	Long-term
P-2C	New	840	-	8	Long-term
P-3	Upsize	900	2/6	8	Short-term
P-4A	Upsize	250	6	12	Short-term
P-4B	Upsize	400	4	8	Short-term
P-4C	Upsize	450	6	8	Short-term
Total		11,990			

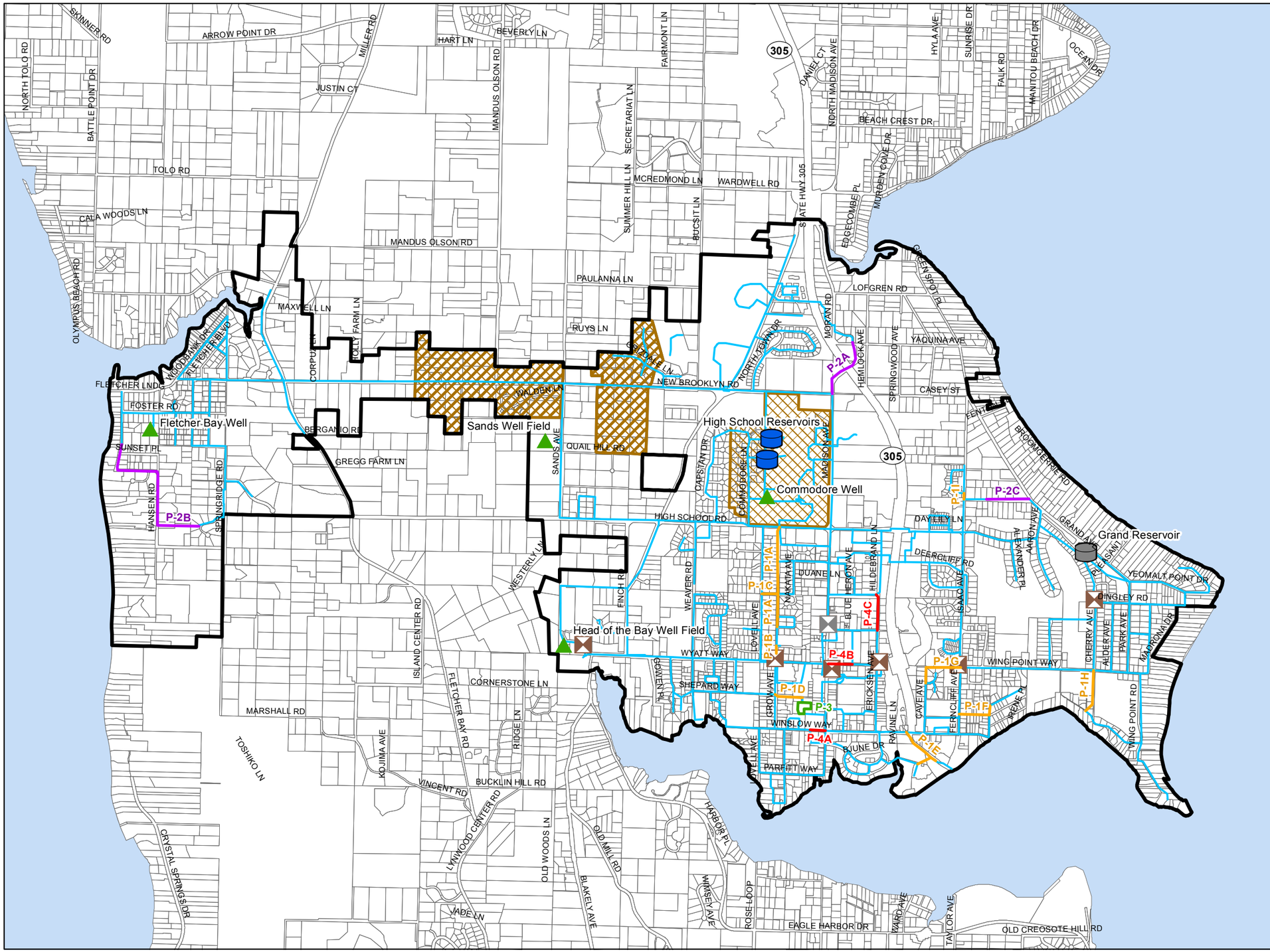


Figure 9.1
Pipeline and Rezone Improvement Projects
Water System Plan
City of Bainbridge Island

9.3.2 P-2: Winslow Pipeline Installation Projects

Three new pipe segments are recommended to provide looping within the Winslow Water System and thereby allow the distribution system to meet fire flow requirements. These projects are listed as P-2A, P-2B, and P-2C in Table 9.2 and shown on Figure 9.1. Projects to provide looping on the west side of the Winslow Water System such as Project P-2B will be implemented as the water system expands. These projects will be paid for by developers. Therefore the cost of P-2B is not included in the CIP.

9.3.3 P-3: Shepherd Way Pipeline Improvement Project

The City found that the water feed to the Winslow Park Condominium Complex on Shepherd Way is undersized. A high priority project for the City is to increase the diameter of the 900 feet of pipes supplying the complex to 8 inches. This project is shown on Table 9.2 and Figure 9.1 as P-3.

9.3.4 P-4: Winslow Core Fire Flow Improvement Projects

The 2015 inspection by the Washington State Survey and Rating Bureau (Bureau) brought to the City's attention some buildings within the Winslow Core require fire flows above the City's general policy of 1,500 gallons per minute (gpm) for commercial and multi-family buildings. Carollo Engineers prepared a memorandum for the City that lists the fire flows available to many of the buildings in the Winslow Core as predicted by the City's hydraulic model. This memorandum is included in this Plan as Appendix Q.

The City is in the process of evaluating these fire flow requirements further and determining how to provide increased fire flow capacity to specific buildings in the Winslow Core. At this time, the City has identified three pipeline upgrade projects to be implemented in the short-term. These projects are listed in Table 9.2 as projects P-4A, P-4B, and P-4C and are shown on Figure 9.1.

9.4 WELL SITE PROJECTS

9.4.1 W-1: Winslow Water Quality Analysis

The City has budgeted □50,000 in the short-term planning period to assess iron, manganese, hydrogen sulfide, chlorine residual, arsenic, and disinfection byproducts DBPs in the water system.

9.4.2 W-2: Winslow Water Treatment Improvements

The City has budgeted □500,000 in the short-term planning period to implement water treatment improvements to keep iron, manganese, and sulfide levels from exceeding the maximum contaminant levels (MCLs).

9.4.3 W-3: Head of the Bay Emergency Generator

The City will be installing an emergency generator at the Head of the Bay Well Site within the short-term planning period to provide a permanent redundant power supply to the Head of the Bay wells, booster pumps, and treatment system. The generator installation is estimated to cost □100,000.

9.4.4 W-4: Chlorine Generator Upgrades

The City's chlorine generators at the Sands, Fletcher Bay, and Head of the Bay Well Site are between 7 and 13 years old. These three 36 pounds per day (ppd) units will need to be replaced within the mid-term planning period. The City is budgeting □60,000 for each unit.

9.4.5 W-5: Winslow Supply Options Evaluation

The Winslow Water System has adequate supply in the Short-term and Mid-term planning periods. However, as demands approach 2035 projection levels, additional supply will need to be acquired in order to meet the City's supply redundancy criteria. A supply evaluation will need to be done within the long-term planning period to determine the best option for giving the Winslow Water System additional supply. The budget for this task is □40,000.

9.4.6 W-6: Winslow Well and Booster Pump Improvements

This CIP project is a budgetary placeholder of □1.5 million for the supply rehabilitation and capacity upgrades that the City will need to implement in order to meet the City's supply redundancy criteria in the long-term planning period. This project includes existing well rehabilitation. It may also involve the construction of a new well site with new booster pumps and the transfer of water rights. Project W-5 will determine the necessary supply improvements.

9.4.7 RB-1: Rockaway Beach Supply and Storage Evaluation

The Rockaway Beach Water System requires additional supply and storage in the short-term planning period to meet the City's criteria. The alternatives that the City is considering are:

- Acquire an adjacent utility with excess water supply and storage,
- Construct an intertie, buy water, and lease storage from an adjacent utility,
- Drill a new 80-gpm well to utilize the full Taylor Avenue water right,
- Acquire an additional well and water rights such as the Wyckoff Well,
- Construct a new storage tank, and

- Construct a transmission main that connects Rockaway Beach to the Winslow Water System.

□100,000 is budgeted for this evaluation.

9.4.8 RB- 1: Rockaway Beach Supply and Storage Improvements

A budgetary placeholder of □3.0 million is included in the CIP for the supply and storage improvement project, which should be implemented in the short-term. The cost estimate for this project is based on constructing a 2-mile transmission main that connects Rockaway Beach to the Winslow Water System.

This CIP item includes a cost estimate of □1,000,000 in the short-term planning period for improvements that would connect the Wyckoff Well to the Rockaway Beach Water System.

9.5 STORAGE PROJECTS

9.5.1 S-1: Winslow Tank Structural Integrity Analysis

The purpose of this project is to assess the seismic resiliency of the City's High School reservoirs. The project also includes analysis of tank mixing, the integrity of tank valves, and the condition of tank interior and exterior coating. The tanks were last inspected in 2009 and upgrades were most recently performed in 2003. The City's budget for storage facility analysis is □50,000 in the short-term planning period.

9.5.2 S-2: Winslow Storage Improvements

This projects encompasses the implementation of the necessary storage facility improvements that are identified during the Winslow Tank Structural/Integrity Analysis. At this time it is not known what projects will be necessary. A budget placeholder of □500,000 is included in the CIP for this project.

9.6 HIGH ELEVATION FIRE FLOW PROJECTS

9.6.1 HE-1: Winslow High Elevation Fire Flow Evaluation

Some high elevation customers within the Winslow Water System do not have adequate pressure or fire flow to meet the City's criteria. These high elevation customers also minimize the amount of storage that is considered available. □50,000 is budgeted for this evaluation that would determine the required system modifications. Remodeling at the high school will lower the maximum fire flow requirements there, which may reduce some of the deficiencies at the school.

9.6.2 HE-2: Winslow High Elevation Fire Flow Improvement Implementation

Implementation of projects to supply adequate pressure and fire flow to high elevation customers is to be completed in the short-term planning period. A budgetary placeholder of □900,000 is included in the CIP. This budget is subject to change as the project is more clearly defined by evaluation HE-1.

9.7 GENERAL PROJECTS

9.7.1 G-1: Water System Plan Updates

Although water system plan updates are currently required every 6 years, the City's next water system plan update will likely not be required for another 10 years, as the Washington State Department of Health (DOH) is considering modifying the requirement. The City's next water system plan updates would be in the years 2025 and 2035. Each plan will cost approximately □125,000.

9.7.2 G-2: SCADA Improvements

Supervisory Control and Data Acquisition (SCADA) system improvements are planned to occur throughout the planning period. In the short-term, □250,000 is budgeted. The City is budgeting □150,000 each for the mid-term and long-term planning periods.

9.7.3 G-3: Meter Replacement

The City has budgeted □20,000 per year for meter upgrades throughout the 20-year planning period.

9.8 EXPANSION PROJECTS

As the water system expands to serve new customers within the retail water service area, piping, storage, pumping, and pressure reducing valve (PRV) projects will be required. Some of the anticipated projects are shown in green on Figure 9.2. The City assumes that these projects will largely be funded by the new customers added to the system. Therefore, these project are not budgeted in the CIP.

9.9 CIP SUMMARY

The total Water CIP cost over the next 20 years is □12,101,000, which equates to □605,000 annually, as presented in Table 9.3. Of the total cost, □4,224,000 is budgeted for the Short-term Phase, □3,535,000 is budgeted for the Mid-term Phase, and □4,342,000 is budgeted for the Long-term Phase.

The Water CIP is split into six categories: pipeline, well site/supply, storage, high elevation fire flow, Rockaway Beach, and general. Throughout the 20-year planning period, □2,931,000 (24 percent) is budgeted for pipeline projects, □2,370,000 (20 percent) is budgeted for well site/supply projects, □550,000 (5 percent) is budgeted for storage projects, □950,000 (8 percent) is budgeted for high elevation fire flow projects, □4,100,000 (34 percent) is budgeted for Rockaway Beach Projects, and □1,200,000 (10 percent) is budgeted for general projects.

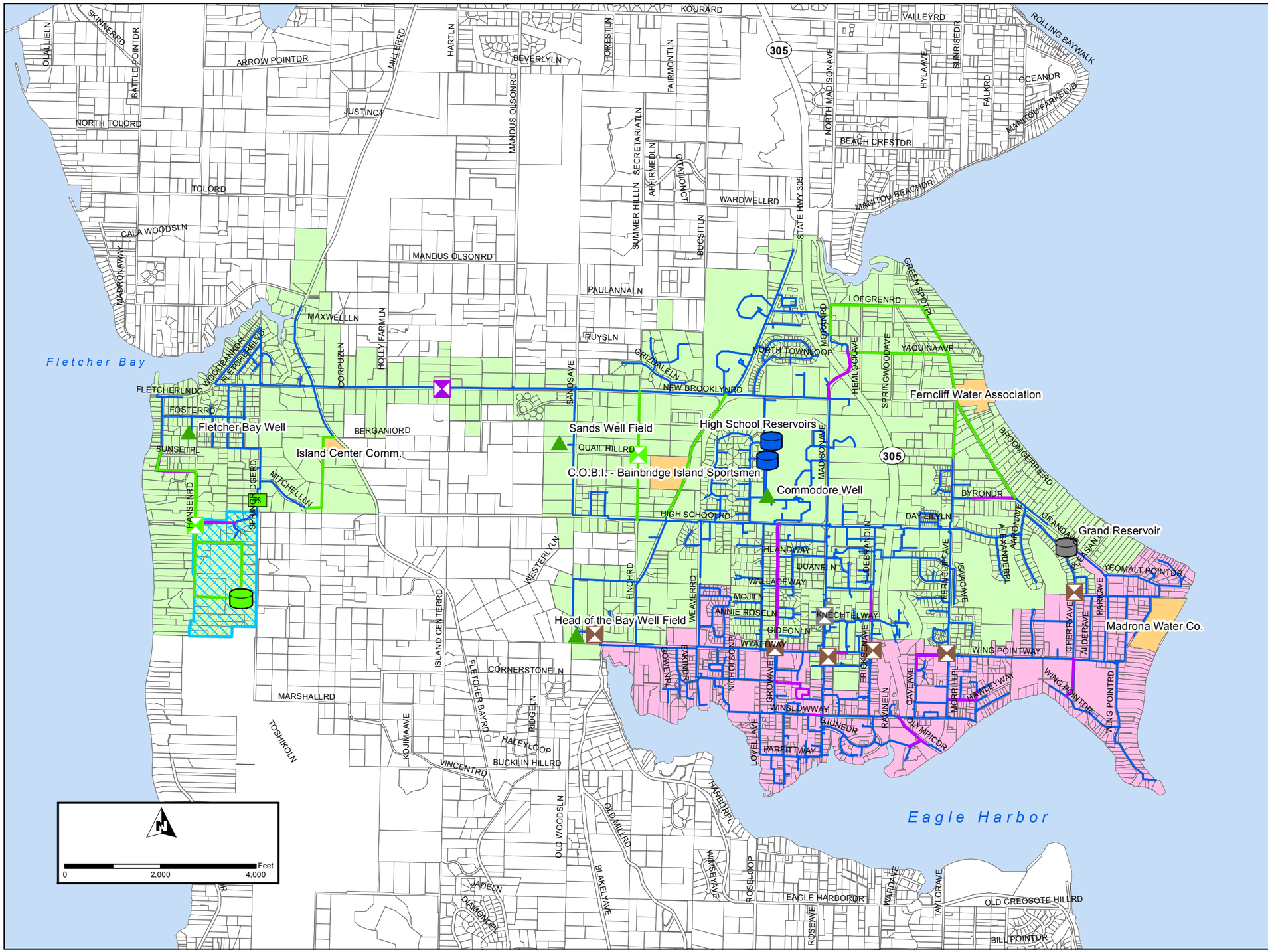
Table 9.3 Capital Improvements Plan
Water System Plan
City of Bainbridge Island

Project ID	Description	Total Capital Cost ($)	Capital Improvement Phasing		
			Short-Term (2016-2021)	Mid-Term (2022-2025)	Long-Term (2026-2035)
Pipe Projects					
P-1	Winslow Pipeline Upsize Projects	1,705,000			1,705,000
P-2	Winslow Pipeline Installation Projects	622,000			622,000
P-3	Shepherd Way Pipeline Improvement Project	267,000	267,000		
P-4	Winslow Core Fire Flow Improvement Projects	337,000	337,000		
Total		**$2,931,000**	**$604,000**	**-**	**$2,327,000**
Well Site Projects					
W-1	Winslow Water Quality Analysis	50,000	50,000		
W-2	Winslow Water Treatment Improvements	500,000	500,000		
W-3	Head of the Bay Emergency Generator	100,000	100,000		
W-4	Chlorine Generator Upgrades	180,000		180,000	
W-5	Winslow Supply Options Evaluation	40,000			40,000
W-6	Winslow Well and Booster Pump Improvements	1,500,000			1,500,000
Total		**$2,370,000**	**$650,000**	**$180,000**	**$1,540,000**
Storage Projects					
S-1	Winslow Tank Structural/Integrity Analysis	50,000	50,000		
S-2	Winslow Storage Improvements	500,000	500,000		
Total		**$550,000**	**$550,000**	**-**	**-**

Table 9.3 Capital Improvements Plan
Water System Plan
City of Bainbridge Island

Project ID	Description	Total Capital Cost ($)	Capital Improvement Phasing		
			Short-Term (2016-2021)	Mid-Term (2022-2025)	Long-Term (2026-2035)
High Elevation Fire Flow Projects					
HE-1	Winslow High Elevation Fire Flow Evaluation	$50,000	$50,000		
HE-2	Winslow High Elevation Fire Flow Improvement Implementation	$900,000	$900,000		
Total		**$950,000**	**$950,000**	**-**	**-**
Rockaway Beach Projects					
RB-1	Rockaway Beach Supply and Storage Eval.	$100,000	$100,000		
RB-2	Rockaway Beach Supply and Storage Improv.	$4,000,000	$1,000,000	$3,000,000	
Total		**$4,100,000**	**$1,100,000**	**$3,000,000**	**-**
General Projects					
G-1	Water System Plan Updates	$250,000		$125,000	$125,000
G-2	SCADA Improvements	$550,000	$250,000	$150,000	$150,000
G-3	Meter Replacement	$400,000	$120,000	$80,000	$200,000
Total		**$1,200,000**	**$370,000**	**$355,000**	**$475,000**
All CIP Projects					
Total Cost		**$12,101,000**	**$4,224,000**	**$3,535,000**	**$4,342,000**
Annual Cost		**$605,000**	**$704,000**	**$884,000**	**$434,000**

Notes:
(1) All cost estimates in 2015 dollars.



Legend

Future Service Connection Assumptions

- New Reservoir for Future Service Connections
- Proposed Pump Station for New Connections
- New PRV for Future Service Connections
- Proposed New Service Connection

Proposed System Improvements

- New PRV Station
- Proposed Pump Station
- New Pipes

Existing System

- PRV (Out of Service)
- PRV
- Reservoir (Out of Service)
- Reservoir
- Well Field
- Existing Water Pipelines
- Water Body
- Other Water Purveyors
- Parcels

Pressure Zone

- Low
- High
- New 460 Zone

Figure 9.2
Future Connection Assumptions
Water System Plan
City of Bainbridge Island

FINANCIAL ANALYSIS

10.1 INTRODUCTION

The purpose of this chapter is to assess the City of Bainbridge Island's ability to fund the water capital improvements plan (CIP) outlined in Chapter 9. Financial status of the water utility, funding required to finance the scheduled improvements, potential funding sources and the impact of water system improvements on water rates are presented.

10.2 HISTORICAL FINANCIAL PERFORMANCE

10.2.1 Current Water Rates

The City's water rates were initially set by Ordinance 82-20, and later amended through Ordinance 2011-26. In August 2013, there was a 30 percent reduction in rates implemented by Ordinance 2013-22. Since then, City Council has eliminated the automatic rate increase included in the Bainbridge Island Municipal Code, and therefore keeping rates static. The most recent list of charges for the water system can be found in Appendix P. The City has six rate categories which are as follows:

- Category 1 - Single Family Residences (SFR).
- Category 2 - Multi-Family, or Multi-Dwellings, including but not limited to apartment houses, condominiums, and mobile homes.
- Category 3 - Commercial, including but not limited to retail sales, personal and professional services, entertainment, repair facilities, and restaurants.
- Category 4 - Other (any users not identified in Categories 1, 2, 3, 5, and 6).
- Category 5 - Industrial.
- Category 6 - Irrigation Systems.

The base rates for categories 1, 3, 5, and 6 are shown in Table 10.1. Category 2 (Multi-Family) has a base rate of □5.37 per each residential unit in the multi-family complex. Category 5 (Industrial) has the rates set by an individual contract with the rates being no less than any of the rate schedules in categories 1-4.

In addition to the base charge, the customers also pay a usage charge for the water consumed. Table 10.2 provides the usage charge for rate categories 1 (Single Family) and 2 (Multi-Family). The City implemented this inclining block rate to promote conservation.

Categories 3 (commercial) and 4 (Other) are charged □1.43 per 100 cubic feet from November to April and □1.65 per 100 cubic feet from May to October. Category 5

(Industrial) is set by contract but is to be no less than the usage charges outlined in the first four categories. Category 6 (Irrigation) is charged a usage fee of □3.89 per cubic feet.

Table 10.1 Base Water Rates, 2015
Water System Plan
City of Bainbridge Island

Meter Size	Single-Family	Commercial	Other	Irrigation Systems
Up to 3/4 inch	□10.77	□16.45	□24.04	□4.73
1 inch	□21.24	□36.40	□55.37	□6.22
1-1/2 inch	□38.72	□69.78	□107.58	□8.70
2 inch	□59.71	□109.52	□170.23	□11.70
3 inch	□115.70	□215.89	□337.28	□19.64
4 inch	□178.65	□335.55	□525.22	□28.59
6 inch	□353.94	□667.94	□1047.31	□53.47

Table 10.2 Residential Single-Family and Multi-Family Usage Water Rates, 2015
Water System Plan
City of Bainbridge Island

Usage Category	Rate
For the first 500 cubic feet	□1.09 per 100 cubic feet
For the next 700 cubic feet	□1.76 per 100 cubic feet
For the next 1,800 cubic feet	□2.49 per 100 cubic feet
For amounts over 3,000 cubic feet	□3.39 per 100 cubic feet

10.2.2 System Participation Fees

The connection fees charged to new connections are outlined in Table 10.3 below and have been determined through Ordinances 97-26 and 2005-18.

The City also has an installation fee for installing the meter and activating the service. Ordinance 99-24 has set this cost at either □950 for a 3/4-inch line (□1,100 for a 1-inch line) if the service is on the same side of the street or □2,500 for a 3/4-inch line (□2,750 for a 1-inch line) if it is on the opposite side of the street. Larger pipe sizes are calculated on a case-by-case basis at 125□ of direct costs.

Table 10.3 System Participation Fee Water System Plan City of Bainbridge Island				
Meter Size	**Single-Family**	**Multi-Family**	**Commercial**	**Irrigation**
Up to 3/4 inch	□2,754	□4,515	□5,692	□4,498
1 inch	□6,885	□11,287	□14,231	□11,245
1-1/2 inch	□13,770	□22,575	□28,462	□22,490
2 inch	□22,033	□36,120	□45,539	□35,984
3 inch	□44,066	□72,241	□91,079	□71,968
4 inch	□68,854	□112,876	□142,311	□112,450
6 inch	□137,708	□225,753	□284,623	□224,901

10.2.3 Historical Financial Operations

Water utility revenues for the years 2012 through 2014 are summarized in Table 10.4. Water sales decreased approximately □300,000 from 2013 to 2014 due to a decrease in water rates. In 2011, the City commissioned a consultant team to determine if water rates could be lowered. The Utility Business Advisor Report provided the City with enough information to lower rates to a level that would cover operation costs and to use their reserves to cover future capital projects. The 2015 budget was determined by the City and is used in the projections presented later in the chapter.

Table 10.4 Historical Operating Revenues Water System Plan City of Bainbridge Island				
Operating Revenues	**2012**	**2013**	**2014**	**2015 Budget**
Water Sales	□1,263,128	□1,237,635	□939,707	□935,000
Other Charges	□161,229	□183,431	□138,710	□157,200
Miscellaneous	□131,862	□170,144	□128,053	□138,000
Interest	□33,574	□25,610	□27,092	□28,000
Total Revenues	□1,589,793	□1,616,820	□1,233,562	□1,258,200

Water utility expenditures for the years 2012 through 2014 are summarized in Table 10.5. The 2015 budget was determined by the City and is used in the projections presented later in the chapter.

Table 10.5 Historical Operating Expenditures Water System Plan City of Bainbridge Island				
Operating Expenditures	**2012**	**2013**	**2014**	**2015 Budget**
Salaries	□359,021	□361,296	□378,882	□412,217
Other Services and Charges	□209,849	□221,888	□171,518	□202,970
Intergovernmental Services	□161,700	□155,430	□113,858	□155,400
Benefits	□130,695	□131,840	□143,677	□162,005
Professional Services	□60,848	□56,095	□113,688	□110,766
Supplies	□23,131	□38,814	□43,562	□53,272
Capital Equipment	□0	□0	□0	□10,000
Total Expenditures	□945,244	□965,363	□965,185	□1,106,670

10.3 OUTSTANDING DEBT

The City's water utility does not have any debt obligations at the time of writing this report.

10.4 FINANCIAL FORECAST

10.4.1 Projected Operating Revenues and Expenses

Table 10.4 and Table 10.5 show the baseline data upon which the projections developed below were based. Forecast factors are based on historical and projected data and were discussed with the City. The factors are used in determining projections and are shown in Table 10.6. The ERU growth rate is based upon historical new connection data for the water system over the last three years. Electricity increases were determined to be linked with general inflation. A zero percent growth for insurance expenses is a reasonable assumption as the City does not foresee any future increases and their insurance expenses have been decreasing the past three years. Table 10.7 and Table 10.8 present the projected operating revenues and expenses for the water utility.

Table 10.9 shows the projected operating cash flow for the water utility.

Table 10.6 Forecast Factors Water System Plan City of Bainbridge Island	
Forecast Factors	**Value**
Water ERU Growth Rate	1.0□
Interest Earning Rate	0.5□
COLA	2.5□
Inflation	3.0□
Electricity Increase	3.0□
Insurance Increase	0.0□

Table 10.7 Projected Operating Revenues
Water System Plan
City of Bainbridge Island

Operating Revenues	2016	2017	2018	2019	2020	2021
Water Sales	944,400	953,800	963,300	972,900	982,600	992,400
Connection Fees	106,240	107,300	108,370	109,450	110,550	111,650
Other Charges	157,200	157,200	157,200	157,200	157,200	157,200
Miscellaneous	138,000	138,000	138,000	138,000	138,000	138,000
Interest (1)	28,430	24,070	22,470	13,300	2,770	0
Total Revenues	1,374,270	1,380,370	1,389,340	1,390,850	1,391,120	1,399,250

Notes:
(1) Interest is calculated by multiplying the 0.5 assumed rate by the City's beginning fund balance.

Table 10.8 Projected Operating Expenditures
Water System Plan
City of Bainbridge Island

Operating Revenues	2016	2017	2018	2019	2020	2021
Salaries	422,500	433,000	443,800	454,900	466,300	478,000
Other Services and Charges	208,600	214,300	220,100	226,100	232,400	238,800
Intergovernmental Services	160,200	165,000	170,000	175,100	180,400	185,800
Benefits	170,200	178,700	187,700	197,100	206,900	217,200
Professional Services	114,100	117,500	121,000	124,600	128,300	132,100
Supplies	54,800	56,400	58,100	59,800	61,500	63,300
Capital Equipment	10,300	10,600	10,900	11,200	11,500	11,800
Total Expenditures	1,140,700	1,175,500	1,211,600	1,248,800	1,287,300	1,327,000

Table 10.9 Summary Projected Cash Flow Water System Plan City of Bainbridge Island						
Operating Revenues	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
(+) Total Operating Revenues	□1,374,270	□1,382,720	□1,390,390	□1,398,210	□1,405,760	□1,413,250
(-) Total Operation &Maintenance	□1,140,700	□1,175,500	□1,211,600	□1,248,800	□1,287,300	□1,327,000
(-) Total Debt	□0	□0	□0	□0	□0	□0
NET REVENUE	□233,570	□207,220	□178,790	□149,410	□118,460	□86,250
Notes: (1) Does not take into account the 60-day minimum operating reserves.						

10.4.2 Projected Capital Revenues and Expenditures

Table 10.10 presents the projected connection charge revenues while Table 10.11 presents the projected capital revenues. These are the funds available to upgrade and expand the water system. "Transfer from Operations" is the remaining amount of funds after operation expenses and current debt payments have been met. This does not include the minimum 60 day operating reserve. The connection charges are based on the number of new ERUs expected in the system. The ERU projections are shown in Table 10.10 and are based on a growth rate of 1.0 percent. The projected connection charge revenue (system participation fee) is based on the typical residential single family meter as the growth is projected in ERUs.

Table 10.10 Connection Charge Revenues Water System Plan City of Bainbridge Island							
Operating Revenues	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Number of ERUs	3,858	3,896	3,935	3,974	4,014	4,054	4,095
Annual Growth Rate	1.0□	1.0□	1.0□	1.0□	1.0□	1.0□	1.0□
Growth in ERUs		38	39	39	40	40	41
Connection Charge ($/ERU)	□2,754	□2,754	□2,754	□2,754	□2,754	□2,754	□2,754
Projected Connection Charge Revenue		□106,240	□107,300	□108,370	□109,450	□110,550	□111,650

Table 10.11 Projected Capital Revenues Water System Plan City of Bainbridge Island						
Operating Revenues	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Transfer from Operations	□43,453	□11,303	□0	□0	□0	□0
Connection Charges	□106,240	□107,300	□108,370	□109,450	□110,550	□111,650
Interest Earning from Cash	□28,430	□24,320	□22,480	□13,300	□2,770	□0
Capital Revenues Total	□178,123	□140,823	□130,850	□122,750	□113,320	□111,650

Notes:
(1) Transfer from Operations is the amount after operating expenses are met including a 60 day minimum operating reserve.

Table 10.12 presents the six-year water CIP based on the short-term projects (2016 to 2021) listed in Chapter 9. For the purpose of this analysis, the projects were designated to certain years within the 2016-2021 period. These designations are assumptions and can be shifted as the utility determines a more detailed schedule. The financial model shows that the utility will have to use reserves in order to pay for the projected capital projects. By the end of the short-term planning period the reserves will have been decreased by more than 50 percent.

Table 10.13 provides a summary of the projected water utility cash flow for the next six years. Based on the current water utility status and the projected growth within the system, the City should be able to adequately fund its operations budget. However, the projected capital projects for the next six years will require the utility to use its reserves. It is recommended that the City considers funding certain projected projects, including the Rockaway Beach supply and storage improvement projects, through issuing debt or applying to qualifying grants and loans that are discussed in this chapter.

10.5 SUMMARY

Upon analysis of the financial status of the water utility, the City has adequate revenues from water rates and system facility charges to meet the expected operating costs of the water system. However, significant capital projects are projected to be implemented in the next six years, which will require the utility to use reserves to fund these projects. By 2021, the utility's beginning fund balance will have decreased by more than □3 million, or 55 percent. The City has approximately □7.8 million in capital projects for the mid to long-term phases and the reserves will most likely not be able to fund them given the current situation. The City has the option to issue debt or apply to qualifying grants, or conducting a rate study to determine if rate increases would help to cover the costs of the projected capital costs.

Table 10.12 Projected Capital Expenditures
Water System Plan
City of Bainbridge Island

	Projected Capital Expenditures						
	2016	2017	2018	2019	2020	2021	Total
PIPE PROJECTS (P)							
P-3 Shepherd Way Pipeline Improvement Project	$267,000	$0	$0	$0	$0	$0	$267,000
P-4 Winslow Core Fire Flow Improvement Projects	$0	$337,000	$0	$0	$0	$0	$337,000
WELL SITE PROJECTS (W)							
W-1 Winslow Water Quality Analysis	$50,000	$0	$0	$0	$0	$0	$50,000
W-2 Winslow Water Treatment Improvements	$100,000	$100,000	$100,000	$100,000	$100,000	$0	$500,000
W-3 Head of the Bay Emergency Generator	$0	$0	$100,000	$0	$0	$0	$100,000
STORAGE PROJECTS (S)							
S-1 Winslow Tank Structural/Integrity Analysis	$0	$50,000	$0	$0	$0	$0	$50,000
S-2 Winslow Storage Improvements	$0	$0	$0	$250,000	$250,000	$0	$500,000
HIGH ELEVATION FIRE FLOW PROJECTS (HE)							
HE-1 Winslow High Elevation Fire Flow Evaluation	$0	$50,000	$0	$0	$0	$0	$50,000
HE-2 Winslow High Elevation Fire Flow Improvement Implementation	$0	$0	$300,000	$200,000	$200,000	$200,000	$900,000
ROCKAWAY BEACH PROJECTS (RB)							
RB-1 Rockaway Beach Supply and Storage Evaluation	$100,000	$0	$0	$0	$0	$0	$100,000
RB-2 Rockaway Beach Supply and Storage Improvements	$0	$0	$250,000	$250,000	$250,000	$250,000	$1,000,000
GENERAL PROJECTS							
G-2 SCADA Improvements	$0	$50,000	$50,000	$50,000	$50,000	$50,000	$250,000
G-3 Meter Replacement	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$120,000
Total	$537,000	$607,000	$820,000	$870,000	$870,000	$520,000	$4,224,000

Table 10.13 Projected Capital Expenditures
Water System Plan
City of Bainbridge Island

Line		Budgeted 2015	Projected --> 2016	2017	2018	2019	2020	2021
1	SOURCES OF FUNDS							
2	Beginning Fund Balance[1]	$6,450,986	$5,686,516	$5,383,086	$4,983,806	$4,343,996	$3,624,466	$2,873,636
3	Revenues, Subject to Rate Increases							
4	Water Sales	$935,000	$944,400	$953,800	$963,300	$972,900	$982,600	$992,400
		$0	$0	$0	$0	$0	$0	$0
5	Other Revenue	$0	$0	$0	$0	$0	$0	$0
6	Other Charges for Utility Services	$157,200	$157,200	$157,200	$157,200	$157,200	$157,200	$157,200
7	Connection Fees	$0	$106,240	$107,300	$108,370	$109,450	$110,550	$111,650
8	Miscellaneous	$138,000	$138,000	$138,000	$138,000	$138,000	$138,000	$138,000
9	Interest	$28,000	$28,430	$26,920	$24,920	$21,720	$18,120	$14,370
10	Total Revenue	$1,258,200	$1,374,270	$1,383,220	$1,391,790	$1,399,270	$1,406,470	$1,413,620
11	Total Source of Funds	$7,709,186	$7,060,786	$6,766,306	$6,375,596	$5,743,266	$5,030,936	$4,287,256
12	USES OF FUNDS							
13	Expenses							
14	Salaries	$412,217	$422,500	$433,000	$443,800	$454,900	$466,300	$478,000
15	Other Services and Charges	202,970	208,600	214,300	220,100	226,100	232,400	238,800
16	Intergovernmental Services	155,440	160,200	165,000	170,000	175,100	180,400	185,800
17	Benefits	162,005	170,200	178,700	187,700	197,100	206,900	217,200
18	Professional Services	110,766	114,100	117,500	121,000	124,600	128,300	132,100
19	Supplies	53,272	54,800	56,400	58,100	59,800	61,500	63,300
20	Capital Equipment	10,000	10,300	10,600	10,900	11,200	11,500	11,800
21	Total Expenses	$1,106,670	$1,140,700	$1,175,500	$1,211,600	$1,248,800	$1,287,300	$1,327,000
22	Net Funds, before CIP, not including Reserves	$151,530	$233,570	$207,720	$180,190	$150,470	$119,170	$86,620
23	Net Funds, before CIP,including Reserves	$6,602,516	$5,920,086	$5,590,806	$5,163,996	$4,494,466	$3,743,636	$2,960,256
24	Capital Projects							
25	Historical and Budgeted Capital Projects	916,000						
26	Pipe Projects		$267,000	$337,000	$0	$0	$0	$0
27	Well Site Projects		$150,000	$100,000	$200,000	$100,000	$100,000	$0
28	Storage Projects		$0	$50,000	$0	$250,000	$250,000	$0
29	High Elevation Fire Flow Projects		$0	$50,000	$300,000	$200,000	$200,000	$200,000
30	Rockaway Beach Projects		$100,000	$0	$250,000	$250,000	$250,000	$250,000
31	General Projects		$20,000	$70,000	$70,000	$70,000	$70,000	$70,000
32	Total Capital Projects	$916,000	$537,000	$607,000	$820,000	$870,000	$870,000	$520,000
33	Amount to transfer From Reserves to Pay for Capital		$43,453	$11,803	$0	$0	$0	$0
34	Ending Fund Balance	$5,686,516	$5,383,086	$4,983,806	$4,343,996	$3,624,466	$2,873,636	$2,440,256

Notes:
(1) 2015 beginning fund balance per City Finance Director.