



GENERAL SEWER PLAN

December 2014

DRAFT



**CITY OF
BAINBRIDGE ISLAND**

GENERAL SEWER PLAN

AGENCY REVIEW

DECEMBER 2014





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CITY OF BAINBRIDGE ISLAND

GENERAL SEWER PLAN

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ACRONYMS & ABBREVIATIONS	
AA	Average annual
AAD	Average Annual Demand
AAF	Average annual flow
ac-ft	Acre-feet
ADD	Average Daily Demand
ADS	ADS Environmental
ADWF	Average Dry Weather Flow
BIMC	Bainbridge Island Municipal Code
BOD	Biochemical Oxygen Demand
BWF	Base wastewater flow
CIP	Capital Improvement Program
City	City of Bainbridge Island
DNS	Determination of Non-significance
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
EIS	Environmental Impact Statement
ERU	Equivalent Residential Unit
F	Fahrenheit
fps	Feet per Second
FTE	Full Time Equivalent
gpad	Gallons per acre per day
gpd	Gallons per day
gpm	Gallons per minute
GSP	General Sewer Plan
GW	Groundwater infiltration
I/I	Inflow and Infiltration
KCSD	Kitsap County Sewer District
LOSS	Large on-site sewage systems
MM	Maximum month
MMD	Maximum Month Demand
MMF	Maximum month flow
NOAA	National Oceanic and Atmospheric Association
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Services

ACRONYMS & ABBREVIATIONS

NSC	Neighborhood Service Center
O&M	Operations and Maintenance
PDF	Peak demand flow
PHF	Peak Hour Flow
Plan	General Sewer Plan
ppd	Pounds per day
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
sf	Square Feet
SSO	Sanitary sewer overflow
TSS	Total Suspended Solids
UV	Urban Village
WAC	Washington Administrative Code
WMPSA	Winslow Master Plan Service Area
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The City of Bainbridge Island (City) has prepared this General Sewer Plan (Plan) to document the status of the City's sewer system and analyze the system to anticipate future needs. In order to provide effective, reliable, and safe sewer service, this Plan will be used as a guide for operation, maintenance, and expansion of the sewer system for the next 20 years. This Plan is prepared in accordance with WAC 173-240-050.

This Plan integrates planning for the Winslow and South Island service areas into a single comprehensive planning document. The City completed a sewer plan for the Winslow service area in 1992 and a South Island sewer area plan in 2001.

Recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable service for the existing customers and to serve anticipated growth, the City initiated the preparation of this Plan. In 2012, the City selected the Carollo Engineers team to develop this General Sewer Plan in accordance with applicable rules and regulations governing planning for wastewater utility systems.

The City owns their sewer system and the Winslow Wastewater Treatment Plant (WWTP). Portions of the City's sewer system are within the South Island area served by Kitsap County Sewer District (KCSD) #7's WWTP. Operations of the Winslow WWTP are overseen by the Public Works Department.

ES.2 BASIS OF PLANNING

Throughout most of the island, wastewater is treated by private septic systems. The City maintains collection system facilities in two separate areas of the island: Winslow and South Island. Winslow was the first sewer system developed on Bainbridge Island starting in 1947. The Lynwood Center Pump Station within the South Island collection system was constructed with private funds in 1998. In 2005 the City acquired the Lynwood Center Pump Station and constructed sewer collection facilities for the neighborhoods of Point White, Emerald Heights, Blakely School, Pleasant Beach and Rockaway Beach. The Rockaway Beach Pump Station was commissioned in 2005. The South Island Collection System conveys wastewater to the Kitsap County Water District (KCSD) #7 WWTP near Fort Ward through an interlocal agreement.

As development of this Plan began, the General Sewer Plan Advisory Committee established a Sewer Service Study Area (Study Area) to help the City identify available collection and treatment options that support the Comprehensive Plan and protect the City's environmental quality. As shown in Figure ES.1, Figure ES.2 and Figure ES.3, the Study

Area extends beyond the Existing Service Area in both Winslow and South Island and includes a new area, referred to as the Mid-Island Study Area. The first priority expansion for the South Island Sewer Service Area is along Pleasant Beach, while expansion to beach homes on the west side of Point White is a second priority. Mid-Island is an area that is currently not served by the City that includes urban land use and development. The east pocket of the Mid-Island Study Area covers the portion of the Rolling Bay Neighborhood Service Center (NSC) that is zoned NSC. The west pocket includes all of the property of the Island NSC that was included in the "Island NSC Planning Area Boundary" in the Island Center Special Planning Study.

Land use designations and regulations provide important information in evaluating sewer system capacity. Existing and future land use information is an integral component in projecting wastewater generation within the Study Area. Maps of the City's existing and future land use within the Study Area are presented in Chapter 2.

Also presented in Chapter 2 are the sewer system policies and criteria that have been adopted by the City to facilitate the successful management of the wastewater system and compliance with all local, state, and federal regulations. The policies and criteria are organized into the categories of sewer service and service extensions, system reliability, environmental stewardship, design criteria, and financial policies.

ES.3 FLOW PROJECTIONS

A three-month flow monitoring program was performed during development of this Plan for the purpose of determining average dry weather flow (ADWF), defining the collection system's weekday and weekend diurnal flow patterns, and developing land use flow factors that facilitated the development of flow projections. Flow monitoring data was also used to calibrate the Winslow collection system hydraulic model and identify areas with high inflow and infiltration (I/I).

Peak hour flows were developed by using the City's hydraulic model, which was calibrated against the flow metering data. Peak hour flows for each basin were derived for a design storm consisting of two consecutive 2-year, 24-hour storms followed by a 25-year, 24-hour storm. Selection of the design storm was based on an analysis of historical rainfall and WWTP influent flow data that showed the WWTP flow response to rainfall events. The calculated peak hour flows are used to evaluate the capacity of the current wastewater system for conveying existing and future flows, and thereby identify necessary capacity improvements. Current peak hour flows into the WWTP during the design storm amount to 2.5 mgd. Year 2035 PHF during the design storm are projected to be 4.2 mgd. It is noted that the projected 2035 peak hour flows exceeds the Tetra Tech WWTP design capacity of 3.6 mgd.







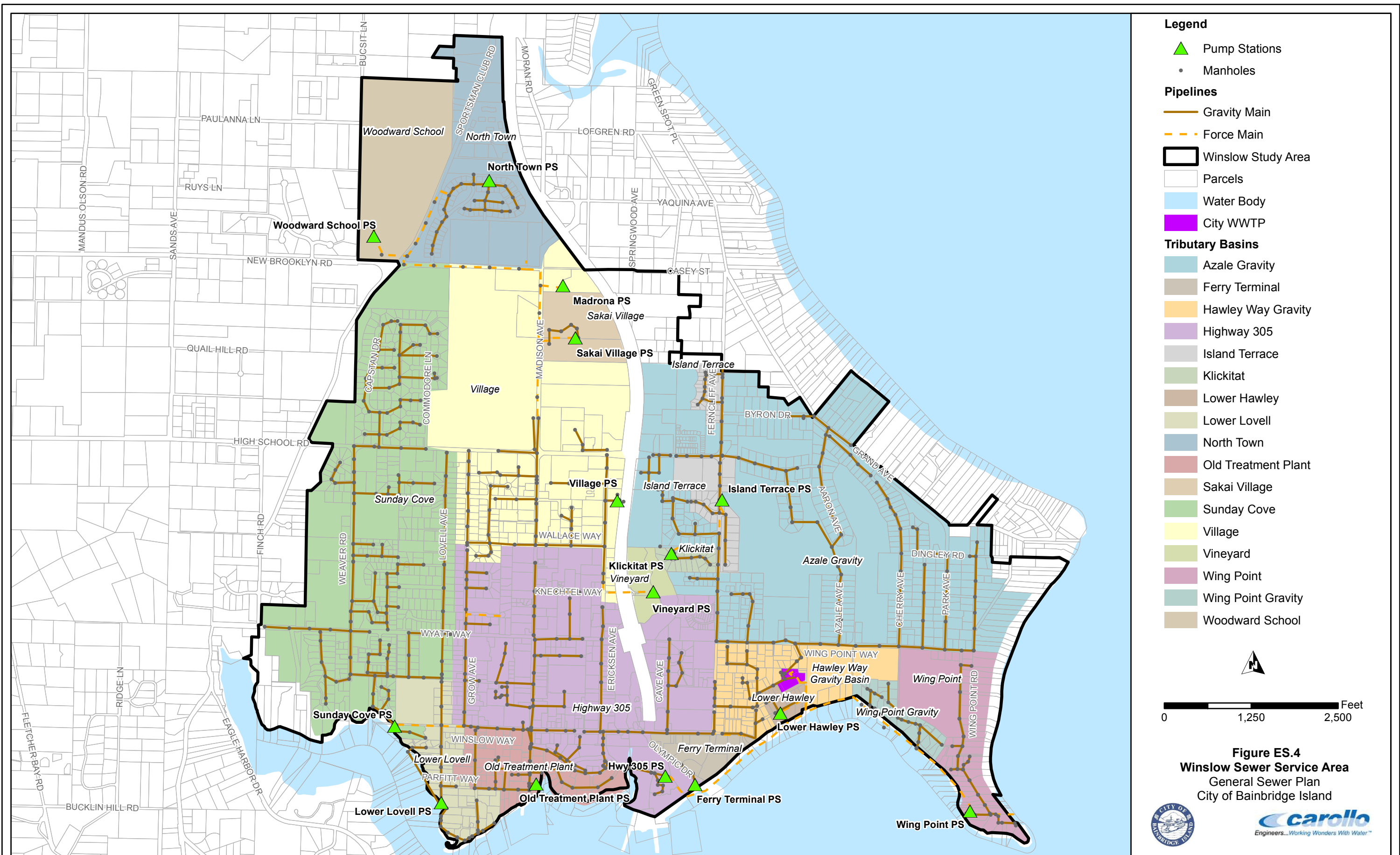
BOD and TSS loads to the WWTP were also projected. Projected 2035 TSS loads of 2000 ppd AA and 2660 ppd MM closely match the design criteria used by Tetra Tech for the 2007 WWTP expansion. Projected BOD loads exceed Tetra Tech design criteria with AA BOD of 2260 and MM BOD of 2880 by 2035. WWTP Flow and load projections are summarized in Table ES.1.

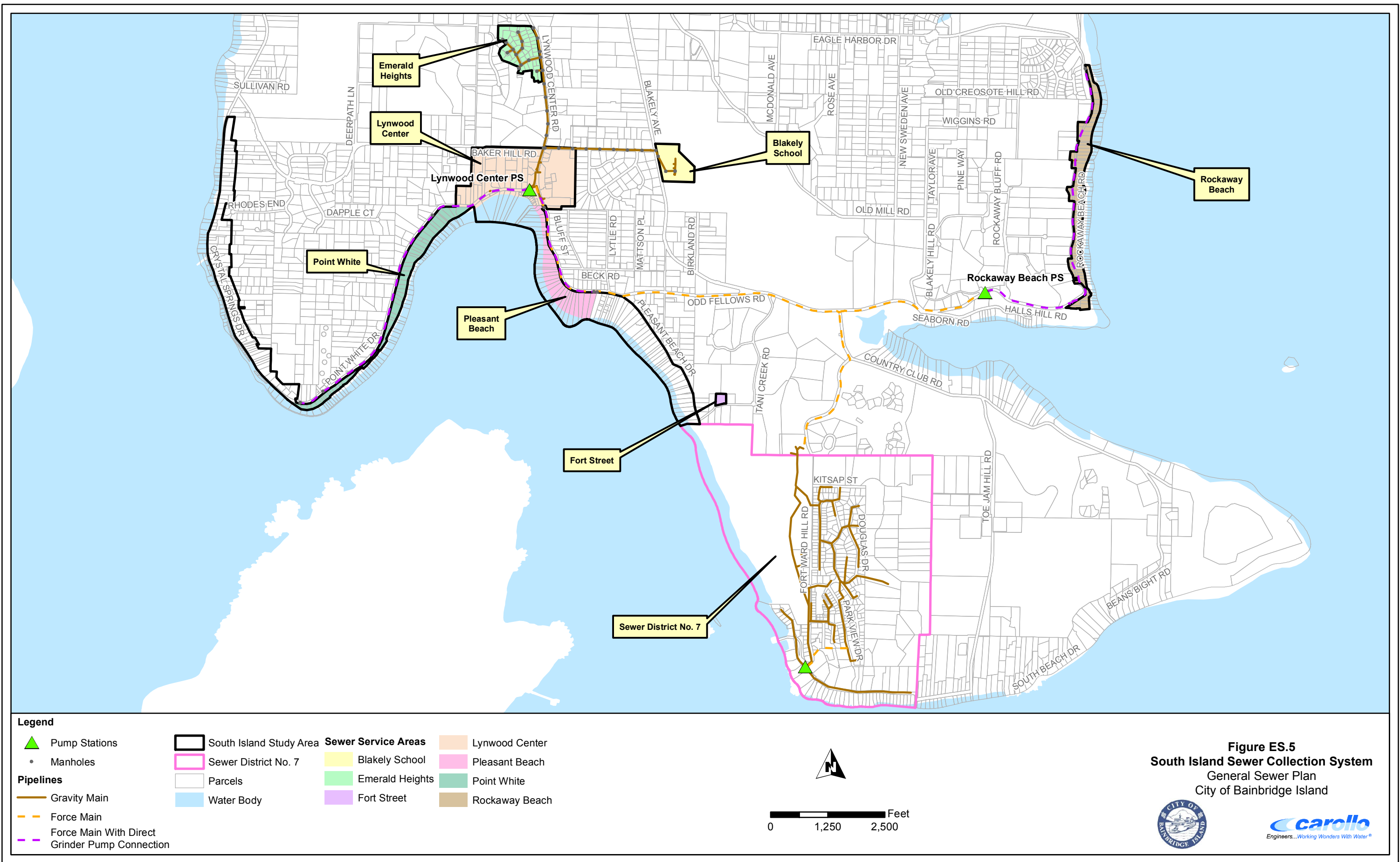
Table ES.1 Winslow WWTP Influent Flow and Load Projections General Sewer Plan City of Bainbridge Island				
Flow, mgd	2013	2025	2035	WWTP Design Capacity
ADWF	0.43	0.59	0.72	3.6
PHF	2.48	3.25	4.19	3.6
Load, ppd	2010	2025	2035	
AA BOD	1410	1920	2260	2000
MM BOD	1800	2450	2880	2642
AA TSS	1270	1730	2000	2000
MM TSS	1670	2260	2660	2642

Build-out flow projections were also developed for the Mid-Island Study Area. For the eastern pocket build-out flows are anticipated to be 2,570 gpd ADWF and 7,710 gpd PHF. Projected build-out flows for the western pocket are estimated as 13,020 gpd ADWF and 39,060 gpd PHF. Chapter 3 includes a discussion of sewer treatment and disposal options for the Mid-Island Study Area including cost estimates.

ES.4 EXISTING SYSTEM AND CONDITION ASSESSMENT

Throughout the entire sewer system, the City maintains approximately 37 miles of gravity and force main pipes and 17 pump stations. The pump stations were originally constructed between 1950 and 2013, with most of the stations having been constructed in 1979. Four of the oldest and largest stations have been rehabilitated since construction. Most of the older stations are of the drywell/wet well configuration. Stations constructed after 2003 are based on a standardized submersible pump wet pit design. Firm pump station capacities range from 60 to 2,720 gallons per minute (gpm). All of the sites have a permanent onsite source of emergency power in case of a utility power outage. The Winslow and South Island Service Areas and collection systems are shown in Figure ES.4 and Figure ES.5.





A pipeline remaining useful life assessment was performed for the entire sewer system. The majority of the City's pipelines have greater than 20 years of remaining useful life. The RUL analysis predicts that 5% of the pipes in the collection system will reach the end of their useful life by 2035. Approximately 9,980 LF per year of pipeline needs to be replaced throughout the planning period.

Most of the collection system pump stations will require major upgrades by 2035. A prioritized pump station repair and replacement program will be established and used to guide the timing of pump station rehabilitation and replacement projects.

ES.5 HYDRAULIC MODEL DEVELOPMENT

A hydraulic model of the Winslow collection system was developed using Innovyze's InfoSWMM. The hydraulic model includes the major trunks and interceptors within the Winslow collection system, which are primarily 10 inches and larger. The modeled sewer system consists of approximately ten miles of sanitary sewer pipelines including both gravity and force mains ranging in diameter from six to 12 inches, fourteen city-owned sanitary sewer pump stations, and two private pump stations.

Baseline wastewater loads were allocated (assigned to specific nodes) in the hydraulic model based on land use data provided by the City and wastewater flow coefficients developed for each land use type. The flow coefficients and land use data provide a means to transform a specific land use category into an average dry weather flow.

Calibration of the City's hydraulic model was a multi-step process that involved comparing model-simulated flow to the actual field-measured data for both dry and wet weather conditions. Results indicated that the model correlated well with the field-measured data.

ES.6 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

A capacity evaluation of the Winslow Collection System was performed using the calibrated hydraulic model. Three pump station capacity deficiencies for conveying future flows were identified for the Winslow Collection System. It is projected that the capacities of the Village Pump Station and North Town Woods Pump Station will need to be increased within the short-term planning period. The Sunday Cove Pump Station is expected to require additional capacity by 2035. One deficiency was identified for the existing system. Under design storm PHF conditions, surcharging occurs at the inlet piping of the WWTP. In addition, an evaluation of the New Brooklyn force main that serves the North Town Woods, Woodward School, Madrona, and Sakai Village pump stations identified that due to high head conditions, Woodward School cannot operate when the other three pump stations are pumping simultaneously. Further evaluation and modifications are necessary to prevent wet well overflow at Woodward School.

Additionally, for South Island, the capacity of the Lynwood Pump Station must be upgraded in order to serve all unconnected parcels within the Study Area. A detailed flow evaluation is necessary for the South Island Study Area in order to determine the required future capacity of the Lynwood Pump Station and to provide a basis for future renegotiations with KCSD #7 to increase flows to the WWTP that are reserved for the City in order to serve the entire Study Area.

ES.7 TREATMENT SYSTEM ANALYSIS

A capacity evaluation was also performed for the Winslow WWTP to identify potential improvements within the treatment plant that may be needed to provide capacity for flow and loads projected through year 2035. Table ES.2 summarizes the recommended plant improvements to meet the projected 2035 flows and loads. Projects are categorized by timing as short-term or long-term. Short-term projects are necessary to meet 2025 flow and load projections. Long-term projects are necessary to meet 2035 flows and loads.

Table ES.2 Recommended Improvements General Sewer Plan City of Bainbridge Island		
Unit Process	Recommended Improvement	Timing⁽¹⁾
General	Develop a hydraulic model of the WWTP to confirm hydraulic capacity.	Short-term
Fine screens	Evaluate alternatives to increase screening capacity; implement recommendations.	Long-term
Grit removal	Evaluate alternatives to increase grit removal performance; implement recommendations.	Short-term
Aeration basins	Add baffle wall to divide Zone 1; add diffusers to Zones 1 and 2.	Short-term
Secondary clarifiers	Analyze alternatives to reduce SVI ⁽²⁾ .	Short-term
UV disinfection	Evaluate alternatives to improve disinfection capacity; implement recommendations.	Short-term
Solids Handling	Evaluate/implement alternatives to improve sludge stabilization for odor control.	Long-term
Effluent pumping	Add air-vacuum relief valve(s) effluent pump discharge piping.	Short-term
Notes: (1) Short-term projects are those required between now and 2025. Long-term projects are those required between 2026 and 2035. (2) If SVI cannot be maintained in the range of 125 to 150 mL/g on a regular basis, additional secondary clarifier capacity will be required. Improvements to achieve this capacity are not included in this list of recommended improvements.		

ES.8 OPERATION AND MAINTENANCE

The City of Bainbridge Island has a Manager-Council form of government. The City Manager oversees management of the Public Works Department and the Wastewater Utility through the Public Works Director. The Wastewater 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 1.59 full time equivalent (FTE) positions.

The majority of routine operation and maintenance activities are performed by the Public Works Department Operations and Maintenance Division. These activities are described in Chapter 8 – Operation and Maintenance. A list of items being implemented to improve the function of the current operation and maintenance program are also presented in Chapter 8.

ES.9 CAPITAL IMPROVEMENTS PLAN

The necessary pipeline, pump station, WWTP, and other general projects are compiled into a comprehensive capital improvements plan (CIP) for the sewer system. The purpose of the CIP is to provide the City with a guideline for planning and budgeting of its sewer system. The CIP consists of schedule and cost estimates for the recommended improvements. Project phasing is described as either Short-Term (2015 through 2025) or Long-Term (2026-2035). A map of pipeline replacement projects is presented in Figure ES.6.

The total Sewer CIP cost over the next 21 years is \$15,894,000, which equates to \$757,000 annually as presented in Table ES.3. Of the total cost, \$10,220,000 is budgeted for the Short-Term phase, while \$5,674,000 is budgeted for expenditure during the Long-Term phase.

The Sewer CIP is split into four categories: pipe, pump station, treatment plant, and general projects. Throughout the planning period \$2,594,000 (16 percent) is budgeted for pipe projects, \$5,950,000 (38 percent) is budgeted for pump station projects, \$7,000,000 (44 percent) is budgeted for treatment plant projects, and \$350,000 (2 percent) is budgeted for general projects.

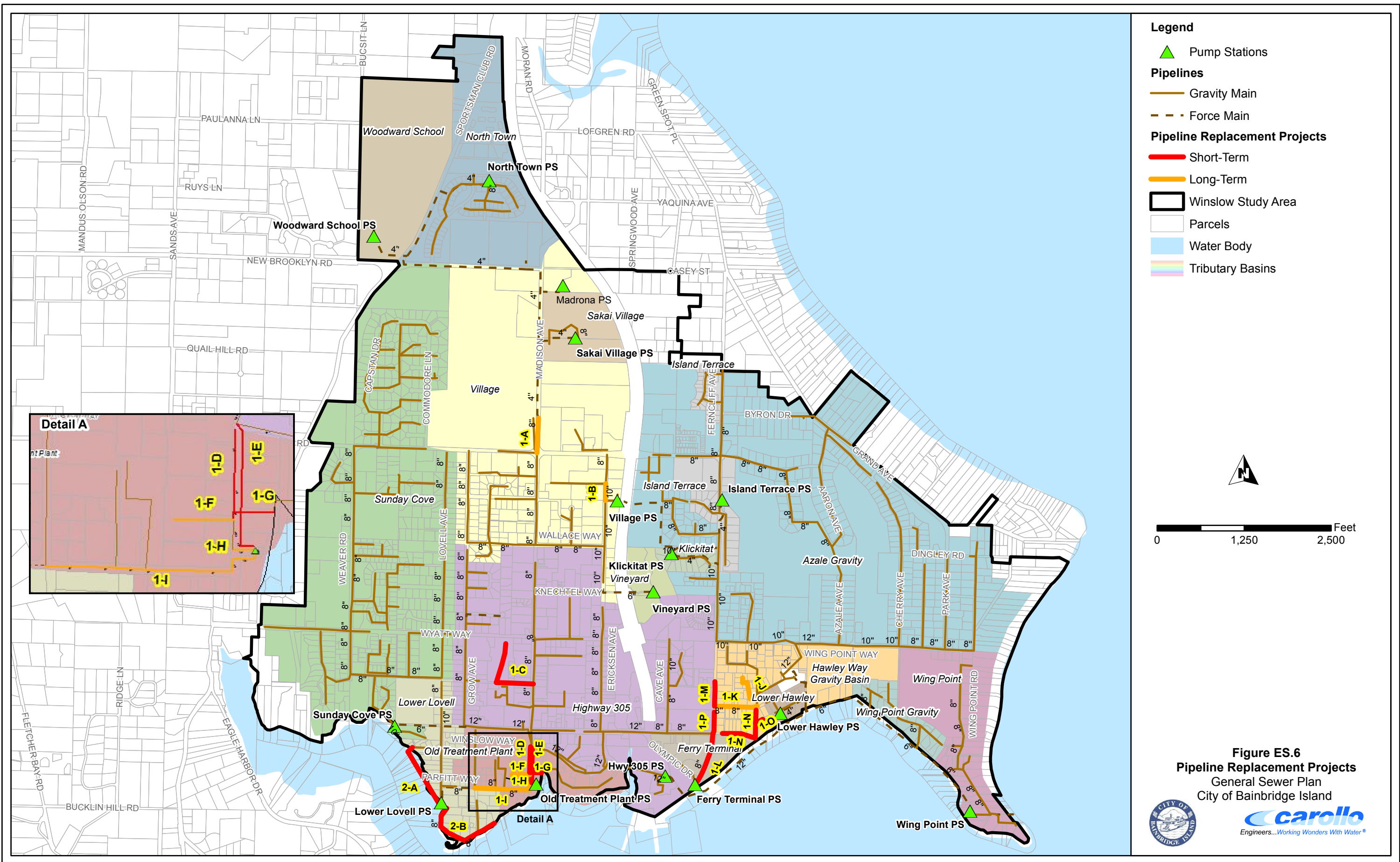


Table ES.3 Capital Improvements Plan General Sewer Plan City of Bainbridge Island				
Project ID	Description	Total Capital Cost (\$)	Capital Improvement Phasing	
			Short-Term (2015-2025)	Long-Term (2026-2035)
Pipe Projects				
P-1 ⁽¹⁾	Annual Pipeline Preservation Program	\$ 1,999,000	\$ 1,317,000	\$ 682,000
P-2	Lower Lovell Beach Mains Replacement	\$ 595,000	\$ 595,000	
Total		\$ 2,594,000	\$ 1,912,000	\$ 682,000
Pump Station Projects				
PS-1 ⁽²⁾	Pump Station Repair and Improvements Program	\$ 3,690,000	\$ 2,870,000	\$ 820,000
PS-2	Village Pump Station Upgrade	\$ 488,000	\$ 488,000	
PS-3	North Town Woods Pump Station Upgrade	\$400,000	\$ 400,000	
PS-4	Sunday Cove Pump Station Upgrade	\$ 455,000		\$ 455,000
PS-5	New Brooklyn Force Main and Woodward PS Modifications	\$200,000	\$200,000	
PS-6	Lynwood Center Pump Station Upgrade	\$ 423,000		\$ 423,000
PS-7 ⁽³⁾	South Island Grinder Pump Replacement Program	\$ 294,000		\$ 294,000
Total		\$ 5,950,000	\$ 3,958,000	\$ 1,992,000

Table ES.3 Capital Improvements Plan General Sewer Plan City of Bainbridge Island				
Project ID	Description	Total Capital Cost (\$)	Capital Improvement Phasing	
			Short-Term (2015-2025)	Long-Term (2026-2035)
Wastewater Treatment Plant Projects				
TP-1	Short-Term Capacity and Improvements Evaluation	\$ 150,000	\$ 150,000	
TP-2	Outfall Extension	\$ 2,600,000	\$ 2,600,000	
TP-3	Short-Term WWTP Improvements	\$ 1,000,000	\$ 1,000,000	
TP-4	WWTP Influent Pipe Improvements	\$ 400,000	\$ 400,000	
TP-5	Long-Term Capacity and Improvements Evaluation	\$ 50,000		\$ 50,000
TP-6	Long-Term WWTP Improvements	\$ 2,800,000		\$ 2,800,000
Total		\$ 7,000,000	\$ 4,150,000	\$ 2,850,000
General Projects				
G-1	General Sewer Plan Updates	\$ 300,000	\$ 150,000	\$ 150,000
G-2	South Island Study Area Flow Evaluation	\$50,000	\$50,000	
Total		\$ 350,000	\$ 200,000	\$ 150,000
All CIP Projects				
Total Cost		\$ 15,894,000	\$ 10,220,000	\$ 5,674,000
Annual Cost		\$ 757,000	\$ 929,000	\$ 567,000
Notes: (1) P-1 budgets approximately \$95,000 annually. (2) PS-1 budgets 410,000 per pump station requiring rehabilitation during the planning period. (3) PS-6 budgets approximately \$2,000 per grinder pump to be replaced.				

INTRODUCTION

1.1 PURPOSE

The City of Bainbridge Island (City) has prepared this General Sewer Plan (Plan) to document the status of the City's sewer system and analyze the system to anticipate future needs. In order to provide effective, reliable, and safe sewer service, this Plan will be used as a guide for operation, maintenance, and expansion of the sewer system for the next 20 years. This Plan is prepared in accordance with WAC 173-240-050.

This Plan integrates planning for the Winslow and South Island service areas into a single comprehensive planning document. The City completed a sewer plan for the Winslow service area in 1992 and a South Island sewer area plan in 2001.

1.2 SCOPE AND AUTHORIZATION

Recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable service for the existing customers and to serve anticipated growth, the City initiated the preparation of this Plan. In 2012, the City selected the Carollo Engineers team to develop this General Sewer Plan in accordance with applicable rules and regulations governing planning for wastewater utility systems.

The objectives of the Plan include:

- Develop a basis of planning for the overall system plan by establishing the service area goals and policies and by identifying the existing and future study area boundaries.
- Perform a demographic analysis summarizing the household, employment, and land use projections for the City.
- Develop accurate flow and loading projections for the sewer system to forecast future expansion needs.
- Describe and inventory the City's existing wastewater collection system.
- Assess the condition of the City's existing wastewater collection system and its ability to meet the future needs of the City's sewer service area.
- Recommend asset management program elements that can assist the City in maintenance of the sewer system.
- Assess the condition of the Winslow Wastewater Treatment Plant (WWTP) facilities, established treatment goals, and evaluate the Winslow WWTP's treatment performance.

- Assess the Winslow WWTP's ability to meet the future needs of the City's sewer service area.
- Develop a recommended Capital Improvements Plan (CIP) including collection system and treatment plant improvements.
- Develop a funding strategy that will provide the City with the financial strength and viability to implement the CIP.
- Support the City through the State Environmental Protection Act (SEPA) process.

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 general overview of the existing sewer system, outlines the policies and criteria governing the sewer system, and summarizes the involvement of the General Sewer Plan (GSP) Advisory Committee in establishing the policies and criteria and the boundaries of the sewer service study area.

Chapter 3 – Flow Projections describes the existing and future land use of the sewer service study area, explains the demographic analysis performed to estimate growth rates within the study area, and establishes flow and load projections.

Chapter 4 – Existing System describes the collection system in detail, assesses the condition of the existing system, presents a recommended repair program, and reviews the City's asset management elements.

Chapter 5 – Hydraulic Model Development summarizes the development and calibration of the new hydraulic model of the collection system.

Chapter 6 – Capacity Evaluation summarizes the performance criteria used to evaluate the hydraulic capacity of the collection system and the results of the hydraulic model capacity evaluation. Recommended lift station and collection system improvements are presented as well as predicted sewer system expansions.

Chapter 7 – Treatment System Analysis summarizes the existing treatment facilities, as well as their condition and treatment performance. A description of the process model capacity results and recommended improvements is also presented.

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

Chapter 9 – Capital Improvements Plan outlines a schedule and budget for recommended collection system and treatment 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.

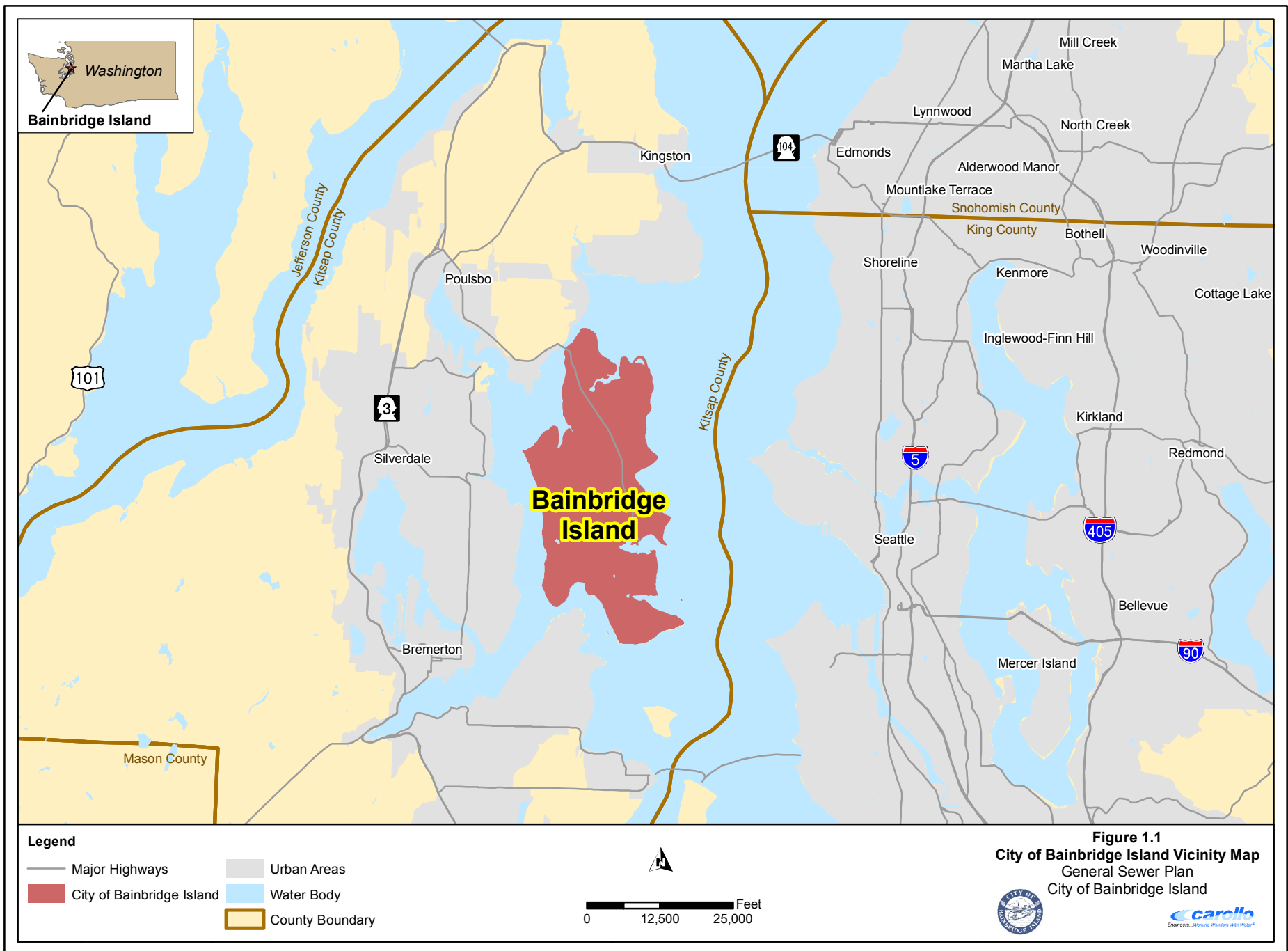
1.5 AUTHORITY AND MANAGEMENT

The City owns their sewer system and the Winslow WWTP. Portions of the City's sewer system are within the South Island area served by Kitsap County Sewer District (KCSD) #7's WWTP. Operations of the Winslow WWTP are overseen by the Public Works Department.

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.

- 1992 Wastewater Facilities Improvement Plan Winslow Service Area (Brown & Caldwell).
- 2001 South Island Sewer Facilities General Plant and Engineering Report (H. R. Esvelt Engineering).
- 2003 Winslow Wastewater Treatment Plant Engineering Report (H. R. Esvelt Engineering).
- 2003 Engineering Report Addendum (Tetra Tech).
- 2005 Sunday Cove Pump Station Build-out Analysis (Berryman & Hennigar).
- 2007 Winslow Wastewater Treatment Plant Study (Tetra Tech).
- 2008 Bainbridge Island Closure Zone Analysis (Cosmopolitan).
- 2009 City of Bainbridge Island Wastewater Treatment Plant Biosolids Report (Tetra Tech).



- 2011 Design memorandum Pump Station Evaluations (BHC).
- 2012 NPDES Permit.

1.7 APPROVAL PROCESS

This Plan is required to meet state, county, and local requirements. It complies with the requirements of the Department of Ecology (DOE) as set forth in the WAC 172-240-050, the Department of Health (DOH) as set forth in WAC 246-271-040, and the Revised Code of Washington (RCW) as set forth in RCW 90.48.110. The City will submit this Plan to DOE, Kitsap County, and KCSD #7 during the environmental assessment. See Appendix A for the SEPA Checklist and Determination of Non-Significance, and Appendix B for Comment Letters. The Adopting Resolution will be included in Appendix C, upon Plan approval by the City Council.

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 under WAC 197-11-340 (2). It is anticipated that an Environmental Impact State (EIS) will not be required. However, 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.

1.9 ACKNOWLEDGEMENTS

Carollo Engineers and their team members, including ADS Environmental and Katy Isaksen & Associates, 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.
- Steve Pyke, WWTP Operator.
- Cami Apfelbeck, Water Resources Specialist.
- Jennifer Sutton, Special Project Planner for Department of Planning and Community Development.
- Katharine Cook, Planning and Community Development Director.
- Ellen Schroer, Finance and Administrative Services Director.

BASIS OF PLANNING**2.1 INTRODUCTION**

This chapter provides an overview of the City of Bainbridge Island's (City) sewer system and the policies in place to guide the management and extension of the system. The sewer system overview includes information regarding the sewer service area's history, the characteristics of the sewer service area, the Winslow Wastewater Treatment Plant (WWTP), and neighboring jurisdictions. This chapter will serve as the framework on which to base the General Sewer Plan (Plan). These considerations establish the basis of the planning for the demographic and system analysis used to evaluate the potential for development within the established service area and the adequacy of the system to serve the anticipated development within the service area study boundaries.

2.2 SEWER SERVICE AREA**2.2.1 Existing Service Area**

The City provides sewer service within two separate areas known as the Winslow Sewer Service Area and the South Island Sewer Service Area. The existing sewer service areas are presented in Figure 2.1 and Figure 2.2. The Winslow Sewer Service Area covers approximately 2.3 square miles serving approximately 5,730 residents, while the South Island Sewer Service Area currently encompasses 0.3 square miles and serves approximately 700 residents.

2.2.2 Sewer Service Providers

Throughout most of the island, wastewater is treated by private septic systems. The City maintains collection system facilities in two separate areas of the island: Winslow and South Island. Winslow was the first sewer system developed on Bainbridge Island in 1947. The South Island collection system conveys wastewater to the Kitsap County Water District (KCSD) #7 WWTP near Fort Ward through an interlocal agreement (Appendix D).

2.2.3 History of the City

In 1792 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 it's county seat at Port Madison on the northern shore of Bainbridge Island.

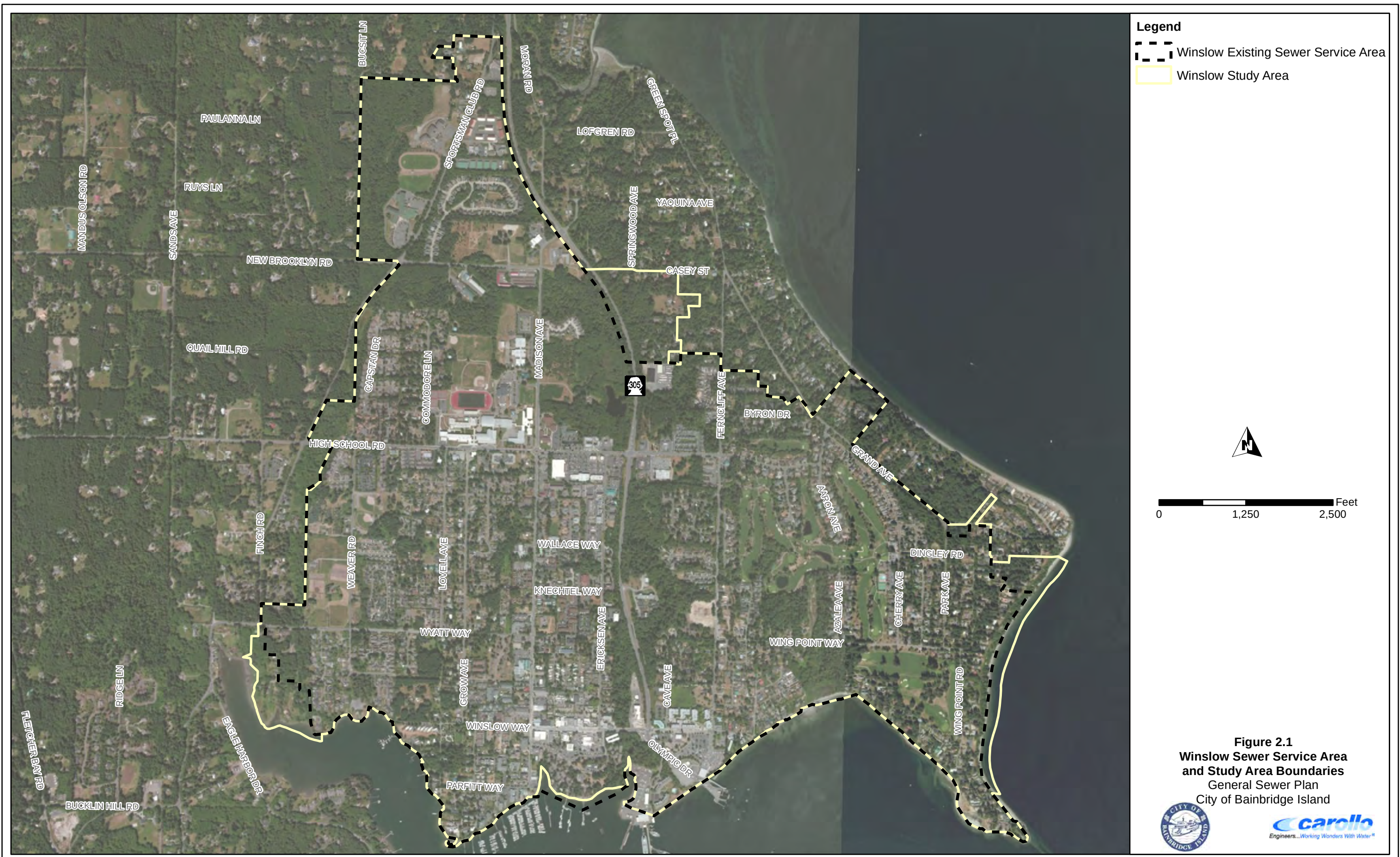


Figure 2.1
Winslow Sewer Service Area
and Study Area Boundaries
 General Sewer Plan
 City of Bainbridge Island






The main industries on Bainbridge 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.

2.2.4 History of Sewer System

2.2.4.1 Winslow

Winslow became incorporated as the island's first town in 1947. The first components of the sewer collection system were built during this time period. The town's first WWTP was a primary treatment facility located near the intersection of Madison and Winslow Way constructed around 1950. The City's sewer system was greatly expanded in the 1970s with the construction of six new pump stations and a new WWTP between Donald Place NE and Hawley Way NE that was commissioned in 1978. The sewer collection system continued to expand throughout the 1980s, 1990s, and 2000s. The WWTP went through extensive upgrades in the mid 1990s and most recently in 2010.

2.2.4.2 South Island

By World War II Fort Ward on the southern tip of Bainbridge Island was a thriving community of several hundred people with its own sewer system that discharged directly into Puget Sound. In the early 1950s the Federal Government surplused Fort Ward and auctioned it to private interests and KCSD #7 was established with a boundary matching the original boundary to the fort. As a result of the passage of the 1972 Clean Water Act, Fort Ward was required to meet secondary treatment standards for its wastewater. For a decade KCSD #7 along with the community attempted to develop a treatment plan, but each plan was rejected due to financial constraints. In 1984 the State of Washington sued KCSD #7 for noncompliance with their National Pollutant Discharge Elimination System (NPDES) permit. An agreement was made to allow primary treatment and discharge for a period while KCSD #7 planned for the development of a secondary treatment plant. KCSD #7 was finally able to secure a federal grant and planning for the construction of a WWTP began in 1989. The plant was completed and operational by 1996.

Since the 1980s Lynwood Center had experienced failing septic systems. With private funds, the community built a pump station and force main and entered into an interlocal agreement with KCSD #7 to have their sewer treated at the WWTP. As a result of drain-field failures and associated health and environmental concerns, citizens of several other neighborhoods in the South Island area requested sewer service from the City. In the 2000s the City constructed sewer collection facilities and contracted with KCSD #7 to treat

wastewater from several South Island neighborhoods including: Point White, Emerald Heights, Blakely School, Pleasant Beach, and Rockaway Beach.

2.2.5 Service Study Area

As development of this Plan began, a General Sewer Plan (GSP) Advisory Committee consisting of members of the Planning Commission, Utility Advisory Committee, and Technical Environmental Advisory Committee was formed by the City Manager to provide input to the GSP update. A total of four GSP Advisory Committee meetings were held from July through August, 2013.

The first task of the GSP Advisory Committee was to provide input and guidance on the future sewer service areas to be studied as part of the Plan. The GSP Advisory Committee established a Sewer Service Study Area (Study Area) to help the City identify available collection and treatment options that support the Comprehensive Plan and protect the City's environmental quality. The GSP Advisory Committee recognized that planning for municipal sewer service within the Study Area would inform future comprehensive planning and identify constraints on future service area boundaries. In recommending the Study Area, the GSP Advisory Committee considered a range of issues including land use planning and zoning, areas with failing on-site septic systems, surface water quality protection, groundwater protection, costs, growth and development impacts, and available capacity within the existing sewer system and wastewater treatment facilities.

As shown in Figure 2.1, Figure 2.2 and Figure 2.3, the Study Area extends beyond the Existing Service Area in both Winslow and South Island and includes a new area, referred to as the Mid-Island Study Area. In Winslow, the Study Area extends beyond current boundaries in the southwest corner, northeast corner, and southeast section to align with similar and more urban land uses. In South Island, the Study Area includes a first priority expansion to the sewer service area on Pleasant Beach and a second priority expansion to include the beach homes on the west side of Point White. It is anticipated that these areas may have further septic and sewer service challenges in the future. Mid-Island is an area that is currently not served by the City that includes urban land use and development. The east pocket of the Mid-Island Study Area covers the portion of the Rolling Bay Neighborhood Service Center (NSC) that is zoned NSC. The west pocket includes all of the property of the Island NSC that was included in the "Island NSC Planning Area Boundary" in the Island Center Special Planning Study.

2.2.6 Study Area Physical Features

This section describes the unique physical features of the study area including watersheds, water bodies, climate, and topography.

2.2.6.1 Surface Waters

The study area's surface water system consists of natural and constructed drainages that eventually discharge to the marine waters of Puget Sound. The Winslow Study Area is bordered by the Puget Sound in the South and West. Approximately sixty individual streams exist across the whole island. These are either perennial or seasonal stream courses. There are nine streams within the Winslow Study Area that all flow from the north to the south into the Puget Sound. Ten seasonal and perennial streams flow within the South Island Study Area. These streams are flowing from the inner island to the coast and into Puget Sound. Two streams flow through the Mid-Island Study Area. The streams of Bainbridge Island are shown on Figure 2.4.

2.2.6.2 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 2.4 shows the locations of the island's watersheds.



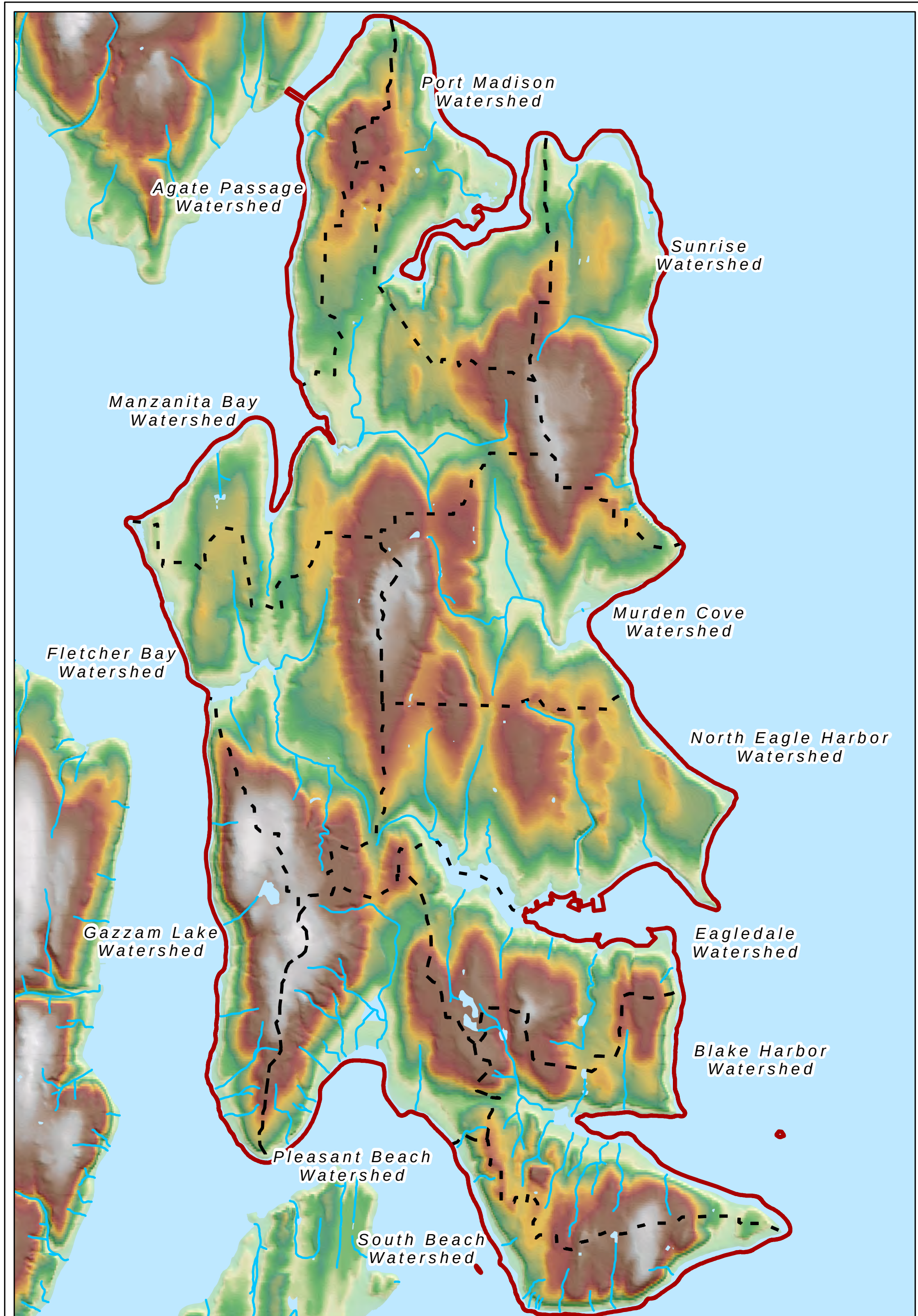


Figure 2.4
Bainbridge Island Physical Features
 General Sewer Plan
 City of Bainbridge Island



Legend

- Streams
- City of Bainbridge Island
- Watersheds
- Water Body

Elevation

- High : 435 Feet
- Low : -Sea Level

0 2,000 4,000 Feet

The Winslow area is located within two of these watersheds: Murden Cove and North Eagle Harbor. The South Island is located within three of the twelve watersheds: Blakely Harbor, Pleasant Beach and Gazzam Lake. The Mid-Island Study Areas are located within the Fletcher Bay and Murden Cove watersheds.

2.2.6.3 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 area elevations range from sea level to approximately 250 feet above sea level in the western-center part of this study area. Figure 2.4 shows the general topography of Bainbridge Island.

2.2.6.4 Climate

The 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 City's 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 City's 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 (°F)	Average Minimum Temperature (°F)	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			

2.2.7 Land Use

Land use designations and regulations provide important information in evaluating sewer system capacity. Existing and future land use information is an integral component in projecting wastewater generation within the Study Area.

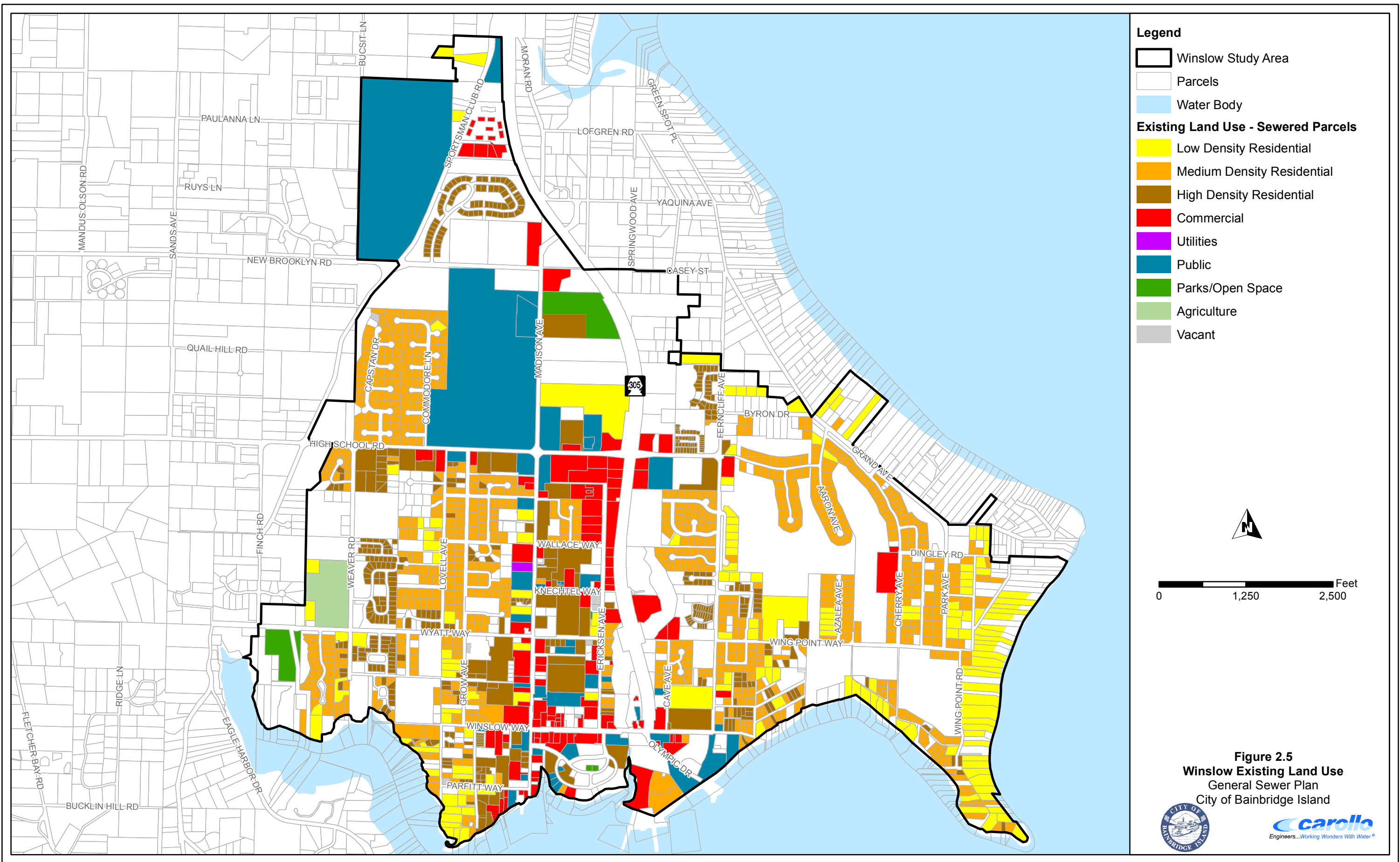
2.2.7.1 Existing Land Use

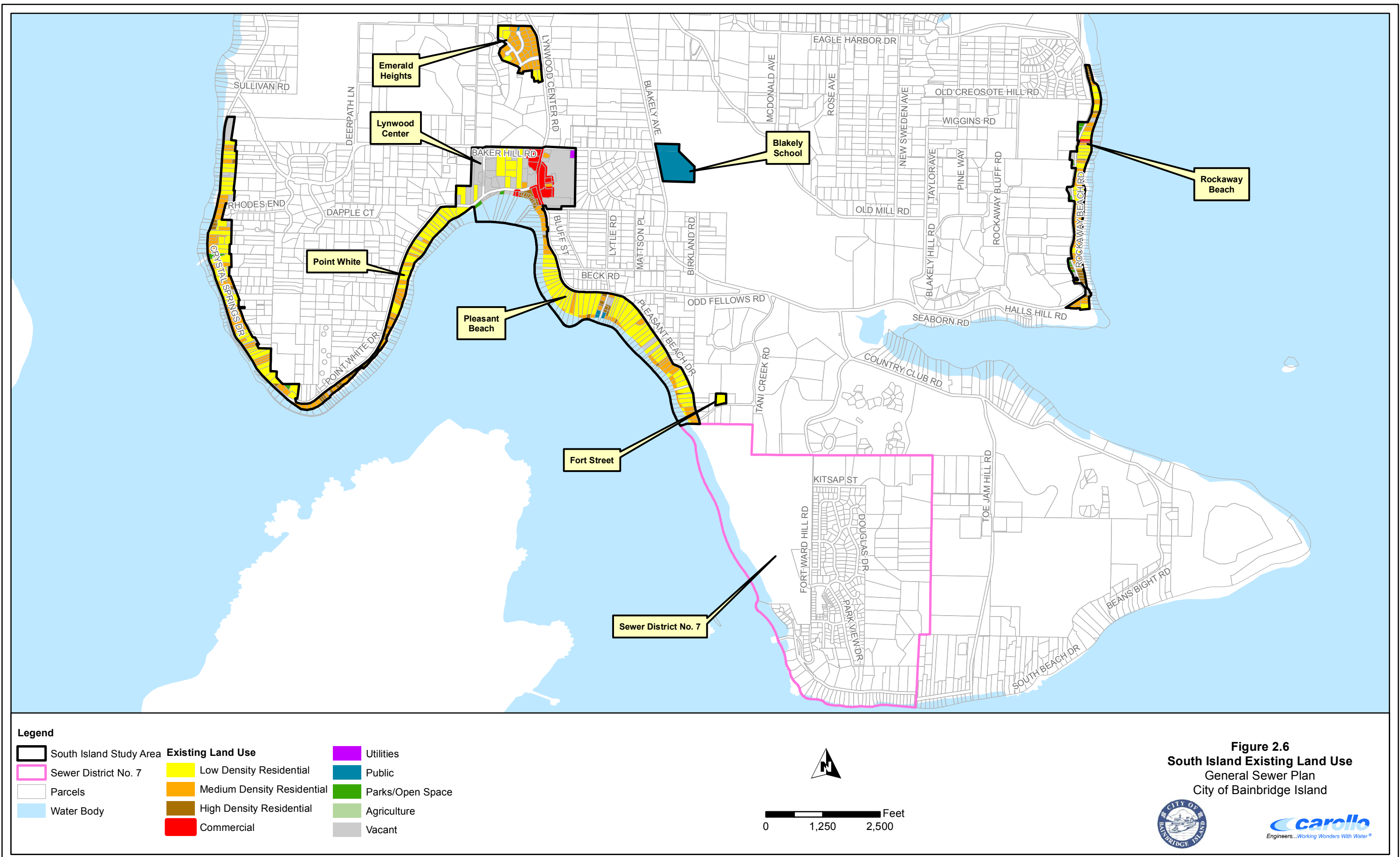
Maps of the City's existing land use within the Sewer Study Area were developed with data from Kitsap County and verified by the City's planning department. Maps of existing land use for the Winslow, South Island, and Mid-Island Study Areas are shown on Figure 2.5 through Figure 2.7. Only land use for parcels that are currently sewerred are shown on the Winslow and South Island maps. Existing land use for all Mid-Island Study Area parcels are shown even though none of the Mid-Island parcels are currently sewerred.

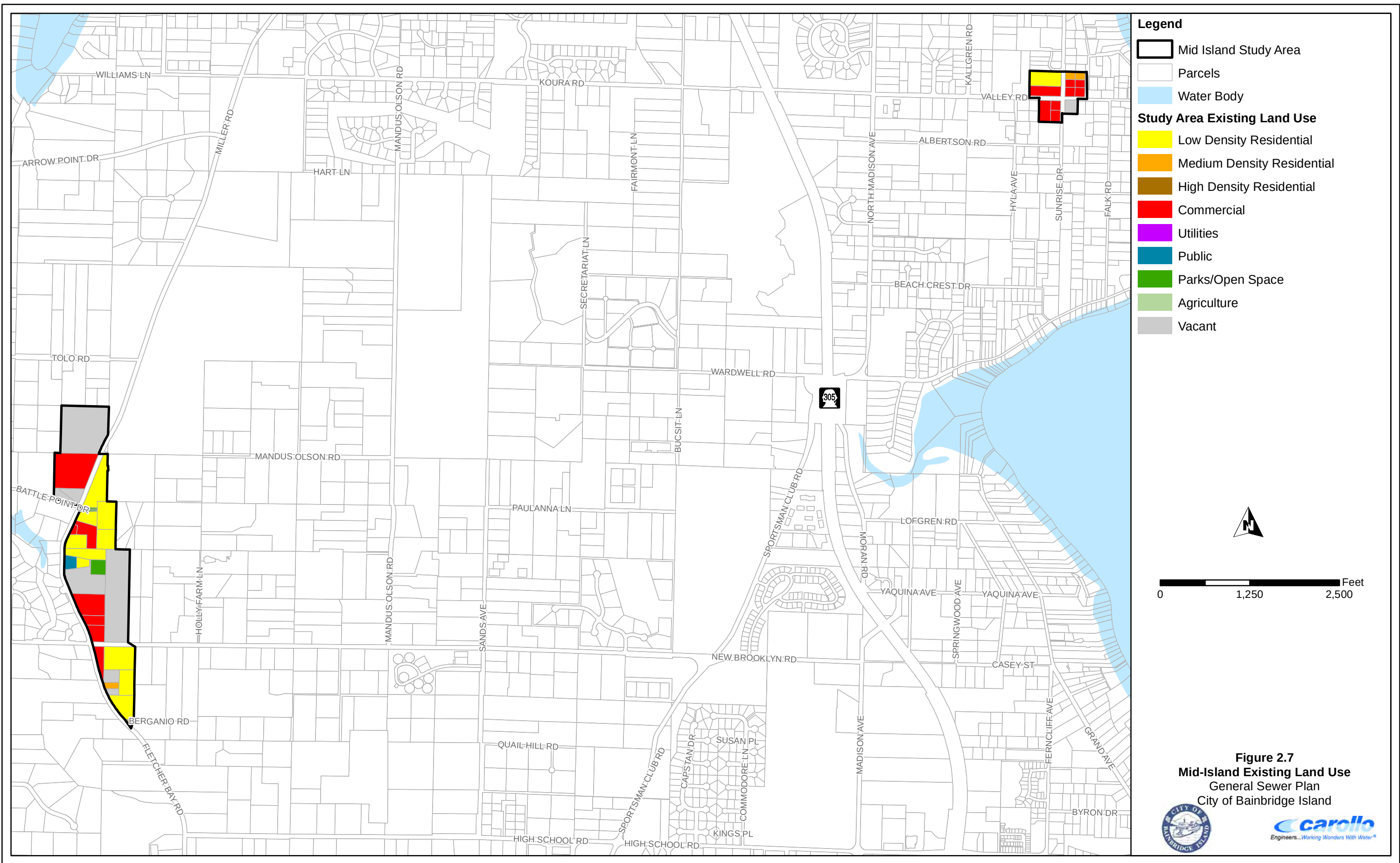
Parcels were organized into nine land use categories including:

- 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 Study Area is characterized by mostly low and medium density residential parcels with a downtown core dominated by commercial and high density residential development. Much of the Winslow Study Area is currently unserved by the City's sewer collection system. Of the approximately 1550 acres within the Winslow Study Area, a little more than half (835 acres) are currently served.

The South Island Study Area consists of mostly low and medium density single family residences along the coast with a small commercial area called Lynwood Center. The medium density residential neighborhood of Emerald Heights, as well as the Blakely School are also served. The Mid-Island Study Area currently consists of a mix of mostly commercial, residential, and vacant parcels.

2.2.7.2 Future Land Use

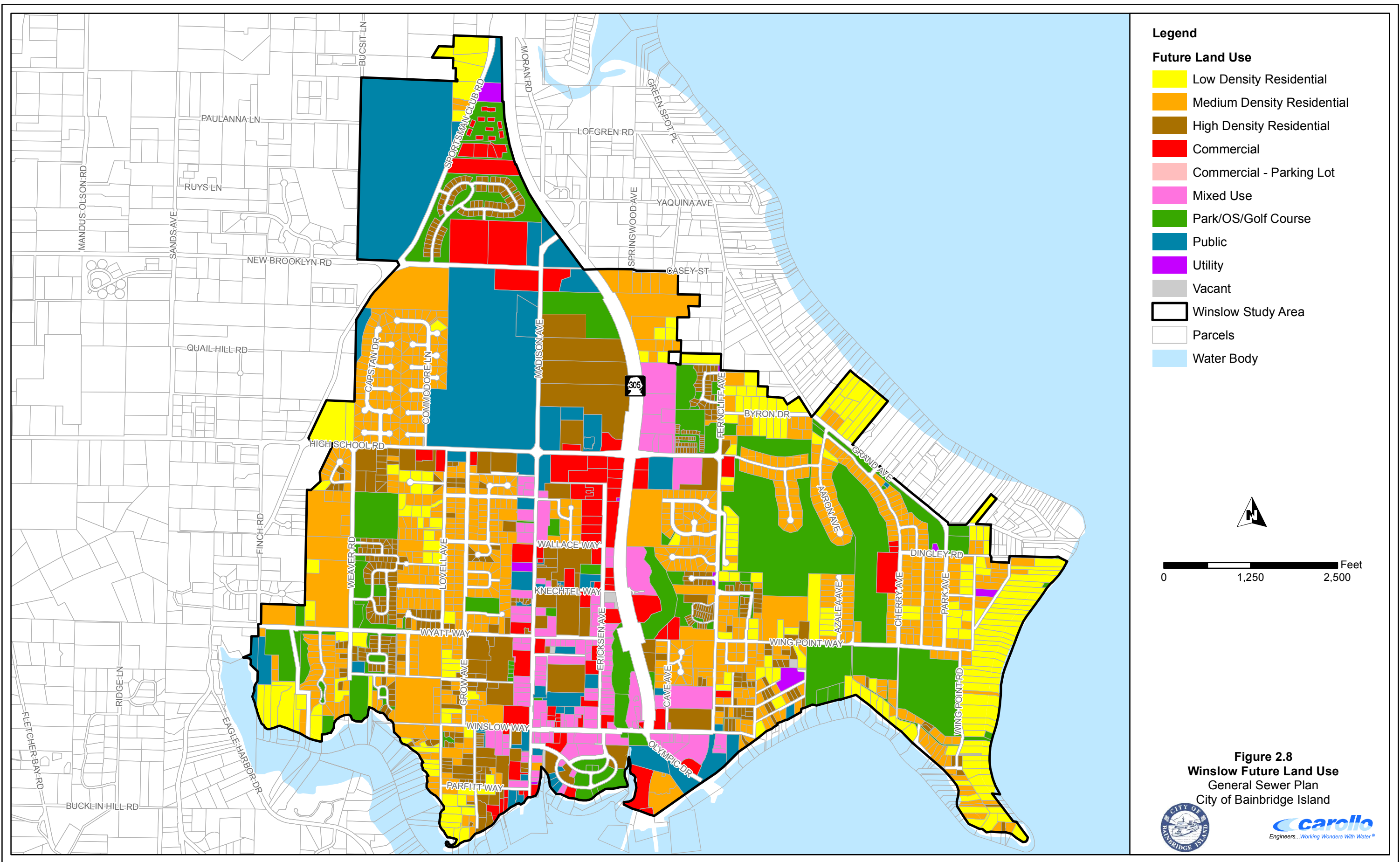
Study Area future land use designations were developed with the guidance of the City's Department of Planning & Community Development. The future land use designations represent the maximum build-out feasible by year 2035. It is assumed that all parcels within the Study Area will be served by the City's collection system. Most of the low and medium density residential neighborhoods within the Study Area are not expected to redevelop. Most development and redevelopment is expected to occur in Winslow's downtown core and the neighborhood service centers such as Lynwood Center. The City's policies encourage mixed use redevelopment. 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 that is defined by parcels containing both commercial and high density residential units. Future land use maps for each of the Study Areas are shown in Figures 2.8 through 2.10.

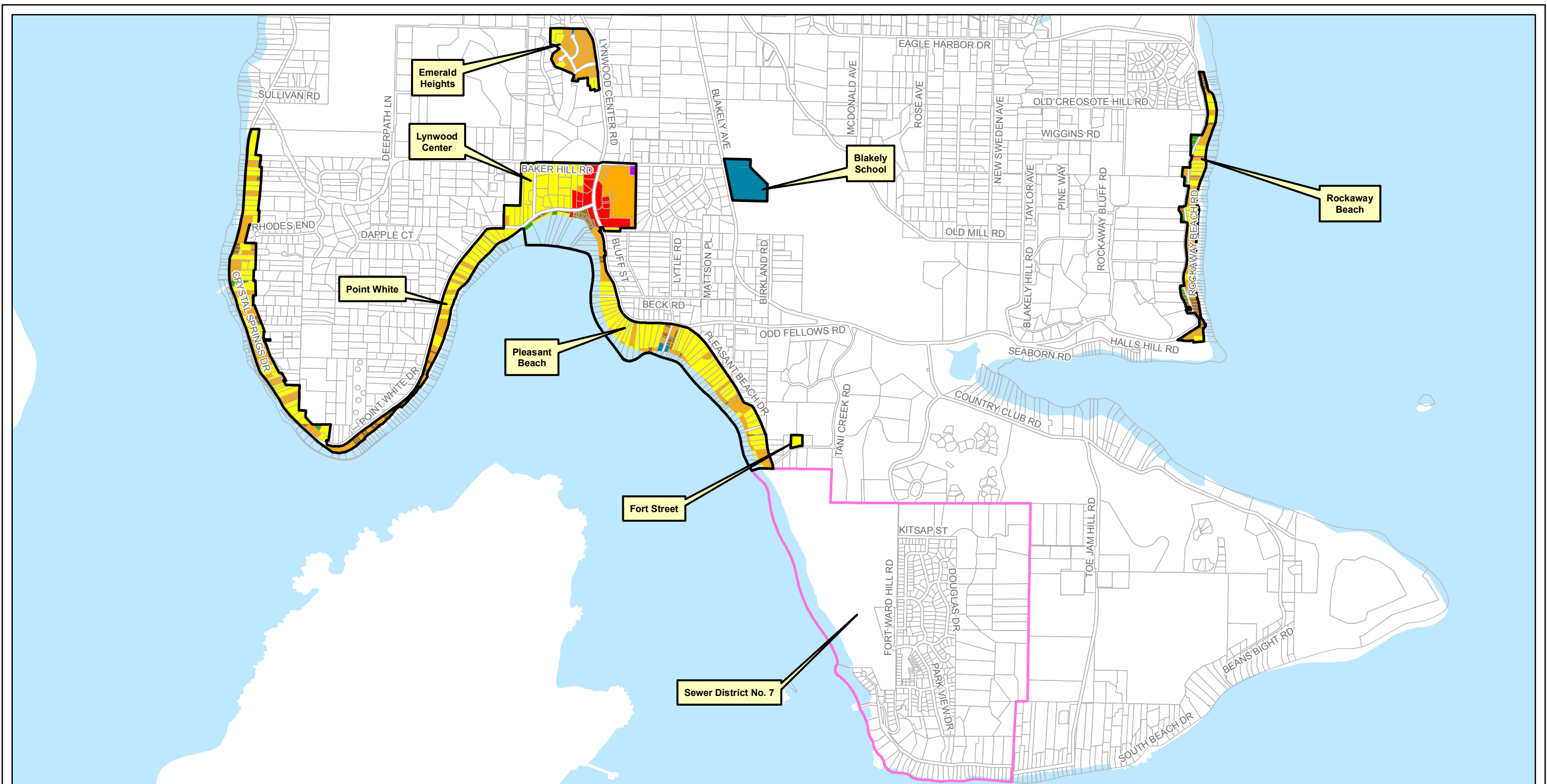
2.3 POLICIES AND CRITERIA

The City is responsible for managing and operating its wastewater system in accordance with all local, state, and federal regulations. To best manage the wastewater system and comply with regulations, the City has adopted wastewater system policies and criteria. These policies guide the development and financing of the infrastructure required to provide wastewater service, and document the City's commitments to current wastewater 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 sewer system planning. Existing policies are listed in Table 2.2 through Table 2.6. Proposed new policies are also listed in each table. These policies and criteria will guide the planning process throughout this General Sewer Plan.

The policies and criteria are organized into the following categories:

- Sewer service and service extensions
- System reliability





Legend

	South Island Study Area	Future Land Use			Commercial
	Sewer District No. 7		Low Density Residential		Utilities
	Parcels		Medium Density Residential		Public
	Water Body		High Density Residential		Parks/Open Space

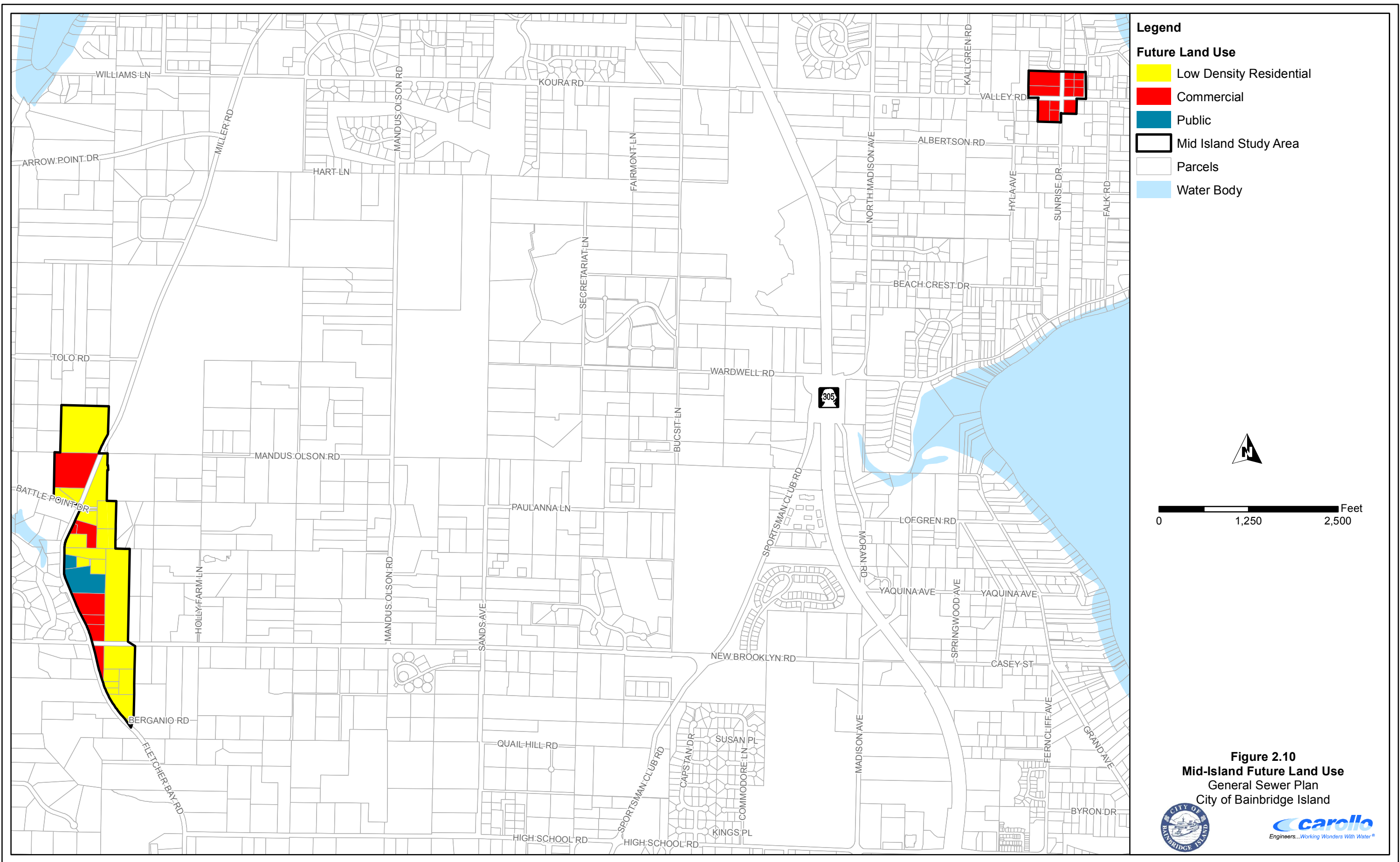


0 1,250 2,500 Feet

Figure 2.9
South Island Future Land Use
 General Sewer Plan
 City of Bainbridge Island



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- Environmental stewardship
- Design criteria
- Financial Policies

2.3.1 General Sewer Service and Service Extensions

Table 2.2 summarizes the existing and proposed policies regarding the wastewater service area and extension of sewer service to additional properties. The City is committed to serving customers in its sewer service area in accordance with established policies. The City's established policies state that emergency service or other minor modifications to the existing service area may be permitted if approved by the City Council, provided that flows remain within the existing sewer facility capacity. However, major service area expansions that require a facility capacity analysis must be further evaluated. Service is provided by either the City or KCSD #7, or a combination of the two agencies. The City currently has an Interlocal Agreement (ILA) with KCSD #7 to serve 480 equivalent residential units (ERUs) of capacity at the KCSD #7 WWTP.

Table 2.2 General Sewer Service and Sewer Service Extension Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Service Area	Public sewer service should be provided for areas designated in the Comprehensive Plan, including Winslow, the City-contracted service areas of Sewer District 7 and the future service areas at Point Monroe Drive and Lafayette Avenue. Such public sewer service shall not be used to justify development counter to the Comprehensive Plan.	Comp Plan SSP 2.1
Service Area	In public sewer system service areas, new construction should provide for eventual connection to public sewer systems.	Comp Plan SSP 2.2
Service Area	Emergency service or other minor modifications to areas outside of the Winslow Sanitary Sewer System Service Area, which are within the existing sewer facility capacity, may be allowed with approval by the City Council, provided that such extensions serve areas that have an environmental need for sewer due to 1) a high number of documented failing septic systems; or 2) proximity to sensitive bodies of water that are unsuitable for on-site septic systems, according to the Kitsap Public Health District.	Comp Plan SSP 2.4

Table 2.2 General Sewer Service and Sewer Service Extension Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Service Area	City of Bainbridge Island sewer service may, at the discretion of the Public Works Director, be extended outside the City sewer service boundary to area contiguous or noncontiguous upon the following events occurring: A. The total number of new connections does not exceed one percent of the existing customer base in a single year. B. The property is within 300 feet of the City's sewer service boundary. C. There is no change in zoning land use designation associated with the sewer extension that will result in an increase of ERUs served by the property. D. There is no change in Comprehensive Plan land use designation associated with the sewer extension that will result in an increase of ERUs served by the property. E. The proposed extension of City sewer mains and system appurtenances are within the existing sewer facility capacity. F. The applicant has executed a utility extension agreement containing the following conditions, as a minimum: 1. The agreement shall be executed by the property owner(s) and shall be recorded and constitute a covenant upon the land. 2. The owner(s) shall pay all connection charges, service fees, etc. as prescribed by City ordinance when the service is applied for. Sewer system expansions outside of the sewer service boundary and in excess of these requirements require approval in accordance with the Comprehensive Plan and Municipal Code.	
Interlocal Agreement	A. The [Kitsap County Sewer] District operates a sewer service area consisting of a collection system and wastewater treatment plant that serves a portion of the south end of the city. E. By Ordinance No. 2001-43, effective December 24, 2001, the City Council expanded the sewer service area in the south part of the City by establishing a City owned, operated, and maintained collection system to include, generally, Rockaway Beach, Pleasant Beach, Emerald Heights, Point White Drive and Blakely School, in addition to Lynwood Center. G. The City needs to treat the wastewater from 231 residential connections in the local improvement district areas. The District is willing and able to provide wastewater treatment for 250 residential connections to serve the expanded sewer service area, in addition to the 80 ERUs allocated to the Lynwood Center area under the interlocal agreement.	2003 COBI/KCSD ILA Recitals A, E, and G

Table 2.2 General Sewer Service and Sewer Service Extension Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Interlocal Agreement	H. The City has requested the District to provide 150 additional ERUs to serve Lynwood Center, LID20, and Adjacent "Open Space" Residential areas as shown on the attachment to Procedure 2.14 entitled "Figure 1 – South Island Sewer Connections". I. The District desires to provide 150 additional ERUs as requested by the City, which reservation of capacity in the District's wastewater treatment plant is consistent with the District's comprehensive plan and resolutions.	2007 BI/KCSD ILA Recitals H and I
General Service Extension	A. The owner of property within the city's sewer service area, as identified in the city's comprehensive plan, requiring sewer service shall not be allowed to install a septic system if the distance from the property to an existing sewer main with capacity to serve the property is 300 feet or less. The distance shall be measured as a straight-line distance from the end of the main to the nearest corner or edge of the property to be served. The owner of the property shall apply to the city for sewer service, extend the sewer main, and connect the property to the city's sewer system. In addition, the owner of property containing a building or structure for human occupancy or other use necessitating sewer service which is located within the city's present or future sewer service area as identified in the city's comprehensive plan and which is located within 300 feet of a sewer main, and which is certified by the local health office to be a health hazard, shall apply to the city for sewer service, extend the sewer main, and connect the property to the city's sewer system. B. The owner of property within the city's sewer service area as identified in the city's comprehensive plan requesting sewer service may, but shall not be required to, extend an existing sewer main with capacity to serve the property if the distance from the property to the main is more than 300 feet; provided, that sewer extensions shall be sized and configured in accordance with the city's design and construction standards and specifications. C. A person applying to request city sewer or contract sewer system capacity availability, to connect to the city's sewer or contract sewer system, or to change his or her use of the city's sewer or contract sewer system shall request city approval on a form to be provided by the city. The application shall contain the subject parcel tax account, owner, agent, application purpose, current or previous site use, and proposed site use information. The applicant shall complete and attach to the application a project summary in a format required by the city, a sewer connection analysis form to be provided by the city, and a site plan at one-half drawing scale showing proposed sewer mains, lift stations, and manholes for all applications other than for a change in use that does not require a building permit. The application shall be signed by the owner of the premises to be served, or by the owner's duly authorized agent, and shall be filed with the city. The applicant shall pay all related application and processing fees and costs, as established by resolution or ordinance of the city council.	BIMC 13.12.010

Table 2.2 General Sewer Service and Sewer Service Extension Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Service Extension	Whenever 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 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 so that utility service can be provided to other properties not fronting the right-of-way.	BIMC 13.18.010
Connections	Sewer connections shall not be mandated for uses with existing septic systems that are fully functioning and maintained, provided that the use does not change.	Comp Plan SSP 2.5
Inflow Connection	The City must strictly enforce its sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.	NPDES 2012
Unlawful Water Discharge	It is unlawful for any person to discharge into the city sanitary sewage disposal system water from such sources as, but not limited to, roof leaders, cellar, yard and area drains, foundation drains, cooling water discharges, drains from springs, and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catch basins, storm waters, surface runoff, street wash waters, or drainage, or swimming pool drains.	BIMC 13.12.030
Service Lateral Ownership	That portion of any side sewer pipe lying within the street right-of-way or easement shall be maintained by and kept within the exclusive control of the city. That portion lying beyond the right-of-way or easement shall be the responsibility of the abutting property owner.	BIMC.13.12. 060
On-site Disposal Systems	The Kitsap Public Health District is the regulatory agency responsible for on-site sewerage disposal systems. The owners of on-site sewerage disposal systems shall operate and maintain the facilities according to the Kitsap Public Health District regulations and those facilities shall be operated in a sanitary manner at all times at no expense to the City.	Proposed New Policy

Table 2.2 General Sewer Service and Sewer Service Extension Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Alternative Pumping Systems	Pumped sewer systems shall only be approved where gravity sewer systems are not technically or economically feasible. All pumped sewer systems must be designed by a licensed professional engineer. To comply with WAC 173-240-104, the City shall take ownership and responsibility for operation and maintenance of all sewage pumps connected to the City's sewer system with the following exceptions: ▪ Facilities existing or approved prior to August 11, 2000, the effective date of WAC 173-240-104 are excluded from this mandatory requirement until the time they are expanded to serve additional development. ▪ Facilities that serve a single nonresidential, industrial, or commercial establishment are excluded from this mandatory requirement. However, at the discretion of the City, these establishments may be required to be owned and operated by the City to insure proper enforcement of this policy for facilities that may be likely to have a future change in use of occupancy. Commercial/industrial complexes serving multiple owners or tenants and multiple residential dwelling facilities such as mobile home parks, apartments, and condominiums are not considered commercial establishments for the purpose of this section.	Proposed New Policy
Change of Use or Occupancy	Side sewers shall be video inspected at the expense of the owner during a change in owner occupancy or change in owner use of side sewer. The owner shall be responsible to repair or replace the side sewer, from the structure to the sewer main, as necessary, to ensure the side sewer meets current standards.	Proposed New Policy

2.3.2 System Reliability

The following section summarizes the existing and proposed policies regarding system reliability.

Table 2.3 System Reliability Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
O&M	The Permittee (City) must: Institute an adequate operation and maintenance (O&M) program for the entire sewage system. Keep maintenance records on all major electrical and mechanical components of the treatment plant, as well as the sewage system and pumping stations. Such records must clearly specify the frequency and type of maintenance recommended by the manufacturer and must show the frequency and type of maintenance performed. Make maintenance records available for inspection at all times.	NPDES 2012 S5.B
O&M Manual	The Permittee (City) must: Review the O&M manual at least annually. Submit to Ecology for review and approval substantial changes or updates to the O&M manual whenever it incorporates them into the manual. The City must submit a paper or an electric copy (pdf). Keep the approved O&M manual at the permitted facility. Follow the instructions and procedures of this manual. O&M Manual components. In addition to the requirements of WAC 173-240-080 1 through 5, the O&M manual must include: Emergency procedures for plant shutdown and cleanup in the event of wastewater system upset or failure. Wastewater system maintenance procedures that contribute to the generation of process wastewater. Wastewater sampling protocols and procedures for submitting reports to Ecology for compliance with the sampling and reporting requirements in the wastewater discharge permit. Any directions to maintenance staff when cleaning or maintaining other equipment or performing other tasks which are necessary to protect the operation of the wastewater system (for example, defining maximum allowable discharge rate for draining a tank, blocking all floor drainings before beginning the overhaul of a stationary engine). The treatment plant process control monitoring schedule. Minimum staffing adequate to operate and maintain the treatment processes and carry out compliance monitoring required by the permit.	NPDES 2012 S5.G

Table 2.3 System Reliability Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Adequate Capacity	The Permittee (City) must submit a plan and a schedule for continuing to maintain capacity to Ecology when: The actual flow or waste load reaches 85 percent of any one of the permitted design criteria for three (3) consecutive months. The projected plant flow or loading would reach design capacity within five (5) years. The plan and schedule for continuing to maintain capacity must be sufficient to achieve the effluent limits and other conditions of this permit. This plan must identify any of the following actions or any other actions necessary to meet the objective of maintaining capacity: Analysis of the present design, including the introduction of any process modifications that would establish the ability of the existing facility to achieve the effluent limits and other requirements of this permit at specific levels in excess of the existing design criteria. Reduction or elimination of excessive I/I of uncontaminated ground and surface water into the sewer system. Limits on future sewer extensions or connections or additional waste loads. Modification or expansion of facilities necessary to accommodate increased flow or waste load. Reduction of industrial or commercial flows or waste loads to allow for increasing sanitary flow or waste load. Engineering documents associated with the plan must meet the requirements of WAC 173-240-060, Engineering Report, and be approved by Ecology prior to any construction.	NPDES 2012 S4.B
Electrical Power Failure	The Permittee (City) must ensure that adequate safeguards prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of the current NPDES during electrical power failure at the treatment plant and/or sewage lift stations. Adequate safeguards include, but are not limited to, alternate power sources, standby generator(s), or retention of inadequately treated wastes. The Permittee (City) must maintain Reliability Class II (EPA 430/9-74-001) at the WWTP. Reliability Class II requires a backup power source sufficient to operate all vital components and critical lighting and ventilation during peak wastewater flow conditions. Vital components used to support the secondary processes (i.e., mechanical aerators or aeration basin air compressors) need not be operable to full levels of treatment, but must be sufficient to maintain the biota.	NPDES 2012 S5.D

2.3.3 Environmental Stewardship

The following section summarizes existing policies regarding environmental stewardship.

Table 2.4 Environmental Stewardship Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Groundwater	The City shall assess the impacts of proposed activities and development on the flow of springs and streams and levels of wetlands that are either sustained by groundwater discharge or contribute recharge to groundwater by requiring a hydrologic assessment report, and restricting the activities or development based on the report, and/or mitigating impacts.	Comp Plan WR 2.3
Industrial Waste – Prohibited Substances	No person shall discharge any of the following prohibited substances directly or indirectly into any public sewer, private sewer or side sewer tributary to the city: A. Flammable or Explosive Materials. Flammable liquids, solids, or gases capable of causing or contributing to explosion or supporting combustion in any sewerage facilities including, but not limited to, the following: fuel oil, waste crankcase oil, and acetylene generation sludge; B. Substances Which Can Cause Obstruction or Interference. Any solid or viscous substances in quantities, either by itself or in combination with other wastes, which are capable of obstruction of flow or of interfering with the operation or performance of sewer works or treatment facilities, including, but not limited to, the following: ashes, cinders, sand, mud, straw, grass clippings, shavings, metal, glass, tar, asphalt, plastics, cloth, wood, chemical residues, brewing or distilling slops, spent grain or hops, whole blood, meat trimmings and wastes, animal paunch contents, hide, hair, offal, fish or fowl heads or parts, entrails, lard, tallow, baking dough, cannery waste bulk solids, plastics or paper utensils, plastic or paper containers either whole or ground; C. Odorous Substances. Any noxious or malodorous gas or substance which either by itself or by interaction with other wastes is capable of creating a public nuisance or hazard to life or of preventing entry by authorized personnel to pump stations and other sewerage facilities; D. Toxic Vapor. Any gas or substance which either by itself or by interaction with other wastes can produce a toxic vapor. These substances include, but are not limited to, chlorinated hydrocarbons, hydrogen sulfide, sulfur dioxide and cyanide compounds;	BIMC 13.12.070

Table 2.4 Environmental Stewardship Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Industrial Waste – Prohibited Substances (cont'd)	E. Corrosive Substances. 1. Any gas or substance which either by itself or by interaction with other waste may cause corrosive structural damage to sewer works or treatment facilities, but in no case wastes with a pH lower than 5.5, 2. Any salt water; F. Excessive Waste. Wastes at a flow rate and/or pollutant discharge rate which are excessive over relatively short time periods as described in the discharger's waste discharge permit so that there is a treatment process upset and subsequent loss of treatment efficiency; G. High Temperature. Heat in amounts which will inhibit biological activity in treatment plant facilities resulting in an interference in the treatment process and specifically including heat in such quantities that the temperature at the treatment works influent exceeds 20 degrees Centigrade (68 degrees Fahrenheit), or the temperature exceeds 40 degrees Centigrade (104 degrees Fahrenheit) at the point of discharge from the industrial source to public sewers and/or the city sewerage system; H. Radioactive Substances. Any radioactive wastes or isotopes discharged to any sewer shall not exceed such concentration limitations as established by applicable State Department of Social and Health Services regulations. (Ord. 82-20 § C(7)(A), 1982)	

Table 2.4 Environmental Stewardship Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Industrial Waste – Restricted Substances	A. Generally. No person shall discharge wastes containing restricted substances directly or indirectly into any public sewer, private sewer, or side sewer tributary to the city sewerage system, in excess of limitations specified by conditions of the waste discharge permit or by the city or in excess of other city, state or federal standards. Limitations shall be established to the extent necessary to enable the city to comply with current national Pollutant Discharge Elimination System requirements, as promulgated by the Environmental Protection Agency or the State Department of Ecology, and to the extent necessary for compliance by city and by industrial dischargers with any applicable federal and state regulations and with requirements for the protection of sewerage facilities and treatment processes, public health and safety and the receiving waters and when determined by the city to be necessary for the protection of water quality and avoidance of nuisance in the city. The engineer shall publish and revise from time to time standards which as a minimum establish the following restricted parameters: pH, temperature, fats, oils and greases of animal or vegetable origin, fats, oils and greases of mineral origin, and other toxic substances including those defined in applicable state and federal regulations. These published standards shall, by this reference, be made a part of this title. Discharge limits or standards in effect and incorporated into any issued waste discharge permit shall remain in effect for that permit until it expires, except as modified as provided in Section 13.12.210. B. Food Waste. Food waste discharged into any sewer shall have been properly shredded so that 100 percent will pass a three-eighths-inch sieve and 75 percent will pass a one-fourth-inch sieve. Persons engaged in the retail sale of raw produce shall be limited to one grinder having a prime mover not exceeding five hp for the processing of raw produce waste. C. Septic Tank Waste. Any material from a cesspool, privy, septic tank or other on-site disposal system shall not be discharged into a sewer. D. High Strength Wastes. Any waters or wastes containing higher than ordinary concentrations or quantities of compatible pollutants, including but not limited to, biochemical oxygen, demanding pollutants, suspended solids, pH and fecal material, may be required to discharge at a specific release rate or at a specified strength if, in the opinion of the city, the release of such waste in an uncontrolled manner could adversely affect proper handling and treatment in the sewage system. (Ord. 82-20 § C(7)(B), 1982)	BIMC 13.12.080

2.3.4 Design Criteria and Standards

The City currently has wastewater system design and construction standards and specifications. These standards exist within Section 10 – Utilities and other Right-of-Way Uses of the Engineering Standards. Additional design requirements and recommendations applicable to the City's sewer system are found in the Washington State Department of Ecology's (DOE) Criteria for Sewage Works Design book, also known as the Orange Book. Current design criteria policies are outlined in Table 2.5.

The following section summarizes the existing and proposed policies regarding system design. It is recommended that the proposed new policies listed below be adopted by the City. Within this Plan, the capacity limitations of the collection system are evaluated against the proposed new design criteria policies.

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Design	Sewer systems shall be designed and constructed to achieve total containment of sanitary wastes and maximum exclusion of inflow and infiltration (I/I). No new combined sewers will be approved.	Orange Book Section C1-1.3
Infiltration & Inflow Reduction	In all areas of special flood hazards, the following standard is required: New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharge from the systems into floodwaters	BIMC 15.16.050 Section C.2
Sewer location	Siting of public sanitary sewer mains and manholes shall be restricted to the public right-of-way and/or easement dedicated for this utility. Due to the depth of this type of utility, the pipe is normally located in the center of the right-of-way.	Orange Book Section C1-1.5
Separation of Water and Sewer Pipelines	The minimum separation requirements apply to all gravity and pressure sewers of 24-inch diameter or less. Larger sewers may create special hazards because of flow volumes and joint types, and generally require additional separation. A minimum horizontal separation of 10 feet between sanitary sewers, reclaimed water lines, and any existing potable water lines, and a minimum vertical separation of 18 inches between the bottom of the drinking water line and the crown of the sewer shall be maintained. The distance shall be measured edge to edge (i.e., from the outer diameter of the pipes.) Sewer lines crossing water lines at angles including perpendicular shall be laid below the water lines to provide a separation of at least 18 inches between the invert of the water line and the crown of the sewer.	Orange Book Section C1-9.1

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Design Period	A. Service laterals shall be designed for the ultimate development of the parcel being served. B. Collection sewers (that is, laterals and submains) shall be designed for the ultimate development of the tributary area. C. Selection of the design period for trunk and interceptor sewers shall be based on an evaluation of economic, functional, and other considerations.	Orange Book Section C1-3.2
Design Flows	Sewer systems shall be designed on the basis of per capita flows for the design period in conjunction with a peaking factor, or approved alternative methods. Generally, the sewers shall be designed to carry at least the peak hourly flow when operating at capacity. Peak hourly flow should be the design average daily flow in conjunction with a peaking factor.	Orange Book Section C1-3.3
Preference of Gravity Systems	Gravity flow should be a primary factor in siting considerations.	Orange Book Section C1-1.5
Inspection	Ecology recommends the use of a television camera for a recorded inspection prior to placing the sewer in service. Ecology also recommends spot re-inspection of 50 percent of the pipe after 10 months of service	Orange Book Section C1-5.2
Testing	All elements of the sewer system require leak tests. Engineers may specify either air or water testing. For sanitary sewers constructed of flexible pipe, engineers should test for deflection not less than 30 days after the trench backfill and compaction has been completed. The engineer must conduct the test by pulling a properly sized "go-no-go" mandrel through the completed pipeline. On a manhole-to-manhole basis, the engineer will conduct the testing after the line has been completely flushed out with water. Engineers must test all pipelines and appurtenances subject to hydraulic pressure.	Orange Book Section C1-5.1 Orange Book Sections C1-5.3 C1-5.4
Configuration and Installation	Minimum pipe diameter will be 8 inches or as required by the city engineer. Minimum design velocity shall be 2 feet per second flowing full. Sewer lines shall have a 0.1 foot drop through manholes from inlet invert to outlet invert. Sewers should not be less than 3 feet deep, be sufficiently deep to prevent freezing and physical damage, and should receive sewage from existing dwellings by gravity. Where velocities greater than 15 fps are expected, special provision shall be made to protect against internal erosion or displacement by shock.	BI Design and Construction Standards – Section 10.12 Orange Book Sections C1-4.2 C1-4.7

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Minimum slopes	A 0.02 foot per foot minimum slope shall be provided for all piping, unless waived by the city engineer. 8 inch-sewer minimum slope = 0.40 feet per 100 feet 10 inch-sewer minimum slope = 0.28 feet per 100 feet 12 inch-sewer minimum slope = 0.22 feet per 100 feet 14 inch-sewer minimum slope = 0.17 feet per 100 feet 15 inch-sewer minimum slope = 0.15 feet per 100 feet 16 inch-sewer minimum slope = 0.14 feet per 100 feet 18 inch-sewer minimum slope = 0.12 feet per 100 feet 21 inch-sewer minimum slope = 0.10 feet per 100 feet 24 inch-sewer minimum slope = 0.08 feet per 100 feet 27 inch-sewer minimum slope = 0.07 feet per 100 feet 30 inch-sewer minimum slope = 0.06 feet per 100 feet 36 inch-sewer minimum slope = 0.05 feet per 100 feet	BI Design and Construction Standards – Section 10.12 Orange Book Section C1-4.4
Manning's coefficient	An "n" value of 0.013 shall be used in Manning's formula for the design of all sewer facilities (regardless of pipe material) except inverted siphons, where an "n" value of up to 0.015 can be used.	Orange Book Section C1-4.3
Cleanouts	Cleanouts will not be allowed at the terminus of a main extension (manhole required).	BI Design and Construction Standards – Section 10.12
Connections and Side sewers - location	Connection to city sewer main with a side sewer is mandatory within the existing service area. It is also mandatory outside the existing service area for all properties that contain structures constructed for human occupancy and are within 100 feet of city sewer system, or if over 100 feet, may create a health hazard. Side sewers shall be installed from the City sewer main to five feet beyond the property line at all building sites.	BI Design and Construction Standards – Section 10.12
Connections and Side sewers - Configuration and Installation	Sewer line connections to side sewers shall be a minimum of 4 inches in diameter, minimum of 6 inches for commercial/industrial piping. Connection of side sewer to existing main line shall be with a tee. New connection shall use the sweeping tee connection into the new sewer main. Minimum slope for a side sewer shall be 2%.	BI Design and Construction Standards – Section 10.12

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Sanitary sewer mains materials	6-inch pipe used in collection system shall be PVC conforming to ASTM D 3034, SDR 35, ABS conforming to ASTM D 2680, HDPE, PE3408 conforming to ASTM 714, or Ductile Iron Class 50 conforming to ASTM A 21.51. Any generally accepted material for sewers, such as polyethylene, ductile iron, PVC, or concrete, will be given consideration, but the material selected should be adapted to local conditions, such as characteristics of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, and similar problems.	Orange Book Sections C1-4.1 C1-4.8
Manhole Spacing	Sanitary sewer manholes are required at the following locations: The end of each public sanitary sewer line At distances not greater than 400 feet for sewers 15 inches in diameter or less, and 500 feet for sewers with diameters of 18 inches to 30 inches. Greater distances may be acceptable in cases where adequate cleaning equipment is provided. Where a 6-inch pipe connects to a 8-inch or larger pipe. At all changes in direction, grade, size of pipe, or pipe alignment At all intersections	BI Design and Construction Standards – Section 10.12 Orange Book Sections C1-4.1 C1-6.1
Manhole Size	The minimum inner diameter of manholes shall be 48 inches. For incoming pipe larger than 24 inches in diameter, the manhole diameter shall be 54 inches or greater. Manholes are mandatory when connecting significant industries to the system and should be of adequate size to provide for monitoring and sampling equipment.	Orange Book Section C1-6.3
Manhole Materials	Watertight manhole covers shall be used wherever the manhole tops may be flooded. Joints between precast manhole units shall have rubber gaskets or be provided with a positive self-sealing mastic. Frames and covers shall be cast or ductile iron or other suitable material for specialized site conditions. All covers located in an easement or constructed of aluminum material should be the locking type.	Orange Book Sections C1-6.5 C1-6.7
Lift Station Design Criteria	The firm capacity of a pumping station shall be equal to or greater than the peak hourly design flow. Because mechanical and electrical equipment is typically designed for a 20 year life, it is recommended that the peak design flow be based on a 20-year forecast or greater. The number of pumps selected shall allow the station to provide the peak design flow with the largest pump out of order. The station shall be designed to remain fully operational during the 100-year flood/wave event.	Orange Book Sections C2-1.2.1 C2-1.2.3 C2-1.1

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Lift Station Pump	Pumps should be designed for pumping sewage and capable of passing solids at least 3-inches in diameter. Pump suction and discharge should be 4 inches or greater.	Orange Book Section C2-1.2.4
Flow Meters	Suitable devices for measuring sewage flow shall be provided at pump stations. Run timers should be provided on all pumps.	Orange Book Section C2-1.4
Emergency Back-up Power	All sewage pump stations should be designed with capability for emergency power in case the primary electrical feed is out of service. A portable engine generator unit that is plugged into a pigtail at the pump station commonly provides emergency power for small pump stations. Larger pump stations should have permanent engine generator units with automatic transfer switches to transfer the electrical feed from the primary to the standby unit when a power failure is detected by the instrumentation and control system.	Orange Book Section C2-1.8.3
Conformance to City Standards	All sanitary sewers and appurtenant structures shall be designed and constructed in conformance with City Engineering Division's policies, design standards, technical specifications and standard details, and shall include, but not be limited to, such items as: 1. Pipe size and materials 2. Manholes 3. Cleanouts 4. Backfill requirements 5. Service laterals	Proposed New Policy
Professional Engineer	All wastewater facilities and appurtenant structures shall be designed in accordance with good engineering practice by a licensed professional engineer.	Proposed New Policy
DOE Requirements	All wastewater facilities and appurtenant structures shall be designed in conformance with Department of Ecology regulations, except as City standards differ.	Proposed New Policy
Design Storm	In accordance with all applicable federal, state, and local regulations, the City should design its wastewater system facilities to adequately and reliably convey peak hour flows associated with a Design Storm event without overflowing or discharging to any water bodies. The Design Storm is defined as two 2-year, 24-hour storms followed by a 25-year, 24-hour storm.	Proposed New Policy
Preference of Gravity Systems	Gravity wastewater systems shall be used wherever feasible to provide wastewater service since they are less susceptible to interruption of service and require the least amount of maintenance.	Proposed New Policy
Design Storm	Wastewater system flows are composed of residential, institutional, commercial, and industrial sewage, along with infiltration and inflow. Wastewater systems must be capable of conveying the ultimate peak hour flows of these wastewater sources.	Proposed New Policy

Table 2.5 Design Criteria Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Design Flows based on Master Plan	All future planning and evaluation of wastewater facilities shall use the base and peak flows established in the 2014 Wastewater System Master Plan, as a minimum standard.	Proposed New Policy
Surcharging	The City's design criteria require the depth of flow versus the diameter of the pipe (d/D) ratio to be equal to or less than 50%. Every pipe in the network must be able to carry the most extreme flows (peak wet-weather flows) without surcharging the system.	Proposed New Policy
Encroachments	The City shall prohibit the construction of structures which would prevent access to public sewer lines and easements.	Proposed New Policy
Inspection	New gravity sewer construction shall be inspected with video equipment to assure compliance with the design standards. Final acceptance of gravity sewers will be subject to City approval.	Proposed New Policy
Testing	Gravity sewers and service laterals between the main line and the edge of the right-of-way or easement shall be pressure tested after backfilling by the low-pressure air method. Service laterals from the edge of the right-of-way or easement to the building shall be tested after backfilling by either the exfiltration or low-pressure air method.	Proposed New Policy
Pump Stations	All pump stations shall conform to the City's Pump Station Design Standards.	Proposed New Policy
Operability during Flood	Provisions shall be included in the design of any pump station to allow the station to remain fully operational and accessible during a 100-year flood.	Proposed New Policy
Redundancy	All pump stations, except for private stations for a single-family home, shall have a minimum of two pump units, each with the capacity to handle the expected maximum flow.	Proposed New Policy
Reliability	All pump stations shall have an emergency back-up power generators permanently mounted on site. Power sources shall be capable of powering all equipment. Permanent on-site generators shall be sized to provide continuous power for a minimum of 24 hours before servicing is required. In case of permanent generator failure there shall be receptacles for portable generators and bypass pump connections at all of its pump stations.	Proposed New Policy
Operations & Maintenance Manuals	Operation and Maintenance (O&M) manuals shall be prepared for all pump stations.	Proposed New Policy
Inflow/Infiltration	Future development shall be designed for a peak inflow and infiltration rate of 1,100 gpad.	Proposed New Policy

2.3.5 Financial Policies

The City currently has many financial policies related to the wastewater system. As shown in Table 2.6, these include user fees, wastewater system development charges, fees pertaining to sewer extensions, and policies regarding operating fund balances available for the utility system. An in-depth review of the financial policies of the sewer utility based on City codes, ordinances, and budget documents is included in Chapter 10 – Financial Analysis.

Table 2.6 Financial Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Rates and Charges	Rates and charges for city sewer service shall be adopted by ordinance and published in the city's combined fee schedule.	BIMC 13.12.300
Rate Adjustment	A. All water and sewer rates shall be subject to an adjustment beginning with the first full billing period of each year equal to the annual percentage increase in the United States Consumer Price Index, All Urban Consumers (CPI-U) for November of the preceding year as shown in the release from the Bureau of Labor Statistics plus two percent unless the city council determines by December 31st of any year that the adjustment shall be another amount or shall not occur for the next year. B. In calculating the annual adjustment, the city shall round off all final calculations to the nearest cent where the rate provides for cents and to the nearest dollar where the rate does not provide for cents.	BIMC 13.16.060
Rate Adjustment	There will be no automatic annual fee adjustment of the City's sewer utility fees under Section 13.16.060 of the Bainbridge Island Municipal Code for 2013 and 2014.	Ordinance 2012-22, Section 1 and Ordinance 2013-29

Table 2.6 Financial Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Billing	A. Water and/or sewer service accounts shall be billed on a periodic basis on or before the tenth day of the month succeeding the billing cycle in which such service is furnished. Water meters shall be read at the end of each billing cycle and the billings shall be based upon that reading. All bills are the responsibility of the owner of the property served. Bills may be sent to a person other than the owner at the owner's written request, which request must contain a commitment to pay on demand all amounts not paid by the person billed. B. All charges for sewer and/or water service shall be due and payable on the last day of the month in which the bill was sent; provided, that the bill shall not be due less than 20 days from the date of billing. If the whole or any portion of the water and/or sewer charge remains unpaid after the due date, the account shall be delinquent. All delinquent water and/or sewer accounts shall be subject to a monthly penalty charge of 10 percent of the amount of the delinquent service charges. In addition, accounts which are delinquent more than 120 days shall be subject to interest at the rate of eight percent per annum on the entire amount of the service charges owing and unpaid.	BIMC 13.16.070
Discounts	Low-income disabled citizens who meet the requirements set forth in BIMC 13.16.084 and 13.16.086 shall be entitled to a reduction in the city's water, sewer, and storm and surface water service charges as established by the city by resolution. For the purposes of this chapter, a disabled citizen is a person who is disabled as defined by the Social Security Administration and who received Social Security benefits, or any other benefits, for that disability from any governmental source.	BIMC 13.16.082
Discounts	In order to qualify for the rate reductions set forth in BIMC 13.16.080 and 13.16.082, a person must file an application for the reduction with the city clerk prior to January 1st of the year for which the rate reduction is desired. Persons qualifying for the discount after the first of the year may apply at any time at least 30 days prior to the billing date upon which the rate reduction is to be effective. Applicants must meet the requirements for eligibility set forth in BIMC 13.16.086	BIMC 13.16.084

Table 2.6 Financial Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Discounts	A. The rate reduction shall only apply to utility charges for service to a residence. The residence for which the rate reduction is requested must be the applicant's principal place of residence. B. The applicant must be the head of the household for the residence for which the rate reduction is requested. C. The utility account must be in the applicant's name or the name of the applicant's spouse or in the name of a cooperative or condominium association. In situations where the utility account is in the name of a cooperative or condominium association, that organization must guarantee to the city that the full benefit of any rate reduction shall be received by the qualifying individuals under BIMC 13.16.080 or 13.16.082. D. No person may claim a rate reduction for more than one dwelling unit during the same billing period. E. The rate reduction authorized by BIMC 13.16.080 shall not be used in conjunction with the rate reduction authorized by BIMC 13.15.082. F. For purposes of this chapter, a "senior citizen" is a person who is at least 62 years of age on the date of the person's application for a utility rate reduction under this chapter. G. For purposes of this chapter, "low income" means that the person has a combined disposable income in an amount that would qualify the person for property tax exemption under RCW 84.36.381. "Combined disposable income" shall be defined as stated in RCW 84.36.383.	BIMC 13.16.086
Enforcement of Sewer Liens	A. All charges for sanitary sewage disposal service and for connections thereto, together with penalties and interest thereon as provided in this title and by statute, shall be a lien upon the property to which such connection is made or such service furnished, superior to all other liens or encumbrances except those for general taxes, special assessments, and city water service. A sewer lien shall be effective for a total not to exceed one year's delinquent service charges without the necessity of any writing or recording of the lien with the county auditor. Enforcement and foreclosure of any sewer lien shall be in the manner provided by state law. B. As an additional and concurrent method of enforcing a sewer lien authorized by this section and state law, the city may shut off the water service to the premises to which such sewer service was furnished or connections made after the charges became delinquent and unpaid, until the charges are paid, subject to the conditions set forth in state law.	BIMC 13.16.090

Table 2.6 Financial Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Budgets	A. The City shall use major one-time revenue to fund capital improvements, debt reductions, contingency funds or reserves. The use of one-time revenues to fund operating expenditures is discouraged. B. The City shall maintain a structure for all fees and charges where the beneficiary of the service pays the cost of that service except to the extent that the City Council has determined that provision of the specific service in question provides a general public benefit. The Council shall review, at least annually, the Administration's recommended policy for the allocation of City costs to various funds. C. The City is authorized to allocate up to three percent (3%) of unrestricted revenues of the tax-supported and respective utility funds for replacement of capital equipment as deemed appropriate by the Administration.	Resolution 2009-34 Section 5.2
Service Extension Costs	Sewer and storm and surface water main extensions shall be sized and configured in accordance with this code, resolutions and water and sewer system plans. If main extension sizing required by the public works director exceeds the minimum allowable extension pipe sizing for the project, the City Public Works, 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 shall reimburse the developer for the differential cost of the pipe oversizing within 60 days of the final acceptance of the installed main extension.	BIMC 13.18.030

Table 2.6 Financial Policies General Sewer Plan City of Bainbridge Island		
Subject	Policy	Source
Reserves	In 2010 and thereafter the City shall maintain separate reserves for each utility fund, as follows: <u>Capital Contingency Reserve.</u> This designated reserve shall have a targeted level (by December 2011 and thereafter) of at least one percent (1%) of the utility system's fixed assets (at book value). The primary purpose of the reserve is to provide a ready source of cash in case of an emergency, should a major piece of equipment or a portion of the utility's infrastructure fail unexpectedly. This reserve holds debt proceeds, system participation fee revenues, system reinvestment funding from rates, and any transfers of surplus cash reserves from the operating account. <u>Operating Reserve.</u> This designated reserve shall have a targeted level as of each year-end of at least forty-five (45) days' operating expenses in the cases of the sewer and stormwater funds, and at least sixty (60) days in the case of the water fund. The primary purpose of the Reserve is to provide cash for, operations in case of seasonal variations in revenue or expenses, or to support operations in a year in which revenues are abnormally low. Because water usage for irrigation, and therefore water revenues, are particularly sensitive to a year's weather patterns, the reserve requirements for the water fund are set higher than for the other two utilities. <u>Restricted Debt Reserve.</u> To the extent that the City issues bond debt (e.g. Revenue Bonds) that requires the municipality to maintain a restricted cash reserve during the term of the debt repayment period, the utility shall maintain a restricted reserve for such purpose. This reserve is to safeguard the purchasers of the utility's debt, and may be used to fund the final installment or last year's debt service.	Resolution 2009-34 Section 5.3(a)
Self-sufficiency	The City will maintain water, sewer and stormwater utility rates adequate to ensure that each of the three utility funds is fully self-supporting.	Resolution 2009-34 Section 5.3
Self-sufficiency	The City's Water Utility, Sewer Utility and Storm and Surface Water utility are proprietary services. The funds from those utilities shall not be expended for general governmental services.	Resolution 2013-13

FLOW PROJECTIONS

3.1 INTRODUCTION

This chapter describes the flow monitoring program performed during the development of this Plan, reviews existing Winslow Collection System wastewater flows and presents the projected wastewater flows for future conditions within the Winslow collection system. Historical and projected wastewater flows and loads to the Winslow Wastewater Treatment Plant (WWTP) are also included in the chapter. Finally, build-out flows and a brief discussion of wastewater collection, treatment and discharge options for the Mid-Island Study Area is presented. The South Island flow projections and capacity evaluation were performed based on equivalent residential units (ERUs) and are discussed in Chapter 6. The planning years for this evaluation include the existing year (2013), the short-term planning year (2025), and the long-term planning year (2035).

3.2 FLOW AND LOAD PARAMETERS

The flow and load parameters of primary interest for planning purposes are defined as follows:

- **Average Dry Weather Flow (ADWF)** is the average flow that occurs on a daily basis during the two driest months of the year (July and August). The ADWF includes the base wastewater flow (BWF) generated by the City's residential and commercial plus the dry weather groundwater infiltration (GWI) component. For the City, the ADWF was estimated throughout the service area based on the historical influent flow data from the City's Wastewater Treatment Plant (WWTP), and from the flow monitoring program.
- **Average Annual Flow/Load (AAF)** is the average flow or load that occurs over a calendar year. AAF/load was estimated based on the historical influent flow and load data from the City's WWTP.
- **Maximum month flow/load (MMF)** is the maximum 30-day running average flow during a calendar year. MMF/load was estimated based on the historical influent flow/load data from the City's WWTP.
- **Peak day flow/load (PDF)** is the maximum 24-hour average flow/load during a calendar year. PDF/load was estimated based on the historical influent flow/load data from the City's WWTP.
- **Peak hour flow (PHF)** is the highest observed hourly flow that occurs following a design storm event in a calendar year. Wet weather Inflow and Infiltration (I/I) causes flows in the collection system to increase. PHF is typically used for designing sewers and lift stations. Therefore, the PHF and the "Design Flow" are synonymous and will

be used interchangeably throughout this Plan. The PHF was estimated throughout the service area based on the historical influent flow data from the City's WWTP, and from the flow monitoring program.

3.3 FLOW MONITORING PROGRAM

This section summarizes the three-month flow monitoring program that was conducted for this Plan and presents the data and results obtained.

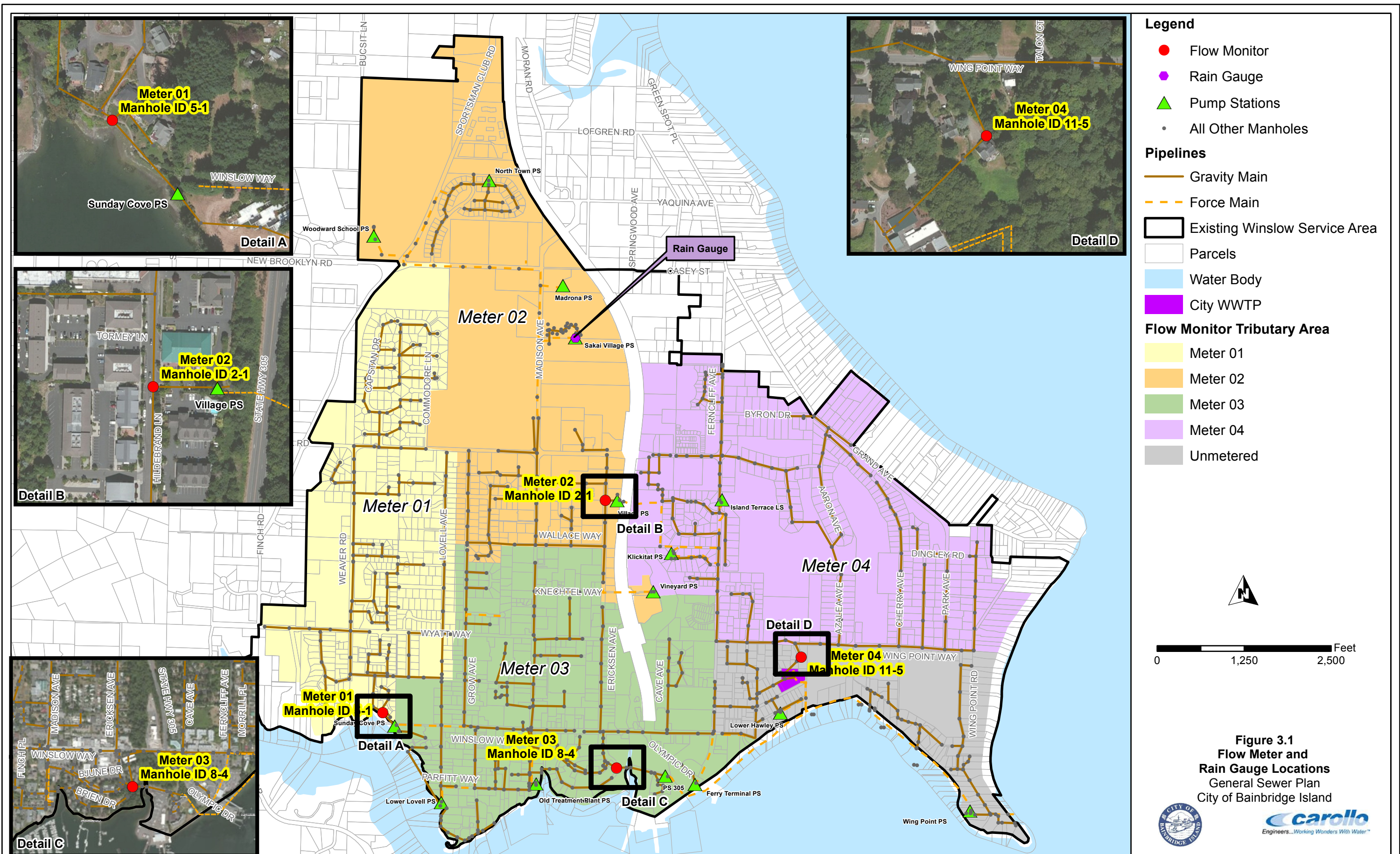
3.3.1 Flow Monitoring Sites and Rainfall Data

The purpose of a flow monitoring program is to determine average dry weather flow (ADWF), define the collection system's weekday and weekend diurnal flow patterns, and develop land use flow factors that facilitate the development of flow projections. Flow monitoring data is also used to calibrate the collection system hydraulic model for dry-weather and wet-weather flow, and to help identify areas of the system with the highest I/I rates.

The flow monitoring data was collected from four temporary flow meters installed for the purpose of this Plan by ADS Environmental Services (ADS). The monitoring period chosen for the analysis was from November 7, 2013 to February 4, 2014.

The four meter sites were selected to best isolate and model the critical areas and subareas within the sewer system. The four flow monitoring locations, as well as the area tributary to each site, are presented in Figure 3.1. Table 3.1 lists the flow monitoring locations and the diameters of the pipes in which the meters are installed. Figure 3.2 provides a schematic illustration and understanding of the flow monitoring locations and the City's wastewater collection system.

Table 3.1 Temporary Flow Monitoring Locations General Sewer Plan City of Bainbridge Island			
Meter ID	Basin Associated	Address	Pipe Diameter (inch)
Site 5-1	Basin 01	South of Bromley Place NW	10
Site 2-1	Basin 02	High School Rd NE and Hildebrand Ln	10
Site 8-4	Basin 03	Harborview Drive SE	10
Site 11-5	Basin 04	NE Wing Point Way	12



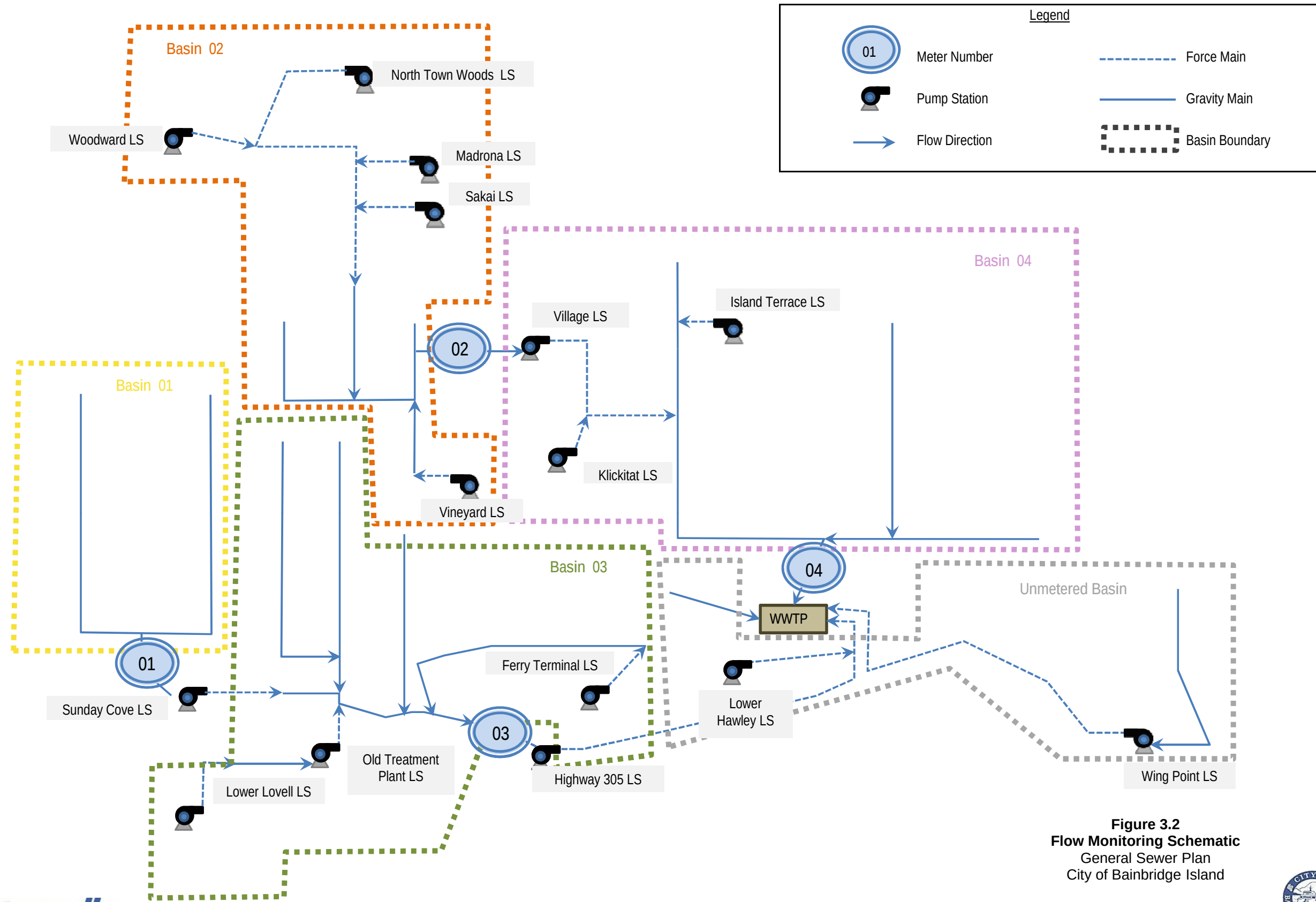


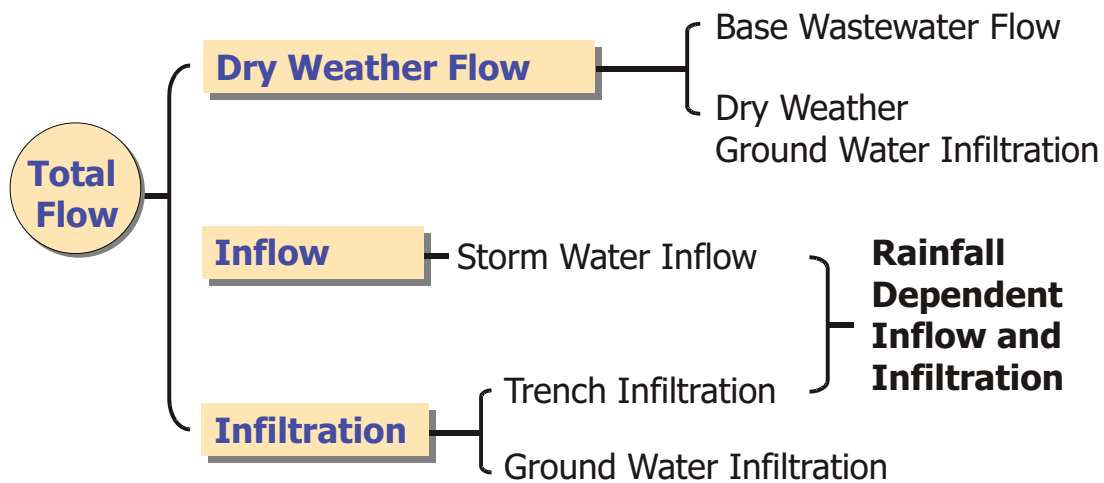
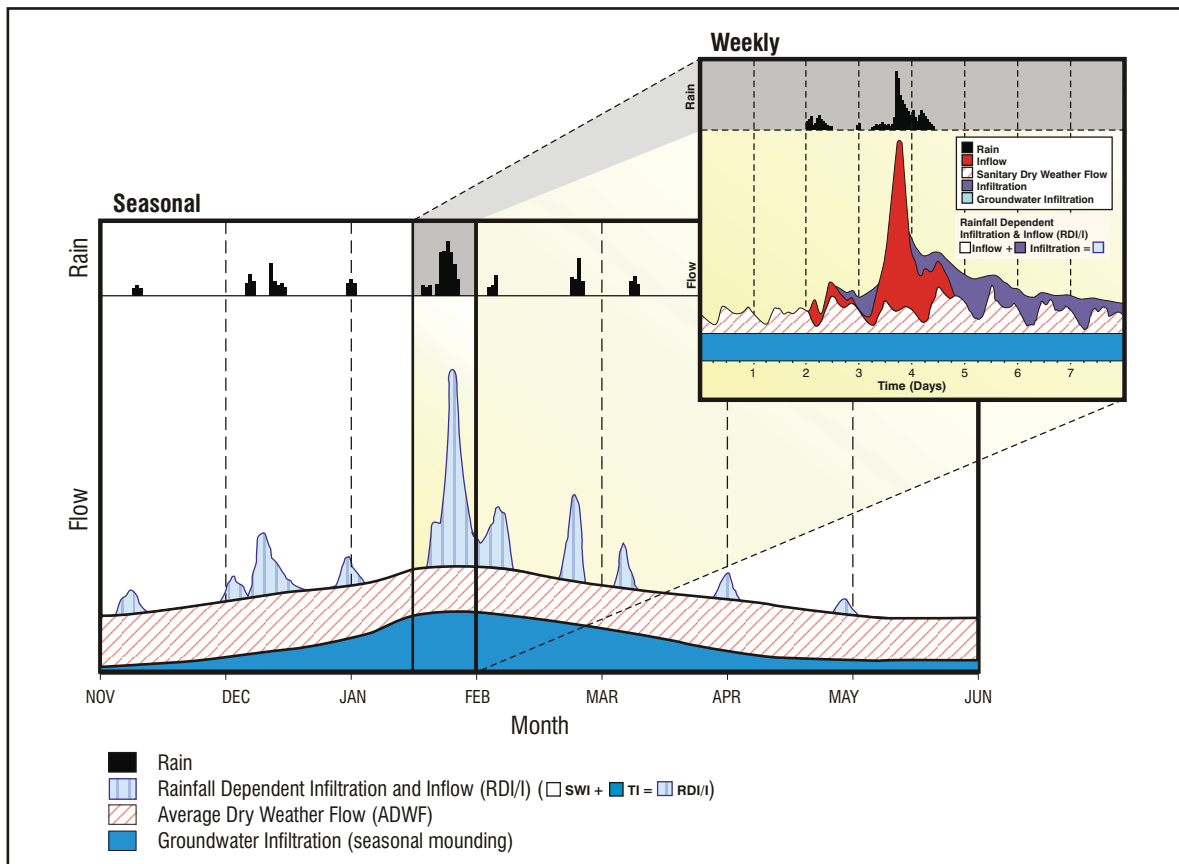
Figure 3.2
Flow Monitoring Schematic
 General Sewer Plan
 City of Bainbridge Island

One rain gauge was installed by ADS as part of the flow monitoring program to capture rainfall that occurred throughout the study area. The location of the rain gauge used for the purpose of the flow monitoring program is shown on Figure 3.1.

3.3.2 Collection System Flow Components

In general, wastewater consists of the three components defined below. Figure 3.3 illustrates the various wastewater flow components.

- **BWF**: Base wastewater flow (BWF) is generated by routine water usage in the residential, commercial, business and industrial sectors of a collection system. The flow has a diurnal pattern that varies depending on the type of use. Commercial and industrial patterns, though they vary depending on the type of use, typically have more consistent, higher flows during business hours and lower flows at night. Furthermore, the diurnal flow pattern experienced during a weekend may vary from the diurnal flow experienced during a weekday.
- **Dry Weather GWI**: Dry weather groundwater infiltration (GWI) enters the sewer system when the relative depth of the groundwater table is higher than the depth of the pipeline and when the susceptibility of the sanitary sewer pipe or manhole allows infiltration through defects such as cracks, misaligned joints, and broken pipelines. GWI may occur throughout the year, although rates are typically higher in the late winter and early spring. Dry weather GWI (or base infiltration) cannot easily be separated from BWF by flow measurement techniques. Therefore, dry weather GWI is typically grouped with BWF, and the combination is referred to as average dry weather flow (ADWF).
- **I/I**: Infiltration/Inflow includes stormwater inflow and trench infiltration. The I/I flow response in the sewer system to rainfall is seen immediately (as with inflow) or within hours after the storm (as with infiltration). All wastewater collection systems have some I/I, although the characteristics and severity vary by region and individual collection system. Some of the most common sources of I/I are shown on Figure 3.4. Infiltration is defined as storm water flows that enter the sewer system by percolating through the soil and then through defects in pipelines, manholes, and joints. Examples of infiltration entry points are cracks in pipelines, misaligned joints, and root penetration. Inflow is defined as storm water that enters the sewer system via storm drain cross connections, leaky manhole covers, or cleanouts. Examples of inflow entry points are roof drain and downspout connections, leaky manhole covers, and illegal storm drain connections. The adverse effects of I/I entering the sewer system include increases to both flow volume and peak flows, as illustrated on Figure 3.5. If too much I/I enters the sewer system such that the sewer system is operating at or above its capacity, sanitary sewer overflows (SSOs) could occur.



TYPICAL WASTEWATER FLOW COMPONENTS

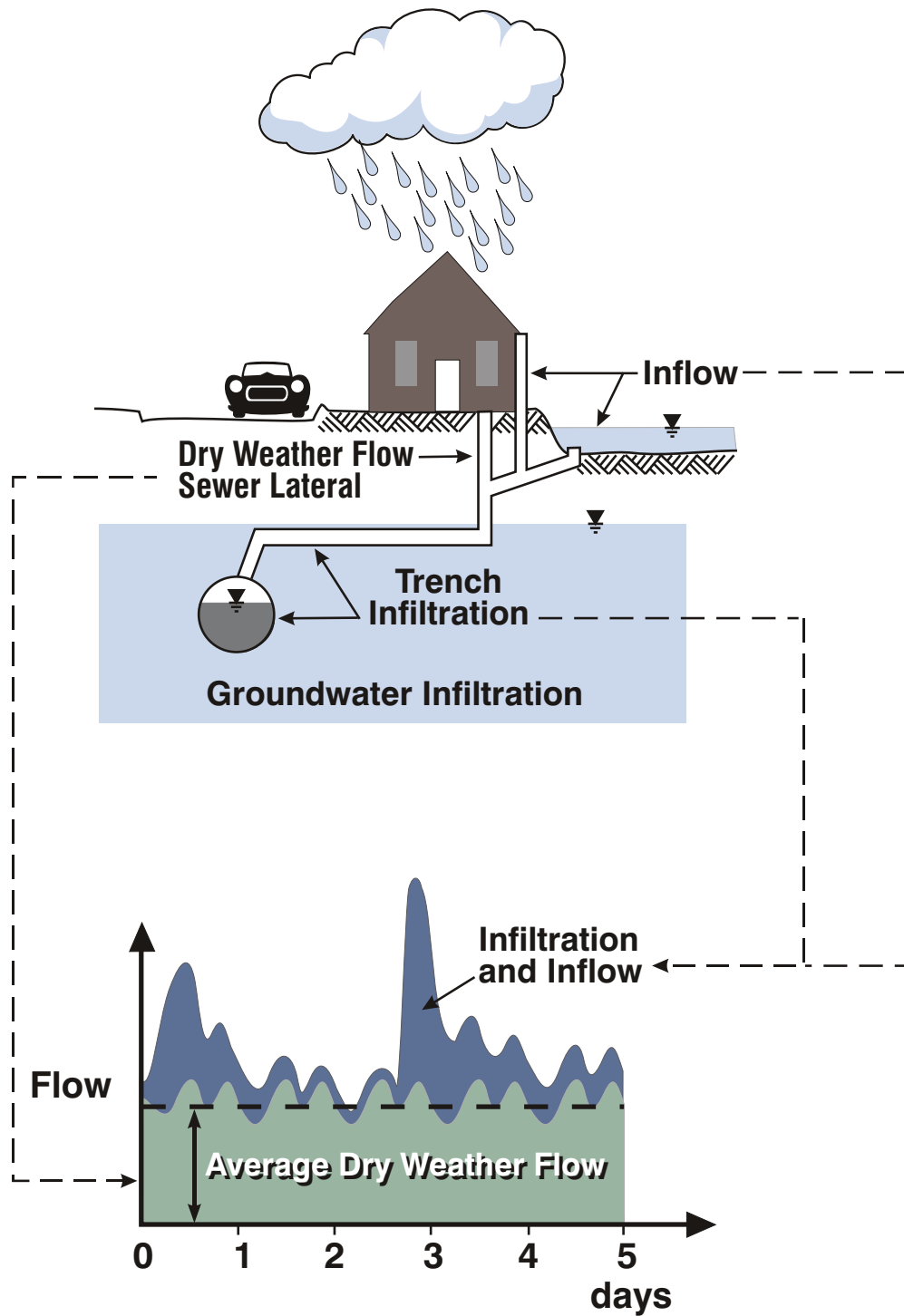
Note: This figure is not based on flow data specific to the City or this Master Plan

FIGURE 3.3

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



TYPICAL EFFECTS OF INFILTRATION AND INFLOW

FIGURE 3.5

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

3.3.3 Flow Monitoring Results and Analysis

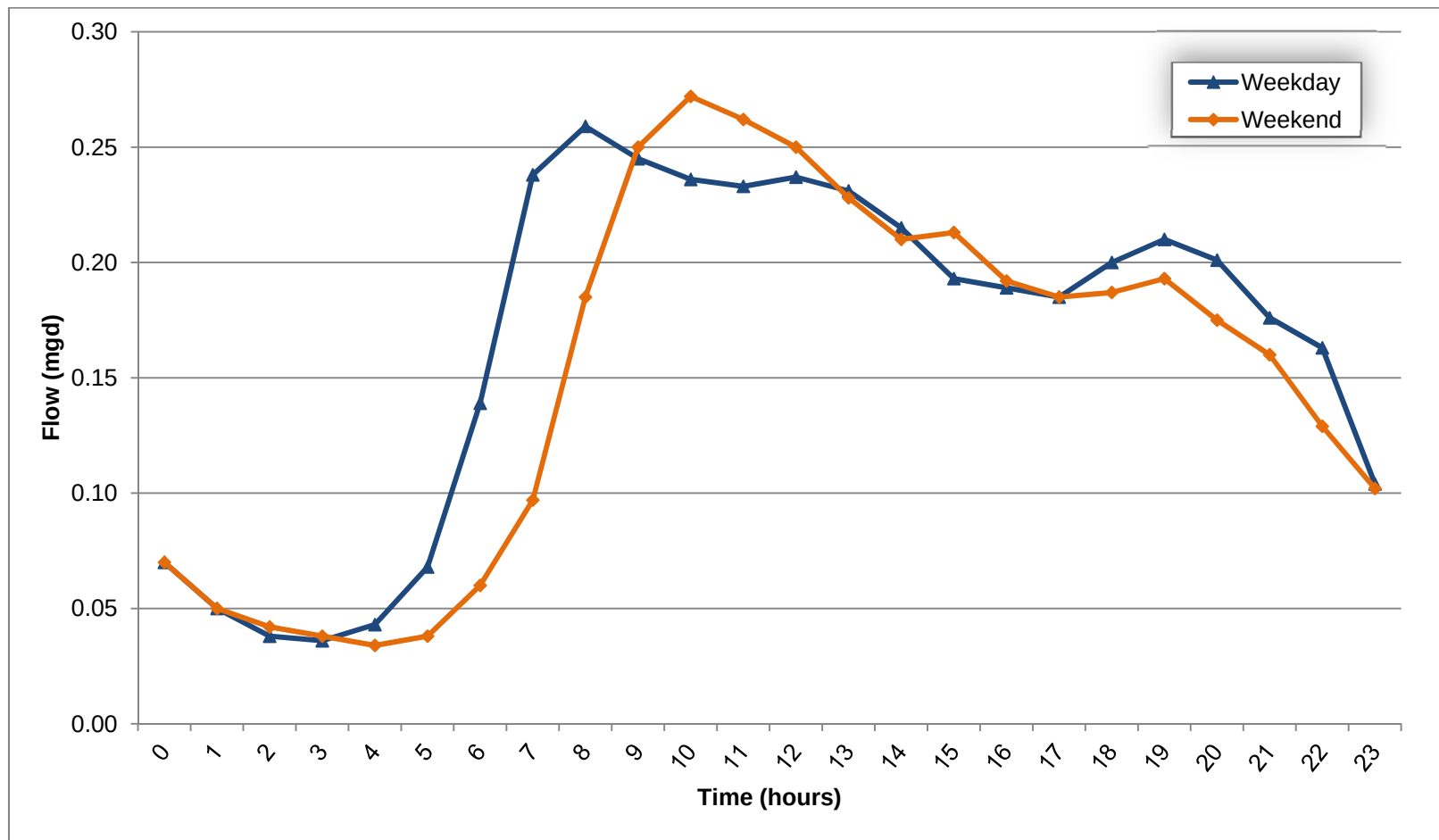
This section summarizes the results of the flow monitoring program, including dry weather flow data, rainfall data, and wet weather flow data. Throughout this Plan, typically data from only one meter will be presented as an example of the results obtained from the flow monitoring program. Refer to Appendix E for additional data summaries and other information associated with the remaining meter sites.

3.3.3.1 Dry Weather Flow Data

During the flow monitoring period, depth and velocity data were collected at each meter at 5-minute intervals. The 5-minute data were aggregated to hourly data for use in the hydraulic model. Characteristic dry weather, 24-hour diurnal flow patterns for each site were developed based on the hourly data. This hourly flow data was then used to calibrate the hydraulic model for the observed dry weather flows during the flow monitoring period.

Hourly patterns for weekday and weekend flows vary and are separated to better understand dry weather flow. Data from the days least affected by rainfall were used to estimate the weekday and weekend dry weather flows. In addition, estimates for the average weekday and weekend levels and velocities at each site were calculated and are used in dry weather flow calibration. Figure 3.6 illustrates a typical variation between weekday and weekend flow in the City, which is based on the data collected from Meter 4. Similar graphics associated with the remaining sites are included in Appendix K. Table 3.2 summarizes the dry weather flows at each meter.

Table 3.2 Dry Weather Flow Summary General Sewer Plan City of Bainbridge Island				
Metering Site	Weekday Dry Weather Flow (mgd)	Weekend Dry Weather Flow (mgd)	Overall Dry Weather Flow (mgd)⁽³⁾	Weekend/ Weekday Ratio
Basin 01 ⁽¹⁾	0.06	0.06	0.06	1.02
Basin 02 ⁽¹⁾	0.08	0.06	0.07	0.81
Basin 03 ⁽¹⁾	0.21	0.21	0.21	0.99
Basin 04 ⁽¹⁾	0.16	0.15	0.16	0.92
Unmetered ⁽²⁾	0.05	0.06	0.05	0.93
Notes				
(1) Source: Sanitary Sewer Flow Monitoring, Winter 2013/2014 – ADS Flow Monitoring Report.				
(2) Source: Wastewater Treatment Plant data from January 2013 to August 2013 included, provided by the City. Unmetered flow calculated as WWTP flow minus metered flow.				
(3) Overall Dry Weather Flow = (5 × Weekday + 2 × Weekend)/7.				



**TYPICAL WEEKDAY VS.
WEEKEND DRY WEATHER FLOW
VARIATION (METER 04)**

FIGURE 3.6

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

3.3.3.2 Rainfall Data

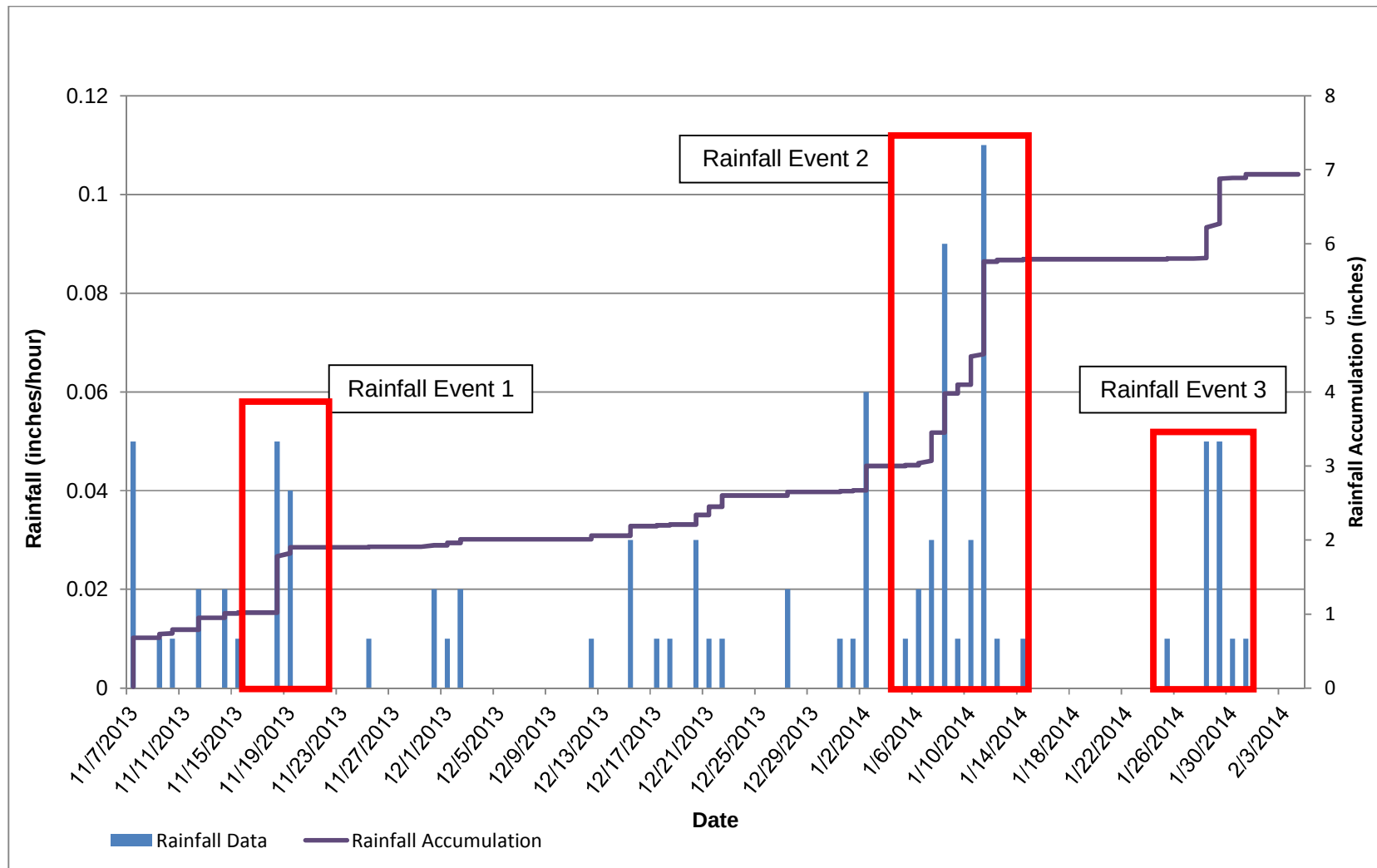
There were three main rainfall events that occurred during the course of the flow monitoring period, as well as a few other relatively minor events. Figure 3.7 illustrates the accumulation of rainfall over the course of the flow monitoring period. Table 3.3 summarizes the peak intensity and total rainfall recorded at the rain gauge during the three main rainfall events.. The flow monitoring report prepared by ADS, included in Appendix E, classifies each of the three main rainfall events as less than 2-year, 24-hour events. The rainfall event classification is shown in Figure 3.8. The storms presented valuable data in terms of the collection system's I/I response to wet weather flow events, and is therefore appropriate for I/I analysis and model calibration purposes.

Table 3.3 Rainfall Event Summary General Sewer Plan City of Bainbridge Island				
Rainfall Event ID	Start Date	End Date	Peak Intensity (inch/hour)	Measured Rain (inches)
1	11/18/2013	11/20/2013	0.09	0.88
2	01/05/2014	01/15/2014	0.28	2.79
3	01/27/2014	01/31/2014	0.17	1.09

3.3.3.3 Wet Weather Flow Data

The flow monitoring data was also evaluated to determine how the collection system responds to wet weather events. As mentioned above, the flow monitoring program captured three main rainfall events. The rainfall events that occurred between January 5, 2014 and January 15, 2014 were associated with the largest I/I response during the flow monitoring period, and are the most appropriate to be used for I/I analysis. However, the model was calibrated to all three of the main rainfall events. Figure 3.9 shows an example of the wet weather response at Meter 04 during the January 5, 2014 rainfall event. Figure 3.9 illustrates the volume of I/I that entered the system from the collection system upstream of Meter Site 04. The light blue area represents the base sanitary flow while the gray area is the measured flow from the flow monitoring period. As can be seen in the figure, discernible amounts of I/I do enter the system during wet weather events. Similar graphs were generated for the remaining monitoring sites and can be found in Appendix E.

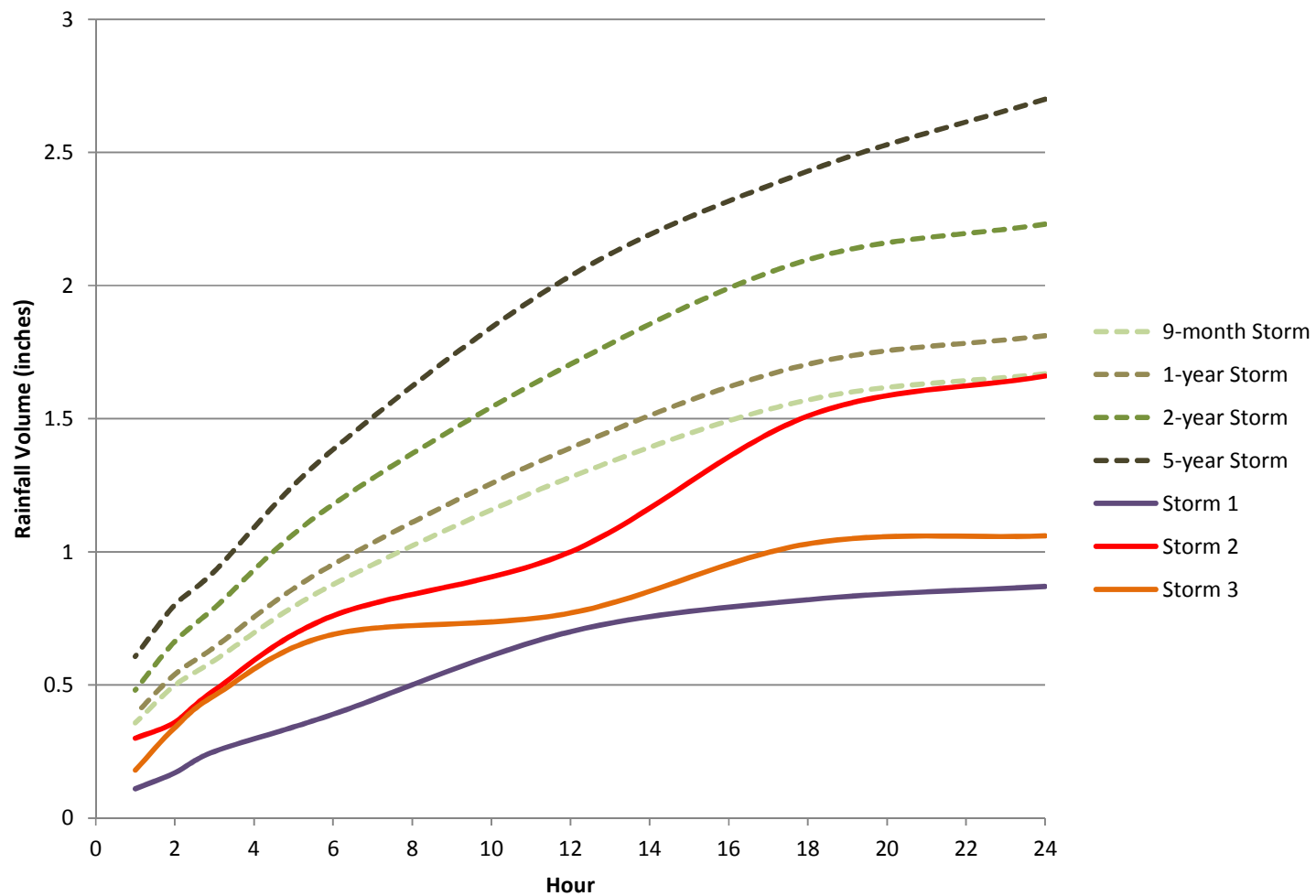
The metric typically used to quantify the severity of the system's I/I is the peak hour I/I rate value. The peak hour I/I rate value defines the amount of flow that makes it into the collection system as I/I and has a typical threshold of 3,500 gallon per acre per day (gpac) above which I/I is considered significant. Table 3.4 summarizes the results for the major rainfall event that occurred during the first week of January, 2014.



FLOW MONITORING RAINFALL DATA

FIGURE 3.7

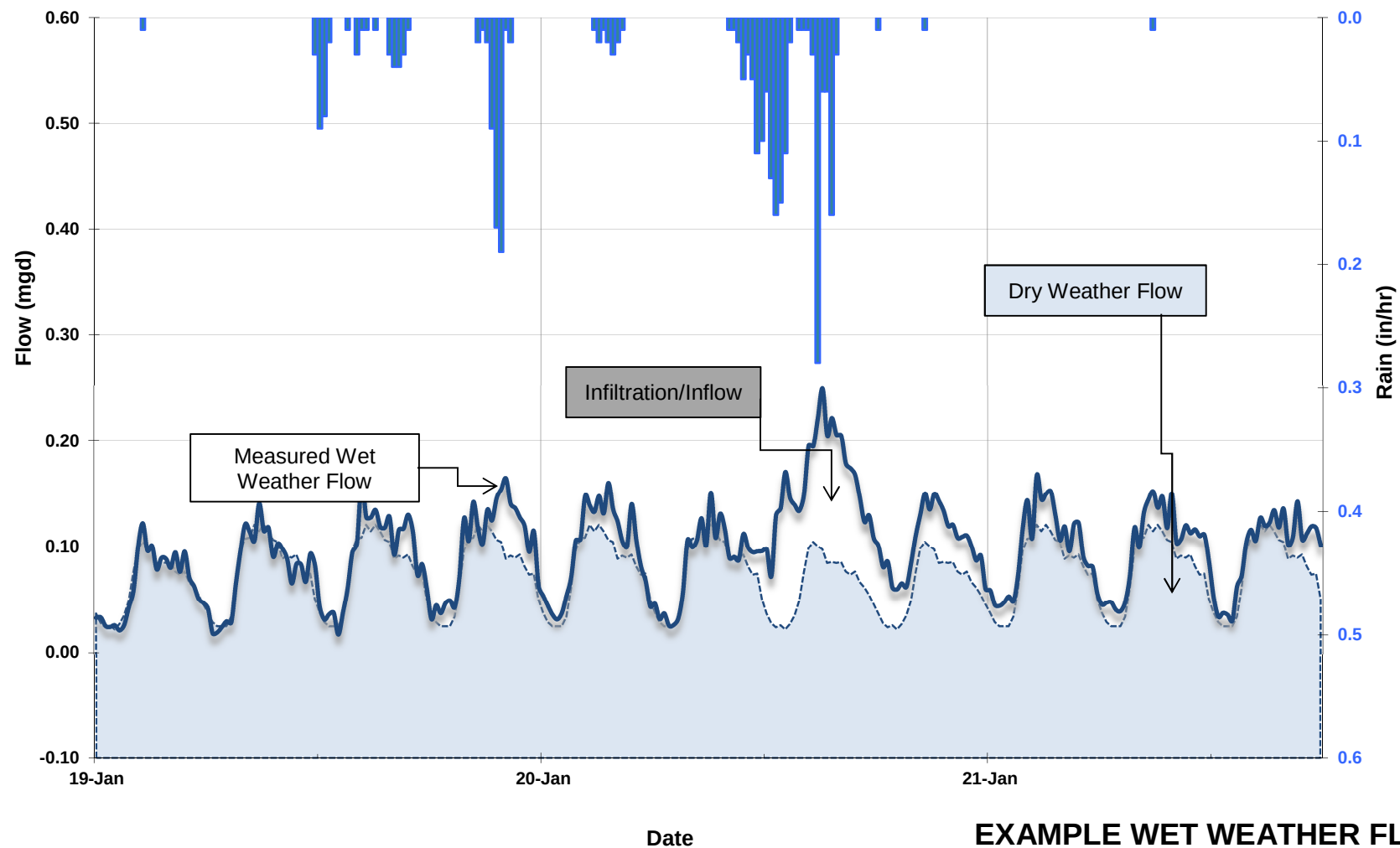
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



RAINFALL EVENT CLASSIFICATION

FIGURE 3.8

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



**EXAMPLE WET WEATHER FLOW
RESPONSE (METER 04)**

FIGURE 3.9

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Table 3.4 I/I Analysis Summary General Sewer Plan City of Bainbridge Island			
Meter ID	Acreage contributing I/I (acre)	Peak hour I/I⁽¹⁾ (mgd)	Peak hour I/I Rate⁽²⁾ (gpad)
Meter 01	136.5	0.08	610
Meter 02	261.5	0.15	580
Meter 03	149.9	0.09	630
Meter 04	161.7	0.04	220
Notes: (1) The Peak hour I/I corresponds to the maximum hourly flow over the course of the flow monitoring period minus the base flow to isolate only I/I contribution to flow. (2) Peak hour I/I rate equals to the Peak I/I divided by the total acreage contributing to I/I for each flow monitoring basin.			

3.4 COLLECTION SYSTEM FLOWS

3.4.1 Existing Base-Flows

Base flow can be estimated for a wastewater system by comparing dry weather flow and wet weather flow at the various flow monitoring locations. To estimate base flows for more specific areas, such as individual wastewater basins, base flows are typically estimated based on the area contributing to flows and flow factors developed for each land use type. This method is developed based on the assumption that areas with similar land uses, such as low density residential parcels, produce equivalent quantities of wastewater flow. System-wide flows can be compared to known flows at flow monitors, or at the treatment plant to verify accuracy. This method of estimating base flows is an industry standard for planning and provides sufficiently accurate data for planning purposes.

The City's current base flows were derived by calculating the areas of land currently contributing flow to the wastewater collection system. The total acreage only accounts for the properties that are currently connected to the collection system. Figure 2.5 in Chapter 2 shows the sewered lots of the Winslow Sewer Service Area that currently contribute flow to the wastewater system.

3.4.1.1 Land Use

Land use information is an integral component in determining the amount of wastewater generation within the City. Adequately estimating the generation of wastewater from various land use types is important in sizing and maintaining effective sewer system facilities.

Land uses that contribute similar wastewater flows were identified and grouped into land use categories including commercial, high density residential, medium density residential,

low density residential, park/open space, public, utility, and vacant. Current and future land use maps are presented in Chapter 2.

Table 3.5 presents the acreage of each land use category comprising each basin. As seen in Table 3.5, the residential land use categories are the most prominent within the Winslow sewer service area, making up approximately sixty-two (62) percent of the total acreage.

3.4.1.2 Wastewater Flow Factors

In order to develop wastewater flow projections and allocate future flows to the collection system, relationships between land use and wastewater generation were developed. These relationships, called wastewater flow factors are established based on the average wastewater flow generated for each existing land use type. The land use flow factors were established to project the estimated ADWF through build out of the City's wastewater collection system and project future flows within the study area boundary.

Average wastewater flow factors are rates, usually expressed in gallons per day per acre (gpd/ac), applied to land use acreage to calculate the ADWF generated from a particular land use. A unique flow factor was developed for each land use classification. The flow factor provides a means to transform a land use category from acreage into wastewater flow. The resulting flow can be used to estimate the ADWF associated with development of existing vacant land areas. Typical wastewater flow factors for residential areas range between 100 to 4,000 gpd/ac, and commercial areas might range from 300 to 2,000 gpd/ac. Land uses designated as open space and parks are assumed to generate negligible amounts of sewage flow, and as a result have a flow factor of zero.

The ADWF flow factors are developed using the following procedure:

- Average flows for each flow monitor tributary area were derived from the flow monitoring data (as previously discussed in Section 3.3.3).
- Using GIS data, the acres for each land use type contained in each flow monitor tributary area were determined.
- Preliminary factors for each land use type were estimated based on values that are typical for the approximate number of dwelling units per acre and the typical number of people per dwelling unit for each land use type.
- The factors for each flow monitor tributary area were then adjusted up or down (balanced) so that the calculated average flows from each tributary area matched the values measured during the flow monitoring period. Appendix F shows the balanced flow factors developed for each flow monitor tributary area.
- For future planning purposes, once the factors for each of the flow monitor tributary areas were balanced, the weighted average of the factors for each land use type was calculated based on the acreage contribution from each individual monitor tributary area.

- The weighted average factors were then adjusted for the entire sewer collection system to match the existing ADWF. The adjusted weighted average factors are considered representative of wastewater generation by land use type for the City as a whole, and are used to project future average wastewater flows. The future balanced wastewater factors are presented in Table 3.5.

The calibrated wastewater flow factors developed for this Plan range from 50 gpd/acre to 1350 gpd/acre, and are presented in Table 3.5.

Table 3.5 Wastewater Flow Balance Summary General Sewer Plan City of Bainbridge Island			
Land Use Classification	Service Area Land Use ⁽¹⁾	Wastewater Flow Factor (gpd/acre)	Existing ADWF (mgd)
	Total Developed Area (acres)		
Agriculture	11.8	50	0.00
Commercial	90.7	300	0.03
Low-density Residential	122.8	200	0.02
Medium-density Residential	257.7	700	0.18
High-density Residential	141.7	1,350	0.19
Parks/Open Space	16.4	0	0.00
Public	187.0	70	0.01
Utilities	0.93	50	0.00
Vacant	0.0	0	0.00
Roads, etc.	4.3	0	0.00
833.3		Total Estimated ADWF =	0.44
		Measured ADWF⁽²⁾ =	0.43
		% Difference⁽³⁾ =	1.8%
Notes: (1) Total area for the City's existing sewer service area. Source: City provided GIS database. (2) Total does not include not metered area in the system. (3) % Difference = (Estimated ADWF - Measured ADWF) / (Measured ADWF) x 100.			

3.4.2 Sewer Base-Flow Projections

3.4.2.1 Dry Weather Flow Projection based on Land Use

Projected Base Flow is based on future land use. The first step in projecting ADWF is to determine future wastewater flow factors that will be used to project base flows for the long-term planning year of 2035.

3.4.2.1.1 Future Wastewater Flow Factors

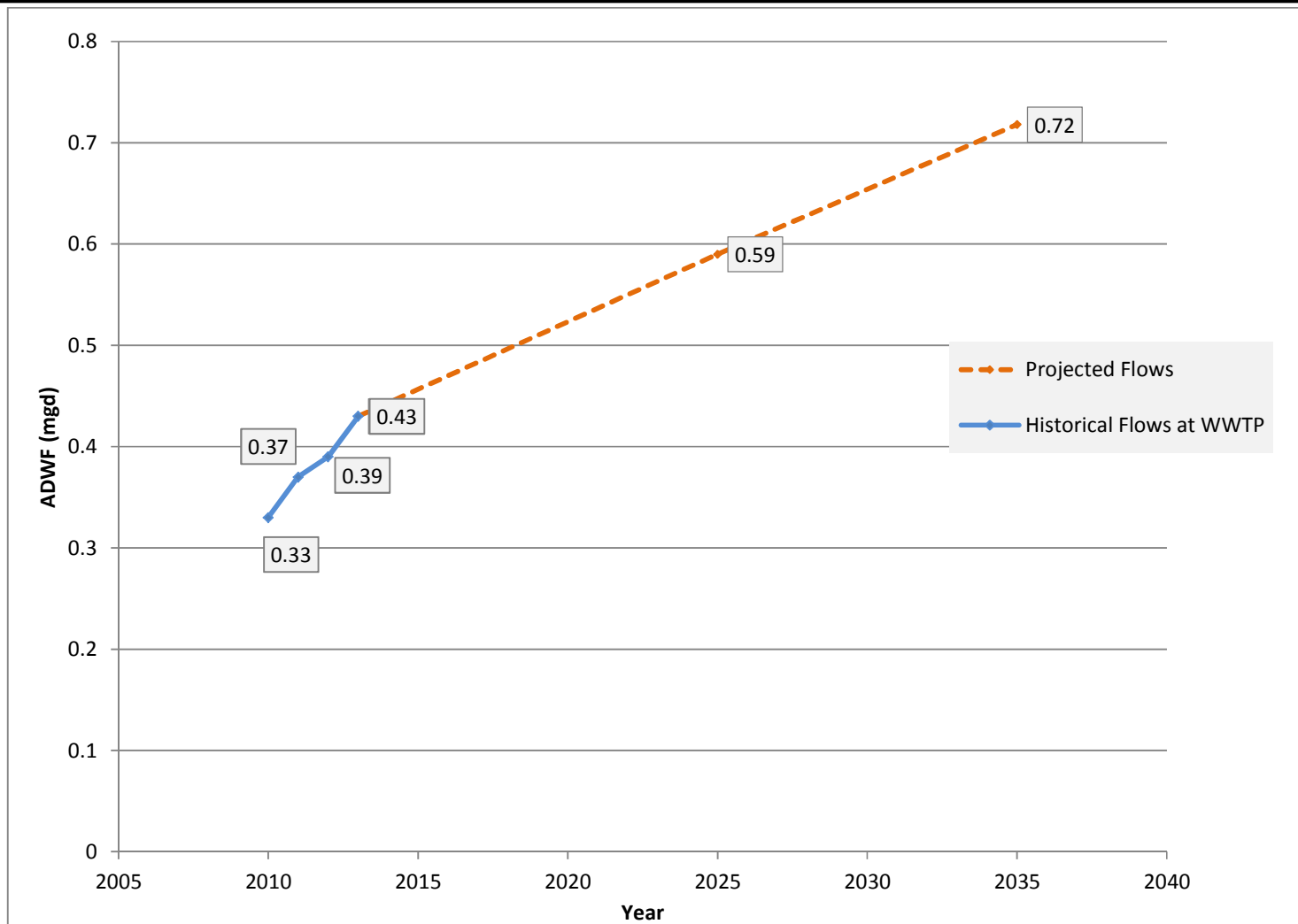
The adjusted weighted average flow factors for each land use type, as shown in Table 3.5, were used to project future flows. The City's policies encourage mixed-use developments within the Winslow downtown area. Mixed-use is defined as a combination of residential and commercial units on the same parcel. This land use type is not represented on the existing land use map, and therefore no existing flow factor was developed for this specific land use category. A mixed-use flow factor was therefore developed for planning purposes by combining the balanced commercial flow factor with the balanced high density residential flow factor resulting in a new mixed-use flow factor of 1,650 gpd/acre. Table 3.6 presents the wastewater flow factors used to project future flows.

Table 3.6 Future Wastewater Flow Factors General Sewer Plan City of Bainbridge Island	
Land Use Classification	Wastewater Flow Factor (gpd/ac)
Commercial	300
Low-density Residential	200
Medium-density Residential	700
High-density Residential	1,350
Public	70
Utilities	50
Mixed-Use	1,650
Parks/Open Space	0
Vacant	0
Roads, etc.	0

3.4.2.1.2 Future Base Flows

The long-term base flows were developed based on the future land-use map presented in Chapter 2. Table 3.7 details the future land use acreage contributing to base flow by 2035 and summarizes the future flow projections. Land use information specific to the year 2025 was not available. Therefore, short-term flow projections were developed by linear interpolation between 2013 and 2035 flows. Historical and projected flows are shown in Figure 3.10. Future average base flows for the Winslow area are anticipated to increase to 0.59 mgd by the year 2025 and 0.72 mgd by the year 2035.

Table 3.7 Future 2035 Acreage General Sewer Plan City of Bainbridge Island	
Land Use Classification	Total Developed Area (acres)
Commercial	97.7
Low-density Residential	153.9
Medium-density Residential	388.2
High-density Residential	180.0
Public	207.5
Utilities	6.5
Mixed-Use	85.0
Parks/Open Space	233.6
Vacant	4.3
Roads, etc.	196.9
Total	1,553.6



**HISTORICAL AND PROJECTED
FLOW TREND**

FIGURE 3.10

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

3.4.3 Peak Hour Flow Development

Peak hour flows in a wastewater collection system are caused by rainfall dependent I/I. Peak hour flows can result in flows more than ten times the base flow, causing utilities to construct high-capacity infrastructure to convey and treat these extraneous flows. This section describes the methodology used for developing existing and future peak hour flows within the City's sewer system, which was subsequently used for performing the capacity analysis as described in Chapter 6.

3.4.3.1 Design Storm

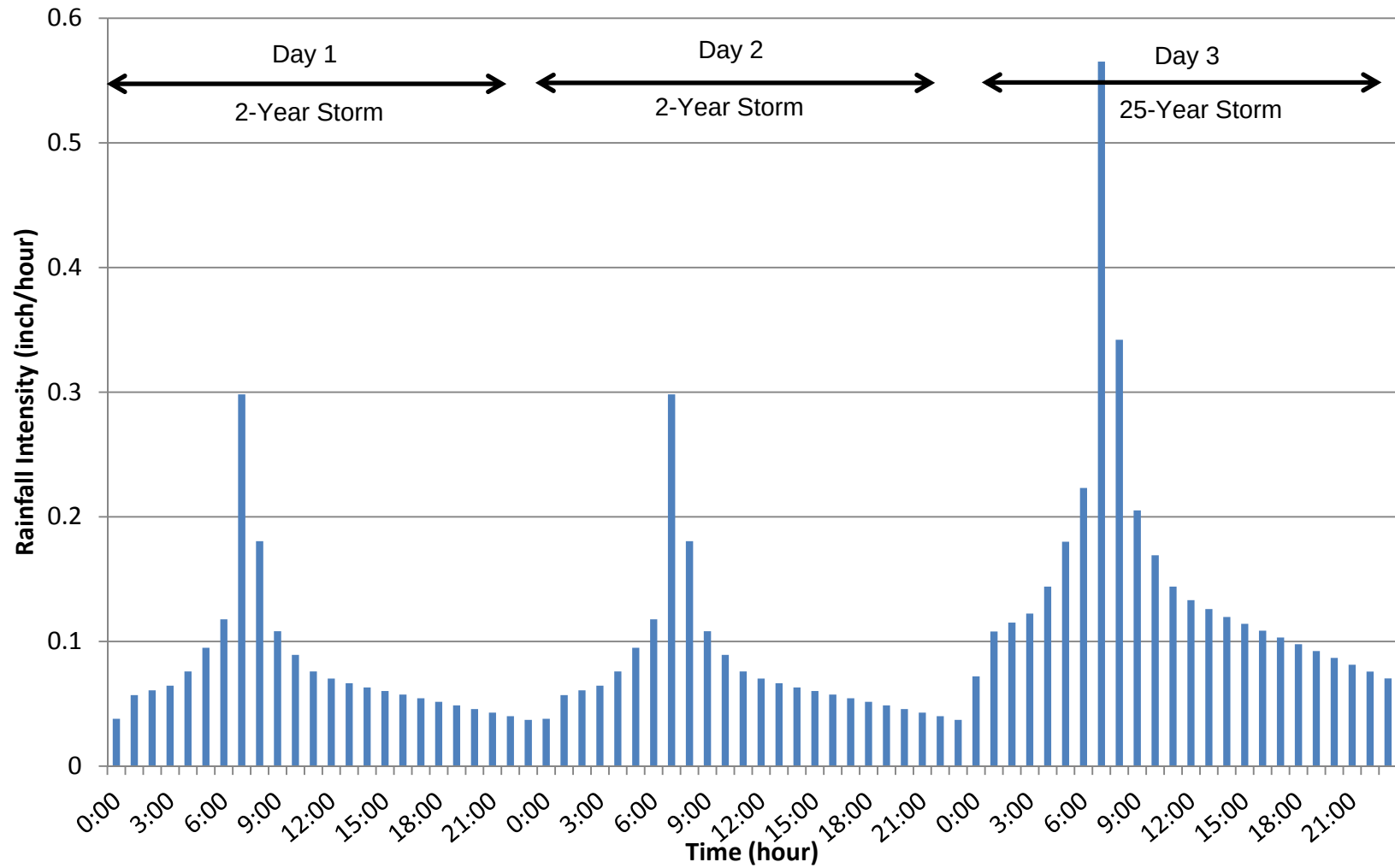
Design storms are rainfall events used to analyze the performance of a collection system under extreme wet weather events. The first step in the development of the design storm is to define its recurrence interval and rainfall duration. The recurrence interval is based on the probability that a given rainfall event will occur or be exceeded in any given year. For example, a "100-year storm" means there is a 1 in 100 chance that a storm as large as or larger than this event will occur at a specific location in any year. Duration is the length of time in which the rainfall occurs.

The design flow, or PHF is the maximum hourly flow rate used for the capacity evaluation and design of the sanitary sewer system, which is determined based on the selected design storm, future land use and the peak I/I rate. Capacity requirements are assessed by routing a design storm through the City's hydraulic model. For this Plan the design storm consists of two 2-year, 24-hour storms followed by a 25-year, 24-hour storm for a total storm duration of 72 hours.

The volume of each 24-hour storm is provided by the National Oceanic and Atmospheric Administration's (NOAA) Atlas 2 Precipitation-Frequency Atlas of the Western US. For Bainbridge Island, a 2-year, 24-hour storm has a volume of 1.9 inches and a peak intensity of 0.27 inches per hour, while a 25-year, 24-hour storm has a volume of 3.6 inches and a peak intensity of 0.51 inches per hour. Distributing the rainfall of each individual storm over the 24-hour period was accomplished using a synthetic hyetograph developed by the Natural Resource Conservation Service (NRCS). Based on the geographic location of Bainbridge Island, a Type IA hyetograph was selected. Figure 3.11 shows the hyetograph of the full design storm used in this Plan.

The selection of the design storm was based on an analysis of historical rainfall and WWTP influent flow data that showed the WWTP flow response to rainfall events. Rainfall data, shown in Figure 3.12, were available from two rain gauges in the proximity of the Winslow WWTP: rain gauges OFL169 and WS1. Seven significant rainfall events were identified during the period from June 2010 to September 2013. Table 3.8 presents the seven storm events and indicates the approximate frequency of each storm. Several storms comparable in intensity and volume to a 25-year, 24-hour storm occurred on Bainbridge island between 2010 and 2013. Thus, selecting a design storm at least as big as a 25-year storm is necessary.

Table 3.8 Categorizations of Historical Storms General Sewer Plan City of Bainbridge Island							
Storm ID	Storm 1	Storm 2	Storm 3	Storm 4	Storm 5	Storm 6	Storm 7
Date	12/12/10	03/14/11	11/22/11	03/15/12	10/31/12	11/19/12	12/20/12
Max Intensity (in/hr)	0.28	0.25	0.32	0.29	0.49	0.46	0.46
24-hour volume (inch)	3.41	1.4	2.97	1.26	2.52	3.27	2.14
Approximate Storm Frequency	25-year	2-year	5-year	2-year	5-year	25-year	5-year



DESIGN STORM HYETOGRAPH

FIGURE 3.11

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Figure 3.13 shows the hyetographs of four of the seven storm events. Large storms on Bainbridge Island tend to be preceded by smaller rainfall events. Figure 3.13 shows that many historical storm events on Bainbridge Island have a pattern of two small storms followed by a larger storm. Two 2-year, 24-hour storms followed by a 25-year, 24-hour storm was selected as the design storm to match the size and pattern of storms historically experienced on Bainbridge Island.

3.4.3.2 I/I Flow Factors

Peak hour flows for the City's wastewater system were derived from the updated wastewater collection system hydraulic model. Before developing the peak hour flows, the hydraulic model was calibrated under both dry weather and wet weather conditions. Detailed information regarding the calibration of the City's hydraulic model is provided in Chapter 5. To develop peak hour flows, the model used the base flows presented in Section 3.4.2.1.2 in addition to the flow contribution from I/I.

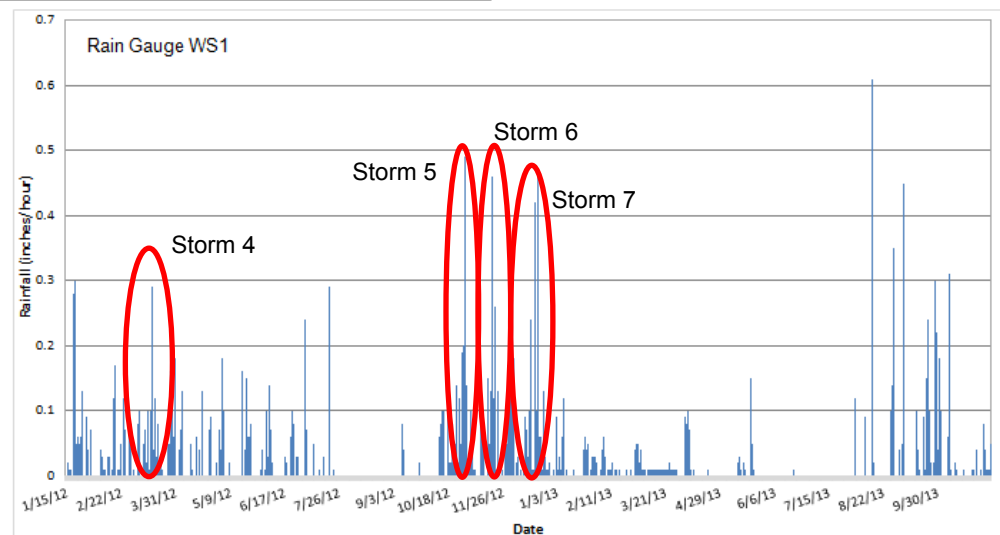
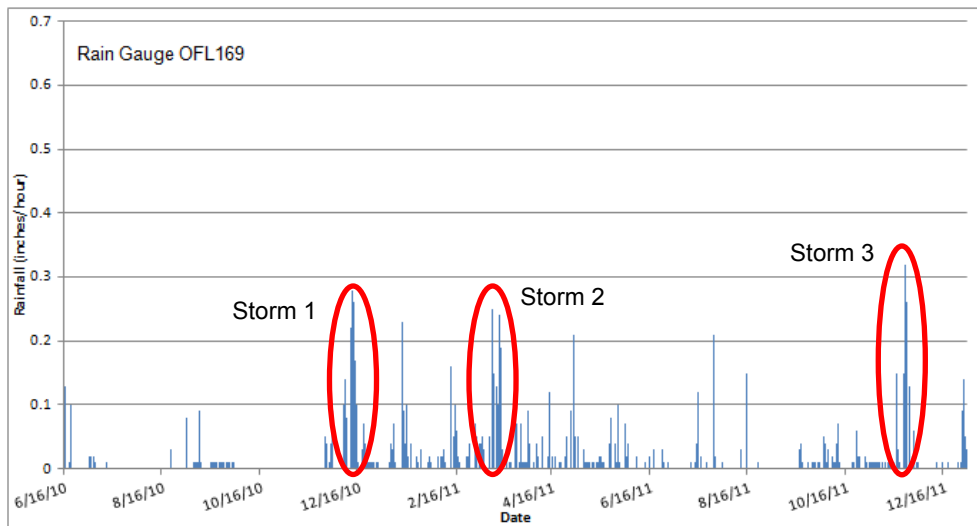
Areas of new development are anticipated to have lower I/I flow factors than existing development due to more stringent modern pipe construction standards. City policy for future development is a peak I/I rate of 1,100 gpd/acre for future development. This peak I/I rate of 1,100 gpd/acre was applied to all new development within the hydraulic model to predict future peak flows.

As collection pipelines age and degrade, they are susceptible to greater I/I. For the development of future hour peak flows for this Plan, the existing collection system was assumed to degrade at a rate of 1 percent every year, thereby increasing the I/I rate each year.

3.4.3.3 Peak Hour Flows

The design storm event discussed in section 3.4.3.1 was routed through the City's hydraulic model to simulate peak hour flows for each basin for each of the planning periods. The peak hourly rainfall was modeled to coincide with the diurnal dry weather flow peak in order to most conservatively predict peak hour flows. These flows, summarized in Table 3.9, represent the highest hourly flows anticipated in each basin under this storm given the basin hydrographs.

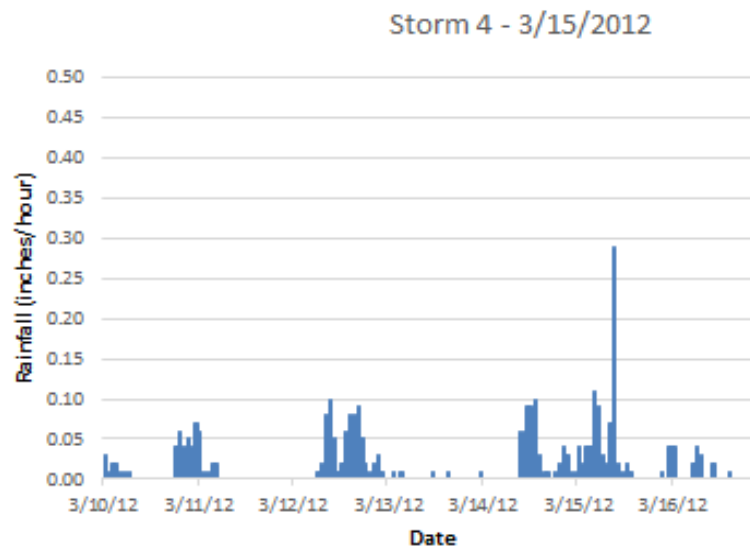
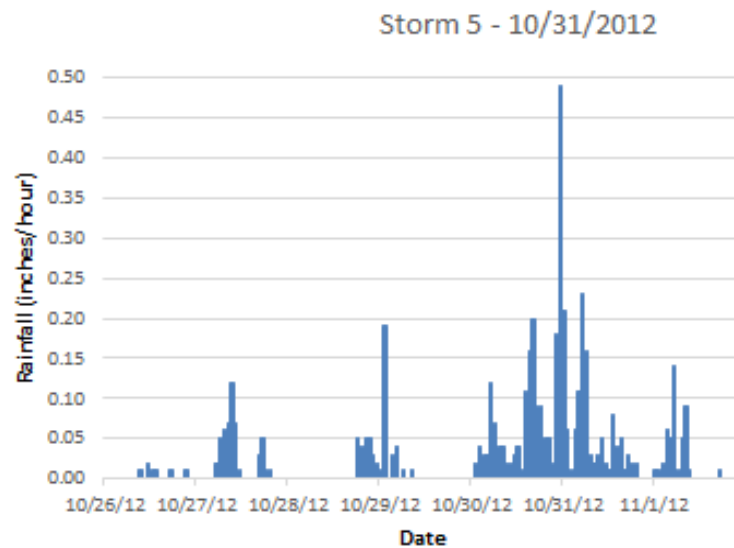
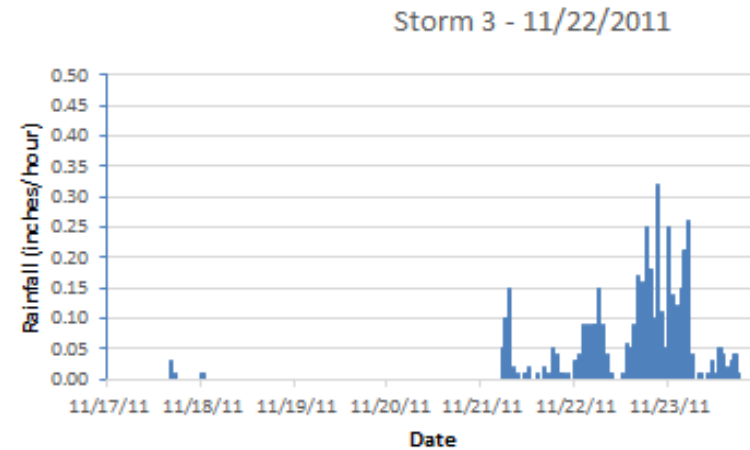
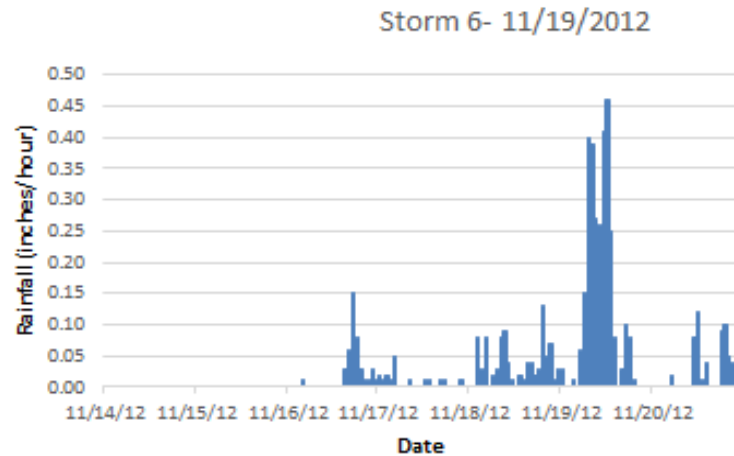
Chapter 6 discusses the capacity limitations of the current wastewater collection system, and the I/I results.



HISTORICAL RAINFALL EVENTS (2010-2013)

FIGURE 3.12

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL STORMS PATTERN

FIGURE 3.13

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Table 3.9 Peak Hour Flows from the Design Storm Event General Sewer Plan City of Bainbridge Island			
Basin ID	Peak Hour Flows (mgd)		
	Existing	Year 2025	Year 2035
Basin 01	0.45	0.66	0.84
Basin 02	0.64	0.94	1.17
Basin 03 ⁽¹⁾	0.92	1.18	1.53
Basin 04 ⁽¹⁾	1.00	1.38	1.71
Entire System (WWTP)	2.48	3.25	4.19
Notes: (1) Peak Flows for Basin 03 and Basin 04 are obtained by subtracting the peak flow from their upstream basin, respectively Basin 01 and Basin 02. When subtracting flows between basins, the accuracy in reported peak flows decreases.			

3.4.3.4 Peak Hour Flows and Peak Hour I/I Rates

The peak hour I/I rate is calculated by subtracting the base flow from the peak hour flow at the time the peak flow occurred. The base flow occurring at the time of the peak hour flow event was determined using the diurnal curves for each wastewater basin. The instantaneous peak I/I rate was estimated by dividing the peak hour I/I by the total acreage contributing to I/I. Table 3.10 presents the calculated peak hour flows and peak hour I/I rate for each basin for current conditions under the design storm.

Table 3.10 Existing Peak Flows and Peak I/I Rates General Sewer Plan City of Bainbridge Island				
Basin ID	Peak Hour Flow (mgd)	Peak Hour I/I (mgd) ⁽¹⁾	Basin Area (acre)	Peak Hour I/I Rate (gpad)
Basin 01	0.45	0.34	136.5	2,520
Basin 02	0.64	0.54	261.5	2,080
Basin 03	0.92	0.43	149.9	2,200
Basin 04	1.00	0.20	161.7	1,220
Entire System (WWTP)	2.48			
Notes: (1) Peak hour I/I corresponds to the peak hour flow minus base flow. The base flow corresponds to the dry weather flow at the time the peak hour flow occurred, therefore base flow is different from the ADWF.				

I/I rates over 3,500 gpad are considered significant and warrant implementation of an I/I reduction program. Table 3.10 shows that the City's collection system does not have significant I/I response as all basins are below the 3,500 gpad threshold.

Future peak hour flows and peak hour I/I rates were also developed for years 2025 and 2035 and are summarized below in Table 3.11 and Table 3.12.

Table 3.11 Future 2025 Projected Peak Flows and Peak I/I Rates General Sewer Plan City of Bainbridge Island				
Basin ID	Peak Hour Flow (mgd)	Peak Hour I/I (mgd)⁽¹⁾	Basin Area (acre)⁽²⁾	Peak Hour I/I Rate (gpad)
Basin 01	0.66	0.51	200.0	2,530
Basin 02	0.94	0.79	318.8	2,465
Basin 03	1.18	0.51	242.4	2,120
Basin 04	1.38	0.34	218.4	1,550
Entire System (WWTP)	3.25			
Notes: (1) Peak hour I/I corresponds to the peak hour flow minus base flow. The base flow corresponds to the dry weather flow at the time the peak hour flow occurred; therefore, base flow is different from the ADWF. (2) Basin acreages are different from existing and correspond to the projected developed acreage for each basin by year 2025.				

Table 3.12 Future 2035 Projected Peak Flows and Peak I/I Rates General Sewer Plan City of Bainbridge Island				
Basin ID	Peak Hour Flow (mgd)	Peak Hour I/I (mgd)⁽¹⁾	Basin Area (acre)⁽²⁾	Peak Hour I/I Rate (gpad)
Basin 01	0.84	0.61	252.9	2,400
Basin 02	1.17	0.97	366.6	2,630
Basin 03	1.53	0.62	283.4	2,190
Basin 04	1.71	0.42	265.8	1,580
Entire System (WWTP)	4.19			
Notes: (1) Peak hour I/I corresponds to the peak hour flow minus base flow. The base flow corresponds to the dry weather flow at the time the peak hour flow occurred; therefore, base flow is different from the ADWF. (2) Basin acreages are different from existing and 2025 and correspond to the projected developed acreage for each basin by year 2035.				

3.5 WASTEWATER TREATMENT PLANT FLOW AND LOADS

This section describes how the sewered population is expected to grow through the planning period (through the year 2035) and summarizes the current and projected flows and loads for the treatment plant.

3.5.1 Sewered Population

The City's Department of Planning and Community Development provided a 2010 census population estimate for the Winslow Master Plan Study Area (WMPSA), which is defined in the City's Comprehensive Plan, of 6,095. Using the assumption of the City's Comprehensive Plan that 50% of the City's population growth will occur in the WMPSA, 8,913 is the estimated WMPSA population for year 2035.

Using land use data, knowledge of which parcels are currently sewered, and the City's standard household size estimate of 2.5 persons per single family residence, the 2010 Winslow sewered population was estimated at 5,730 residents as a basis for further analysis. With the City's assumption that all Winslow Study Area parcels will be sewered by 2035, the estimated 2035 sewered population is 9,160.

3.5.2 Historical Influent Flows

In addition to the flow monitoring program (summarized in the section above), this project reviewed historical influent flow data at the WWTP from year 2010 to through August of 2013. The Winslow WWTP measures influent flow upstream of the influent screens and

effluent flow just prior to disinfection. Since the influent flow includes recycled flow, effluent flow data was used for the analysis. Table 3.13 summarizes the ADWF, AAF, MMF, PDF, and PHF for the years 2010 through 2012 since these were the years for which complete data was available. Table 3.14 summarizes the flow peaking factors.

Table 3.13 WWTP Effluent Flow Summary General Sewer Plan City of Bainbridge Island			
Flow (mgd)	2010	2011	2012
ADWF	0.33	0.37	0.39
AAF	0.48	0.49	0.49
MMF	0.73	0.73	0.79
PDF	1.86	1.46	1.47
PDF (Month)	December	March	December
PHF	n/a	n/a	2.67

Table 3.14 WWTP Peaking Factor Summary General Sewer Plan City of Bainbridge Island					
Flow (mgd)	2010	2011	2012	Average PF	Max PF
ADWF	1	1	1	1	1
AAF	1.43	1.34	1.27	1.25	1.43
MMF	2.19	2.01	2.04	1.93	2.19
PDF	5.57	3.98	3.81	3.98	5.57
PHF	n/a	n/a	6.91	6.91	6.91

3.5.3 Historical Wastewater Loads

Wastewater loading data are important for sizing several critical treatment processes. The wastewater loading components of principal interest are the biochemical oxygen demand (BOD) and total suspended solids (TSS). WWTP operations staff measure influent TSS and influent BOD twice a week.

The historical influent annual average (AA) and maximum monthly (MM) BOD loads along with the AA per capita loads and MM BOD load peaking factors are summarized in Table 3.15. Table 3.16 summarizes the same information for TSS. As is shown in Table 3.15 and Table 3.16, the AA per capita BOD load has ranged from 0.23 to 0.28 pounds per capita per day (ppcd) and has average 0.25 ppcd while the AA per capita TSS load has ranged from 0.20 to 0.26 ppcd and has averaged 0.22 ppcd. Typical BOD and TSS per capita

loads for primarily residential collection systems are around 0.20 ppcd, so these values are slightly higher than normal, but not outside the normal range. From 2010 through 2012, the maximum MM BOD peaking factor has been 1.28 and the maximum MM TSS peaking factor has been 1.30.

Table 3.15 WWTP Historical Influent BOD Loadings Summary General Sewer Plan City of Bainbridge Island					
Year	Population	AA BOD, ppd	AA BOD, ppcd	MM BOD, ppd	MM BOD PF
2010	5730	1580	0.28	1900	1.21
2011	5870 ⁽¹⁾	1380	0.23	1630	1.18
2012	6000 ⁽¹⁾	1390	0.23	1770	1.28
Average			0.25		1.22
Max			0.28		1.28
<u>Notes:</u> (1) Determined by linear interpolation between the 2010 and 2035 sewer population estimate.					

Table 3.16 WWTP Historical Influent TSS Loadings Summary General Sewer Plan City of Bainbridge Island					
Year	Population	AA TSS, ppd	AA TSS, ppcd	MM TSS, ppd	MM TSS PF
2010	5730	1470	0.26	1880	1.28
2011	5870 ⁽¹⁾	1210	0.21	1580	1.31
2012	6000 ⁽¹⁾	1230	0.20	1600	1.31
Average			0.22		1.30
Max			0.26		1.31
<u>Notes:</u> (1) Determined by linear interpolation between the 2010 and 2035 sewer population estimate.					

3.5.4 Projected Wastewater Flows

Influent AAF, MMF and PDF to the wastewater treatment plant were projected for the years 2025 and 2035 by applying the average peaking factors summarized in Table 3.14 to the ADWF projected as part of the collection system model summarized in Figure 3.10. The projected PHFs were determined as part of the collection system modeling as shown in Table 3.10 through Table 3.12. The projected influent flows are summarized in Table 3.17 along with the values used in 2007 by Tetra Tech as part of the WWTP expansion.

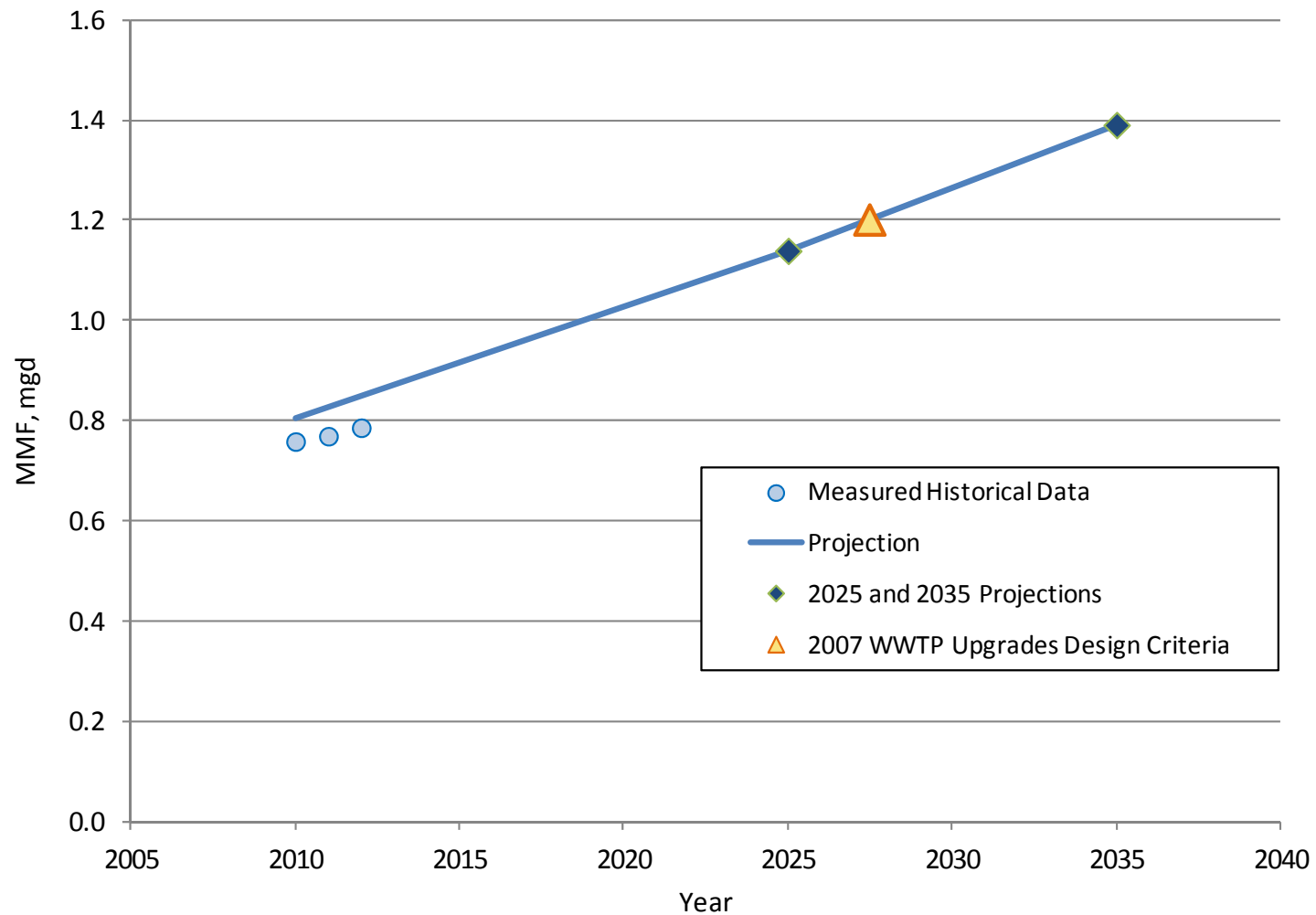
While the projected 2035 AAF, MMF and PDFs are similar to the AAF, MMF and PDF used by Tetra Tech as part of the 2007 WWTP expansion project, projected 2035 PHF exceeds the Tetra Tech design criteria of 3.6 mgd. Figure 3.14, Figure 3.15, and Figure 3.16 summarize the current and projected MMF, PDF and PHF, respectively. The triangle on each chart represents the design value used by Tetra Tech as part of the 2007 upgrades project.

Table 3.17 WWTP Influent Flow Projection General Sewer Plan City of Bainbridge Island				
Flow (mgd)	2010	2025	2035	Tetra Tech Design Criteria
ADWF	0.42	0.59	0.72	n/a
AAF	0.52	0.74	0.90	0.96
MMF	0.81	1.14	1.39	1.20
PDF	1.66	2.35	2.87	2.90
PHF	2.48	3.25	4.19	3.60

3.5.5 Projected Wastewater Loads

AA BOD and TSS loads were projected to the year 2025 and the year 2035 by multiplying the projected sewer population by the AA BOD and TSS per capita loads shown in Table 3.15 and Table 3.16. MM BOD and TSS loads were projected by applying the maximum MM peak factor shown in bold in Table 3.15 and Table 3.16 to projected AA loads. The projected influent loads are summarized in Table 3.18 along with the values used in 2007 by Tetra Tech as part of the WWTP expansion. While the projected 2035 AA and MM TSS loads are very similar to the values projected by Tetra Tech, the projected 2035 AA and MM BOD loads are slightly higher than those used by Tetra Tech. Figure 3.17 and Figure 3.18 summarize the current measured and projected MM BOD and MM TSS load, respectively.

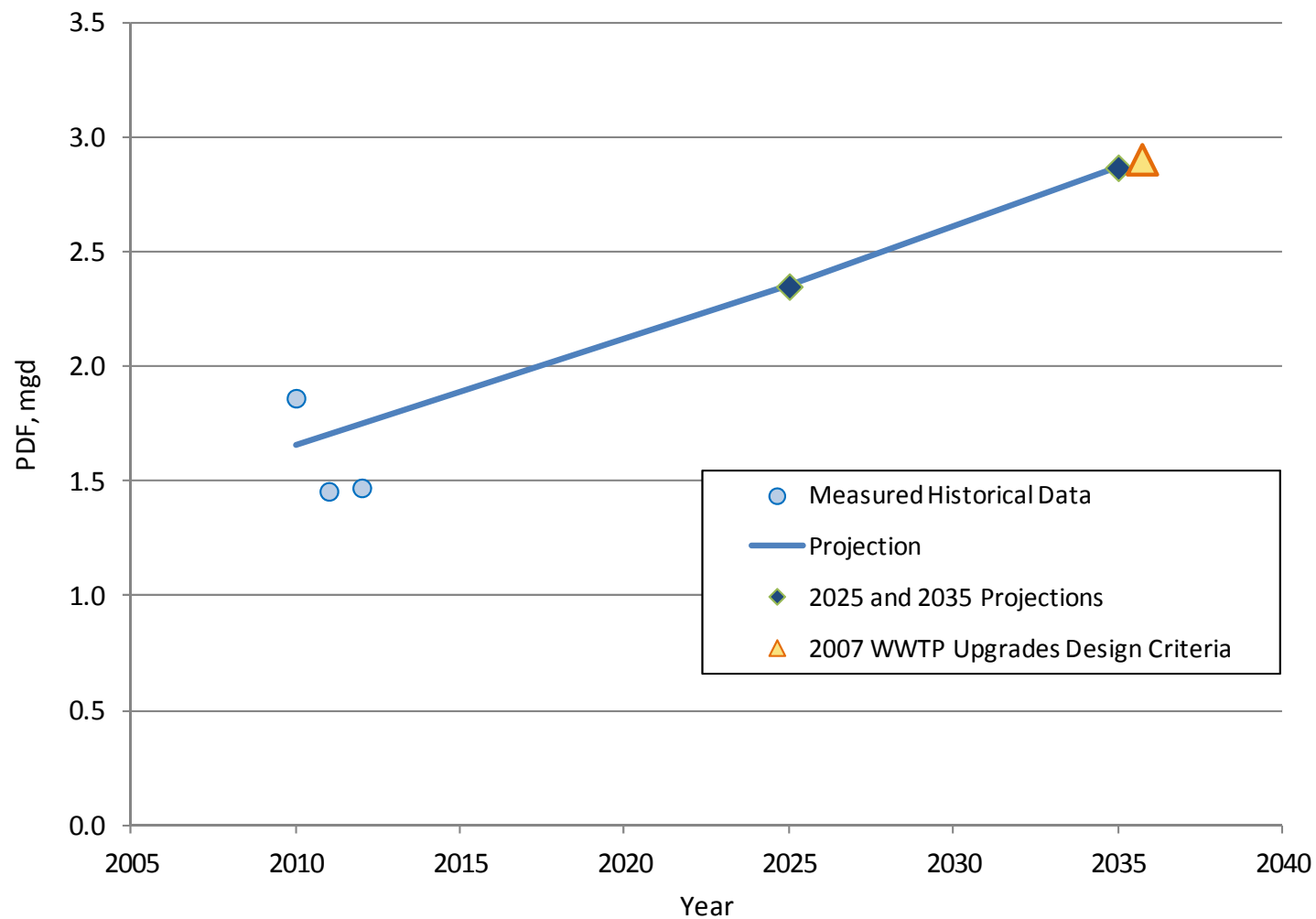
Table 3.18 WWTP Influent Load Projection General Sewer Plan City of Bainbridge Island				
Load, ppd	2010	2025	2035	Tetra Tech Design Criteria
AA BOD	1410	1920	2260	2000
MM BOD	1800	2450	2880	2642
AA TSS	1270	1730	2000	2000
MM TSS	1670	2260	2660	2642



MAXIMUM MONTH FLOW PROJECTION

FIGURE 3.14

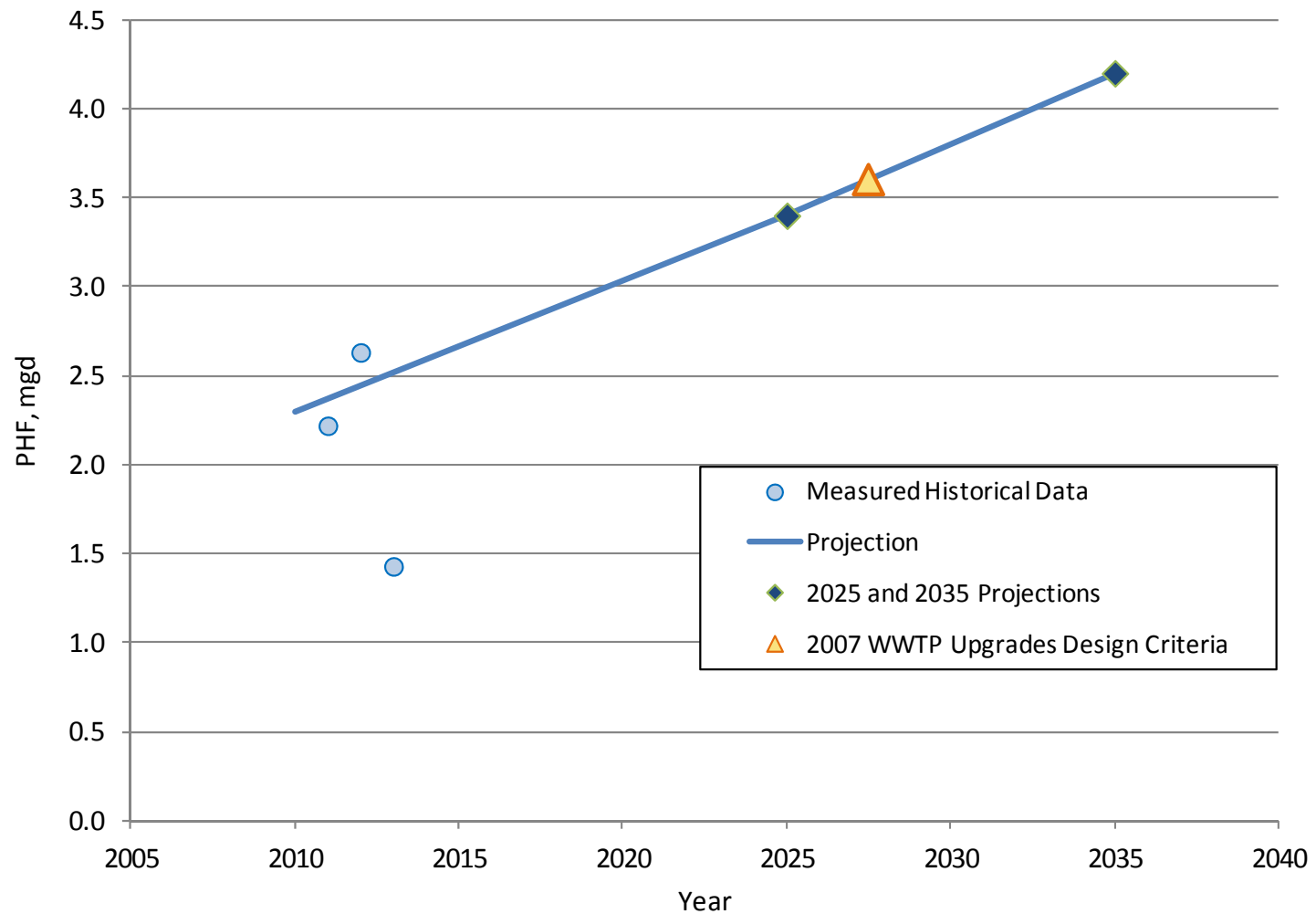
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



PEAK DAY FLOW PROJECTION

FIGURE 3.15

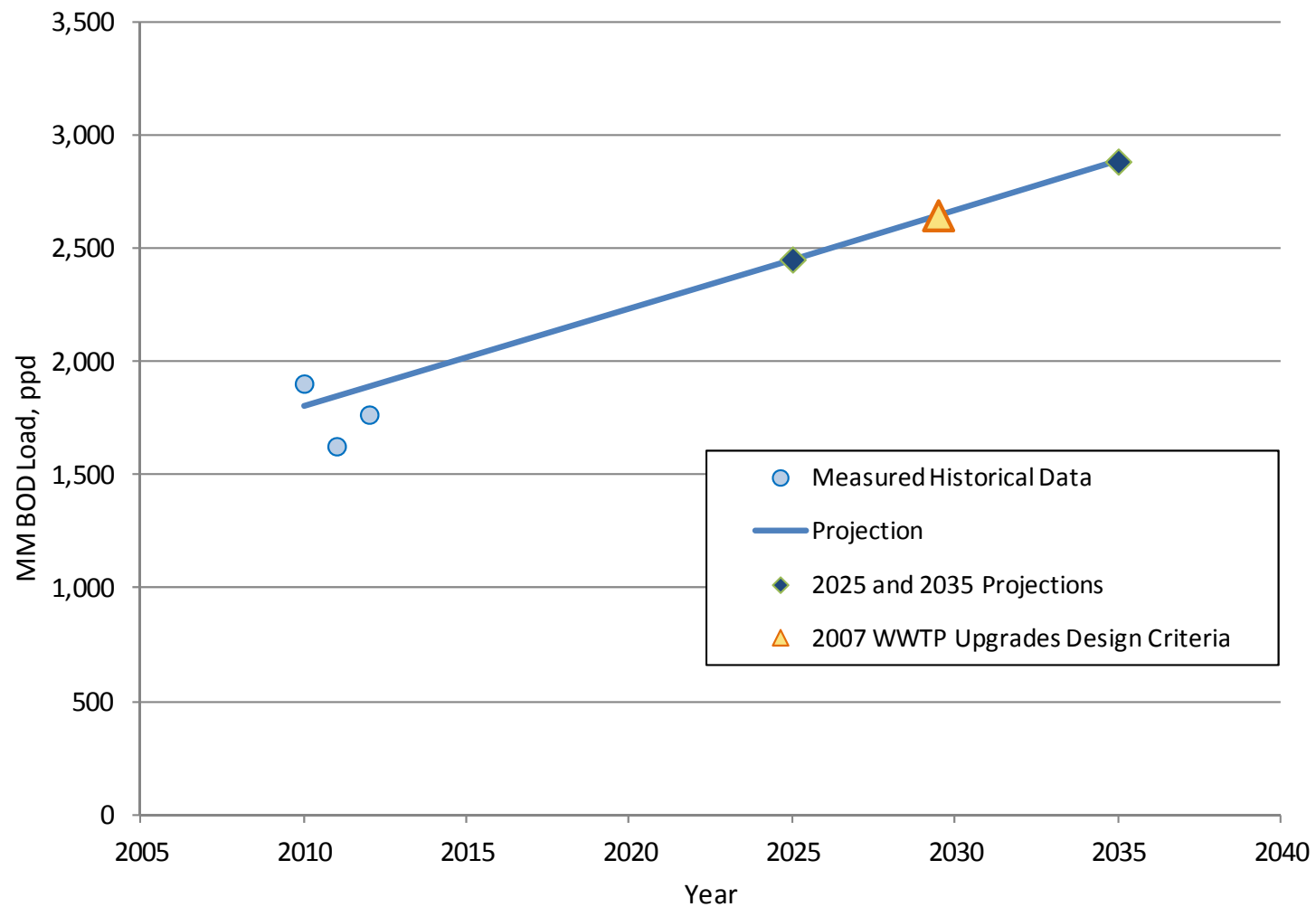
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



PEAK HOUR FLOW PROJECTION

FIGURE 3.16

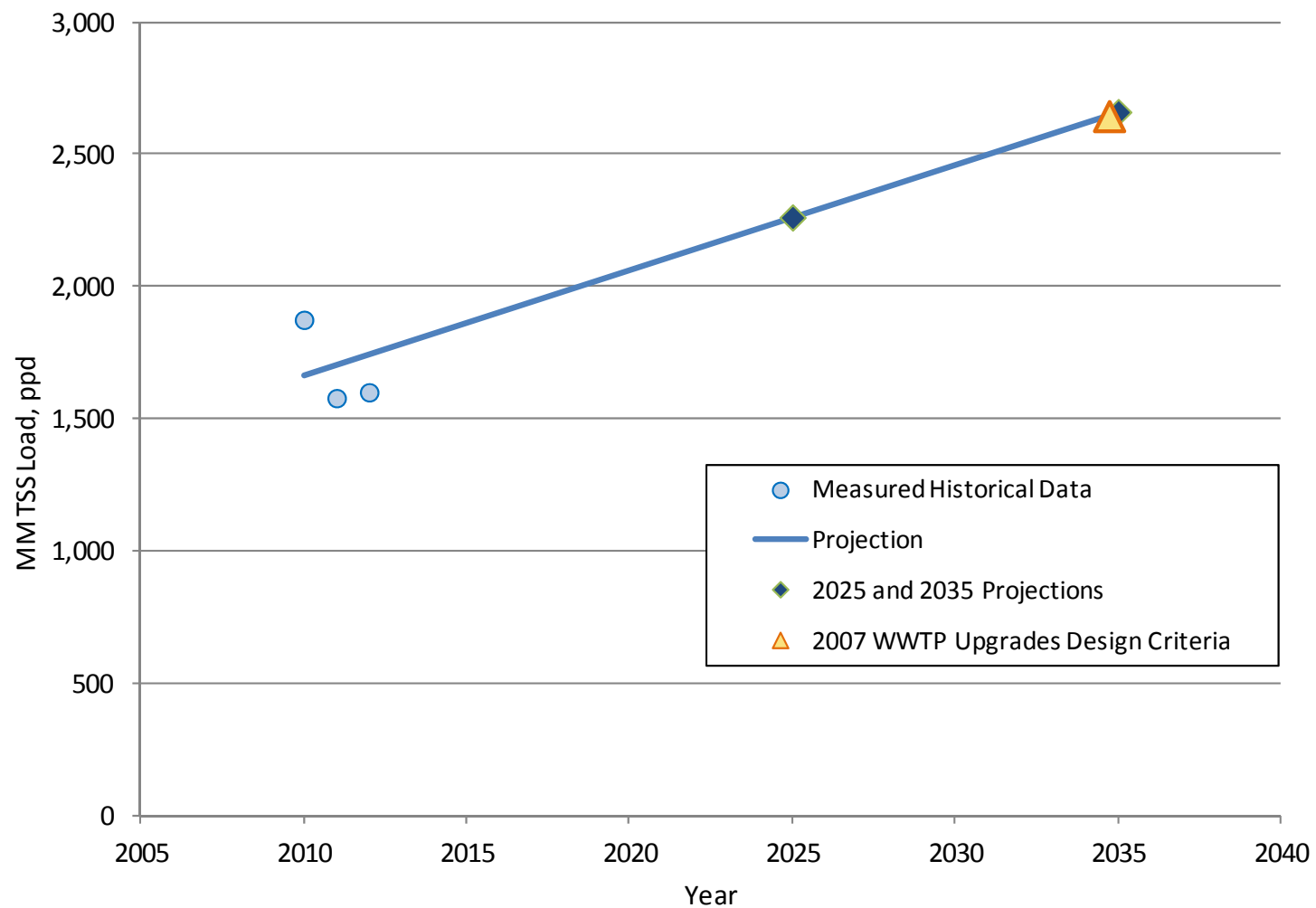
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



MAXIMUM MONTH BOD PROJECTION

FIGURE 3.17

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



MAXIMUM MONTH TSS PROJECTION

FIGURE 3.18

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

3.6 MID-ISLAND STUDY AREA FLOWS

During the development of this Plan, two neighborhood service centers in the middle portion of Bainbridge Island, that are not currently sewered by the City, were identified for potential future City sewer service. These two neighborhood service centers (NSC) were delineated as the Mid-Island Study Area. The boundary of the Mid-Island Study Area is shown in Figure 2.3 of Chapter 2. The western neighborhood service center, or western pocket, is located near the intersection of Miller Road and new Brooklyn Road and encompasses the parcels zoned NSC in the Island Center NSC. The eastern pocket is centered at the intersections of Valley Road and Sunrise Drive and encompasses the Rolling Bay NSC. Build-out flows were developed for each of the Mid-Island pockets. An overview of sewer treatment and disposal options is provided herein.

3.6.1 Build-Out Flow Projections

A build-out land use map for the Mid-Island Study Area is provided in Figure 2.10 of Chapter 2. Build-out ADWF projections for the eastern and western Mid-Island pockets were estimated using the wastewater flow factors developed for the Winslow Collection System. A peaking factor between ADWF and PHF of three (3) was assumed to estimate peak hour flows. As shown in Table 3.19, ADWFs of 2,570 gpd and 13,020 gpd are projected for the eastern and western pockets, respectively.

Table 3.19 Mid-Island Build-out Flows General Sewer Plan City of Bainbridge Island			
Land Use Classification	Acreage (acres)	Flow Factor (gpd/ac)	Flow (gpd)
Eastern Pocket			
Commercial	8.6	300	2,570
Roads, etc.	1.9	0	0
Total ADWF			2,570
Total PHF			7,710
Western Pocket			
Commercial	13.7	300	4,110
Low-density Residential	42.9	200	8,580
Public	4.7	70	330
Roads, etc.	2.1	0	0
Total ADWF			13,020
Total PHF			39,060
Note: 1. Peaking factor of 3.			

3.6.2 Treatment and Disposal Options

3.6.2.1 Conveyance to Winslow Collection System

The City has two basic options for treating the wastewater flows of the eastern and western pockets: individual on-site treatment systems for each pocket, or conveyance of wastewater flows from each pocket to the Winslow Collection System where it can be treated at the Winslow Wastewater Treatment Plant (WWTP). The eastern and western pockets are situated far enough apart such that separate treatment systems would need to be constructed for each pocket. Also, in the case of conveyance to the Winslow Collection System, separate pump stations and force mains would be constructed for each pocket.

The force mains from each pocket would have an approximate length of 11,500 ft. The western pocket would likely connect to the Winslow Collection System near Woodward School and the eastern pocket would connect upstream of the Island Terrace Pump Station. The amount of flow contributed by the Mid-Island pockets would account for about two percent of the 0.72-mgd ADWF projected for 2035 for the Winslow Collection System. The estimated capital cost for this option is \$4 million as shown in Table 3.21.

3.6.2.2 On-Site Treatment and Disposal Options

Large on-site sewage systems (LOSS) treating peak flows of 3,500 to 100,000 gpd are regulated by the Washington State Department of Health (DOH) under 246-272B WAC. Local health jurisdictions retain regulatory authority for systems designed to treat less than 3,500 gpd. Sewage treatment systems larger than 100,000 gpd in capacity are regulated by the Department of Ecology (Ecology). Ecology also regulates any surface water discharge regardless of flow. The peak flows of the eastern and western Mid-Island pockets place them within DOH's regulatory jurisdiction.

Under 246-272B WAC, DOH defines five levels of treatment; A through E as defined in Table 3.20. A minimum level of treatment is required for each disposal option. The minimum required level of treatment is also dependent on the soil conditions of the disposal site.

Table 3.20 DOH Treatment Levels General Sewer Plan City of Bainbridge Island			
Level	CBOD₅	TSS	FC
A	10 mg/L	10 mg/L	200/100 mL
B	15 mg/L	15 mg/L	1,000/100 mL
C	25 mg/L	30 mg/L	50,000/100 mL
D	25 mg/L	30 mg/L	---
E	125 mg/L	80 mg/L	---
Notes: (1) Table is reprinted from WAC 246-272A-0110 Table III. (2) CBOD ₅ = five-day carbonaceous biochemical oxygen demand. TSS = total suspended solids. FC = fecal coliform.			

There are two general options for wastewater disposal: surface water or land. The means of wastewater effluent disposal drives the treatment requirements and dictates regulatory authority. A surface water disposal system would consist of a new outfall to Puget Sound. This option would be the most challenging disposal option to permit, requiring extensive science and engineering studies for permit approval.

Any land disposal option will require an evaluation of soil and groundwater conditions. The possible land disposal options include land treatment, drainfields, subsurface drip systems, and groundwater disposal/irrigation of reclaimed water. Drainfields and subsurface drip systems have large acreage requirements, while groundwater disposal requires high effluent quality meeting Class A reclaimed water standards. Selection of disposal and treatment systems are interdependent.

On-site sewage treatment options for the City to consider include septic systems, sand filters, recirculating gravel filters, mound systems, aerobic treatment units (ATUs), and membrane bioreactors (MBRs). Conceptually, the treatment system would be sited at a central location for each pocket and receive wastewater flow from individual homes and businesses through a collection system. Treated effluent would be either disposed on-site or pumped to a suitable disposal location. Each of the disposal and treatment options are described in detail in PM 1 – Mid-Island Study Area Service Options (Appendix G).

A comparison of several treatment and disposal combinations was performed as described in Appendix G. The two options that emerge as the best options for further evaluation are community septic tank/drainfield and MBR/percolation pond. Costs and acreage requirements for these two options are provided in Table 3.21. Detailed cost development tables are provided in Appendix G. Development of the collection systems for each Mid-Island pocket is not considered herein because they would be similar regardless of the treatment/disposal options selected.

3.6.2.3 Community Septic Tanks with Conventional Drainfields

One service option consists of installing a community septic tank with a conventional drainfield for each Mid-Island pocket. The collection systems for each pocket would convey wastewater to an underground septic tank large enough to allow solids in the wastewater to settle to the bottom and grease to float at the top. As wastewater enters the septic tank, clarified, screened effluent flows out of the tank to drainfields. The land required for a drainfield for the study area was determined using the minimum spacing requirements and allowances and assumed fine sandy soils with a loading rate of 0.6 gal/sf/day. Setbacks and a reserve drainfield area of 100 percent is included in the area estimates.

The eastern pocket would require approximately an 8,000-gallon capacity septic tank with a drainfield spanning nearly two acres. The western pocket would require a 40,000-gallon septic tank with drainfields covering approximately 24 acres. The estimated capital cost of this option for the eastern and western pockets is \$1.0 and \$10.3 million, respectively.

3.6.2.4 MBR Package Plants with Percolation Ponds

Another option considered involves installation of MBR package plants with groundwater percolation ponds. MBRs are a compact wastewater treatment process. Many manufacturers make self-contained MBR package plants to treat flows of approximately 20,000 to 150,000 gpd.

With an ADWF of 2,570 gpd, the eastern pocket is probably too small to warrant the installation of an MBR system, however estimated land requirements and capital costs are shown in Table 3.21. An MBR packaged plant is well-sized for the western pocket. Percolation ponds for the western pocket would require approximately 1.5 acres and the capital cost of the system is estimated at \$4.6 million.

Table 3.21 Mid-Island Treatment Options Capital Cost Estimates General Sewer Plan City of Bainbridge Island		
Treatment Option	Land Required (acres)	System Capital Cost
Conveyance to Winslow Collection System		
Eastern Pocket	0	\$2,000,000
Western Pocket	0	\$2,000,000
Community Septic Tanks with Conventional Drainfields		
Eastern Pocket	2	\$1,000,000
Western Pocket	24	\$10,300,000
MBR Package Plants with Percolation Ponds		
Eastern Pocket	0.5	\$2,800,000
Western Pocket	1.5	\$4,600,000

3.7 WATER CONSERVATION

3.7.1 Conservation

The City developed its most recent Water Conservation Plan in 2004. An update of the water conservation goals will be included as part of its 2015 Water System Plan Update. Since 2004, the City's water conservation goal of one-percent annual savings has been exceeded. With one-percent annual savings, the City predicted a 2013 ERU value of approximately 218 gpd/ERU including lost and unaccounted for water. The average ERU value for years 2006 through 2013 including lost and unaccounted for water was 159 gpd/ERU, which is 27% lower than the goal.

This significant reduction was achieved in part due to efforts to more accurately track the City's unaccounted for water. In addition, the City implemented many conservation measures in the areas of public education, technical assistance, system measures, and incentives that contributed to demand reduction. Public outreach measures include school outreach programs, a speakers bureau, conservation program promotion on water bills, and theme shows and fairs. Furthermore, the water utility provides customer assistance such as free leak checks and has recently performed many technical studies related to water resource management. Other conservation incentives initiated by the City include distribution of conservation kits that include low-flow showerheads and educational materials, selling of rain barrels to homeowners, implementation of a conservation water rate structure, and reimbursement for replacement of high-flush toilets with low flow toilets to customers within the Winslow sewer system.

3.7.2 Reclaimed Water Use

The City does not currently have reclaimed water production capability at the Winslow WWTP. Installation of equipment at the WWTP suitable for making reclaimed water effluent

would be difficult due to the limited footprint of the WWTP. For the foreseeable future, the City can meet its water conservation goals without investing in such a significant project. The City will further consider water reuse in its 2015 Water System Plan Update.

3.8 FLOW AND LOAD PROJECTIONS SUMMARY

Base and peak hour flows were developed for the City's wastewater collection system for the existing (2013), short-term (2025), and long-term (2035) scenarios. Flow monitoring data was used to generate wastewater flow factors for each land use type that are specific to the City's system. To develop future base flows, the flow factors were multiplied by the anticipated future sewered acreage of each land use type. Base flows are projected to increase from 0.43 mgd to 0.59 mgd by 2025 and to 0.72 mgd by 2035.

Peak hour flows were developed by using the City's hydraulic model, which was calibrated against the flow metering data. Peak hour flows for each basin were derived for a design storm consisting of two 2-year, 24-hour storms followed by a 25-year, 24-hour storm. The calculated peak hour flows are used to evaluate the capacity of the current wastewater system for conveying existing and future flows, and thereby identify necessary capacity improvements. Current peak hour flows into the WWTP during the design storm amount to 2.5 mgd. Year 2035 peak flows during the design storm are projected to be 4.2 mgd. It is noted that the projected 2035 peak hour flows exceeds the Tetra Tech WWTP design capacity of 3.6 mgd.

BOD and TSS loads to the WWTP were also projected. Projected 2035 TSS loads of 2000 ppd AA and 2660 ppd MM closely match the design criteria used by Tetra Tech for the 2007 WWTP expansion. Projected BOD loads exceed Tetra Tech design criteria with AA BOD of 2260 and MM BOD of 2880 by 2035.

EXISTING SYSTEM AND CONDITION ASSESSMENT

4.1 INTRODUCTION

This chapter provides an overview of the existing City of Bainbridge Island (City) wastewater collection system including a summary of the condition of the pipelines and pump stations and a brief discussion of asset management planning.

The City owns and maintains collection and treatment facilities in two separate areas of the island including the Winslow Sewer Service Area and the South Island Sewer Service Area. In the Winslow Sewer Service Area the collection system serves the Winslow community and conveys wastewater to the City Winslow Wastewater Treatment Plant (WWTP). In the South Island Sewer Service Area, the City also owns and maintains collection facilities that convey wastewater to the Kitsap County Sewer District (KCSD) #7 WWTP.

Throughout the entire system, the City maintains approximately 37 miles of gravity and force main pipes and 17 pump stations. The pump stations were originally constructed between 1950 and 2013, with most of the stations having been constructed in 1979. Four of the oldest and largest stations have been rehabilitated since construction. Most of the older stations are of the drywell/wet well configuration. Stations constructed after 2003 are based on a standardized submersible pump wet pit design. Firm pump station capacities range from 60 to 2720 gallons per minute (gpm). All of the sites have a permanent onsite source of emergency power in case of a utility power outage. The Winslow and South Island Service Areas and collection systems are shown in Figure 4.1 and Figure 4.2.

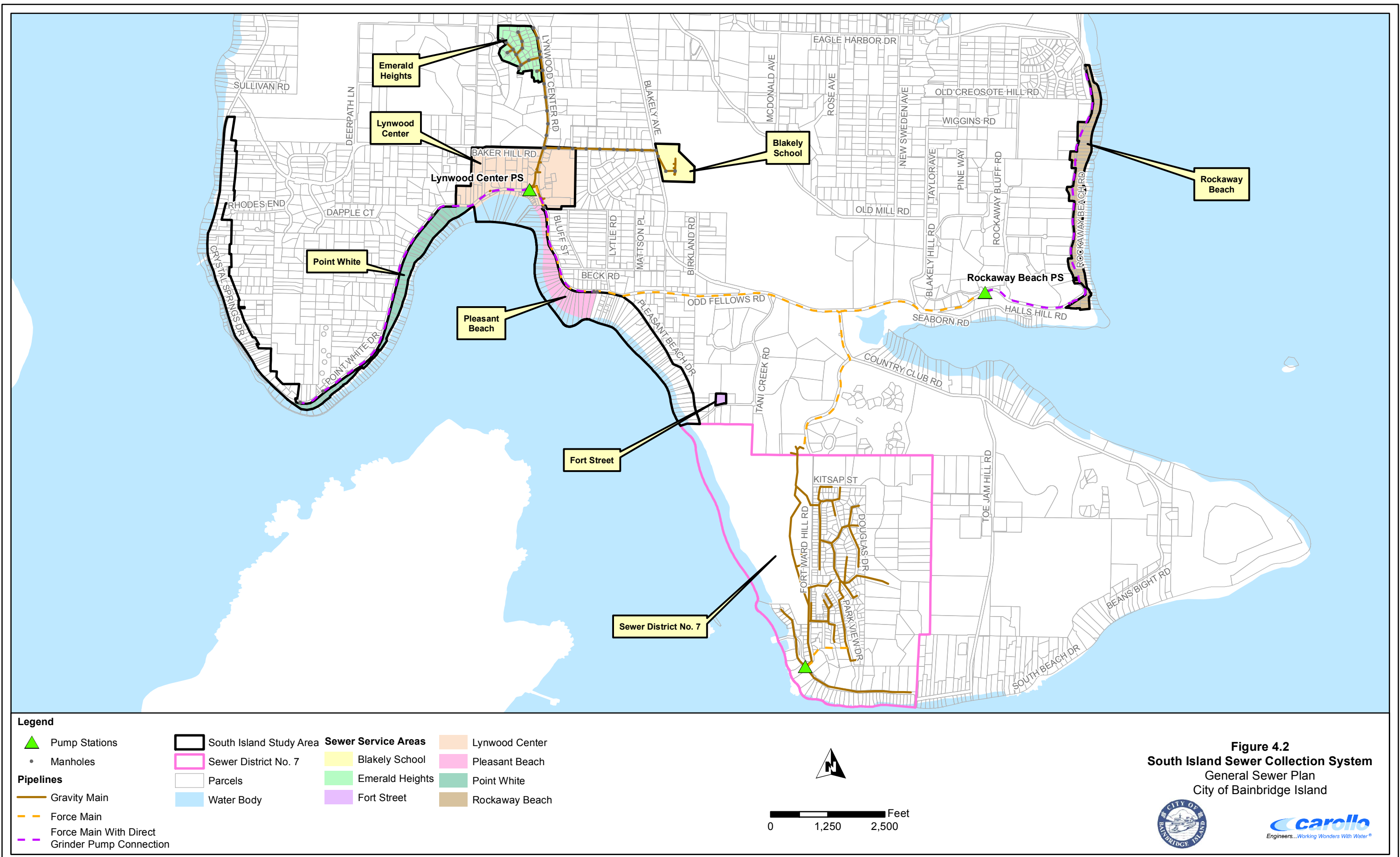
4.2 WINSLOW SEWER

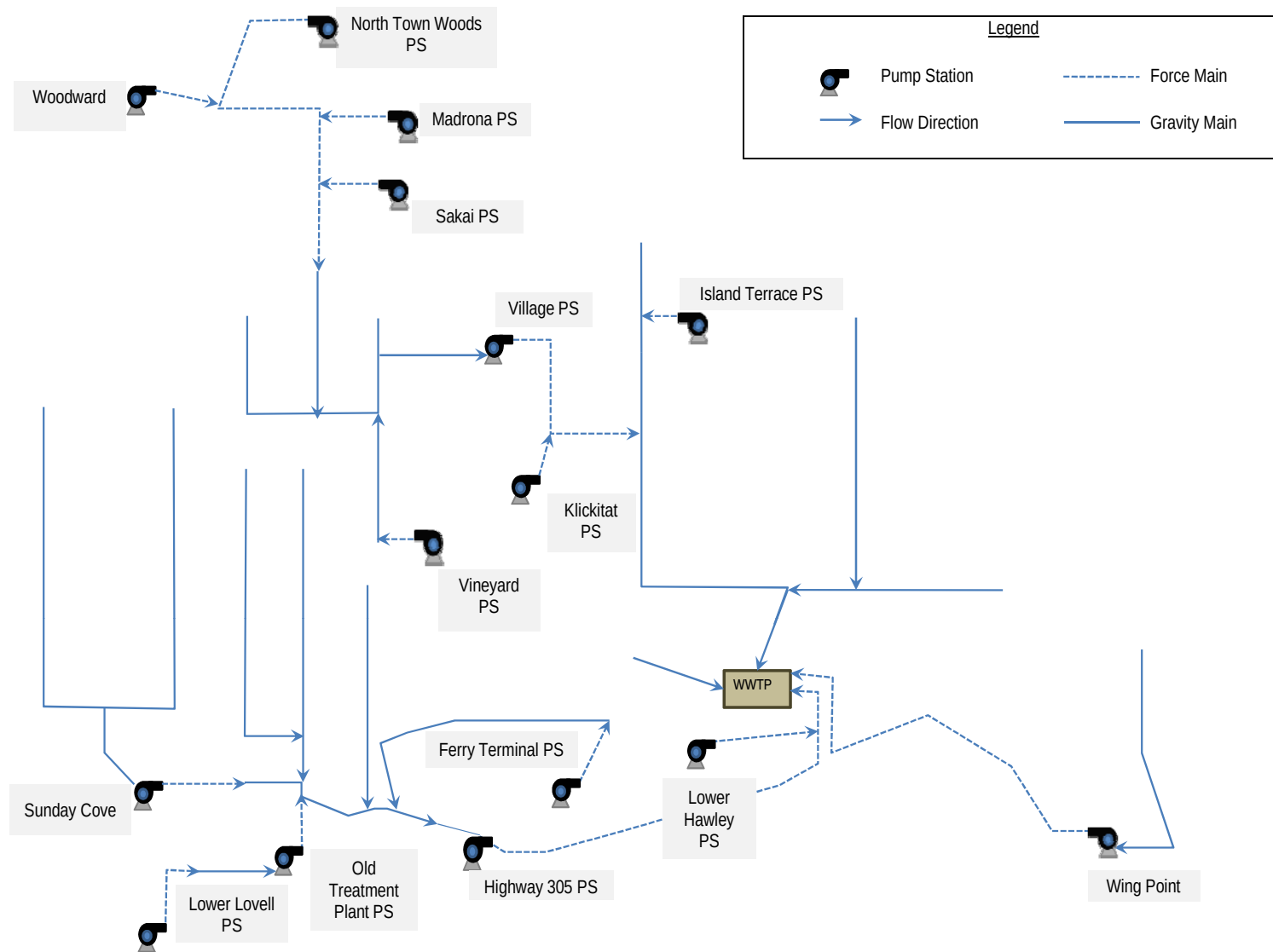
4.2.1 Service Area

The Winslow Sewer Service Area, shown in Figure 4.1, covers approximately 1,500 acres and serves the downtown Winslow community. The sewer system consists of approximately 24 miles of gravity main, 5 miles of force main, and 15 pump stations. The system conveys wastewater to the City's Winslow WWTP, which is located at 1220 Donald Place NE. Figure 4.3 shows a schematic representation of the pump stations and provides an overview of how flow is routed through the collection system to the Winslow WWTP.

4.2.2 History

The oldest parts of the sewer system were constructed around the 1950s and included a primary WWTP located near Madison Avenue and Parfitt Way. In 1972 interim upgrades were made to the treatment plant and the sewer system was greatly expanded in the late 1970s. The expansion included the construction of eight new pump stations and the current





WINSLOW LIFT STATION SCHEMATIC
Figure 4.3

City of Bainbridge Island
General Sewer Plan

secondary WWTP. Through developer extensions the collection system has continued to expand and the WWTP has undergone several upgrades since construction.

4.2.3 Inventory

The gravity collection system ranges in size from 6-inches to 12-inches in diameter with about 80% of the system 8-inches or less in size. The sewer pump station force mains range in size from 4-inches to 12-inches in diameter and the WWTP effluent force main is 16 inches in diameter. The average age of the pipe is about 34 years and the materials of construction include clay, concrete, ductile iron (DI), asbestos cement (AC), concrete cylinder (CCP), polyvinyl chloride (PVC), and high density polyethylene (HDPE).

4.3 WINSLOW SEWER PUMP STATIONS

The City owns and maintains 15 main pump stations within the Winslow Sewer Service Area. In addition, within the service area there are about 18 small government/commercial pump stations and 30 small privately owned residential sewage pumps that are not City maintained. The main pump station characteristics are summarized in Table 4.1. The pumps stations and their tributary areas are shown in Figure 4.1. A schematic representation of the pump stations showing how flow is routed through the collection system to the Winslow WWTP is presented in Figure 4.3. Detailed pump station information can be found in the 2013 Sewage Pump Station Inventory (Appendix H) and Pump Station Inventory Detail (Appendix I). A description of each pump station showing rated pump capacity is presented on the following pages.

4.3.1 Old Treatment Plant Pump Station No.1

The Old Treatment Plant pump station is located at 310 Madison Avenue and was first constructed in the 1950s as part of the original Winslow WWTP at this site. The station was retrofitted under a design by Roats Engineering as part of a major sewer system upgrade in 1978. The pump station has a drywell/wet well configuration consisting of a 6-foot diameter wet well with a depth of 14.1 feet and two 10-horsepower (hp), 250-gpm pumps. An analog probe with back up floats provides wet well level control. Telemetry is limited to monitoring only. A 1980s vintage generator set retrofitted to the site in 1994 provides power during utility power outages. The generator is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives residential and commercial gravity flow from the downtown Winslow area. From the station an 8-inch asbestos cement (AC) force main travels 600 feet north to a manhole at the Madison Avenue and Bjune Drive intersection where the flow turns to gravity.

It has been 36 years since the Old Treatment Plant pump station was last rehabilitated and overall it is in fair to good condition. The drywell, wet well, and mechanical systems are in good condition. The electrical system is in fair condition, the wet well controls may not meet current safety standards, and the telemetry is beyond its useful life. The station should be repainted. Because of their age, the pumps, motors, valves, controls, and telemetry should

be replaced. The emergency generator has been in service for 34 years and is scheduled for replacement in 2019.

4.3.2 Ferry Terminal Pump Station No.2

The Ferry Terminal pump station is located on Olympic Drive. It was originally constructed around 1956 as a sewer system extension to the Washington State Department of Transportation Ferry Terminal. Around 1980 the station was converted to a wet well submersible pump design and upgraded with a new control panel and new submersible pumps. The pump station consists of a 6-foot diameter wet well with a depth of 7.5 feet and two 10-hp, 200-gpm pumps. Wet well level control is provided by float controls. Telemetry is limited to monitoring and is provided by a tone Remote Telemetry Unit (RTU) that was installed in 1995. During utility power outages emergency power is provided by the Ferry Terminal main generator. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure. The Ferry Terminal pump station only receives inflow from the Ferry Terminal. From the pump station the 6-inch, class 100 AC force main heads north for about 756 feet to the intersection of Ferncliff Avenue and Winslow Way where the flow turns to gravity. From there sewage flows by gravity to the Highway 305 South pump station.

It has been 34 years since the Ferry Terminal pump station was last rehabilitated and overall it is in fair to good condition. The mechanical and electrical systems are in good condition. The concrete wet well is rough and should be refinished. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. The telemetry is beyond its useful life and a mobile generator receptacle should be installed. Improvements at this station should be coordinated with Washington State Ferry Terminal capital project upgrades.

4.3.3 Highway 305 Pump Station No.3

The Highway 305 pump station is the largest pump station in the Winslow Sewer System and is located at 400 Harborview Drive. The station was constructed as part of a major sewer system upgrade in 1979. The station was upgraded with new pumps, valves, motors, electrical, telemetry, controls, cathodic protection, and force main pig/pump port in 2008. The station has a drywell/wet well configuration consisting of an 8-foot wet well with a depth of 25 feet and three 25-hp, 1360-gpm pumps. An analog probe with back up floats provides wet well level control. The telemetry provides extensive monitoring and control capabilities. A generator set installed in 2006 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives inflow from most of the downtown Winslow area. From the pump station the 12-inch DI force main generally travels in a northeast direction for about 3000 feet along the Eagle Harbor beach until it discharges to gravity just above the City Winslow WWTP on Donald Avenue. In recent years the force main has broken on the beach near the WWTP on three separate occasions. A project is currently underway to replace the force main.

It has been 6 years since the Highway 305 pump station was last rehabilitated. Overall, it is in good condition and will not reach the end of its useful life during the Long-Term planning period.

4.3.4 Sunday Cove Pump Station No.4

The Sunday Cove pump station is the second largest pump station in the Winslow Sewer System and is located at 691 Winslow Way West. The station was constructed as part of a major sewer system upgrade in 1979. The station was upgraded with new valves, electrical, telemetry, controls, cathodic protection, and force main pig/pump port in 2007. It has a drywell/wet well configuration consisting of a two wet wells, one 6 feet in diameter and one 8 feet in diameter. The controlling wet well has a depth of 14 feet. The drywell contains two 25-hp, 490-gpm pumps. An analog probe with back up floats provides wet well level control. The telemetry provides extensive monitoring and control capabilities. A generator set installed in 1997 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. From the Sunday Cove pump station the 6-inch ductile iron (DI) force main travels 1200 feet east on Winslow Way where the flow turns to gravity. The original PVC force main for the station cracked and broke due to poor bedding materials on at least three occasions prior to 2003 when the main was replaced with a ductile iron pipe.

It has been seven years since the Sunday Cove pump station was last rehabilitated. Overall it is in good condition and not in need of any immediate upgrades. However, the pumps and motors were not replaced during the station upgrade. They will need to be replaced for reliability and to meet long-term station capacity requirements. The emergency generator will be in need of replacement or upgrade before the end of the Long-Term planning period.

4.3.5 Village Pump Station No.5

The Village pump station is the third largest pump station in the Winslow Sewer System and is located at 920 Hildebrand. The station was constructed as part of a major sewer system upgrade in 1979 to replace an existing pump station. It has a drywell/wet well configuration consisting of a 6-foot wet well with a depth of 12.5 feet and two 20-hp, 765-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 2007 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. From the pump station the force main runs east under Highway 305 for 500 feet and then south 600 feet to a clean out. From the clean out the main runs east for 100 feet and then south 600 feet to a second clean out. From the second clean out the main then runs east 850 feet where the flow turns to gravity. The first 20 feet of force main leaving the station are 10-in DI and the remainder of the force main is 8-in PVC. No known air release valves, blow off valves, or pig ports are part of the system.

It has been 35 years since the Village pump station was constructed and overall it is in fair condition. The drywell is showing signs of advanced corrosion, is in need of painting and

the status of the cathodic protection is uncertain. The mechanical and electrical systems are in fair condition, the telemetry is beyond its useful life, and the wet well controls may not meet current safety standards. The pumps have a high cycle rate indicating additional wet well capacity or VFD controlled pumps may be warranted. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. Because this is the third largest station it may require a comprehensive rehabilitation, similar to Highway 305 and Sunday Cove, with all controls relocated to an above ground electrical enclosure. The station has exceeded the estimated useful life and requires rehabilitation.

4.3.6 Lower Lovell Pump Station No.6

The Lower Lovell pump station is located at 426 Lovell Avenue. The station was constructed as part of a major sewer system upgrade in 1979. It has a drywell/wet well configuration consisting of a 4-foot wet well with a depth of 17.3 feet and two 7.5-hp, 100-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 1998 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives limited residential gravity flow. From the station the 4-in force main generally heads 200 feet north on Lovell Avenue and then 475 feet east on Parfitt Way to the point where the flow turns to gravity. From the station the first 14 feet of force main is DI and the remainder is PVC.

It has been 35 years since the Lower Lovell pump station was constructed and overall it is in fair condition. The drywell is showing signs of corrosion, is in need of painting and the status of the cathodic protection is uncertain. The mechanical systems are in good condition. The electrical systems are in fair condition, the telemetry is beyond its useful life, and the wet well controls may not meet current safety standards. The wet well shows signs of saltwater intrusion. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. The emergency generator will be in need of replacement or upgrade before the end of the Long-Term planning period. The station has exceeded the estimated useful life and requires rehabilitation.

4.3.7 Lower Hawley Pump Station No.7

The Lower Hawley pump station is located at 1195 Irene Place. The station was constructed as part of a major sewer system upgrade in 1979. It has a drywell/wet well configuration consisting of a 4-foot wet well with a depth of 14.3 feet and two 3-hp, 100-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 1996 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives limited residential gravity flow. From the station the 4-in DI force main travels east about 275 feet where it connects to the 12-in Highway 305 force main.

It has been 35 years since the Lower Hawley pump station was constructed and overall it is in fair to good condition. The drywell is in need of painting and the status of the cathodic protection is uncertain. The mechanical systems are in good condition. The electrical systems are in fair condition, the telemetry is beyond its useful life, and the wet well controls may not meet current safety standards. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. The emergency generator will be in need of replacement or upgrade before the end of the planning period. The station has exceeded the estimated useful life and requires rehabilitation.

4.3.8 Wing Point Pump Station No.8

The Wing Point pump station is located at 6481 Wing Point Drive. The station was constructed as part of a major sewer system upgrade in 1979. It has a drywell/wet well configuration consisting of a 4-foot wet well with a depth of 12.5 feet and two 5-hp, 200-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 1995 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives gravity flow from the Wing Point residential community. From the station the 6-in DI force main follows the Wing Point shoreline on the beach to the City WWTP located on Donald Avenue. Two gravity sewers and three building sewers discharge directly into the force main. Over the past ten years the main has broken near the pump station on three separate occasions. A project is currently underway to replace the force main.

It has been 35 years since the Wing Point pump station was constructed and overall it is in fair condition. The drywell is in need of painting and the status of the cathodic protection is uncertain. The mechanical systems are in good condition. The electrical systems are in fair condition, the telemetry is beyond its useful life, and the wet well controls may not meet current safety standards. The station access hatch is under water during extreme high tides and should be extended. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. The emergency generator will be in need of replacement or upgrade before the end of the planning period. The station has exceeded the estimated useful life and requires rehabilitation.

4.3.9 Island Terrace Pump Station No.9

The Island Terrace pump station is located at 1174 Ferncliff Avenue. The developer-built station was commissioned around 1983. It has a drywell/wet well configuration consisting of an 8-foot wet well with a depth of 11.5 feet and two 3-hp, 100-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 2002 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives residential and commercial gravity flow. From the

station the 4-inch force main runs 440 feet south on Ferncliff Avenue to the intersection of Eaglecliff and Ferncliff where the flow turns to gravity.

It has been 31 years since the Island Terrace pump station was constructed and overall it is in good condition. The drywell is concrete and only requires painting. The telemetry is beyond its useful life and the wet well controls may not meet current safety standards. Because of their age, the pumps, motors, valves, controls, and telemetry should be replaced. The emergency generator will be in need of replacement or upgrade before the end of the planning period.

4.3.10 Klickitat Pump Station No.10

The Klickitat pump station is located at 692 Klickitat Place. The developer constructed station was commissioned around 1993. It has a drywell/wet well configuration consisting of a 6-foot wet well with a depth of 17.9 feet and two 7.5-hp, 100-gpm pumps. A bubbler system with float control back up provides wet well level control. Telemetry is limited to monitoring and is provided by a tone RTU installed in 1995. A generator set installed in 2003 provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The station receives gravity flow from a limited residential area. From the station the force main runs 200 feet north through an easement and then connects to the force main from the Village pump station. The force main serving both stations then travels about 600 feet east where the flow turns to gravity on Ferncliff Avenue.

It has been 21 years since the Klickitat pump station was constructed and overall it is in good condition. The telemetry is beyond its useful life, the concrete drywell needs to be painted, and the wet well controls may not meet current safety standards. Because of their age, the pumps, motors, valves, controls, and telemetry will need to be replaced. The emergency generator will be in need of replacement or upgrade before the end of the planning period.

4.3.11 Woodward School Pump Station No.11

The Woodward School pump station is located at 9125 NE Sportsman Club Road NE. The station and force main was constructed for the Bainbridge Island School District around 1996 and subsequently turned over to the City. It consists of a 6-foot wet well with a depth of 14.8 feet and two 15-hp, 68-gpm submersible pumps. Wet well level is provided by float controls. Telemetry is limited to monitoring and is provided by a tone RTU. During utility power outages emergency power is provided by the onsite School District generator. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure. The Woodward School pump station only receives flow from two school campuses. From the pump station the 4-inch DI force main travels about 700 feet to the intersection of Sportsman Club and New Brooklyn where it connects with the 4-inch HDPE force main from the North Town Woods pump station. The combined force main travels about 4000 feet to the intersection of High School Road and Madison where the flow turns to gravity. The North Town Woods pump station, Sakai Village pump station, Madrona

pump station, and several small pump stations contribute to this force main to cause varying head conditions.

It has been 18 years since the Woodward pump station was constructed and overall it is in good condition. The telemetry is beyond its useful life. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period. Because of their age, the pumps, motors, valves, controls, and telemetry will need to be replaced during the Long-Term planning period.

4.3.12 North Town Woods Pump Station No.13

The North Town Woods pump station is located at 9673 North Town Loop. The developer-built station was fabricated on site and placed in service in 1999. It has a drywell/wet well configuration consisting of a 6-foot wet well with a depth of 11.5 feet, and two 30-hp, 125-gpm pumps. Due to power supply limitations, the station is not capable of running two pumps simultaneously. An analog probe with back up floats provides wet well level control. Telemetry is limited to monitoring only. The station has a generator set installed equipped with an automatic transfer switch. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure.

The North Town Woods pump station receives inflow from the North Town Woods residential neighborhood as well as pumped discharge from the Sportsman Club Road Church, Sakai School, and two small pump stations located in the Copper Top Loop Business Park. The North Town Woods pump station discharges into 1,800 feet of 4-inch DI force main that runs south on Sportsman Club Road to the intersection of Sportsman Club and New Brooklyn. The Woodward School pump station also discharges into this section of force main. At New Brooklyn Road the force main makes a transition to 4-inch HDPE and heads east to the intersection of New Brooklyn and Madison. At this point the force main heads south before it turns to gravity just north of Madison and High School Road. Along this route the City owned Sakai Village pump station and Madrona pump station as well as three small pump stations operated by others located at the School Bus Maintenance Facility, Madison Avenue Fire Station, and the LDS Church on Madison Avenue all discharge into this section of force main. In addition the future development of Coultas property will discharge into this section of force main. These pump stations combine to cause varying head conditions in the force main.

It has been 15 years since the North Town Woods pump station was constructed and overall it is in fair condition. Concrete drywell structure experiencing groundwater intrusion. Due to power limitations the station cannot operate two pumps simultaneously. A mobile generator receptacle is scheduled for installation in 2014. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period. Because of their age, the pumps, motors, valves, controls, and telemetry will need to be replaced during the Long-

Term planning period. The emergency generator will be in need of replacement or upgrade before the end of the planning period.

4.3.13 Sakai Village Pump Station No.14

The Sakai Village pump station is located at 1879 Sakai Village Loop NE. The station was constructed to serve the Sakai Village development project in 2003. It consists of a 6-foot wet well with a depth of 19.2 feet, and two 10-hp, 150-gpm submersible pumps. The Sakai Village pump station receives flow from the Sakai Village residential area only. Wet well level control is provided by float controls. Telemetry is limited to monitoring only. The station has a generator set equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. From the pump station the 4-inch class 52, DI main extends 362 feet west to a 90 degree bend, 43 feet south to a second 90 degree bend, and finally 160 feet west to the point of intersection with the 4-inch SDR-9 HDPE force main serving the North Town Woods pump station. From the point of connection on Madison Avenue, the 4-inch SDR-9 HDPE force main extends 1200 feet south at which point the flow turns to gravity. Both bends in the 4-inch DI main are equipped with pressure clean out connections. The Sakai Village pump station discharges to the North Town Woods force main which takes flow from several pump stations causing varying head conditions.

It has been 11 years since the Sakai Village pump station was constructed and overall it is in good condition. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period. Because of their age, the pumps, motors, valves, controls, and telemetry will need to be replaced during the Long-Term planning period. The emergency generator will be in need of replacement or upgrade before the end of the planning period.

4.3.14 Vineyard Lane Pump Station No.16

The Vineyard Lane pump station is located on Vineyard Lane and was commissioned in 2006. It consists of a 6-foot diameter wet well with a depth of 11.6 feet. Pumping is accomplished by two 3-hp, 90-gpm submersible pumps. An analog probe with back up floats provides wet well level control. The telemetry provides extensive monitoring and control capabilities. During utility power outages emergency power is provided by the onsite generator operated by the Vineyard Lane Homeowners Association. The pump station receives gravity inflow from about 45 residential units in the Vineyard Lane retirement community. From the station a 4-inch HDPE high pressure force main conveys flow about 823 feet to the west under Highway 305 to discharge to the gravity main on Ericksen Avenue.

It has been eight years since the Vineyard Lane pump station was constructed and overall it is in good condition. The station will not reach the end of its useful life during the planning period.

4.3.15 Madrona Pump Station No.17

The Madrona pump station is located in the southeast corner of New Brooklyn Road and Madison Avenue. It was commissioned in 2013 to serve the Madrona Retirement Center and the future Harrison Hospital Health Care facility. It includes a 6-foot diameter wet well and two 10-hp, 80-gpm pumps. An analog probe with back up floats provides wet well level control. The telemetry provides extensive monitoring and control capabilities. During utility power outages emergency power is provided by the onsite generator operated by the Madrona Retirement Center. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The pump station receives inflow from the Madrona Retirement Center and the future Harrison Hospital Health Care facility. From the station a 3-inch HDPE force main conveys flow about 69 feet west where it connects with the 4-inch SDR-9 HDPE force main serving the Woodward, North Town Woods, and Sakai pump stations as previously described.

It has been one year since the Madrona pump station was constructed and overall it is in good condition. The station will not reach the end of its useful life during the planning period. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period.

4.3.16 High School Way and Upper Hawley Pump Stations

The High School Way and Upper Hawley pump stations were constructed as part of the major sewer system upgrade in 1979. The High School Way pump station was decommissioned and flows rerouted to the Sunday Cove pump station in 1997. The Upper Hawley pump station was decommissioned in 2000 and flows rerouted by gravity to the WWTP in 2000.

Table 4.1 Collection System Pump Station Characteristics General Sewer Plan City of Bainbridge Island												
New Station ID No.	Pump Station Name	Sewer System	Year Commissioned/ Upgraded	Address	Station Type	No. of Pumps	Horse-Power	Firm Capacity (gpm) ⁽²⁾	Force Main Diameter (inches)	Length of Force Main (feet)	Telemetry	Back-up Power ⁽⁴⁾
1	Old Treatment Plant	Winslow	1950/1978	310 Madison Ave	Drywell/Wet	2	10	256	8	600	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
2	Ferry Terminal	Winslow	1956/1980	Olympic Drive	Submersible	2	10	150	6	756	Monitoring Only	Power from Ferry Terminal Main Gen Set
3	Highway 305	Winslow	1979/2008	400 Harborview Drive	Drywell/Wet Well	3	25	2,720	12	3,000	Monitoring and Control	Fixed Generator with Mobile Generator Receptacle
4	Sunday Cove	Winslow	1979/2007	691 Winslow Way West	Drywell/Wet Well	2	25	484	6	1,200	Monitoring and Control	Fixed Generator with Mobile Generator Receptacle
5	Village	Winslow	1979	920 Hildebrand	Drywell/Wet Well	2	20	614	8	2650	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
6	Lower Lovell	Winslow	1979	426 Lovell Avenue	Drywell/Wet	2	7.5	100	4	675	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
7	Lower Hawley	Winslow	1979	1195 Irene Place	Drywell/Wet Well	2	3	100	4	275	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
8	Wing Point	Winslow	1979	6481 Wing Point Drive	Drywell/Wet Well	2	5	200	6	4,007	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
9	Island Terrace	Winslow	1983	1174 Ferncliff Ave	Drywell/Wet Well	2	3	100	4	440	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
10	Klickitat	Winslow	1993	692 Klickitat Place	Drywell/Wet Well	2	7.5	100	4	200	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
11	Woodward	Winslow	1996	9125 NE Sportsman Club Road NE	Submersible	2	15	60	4	700	Monitoring Only	Power from Woodward School Main Gen Set
12	Lynnwood	South Island	1998	4586 Point White Drive	Drywell/Wet Well	2	40	182	6	12,468	Monitoring Only	Fixed Generator ⁽³⁾
13	North Town Woods ⁽¹⁾	Winslow	1999	9673 North Town Loop	Drywell/Wet Well	2	30	104	4	5,800	Monitoring Only	Fixed Generator ⁽³⁾
14	Sakai	Winslow	2003	1879 Sakai Village Loop NE	Submersible	2	10	147	4	565	Monitoring Only	Fixed Generator with Mobile Generator Receptacle
15	Rockaway	South Island	2005	3900 Halls Hill NE	Submersible	2	30	115	4	5,360	Monitoring and Control	Fixed Generator with Mobile Generator Receptacle
16	Vineyard	Winslow	2006	Vineyard Lane	Submersible	2	3	90	4	823	Monitoring and Control	Power from Vineyard Lane Main Gen Set
17	Madrona	Winslow	2013	New Brooklyn Rd and Madison Ave	Submersible	2	10	110	3	70	Monitoring and Control	Power from Madrona Retirement Center Main Gen Set
Notes (1) Station is not capable of two pump run. (2) With the largest pump out of service, the firm capacity corresponds to the lowest value between the design value and the most recent pump test. (3) Mobile generator receptacle is scheduled for installation in 2014. (4) All pump stations have a source of backup power with an automatic transfer switch.												

4.4 SOUTH ISLAND SEWER

4.4.1 Service Area

The South Island Sewer Service Area, shown in Figure 4.2, serves several isolated neighborhoods on the south end of the island including high-density areas along the waterfront and upland areas with poor soils for drain fields. Parcels along the waterfront including Point White, Pleasant Beach, and Rockaway Beach are equipped with residential grinder pumps, which convey wastewater via low pressure force mains to the Lynnwood Center or Rockaway Beach pump stations. The Lynnwood Center, Emerald Heights, and Blakely School areas flow by gravity to the Lynnwood Center pump station.

4.4.2 History

Since the 1980s the Lynnwood Center area experienced failing septic systems. In 1998, a developer built the Lynnwood Center pump station and force main which discharged to the KCSD #7 WWTP where the wastewater was treated through an interlocal agreement. As a result of failing septic systems, several other neighborhoods in the South Island area requested sewer service from the City. In 2005 the City bought out the developer and extended service to the other portions of South Island. These improvements are known as the South Island Sewer Local Improvement District No. 20.

4.4.3 Inventory

The South Island sewer system consists of approximately 11,000 feet of gravity main, 16,000 feet of low-pressure force main, 18,000 feet of force main, 147 grinder pumps, and two main pump stations that convey wastewater to the KCSD #7 WWTP located in the Fort Ward neighborhood. The gravity collection system ranges in size from 6-inches to 8-inches in diameter. The low pressure force mains range in size from 2-inches to 3-inches in diameter and the sewer pump station force mains range in size from 4-inches to 6-inches in diameter. The average age of the pipe is about ten years and the materials of construction concrete, ductile iron (DI), polyvinyl chloride (PVC), and high-density polyethylene (HDPE),

4.5 SOUTH ISLAND SEWER PUMP STATIONS

The City owns and maintains two main pump stations within the South Island Sewer Service Area. In addition, the City owns and maintains 147 grinder pumps in the Point White, Pleasant Beach, and Rockaway Beach areas. The main pump station characteristics are summarized in Table 4.1. The pumps stations and their tributary areas are shown in Figure 4.2. Detailed pump station information can be found in the 2013 Sewage Pump Station Inventory (Appendix H) and Pump Station Inventory Detail (Appendix I). A description of each pump showing rated pump capacity is presented on the following pages.

4.5.1 Lynnwood Center Pump Station No.12

The Lynnwood Center pump station is located at 4586 Point White Drive. The station was constructed in 1998. The station and the force main to the KCSD #7 WWTP were originally constructed to serve the Lynnwood Center area. In 2006, the City bought out the developer and expanded the service area to serve the South Island Sewer Local Improvement District No. 20. The station consists of an 8-foot wet well with a depth of 15.3 feet and two 40-hp, 182-gpm pumps. An analog probe with back up floats provides wet well level control. Telemetry is limited to monitoring only. The station has a generator set installed equipped with an automatic transfer switch. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure.

The gravity collection system collects residential and commercial flows from Lynnwood Center, Emerald Heights, Blakely School, Point White, and Pleasant Beach. The 6-inch force main discharges to the KCSD #7 WWTP. The 12,468 foot force main includes 12,200 feet of 6-inch DI and 268 feet of 6-inch C-900 PVC pipe. From the pump station the main heads 4,100 feet south then east on Pleasant Beach Drive NE, then 2,800 feet west on Oddfellows Road, then 2,000 feet west on Blakely Avenue NE, then 3,568 feet south on NE Country Club Road and then parallel to Fort Ward Hill Road to the point where the flow turns to gravity near the entrance to the WWTP. The Lynnwood Center and Rockaway Beach share the same force main causing variable head conditions on the pump stations.

It has been 16 years since the Lynnwood Center pump station was constructed and overall it is in good condition. A mobile generator receptacle is scheduled for installation in 2014. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period. Because of their age, the pumps, motors, valves, controls, and telemetry will need to be replaced during the Long-Term planning period. The emergency generator will be in need or replacement or upgrade before the end of the planning period.

4.5.2 Rockaway Beach Pump Station No.15

The Rockaway Beach pump station is located at 3900 Halls Hill NE. It was commissioned in 2005 as part of the South Island Sewer Local Improvement District No. 20. It consists of an 8-foot wet well with a depth of 11.7 feet, and two 30-hp, 115-gpm pumps. An analog probe with back up floats provides wet well level control. The telemetry provides extensive monitoring and control capabilities. A generator set provides power during utility power outages. The generator set is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The pump station receives inflow from about 80 homes with on-site grinder pumps located on Rockaway Beach Drive. The low pressure grinder pump force main to the station includes about 2,525 feet of 2-inch HDPE and 2,920 feet of 3-inch HDPE. From the station a 4-inch HDPE high pressure force main conveys flow about 5,360 feet along Halls Hill Road and Blakely Road NE to NE Country Club Road where it connects to a 6-inch DI force main that leads to the KCSD #7 Fort Ward WWTP. The 6-inch force main was installed during construction of the

Lynnwood Center pump station. The Rockaway Beach and Lynnwood Center share the same force main causing variable head conditions on the pump stations.

It has been 9 years since the Rockaway pump station was constructed and overall it is in good condition. The station will not reach the end of its useful life during the planning period. The station experiences variable head conditions because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period.

4.5.3 Residential Grinder Pumps

Public Works Trust Fund loan financing for the South Island Sewer Local Improvement District No. 20 was contingent upon the City owning and maintaining the residential grinder pumps installed as part of the project. This requirement is consistent with WAC 173-240-104 which states “domestic sewage facilities will not be approved unless ownership and responsibility for operations and maintenance is by a public entity.”

The City has since expanded this policy to accept ownership and maintenance of all residential sewer pumps installed anywhere in the City’s sewer system after March, 25, 2010. This is outlined in the following policy statement.

“Pursuant to WAC 173-240-104 and as further outlined in Ecology’s March 15, 2010 position paper on privately-owned grinder pumps, effective March 25, 2010 it is the City’s policy to take ownership and responsibility for operation and maintenance of all sewage pumps connected to the City’s sewer system. Pumped sewer systems shall only be approved where gravity sewer systems are neither technically or economically feasible. Sewage pumps which serve a single nonresidential, industrial, or commercial establishment may be included in this requirement at the discretion of the City to insure proper enforcement of this policy for facilities that may be likely to have a future change in use of occupancy. Pumped sewer systems shall be designed by a licensed engineer. Sewer availability authorization shall be contingent upon these conditions.”

During the South Island Sewer project the City developed a standard specification for E/One residential grinder pumps and the current City standard for residential grinder pumps specifies the E/One Extreme, D-Series, 70 gallon capacity simplex pump for each residential installation. The units include remote alarms and pump cores that can quickly be changed out during an emergency.

Currently the South Island Sewer system includes 147 residential grinder pumps. The majority of the pumps went into service in 2005 and they have since proven to be very reliable. Most of the problems encountered to date can be traced to improper use by homeowners. Long-term life expectancy of these pumps is not fully documented, however for planning purposes the pump cores and associated electrical controls can expect to be replaced and upgraded on a 20 to 25-year frequency. It has been nine years since the

majority of the pumps were installed and all of them will reach the end of their useful life before the end of the Long-Term planning period.

4.6 SUPERVISORY CONTROL AND DATA ACQUISITION

The City pump stations and Winslow WWTP are monitored and/or controlled by a Supervisory Control and Data Acquisition (SCADA) system. The system was designed and installed by S&B Inc. in 1994 and 1995. Monitoring and control of the City water system, pump stations, and WWTP 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 WWTP. Additional integration and upgrades to the system were accomplished in 2010 as part of the WWTP upgrade.

The SCADA system includes a programmable logic controller (PLC), graphical user interface (GUI), telephone network interface (TNIS), Central Archive Server (CAS), and auto dialer. Control and alarm logic 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 is a Historian that archives and stores data. The auto dialer calls out after-hour alarm conditions to standby personnel.

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 1994. This relationship has helped establish standards and provide continuity of systems design, and ensure 24/7 emergency support. Over the years the SCADA system and remote controls have proven extremely reliable. All software and hardware are designed for reliability and redundancy. The SCADA PLC has a backup system available on-site. In newer installations level probes are backed up with floats, smart controllers are widely employed, and software is designed with 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 MTU.

The pump stations and WWTP can be monitored or controlled locally, from the MTU at the WWTP, or at the Public Works Facility through the City network. Typical conditions and alarms monitored include communications fail, power fail, phase fail, smoke/fire, flood, operator in trouble, intrusion, voltage, low level, high level, pump run time, pump cycles, pump excessive start limit, and pump failure. Pump station monitoring and control capabilities continue to expand as telemetry technology improvements are incorporated during station upgrades and new station construction.

4.7 PIPELINE REMAINING USEFUL LIFE ASSESSMENT

Combined, the Winslow Sewer and South Island Sewer collection systems consist of approximately 26 miles of gravity main, 8.4 miles of force main, and 3 miles of low-pressure force main. The gravity and force main inventory is summarized in Table 4.2 and Table 4.3.

Table 4.2 Collection System Gravity Main Inventory General Sewer Plan City of Bainbridge Island		
Diameter (inches)	Length (feet)	Percent of Total Gravity Mains
Unknown	22,611	16.37%
6	831	0.60%
8	98,737	71.47%
10	10,151	7.35%
12	5,820	4.21%
Total (ft)	138,150	100.00%
Total (miles)	26.2	100.00%

Table 4.3 Collection System Force Main Inventory General Sewer Plan City of Bainbridge Island		
Diameter (inches)	Length per Diameter (feet)	Percent of Total Force Mains
2	5,841	9.7%
3	9,919	16.5%
4	14,902	24.8%
6	18,140	30.2%
8	3,230	5.4%
10	20	0.0%
12	3,000	5.0%
16	4,924	8.2%
Total (feet)	59,977	100%
Total (miles)	11.4	100%

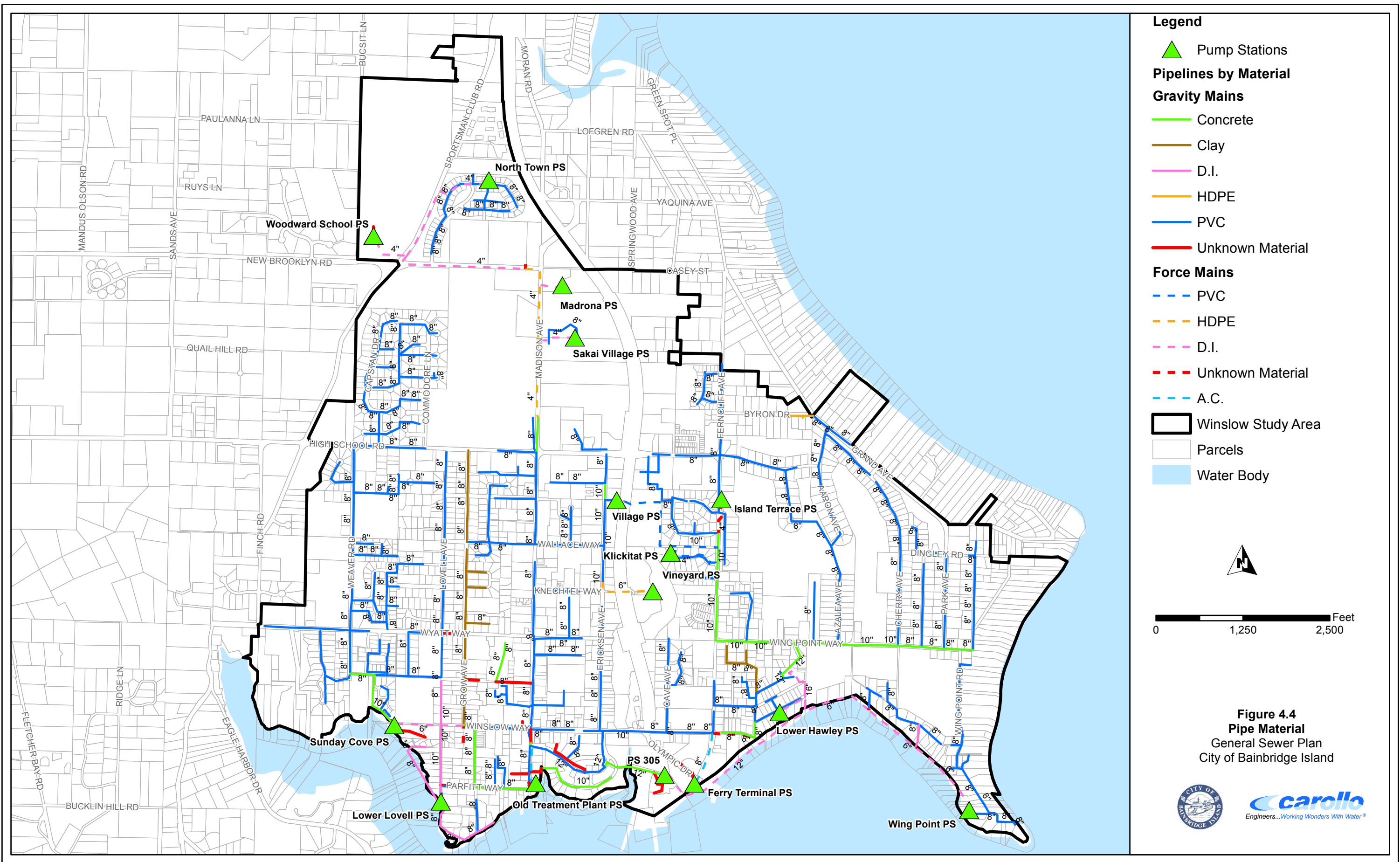
The age and condition of the collection system manholes and pipelines impact the quantity of inflow and infiltration (I/I) able to enter the system. Typically, older sewer pipes have a greater potential of allowing significant I/I into the collection system. Older pipelines are a priority when considering pipelines for rehabilitation.

The length of time that a pipe is anticipated to remain functional is called the useful life. Useful life depends largely on the pipe age and material, but can also depend on soil conditions, wastewater constituents, and installation. When a pipe is in service beyond its useful life the increasing costs of maintenance associated with a failing pipe will likely warrant replacement.

Table 4.4 presents the estimated useful life of pipes of various materials. The original useful life varies from 60 years for concrete pipe to 100 years for clay pipe. Since the shortest useful life for pipes in the City's collection system is 60 years, it is assumed that the original useful life for all unknown pipelines is 60 years.

Table 4.4 Useful Life of Pipes General Sewer Plan City of Bainbridge Island	
Pipe Material	Original Useful Life Assumption (yrs)
Clay Pipe	100
Ductile Iron Pipe (DI)	70
High-Density Polyethylene (HDPE)	70
Polyvinyl Chloride (PVC)	70
Concrete Pipe (Concrete)	60
Asbestos Cement Pipe (AC)	60
Unknown	60

Pipe age and material type were used to determine the remaining useful life (RUL) of the collection system pipelines. GIS data and field research were used to determine the type of material and year or decade that pipe segments were installed. Age and material data for some of the pipelines are unavailable. Remaining useful life cannot be determined for pipe segments with unknown installation year. Pipe material and installation year in the Winslow area are shown in Figure 4.4 and Figure 4.5, respectively and Figure 4.6 and Figure 4.7, respectively for the South Island area.



- Legend**
- Pump Stations
 - Pipelines by Material**
 - Gravity Mains**
 - Concrete
 - Clay
 - D.I.
 - HDPE
 - PVC
 - Unknown Material
 - Force Mains**
 - PVC
 - HDPE
 - D.I.
 - Unknown Material
 - A.C.
 - Winslow Study Area
 - Parcels
 - Water Body

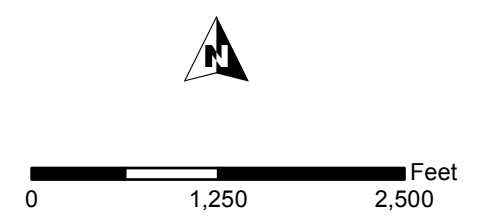
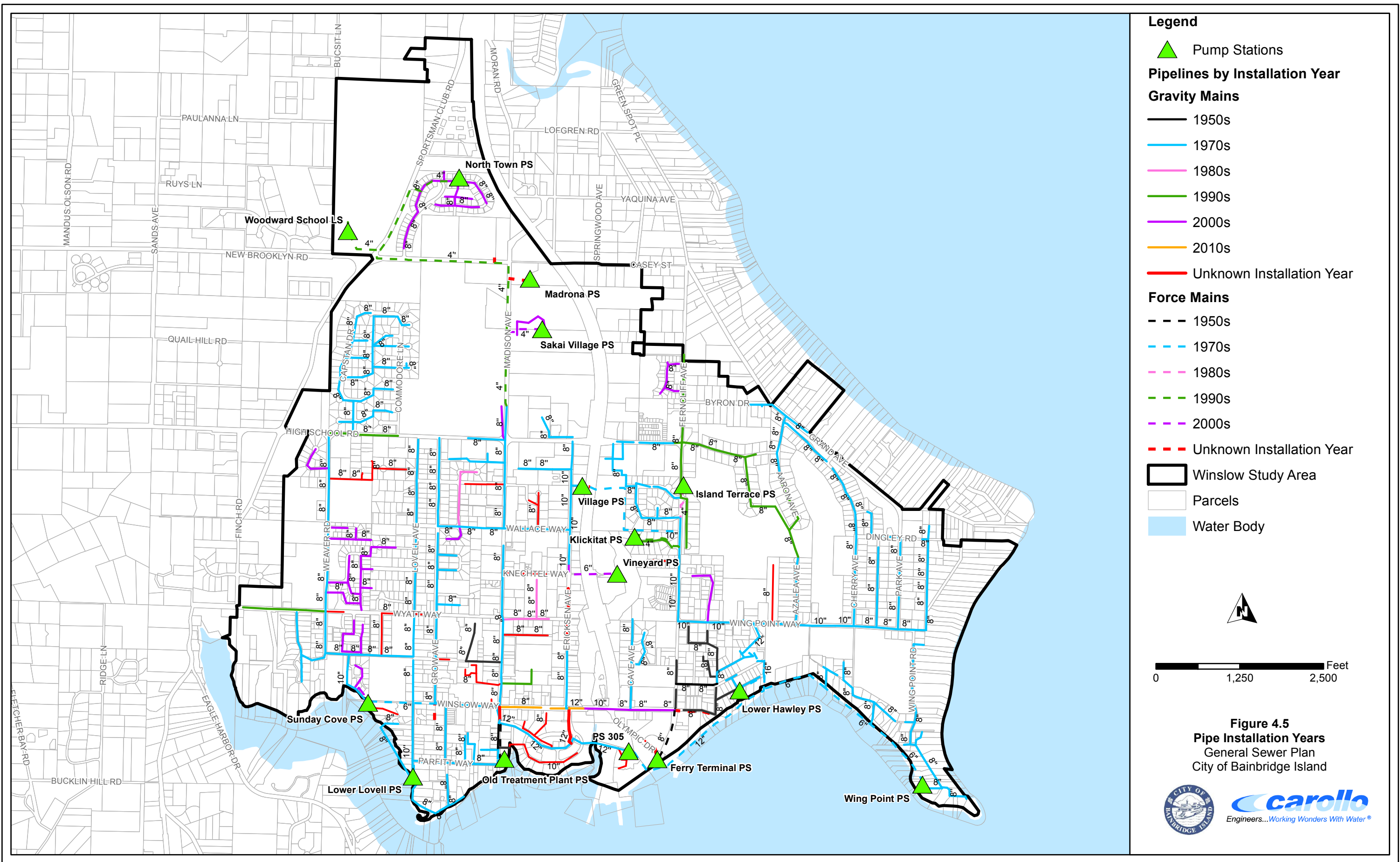


Figure 4.4
Pipe Material
General Sewer Plan
City of Bainbridge Island





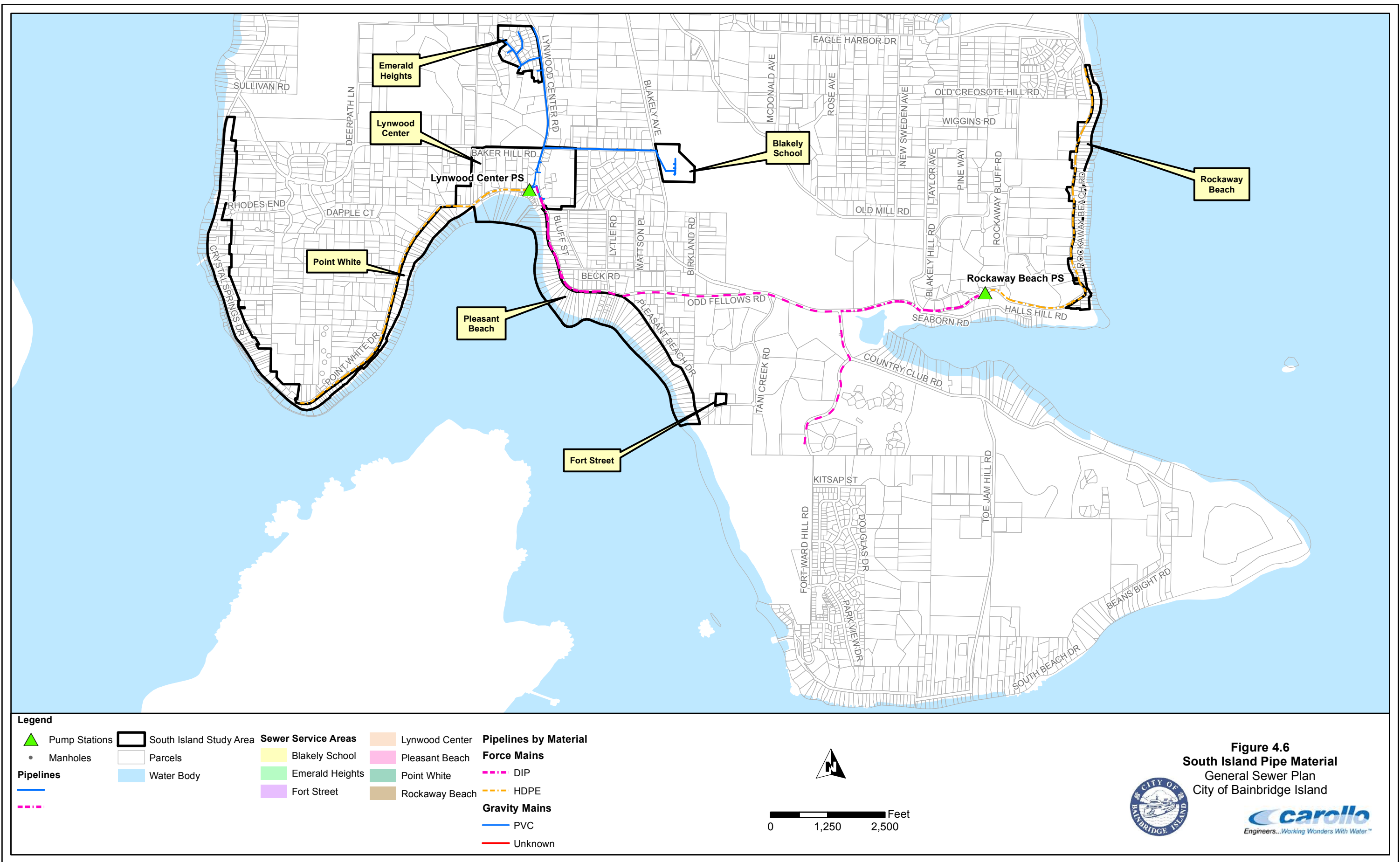


Figure 4.6
South Island Pipe Material
General Sewer Plan
City of Bainbridge Island



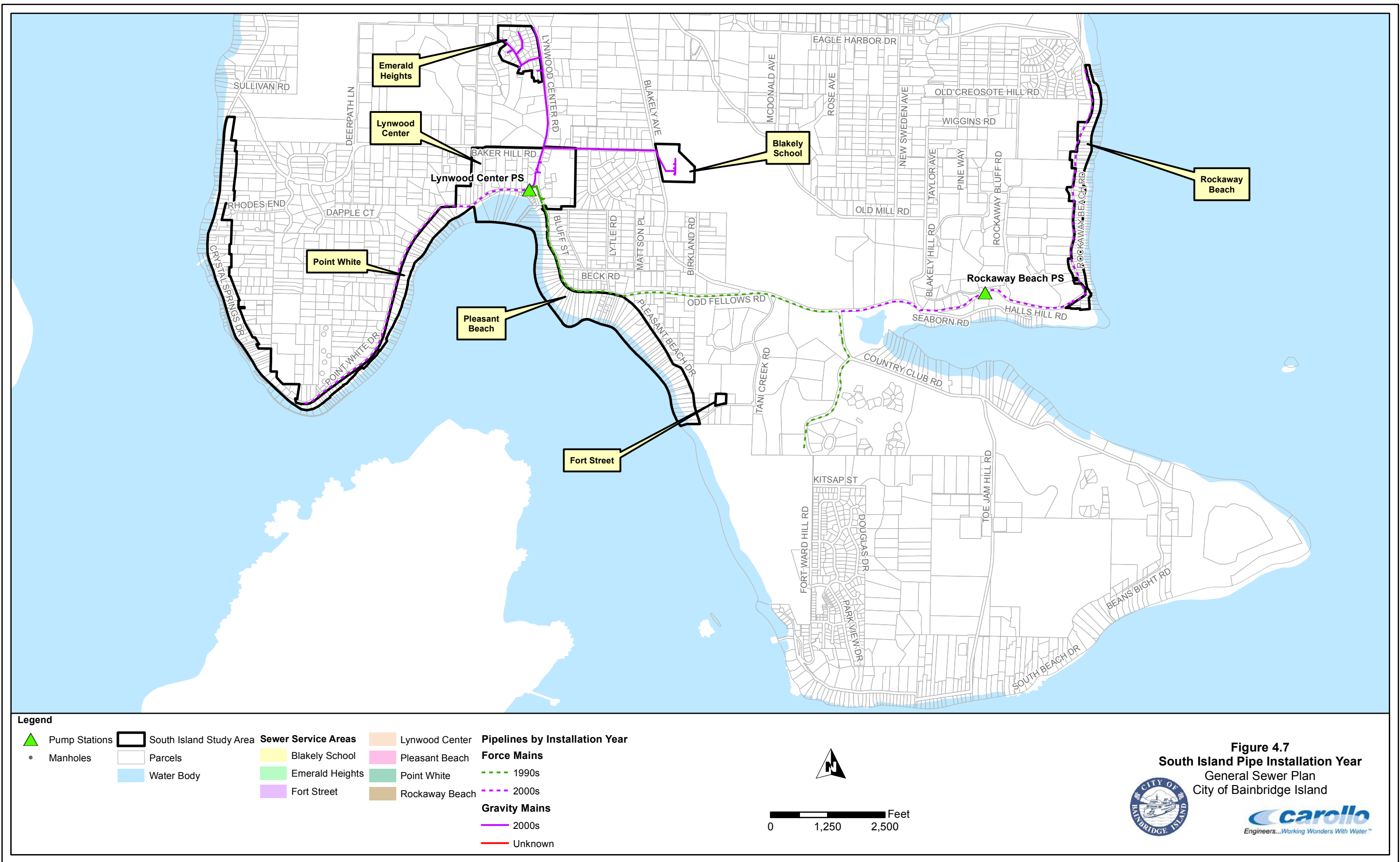
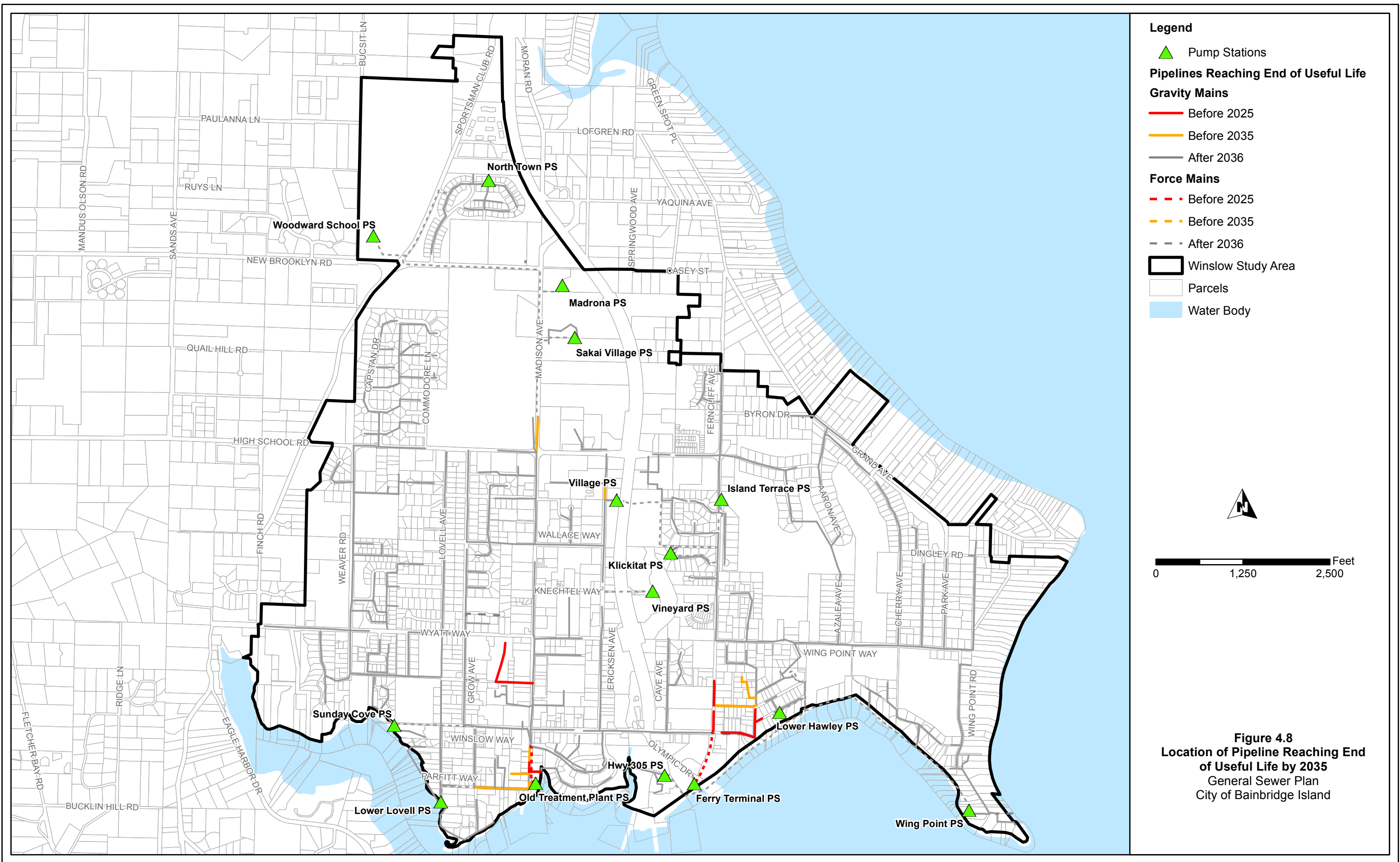
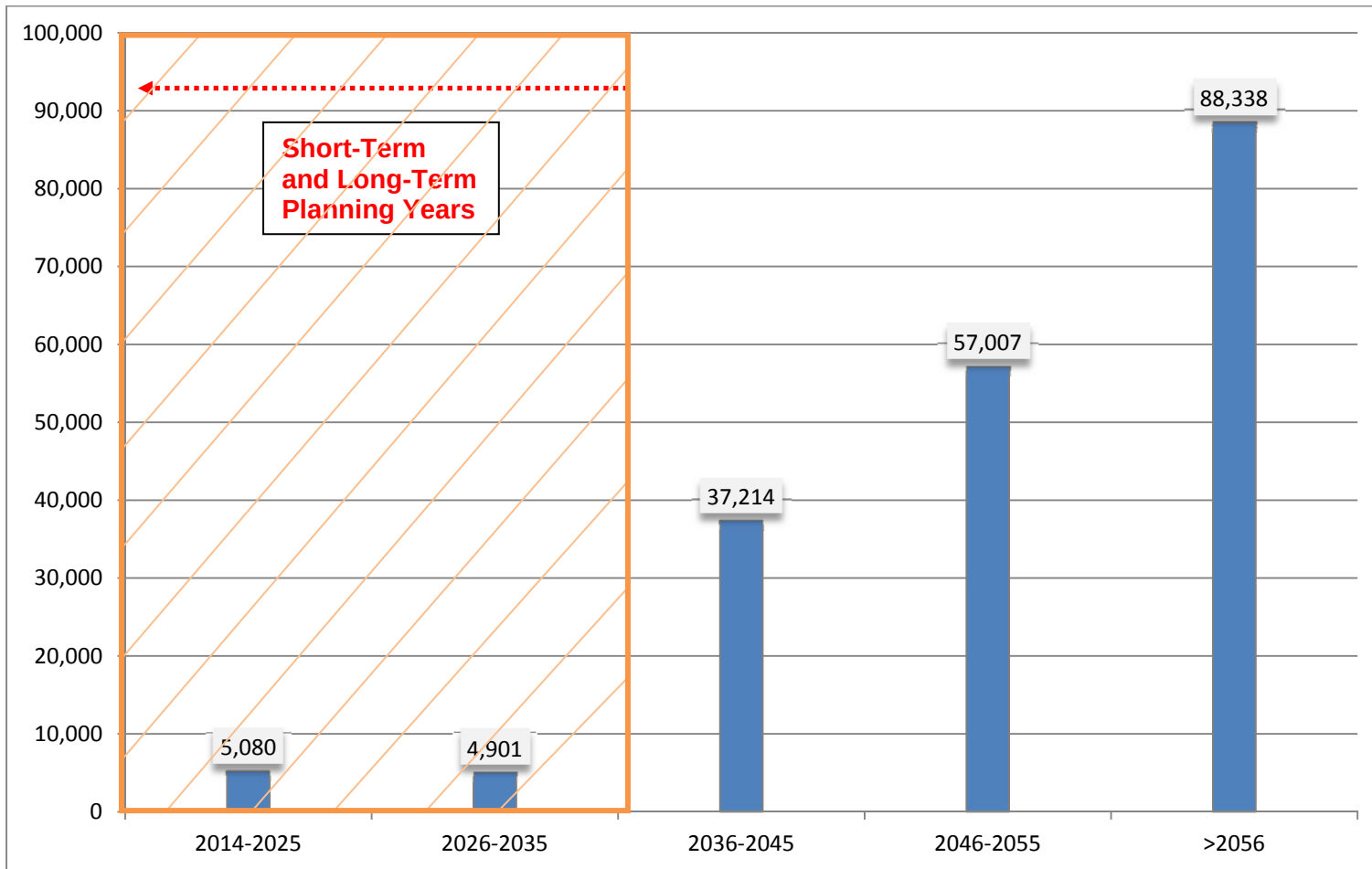


Table 4.5 presents the total length of pipe according to the year installed and material type. The cells of the table are color-coded to show the four categories of RUL; red indicates pipe that is beyond its predicted useful life, dark orange indicates pipe that is expected to reach the end of their useful life in the next 10 years, light orange represents pipe with an RUL of between 10 and 20 years, and yellow represents pipe that has a remaining useful life of over 20 years. Approximately 4,670 LF of collection pipes, which represents 2.7 percent of the pipes with known installation year, have an RUL of 10 years or less. Approximately 3,140 LF of pipe will reach the end of its useful life between 10 and 20 years from 2015, and a majority of the collection pipes have an RUL of over 20 years. Pipes with unknown installation years have an unknown RUL. In total, approximately 4.5 percent of the existing collection pipes with known installation year are expected to reach the end of their useful lives by the year 2035. The location of these pipes as well as pipes with unknown installation year are shown in Figure 4.8.

Figure 4.9 shows the total length of pipe reaching the end of its assumed useful life in each of the coming decades. Length of pipe reaching the end of its useful life by year 2025 is shown in red and by year 2035 in orange. All pipes in the collection system are included in this figure, even those of unknown installation year. Pipes of unknown installation year were allocated throughout the different installation decades according to the distribution of existing pipes of known installation year. For example, about 34 percent of the pipes with known installation year were installed between 1975 and 1984; therefore, 34 percent of the pipes with installation year unknown of each material were allocated to this decade. It is estimated that approximately 9,000 LF of pipe require replacement within the Long-Term planning period, or about 450LF per year for the next 20 years.

Table 4.5 Pipe Length of Major Collectors General Sewer Plan City of Bainbridge Island									
Major Pipelines Length by Year Installed and Material Type									
Total Length (ft) by Year Installed									
Material Type	Unknown	1945-1954	1955-1964	1965-1974	1975-1984	1985-1994	1995-2004	2005-2014	Total (ft)
Clay	16,631		1,239		4,761				6,000
DI				1,074	12,141		16,160		29,376
HDPE				394			1,114	21,951	23,459
PVC		1,349	1,086	22,640	38,963	10,287	17,901	9,267	113,348
Concrete		1,270	0	1,584	9,049				13,100
AC		584	758						1,343
unknown		705		468	825	36	301		4,940
Total Length (ft)	16,631	3,909	3,083	26,160	65,739	10,323	35,477	31,217	192,540
Percent Total System (%)	8.6%	2.0%	1.6%	13.6%	34.1%	5.4%	18.4%	16.2%	100.0%
Legend RUL- Remaining Useful Life									
				Length (ft), Percent (Out of Pipes with Known Installation Year)					
				Over 20 years of RUL	168,104	95.6 %			
				Between 10 and 20 years of RUL	3,137	1.8%			
				Between 0 and 10 years of RUL	2,107	1.2%			
				0 years of RUL	2,560	1.5%			





LENGTH OF PIPELINES REACHING RUL BEFORE 2025 AND 2035

FIGURE 4.9

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

4.8 PUMP STATION CONDITION ASSESSMENT

The general characteristics of each pump station were described in Section 4.3 and Section 4.5 and summarized in Table 4.1. Table 4.6 presents the estimated useful life of various pump station components before rehabilitation, upgrade, or replacement is required. This section compares the condition of the pump stations to the original life assumptions in Table 4.6. The general condition of the pump stations are summarized in Table 4.7 and Table 4.8.

Table 4.6 Useful Life of Pipes General Sewer Plan City of Bainbridge Island	
Pipe Material	Original Useful Life Assumption (yrs)
Main Sewage Pump Station	30 ⁽¹⁾
Sewage Pump	30
Emergency Generator	30 ⁽¹⁾
Telemetry	20
Residential Grinder Pump	20
<u>Notes</u>	
(1) Prior to rehabilitation or upgrade.	

Overall, the City's pump stations are in fair to good condition. Despite the age of some of the older stations they are all still all functioning well and meet current operational needs. However, based on a pump station useful lifetime of approximately 30 years, 14 out of 17 stations will require a major upgrade within the Long-Term planning period with the exception of the Highway 305, Vineyard, and Madrona pump stations.

The pumps, motors, valves, and electrical systems at seven (7) stations currently exceed the useful life of 30 years. These stations include Old Treatment Plant, Ferry Terminal, Village, Lower Lovell, Lower Hawley, Wing Point, and Island Terrace. Before the end of the planning period the pumps, motors, valves, and electrical systems will exceed their useful life at an additional six (6) stations including Klickitat, Woodward, Lynnwood, North Town Woods, Sakai Village, and Rockaway Beach.

The metal drywell/wet well-style stations at five (5) locations that have not been rehabilitated are showing signs of moderate to advanced corrosion. These stations need painting and a cathodic protection assessment. These stations include Village, Lower Lovell, Lower Hawley, Wing Point, and Klickitat. The concrete drywell/wet well stations at three (3) locations including Old Treatment Plant, Island Terrace, and Lynnwood require painting.

The remote tone RTU and older PLC telemetry systems have not been upgraded since they were installed in 1995 at nine (9) stations. Repair and placement parts are becoming increasingly difficult to obtain and these systems need to be replaced in the Short-Term planning period. These stations include Old Treatment Plant, Ferry Terminal, Village, Lower Lovell, Lower Hawley, Wing Point, Island Terrace, Klickitat, and Woodward.

Variable head conditions are experienced at six (6) stations because multiple stations discharge to a common force main. This could cause capacity issues during the Long-Term planning period. These stations include Woodward, North Town Woods, Sakai Village, Madrona, Lynnwood Center, and Rockaway.

The wet well controls may not meet current safety standards at seven (7) locations including the Old treatment Plant, Village, Lower Lovell, Lower Hawley, Wing Point, Island Terrace, and Klickitat pump stations.

The Ferry Terminal, Woodward, Vineyard, and Madrona Pump Stations all rely on backup power from generators that are not owned by the City. Reliability would be increased if fixed generators owned and operated by the City were installed at these pump stations. The redundancy would be increased if mobile generator receptacles were installed at the Ferry Terminal, and Woodward, North Town Woods, and Lynnwood Center stations.

The age of the generator at the Old Treatment Plant pump station will be about 39 years in 2019 when it is scheduled for replacement. Assuming generators begin to reach their useful life at 30 years, before the end of the Short-Term planning period, the emergency generators at nine (9) additional stations will need replacement or upgrades. Those stations include Sunday Cove, Lower Lovell, Lower Hawley, Wing Point, Island Terrace, Klickitat, Lynnwood, North Town Woods, and Sakai Village.

Table 4.7 Collection System Pump Station Condition Summary ⁽¹⁾ General Sewer Plan City of Bainbridge Island																	
	OTP	Ferry Terminal	Highway 305	Sunday Cove	Village	Lower Lovell	Lower Hawley	Wing Point	Island Terrace	Klickitat	WWS	LWC	NTW	Sakai Village	RB	Vineyard Lane	Madrona
Station Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2012 Max Daily Cycles	263	8	288	274	440	225	342	381	236	46	18	112	106	42	29	20	NA
2012 Ave Daily Cycles	141	2	184	151	221	127	84	64	97	18	3	59	52	15	11	13	NA
Year Commissioned	1950	1956	1979	1979	1979	1979	1979	1979	1983	1993	1996	1998	1999	2003	2005	2006	2013
Year Rehabilitated	1978	1980	2008	2007	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Projected Rehabilitation (30 yr)	2008	2010	2038	2037	2009	2009	2009	2009	2013	2023	2026	2028	2029	2033	2035	2036	2043
2014 Current Age	36	34	6	7	35	35	35	35	31	21	18	16	15	11	9	8	1
Age at end of STP Period (2025)	47	45	17	18	46	46	46	46	42	32	29	27	26	22	20	19	12
Age at end of LTP Period (2035)	57	55	27	28	56	56	56	56	52	42	39	37	36	32	30	29	22
Telemetry Installation/Upgrade	1995	1995	2008	2007	1995	1995	1995	1995	1995	1995	1996	2012	2012	2003	2005	2006	2013
Projected Replacement (20 yr)	2015	2015	2028	2027	2015	2015	2015	2015	2015	2015	2016	2025	2032	2023	2025	2026	2033
2014 Current Age	19	19	6	7	19	19	19	19	19	19	18	2	2	11	9	8	1
Age at end of STP Period (2025)	30	30	17	18	30	30	30	30	30	30	29	13	13	22	20	19	12
Age at end of LTP Period (2035)	40	40	27	28	40	40	40	40	40	40	39	23	23	32	30	29	22
Generator Installation Year	1980	NA	2006	1997	2007	1998	1996	1995	2002	2003	NA	1998	1999	2003	2005	NA	NA
Projected Replacement (30 yr)	2010	NA	2036	2027	2037	2028	2026	2025	2032	2033	NA	2028	2029	2033	2035	NA	NA
2014 Current Age	34	NA	8	17	7	16	18	19	12	11	NA	16	15	11	9	NA	NA
Age at end of STP Period (2025)	45	NA	19	28	18	27	29	30	23	22	NA	27	26	22	20	NA	NA
Age at end of LTP Period (2035)	55	NA	29	38	28	37	39	40	33	32	NA	37	36	32	30	NA	NA
Varying Head	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Drywell Condition	Good	NA	Good	Good	Poor	Fair	Good	Fair	Good	Good	NA	Good	Fair	NA	NA	NA	NA
Wet Well Condition	Good	Poor	Good	Good	Good	Poor	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Mechanical Condition	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Electrical Condition	Fair	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Fair	Good	Good	Good	Good
Telemetry Condition	Fair	Fair	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Good	Good
Overall Condition	F-G	F-G	Good	Good	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Fair	Good	Good	Good	Good

(1) Pink shading indicates remaining useful life has been exceeded.

Table 4.8 Pump Station Condition Assessment Summary General Sewer Plan City of Bainbridge Island					
Pump Station Name	Year Commissioned	Rehabilitation		Condition	Rehab Anticipated During Planning Period ⁽¹⁾
		Year	Extent of Upgrades		
Old Treatment Plant PS No. 1	1950s	1978	New pumps, valves, motors, electrical, and, controls.	Fair – Good Telemetry beyond useful life. Electrical system in fair condition. Wet well controls may not meet current safety standards. Generator scheduled for replacement.	Yes, Short-Term
Ferry Terminal PS No. 2	1956	1980	Reconfigured to submersible station. Installed new pumps and control panel.	Fair – Good Telemetry beyond useful life. Wet well structure in poor condition. Needs mobile generator receptacle.	Yes, Short-Term
Highway 305 PS No. 3	1979	2008	New pumps, valves, motors, electrical, telemetry, controls, cathodic protection, force main pig launch/emergency pump connection.	Good	No
Sunday Cove PS No. 4	1979	2007	New valves, electrical, telemetry, controls, cathodic protection, additional wet well capacity, force main pig launch/emergency pump connection.	Good Pumps and motors need to be replaced.	Yes, Short-Term

Table 4.8 Pump Station Condition Assessment Summary General Sewer Plan City of Bainbridge Island					
Pump Station Name	Year Commissioned	Rehabilitation		Condition	Rehab Anticipated During Planning Period ⁽¹⁾
		Year	Extent of Upgrades		
Village PS No. 5	1979			Fair Telemetry beyond useful life. Electrical and mechanical systems in fair condition. Wet well controls may not meet current safety standards. Advanced dry well corrosion and status of cathodic protection uncertain. High pump cycle rate.	Yes, Short-Term
Lower Lovell PS No. 6	1979			Fair Telemetry beyond useful life. Drywell structure in fair condition. Status of cathodic protection uncertain. Electrical systems in fair condition. Wet well controls may not meet safety standards. Wet well structure in fair condition and showing signs of saltwater intrusion.	Yes, Short-Term

Table 4.8 Pump Station Condition Assessment Summary General Sewer Plan City of Bainbridge Island					
Pump Station Name	Year Commissioned	Rehabilitation		Condition	Rehab Anticipated During Planning Period ⁽¹⁾
		Year	Extent of Upgrades		
Lower Hawley PS No. 7	1979			Fair Telemetry beyond useful life. Status of cathodic protection uncertain. Electrical systems in fair condition. Wet well controls may not meet safety standards.	Yes, Short-Term
Wing Point PS No. 8	1979			Fair Telemetry beyond useful life. Status of cathodic protection uncertain. Electrical systems in fair condition. Wet well controls may not meet safety standards. Drywell structure corrosion. Access hatch under water during extreme high tides.	Yes, Short-Term
Island Terrace PS No. 9	1983			Good Telemetry beyond useful life. Wet well controls may not meet current safety standards.	Yes, Short-Term

Table 4.8 Pump Station Condition Assessment Summary General Sewer Plan City of Bainbridge Island					
Pump Station Name	Year Commissioned	Rehabilitation		Condition	Rehab Anticipated During Planning Period ⁽¹⁾
		Year	Extent of Upgrades		
Klickitat PS No. 10	1993			Good Telemetry beyond useful life. Condition of cathodic protection unknown. Wet well controls may not meet current safety standards.	Yes, Short-Term
Woodward School PS No. 11	1996			Good Telemetry beyond useful life. Variable head conditions.	Yes, Long-Term
Lynwood Center PS No. 12	1998			Good Mobile generator receptacle scheduled for installation in 2014. Variable head conditions.	Yes, Long-Term
North Town Woods PS No. 13	1999			Fair Poorly constructed. Concrete drywell structure experiencing groundwater intrusion. Limited to one pump run only. Mobile generator receptacle scheduled for installation in 2014. Variable head conditions.	Yes, Long-Term

Table 4.8 Pump Station Condition Assessment Summary General Sewer Plan City of Bainbridge Island					
Pump Station Name	Year Commissioned	Rehabilitation		Condition	Rehab Anticipated During Planning Period ⁽¹⁾
		Year	Extent of Upgrades		
Sakai Village PS No.14	2003			Good Variable head conditions.	Yes, Long-Term
Rockaway PS No. 15	2005			Good Variable head conditions.	Yes, Long-Term
Vineyard PS No. 16	2006			Good Variable head conditions.	No
Madrona PS No. 17	2013			Good Variable head conditions.	No
Notes: (1) Based on pump station useful lifetime of approximately 30 years.					

4.9 ASSET MANAGEMENT PLANNING EVALUATION

In the coming decades, the City will need to make decisions between continuing maintenance, repairing, or replacing its aging infrastructure.

Asset Management Plans (AMPs) help utilities find the optimal timing for repair or replacement (R&R) of assets by weighing the costs of continued maintenance against the costs of R&R. These plans also prioritize projects to reduce operation and maintenance risks with the goal of lowering cost to the ratepayers.

Many resources and planning tools have been developed to assist utilities in implementing AMPs. It is recommended that the City review and consider the guidelines outlined in the *International Infrastructure Management Manual*, the 2008 *Effective Utility Management – A Primer for Water and Wastewater Utilities* created by several water and wastewater agencies including the Water Environment Foundation (WEF), and the (SIMPLE) *Asset Management Strategic Planning and Implementation Guidelines for Wastewater Infrastructure* created by the Water Environment Research Foundation.

The City currently maintains an inventory of pump stations along with a pump station condition assessment. Additionally, as a result of this plan development, much of the City's collection system information has been integrated within the City's GIS database. The wastewater treatment plant is largely new and asset management has not been a priority there, but effective asset management will likely become more important as treatment plant equipment ages and requires more maintenance or replacement.

4.9.1 Integration of Asset Management Tools

The need for asset management tools varies depending upon the size of the utility and the complexity of its inventory of assets. Asset management planning tools range from simple spreadsheets and databases, to complex computerized maintenance management software (CMMS) programs that integrate data acquisition, field reports, work order generation, and GIS updating.

Given the relatively small collection system, and limited inventory of assets, the City's current approach can continue to be updated and improved without investment in expensive asset management planning software and/or a CMMS.

4.9.2 Stepwise Strengthening of the City's On-going Asset Management Approach

The following steps will be considered as the City continues to strengthen and improve its ability to properly manage its wastewater collection, pumping, and treatment assets.

1. **Asset Inventory.** An inventory of many of the wastewater collection, pumping and treatment assets is in place. This planning effort has helped fill in some of the

remaining gaps. The City will continue with building and strengthening its inventory of all of its key assets.

2. Condition Assessment.

- a. Establish consistent condition assessment criteria scoring. For collection systems, the National Association of Sewer Service Companies (NASSCO) has developed industry standards for scoring the condition of assets, such as the Pipeline Assessment and Certification Program (PACP) and the Manhole Assessment and Certification Program (MACP). Similar programs for manholes and sewer laterals have also been developed.
- b. Update existing condition assessments for aboveground facilities, such as pump stations and wastewater treatment equipment.

3. Project Prioritization.

Following asset inventory and condition assessment, the next step is to develop prioritization criteria and identify annual repair and replacement needs.

- a. Establish criteria and scoring for vulnerability (or likelihood of failure) and criticality (consequence of failure).
- b. Assign scoring for vulnerability and criticality to assets.
- c. Perform risk-based prioritization based on vulnerability and criticality scoring. Risk is equal to vulnerability multiplied by criticality.
- d. Prepare cost estimates for repair or replacement needs.
- e. Prepare an implementation schedule that is consistent with established repair and replacement priorities.

4.10 EXISTING SYSTEM AND CONDITION ASSESSMENT SUMMARY

4.10.1 Pipelines

Some of the oldest collection system pipelines are beginning to reach the end of their useful lives. The RUL analysis predicts that 4.5% of the pipes in the collection system will reach the end of their useful life by 2035. Approximately 9,000 LF per year of pipeline needs to be replaced throughout the planning period. A more detailed condition assessment of the collection system will be developed to provide additional information on material and installation year, accurately define the extent of replacement or rehabilitation options, and further refine the prioritization of all condition-related improvements projects. A prioritized pipe replacement plan will be established and used to guide the timing of pipeline rehabilitation and replacement projects.

4.10.2 Pump Stations

Most of the collection system pump stations will require major upgrades by 2035. A prioritized pump station repair and replacement program will be established and used to guide the timing of pump station rehabilitation and replacement projects.

HYDRAULIC MODEL DEVELOPMENT

5.1 INTRODUCTION

Wastewater collection system models are valuable tools used to assess the performance of collection systems during dry and wet weather conditions, and to plan for future improvements. These models provide a means to simulate the impact of different sized storms on the collection system, and determine where future system deficiencies are likely to occur. In addition, a well-calibrated model provides an easy way to test alternative improvement scenarios. This chapter summarizes the Winslow collection system hydraulic model development and calibration for use in the City's wastewater conveyance planning within the Winslow Sewer Service Area. A hydraulic model was not developed for the South Island Sewer Service Study Area or Mid-Island Study Area.

5.2 HYDRAULIC MODEL DEVELOPMENT

A sewer collection system model is a simplified representation of the real sewer system. Sewer system models can assess the conveyance capacity for a collection system. In addition, sewer system models can perform "what if" scenarios to assess the impacts of future developments and land use changes. The City's collection system hydraulic model was constructed using a multi-step process utilizing data from a variety of sources. This section summarizes the hydraulic model development process, including a summary of the modeling software selection, a description of the modeled collection system, the hydraulic model elements, and the model creation process.

5.2.1 Hydraulic Modeling Software Selection

In the past decade, significant improvements have been made to the hydraulic modeling software available on the market. Some examples of the improvements that have been made include modifications to the hydraulic routing engine as well as an enhanced graphical user interface (GUI), model output reports, and GIS compatibility. This Plan provided the City an opportunity to examine the software available on the market today and make a decision on which hydraulic modeling software to use to develop its model.

In 2013, Carollo conducted an evaluation of the major sanitary sewer hydraulic modeling software applications. The results of the evaluation are presented in a technical memorandum, which is provided in Appendix J for reference. This technical memorandum summarizes the major software vendors, briefly explains software features, compares the advantages and disadvantages of each software program, and provides a software program recommendation.

Based on the results of the evaluation, it was agreed that InfoSWMM, by Innovyze, would be used to assemble the City's hydraulic model. InfoSWMM is a fully dynamic, geospatial

wastewater and stormwater modeling and management software application, which is built to run within the ESRI ArcGIS software platform. The hydraulic modeling engine for the InfoSWMM software package uses the Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM), which is widely used throughout the world for planning, analysis, and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems. InfoSWMM routes flows through the model using the Dynamic Wave method, which solves the complete Saint Venant, one dimensional equations of fluid flow.

The latest version (v 12.0) of InfoSWMM was used to assemble the InfoSWMM hydraulic model.

5.2.2 Modeled Collection System and Skeletonization

Skeletonization is the process by which sewer systems are stripped of pipelines not considered essential for the intended analysis purpose. The purpose of skeletonizing a system is to develop a model that accurately simulates the hydraulics of a collection system, while at the same time reducing the complexity of a large model.

It is common practice in sewer system master planning to exclude small diameter sewers when developing a hydraulic computer model. The City's hydraulic model includes pipelines that are 10 inches in diameter and larger. Some smaller diameter are also included in the hydraulic model where needed for connectivity. The model created for the purposes of this Plan only includes the major trunks and interceptors within the Winslow Sewer Service Area.

The modeled sewer system consists of approximately ten miles of sanitary sewer pipelines (including both gravity and force mains) ranging in diameter from 6 inches to 12 inches, fourteen city-owned sanitary sewer pump stations, and two private pump stations were included for modeling purposes in the Wing Point area. The City-owned Madrona pump station was not modeled because it was under construction at the time the model was built.

Figure 5.1 presents the City's modeled wastewater collection system. Table 5.1 presents a summary of the modeled sewer system by diameter and length of pipe. Not included in these totals are the smaller sewer mains that were excluded during model skeletonization and therefore not modeled.

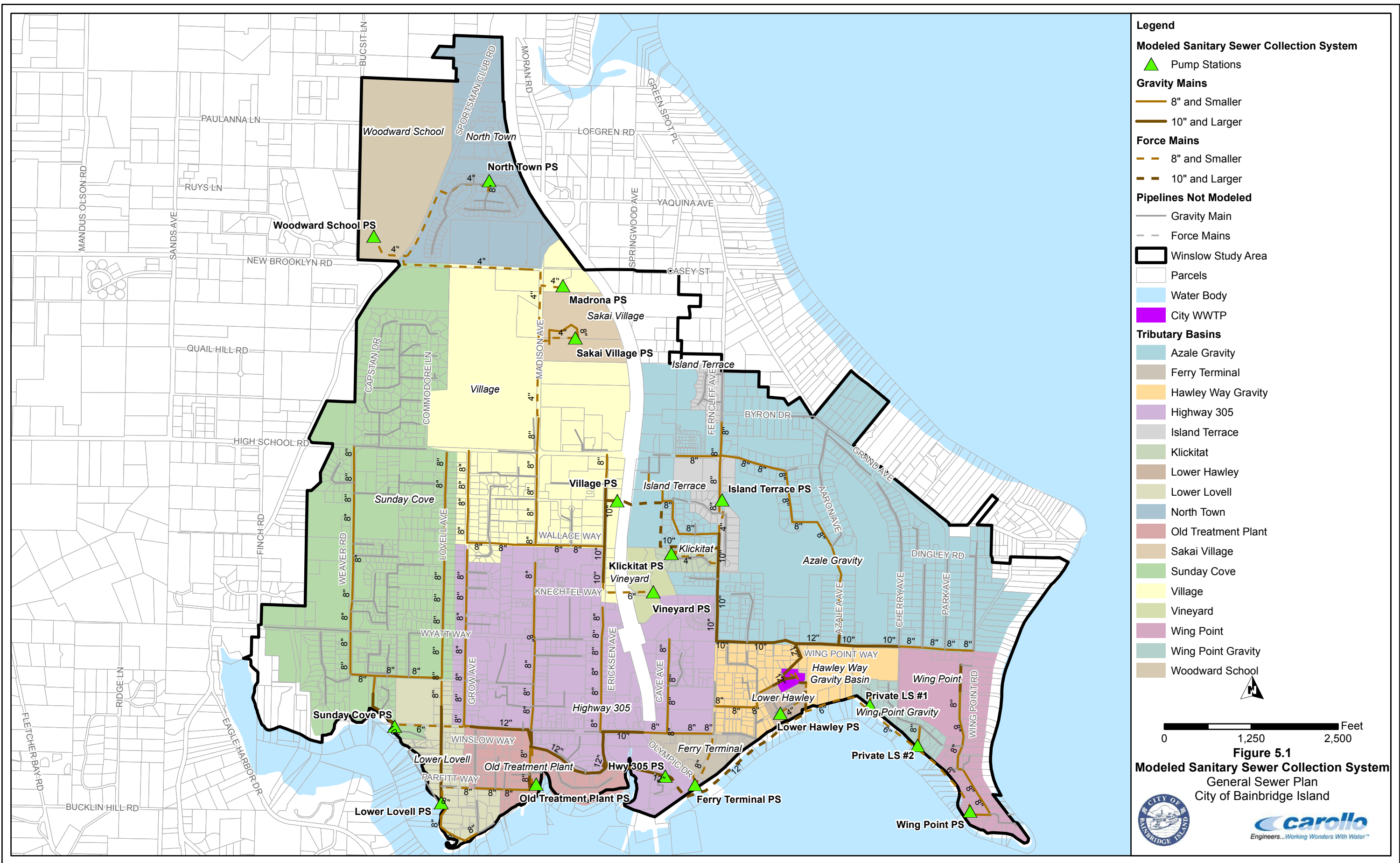


Table 5.1 Modeled System Pipelines General Sewer Plan City of Bainbridge Island		
Diameter (inch)	Total Length (ft)	Percent System
6	167.4	0.3%
8	38,363.3	71.8%
10	11,193.3	21.0%
12	3,673.8	6.9%
Total System (ft)	53,397.7	100.0%
Total System (mile)	10.2	100.0%

Fourteen city owned sanitary sewer pump stations and two private pump stations are connected to the modeled trunk system and are therefore included in the hydraulic model.

5.2.3 Elements of the Hydraulic Model

The following provides a brief overview of the major elements of the hydraulic model and the required input parameters associated with each:

- **Junctions:** Sewer manholes, cleanouts, as well as other locations where pipe sizes change or where pipelines intersect are represented by junctions in the hydraulic model. Required inputs for junctions include rim elevation, invert elevation, and surcharge depth (used to represent pressurized systems). Junctions are also used to represent locations where flows are split or diverted between two or more downstream links.
- **Pipes:** Gravity sewers and force mains are represented as pipes in the hydraulic model. Input parameters for pipes include length, friction factor (e.g., Manning's n for gravity mains, Hazen Williams C for force mains), invert elevations, diameter, and whether or not the pipe is a force main.
- **Storage Nodes:** For sewer system modeling, storage nodes typically are used to represent pump station wet wells (although other storage basins, etc. can be modeled as storage nodes). Input parameters for storage nodes include invert elevation, wet well depth, and wet well cross section.
- **Pumps:** Pumps are included in the hydraulic model as links. Input parameters for pumps include pump curves and operational controls.
- **Outfalls:** Outfalls represent areas where flow leaves the system. For sewer system modeling, an outfall typically represents the connection to the influent pump station at a wastewater treatment plant.
- **Rain Gauges:** Rain gauges are input into the hydraulic model to simulate historical or theoretical hourly rainfall events.

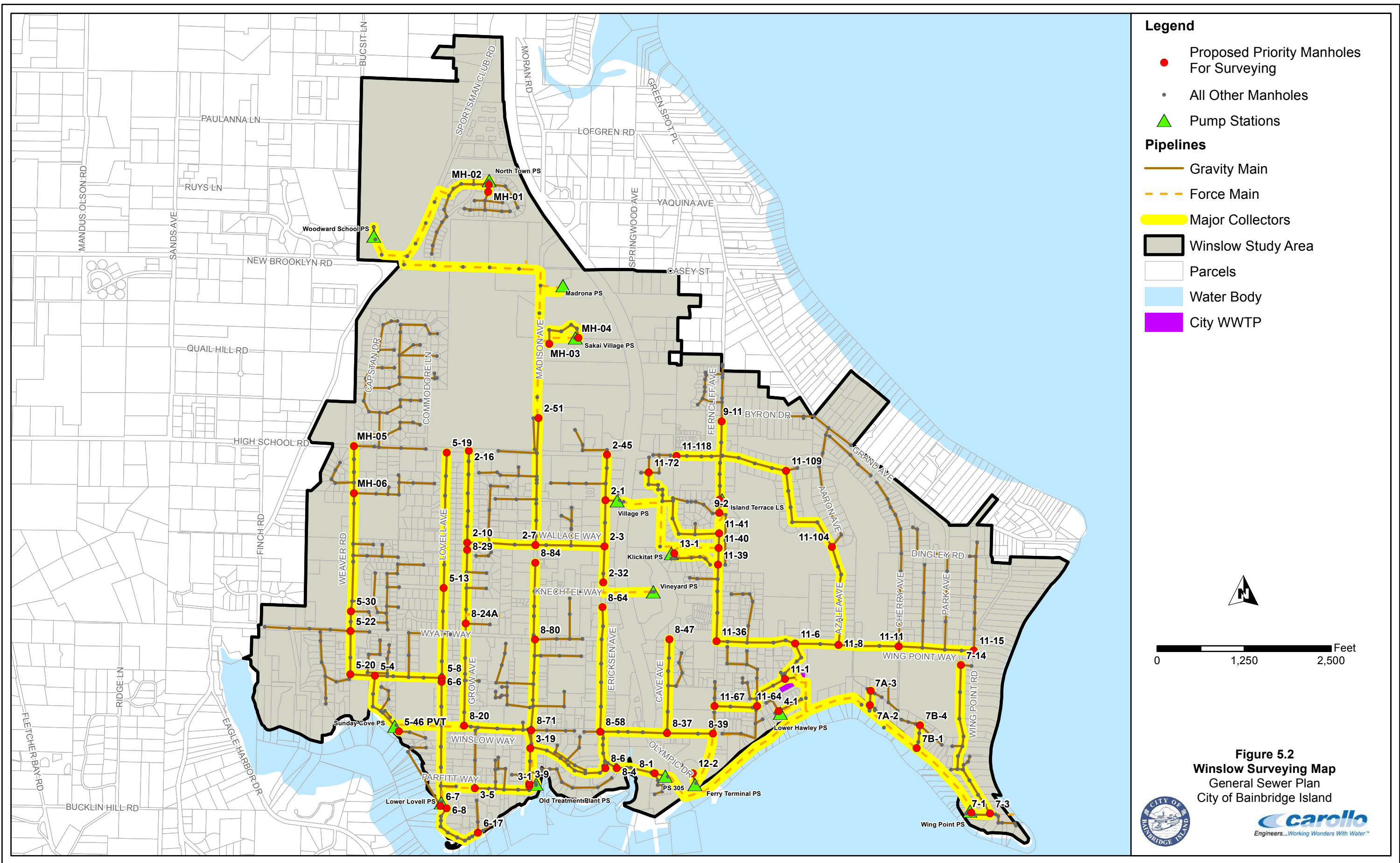
- **Inflows:** The following are the three types of wastewater flow sources that can be injected into individual model junctions (and storage nodes):
 - External. External inflows can represent any number of flows into the collection system, such as metered flow data or groundwater inflow. External inflows are applied to a specific model junction by applying a baseline flow value and a pattern that varies the flow by hour, day, or month of the year.
 - Dry Weather. Dry weather inflows simulate base sanitary wastewater flows and represent the average flow. The dry weather flows can be multiplied by up to four patterns that vary the flow by month, day, hour, and day of the week (e.g., weekday or weekend). The dry weather diurnal patterns are adjusted during the dry weather calibration process.
 - RDII. Rainfall Derived Infiltration and Inflows (RDII) are applied in the model by assigning a unit hydrograph and a corresponding tributary area to a given junction. The unit hydrographs consist of several parameters that are used to adjust the volume of RDII that enters the system at a given location. These parameters are adjusted during the wet weather calibration process.

5.2.4 Model Construction

The City's hydraulic model combines information on the physical and operational characteristics of the wastewater collection system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes.

The model construction process consisted of eight steps, as described below:

- **Step 1** - The City's geographic information system (GIS) shape files for the sewer collection system were obtained.
- **Step 2** - The GIS data were reviewed and formatted to allow easy import into the InfoSWMM modeling platform. The City's GIS did not include information on pipeline inverts or manhole rims. Carollo determined manhole locations, major collectors and sites necessary to survey to obtain the minimum necessary data to build the hydraulic model. These data were input manually based on information collected during a survey performed by the City. A map showing the manholes surveyed is shown in Figure 5.2.
- **Step 3** - The City's GIS data set was skeletonized to exclude gravity sewers 8 inches in diameter and smaller (except where needed for connectivity). The City's hydraulic model is an interceptor model.

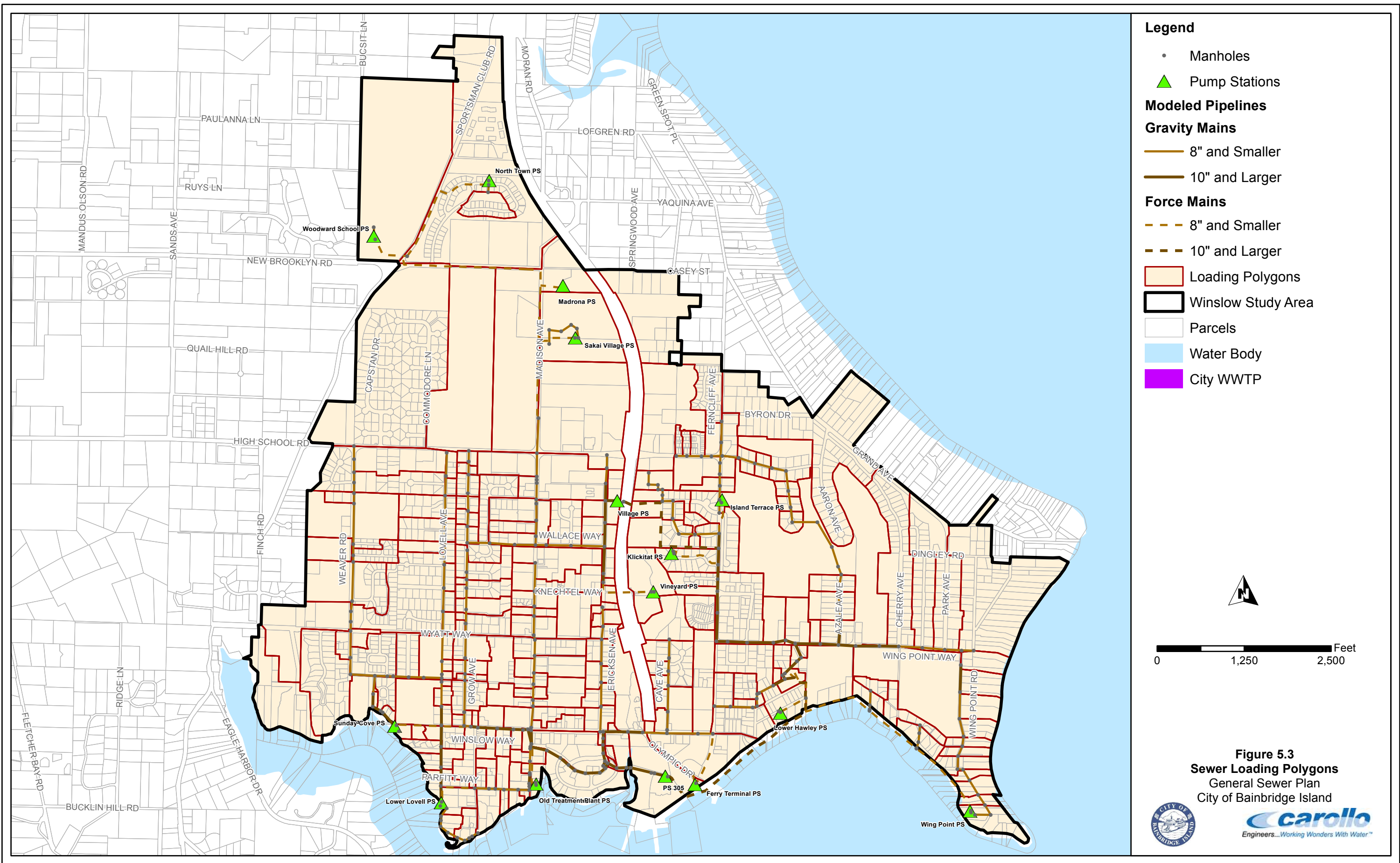


- **Step 4** - The collection system pipeline and facility data were imported into the modeling software and verified. Physical and operational data for the City's wastewater collection facilities was not available from the GIS data. This type of data, such as wet well dimensions, pump stations, and other special features, were input manually into the model based on available information. Pipe invert elevations were only known at survey manholes. Therefore, elevations of junctions in between two survey manholes were inferred using the inferring built-in tool in InfoSWMM and the slope was assumed to be constant between each survey manhole.
- **Step 5:** Once all the relevant data was input into the hydraulic model, the model was reviewed to verify that the model data was input correctly and that the flow direction, size, and layout of the modeled pipelines were logical. Additionally, the modeled pump stations were also checked to verify that they operated correctly.
- **Step 6:** Dry weather wastewater flows were then allocated to the appropriate model junctions as described in Section 5.2.5.
- **Step 7:** The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include run dates, time steps, reporting parameters, output units, and flow routing method. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

5.2.5 Wastewater Load Allocation

Determining the quantity of dry weather wastewater flows generated by a municipality and how they are distributed throughout the collection system is an important component of the hydraulic modeling process. Various techniques can be used to assign wastewater flows to individual model junctions, depending on the type of data that is available. Adequate estimates of the volume of wastewater are important in maintaining and sizing sewer system facilities, both for present and future conditions. Baseline wastewater loads were allocated (assigned to specific nodes) in the hydraulic model based on land use data provided by the City and wastewater flow coefficients developed for each land use type (these are described in detail in Chapter 3). The flow coefficients and land use data provide a means to transform a specific land use category into an average dry weather flow, as described below:

- **Step 1:** The City's service area was broken up into 203 individual loading polygons. Each loading polygon represents the geographic area that contributes flows into a single model node (i.e., trunk system manhole). In an all pipe model, however, a loading polygon could be as small as a few parcels. In a skeletonized model, such as the City's hydraulic model, a loading polygon will usually encompass a particular subdivision or grouping of lots. Figure 5.3 shows the different individual loading polygons developed in this step.



- **Step 2:** The loads were calculated for each loading polygon using GIS by multiplying the appropriate flow factor (having units of gpad) by the land use acreage. A description of flow factor development is provided in Chapter 3.
- **Step 3:** The loads obtained in step 2 correspond to the average dry weather flow and were allocated to the appropriate node in the sewer system model.
- **Step 4:** The allocated loads were adjusted as necessary during the dry weather flow calibration process (see Section 5.3.2) to closely match the actual measured dry weather flows recorded during the flow monitoring period.

5.3 HYDRAULIC MODEL CALIBRATION

Hydraulic model calibration is a crucial component of the hydraulic modeling effort. Calibrating the model to match data collected during the flow-monitoring program ensures the most accurate results possible. The calibration process consists of calibrating to both dry and wet weather conditions.

For this project, flow monitoring was conducted at 4 meter sites for a period of approximately fourteen weeks from November 2013 to February 2014. Dry weather flow (DWF) calibration ensures an accurate depiction of base wastewater flow generated within the study area. The wet weather flow (WWF) calibration consists of calibrating the hydraulic model to specific storm events to accurately simulate the peak and volume of infiltration/inflow (I/I) into the sewer system. The amount of I/I is essentially the difference between the WWF and DWF components.

5.3.1 Calibration Standards

The hydraulic model was calibrated in accordance with international modeling standards. The Wastewater Planning Users Group (WaPUG), a section of the Chartered Institution of Water and Environmental Management, has established generally agreed upon principles for model verification. The dry weather and wet weather calibration focused on meeting the recommendations on model verification contained in the “Code of Practice for the Hydraulic Modeling of Sewer Systems,” published by the WaPUG (WaPUG 2002), as summarized below:

- **Dry Weather Calibration Standards:** Dry weather calibration should be carried out for two dry weather days and the modeled flows and depths should be compared to the field measured flows and depths. Both the modeled and field measured flow hydrographs should closely follow each other in both shape and magnitude.

In addition to the shape, the flow hydrographs should also meet the following criteria as a general guide:

- The timing of flow peaks and troughs should be within one hour.
- The peak flow rate should be within the range of ± 10 percent

- The volume of flow (or the average rate of flow) should be within the range of ± 10 percent. If applicable, care should be taken to exclude periods of missing or inaccurate data.
- **Wet Weather Calibration Standards:** For at least two storm events from the flow monitoring period, the model simulated flows and depths should be compared to the field measured flows and depths. The flow hydrographs for both events should closely follow each other in both shape and magnitude, until the flow has substantially returned to dry weather flow rates.

In addition to the shape, the flow hydrographs should also meet the following criteria as a general guide:

- The timing of the peaks and troughs should be similar with regard to the duration of the events.
- The peak flow rates at significant peaks should be in the range of +25 percent to -15 percent and should be generally similar throughout.
- The volume of flow (or the average flow rate) should be within the range of +20 percent to -10 percent.

The WaPUG recommends that for wet weather calibration, the use of a single calibration period incorporating a number of rainfall events should be considered whenever possible. In other words, if the flow monitoring program captured several back to back storms, it may be preferable to use the back to back storms events as the calibration storms, as opposed to calibrating to two separate storms that have occurred weeks or months apart.

5.3.2 Dry Weather Flow Calibration

The DWF calibration process consists of several elements, as outlined below:

- **Divide the system into areas tributary to each flow meter.** The first step in the calibration process was to divide the sewer service area into flow meter tributary areas. Four tributary areas were created, one for each flow meter from the temporary flow monitoring program. A map showing the locations of each flow monitoring site and their associated tributary area are provided in Chapter 3.
- **Define flow volumes within each area.** The next step was to define the dry weather flow volumes within each area, which was accomplished in the flow allocation step of model construction.
- **Create diurnal patterns to match the temporal distribution of flow.** A diurnal curve is a pattern of hourly multipliers that are applied to the base flow to simulate the variation in flow that occurs throughout the day. Two diurnal curves were developed for each flow monitoring tributary area; one representing weekday flow and one representing weekend flow. The diurnal patterns were initially developed based on the flow monitoring data and adjusted as part of the calibration process until the

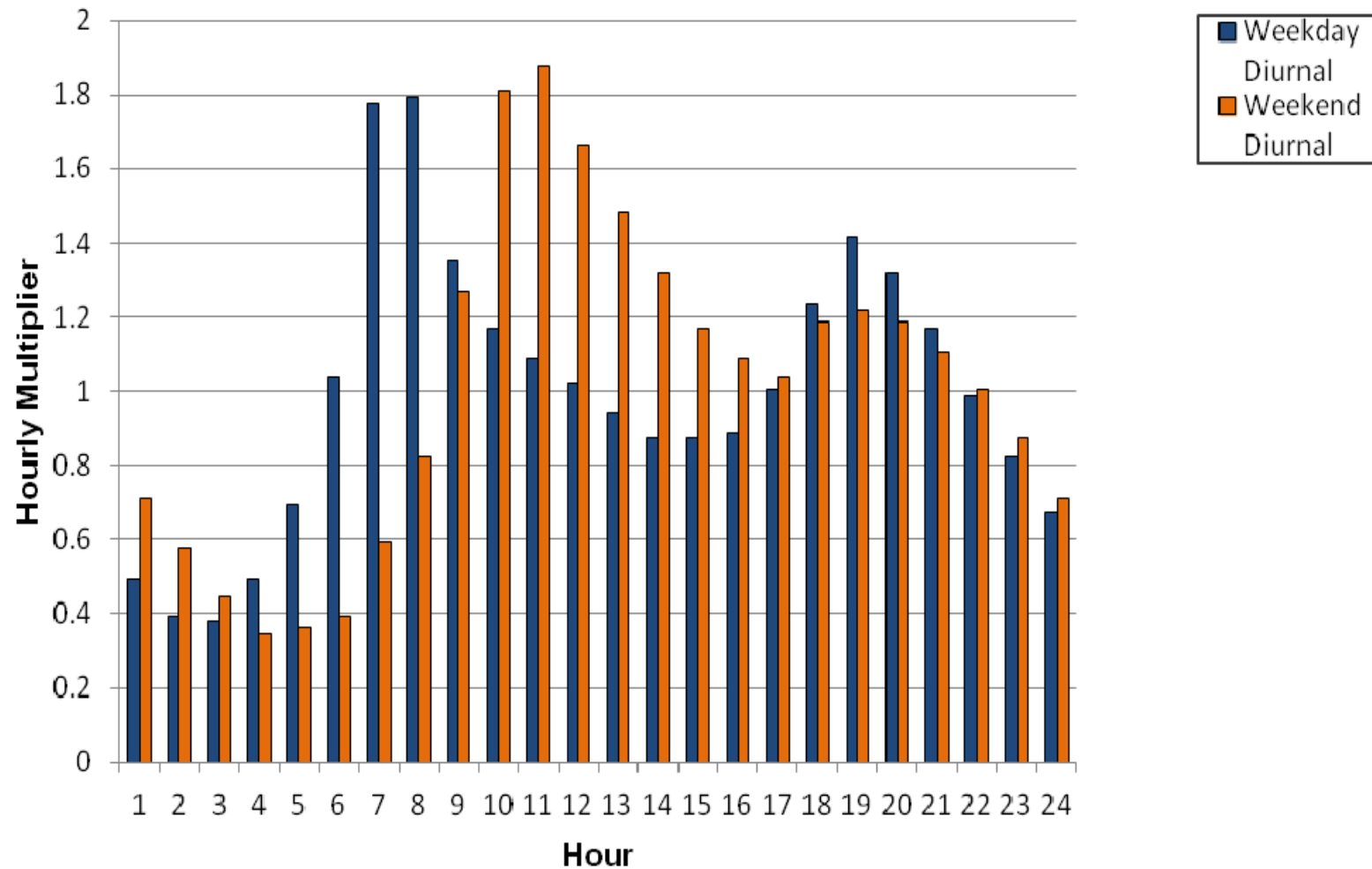
model simulated flows closely matched the field measured flows. Figure 5.4 shows the calibrated weekday and weekend diurnal patterns for the area tributary to Site Meter 01. Similar diurnal curves were developed for each of the meters and its tributary area. These additional curves are available in Appendix K.

- **Adjust model variables to match field measured velocity and flow depths.** Once the model simulated flows acceptably matched the field measured flows, the model simulated velocity and flow depth were compared to the field measured velocity and flow depth. Adjustments were made to various model parameters until the modeled and measured velocity and depth closely matched one another. The primary variable parameters for this process are pipeline roughness (Manning's n) and sediment build up in the pipe, although other parameters can also be adjusted as calibration results are generated.

Manning's roughness coefficients, or n values, have industry accepted ranges based on a number of variables. Roughness coefficients increase over time depending on the construction methods, installation quality, system maintenance, and other environmental factors. There can be certain factors within the City's collection system that can result in roughness coefficients which differ from the typical range. For example, pipeline bellies, joint misalignment, cracks, and debris (e.g., root intrusion, etc.) lead to increased turbulence in a pipe, as well as the apparent Manning's n factor.

If the model is unable to reasonably match the field measured flow depth and velocity without leaving the acceptable range of Manning's roughness coefficients, further investigation is conducted to help determine the cause of the discrepancy. Some issues that could cause such a discrepancy can include errors in the slope or diameter of a pipeline, downstream blockages, pipeline sags, and, in some cases, influences from downstream pump station operations.

Table 5.2 provides a summary of the dry weather flow calibration using the average and daily peak flow results for both weekday and weekend conditions. As shown on Table 5.2, the model simulated average flows, levels, and velocities for both weekday and weekend DWF were all within 10-percent. In general, the percent difference between the overall modeled and measured DWF ranged between -0.7% and 7.5% percent



**EXAMPLE DIURNAL PATTERNS
(METER SITE 01)**

FIGURE 5.4

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Table 5.2 Dry Weather Flow Calibration Results General Sewer Plan City of Bainbridge Island				
Meter ID	Pipe Diameter (in)	Average Dry Weather Flow ⁽⁴⁾ Percent Error ⁽³⁾		
		Average Flow ⁽²⁾ (%)	Average Velocity (%)	Average Level (%)
Meter 01	10	-0.7%	6.0%	6.6%
Meter 02	10	0.0%	0.7%	7.5%
Meter 03	12	5.2%	1.0%	1.6%
Meter 04	12	-1.9%	2.7%	6.5%
Notes: (1) Source: ADS Flow Monitoring Data Report. (2) Average flow is calculated from weekday/weekend dry weather flow monitoring data. Maximum flow values are hourly peaks corresponding to either weekend or weekday conditions, as appropriate. (3) Percent Difference = (Modeled - Measured)/Measured*100. (4) Average Dry Weather Flow = (5*Weekday Dry Weather Flow + 2*Weekend Dry Weather Flow)/7.				

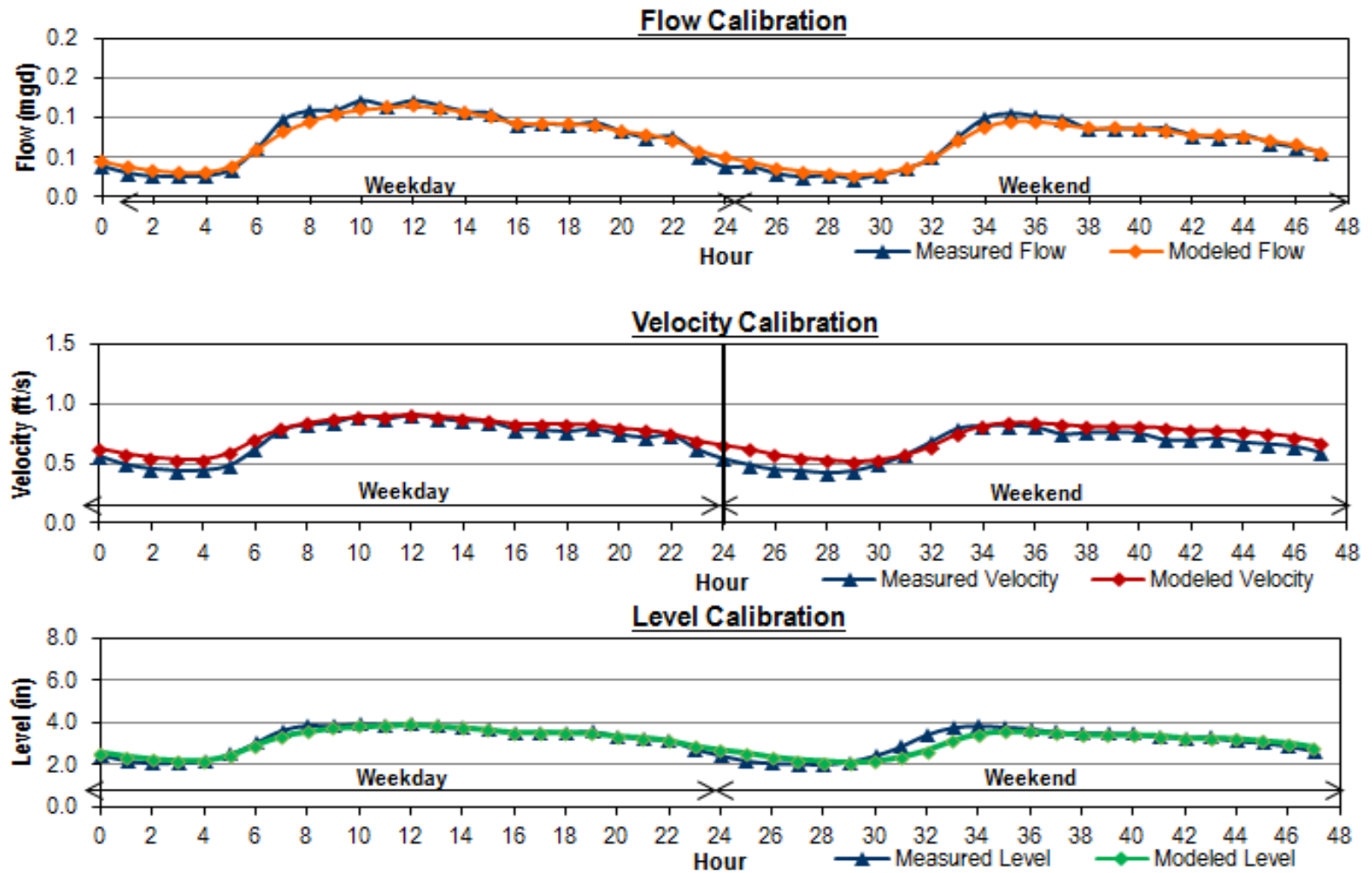
Appendix K provides a detailed dry weather flow calibration summary sheet for each of the four meter sites. Each calibration sheet includes plots comparing the model-simulated and field-measured flow data for both weekday and weekend conditions. An example of the dry weather calibration for Meter Site 02 is shown on Figure 5.5. As shown in Figure 5.5 and in Appendix K there is good overall correlation of the field-measured data to the model output results.

5.3.3 Wet Weather Flow Calibration

The WWF calibration enables the hydraulic model to accurately simulate Inflow and Infiltration (I/I) entering the collection system during a large storm. As outlined below, the WWF calibration process consists of several elements:

- Identify calibration rainfall events.** The WWF calibration process consists of running model simulations of historic rainfall events based on data collected as part of the flow monitoring program. The goal of any wet weather flow monitoring program is to capture and characterize a system's response to a significant rainfall event, preferably during wet antecedent moisture conditions.

The selection of a particular calibration storm or group of storms is based on a review of the flow and rainfall data. For WWF calibration, the model was run from November 7th, 2013 to February 4th, 2014, and calibrated to the three main rainfall events that occurred during the course of the flow monitoring period.



EXAMPLE OF DRY WEATHER CALIBRATION (METER SITE 02)

FIGURE 5.5

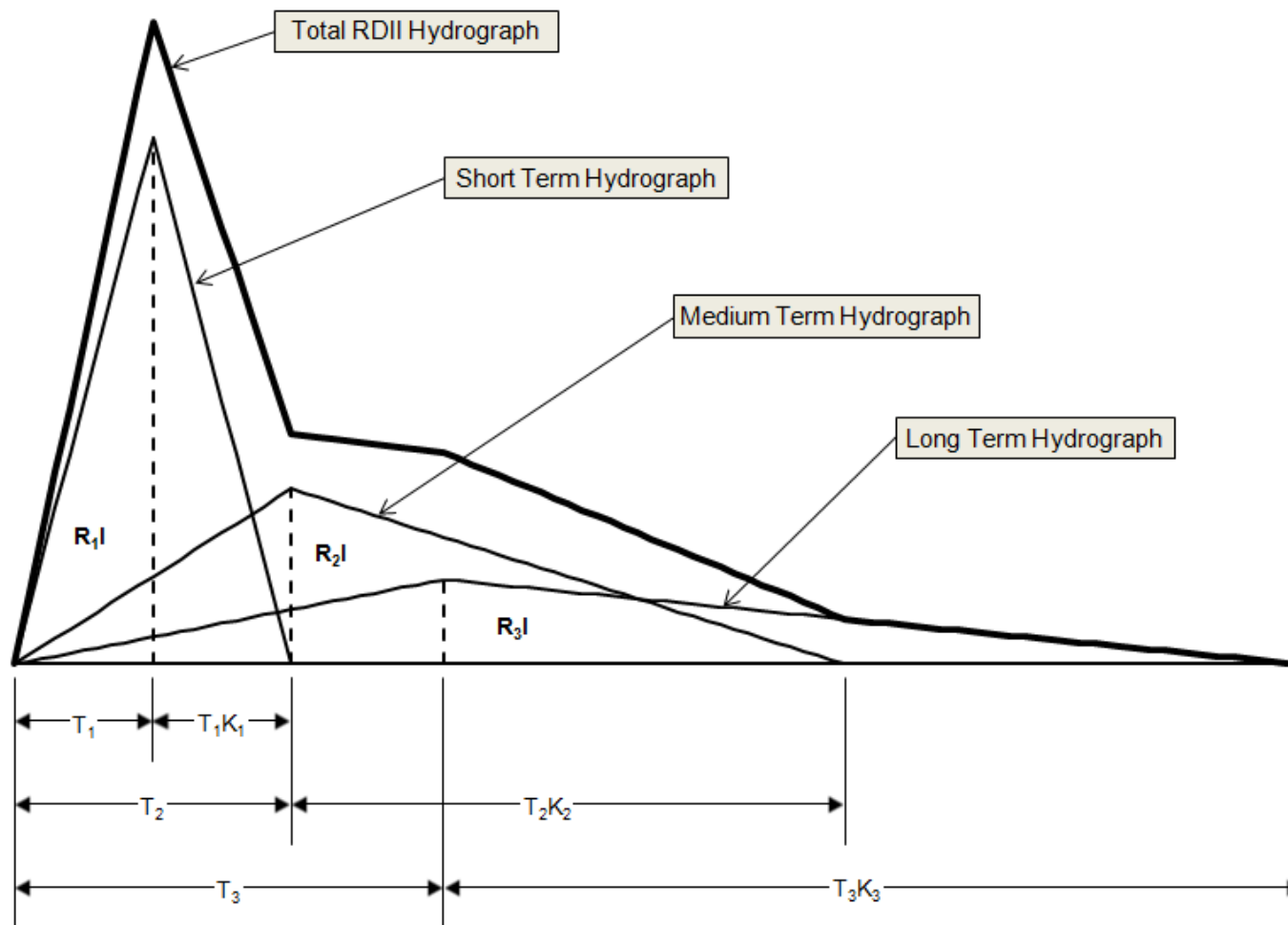
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

In order to run a model simulation for the period of these rainfall events, the hourly rainfall data were input into the model for these events. Each flow monitoring tributary area, or basin, was assigned a specific rainfall hyetograph, which was calculated for each basin based on the rainfall data collected at the rain gauges referenced in Chapter 3, which also details how this computation was performed.

- **Define RDII tributary areas.** For the WWF calibration, RDII flows are superimposed over the DWF. The model calculates RDII by assigning “RDII Inflows” to each node in the model. RDII inflows consist of both a unit hydrograph and the total area that is tributary to the model node. The RDII tributary areas were calculated in GIS using the loading polygons, excluding any large vacant, open space, or other areas in the system which are not expected to contribute to I/I into the collection system. The tributary area provides a means to transform hourly rainfall depth from the rainfall hyetographs into a rainfall volume. The rainfall volume is transformed into actual RDII flows using the unit hydrograph, as described in the next step.
- **Create I/I parameter database and modify to match field measured flows.** The main step in the WWF calibration process involves creating custom unit hydrographs for each flow monitoring tributary area using the “RTK Method,” which is widely used in collection system master planning. Using the RTK Method, the RDII unit hydrograph is the summation of three separate triangular hydrographs (short-term, medium-term, and long-term), which are each defined by three parameters: R, T, and K. R represents the fraction of rainfall over the sewer shed that enters the collection system; T represents the time to peak of the hydrograph; and K represents the ratio of time to recession to the time to peak. Therefore, there are a total of nine separate variables associated with each unit hydrograph. Figure 5.6 shows an example of a unit hydrograph.

The hydrographs utilize the R-values (percent of rainfall that enters the collection system) calculated for each basin to simulate I/I. The nine variables in each unit hydrograph were initially set based on engineering judgment. Through an iterative process, the variables are then adjusted until the model-simulated flows (both peak flows and average flows) match closely with the field-measured flows.

As with the dry weather calibration, the wet weather calibration process compared the meter data with the model output. Comparisons were made for average and peak flows as well as the temporal distribution of flow until flows returned to their baseline levels. According to the WaPUG, a hydraulic model is generally considered to be satisfactorily calibrated to WWF conditions if the modeled peak flows are within +25 percent to -15 percent of the field-measured data, and if the average modeled flows are within +20 percent to -10 percent of the field-measured data.



EXAMPLE RDII HYDROGRAPH

FIGURE 5.6

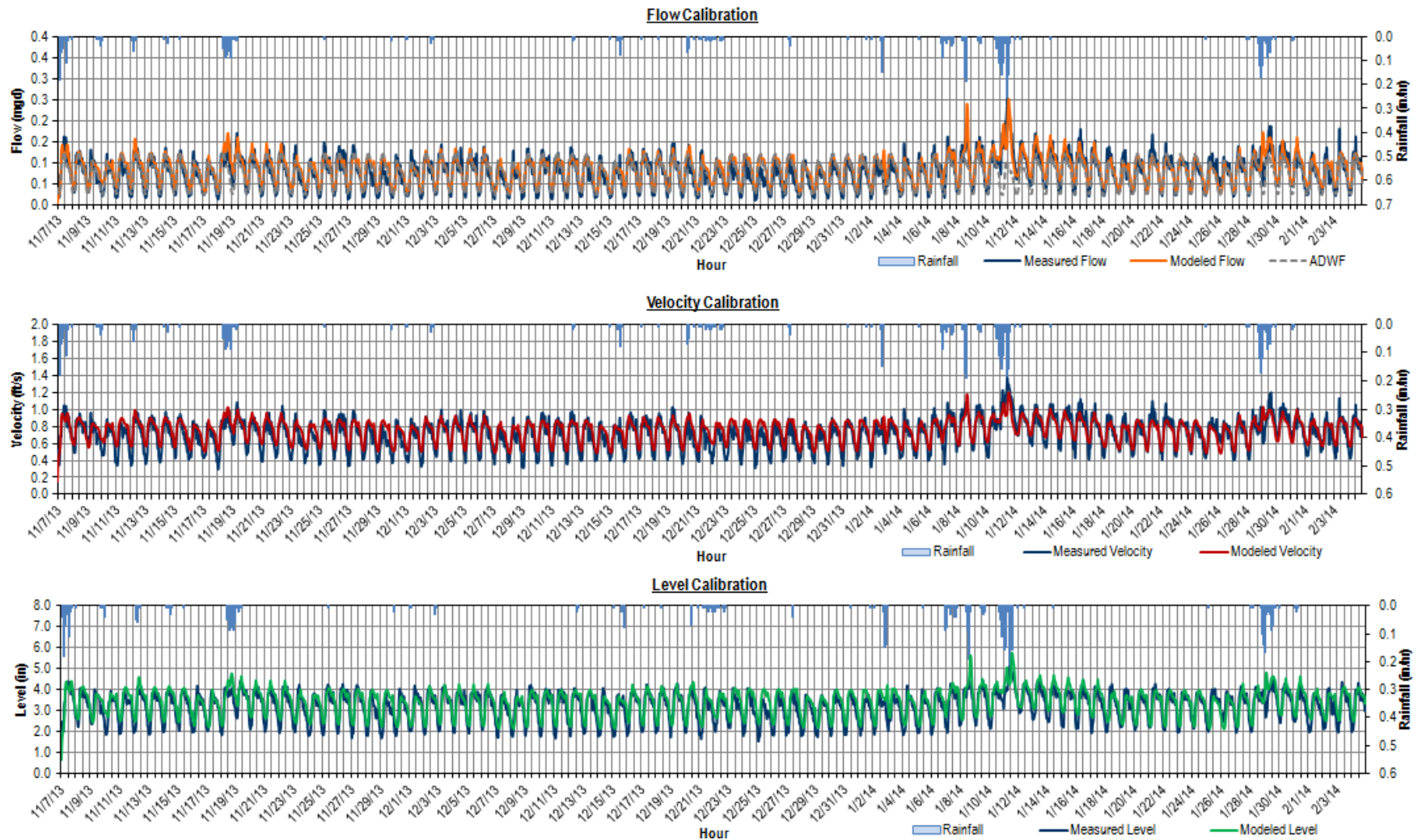
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

- **Refine model variables to match field-measured velocity and flow depths.** After the model was considered to be satisfactorily calibrated for wet weather flows, the model simulated velocities and flow depths were checked against the field measured velocities and flow depths during the calibration storms. Refinements were made to the various model parameters so that the modeled and measured velocity and depth closely matched one another. If any adjustments were made to Manning's n values or other parameters, the DWF calibration was rechecked as well to make sure that the flow depth and velocities still matched well under DWF conditions.

An example of the wet weather calibration for Meter Site 02 is shown on Figure 5.7. Table 5.3 provides a summary of the wet weather flow calibration using the average and peak flow results. As shown on Table 5.3, the model simulated average and peak flows at all meter sites were within the acceptable tolerances for at least two of the three calibration storms, and therefore the model was considered calibrated and ready to use for capacity analysis purposes.

In addition, verification storms from the wet weather events that occurred during the course of the flow monitoring period and plant influent data were used to verify that the flows simulated in the model closely matched the flows measured at the WWTP (see Figure 5.8).

Appendix K contains a detailed wet weather flow calibration summary sheet for each of the four meter sites. Each calibration sheet provides plots that compare the model simulated and field measured flow, velocity, and level data for the calibration storms.



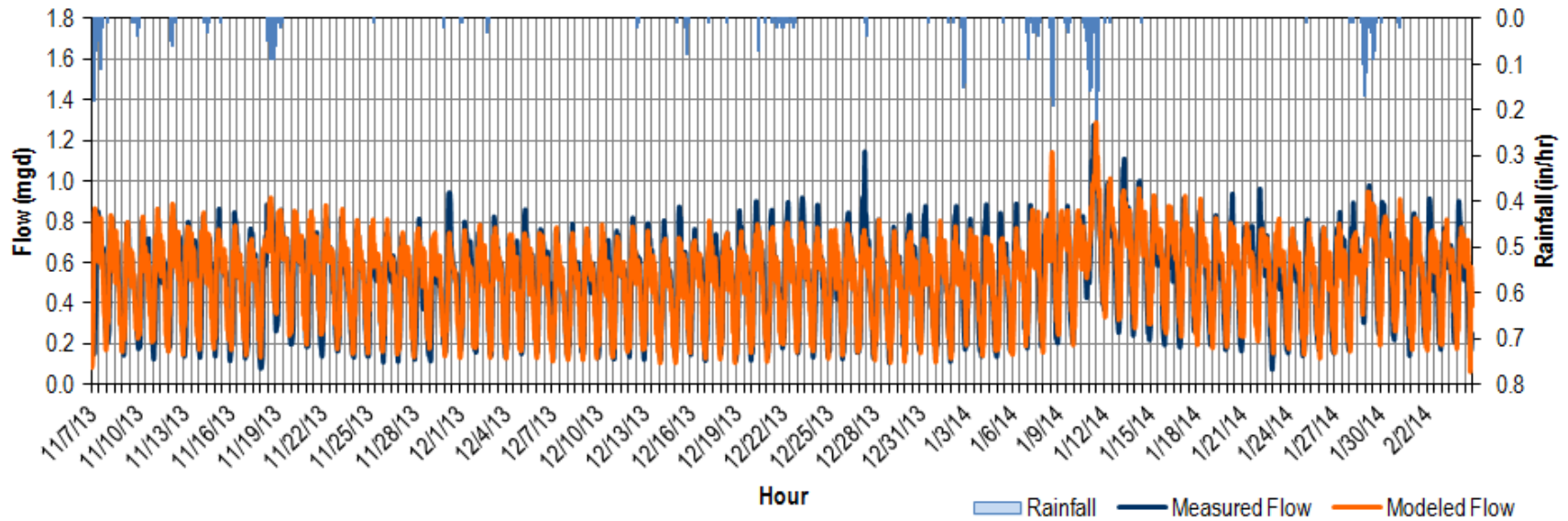
**EXAMPLE WET WEATHER
FLOW CALIBRATION (SITE 02)**

FIGURE 5.7

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Table 5.3 Wet Weather Flow Calibration Results General Sewer Plan City of Bainbridge Island													
Meter ID	Pipe Diameter (in)	Storm 1 (11/18/2013-11/20/2013)				Storm 2 (1/5/2014-1/15/2014)				Storm 3 (1/27/2014-1/31/2014)			
		Percent Error ⁽³⁾				Percent Error ⁽³⁾				Percent Error ⁽³⁾			
		Avg. Flow ⁽²⁾ (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow ⁽²⁾ (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow ⁽²⁾ (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)
Meter 01	10	15.0%	23.2%	11.7%	1.4%	10.0%	3.7%	5.5%	2.9%	8.1%	-3.7%	5.7%	1.0%
Meter 02	10	14.6%	12.8%	9.8%	6.1%	7.2%	-0.1%	1.7%	7.2%	5.6%	-7.1%	1.2%	5.2%
Meter 03	12	-3.9%	6.2%	0.0%	-4.5%	6.1%	4.8%	0.5%	-0.2%	7.2%	16.2%	3.2%	-0.4%
Meter 04	12	30.9%	17.2%	24.0%	11.2%	14.1%	19.1%	4.8%	13.1%	14.9%	6.9%	6.8%	12.0%
Notes: (1) Source: City of Bainbridge Island, ADS Report. (2) Average flows are calculated from flow monitoring data. Maximum flow values are hourly peaks. (3) Percent Difference = (Modeled - Measured)/Measured*100.													

Flow Calibration



Storm Event	Measured Data		Modeled Data		% Error	
	Average Flow	Peak Flow	Average Flow	Peak Flow	Average Flow	Peak Flow
Storm 1	0.57	0.88	0.60	0.92	6.1%	3.9%
Storm 2	0.62	1.27	0.63	1.28	1.2%	0.9%
Storm 3	0.59	0.98	0.58	0.94	-2.2%	-3.6%

WET WEATHER FLOW VERIFICATION AT THE WWTP

FIGURE 5.8

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

5.3.4 Hydraulic Model Calibration Summary

Calibration of the City's hydraulic model was a multi-step process that involved comparing model-simulated flow to the actual field-measured data for both dry and wet weather conditions. Results indicated that the model correlated well with the field-measured data. There was one site, Meter 04, for wet weather conditions with percent errors that were outside the generally accepted calibration standards. However, the percentages for this site for wet weather conditions were inside the generally accepted standards for two of the three storms the model has been calibrated to. Therefore, no further investigation was required.

Of the four meter sites used for model calibration, 100 percent of the meters were within a range of 25 percent for peak flows, and almost 92 percent were within a range of 20 percent for flow volume. For each meter site, at least two storms out of three were calibrated for each of the calibration parameters (peak flow, flow volume, average velocity, average level). This provides a high level of confidence in the model's accuracy such that the model can be considered calibrated and ready to use for subsequent capacity analysis.

5.4 HYDRAULIC MODEL MAINTENANCE

The sewer system hydraulic model will likely be maintained by a consulting firm through an on-call modeling contract. Many consulting firms in the wastewater industry maintain licenses for Innovyze InfoSWMM and can perform modeling tasks when needed. Generally, an on-call modeling contract consists of an hourly fee schedule. If no modeling services are required for the duration of the contract, the City incurs no cost. Ultimately, the costs of using and maintaining the sewer model depend on how the City plans to utilize the model in the future. The City may use the model to size developer extensions, consider new service areas, evaluate flooding, and size capital projects. To maintain and update the model and to make model runs to assess the impacts of system changes and growth proposals is estimated to require approximately 120 man-hours per year.

CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

6.1 INTRODUCTION

This chapter discusses the hydraulic evaluation of the Winslow Collection System and the proposed projects required for meeting the planning criteria identified in Chapter 2 – Basis of Planning. The following sections describe the performance criteria, the pump station capacity evaluation, the collection system capacity evaluation, and recommendations for how to serve new areas of growth in the Winslow Study Area.

This chapter also includes a capacity evaluation of the South Island Collection System. The chapter summarizes the number of equivalent residential units (ERUs) currently connected to the sewer system, ERUs with binding reservation commitments, and total ERUs within the South Island Study Area. The analysis was limited to the City's South Island pump station capacity compared to these service requirements.

6.2 WINSLOW CAPACITY EVALUATION

6.2.1 Performance Criteria

A capacity analysis of the existing and future Winslow Collection System was performed using the calibrated hydraulic model following the dry and wet weather flow calibration process. The analysis entailed identifying areas in the sewer system where flow restrictions occur or where capacity is insufficient to convey peak hour flows (PHF). Sewer pipes that lack sufficient capacity to convey PHF may create bottlenecks in the collection system that can potentially cause sanitary sewer overflows (SSOs). Collection system planning criteria establishes the metrics by which existing collection system infrastructure is evaluated, and by which future facilities will be designed. Chapter 2 – Basis of Planning established criteria for evaluating the wastewater system; these are summarized as follows:

6.2.1.1 Design Storm

The hydraulic capacity analysis was performed using a 25-year, 24-hour design storm preceded by two 2-year, 24-hour storms as discussed in Chapter 3 – Flow Projections.

6.2.1.2 Pump Stations

All pump stations, except for private single-family home pumps, shall have a minimum of two pump units. Firm pump station capacity shall be adequate to handle the expected peak hour flow for both existing and planning years. Firm capacity corresponds to the capacity of the pump station with the largest pump out of service.

6.2.1.3 Conveyance System

Criteria governing evaluation of the conveyance system include:

- No surcharging is allowed in the system. Under PHF, pipes can flow full with a depth to full depth (d/D) ratio of 1.0.
- Future pipelines shall convey future peak hour flow with a d/D ratio not to exceed 0.50. However, this criterion is not relevant to the analysis performed because only existing pipelines are included in the hydraulic model.
- The collection system is assumed to degrade by one percent each year, thereby increasing Inflow and Infiltration (I/I) over time.

6.2.2 Winslow Pump Station Capacity Evaluation

Ensuring that pump stations have adequate capacity to convey peak flows is important for preventing unwanted wastewater overflows at pump stations. If a pump station has inadequate capacity to pump peak flows, the water level in the wet well may rise to the overflow point, discharging wastewater to stormwater collection systems that eventually discharge to water bodies. The following sections present the pump station capacity evaluation, which compares the estimated current and future peak flows to the pump station firm capacities. For this evaluation, the firm capacity of each pump station was taken as the lower value between design firm capacity and tested firm capacity. Recommendations to address identified deficiencies are presented in Section 6.2.5.

The City's hydraulic model includes 14 of the 15 pump stations located in the Winslow Service Area. The Madrona Pump Station, which serves the Madrona Retirement Center and the future Harrison Hospital Health Care, was not included because it was constructed and tested after the model was completed. In accordance with the established planning criteria, the modeled pump stations were evaluated to determine if each one has available firm capacity to convey existing and future PHF. Pump stations with an influent PHF above the existing firm capacity may need to be upgraded during the planning period. Table 6.1 summarizes the results of the pump station evaluation.

- **Existing:** All of the pump stations included in the hydraulic model are adequately sized to convey the current simulated PHF during the design storm.
- **Year 2025 – Short-Term Planning Period:** The majority of the City's pump stations are adequately sized to convey the projected 2025 simulated peak wet weather flows. For the planning year of 2025, both Village and North Town Woods Pump Stations cannot adequately convey the peak flows during the design storm.
 - *Village Pump Station:* The Village Pump station cannot convey the projected 2025 simulated peak flows during the design storm with its firm capacity. The modeled 2025 PHF into the Village Pump Station is predicted to be 0.94 million gallons per day (mgd), which exceeds its firm capacity (0.88 mgd) by 0.06 mgd as shown in Table 6.1. The firm capacity of the Village Pump Station used for

this analysis corresponds to the actual flow measured during the latest pump test performed in 2013, which was more conservative than the design flow. The 2013 pump test flow is 0.33 mgd less than the design flow.

- *North Town Woods Pump Station:* The modeled 2025 PHF into the North Town Woods Pump Station is anticipated to be 0.16 mgd, which exceeds its firm capacity (0.15 mgd) by 0.01 mgd as shown in Table 6.1.
- **Year 2035 – Long-Term Planning Period:** The majority of the City's pump stations are adequately sized to convey the projected 2035 simulated peak wet weather flows. For the 2035 planning year, the Village, North Town Woods, and Sunday Cove pump stations cannot adequately convey the peak flows during the design storm.
 - *Village Pump Station.* The modeled 2035 PHF into the Village Pump Station is anticipated to be 1.17 million gallons per day (mgd), which exceeds its firm capacity (0.88 mgd) by 0.29 mgd as shown in Table 6.1.
 - *North Town Woods Pump Station:* The modeled 2035 PHF into the North Town Woods Pump Station is anticipated to increase to 0.19 mgd, therefore exceeding its capacity by 0.03 mgd as shown in Table 6.1.
 - *Sunday Cove Pump Station.* The modeled 2035 PHF into the Sunday Cove Pump Station is 0.81 mgd, which exceeds its firm capacity (0.70 mgd) by 0.11 mgd. PHF was compared to the most recent pump test performed in 2007.

Locations of the pump stations likely to require capacity upgrades are shown in Figure 6.1.

Table 6.1 Pump Station Capacity Evaluation General Sewer Plan City of Bainbridge Island						
Pump Station Name	Firm Capacity (gpm) ⁽¹⁾	Firm Capacity (mgd)	Maximum Total Inflow (mgd) – Design Storm			Pump Upgrade
			Existing	Year 2025	Year 2035	
Ferry Terminal	150	0.22	0.004	0.006	0.009	No
Island Terrace	100	0.14	0.02	0.04	0.06	No
Klickitat	100	0.14	0.006	0.009	0.012	No
Lower Hawley	100	0.14	0.02	0.02	0.03	No
Lower Lovell	100	0.14	0.03	0.05	0.07	No
North Town Woods	104	0.15	0.13	0.16	0.19	Before 2025
Old Treatment Plant	256	0.37	0.05	0.09	0.14	No
Highway 305	2720	3.92	1.40	1.53	1.88	No

Table 6.1 Pump Station Capacity Evaluation General Sewer Plan City of Bainbridge Island						
Pump Station Name	Firm Capacity (gpm) ⁽¹⁾	Firm Capacity (mgd)	Maximum Total Inflow (mgd) – Design Storm			Pump Upgrade
			Existing	Year 2025	Year 2035	
Sunday Cove	484	0.70	0.51	0.67	0.81	Before 2035
Sakai Village	147	0.21	0.02	0.05	0.07	No
Village	614	0.88	0.64	0.94	1.17	Before 2025
Vineyard	90	0.13	0.002	0.004	0.005	No
Wing Point	200	0.29	0.17	0.24	0.27	No
Woodward School	60	0.09	0.07	0.07	0.07	No
Notes: (1) Firm capacity corresponds to the lower value between design capacity (D) and test capacity (T).						

6.2.3 New Brooklyn Force Main Evaluation

A separate analysis was performed to evaluate the capacities of the four City pump stations that pump into a common 4-inch force main. Woodward School, North Town Woods, Sakai Village, and Madrona pump stations all pump into the same 4-inch force main along Madison Avenue and New Brooklyn Road. In addition, four small private pump stations discharge into the force main.

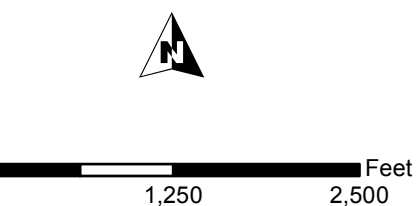
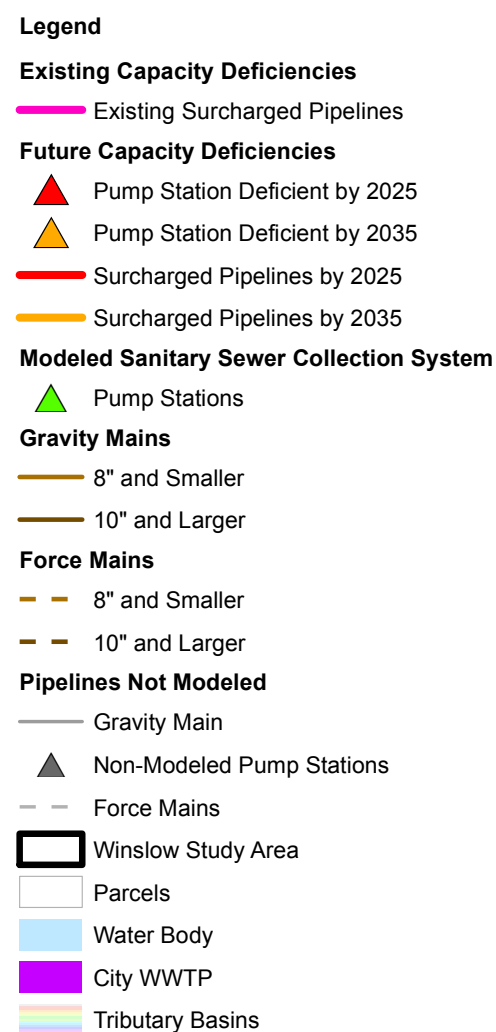
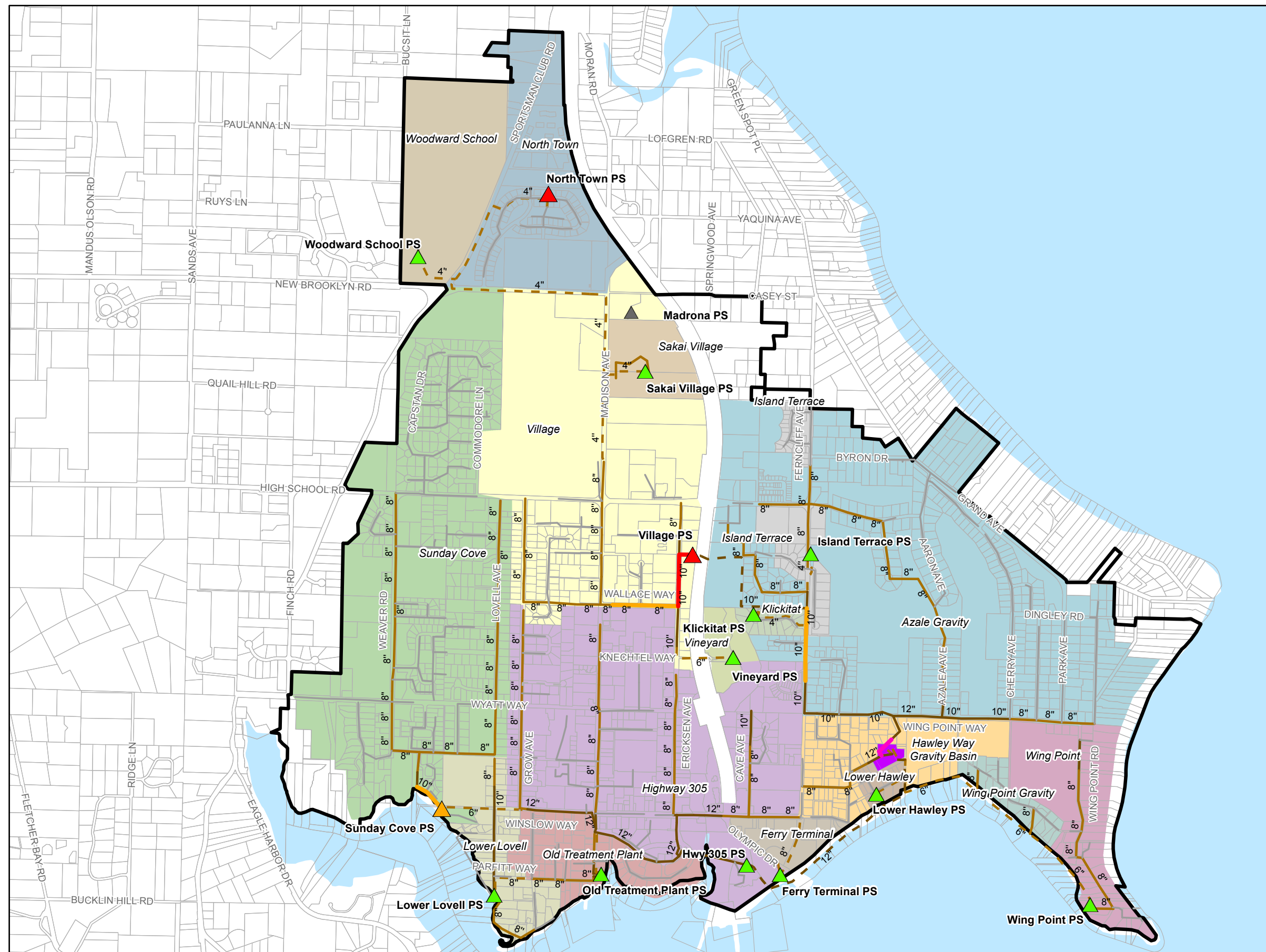
To evaluate how variable head conditions in the force main affect pump station operation, these four pump stations were evaluated in a simplified version of the hydraulic model. The private pump stations were not included in the model. This separate modeling analysis demonstrated that during simultaneous pumping of all four City pump stations, the increased head in the common force main significantly reduces the capacity of the pump stations, as shown in Table 6.2. Under this condition, the modeling indicates that the Woodward School Pump Station is not able to pump into the force main at all due to excessive head. The North Town Woods Pump Station is also deficient under this condition. The Sakai Village Pump Station, on the other hand, has sufficient capacity to pump peak inflows even when all four pump stations are operating simultaneously. Madrona Pump Station capacity is reduced under these conditions, but was not compared to inflow because the Madrona Pump Station was not part of the initial model calibration process and therefore peak hour inflow is unknown.

Two general approaches are available for addressing the issues associated with the New Brooklyn force main. Either modifications can be made to the force main, or modifications can be made to the deficient pump stations. Force main modifications would increase the

diameter of sections of the force main from four to six inches. One concern with this approach is that a 6-inch force main would have very low velocities, ranging from 0.7 to 1.7 ft/s, when only one pump station is operating at a time. With the existing 4-inch force main, velocities range from 1.5 ft/s with only Woodward School Pump Station operating to approximately 8 ft/s when all four pump stations are operating simultaneously. In addition, the 4-inch force main was installed in the 1990s and is likely in good condition.

Modifying the pump stations is probably the more cost-effective approach. The need for all four pump stations to pump simultaneously is only for short durations during large storm events. It may be possible to adjust pump station controls to make it less likely that all four pump stations will operate at once. In addition to capacity concerns when all four pump stations are operating simultaneously, the North Town Woods Pump Station is anticipated to have capacity deficiencies under normal operating conditions by 2025 due to growth in the north part of Winslow. Modifications to the pump station to address the variable head conditions in the force main can be accomplished in conjunction with the short-term capacity upgrade project. The only other City pump station that is deficient under this simultaneous pumping condition is Woodward School. It may be necessary to replace the Woodward School pumps with new pumps that can operate at a wider range of head in order to respond to the conditions of the force main. However, further evaluation of the New Brooklyn force main and associated City and private pump stations is necessary to determine a solution. The first step would be to increase pump station data collection including continuous monitoring of flow, pressure, and pump operation at each of the pump stations discharging into the New Brooklyn force main. Field-testing of the pump stations under simultaneous pumping conditions is also recommended.

Table 6.2 Common Force Main Pump Station Capacity Evaluation General Sewer Plan City of Bainbridge Island					
Pump Station Name	Design Firm Capacity (mgd)	Pump Capacity during Simultaneous Pumping (mgd)	Maximum Total Inflow (mgd) Design Storm		
			Existing	Year 2025	Year 2035
Madrona	0.15	0.09	N/A ⁽¹⁾	N/A ⁽¹⁾	N/A ⁽¹⁾
North Town Woods	0.15	0.07	0.13	0.16	0.19
Sakai Village	0.21	0.12	0.02	0.05	0.07
Woodward School	0.09	0.00	0.07	0.07	0.07
Notes: (1) Inflow projections not available for Madrona Pump Station because it was not included in model calibration.					



6.2.4 Winslow Pipe Capacity Evaluation

The capacity analysis entailed identifying areas in the sewer collection system where flow restrictions occur or where capacity is insufficient to convey PHF. This section discusses the locations of current and projected surcharging in accordance with flows exceeding the maximum flow depth criterion of d/D less than 1.0, as presented in Section 6.2.1.3.

No additional future trunks were added to the model for future scenarios. Loads for future development and growth were allocated in the hydraulic model at existing manhole locations.

In many cases, a surcharged condition within a given segment is due to backwater effects created by a downstream bottleneck. For this reason, the hydraulic model was analyzed to identify the pipeline segments or pump stations that are the cause of the surcharged conditions.

- **Existing System:** One deficiency was identified for the existing system. Under design storm PHF conditions, surcharging occurs at the WWTP inlet piping up into the gravity main that enters from the North East side of the plant. The location of this pipe is shown in Figure 6.1 in magenta. The rest of the collection system is sized to adequately convey existing design storm PHF.
- **Year 2025 – Short-Term Planning Period:** The Short-Term scenario evaluated whether or not the sewers are adequately sized to convey 2025 PHF without surcharging. One additional pipeline was identified as surcharging by 2025. This section is located upstream of the Village Pump Station along Ericksen Avenue. Figure 6.1 illustrates the location of the surcharging pipe in red. The surcharging of this pipe is due to backwater caused by the capacity limitation of the Village Pump Station located immediately downstream of the surcharged area. The rest of the system is sized adequately to convey the projected PHF of the design storm in 2025.
- **Year 2035 – Long-Term Planning Period:** The Long-Term system evaluation identified locations of sewers that are not adequately sized to convey 2035 PHF without surcharging.

In accordance with the established flow depth criteria, three additional pipelines were identified as surcharging by 2035: the pipe along Ferncliff Avenue, downstream of the Village and Klickitat pump stations, a section of pipe located immediately upstream of Sunday Cove Pump Station and additional pipe located upstream of the Village Pump Station along Wallace Way. These surcharged sections are due to the Village and Sunday Cove Pump Station capacity deficiencies in 2035. When the inflow to the Village pump station surpasses its firm capacity, the model indicates that the standby pump turns on in addition to the duty pump. This high flow causes surcharging downstream of the pump. The model shows surcharging upstream of the Sunday

Cove pump station when the pumps cannot keep up with inflow. The locations of these surcharged pipelines are shown on Figure 6.1 in orange.

6.2.5 Winslow Capacity Improvements

The Winslow collection system has one pipeline capacity deficiency for conveying peak flows under existing conditions, three pump station capacity deficiencies for future scenarios, and capacity deficiencies with regard to the common 4-inch force main that collects from the Woodward School, North Town Woods, Madrona, and Sakai Village pump stations.

The first proposed project is required to avoid surcharging of the WWTP inlet piping. Modifications need to be made to the WWTP inlet piping and manholes to provide additional pipe capacity, flow attenuation, and storage.

In terms of pump station projects, it is projected that the capacity of the Village and North Town Woods pump stations will need to be increased within the short-term planning period to handle projected 2025 PHF. The Sunday Cove Pump Station is expected to require additional capacity by 2035 to pump projected PHF. Increasing the capacity of the Village and Sunday Cove Pumps Stations eliminates surcharging in the collection system under future scenarios.

Additionally, increased monitoring and an evaluation of the 4-inch New Brooklyn force main and pump stations under simultaneous pumping conditions should be performed in the short-term. Likely, modifications to the Woodward School Pump Station will be required in the short-term to avoid the risk of wet well overflow during storm events.

The pump station upgrade requirements are attributable to the assumption that significant development and additional sewer connection of already developed parcels will occur within the Winslow Study Area. For instance, large high-density residential neighborhoods are expected to be developed east of Madison Avenue, upstream of the Village Pump Station and a significant medium-density residential development is planned to be built by 2035 west of Weaver Road. Actual timing of the need to upgrade the Village, North Town Woods, and Sunday Cove pump stations will depend on the construction timing of developments such as these.

6.3 SOUTH ISLAND CAPACITY EVALUATION

The South Island Collection System consists of two pump stations: the Lynwood Center Pump Station and the Rockaway Beach Pump Station. All of the flows from Blakely School, Emerald Heights, Pleasant Beach Drive, Point White Drive, and Lynwood Center are pumped by the Lynwood Pump Station to the Kitsap County Sewer District (KCSD) #7 Wastewater Treatment Plant (WWTP) located off of Fort Ward Hill Road in the southwest corner of the island. All remaining flows in the South Island Collection System are pumped by the Rockaway Beach Pump Station and conveyed the to KCSD #7 WWTP.

The City and KCSD first entered into an interlocal agreement in 1997 whereby KCSD #7 reserved for the City and accepted for treatment 80 ERUs of capacity in the KCSD #7 WWTP in order to reduce water pollution problems in the Lynwood Center area. The agreement was amended in 2003 to reserve an additional 250 ERUs of treatment capacity at the KCSD #7 WWTP, and again in 2007 for an additional 150 ERUs for a total of 480 ERUs. The latest interlocal agreements are included in Appendix D.

6.3.1 Kitsap County Sewer District #7 WWTP

The KCSD #7 WWTP treats domestic wastewater with an extended aeration activated sludge process and UV disinfection. The plant discharges into Rich Passage. KCSD #7 recently expanded the facility to 0.28 mgd maximum monthly flow capacity, doubling the plant's original capacity. This Phase 2 expansion added a second aeration basin, a third clarifier, a second UV bank, a second digester, and a solids handling facility. Based on the design criteria of the Phase 2 Wastewater Treatment Plant Upgrades Project, the plant is currently rated to handle 0.7 mgd peak hourly flows with a hydraulic capacity of 1.4 mgd. The plant is designed to handle 600 lbs/day maximum monthly average for both biological oxygen demand (BOD) and total suspended solids (TSS). KCSD #7 WWTP Design Criteria is presented in Table 6.3.

Table 6.3 KCSD #7 WWTP Design Criteria General Sewer Plan City of Bainbridge Island	
Component	Criteria
Flow (mgd)	
Annual Average	0.23
Maximum Monthly Average	0.28
Peak Hourly	0.70
Hydraulic Capacity	1.4
Loads (lbs/day)	
BOD Annual Average	460
BOD Maximum Monthly Average	600
TSS Maximum Monthly Average	600

From January 2014 through April 2014, the maximum monthly average flow occurred in March and amounted to 0.16 mgd, which is less than the rated maximum monthly average of 0.28 mgd. Daily flows for each month have averaged 0.12 mgd with a maximum daily flow during that time period of 0.37 mgd. Influent BOD and TSS loads have been well under the 600 lbs/day limit averaging 286 lbs/day and 199 lbs/day, respectively. From these data,

it appears that the KCSD #7 WWTP has the capacity to treat additional South Island customers. Historical KCSD #7 influent flow and load data is shown on Table 6.4.

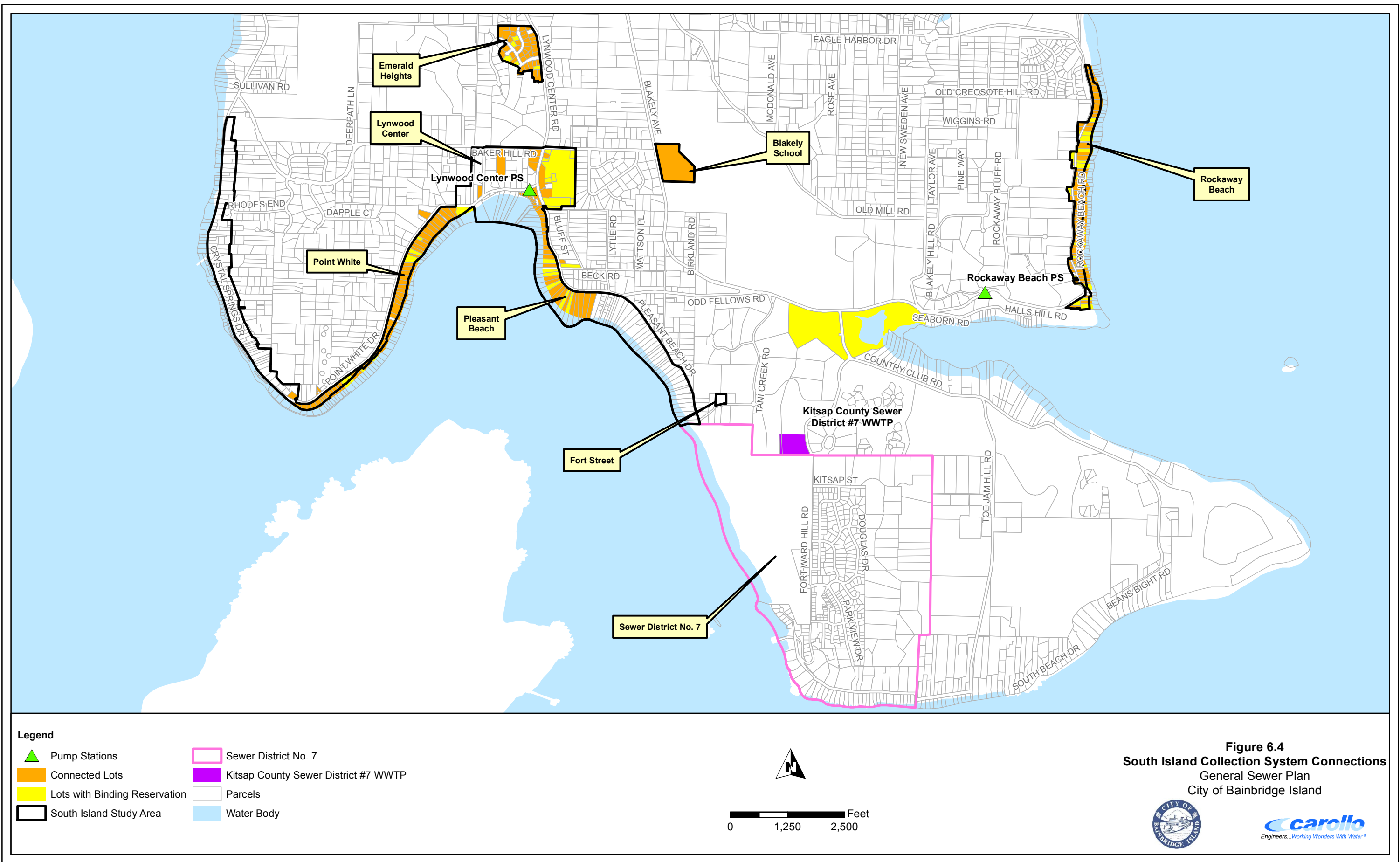
Table 6.4 KCSD #7 WWTP Influent Flows and Loads General Sewer Plan City of Bainbridge Island				
Month	Monthly Average Flow (MGD)	Max Day Flow (MGD)	BOD (lbs/day)	TSS (lbs/day)
January, 2014	0.10	0.27	229	229
February, 2014	0.14	0.34	316	196
March, 2014	0.16	0.37	350	212
April, 2014	0.09	0.14	250	160
Average	0.12	0.28	286	199
Maximum	0.16	0.37	350	229

6.3.2 South Island Projected Flow

Within the South Island Collection System, currently 297 ERUs are served by the City and conveyed to the KCSD #7 WWTP. Of these connections, 241 ERUs are within the Lynwood Center Pump Station tributary area and 56 ERUs are within the Rockaway Beach Pump Station tributary area. Thus, the City's current flow contribution to the KCSD #7 WWTP is within the interlocal agreement limit of 480 ERUs. shows the currently connected parcels within the South Island Study Area as orange. Table 6.5 summarizes the ERUs served by each pump station.

The City has granted binding reservation commitments amounting to an additional 45 ERUs. The total number of ERUs including both connected parcels and parcels with binding reservations is 342 ERUs. Therefore, if the City fulfills all of its current service obligations in the South Island Service Area, City flows will still be within the interlocal agreement limit. Parcels with binding reservations are shown in Figure 6.1 as yellow.

Many parcels within the South Island study area are not currently connected to the sewer system and do not have a binding reservation. Most of these parcels are within Lynwood Center, along Crystal Springs, and along the east side of Pleasant Beach. To predict future flow contributions of these parcels, assumptions had to be made about the number of ERUs each land use type will contribute. Each residential parcel is considered to contribute one ERU of flow because the residential parcels within the South Island Study Area are primarily single family residences. Commercial parcels contribute multiple ERUs. Information about the number of ERUs that connected commercial parcels within Lynwood Center currently contribute was used to create a planning value for the flow contribution of commercial parcels to be connected in the future. Table 6.6 shows parcels that were part of



Legend

Pump Stations	Sewer District No. 7
Connected Lots	Kitsap County Sewer District #7 WWTP
Lots with Binding Reservation	Parcels
South Island Study Area	Water Body

0 1,250 2,500 Feet

Figure 6.4
South Island Collection System Connections
 General Sewer Plan
 City of Bainbridge Island

the original 1997 service agreement and the associated current ERU values. From this data, the average ERU allotment for a commercial parcel in Lynwood Center is 18. Therefore, a planning value of 18 ERUs per commercial parcel was used for commercial parcels that will connect to the sewer collection system in the future.

Based on the planning values presented above, the total number of ERUs to be served within the South Island Study Area is approximately 642. In order to serve the entire South Island Study Area, the City will need to renegotiate an agreement with KCSD #7, and increase flows to the KCSD #7 WWTP that are reserved for the City.

6.3.3 Pump Station Capacity Evaluation

The firm capacities of the Lynwood Center and Rockaway Beach Pump Stations were compared to the ERUs to be served in each of their tributary areas. To convert pump station gallon per minute capacity to capacity in terms of ERUs, planning values from the 2002 South Island Sewer Facilities General Plan and Engineering Report (Appendix L) were used. These planning values included an ERU base flow of 220 gpm and a peaking factor of three between base flow and peak hour flow. Using these criteria, the Lynwood Center Pump Station has a capacity of approximately 400 ERUs and the Rockaway Beach Pump Station has a capacity of approximately 250 ERUs.

Both of the South Island pump stations have adequate capacity to serve connected parcels plus parcels with binding reservations. Within the Lynwood Center Pump Station tributary area, there are 265 ERUs that either are connected or have a binding reservation compared to a pump station capacity of 400 ERUs. Within the Rockaway Beach area, 77 ERUs either are connected or have a binding reservation compared to a pump station capacity of 250 ERUs.

Considering the entire South Island Study Area, the Rockaway Beach Pump Station has capacity to serve the 79 total ERUs within its service area. Assuming flows from all unconnected parcels along Point White and Pleasant Beach would be routed through the Lynwood Center Pump Station, build-out flows for the Study Area tributary to the Lynwood Pump Station amount to 563 ERUs as shown in Table 6.5. This exceeds the 400-ERU capacity of the Lynwood Pump Station.

Table 6.5 South Island Pump Station Capacity Evaluation General Sewer Plan City of Bainbridge Island		
Category	ERUs in Category	Pump Station Capacity (ERUs)
Lynwood Center Pump Station		
Connected	241	400
Binding Reservations	24	400
Study Area	563	400
Rockaway Beach Pump Station		
Connected	56	250
Binding Reservations	21	250
Study Area	79	250
Total		
Connected	297	
Binding Reservations	45	
Study Area	642	

Table 6.6 Lynwood Center ERUs General Sewer Plan City of Bainbridge Island		
Property	Current ERUs	Land Use Type
Serenity House	23	Commercial
Lynwood Center Building	18.7	Commercial
Pleasant Beach Grill	4.6	Commercial
Blossom Property (Lynwood Commons)	23	Residential
Blossom Property (Pleasant Beach Village)	27.1	Commercial
Pleasant Beach Village	10	Residential
Average Commercial ERU Contribution	18	

6.3.4 South Island Capacity Improvements

In order to serve all of the unconnected parcels within the South Island Study Area, the City will need to work with KCSD #7 to increase the flows to the KCSD #7 WWTP that are reserved for the City. It appears that KCSD #7 has capacity to treat additional flow from the City.

Additionally, in order to serve all unconnected parcels within the South Island Study Area, the capacity of the Lynwood Pump Station must be upgraded. It is recommended that the City perform an in-depth flow projection evaluation for the South Island Study Area. This

study would establish how parcels will be connected to the collection system in the future, determine the required capacity of the Lynwood Pump Station, and define future ERUs to be reserved for the City at the KCSD #7 WWTP to be included in an amended interlocal agreement with KCSD #7.

6.4 RECOMMENDED IMPROVEMENTS SUMMARY

One pipeline improvement project at the inlet of the WWTP was identified for capacity reasons. Three pump station capacity deficiencies for conveying future flows were identified for the Winslow Collection System. It is projected that the capacities of the Village Pump Station and North Town Woods Pump Station will need to be increased within the short-term planning period. The Sunday Cove Pump Station is expected to require additional capacity by 2035. In addition, increased monitoring and an evaluation of the operating conditions of the 4-inch New Brooklyn force main and associated pump stations located in the northern part of Winslow is required to determine how best to eliminate the potential for wet well overflows when all four pump stations are operating simultaneously. Pump station modifications at Woodward School will likely be necessary.

Additionally, for South Island, the capacity of the Lynwood Pump Station must be upgraded in order to serve all unconnected parcels within the Study Area. A detailed flow evaluation is necessary for the South Island Study Area in order to determine the required future capacity of the Lynwood Pump Station and to provide a basis for future renegotiations with KCSD #7 to increase flows to the WWTP that are reserved for the City in order to serve the entire Study Area.

TREATMENT SYSTEM ANALYSIS

This chapter presents the results of a capacity analysis of the existing Winslow Wastewater Treatment Plant (WWTP), and evaluates potential improvements within the treatment plant that may be needed to provide capacity for flows and loads projected through Year 2035.

7.1 EXISTING TREATMENT FACILITIES

The Winslow WWTP was constructed in 1978 and originally consisted of coarse screens, grit removal, two oxidation ditches with surface aeration, two small secondary clarifiers, chlorine disinfection and effluent pumping. One of the two oxidation ditches was operated as a sludge holding tank and during low flow periods, one of the two secondary clarifiers was operated as a gravity thickener. Liquid sludge was hauled to a land application site in Jefferson County. Since its original construction, The WWTP been upgraded a number of times to increase capacity and improve performance. Upgrades include:

- 1994:
 - Upgraded grit removal system.
 - Replaced the chlorine gas used for disinfection with sodium hypochlorite.
 - Added 60-foot diameter secondary clarifier and Return Activated Sludge (RAS)/Waste Activated Sludge (WAS) pumps for clarifier.
- 2003:
 - Replaced the chlorine disinfection with Ultraviolet (UV) disinfection.
 - Replaced the effluent pump station with a larger pump station.
- 2010:
 - Replaced coarse screens with fine perforated plate screens.
 - Upgraded oxidation ditches to improve both liquid and solids treatment capacity and performance. A portion of the existing oxidation ditches (approximately 80 percent) was converted to a multi-zone plug flow, fine bubble aeration system with both aerated and un-aerated zones, internal recycle and mixing. The remaining volume of the oxidation ditches serves as aerated solids holding and thickening tanks.
 - Added screw press dewatering unit for dewatering stored solids.

The current treatment plant consists of fine screens, grit removal, plug-flow aeration basins, three secondary clarifiers, UV disinfection and effluent pumping. The solids produced in the aeration basins are further aerated in the sludge holding tank. Aerated solids are thickened and dewatered prior to disposal at the Rosevelt Regional Landfill. Currently, because the secondary system is under loaded, the dewatered solids are able to meet CFR 503.C Class B criteria (as demonstrated through testing). The existing plant schematic as presented in

the 2007 Tetra Tech design drawings is shown in Appendix M. Table 7.1 lists the size and construction year for the major unit processes.

Table 7.1 Major Unit Process General Sewer Plan City of Bainbridge Island		
Unit Process	Size	Year Constructed
Perforated Plate Fine Screens	1 x 1/4 inch opening	2010
Grit Removal	2 x 28 sf, 10 ft SWD	1978, upgraded 1994, 2010
Aeration Basins	2 x 0.359 MGal	1978, major upgrade in 2010
Aeration Blowers	3 x 100 hp	2010
Internal Recirculation Pumps	2 x 5 hp	2010
Anoxic Mixers	4 x 2.5 hp	2010
Secondary Clarifiers		
Small	2 x 33 ft diameter,	1978, major upgrade in 2010
Large	1 x 60 ft diameter	1994
RAS / WAS Pumps	2 x 5 hp	2010
	2 x 15 hp	1994
Low Pressure – High Intensity UV Disinfection	2 x channels, 48 lamps total UVT = 60%, UV dose = 36,000 Ws/cm ²	2003
Thickening / Dewatering	1 x 233 lb/hr	2010
Effluent Pumping	3 x 25 hp	2003

7.2 TREATMENT PERFORMANCE

This section summarizes the treatment plant's current effluent limits and the plant's ability to meet the established limits.

7.2.1 NPDES Permit

The current National Pollutant Discharge Elimination System (NPDES) permit for the Winslow Treatment Plant expires on June 30, 2017 and limits the plant to a maximum month flow (MMF) of 1.2 million gallons per day (mgd) and maximum month (MM) biochemical oxygen demand (BOD) and total suspended solids (TSS) loads of 2,642 pounds per day (ppd). The current NPDES permit limits the MM effluent BOD and TSS concentrations to 30 milligrams per liter (mg/L) as summarized below in Table 7.2. The current permit has no limits on effluent ammonia, total nitrogen or total phosphorus. The analysis presented in this chapter is based on the current permit limits, and does not

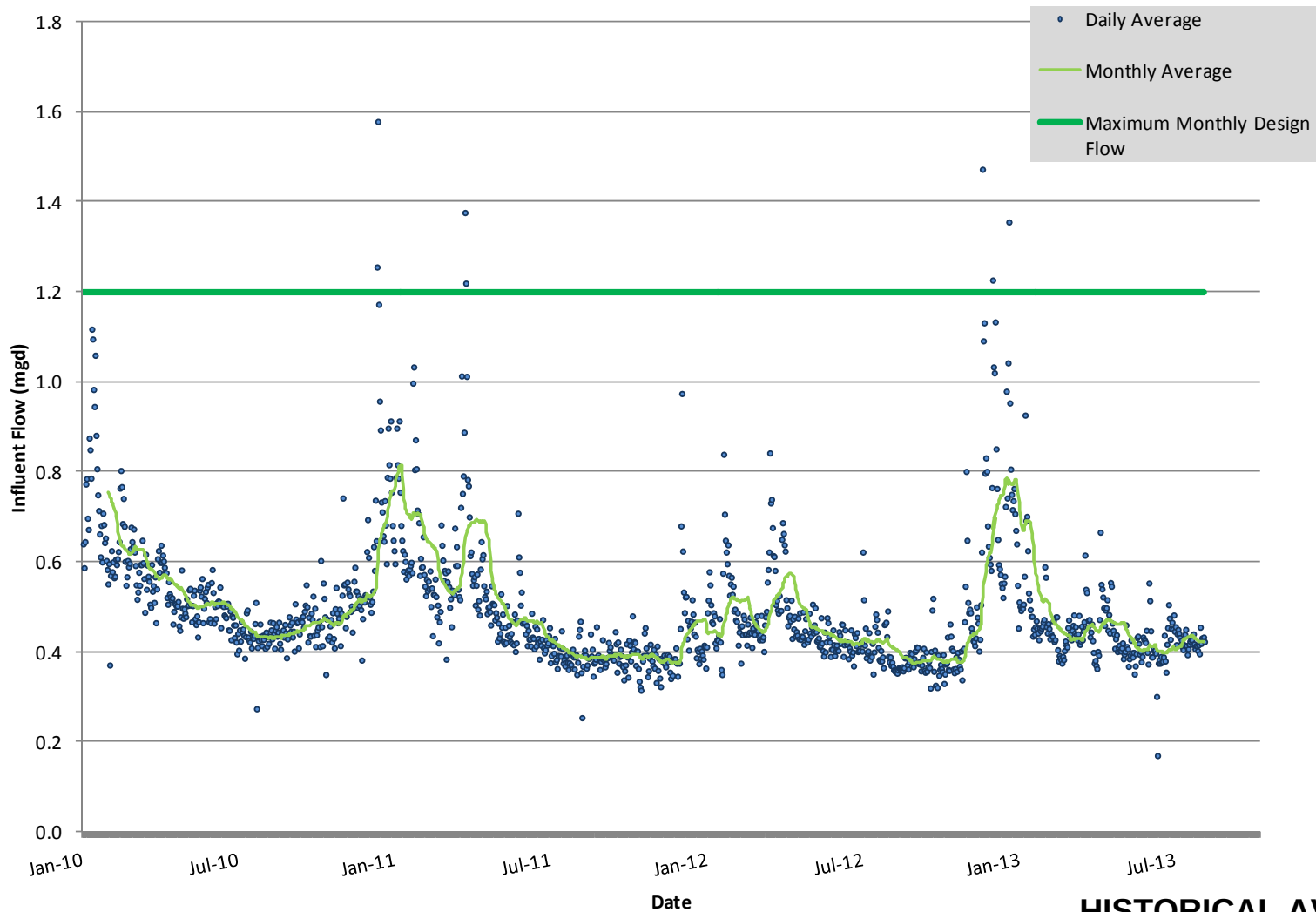
consider improvements that may be needed to meet potential future NPDES permit limits for nutrients.

Table 7.2 NPDES Permit Capacity Requirements General Sewer Plan City of Bainbridge Island		
Parameter	Average Monthly	Average Weekly
BOD5	30 mg/L 300 ppd 85% removal	45 mg/L 450 ppd
TSS	30 mg/L 300 ppd 85% removal	45 mg/L 450 ppd
Parameter	Daily Minimum	Daily Maximum
pH	6.0 standard units	9.0 standard units
Parameter	Monthly Geometric Mean	7-day Geometric Mean
Fecal Coliform Bacteria	200/100 mL	400/100 mL
Parameter	Average Monthly	Daily Maximum
Total Residual Chlorine	0.12 mg/L	0.32 mg/L
Notes:		
(1) NPDES Permit No. WA-0020907.		

7.2.2 Treatment Plant Performance

As is shown in Figure 7.1 and Figure 7.2, monthly influent flow and monthly influent BOD and TSS loads have been within the plant's permitted design capacity since January 2010. In 2011, monthly influent flow hit a high of 0.8 mgd and in 2010, the monthly influent BOD and TSS loads hit a high of around 2,000 ppd.

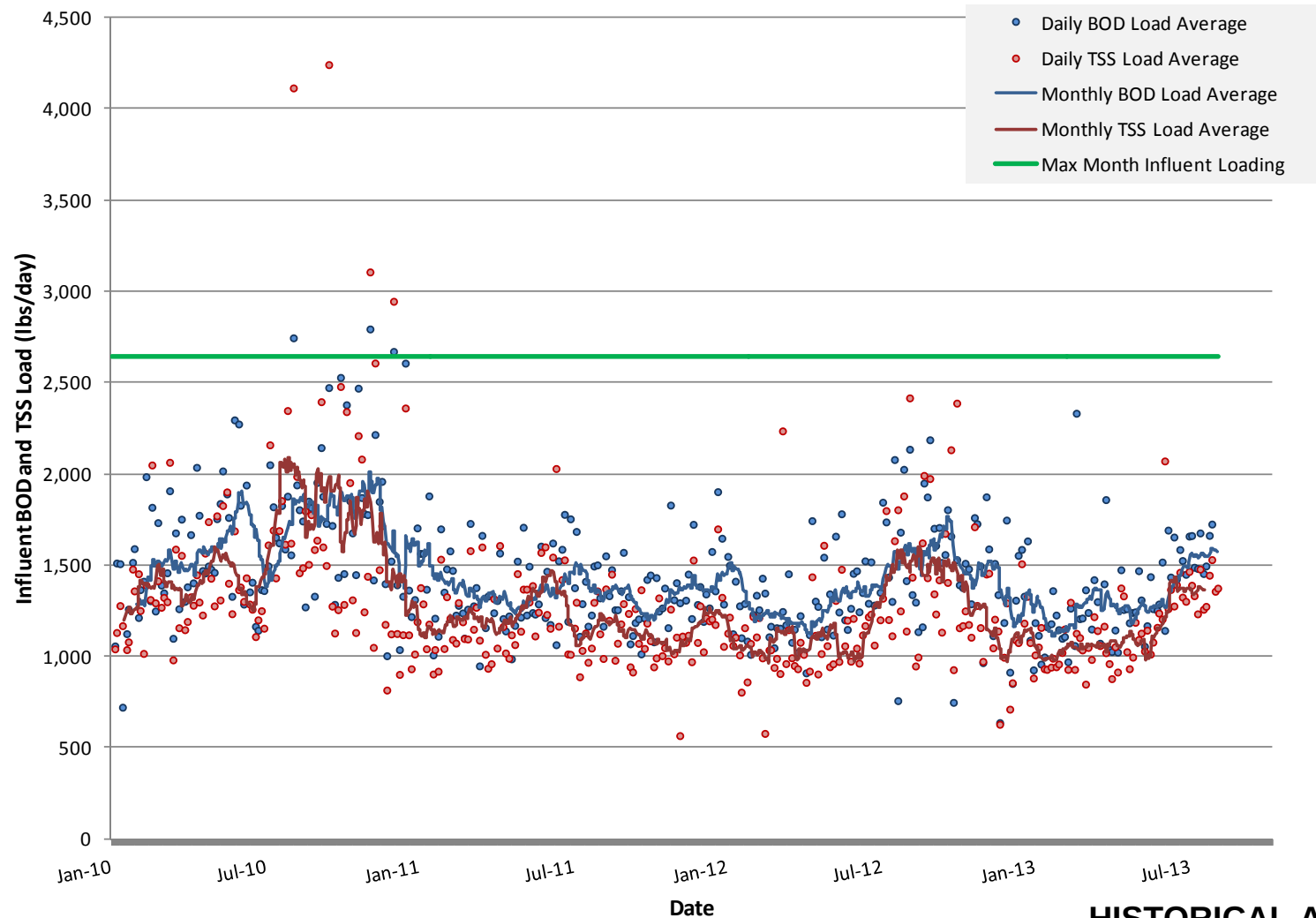
The WWTP produces secondary effluent that is typically well below the current NPDES permit limits. Figure 7.3 and Figure 7.4 show effluent BOD concentrations and loads for the years 2010 through July of 2013. Figure 7.5 and Figure 7.6 show that the plant exceeded the weekly effluent TSS concentration and load limits once in 2011, with one week having an effluent TSS concentration exceeding 60 mg/L and 700 ppd. The plant is also required to remove at least 85 percent of the influent BOD and TSS on a monthly average. Figure 7.7 shows that since 2010, the plant has generally succeeded in removing more than 96 percent of the influent BOD and TSS. Additionally as shown in Figure 7.8 and Figure 7.9, effluent pH and effluent coliform counts have been within permitted limits. Since the plant switched to UV disinfection, there has been no effluent chlorine residual.



HISTORICAL AVERAGE WWTP INFLUENT FLOW

FIGURE 7.1

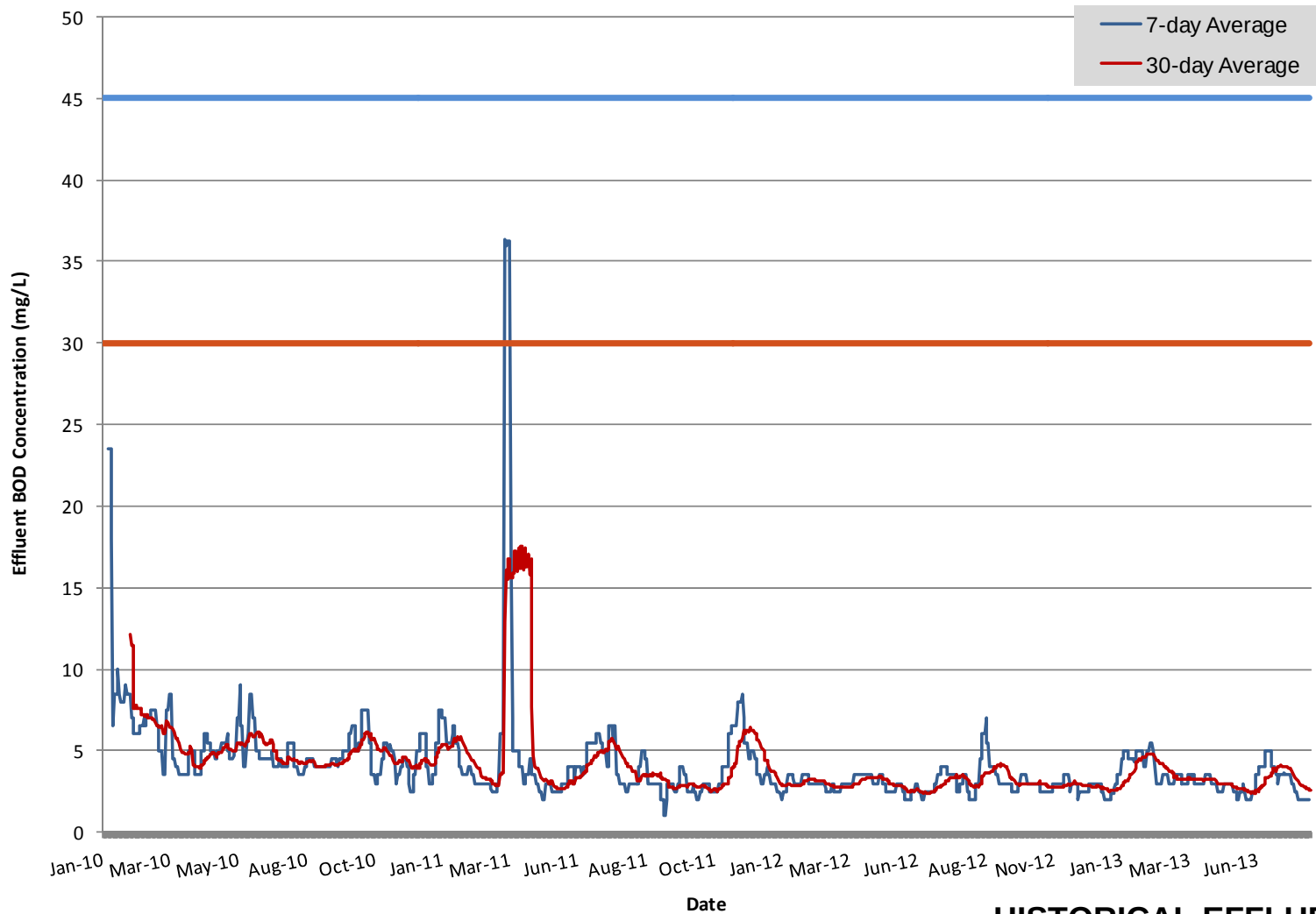
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL AVERAGE WWTP INFLUENT LOAD

FIGURE 7.2

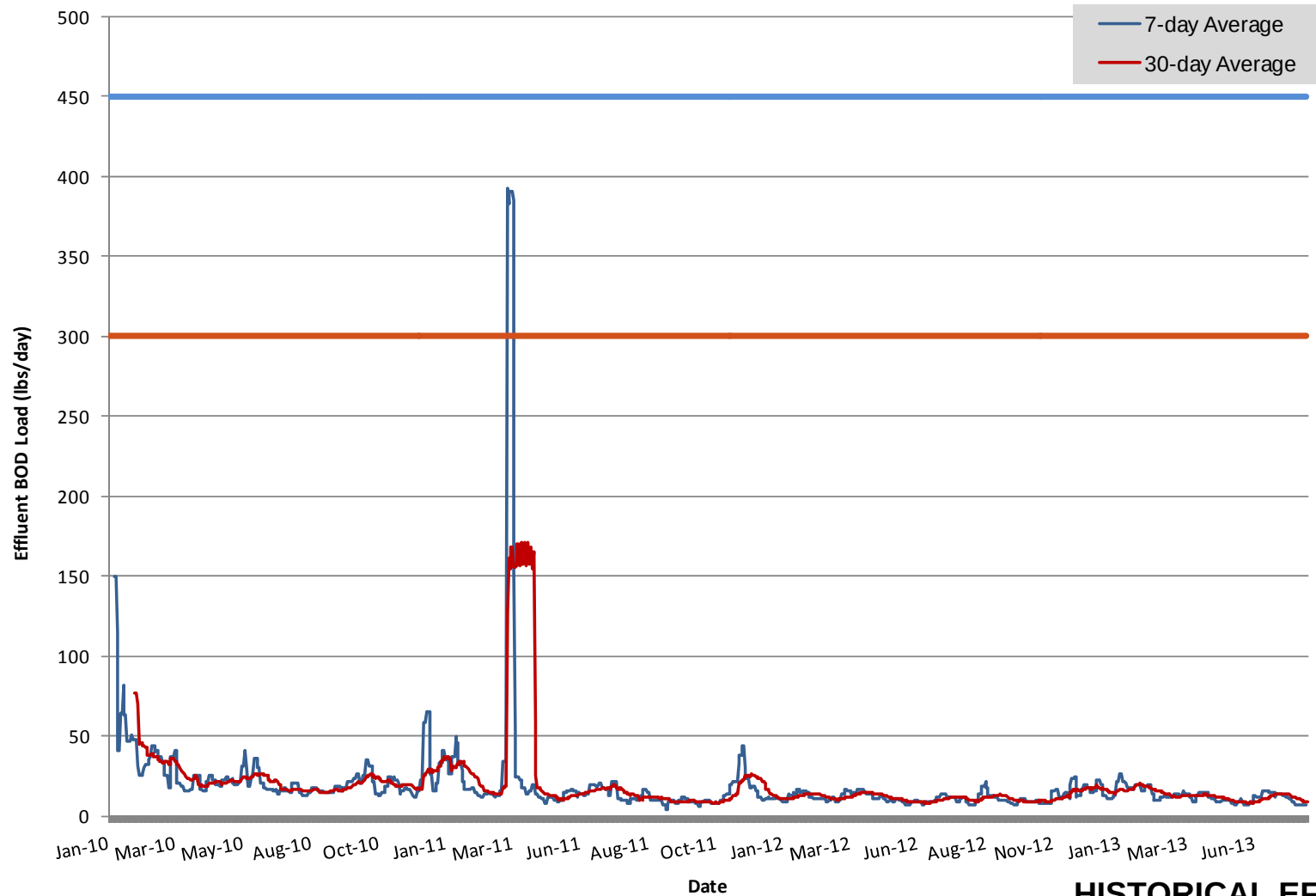
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL EFFLUENT BOD CONCENTRATION

FIGURE 7.3

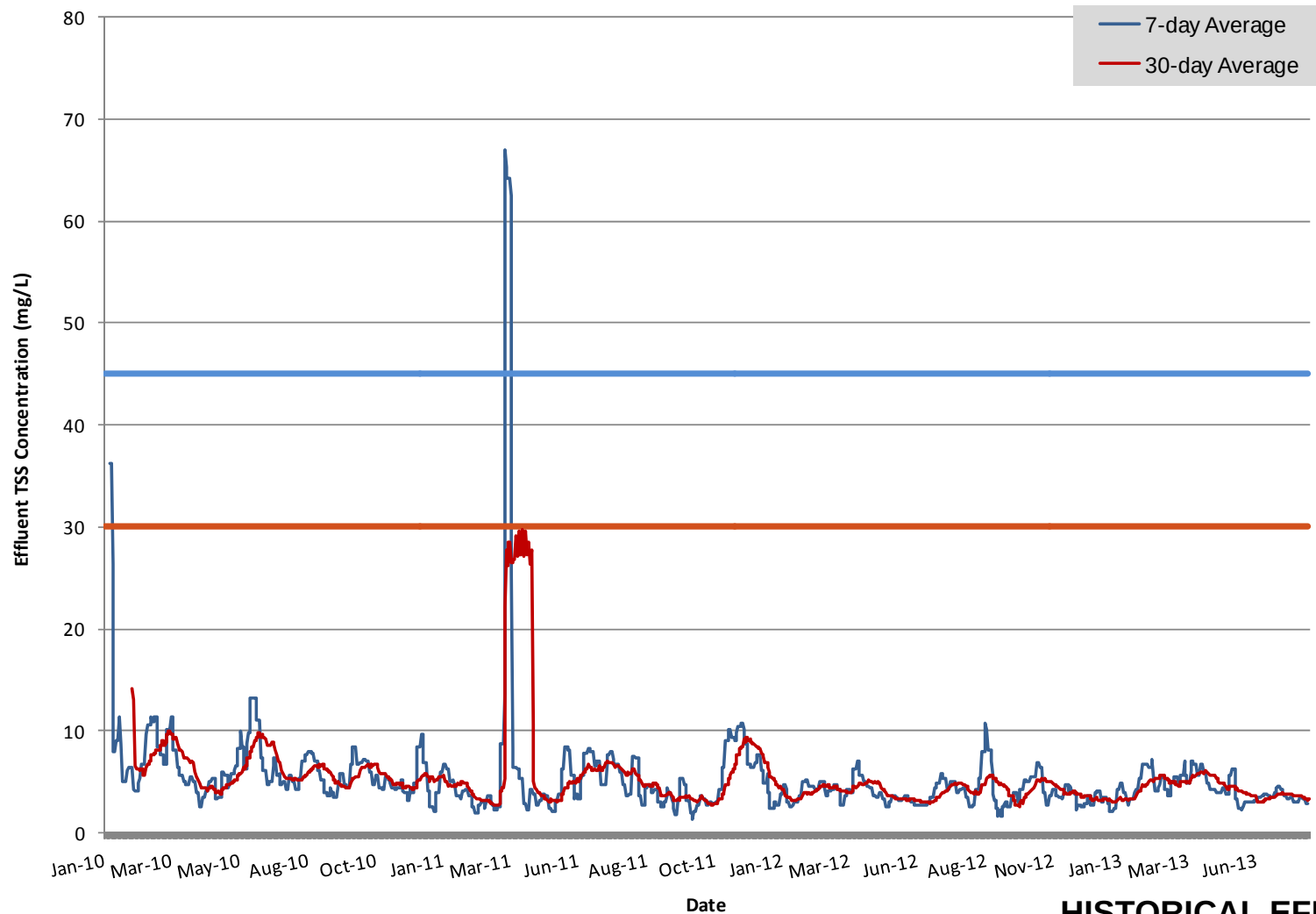
CITY OF BAINBRIDGE ISLAND
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HISTORICAL EFFLUENT BOD LOAD

FIGURE 7.4

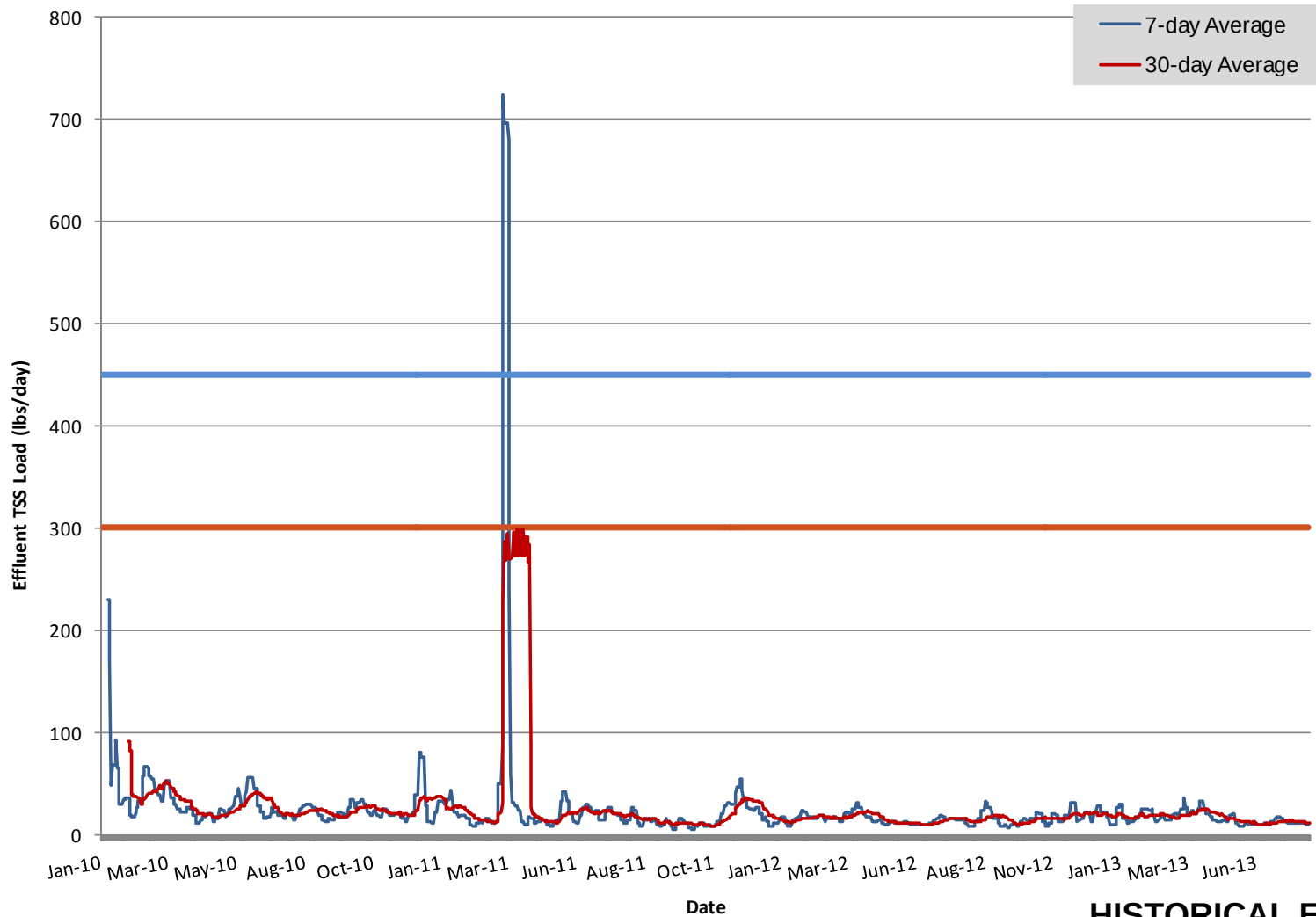
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL EFFLUENT TSS CONCENTRATION

FIGURE 7.5

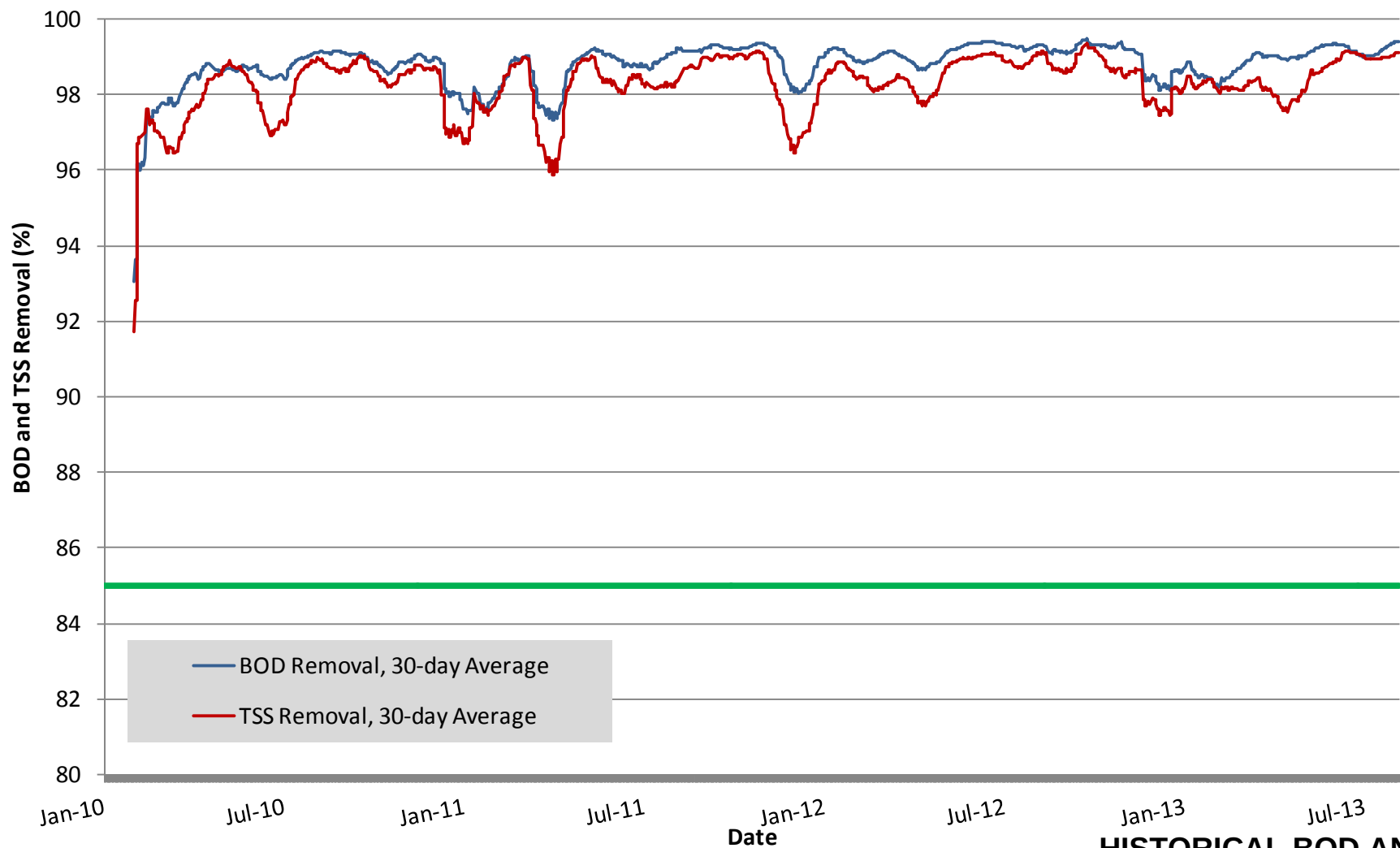
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL EFFLUENT TSS LOAD

FIGURE 7.6

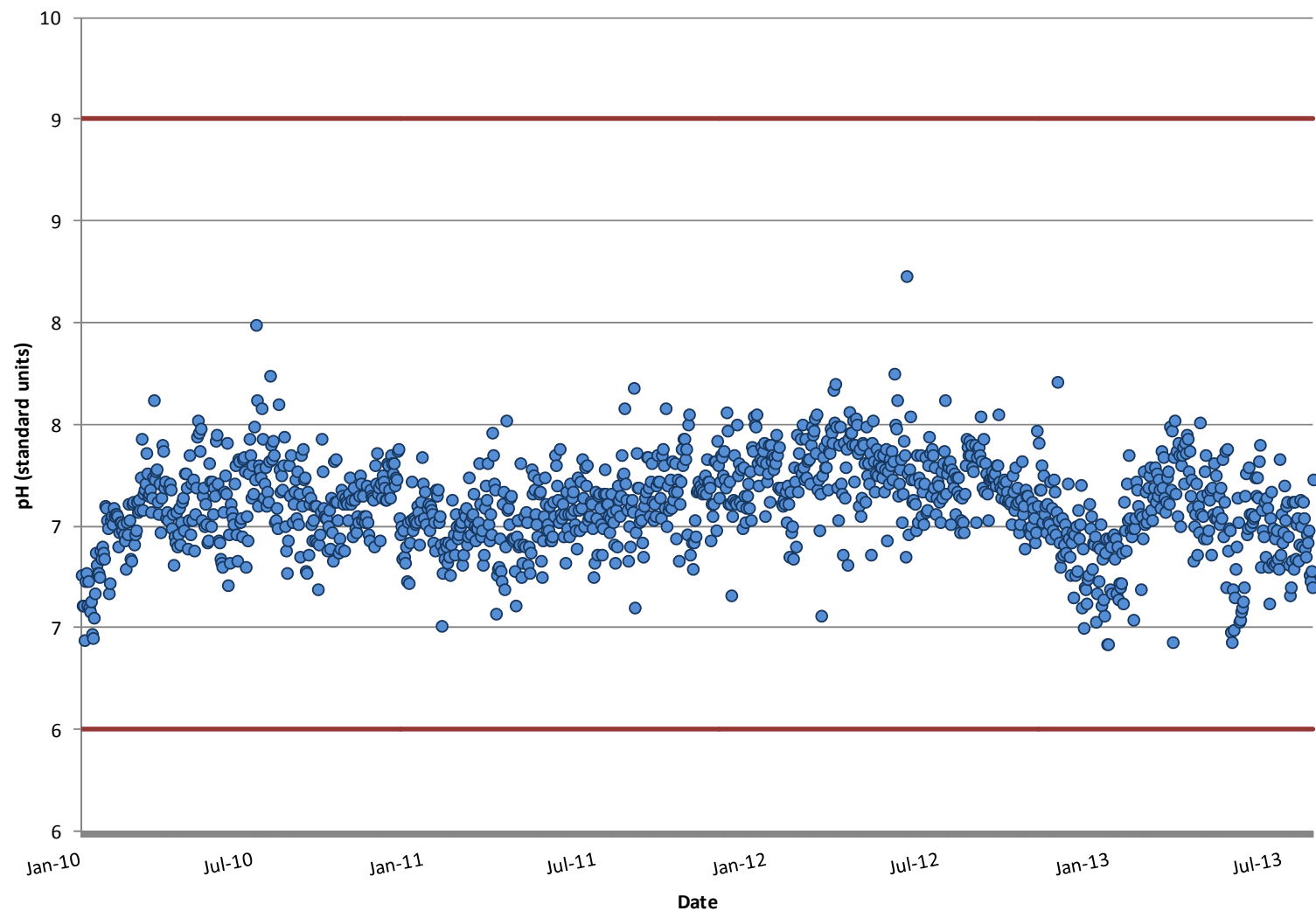
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL BOD AND TSS REMOVALS

FIGURE 7.7

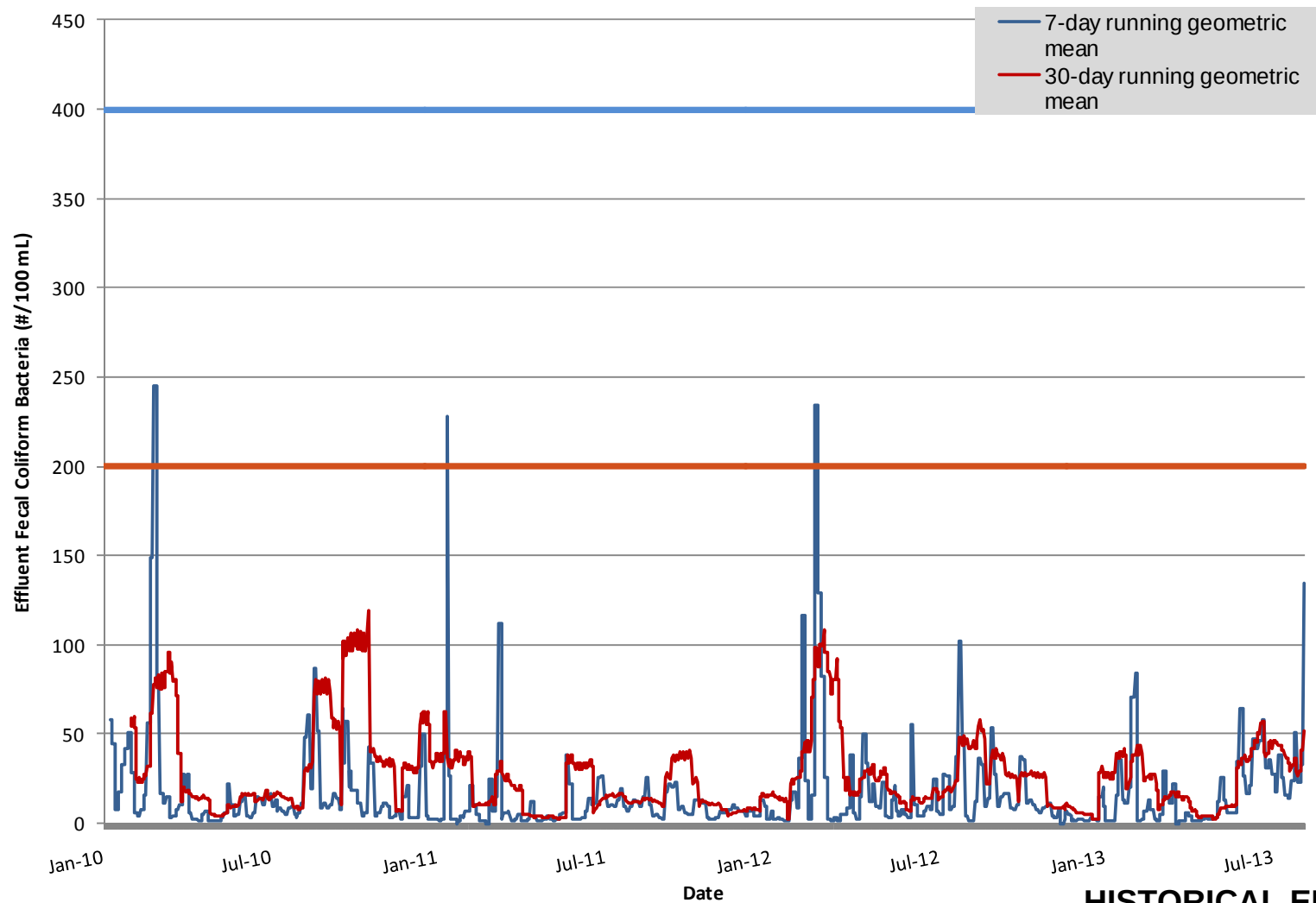
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL EFFLUENT PH

FIGURE 7.8

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL EFFLUENT FECAL COLIFORM

FIGURE 7.9

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

7.3 EXISTING FACILITY OPERATION ASSESSMENT

On August 20, 2013, Carollo Engineers staff toured the Winslow WWTP with City staff to assess existing plant operations. Table 7.3 summarizes input from plant staff on the current operation of each unit process. As is shown, most unit processes operate reliably under the current protocol, which is expected since the majority of the unit processes were recently upgraded. Plant staff identified issues with flow pulsing on the fine screens, grit buildup in downstream processes, and the limited ability to properly turn down the aeration blowers and air pockets in the effluent force main.

Table 7.3 Condition Assessment General Sewer Plan City of Bainbridge Island		
Unit Process	Year Constructed	Operability Comments
Fine screens	2010	Flow pulsing
Grit removal	1978	Grit buildup in downstream processes
Aeration basins	1978, major upgrade in 2010	Good
Blowers	2010	Limited turn down
Internal recirculation pumps	2010	Good
Anoxic mixers	2010	Good
Secondary clarifiers		
Small	1978, major upgrade in 2010	Good
Large	1994	
RAS / WAS pumping	2010 1994	Good
UV disinfection	2003	Good
Thickening / dewatering	2010	Good
Effluent pumping	2003	Air pockets in effluent force main

7.4 TREATMENT CAPACITY EVALUATION

This section summarizes the capacity evaluation for the Winslow WWTP, describing model development and calibration, unit process design criteria, and unit process capacity limitations. No hydraulic model of the treatment plant was conducted as a part of this analysis. The most recent hydraulic analysis of the treatment plant was completed as part of the 1994 Wastewater Facilities Improvement Plan (Brown and Caldwell), and estimated the hydraulic capacity at approximately 2.9 mgd. A 2003 Engineering Report (H. R. Esvelt Engineering) listed the hydraulic capacity of the plant at 3.6 mgd based on the plant's experience of the winter storm dated 12/30/96 – 1/3/97, which resulted in peak flows at the

plant in excess of 3.6 mgd. Plant staff noted that the existing effluent pumps were unable to keep up with flows during this peak event, causing flow to back up through the chlorine contact chamber and into an out-of-service clarifier. Based on experience from this storm, the 2003 Engineering Report recommended increasing the effluent pump capacity to 4.0 mgd and the pumps were subsequently replaced later that year.

7.4.1 Current Capacity

7.4.1.1 Preliminary Treatment

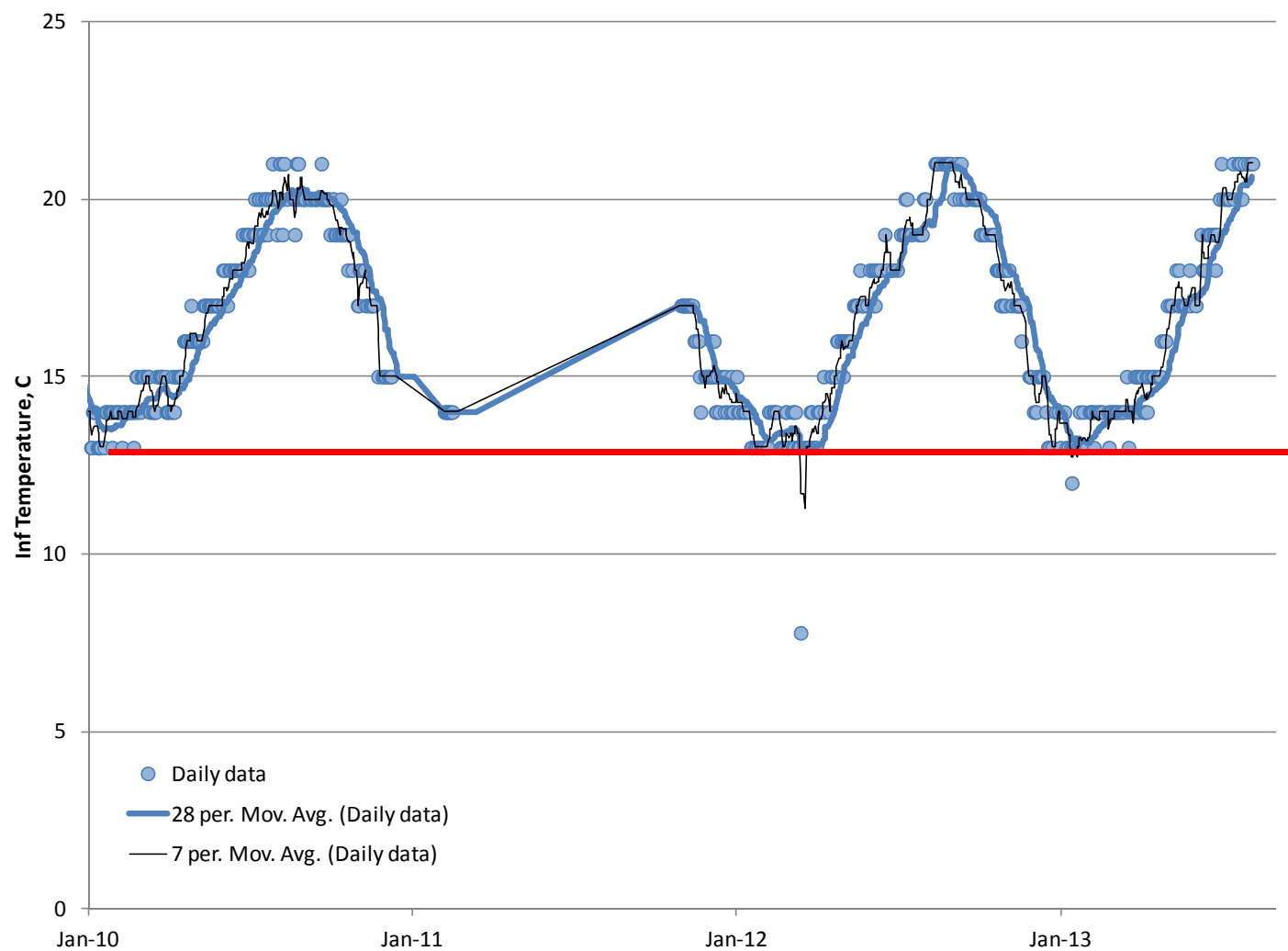
The PHF capacity of the fine screens was listed in the 2007 design criteria as 4.0 mgd. This capacity is sufficient to treat the current PHFs of 2.3 mgd but is less than what is required to treat the projected 2035 PHF (4.2 mgd). The PHF capacity of the grit removal system is dependent on the hydraulics of the headworks. The 2007 design determined that the grit removal system could handle a PHF of 3.6 mgd, which is sufficient to treat the current PHF of 2.3 mgd, but less than what is required to treat the projected 2035 PHF (4.2 mgd).

7.4.1.2 Secondary Treatment

The capacity of the secondary system is dependent on the wastewater characteristics including flow, BOD, TSS and volatile suspended solids (VSS), degradable fraction of particulate material and sludge settleability. Plant operational data were provided for the years 2010 through July of 2013. Data from August 2012 through July 2013 were used to calibrate a BioWin model of the secondary system. During the calibration period, the plant was operated as follows:

- Both aeration basins were online with approximately a 40 percent unaerated volume.
- The average wastewater temperature was 17°C and the minimum weekly wastewater temperature was 13°C (Figure 7.10).
- The mixed liquor suspended solids (MLSS) concentration ranged from 2,500 to 3,500 mg/L (Figure 7.11).
- The aerobic solids retention time (aSRT), excluding the time in the sludge holding tank and secondary clarifiers, averaged approximately 10 days (Figure 7.12).
- The biomass yield averaged 0.79 pounds (lb) TSS/lb BOD (Figure 7.13).
- The sludge volume index (SVI) averaged 253 mL/g (Figure 7.14).

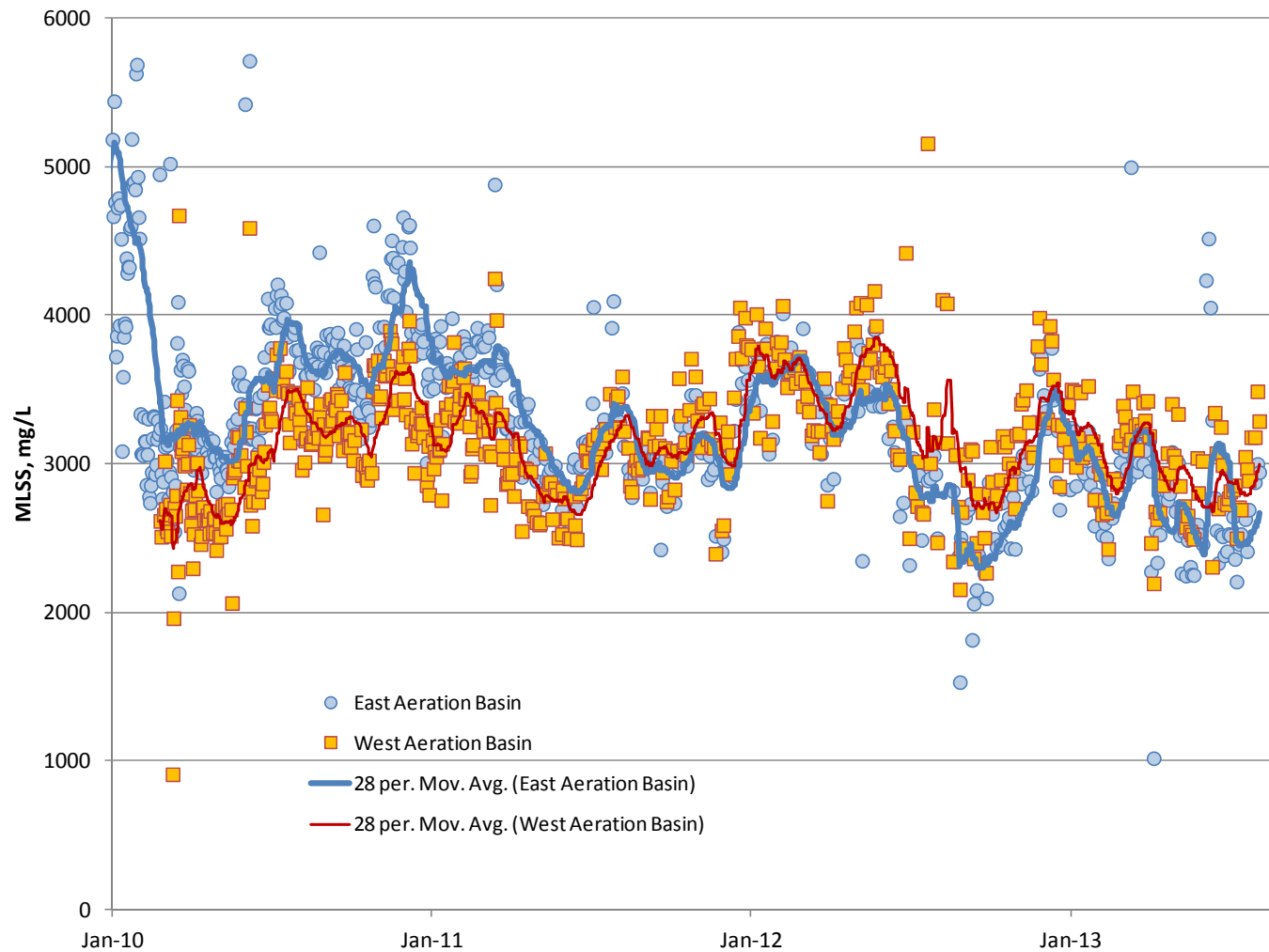
The capacity of the secondary system is highly dependent on the settleability of the sludge. Sludge settleability is typically measured by SVI with healthy biomass populations having a SVI that ranges between 125 mL/g and 150 mL/g. Mixed liquor with excessive filament populations settles poorly, and settleability can also be impacted by rising sludge caused by denitrification in the secondary clarifiers. In these instances SVIs can be much higher than 150 mL/g. During April of 2013, the monthly average SVI peaked at around 340 mL/g.



HISTORICAL WASTEWATER TEMPERATURE

FIGURE 7.10

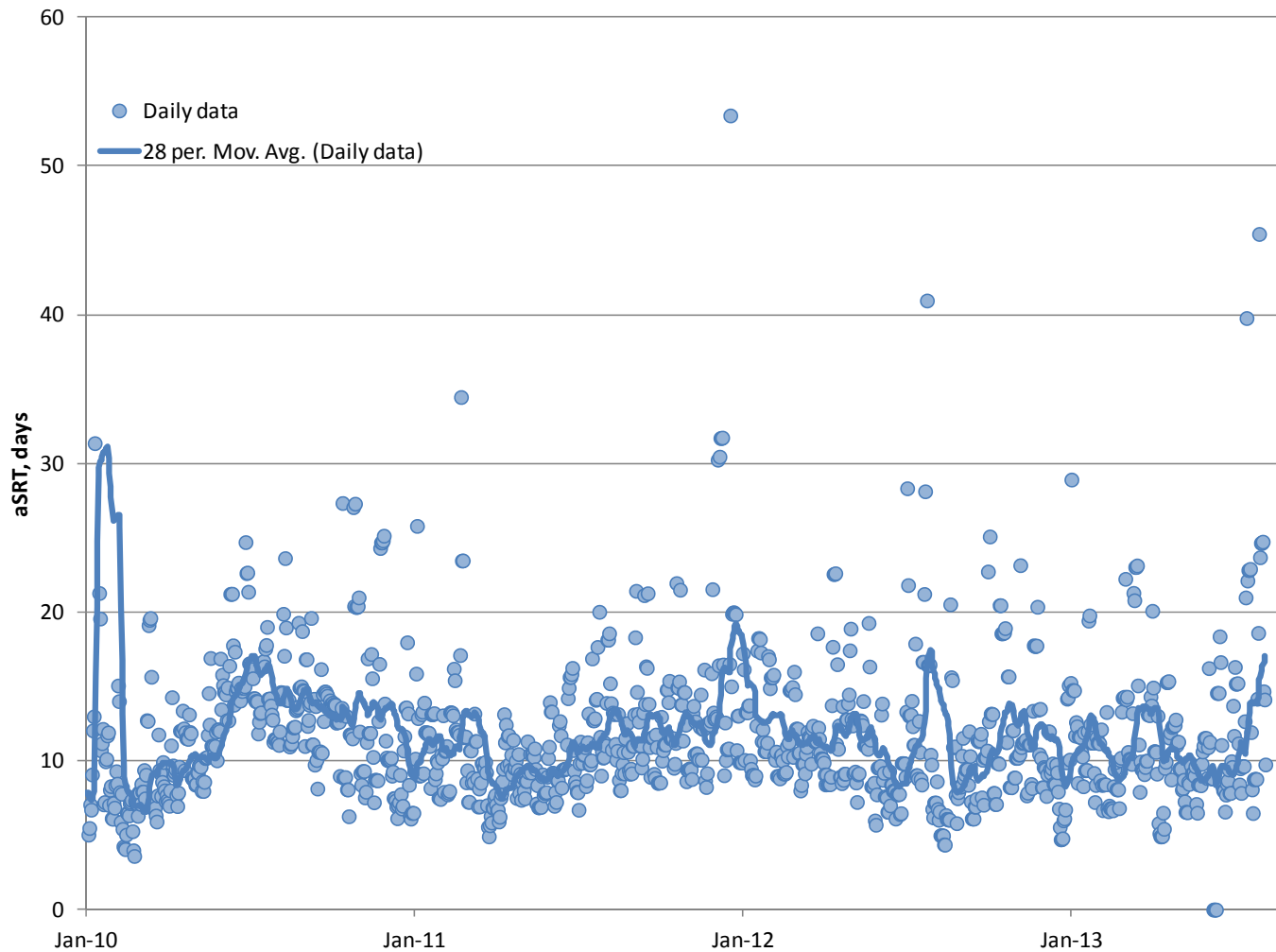
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HISTORICAL MIXED LIQUOR SUSPENDED SOLIDS

FIGURE 7.11

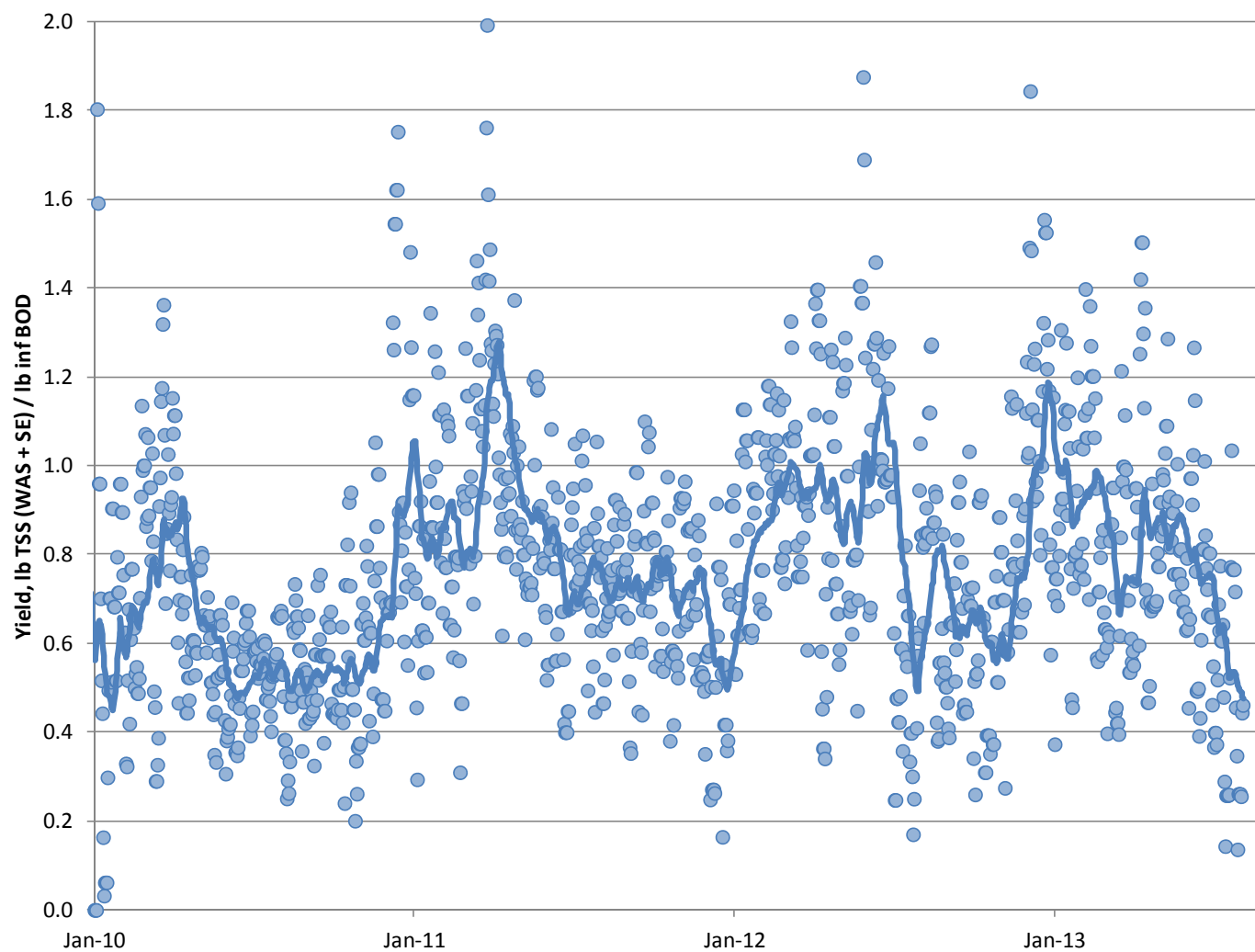
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GENERAL SEWER PLAN



HISTORICAL AEROBIC SOLIDS RETENTION TIME

FIGURE 7.12

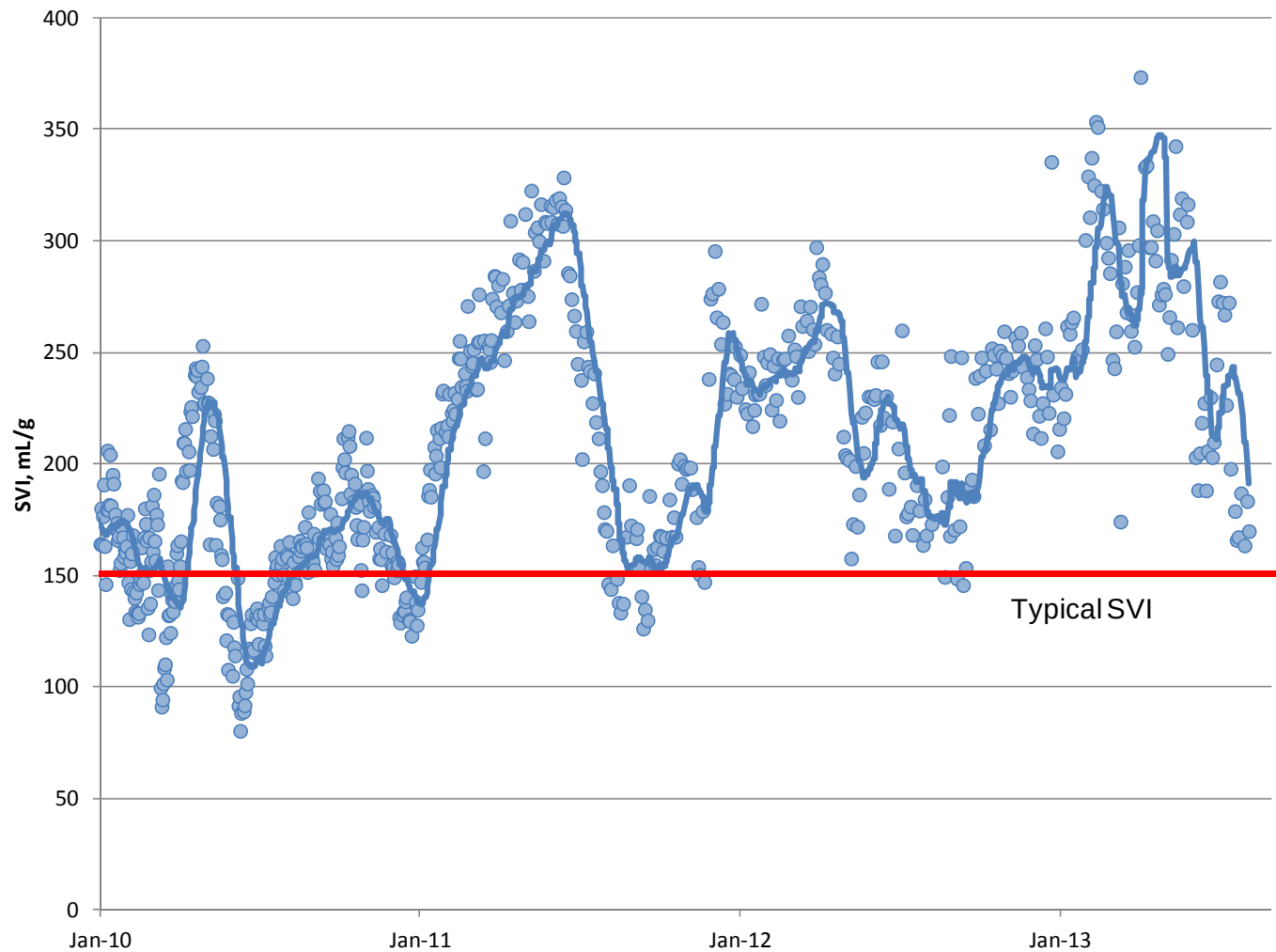
CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL BIOMASS YIELD

FIGURE 7.13

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



HISTORICAL SLUDGE VOLUME INDEX

FIGURE 7.14

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

During this month, the average MLSS concentration was 2,700 mg/L. Because of the very poor settleability under these conditions, the peak hour flow (PHF) capacity of the 150 mL/g. During April of 2013, the monthly average SVI peaked at around 340 mL/g. During this month, the average MLSS concentration was 2,700 mg/L. Because of the very secondary clarifiers is reduced to 1.9 mgd (much lower than the rated PHF capacity of the plant).

To treat the current PHF of 2.5 mgd with a 340 mL/g SVI, the maximum MLSS concentration would need to be maintained at the low end of the normal operating range (2,500 mg/L). With this low of a MLSS concentration, the capacity of the secondary system is severely limited. Using the 2007 design criteria (a 10 day total average annual SRT, which equates to a 4.5 day MM aerobic SRT), the MM BOD capacity of the aeration basins is reduced from the value listed in the 2007 design of 2,642 ppd to 1,970 ppd (WWTP influent BOD). This capacity is sufficient for current MM BOD loads, but is less than what is required to treat projected 2025 MM BOD loads.

7.4.1.3 Solids Handling

With the current MM BOD load, the aerated sludge storage tanks are able to provide 4.6 days of storage for the WAS assuming current operational practices (thickening to a 1 percent solids concentration), and assuming that one third of the basin side water depth is used for decanting. At a MM influent BOD load of 1,970 ppd, process modeling projects that approximately 10,300 lb/week of solids will be sent to the thickening/dewatering process. The 2007 design lists a solids loading capacity of 233 lb/hr. At this solids loading rate, thickening and dewatering processes would need to be operated 44 hours/week, which allows downtime for maintenance.

7.4.1.4 UV Disinfection

The existing UV disinfection system has two channels, each with two banks consisting of two modules that contain 6 lamps (total of 48 lamps). The 2007 design listed the PHF capacity of the UV system at 3.6 mgd at a UVT of 60 percent and a UV dose of 36 mJ per sq cm. The anticipated UV dose delivery (from the UV dose algorithm developed for the Wedeco TAK 55HP in October 2003 by Carollo as part of UV validation work of Wedeco TAK 55HP) was compared to the design dose listed in the 2007 drawings. Assuming a lamp aging factor of 0.88 and sleeve fouling factor of 0.90, the anticipated UV dose delivery of the existing system is estimated to be 26 mJ per sq cm. To provide the rated dose of 36 mJ per sq cm with the safety factors listed above, the maximum PHF capacity of the system must be reduced to 2.4 mgd, which is close to current PHF (2.3 mgd) but insufficient to treat projected Year 2035 PHF (4.2 mgd). The difference between the rated capacity and the calculated capacity may be due to different assumptions in the safety factors for lamp aging and fouling. Further collimated beam testing is recommended to determine the dose required to meet the NPDES permit requirements at the rated PHF.

7.4.1.5 Effluent Pumping

Based on existing pump curves, the firm capacity of the effluent pump station is 4.0 mgd at a TDH of 53 ft. This capacity is sufficient for current PHF, but insufficient for projected Year 2035 PHF (4.2 mgd).

7.4.1.6 Capacity Summary

Table 7.4 summarizes the capacity of the unit processes under current operational conditions, and summarizes the capacity required to meet current and projected (Year 2025 and 2035) flows and loads. Highlighted cells indicate processes that must be expanded or improved to meet projected future conditions.

Table 7.4 Capacity Summary with Current Design Criteria General Sewer Plan City of Bainbridge Island				
Unit Process	Current Capacity (influent flow/load)	Required Capacity		
		2010	2025	2035
Fine Screens	4.0 mgd PHF	2.3 mgd	3.4 mgd	4.2 mgd
Grit Removal	3.6 mgd PHF	2.3 mgd	3.4 mgd	4.2 mgd
Secondary System	1970 ppd MM BOD ⁽¹⁾	1,800 ppd	2,450 ppd	2,880 ppd
	2.5 mgd PHF ⁽²⁾	2.3 mgd	3.4 mgd	4.2 mgd
UV Disinfection	2.4 mgd PHF	2.3 mgd	3.4 mgd	4.2 mgd
WAS Storage	2800 ppd MM TSS ⁽³⁾	1670 ppd	2260 ppd	2660 ppd
Thickening / Dewatering	2900 ppd MM TSS ⁽⁴⁾	1,670 ppd	2,260 ppd	2,660 ppd
Effluent Pumping	4.0 mgd PHF ⁽⁵⁾	2.3 mgd	3.4 mgd	4.2 mgd
Notes:				
(1) Capacity assumes operation at a MM aSRT of 4.5 days and a MLSS of 2,500 mg/L.				
(2) Capacity assumes operation at a SVI of 340 mL/g and a MLSS of 2,500 mg/L.				
(3) Capacity assumes 3 days of storage at a TS of 1 percent.				
(4) Capacity is dependent on operational SRT in the aeration basins and sludge storage tank. Assumes 5 days per week, 14 hours per day operation.				
(5) Capacity is based on a TDH of 53 ft.				

7.4.2 Alternatives to Improve Capacity

The capacity of each process presented in the previous section is based on 2007 design criteria. Capacity limitations in several unit processes must be addressed to meet the projected Year 2035 flows and loads. This section presents alternatives to improve capacity and/or mitigate operational issues that are limiting capacity within each process. As previously discussed, hydraulic capacity of the facility is assumed to be adequate based on

prior work. Additional hydraulic modeling is required to confirm the plant's hydraulic capacity for the projected Year 2035 PHF of 4.2 mgd.

7.4.2.1 Fine Screens

Based on the 2007 design, the PHF capacity of the fine screens is 4.0 mgd. Assuming a linear increase in flow, this will provide sufficient capacity through approximately the year 2032. With only a modest improvement in collection system infiltration and inflow, the projected PHFs could be reduced to the point that the fine screens would have capacity through the Year 2035. Plant staff have indicated that although the screens are generally in good condition they do experience flow pulsing. This flow pulsing could be mitigated by changes to pump station controls within the collection system or by changes in the operation of the fine screen controls. The impact of flow pulsing and potential capacity limitations should be evaluated in the future, as flows increase.

7.4.2.2 Grit Removal

Based on the 2007 design, the PHF capacity of the grit removal system is 3.6 mgd. Assuming a linear increase in flow, this will provide sufficient capacity through approximately the year 2028. With modest improvement in collection system infiltration and inflow, grit removal capacity may be extended even further. Plant staff have observed that grit buildup is an issue in the aeration basins, which indicates less than optimum grit removal. Staff have made adjustment in the operation of the grit removal system and the results are evaluated annually when an aeration basin is dewatered for inspection and service. If these operational changes are not effective, a grit evaluation study may be required to identify potential modifications to the existing process to improve performance and capacity. Additionally, since the existing grit removal system is 20 years old, newer grit removal technologies may improve grit removal and increase capacity.

7.4.2.3 Secondary Treatment

As summarized in the previous section, the secondary system has adequate capacity to treat current MM BOD loads and the current PHF of 2.3 mgd. Process modeling indicated that, with the current WWTP practices, the secondary system does not have sufficient capacity to treat the projected 2035 MM BOD loads and PHF.

In order to treat the projected 2035 PHF of 4.2 mgd, the settleability of the mixed liquor must be improved. As discussed previously, SVIs for a healthy biomass are in the range of 125 to 150 mL/g. If settleability can be improved within this range, the capacity of the existing secondary system will be sufficient to handle 4.2 mgd at a MLSS concentration of 2,500 mg/L. Several measures can be undertaken to achieve an SVI in this range. To help determine the appropriate measure, staff have recently collected samples of the MLSS during a period of high SVI for microscopic analysis to identify the filament population causing poor settling. As a result of that analysis chlorine is being applied to the RAS.

Once the effectiveness of chlorination is known, changing the SRT, the anoxic volume and/or changing the aeration pattern may be evaluated as measures to achieve a desirable SVI. If necessary the addition of polyaluminum chloride (PAX) or polymer to the RAS to improve settleability may be evaluated. If an SVI cannot be maintained within a range of 125 to 150 mL/g, expansion of the existing secondary process would be required to provide adequate capacity to treat a PHF of 4.2 mgd (projected Year 2035).

7.4.2.4 Solids Handling

Currently the WWTP operates at aSRTs at or exceeding 10 days and produces a well stabilized sludge that can be thickened and dewatered without producing odors beyond the City's acceptable threshold. Since the WWTP is located immediately adjacent to a residential area, providing for adequate odor control is very important. Maintaining longer SRTs allows the plant to generate very well stabilized WAS prior to solids storage, transport and disposal. However, SRT will decrease over time as the BOD load increases due to growth. As previously discussed, this issue is exacerbated by the poor settleability of the MLSS, which must be maintained at a concentration of less than 2,500 mg/L to treat current PHF at an SVI of over 300 mL/g. Even if SVI is improved to an acceptable range of 125 to 150 mL/g, MLSS must be reduced to 2,500 mg/L to accommodate Year 2035 PHF. Under Year 2035 MM BOD loads, the aSRT is expected to drop to 2.8 days (total SRT of 4.7 days). At this SRT it is anticipated that odor issues will increase significantly.

To mitigate the potential for odor generation, aSRT could be increased by reducing the anoxic volume from its current level (40 percent) to a more typical level (10 percent). This could be accomplished by dividing Zone 1 into two zones and adding diffusers to the second half of Zones 1 and 2. This modification would increase the aSRT under projected 2035 MM BOD loads to 5.3 days (total SRT of 5.8 days). Although this modification will increase WAS stabilization, it may not fully reduce the potential for odor generation under future loading conditions. In this event, modifying the operational sequence of the aerated WAS storage tank may be implemented to increase sludge residence time and further increase WAS stability prior to dewatering. Aerated sludge storage tanks may be operated in an intermittent aeration and decant mode, allowing the sludge to be thickened to between 1.5 and 2 percent solids. Assuming one third of the sludge storage tank side water depth is needed for decanting, operating the sludge storage tanks in this mode will provide an additional 6.4 days of stabilization under 2035 MM BOD loads.

Even if these modifications to the secondary system and sludge storage tanks are implemented, the combined total retention time in the secondary process is estimated to be 12.2 days with 11.6 days under aeration. Currently the WWTP operates with a total retention time of around 21.3 days with around 14.6 days under aeration. Therefore, the potential for odor generation and the capacity of the existing odor control system to treat foul air may need to be evaluated as part of an overall biosolids management plan.

Based on solids loading, the current thickening and dewatering equipment has sufficient capacity through Year 2035, assuming the equipment is operated five days per week, 12 hours per day. The City has noted that the thickening and dewatering systems are not meeting the 85 percent capture guarantee. However, this deficiency is not impacting capacity at this time. Currently, dewatered cake from the WWTP is very well stabilized, and tests to Class B standards. Dewatered cake is transported for disposal at the Rosevelt Regional Landfill. The Washington Department of Ecology requires beneficial use of biosolids for all new facilities, and may require beneficial use of Bainbridge WWTP biosolids at some point in the future. Additionally, the level of biosolids stabilization will decrease over time as loads to the treatment plant increase. The City will need to continue to monitor the quality of the dewatered cake from the WWTP, and prepare a biosolids management plan to evaluate alternatives to address potential future odor concerns, future disposal and/or beneficial reuse, and the ability to haul unclassified solids to a landfill.

7.4.2.5 UV Disinfection

The design of the current UV system allows for the addition of four more modules and 50 percent more lamps. If these four modules are used to create two new banks, which are placed in series with the existing four banks, the headloss is estimated to exceed two inches at the current rated PHF of 3.6 mgd, and would therefore lead to inefficient disinfection. A disinfection alternatives study is necessary to determine the design UV dose for the existing system, which will better define the capacity of the current system. Additionally this study will evaluate how best to expand the capacity of the system, if required.

7.4.2.6 Effluent Pumping

The current effluent pumps have a capacity of 4.0 at a TDH of 53 ft. City staff have noted that air pockets accumulate in the effluent force main, which reduces pumping capacity. The effluent force main is scheduled to be replaced in 2014. At this time, the anticipated TDH will be approximately 45 ft at a flow of 4.3 mgd, which provides sufficient pumping capacity through the Year 2035. TDH of the pumping system should be monitored after the force main is replaced, to confirm the available pumping capacity. Additionally air vacuum release valves should be installed on the discharge side of the effluent pumps and/or at key locations along the force main to prevent air pockets from continuing to accumulate.

7.5 RECOMMENDED PLANT IMPROVEMENTS

Table 7.5 summarizes the recommended plant improvements to meet the projected 2035 flows and loads.

Table 7.5 Recommended Improvements General Sewer Plan City of Bainbridge Island		
Unit Process	Recommended Improvement	Timing⁽¹⁾
General	Develop a hydraulic model of the WWTP to confirm hydraulic capacity.	Short-term
Fine screens	Evaluate alternatives to increase screening capacity; implement recommendations.	Long-term
Grit removal	Evaluate alternatives to increase grit removal performance; implement recommendations.	Short-term
Aeration basins	Add baffle wall to divide Zone 1; add diffusers to Zones 1 and 2.	Short-term
Secondary clarifiers	Analyze alternatives to reduce SVI ⁽²⁾ .	Short-term
UV disinfection	Evaluate alternatives to improve disinfection capacity; implement recommendations.	Short-term
Solids Handling	Evaluate/implement alternatives to improve sludge stabilization for odor control.	Long-term
Effluent pumping	Add air-vacuum relief valve(s) effluent pump discharge piping.	Short-term
Notes: (1) Short-term projects are those required between now and 2025. Long-term projects are those required between 2026 and 2035. (2) If SVI cannot be maintained in the range of 125 to 150 mL/g on a regular basis, additional secondary clarifier capacity will be required. Improvements to achieve this capacity are not included in this list of recommended improvements.		

OPERATIONS AND MAINTENANCE

8.1 INTRODUCTION

This chapter provides an overview of the City of Bainbridge Island Wastewater Utility organization, staffing, and operation and maintenance (O&M) 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 has a Manager-Council form of government. The City Manager oversees management of the Public Works Department and the Wastewater Utility through the Public Works Director. The Wastewater 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.

8.3 DEPARTMENTAL COORDINATION

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 1.59 full time equivalent (FTE) positions and are outlined in this section.

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

Within the Planning and Community Development Department the Development Engineer is funded at 0.06 FTEs by the Wastewater 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 0.77 FTEs funded by the Wastewater 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 0.47 FTEs funded by the Wastewater Utility is responsible for information technology network and computer services management as well as CAD mapping and geographic information system development and management.

8.4 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 a 36 approved FTE positions. Under the Public Works Director there are a total of 6.2 FTEs assigned responsibility for planning, design, construction, operation, maintenance, and management of the sanitary sewer system.

With the exception of the wastewater treatment plant operators, all of the positions that support the sewer utility have multiple areas of responsibilities and only a portion of each position is funded by the sewer utility. The current Public Works organization chart is shown in Figure 8.1. Positions with a portion of time assigned to support the Wastewater Utility are shown in blue.

8.5 PUBLIC WORKS DEPARTMENT COORDINATION

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

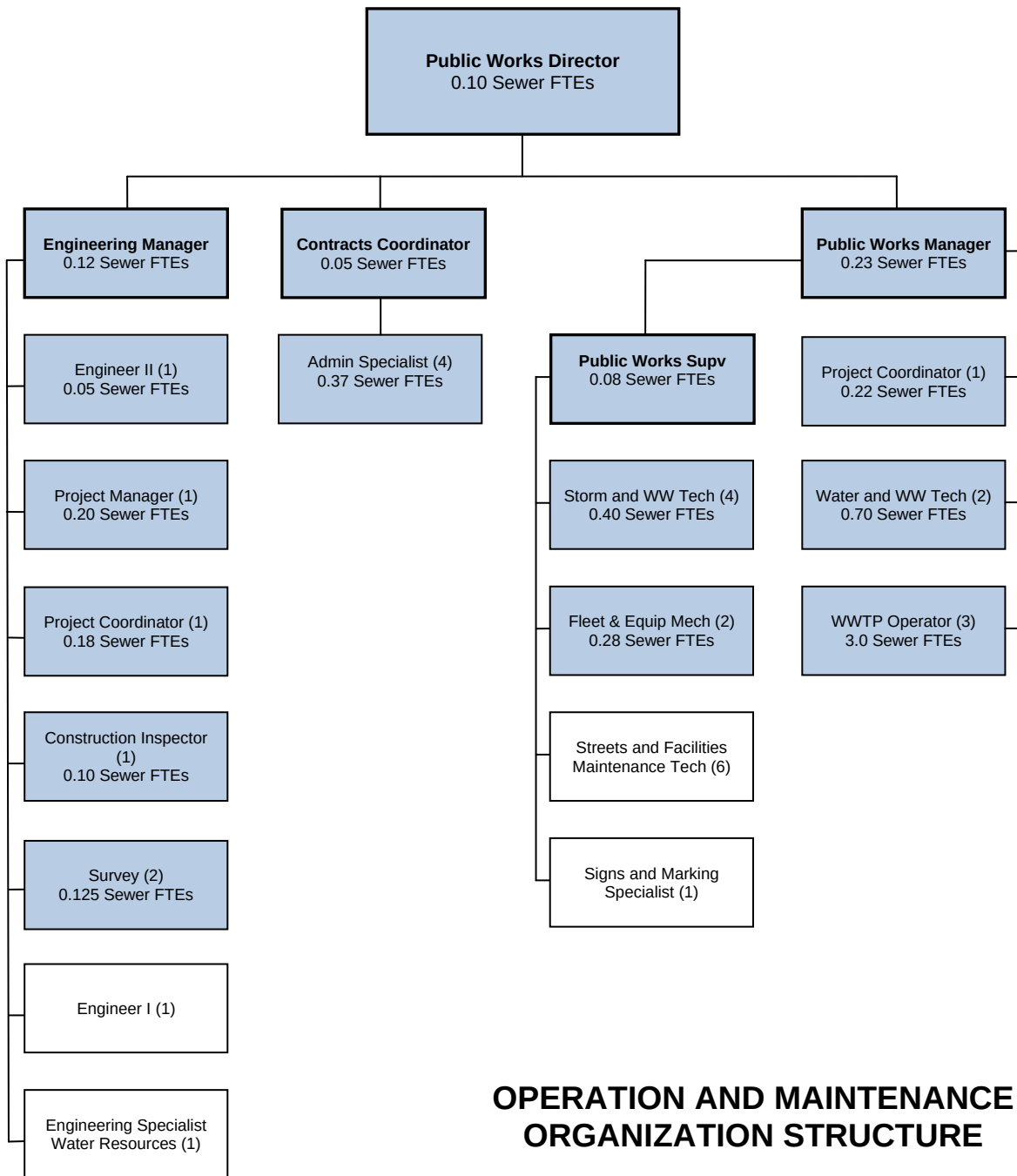
The Engineering Division is responsible for comprehensive sanitary sewer system planning, capital improvement plan (CIP) development, and the design, construction, and inspection of major projects related to the sanitary sewer system. The Engineering Manager oversees the Engineering Division and reports 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 Operations and Maintenance Division is responsible for day to day operations of the sewer collection system, pump stations, and wastewater treatment plant. The Public Works Manager oversees the division and reports to the Public Works Director. The O&M Division Wastewater Utility responsibilities are organized as outlined in the remainder of this section.

The Water/Wastewater Maintenance Group has both water and wastewater responsibilities. Wastewater responsibilities include pump station mechanical, electrical, and telemetry operation, maintenance, and repair. This group also performs underground sewer utility locates and provides customer, development, and capital support activities.

The Stormwater and Wastewater Collection Maintenance Group has both stormwater and wastewater responsibilities. Wastewater responsibilities include collection system, force main, and wet well inspection, cleaning, maintenance, and repair.



OPERATION AND MAINTENANCE ORGANIZATION STRUCTURE

FIGURE 8.1

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN



The Wastewater Treatment Plant Group has three positions assigned solely to operation and maintenance of the wastewater treatment plant. Responsibilities include plant operation, maintenance, repair, laboratory testing, process control, and regulatory reporting.

The Utility Project Coordinator position is responsible for plan review, contractor coordination, contract management, equipment procurement, and small capital project delivery. This position also shares side sewer inspection responsibilities with the Construction Inspector position assigned to the Engineering Division.

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

8.6 OPERATOR CERTIFICATION

The Washington State Department of Ecology, under WAC 173-230, requires every operator in charge of a wastewater treatment plant to be certified at a level equal to or higher than the classification rating of the facility. Under condition S5 of the City's National Pollutant Discharge Elimination System (NPDES) permit, an operator certified for at least a Class III Plant shall be in responsible charge of the day-to-day operations and an operator certified for a Class II Plant shall be in charge during all regularly scheduled shifts. There are currently no Washington State certification requirements for wastewater collection system operators. However, the Department of Ecology encourages participation in a program for collection system certification. Table 8.1 summarizes the certification of staff personnel as of June 2014.

Table 8.1 Wastewater Personnel Certification General Sewer Plan City of Bainbridge Island		
Title	Treatment Plant	Collection System
O&M Manager	WWTP Group II	WW Collection Specialist II
Treatment Plant Operator III	WWTP Group III	
Treatment Plant Operator II	WWTP Group II	
Treatment Plant Operator II	WWTP Group II	WW Collection Specialist II
Water/WW Maintenance Tech II		WW Collection Specialist II
Collection Maintenance Tech II		WW Collection Specialist II
Collection Maintenance Tech I		WW Collection Specialist II
Collection Maintenance Tech I		WW Collection Specialist I
Collection Maintenance Tech I		WW Collection Specialist I

8.7 OPERATION AND MAINTENANCE PROGRAM

The majority of routine operation and maintenance activities are performed by the Public Works Department Operations and Maintenance Division. These activities are generally categorized and prioritized as follows.

Priority 1 emergency repairs – These are unscheduled activities necessary to restore equipment and systems to normal functioning and capacity. Examples include sewer main breaks, blocked sewers, and pump failures.

Priority 2 routine operations – These are essential activities necessary to maintain equipment and systems in good working condition on a day to day basis in order to ensure normal system operation and regulatory compliance. These activities are performed on a regular daily, weekly, and monthly frequency. Examples include sewer availability application processing, pump station inspections, and laboratory testing.

Priority 3 preventive maintenance – These maintenance activities are necessary to maintain equipment and systems in good working order. These activities are performed on a less frequent basis than routine operations. Examples include sewer main cleaning, valve cycling, and pump testing.

Priority 4 corrective maintenance and repairs – These activities are scheduled and are necessary to maintain the normal functioning of equipment and systems. Examples include pump, motor, and piping repair, overhaul, and replacement.

Priority 5 capital and development project support – These activities are necessary to support capital and development projects that add to or enhance system capacity. Examples include plan review, construction coordination, construction inspection, and comprehensive planning support.

The normal operation and maintenance schedule covers critical sewer system components and activities. The schedule balances regulatory requirements, project priorities, manufacturer's recommendations, and industry standards with available manpower and budget to maintain a realistic operations and maintenance program.

The operation and maintenance program responsibilities are separated into the general functional areas that include pump stations, collection system, wastewater treatment plant, and emergency response. The work group responsible for the functional area and normal work activities performed are described in the following sections. The work groups are cross trained and able to provide mutual support during emergencies and peak loads as necessary.

8.7.1 Pump Stations

The City's 17 sewer pump stations were constructed between 1950 and 2013 and the average station age is 26 years. Four of the oldest and largest capacity stations were

reconstructed between 1978 and 2008. The stations include both drywell/wet well and submersible wet pit designs. Station firm capacities range from 60 to 2,720 gpm. Wet well level controls include floats, bubblers, and pressure probes. Electrical controls include both relay logic and PLCs. All stations are monitored by the telemetry system. Each station has an emergency power generator on site and the City has three mobile generators as back up.

Sewer pump station operations, maintenance, and repairs are performed primarily by two Water and Wastewater Maintenance Technicians and the time allocated for this activity is 0.7 FTEs.

Pump station pump run times, cycle times, trends, alarm, and event history is reviewed through the telemetry system daily. Each station is inspected and minor preventive maintenance performed weekly. The emergency generators are inspected and tested monthly. Major pump, motor, mechanical and electrical maintenance is performed semiannually. Station access roads, grounds, and vegetation are maintained annually. The emergency generators are load tested every 36 months and the station pumps are flow tested every 72 months. The current sewer pump station maintenance schedule is summarized in Table 8.2.

Table 8.2 Pump Station Maintenance Summary General Sewer Plan City of Bainbridge Island		
Frequency	Component	Activity
Daily	SCADA	• Review pump station event and alarm history. • Check pump run/cycle times and trends.
Weekly	Air Compressor and Bubbler System	• Inspect for unusual sounds, vibration, and leaks. • Bleed condensation from tank and water separator. • Exercise air flow regulator and reset rotameter.
	Dehumidifier	Check operation, drain and defrost as required.
	Drywell	Inspect and clean as necessary.
	Electrical	Check for loose connections, relays, or burnt wires.
	Exhaust Fan	Check for operation and air movement.
	Isolation Valves	Check for freedom of movement.
	Odor Control System	Inspect for unusual sounds, vibration, odors, and leaks.

Table 8.2 Pump Station Maintenance Summary General Sewer Plan City of Bainbridge Island		
Frequency	Component	Activity
Weekly	Pumps and motors	• Test run each pump and motor set. • Inspect check valve for normal operation. • Inspect for unusual sounds, vibration, odors, and leaks. • Inspect coupling and check mechanical seal for leaks.
	Sump pump	Test pump operation.
	Wet well	• Inspect for excess debris or grease accumulation. • Check floats for freedom of movement. • Inspect bubbler line condition. • Inspect and clean level transmitter.
Monthly	Emergency Generator	• Check belts, hoses and fluids. • Operate and test generator. • Test transfer switch.
6 month	Check Valves	Inspect and clean.
	Dehumidifier	Inspect and clean.
	Drywell	• Inspect and clean. • Check for loose conduits and fasteners. • Lubricate man way and locks.
	Electrical	• Inspect for loose connections, cracked, or burnt wires. • Check starter for burnt or degraded contacts. • Perform infrared test. • Measure amperage readings.
	Exhaust Fan	Inspect and clean.
	Gate Valves	Exercise through complete cycle.
	Level Controls	Clean bubbler, floats, and/or level transmitter.
	Odor Control System	Inspect for unusual sounds, vibration, odors, and leaks.
	Piping	Inspect and clean.
	Pumps and Motor Set	Lubricate.
	Sump Pump	Inspect and clean sump.

Table 8.2 Pump Station Maintenance Summary General Sewer Plan City of Bainbridge Island		
Frequency	Component	Activity
12 month	Access Roadway	Inspect, grade, and gravel as required.
	Grounds and Vegetation	Remove vegetation as required.
36 month	Emergency Generator	Perform load test
72 month	Pump and Motor Set	Perform pump flow test

8.7.2 Collection System

The City's gravity and force main sewer system was constructed between 1950 and 2013. The sewer system includes approximately 26 miles of gravity main, eight miles of force main, three miles of low pressure grinder pump force mains, and 780 manholes. The sewer mains range in size from 2 to 16 inches in diameter and construction materials include clay, concrete, PVC, ductile iron, concrete cylinder, asbestos cement, and HDPE pipe. Sewer collection system operations, maintenance, and repairs are performed primarily by four Stormwater and Wastewater Collection Maintenance Technicians and the time allocated for this activity is 0.4 FTEs.

The majority of sewer main line cleaning is accomplished with a high velocity cleaner/vacuum truck. The City has two of these trucks, one primary and one reserve unit. This equipment is effective to clear emergency blockages, remove grease buildup, flush debris, and cut roots using a hydraulic root cutter. The vacuum portion of the equipment is effective for wet well and manhole maintenance and sewer spill response cleanup.

The City has a truck mounted closed-circuit television inspection unit used for sewer main inspections and a portable inspection unit used for side sewer inspections. The primary use of this equipment is to inspect the condition of the lines associated with capital and development projects and to investigate the cause of line failures and blockages. Currently the City has developed a digital library of about 10 percent of the gravity sewer system.

Sewer pump station wet wells are cleaned on a three to six month frequency dependent upon grease and debris build up at the station. Currently the City has identified 18 sewer main trouble spots in the collection system. Trouble spots are typically the result of low flow, poor grade, grease build up, or root intrusion. Sewer main trouble spots are inspected and cleaned on a three to six month scheduled basis. Dependent upon the site, maintenance activities may consist of television inspection, mechanical rodding, high velocity cleaning or flushing with large volumes of water.

Effectiveness is reassessed during each maintenance cycle. Sewer trouble spots are routinely added or removed or maintenance frequencies adjusted as necessary to prevent

sewer blockages and maintain normal functioning of the sewer system. As a routine practice, all sewer blockages or spill occurrences are added to the trouble spot schedule for follow up to determine if regular maintenance or cleaning is required.

The sewer system is divided into five maintenance zones. Scheduled maintenance is performed in each zone on an annual basis so that 20 percent of the system is maintained each year. During each maintenance cycle, manholes, blowoff, and air release valves are inspected; isolation valves are located and cycled; and gravity sewer mains are cleaned. Low pressure grinder pump force mains are flushed on a 5 year cycle. Collection system maintenance is summarized in Table 8.3.

Table 8.3 Collection System Maintenance Summary General Sewer Plan City of Bainbridge Island		
Frequency	Component	Activity
3 - 6 month	Wet Well	Inspect and clean wet well.
	Sewer Trouble Spots	Inspect and clean trouble spots.
12 month	Sewer System 20%	• Inspect and clean sewer manholes. • Clean gravity sewer mains. • Inspect air release and blow off valves. • Exercise sectional valves.
60 month	Grinder Pump Force Mains	Flush.

8.7.3 Grinder Pumps

In 2005 when the City constructed the South Island Sewer System, the City accepted ownership, operation, and maintenance responsibilities for new residential sewer grinder pumps installed as part of the project. In 2011 the City expanded the policy of accepting ownership, operation, and maintenance responsibilities to include all new residential grinder pumps installations. Routine maintenance and emergency repairs on grinder pumps is provided under contract by a pump service provider. As part of the service agreement regularly scheduled maintenance is provided as outlined in Table 8.4.

Table 8.4 Grinder Pump Maintenance Summary General Sewer Plan City of Bainbridge Island		
Frequency	Component	Activity
48 month	Easement Agreement	Inspect for conformance with standards.
	Electrical	Visually inspect and clean inside of control panel.
	Electrical	Inspect for loose connections, cracked, or burnt wires.
	Electrical	Test emergency alarm and level control sensors.
	Electrical	Measure amperage readings.
	Pump and Motor Set	Perform pump test, check for unusual noises or vibrations.
	Pump and Motor Set	Inspect check valves for leakage.
	Pump and Motor Set	Operate grinder pump and ROW isolation valves.

8.7.4 Winslow Wastewater Treatment Plant

The Winslow Wastewater Treatment Plant (WWTP) is a Class III activated sludge plant. The plant was constructed in 1978 and subsequently upgraded in 1994, 2003, and 2010. The current treatment plant consists of fine screens, grit removal, plug-flow aeration basins, three secondary clarifiers, UV disinfection, and effluent pumping. The solids produced in the aeration basins are further aerated in the sludge holding tank. Aerated solids are thickened and dewatered prior to disposal at the Roosevelt Regional Landfill. Other disposal options are available for Class B solids and will be evaluated in the future.

WWTP operational activities include laboratory testing and process control; biosolids processing and dewatering; and plant maintenance and repair. These activities are performed primarily by three full time Wastewater Treatment Plant Operators. Laboratory sampling and testing is performed on a regularly scheduled basis according to the WWTP NPDES permit and annual biosolids testing requirements. All NPDES permit monitoring tests are performed by an accredited laboratory. The WWTP maintains a laboratory accredited to perform standard WWTP sample analysis and laboratory certification testing is performed on an annual basis. Laboratory analysis required by permit that is beyond the WWTP laboratory accreditation is sent to an outside laboratory accredited for the parameter being tested. The results of NPDES permit monitoring testing are reported in the monthly Discharge Monitoring Report and annual biosolids report. NPDES testing, frequency, and WWTP laboratory accreditation is shown in Table 8.5.

Table 8.5 Wastewater Treatment Plant Laboratory Testing Summary General Sewer Plan City of Bainbridge Island			
Parameter	Location	Frequency	Accredited
BOD	Influent/Effluent	2/week	Yes
TSS	Influent/Effluent	2/week	Yes
Fecal Coliform	Effluent	2/week	Yes
pH	Effluent	5/week	Yes
Total Residual Chlorine	Effluent	Daily	Yes
Acute Toxicity Testing	Effluent	2/permit cycle	No
Chronic Toxicity Testing	Effluent	2/permit cycle	No
Total Ammonia and Nitrate-Nitrite Nitrogen	Effluent	1/year	No
Total Kjeldahl Nitrogen, Dissolved Oxygen, Oil and Grease, and Phosphorus	Effluent	3/permit cycle	No
Priority Pollutants	Effluent	3/permit cycle	No

Daily plant activities include plant inspections, meter reading, and control adjustments. As part of these activities critical WWTP parameters, trends, and alarms are reviewed through the telemetry system and anomalies investigated and corrected as necessary. In addition to the permit required testing outlined above, daily plant activities include laboratory sampling, analysis, and calculations necessary for routine plant process control. Because the WWTP is located in the immediate vicinity of a residential neighborhood routine plant hosing, clean up, and odor control activities are an important part of daily plant operations.

Biosolids processing and dewatering is performed on a regular daily basis. The operations include solids pumping, chemical adjustment, and solids dewatering. Every seven to 10 days the biosolids transport container is filled, prepared for shipping, and changed out for an empty container. An annual biosolids report is completed each year.

WWTP maintenance is performed on a regularly scheduled basis. Minor preventive maintenance is performed on a daily basis. Major pump, motor, mechanical and electrical maintenance is performed at intervals ranging from one to 36 months. The emergency generator is tested weekly, run under load monthly, and load tested every 36 months. Plant electrical systems are inspected annually. Aeration basins and clarifiers are dewatered, inspected, and serviced every 24 months. WWTP maintenance is summarized in Table 8.6.

Table 8.6 Wastewater Treatment Plant Maintenance Summary
General Sewer Plan
City of Bainbridge Island

Schedule Task	Weekly	1-mo	3-mo	6-mo	12-mo	24-mo	36-mo
3W Reuse System	X			X			
Electrical Inspection					X		
Aeration System		X		X	X	X	
Biosolids Systems	X				X		
Blowers	X				X		
Building			X				
Chemical Feed	X				X		
Clarifiers	X	X			X	X	
Effluent Pumping	X		X		X		
Emergency Generator	X	X			X		X
Grit System	X			X	X		
Headworks	X				X		
Grounds							
Odor Control System	X	X			X	X	
Sludge Tanks		X		X	X	X	
UV System		X	X		X		

8.7.5 Emergency Response

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 Wastewater 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 entire City organization is available to provide support as necessary.

Wastewater 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 WWTP and system alarms are routed for response by the plant operators. Emergencies reported by the public are reported to the Operations and Maintenance Division and the appropriate personnel are dispatched to respond.

As part of the SCADA telemetry system an automated dialer system reports sewer 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 sewer 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. Wastewater Utility employees are trained to respond to system alarms or emergencies. The contacted employee assesses the situation and then responds in accordance with established emergency response procedures.

8.8 RECORD KEEPING

Throughout the City a wide variety of Wastewater 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. Planning and Community Development maintains building and development records. Information Technology maintains information system and GIS records. Public Works Engineering maintains project, construction, study, survey, easement, and right of way records.

The Public Works Operations and Maintenance Division maintains sewer availability application, service installation, and inspection records. Building and development projects are tracked through an integrated land use software system. Safety, training, and fleet maintenance records are maintained and incident reports document major events and emergencies.

Sewer pump station, collection system, and WWTP operational records are maintained covering maintenance, video inspections, laboratory performance, biosolids reporting, and NPDES reporting. Through the telemetry system, pump station and WWTP key alarm, event, and monitoring data is archived and stored.

All work performed by the division is organized, documented, and tracked on work orders 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.

8.9 OPERATION AND MAINTENANCE IMPROVEMENT SUMMARY

The following items are being implemented to improve the function of the current operation and maintenance program:

- Update the current maintenance management system structure to better plan, track, and evaluate performance.
- Improve routine maintenance, project close out, and GIS coordination practices to insure comprehensive map records and timely GIS updates.
- Continue to improve and integrate system inventory, records, and information management systems.
- Update the existing operation manuals to account for regular and emergency operation practices.
- 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) pipeline, pump station, wastewater treatment plant, and the other general projects that were recommended in the previous chapters and presents a comprehensive capital improvements plan (CIP) for the sewer system. The purpose of the CIP is to provide the City with a guideline for planning and budgeting of its sewer system. The CIP consists of schedule and cost estimates for the recommended improvements. Project phasing is described as either Short-Term (2015 through 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
- "PS" = Pump Station
- "TP" = Treatment Plant
- "G" = General

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

The cost estimates presented in this CIP are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers' experience on other projects. The cost estimates have been prepared for general master planning purposes. Capital costs, or "total project costs" are presented in the CIP.

All costs are in 2014 dollars and are based on an Engineering News-Record Construction Cost Index (ENR CCI) 20-City Average of 9800 (June 2014). Most of the cost estimates were developed using a Class 4 budget estimate, as established by the American Association of Cost Estimators. This level of estimate is used for master planning and assumes a 1 percent to 15 percent level of project definition. The expected accuracy range is -15 percent to +30 percent. Some projects within the CIP that require further study to be defined have been assigned a conceptual cost estimate as a place-holder for planning purposes because a more refined estimate cannot be provided at this time.

All cost estimates provided in this CIP represent total project cost including materials, construction, engineering, legal, and administrative costs. Unit costs for pipelines are described in Section 9.2.1. Project costs for pump stations were developed using a pump

station cost curve as described in Section 9.2.2. Acquisition of property, easements, and right-of-way (ROW) may be required for some of the recommended projects. However, for the purpose of this Plan, pipeline corridors or easements are assumed to be in public ROW, and therefore do not require land acquisition. Thus, land acquisition is not included in the cost estimates.

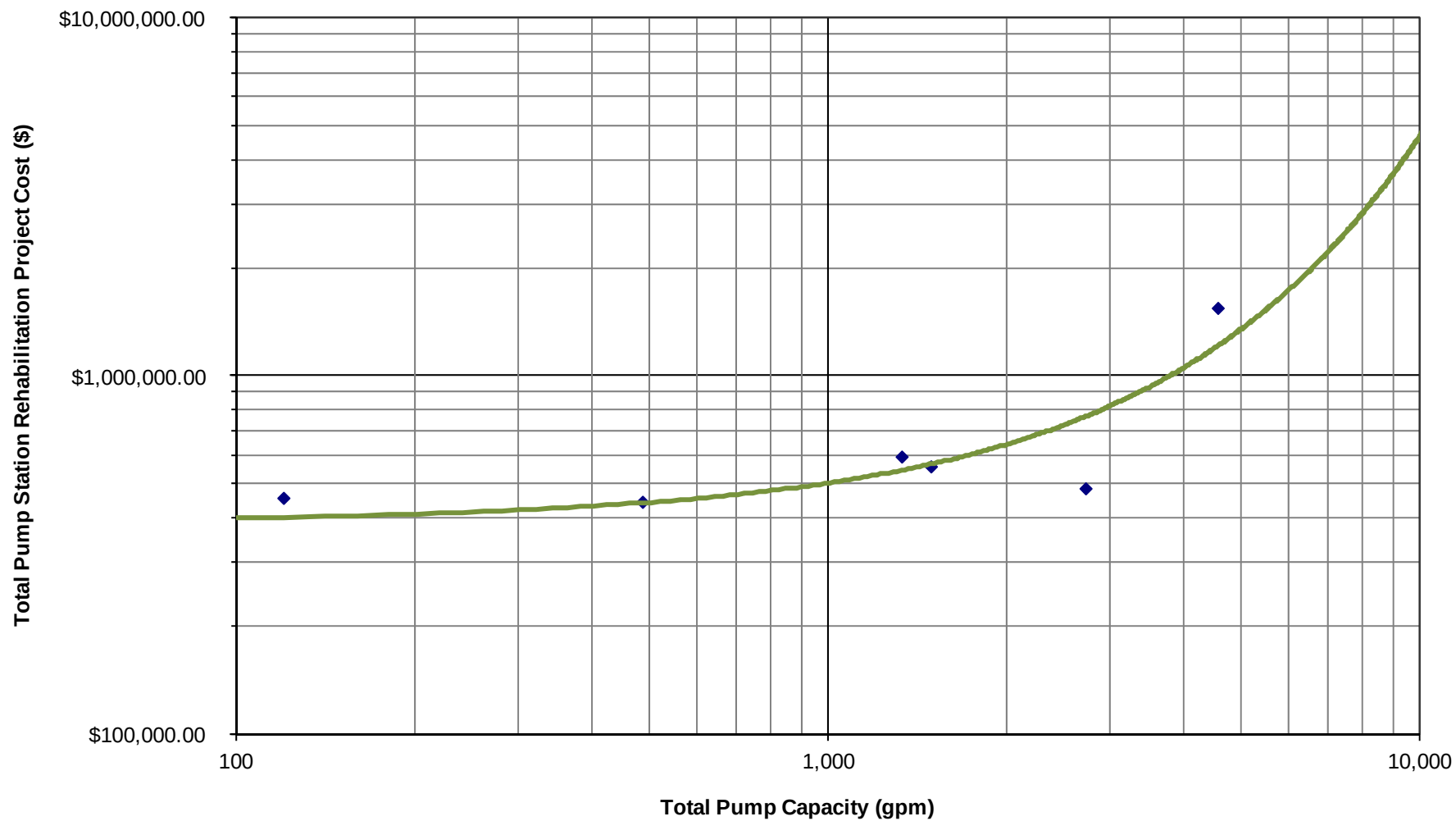
9.2.1 Pipeline Unit Costs

All of the known pipeline improvements required within the planning period are either 8-inch pipe or 10-inch pipe. Pipeline unit costs are shown in Table 9.1. These costs were developed from recent construction costs of various sewer pipelines of either PVC or HDPE materials. 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 contingency, general conditions, contractor overhead and profit, and engineering, legal, and administrative costs.

Table 9.1 Pipeline Unit Costs General Sewer Plan City of Bainbridge Island	
Pipe Size (Inches)	Pipeline Unit Cost (\$/Linear Foot)⁽¹⁾
8	\$ 193
10	\$ 242
Notes: (1) Pipeline unit costs include 30% Contingency, 10% General Conditions, 15% General Contractor Overhead, and 20% Engineering/Legal/Admin.	

9.2.2 Pump Station Cost Curve

Recent pump station rehabilitation projects completed by the City as well as Carollo Engineers were compiled to create the pump station cost curve shown in Figure 9.1. All points on the curve are total project costs and have been adjusted to 2014 dollars. One of the projects included in this curve is the 2008 Highway 305 Pump Station refurbishment project, which amounted to approximately \$300,000 in construction fees and \$100,000 in design and permitting fees. This cost curve was used to estimate the construction cost of pump station repair and upgrade projects in the City’s CIP.



PUMP STATION COST CURVE

FIGURE 9.1

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

9.3 PIPELINE PROJECTS

The City will need to maintain and replace its sewer pipelines as they age. No pipeline improvement projects are required based on capacity deficiencies. Costs associated with replacing aging pipelines, which were identified as part of the remaining useful life analysis described in Chapter 4, are budgeted within P-1: Annual Pipeline Preservation Program. The City has additionally identified P-2: Lower Lovell Beach Mains Replacement as a separate pipe project that is required due to the ductile iron pipe's (DIP) exposure to seawater that has resulted in corrosion. The pipeline projects recommended to be completed during the planning period are listed in Table 9.2 and shown on Figure 9.2.

9.3.1 P-1: Annual Pipeline Preservation Program

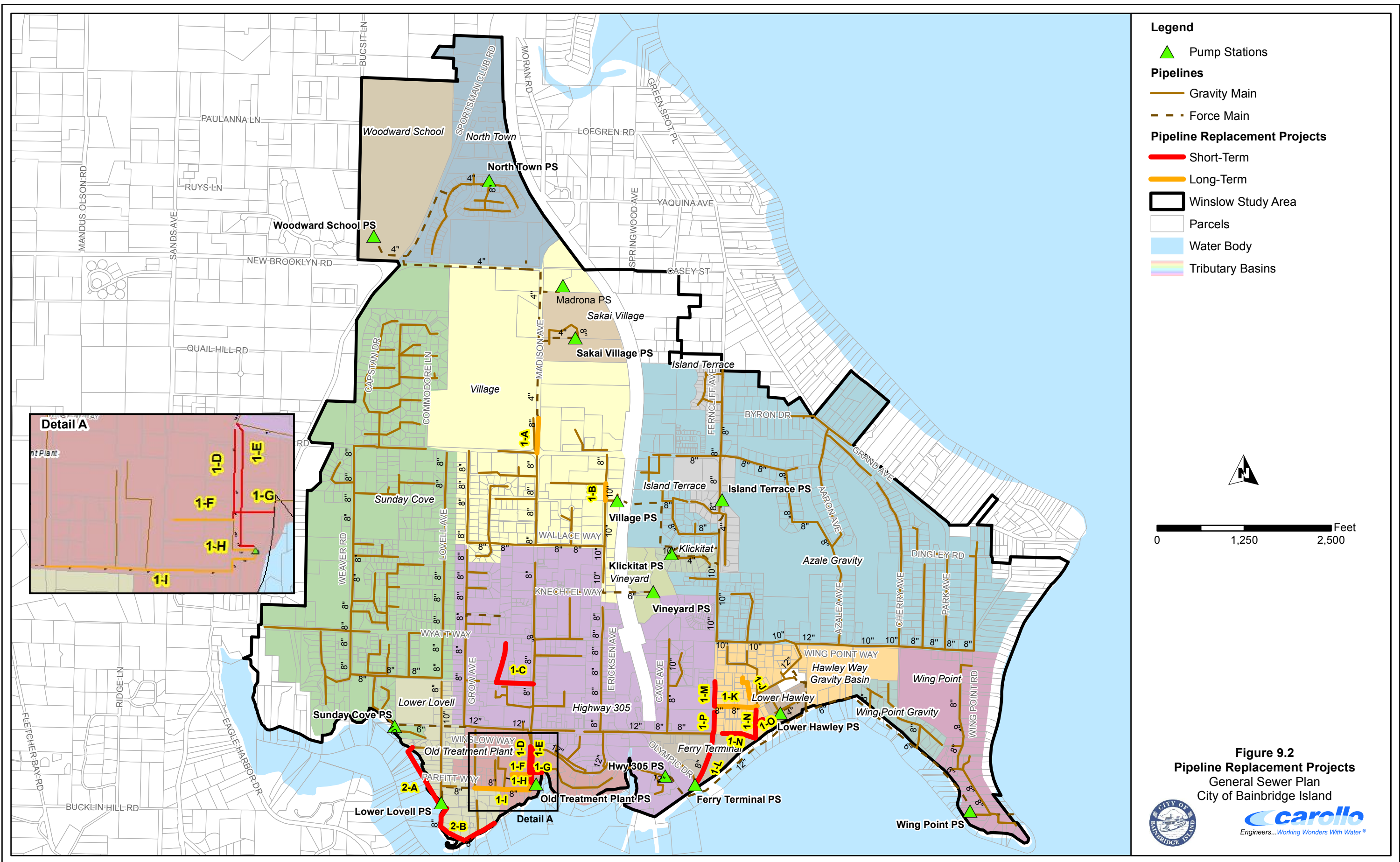
The Annual Pipeline Preservation Program includes replacement of all of the pipelines expected to reach the end of their useful life during the planning period. As reported in Chapter 4, approximately 9,000 LF of pipe is expected to reach the end of its remaining useful life by 2035. The locations of every segment of pipe that will reach the end of its useful life during the planning period are not known because the installation year is unknown for some pipe segments. However, the location of approximately 7,800 LF of pipe that is expected to reach the end of its useful life is known and shown on Figure 9.2 as projects 1-A through 1-P. For the Short-Term phase, \$120,000 per year is budgeted for pipe replacement while \$68,000 per year is budgeted in the Long-Term phase for pipe replacement projects. Pipes of unknown diameter are assumed to be replaced with 10-inch pipe.

9.3.2 P-2: Lower Lovell Beach Mains Replacement

Two DIP gravity beach mains with a total length of 2,010 LF convey sewer to the Lower Lovell Pump Station. They are shown as 2-A and 2-B in Figure 9.2. These pipes were installed in the 1970s along the beach of Eagle Harbor, thereby subjecting them to wetting and draining tidal cycles as well as a corrosive seawater environment. The pipes are likely experiencing severe corrosion and degradation as other DI pipes installed along the beach during the same era have experienced failures.

The City has identified these pipes for replacement in the Short-Term planning period. Replacement of pipes along the beach is more expensive than conventional pipe construction. Based on a similar pipeline replacement project for sewer force mains on the Eagle Harbor beach that was completed during the summer of 2014, the Lower Lovell Beach Mains Replacement Project is estimated to have a total project cost of \$296/LF or approximately \$600,000.

Table 9.2 Pipeline Replacement Projects General Sewer Plan City of Bainbridge Island					
Segment	Diameter (Inches)	Upstream Manhole ID	Downstream Manhole ID	Length (LF)	Phase
1-A	8	2-51	2-25	500	Long-Term
1-B	10	2-40	2-1	240	Long-Term
1-C	8	8-90C	8-77	1,110	Short-Term
1-D	8	3-19	3-10A	380	Short-Term
1-E	8	Old Treatment Plant PS	8-13	580	Short-Term
1-F	Unknown	3-10C	3-10A	260	Long-Term
1-G	Unknown	3-11	3-10	170	Short-Term
1-H	10	3-9	Old Treatment Plan PS	100	Long-Term
1-I	8/10	3-5	Old Treatment Plan PS	950	Long-Term
1-J	8	11-133	11-55	470	Long-Term
1-K	8	11-67	11-64	620	Long-Term
1-L	8	Ferry Terminal PS	8-39	760	Short-Term
1-M	8	11-70	11-67	350	Short-Term
1-N	8	10-2	10-4	880	Short-Term
1-O	Unknown	10-5	10-3	120	Short-Term
1-P	Unknown	8-41	8-39	310	Short-Term
2-A	8	888	6-7	1,000	Short-Term
2-B	8	6-21A	Lower Lovell PS	1,010	Short-Term
Total Short-Term				6,670	Short-Term
Total Long-Term				3,140	Long-Term
Total				9,810	



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

9.4 PUMP STATION PROJECTS

Pump station upgrades projects have been identified to address future capacity deficiencies or to address issues of poor condition due to aging. Projects associated with upgrading pump stations that will reach the end of their expected useful life during the planning period are part of CIP item PS-1: Pump Station Repair and Improvements Program. Pump Stations that need to be upgraded to meet future capacity demands are listed as individual pump station projects. These projects include PS-2: Village Pump Station Upgrade, PS-3: North Town Woods Pump Station Upgrade, PS-4: Sunday Cove Pump Station Upgrade, PS-5: Woodward School Pump Station Modifications and PS-6: Lynwood Center Pump Station Upgrade.

9.4.1 PS-1: Pump Station Repair and Improvements Program

Of the City's 17 pump stations, 14 are expected to reach the end of their useful life, which is assumed to be approximately 30 years, during the planning period. Five of these aging pump stations will additionally require capacity upgrades. The projects for these five pump stations have been listed as separate individual projects in the CIP. Therefore P-1: Pump Station Repair and Improvements Program includes the upgrades of nine pump stations during the planning period. Seven of the nine pump stations are expected to reach the end of their useful life during the Short-Term, while the remaining two will reach the end of their useful life during the Long-Term planning period.

The capacities of the pump stations requiring rehabilitation range from 100 gpm to 250 gpm. Based on the pump station cost curve, Figure 9.1, the cost of a full pump station upgrade for these stations would range from approximately \$400,000 to \$420,000. An average pump station rehabilitation total project cost of \$410,000 was used in the development of this CIP budget item.

As pump stations age and require improvements, the generators associated with them will require upgrades as well. The Ferry Terminal, Woodward School, Vineyard, and Madrona Pump Station all rely on backup power from generators that are not owned by the City. Fixed generators that are owned by the City should be installed for increased reliability. For increased redundancy mobile generator receptacles should be installed at the Ferry Terminal, Woodward School, North Town Woods, and Lynwood Center pump stations. These generator improvements are considered to occur as pump stations are rehabilitated for the purposes of CIP budgeting.

Additionally as upgrade projects take place, wet well controls should be replaced to meet current safety standards specifically at the Old Treatment Plant, Village, Lower Lovell, Lower Hawley, Wing Point, Island Terrace, and Klickitat pump stations.

9.4.1.1 Short-Term Phase Projects

Excluding individual pump station projects PS-2 through PS-6, the following seven pump stations will reach the end of their useful life during the Short-Term planning period: Old Treatment Plant, Ferry Terminal, Lower Lovell, Lower Hawley, Wing Point, Island Terrace, and Klickitat. A sum of \$2,870,000 is budgeted for pump station rehabilitation in the Short-Term.

The following projects have been identified for implementation in the Short-Term phase.

- *Cathodic protection assessment.* The metal drywell/wet well stations at five locations that have not been rehabilitated are showing signs of moderate to advanced corrosion. The performance of the cathodic protection components of these stations should be assessed. The stations include Village, Lower Lovell, Lower Hawley, Wing Point, and Klickitat.
- *Painting of drywell/wet wells.* The five stations listed above that have metal drywell/wet wells showing signs of corrosion need to be painted. Additionally the concrete drywells and wet wells at three pump stations including Old Treatment Plant, Island Terrace, and Lynnwood require painting.
- *Upgrade of remote telemetry unit (RTU) equipment.* The tone RTU and older programmable logic control (PLC) telemetry systems that have not been upgraded since installation in 1995 at nine stations require replacement. These stations include Old Treatment Plant, Ferry Terminal, Lower Lovell, Lower Hawley, Village, Wing Point, Island Terrace, Klickitat and Woodward.
- *Replacement of Old Treatment Plant Pump Station generator.* The City has scheduled to replace the generator at the Old Treatment Plant Pump Station in 2019.
- *Wing Point Pump Station Improvements.* The Wing Point Pump Station has not been upgraded since its construction in 1979 and will reach the end of its useful life within the Short-Term planning period. Besides the general condition concerns that also apply to the City's other aging pump stations, the Wing Point Pump Station has some unique upgrade requirements. Firstly, the station access hatch is currently under water during extreme high tides and should be extended. Secondly, it is recommended that an air-vacuum relief valve be installed in the force main at the discharge of the Wing Point pumps.

9.4.1.2 Long-Term Phase Projects

Excluding Short-Term pump station projects and individual pump station projects, the following two pump stations will reach the end of their useful life during the Long-Term planning period: Sakai Village and Rockaway Beach. A budget of \$820,000 is included in the CIP for Long-Term pump station rehabilitation.

9.4.2 PS-2: Village Pump Station Upgrades

The Village Pump Station is expected to require capacity upgrades by 2025. To meet 2035 projected flows, the Village Pump Station needs to be upgraded to a firm capacity of approximately 850 gpm. Additionally, the Village Pump Station has not been upgraded since its installation in 1979. Due to age, the station's valves, controls, and telemetry need to be replaced. The drywell and wet well are showing signs of advanced corrosion. This station will require a comprehensive rehabilitation similar to the City's 2008 Highway 305 Pump Station upgrade project. Based on the pump station cost curve of Figure 9.1, this comprehensive pump station rehabilitation project is anticipated to have a construction cost of \$375,000 and a total capital cost of approximately \$490,000.

9.4.3 PS-3: North Town Woods Pump Station Upgrades

The North Town Woods Pump Station is expected to require capacity upgrades by 2025. To meet 2035 projected flows, the North Town Woods Pump Station is required to have a firm capacity of approximately 135 gpm. As development within the North Town Woods basin increases flows to this pump station, upgrading the capacity of the station will be a high priority because currently the station cannot operate two pumps simultaneously due to power limitations. This pump station is connected to the 4-inch force main that is common to the Woodward School, Madrona, and Sakai Village pump stations. When upgrading this pump station it will be important to consider the full range of force main head conditions exhibited depending on how many pump stations are operating at once. \$400,000 is allocated for North Town Woods Pump Station upgrades in the Short-Term phase of the CIP.

9.4.4 PS-4: Sunday Cove Pump Station Upgrades

The Sunday Cove Pump Station is expected to require capacity upgrades by 2035. To meet 2035 projected flows, the Sunday Cove Pump Station is required to have a firm capacity of approximately 600 gpm. In addition to replacement of the pumps and motors, this project should include the replacement of the station's emergency generator. This upgrade may not be as extensive as the Village Pump Station Upgrade project because the Sunday Cove Pump Station was rehabilitated in 2007. This pump station upgrade project is anticipated to have a total capital cost of approximately \$455,000 and is scheduled for the Long-Term phase.

9.4.5 PS-5: New Brooklyn Force Main Evaluation and Woodward School Pump Station Modifications

An evaluation of the 4-inch New Brooklyn force main and associated pump stations, including Woodward School, North Town Woods, Sakai Village, and Madrona, under simultaneous pumping conditions should be performed in the Short-Term. The first step would be to increase pump station data collection by installing flow meters and pressure gauges, and monitoring pump operation. Likely, modifications to the Woodward School

Pump Station will be required in the Short-Term to avoid the risk of wet well overflow during storm events. It may be possible to reduce overflow risk through pump control modifications. However, it is likely that the Woodward School Pump Station pumps will need to be replaced with pumps capable of operating at the variable head conditions experienced by the New Brooklyn force main. A budget placeholder of \$200,000 has been included in the CIP for evaluation of the New Brooklyn force main issue and modifications to the Woodward School Pump Station. This CIP item includes upgrades to Woodward School Pump Station that are necessary due to age.

9.4.6 PS-6: Lynwood Center Pump Station Upgrades

In order to serve the entire South Island Study Area, the Lynwood Center Pump Station will require a capacity upgrade. The analysis of this Plan suggests that the Lynwood Pump Station will need to have a firm capacity of approximately 300 gpm. In conjunction with the capacity upgrades project, an in-depth South Island Study Area flow evaluation should be performed to more accurately determine the required capacity of the Lynwood Pump Station. This item is included in the CIP as G-2: South Island Study Area Flow Study. In addition to capacity upgrades, within the Long-Term planning period the Lynwood Pump Station will require upgrades of its valves, controls and telemetry due to age. A budget of approximately \$425,000 is included in the Long-Term phase of the CIP for the Lynwood Center Pump Station Upgrades project.

9.4.7 PS-7: South Island Grinder Pump Replacement

The South Island grinder pumps were installed in 2005 and will be reaching the end of their useful life during the planning period. The City plans to replace the grinder pumps over a five-year period during Long-Term phase. Estimated cost of replacing the grinder pumps is \$294,000 over five years.

9.5 WASTEWATER TREATMENT PLANT PROJECTS

Winslow Wastewater Treatment Plant upgrade and improvement projects have been identified to allow the treatment plant to continue to reliably meet NPDES permit limitations and to not have an adverse impact on the surrounding residential community as the treatment plant approaches its design capacity. Although the treatment plant was recently upgraded, the recommended CIP projects recognize that not all of the treatment plant components were included in the upgrade and that some of the treatment plant's components will reach the end of their service life within the planning period.

As the treatment plant influent flows and loads increase and as NPDES permit limits change, it is important that the City continue to be proactive in evaluating treatment process performance, identifying necessary improvements, and modifying and upgrading the treatment plant, as needed. It is therefore recommended that the City conduct a wastewater treatment plant capacity evaluation and facilities plan update every ten years.

The importance of such a proactive approach is recognized in regulations promulgated by the Washington State Department of Ecology. Their regulations require that, as a minimum, capacity evaluations and facilities planning be initiated when a wastewater treatment plant reaches 85% of its rated capacity.

9.5.1 TP-1: Short-Term WWTP Capacity and Improvements Evaluation

A WWTP Capacity and Improvements Evaluation is recommended in the Short-Term. This evaluation should consider NPDES permit changes, a review of flows and loads compared to the rated capacity of the treatment plant, upgrades to processes and equipment that were not upgraded in the recent treatment plant improvements project, necessary process modifications, and replacement of aging or outdated equipment.

Based on the flow and load projections and the treatment plant evaluations completed within this Plan, it is recommended that the following processes and concerns be evaluated in the Short-Term:

Hydraulic capacity – According to the 2007 WWTP upgrades design documents, the hydraulic capacity of the Winslow WWTP is 3.6 mgd. Peak hour flows (PHF) for year 2035 entering the WWTP are projected to be 4.2 mgd. Hydraulic modeling of the WWTP is required to confirm the plant's hydraulic capacity and determine processes potentially in need of capacity upgrades for year 2035 PHF.

Grit Removal – Upgrade of the grit removal system was not included in the recent treatment plant upgrades and grit removal equipment will reach the end of its useful life in the Short-Term. Based on the 2007 design documents, the PHF capacity of the grit removal system is 3.6 mgd. Based on flow projections, this flow will be exceeded during the planning period.

Activated Sludge and Aeration Basins – Modifications to the aeration basin are recommended in order to accommodate future BOD loads at the WWTP and mitigate the potential for odor generation. This project involves reducing the anoxic volume of the basins from 40 percent to 10 percent by installing a baffle wall to divide Zone 1 into two zones and adding diffusers to the second half of Zones 1 and 2.

The Winslow WWTP currently experiences high sludge volume index (SVI) values, indicating poor activated sludge settleability. As influent flows and loads increase to the design capacity, the operation of the activated sludge process will have to be adjusted to improve sludge settleability and provide sufficient secondary clarifier capacity. As these operational changes are made, there may be an increased potential for odor generation in the existing solids handling processes.

UV Disinfection - The plant's disinfection system will need to be upgraded in the Short-Term to meet disinfection requirements for future PHF. Plant staff note that air pockets are commonly trapped in the effluent pump force main. Consideration of installation of an air-

vacuum relief valve at the discharge side of the effluent pumps is recommended to remove trapped air and thereby increase the flow capacity of the effluent pump force main.

9.5.2 TP-2: Outfall Extension

The existing outfall for the Winslow WWTP consists of 16-inch concrete pipe and with a terminus that is located 1,000 LF offshore of Wing Point in Puget Sound at a depth of 42 feet below the mean lower low water (MLLW) level.

An extension of the outfall is necessary in order to meet Washington State Department of Health (DOH) standards for protection of shellfish resources and allow re-opening of Geoduck harvesting areas. This project involves extending the outfall to 2,400 feet offshore to a depth of 200 feet. The cost estimate of \$2,600,000 for this project assumes a new 16-inch HDPE outfall pipe would be connected to the existing concrete pipe at the existing terminus and would be placed in a pre-excavated trench and covered with gravel. The new terminus would consist of approximately 15 tide flex diffusers. This cost estimate is based on a similar project that consisted of installing a 24-inch HDPE outfall pipe 2,700 LF into Puget Sound to a depth of 200 feet.

9.5.3 TP-3: Short-Term Improvements

Based on the results of the Short-Term Capacity and Improvements Evaluation, some Winslow WWTP improvements will likely be required. A budget placeholder of \$1,000,000 has been identified to implement recommended Short-Term improvements.

9.5.4 TP-4: WWTP Influent Pipe Improvements

Improvements to the WWTP influent piping is necessary to avoid surcharging. Improvements may include upsizing piping and/or adding parallel piping. Additionally, installation of a concrete vault and/or additional manhole volume for high flow attenuation may be required. Rerouting of blower piping between the blower building and the WWTP will likely be required to implement the improvements. A budget of \$400,000 is included in the Short-Term CIP for this project.

9.5.5 TP-5: Long-Term Capacity and Improvements Evaluation

Based on planning projections, age of equipment, and currently rated capacity, there are several processes that may need to be improved or upgraded in the Long-Term (1926-1935). These include:

Influent Screening – Based on the 2007 design documents, the PHF capacity of the fine screens is 4.0 mgd. Within the Long-Term planning period the capacity of screening at the WWTP may need to be increased. It is recommended that capacity limitations of the screens be reevaluated in the future as flows increase.

Solids Handling – Operation of the WWTP will need to be modified within the long-term planning period to treat increased future flows and loads to the WWTP. Currently the WWTP produces a well stabilized sludge that can be thickened and dewatered without producing odors beyond the City's acceptable threshold. As solids retention time (SRT) is decreased, odors will likely increase and odor control may dictate further solids stabilization. In addition, as the loads to the WWTP increase, the dewatered cake from the WWTP may no longer be able to test to Class B status. In the future, Department of Ecology may require Class B status and beneficial use of Winslow WWTP biosolids.

9.5.6 TP-6: Long-Term Improvements

Based on the results of the Long-Term Capacity and Improvements Evaluation, some Winslow WWTP improvements and upgrades will likely be required. A budget placeholder of \$2,800,000 has been identified to implement recommended Long-Term Improvements.

9.6 GENERAL PROJECTS

This section includes projects that concern the sewer system as a whole, updates to the General Sewer Plan, and an evaluation of the South Island Study Area flows.

9.6.1 G-1: General Sewer Plan Updates

It is recommended that the City update its General Sewer Plan every 10 years. The CIP includes one update during the Short-Term Phase and another update during the Long-Term phase. Each update is budgeted at \$150,000.

9.6.2 G-2: South Island Study Area Flow Evaluation

A flow evaluation of the South Island Study Area is recommended to establish how new South Island customers will be served and determine the future capacity requirements of the Lynwood Center Pump Station. This evaluation should be performed during the Short-Term phase and is budgeted to cost approximately \$50,000.

9.7 CIP SUMMARY

The total Sewer CIP cost over the next 21 years is \$15,894,000, which equates to \$757,000 annually as presented in Table 9.3. Of the total cost, \$10,220,000 is budgeted for the Short-Term phase, while \$5,674,000 is budgeted for expenditure during the Long-Term phase.

The Sewer CIP is split into four categories: pipe, pump station, treatment plant, and general projects. Throughout the planning period \$2,594,000 (16 percent) is budgeted for pipe projects, \$5,950,000 (38 percent) is budgeted for pump station projects, \$7,000,000 (44 percent) is budgeted for treatment plant projects, and \$350,000 (2 percent) is budgeted for general projects.

Table 9.3 Capital Improvements Plan General Sewer Plan City of Bainbridge Island				
Project ID	Description	Total Capital Cost (\$)	Capital Improvement Phasing	
			Short-Term (2015-2025)	Long-Term (2026-2035)
Pipe Projects				
P-1 ⁽¹⁾	Annual Pipeline Preservation Program	\$ 1,999,000	\$ 1,317,000	\$ 682,000
P-2	Lower Lovell Beach Mains Replacement	\$ 595,000	\$ 595,000	
Total		\$ 2,594,000	\$ 1,912,000	\$ 682,000
Pump Station Projects				
PS-1 ⁽²⁾	Pump Station Repair and Improvements Program	\$ 3,690,000	\$ 2,870,000	\$ 820,000
PS-2	Village Pump Station Upgrade	\$ 488,000	\$ 488,000	
PS-3	North Town Woods Pump Station Upgrade	\$400,000	\$ 400,000	
PS-4	Sunday Cove Pump Station Upgrade	\$ 455,000		\$ 455,000
PS-5	New Brooklyn Force Main and Woodward PS Modifications	\$200,000	\$200,000	
PS-6	Lynwood Center Pump Station Upgrade	\$ 423,000		\$ 423,000
PS-7 ⁽³⁾	South Island Grinder Pump Replacement Program	\$ 294,000		\$ 294,000
Total		\$ 5,950,000	\$ 3,958,000	\$ 1,992,000
Wastewater Treatment Plant Projects				
TP-1	Short-Term Capacity and Improvements Evaluation	\$ 150,000	\$ 150,000	
TP-2	Outfall Extension	\$ 2,600,000	\$ 2,600,000	
TP-3	Short-Term WWTP Improvements	\$ 1,000,000	\$ 1,000,000	
TP-4	WWTP Influent Pipe Improvements	\$ 400,000	\$ 400,000	
TP-5	Long-Term Capacity and Improvements Evaluation	\$ 50,000		\$ 50,000
TP-6	Long-Term WWTP Improvements	\$ 2,800,000		\$ 2,800,000

Table 9.3 Capital Improvements Plan General Sewer Plan City of Bainbridge Island				
Project ID	Description	Total Capital Cost (\$)	Capital Improvement Phasing	
			Short-Term (2015-2025)	Long-Term (2026-2035)
Total		\$ 7,000,000	\$ 4,150,000	\$ 2,850,000
General Projects				
G-1	General Sewer Plan Updates	\$ 300,000	\$ 150,000	\$ 150,000
G-2	South Island Study Area Flow Evaluation	\$50,000	\$50,000	
Total		\$ 350,000	\$ 200,000	\$ 150,000
All CIP Projects				
Total Cost		\$ 15,894,000	\$ 10,220,000	\$ 5,674,000
Annual Cost		\$ 757,000	\$ 929,000	\$ 567,000
Notes: (1) P-1 budgets approximately \$95,000 annually. (2) PS-1 budgets 410,000 per pump station requiring rehabilitation during the planning period. (3) PS-6 budgets approximately \$2,000 per grinder pump to be replaced.				

FINANCIAL ANALYSIS

10.1 INTRODUCTION

This chapter presents the financial program, including financial history, outstanding debt, fees and charges, and capital improvement funding. A six-year plan is presented to fund the capital improvements recommended in Chapter 9. This chapter has been prepared by Katy Isaksen & Associates for inclusion in the Plan.

10.2 THREE-YEAR FINANCIAL HISTORY

The sewer utility is operated in a self-sufficient manner. Sewer funds are accounted for separately from other City utilities. While the separate accounting structure has been in place for many years, a legislative separation was accomplished in 2011 to clarify that any long-term financing or outstanding sewer debt would be supported by the sewer customers. The Public Works Department manages the system and the Finance Department manages the billing, collection, long-term debt and accounting services, and the two departments jointly prepare and monitor the biennial budget.

Table 10.1 shows the summary history of sewer operations for the recent three-year period.

Table 10.1 Summary Sewer Operating Fund History General Sewer Plan City of Bainbridge Island			
Sewer Operating Fund 402	2011	2012	2013
<i>Sewer Revenue</i>			
Monthly Sewer Charges	\$3,448,709	\$3,258,927	\$3,538,747
Miscellaneous Revenue	\$19,273	\$45,212	\$85,958
Special Capital Assessments - LID's	\$384,189	\$1,036,171	\$336,254
Capital Contrib - System Participation Fees	\$181,999	\$206,906	\$472,984
G.O. Bonds Proceeds w/Premium	\$5,895,851	-	-
State PWTF-Loan Proceeds	-	\$504,125	\$238,542
Total Sewer Revenue	\$9,930,021	\$5,051,341	\$4,672,485
<i>Sewer Expenditures</i>			
Operating Expense	\$1,772,075	\$1,802,352	\$1,954,009
Debt Service	\$6,847,786	\$1,445,550	\$1,371,469
Capital Improvement/Replacement	\$340,487	\$70,488	\$350,301

Table 10.1 Summary Sewer Operating Fund History General Sewer Plan City of Bainbridge Island			
Sewer Operating Fund 402	2011	2012	2013
Total Sewer Expenditures	8,960,347	\$3,318,390	\$3,675,779
Annual Increase/(Use) of Reserves	969,674	\$1,732,951	\$996,706
Ending Sewer Fund Balance			\$3,843,086

From a financial perspective, there are three portions of the sewer system: 1) the City owns and operates the sewer collection system, 2) the City owns and operates the Winslow wastewater treatment facility and 3) the City contracts with Kitsap County Sewer District #7 (KCSD#7) for sewage treatment services. The City sets the monthly rates for operations, maintenance and improvement of the City's sewer lines, pump stations and treatment facility. KCSD#7 sets the monthly rates for their treatment services and bills the City for such services.

The sewer utility has been meeting the operating expense, debt repayment and capital improvement program in each year and has been maintaining a level of reserves for emergency and future replacement.

The 2013 ending sewer operating fund balance was \$3,843,086. This amount is greater than the target minimum balance of \$456,000 and provides approximately \$3, 4 million available for future capital replacement. The City's financial policies include an operating reserve of 45 days of operating expense (\$244,000) and a capital contingency reserve of 1% of fixed assets of \$21,195,000 (\$212,000). The financial policies also refer to a restricted debt reserve for debt when a restricted cash reserve is required, for example, revenue bonds. There are no such requirements at this time.

The 2014 budget included the Eagle Harbor Beach Main Replacement project with associated PWTF loan proceeds and debt repayment. The project is nearing completion at less than anticipated for the loan application, with a project cost of approximately \$3.2 million compared to \$4.2 million.

The City uses debt financing for certain long-term, costly projects to smooth out the impact on rates, for example the wastewater treatment upgrade and the design and replacement of the Eagle Harbor Beach Mains. In 2011, the City restructured certain older debt by issuing limited tax general obligation (LTGO) bonds at the completion of the wastewater treatment plant upgrade project.

The City has also used local improvement districts (LIDs) to assist property owners in financing certain improvements, such as the South Island sewer collection system. The property owners that benefited pay their share through special assessments, which are billed annually.

Monthly service charges are the primary funding source for the sewer utility. The service charges are used to pay for operations and debt service. The remainder is available for current year capital improvements, future capital replacement or reserves.

The sewer rate ordinance calls for automatic adjustments to the monthly rates on an annual basis to keep up with inflation. The City reviews rates during the budget process and the City Council has taken separate action for several years to cancel the automatic increase and maintain the same rates.

System participation fees are paid by new connections to the system, along with appropriate permit, connection and inspection fees.

10.3 OUTSTANDING DEBT

10.3.1 Existing Sewer Debt Obligations

The existing debt obligations for the sewer utility include a LTGO bond issued for the wastewater treatment plant upgrade and five low-interest Public Works Trust Fund loans from the State of Washington Department of Commerce. A sixth PWTF loan was awarded for the Eagle Harbor Sewer Beach Main project construction. The total principal outstanding as of December 31, 2013 was approximately \$13,600,000. If the Beach Main loan of \$4,167,089 is added, the total principal outstanding would be approximately \$17,780,000. Table 10.2 summarizes the existing sewer debt.

Table 10.2 Existing Sewer Debt Obligations General Sewer Plan City of Bainbridge Island					
Existing Sewer Debt	Original Principal	Interest Rate	Principal Outstanding 12/31/13	2014 Principal + Interest	Year Debt Retires
2011 LTGO Bond Issue, WWTP Improv & Refunding	\$5,700,000	2.0%-4.0%	\$4,675,000	\$597,350	2030
2004 PWTF Preconstruction Loan, WWTP Upgrade	\$389,215	0.5%	\$231,963	\$22,247	2024
2004 PWTF Loan, South Island Sewer LID	\$5,600,000	0.5%	\$3,272,500	\$313,863	2024
2005 PWTF Loan, WWTP Upgrade	\$3,618,000	0.5%	\$2,527,479	\$223,261	2025
2006 PWTF Loan, WWTP Upgrade	\$3,564,500	0.5%	\$2,600,105	\$213,009	2026
2008 PWTF Preconstruction Loan, Beach Main	\$383,542	0.5%	\$306,511	\$21,824	2028
Subtotal	\$19,255,257		\$13,613,557	\$1,391,553	

Table 10.2 Existing Sewer Debt Obligations General Sewer Plan City of Bainbridge Island					
<u>Approved, No Draws as of 12/31/13¹</u>			<u>With full draw</u>	<u>Est. 2015</u>	
2013 PWTF Loan, Eagle Harbor Beach Main Rehab	\$4,167,089	0.5%	\$4,167,089	\$240,186	2033
Total	\$23,422,346		\$17,780,646	\$1,631,739	
<u>Notes:</u>					
(1) PWTF loan from State of Washington Department of Commerce - Loan payments are based on loan proceeds drawn through May of each year.					

The City opted to sell LTGO bonds in 2011 for a portion of the wastewater treatment plant upgrades and refunded certain older outstanding bonds at that time. The use of LTGO bonds resulted in savings to sewer customers with lower interest rates than if the City had used revenue bonds. While the LTGO bonds are legally backed by property taxes, the sewer rate revenues are used to make the debt payments.

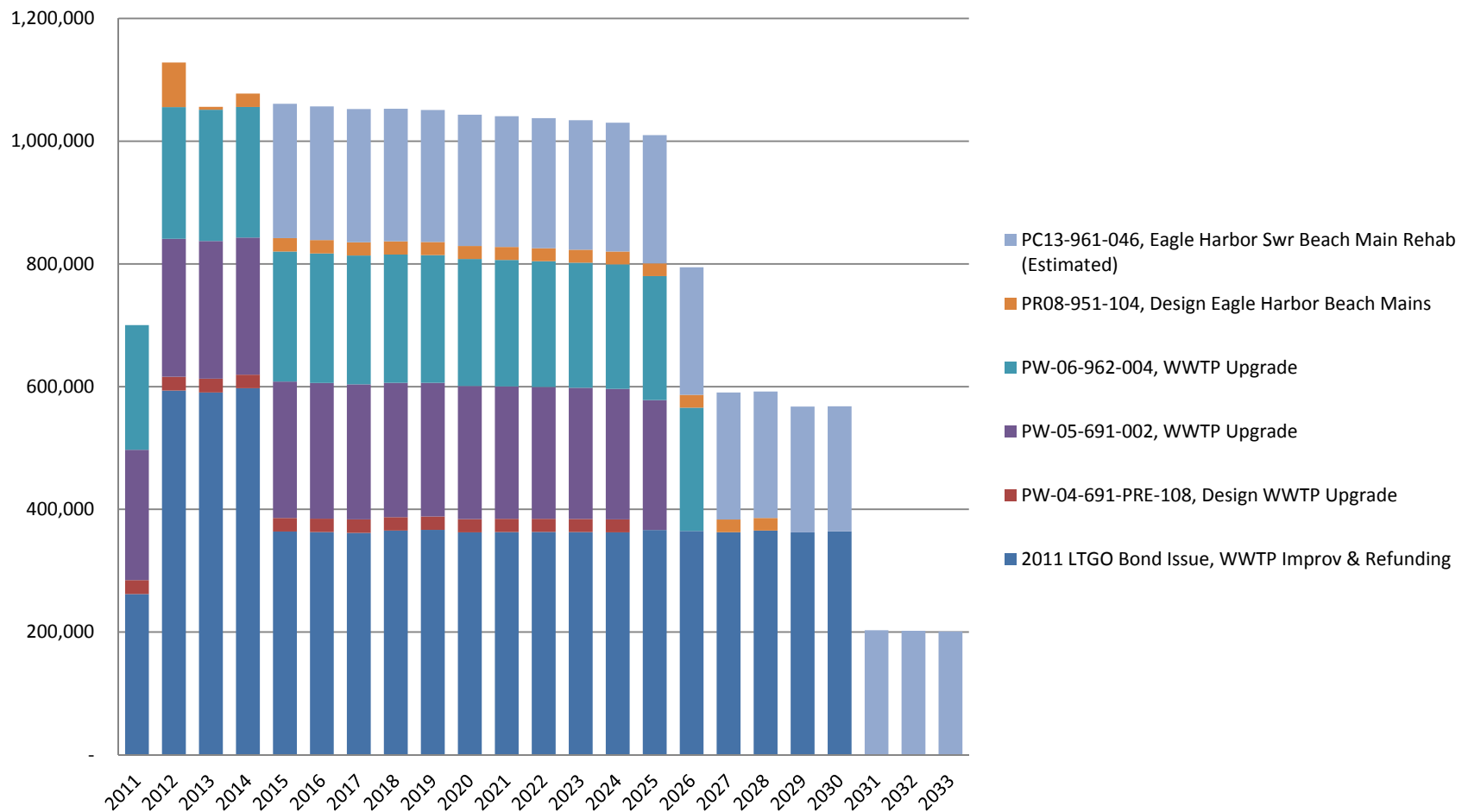
The City has been very successful in using low-interest loans from the State of Washington at 0.5% interest over 20-year loans. This loan program has been designed to be junior in lien to bonded indebtedness. The 2013 loan has been awarded for a maximum of \$4,167,089. The City is eligible to draw loan proceeds for construction activities of the Beach Main project. The debt repayment schedule will be adjusted as necessary until the loan proceeds are fully drawn and the project is complete.

10.3.2 Annual Rate-Supported Sewer Debt Repayment

It is helpful to understand the existing debt obligations on an annual basis to see how they impact monthly sewer rates. The PWTF loan for the South Island Sewer LID is backed by annual assessments and not with sewer rate revenue. Figure 10.1 graphically summarizes the rate-supported annual debt. The 2011 bonds were designed with higher payments in 2012-2014. The bond payments reduce in 2015 and the total debt payment can accommodate the 2013 Beach Main payments with minor impact on rates. The total 2014 rate-supported payments of approximately \$1,078,000 are very similar to the estimated 2015 payments of \$1,082,000.

The overall debt payments decrease slightly each year due primarily to the structure of the PWTF loans (even principal payments and interest on the declining balance). The first opportunity to fund additional projects with future debt without impacting rates would be in 2025 when the existing loans are paid off.

The figure includes the loan for the Eagle Harbor Beach Mains Replacement project at the full \$4.2 million. With the project nearly complete at approximately \$3.2 million, the annual debt service would be less at \$184,000 compared to \$240,000. Because this project is coming in under budget, the City requested and was approved to include the Lower Lovell



ANNUAL RATE-SUPPORTED SEWER DEBT

FIGURE 10.1

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Beach Main Replacement project in the original loan. With an estimated cost of approximately \$600,000, the loan amount would be approximately \$3.8 million, and have an annual payment \$219,000.

10.4 CURRENT RATES AND CHARGES

There are three types of sewer customers in the City: 1) customers of both water and sewer, 2) sewer-only customers that do not receive city water service, and 3) sewer customers that send sewage to Kitsap County Sewer District #7 treatment plant.

The City Council has authority to set rates and charges for the sewer utility to ensure it remains self-sufficient. The rates are reviewed annually during the budget process to determine whether an adjustment is necessary. The current sewer rates and system participation fees have been in place since 2012. The KCSD#7 Board sets their own rate for treatment that has also been the same since 2012.

10.4.1 Current Sewer Rates

There are two components to the sewer rates – a minimum monthly charge per unit for each class of customer and a volume charge based on metered water usage. The summer bills (June-September) for single and multi-family customers are based on the average winter water use (December-May) from the previous period to account for irrigation use that does not flow into the sewer system. Table 10.3 shows the current monthly rate schedule.

Table 10.3 Current Monthly Sewer Rates General Sewer Plan City of Bainbridge Island		
Monthly Sewer Rates & Charges	Per Month	Volume Charge Per 100 CF
Sewer Users of Both Water and Sewer		
Category 1 (Single Family) ¹	\$42.69	\$7.28
Category 2 (Multi-Family) - per Unit ¹	\$37.39	\$7.28
Category 3 (Commercial)	\$123.69	\$7.28
Category 4 (Mixed Use)	\$123.69	\$7.28
Category 5 (Industrial)	Set By Individual Contract	
Category 6 (Senior/Low Income)	\$21.35	\$3.65
Sewer Users without Water Service		
Category 1 (SF) - per unit without meter	\$119.80	
Category 3 (Commercial/Public) - per ERU	\$129.43	
Senior/Low Income - Flat Rate without meter	\$59.90	

Table 10.3 Current Monthly Sewer Rates General Sewer Plan City of Bainbridge Island		
Monthly Sewer Rates & Charges	Per Month	Volume Charge Per 100 CF
Sewer Users to Kitsap County Sewer Dist. 7 Treatment Plant		
KCSD #7 Treatment Rate per ERU (set by KCSD#7, currently \$50.00)		
Properties with Grinder Pump	\$23.59	
Properties without Grinder Pump	\$19.42	
<u>Notes:</u>		
(1) Summer sewer billings for mid-June to mid-September will be set at the property's average billing for the prior mid-December to mid-May. (Cat. 1&2).		

The majority of sewer customers (over 80%) receive both water and sewer service and have water meters to determine the volume charges. There are approximately 20 flat rate customers. The Lynwood Center/South Island Sewer area customers include 137 with grinder pumps and 55 gravity-fed connections.

A typical single family residence using 1,000 cubic feet of water per month currently pays \$115.49 for sewer service. This type of rate structure with a volume charge reinforces the message of water conservation and allows the customer to control their costs for water and sewer service. A single family customer using 800 cubic feet of water would pay \$100.93 for sewer service and another using 500 cubic feet would pay \$79.09. The City also has a low-income senior customer class that receives a 50% discount for income-qualified customers.

10.4.2 Current System Participation Fees

New connections to the sewer system are required to pay a system participation fee for the privilege of connecting into the existing system. Table 10.4 shows the current charges by customer class.

Table 10.4 Current System Participation Fees General Sewer Plan City of Bainbridge Island	
Sewer System Participation Fees	2014
Residential - Single Family	\$5,123.00
Residential - Multi-Family (per living unit)	\$3,178.00
Commercial or Other (per ERU) ¹	\$5,123.00
<u>Notes:</u>	
(1) 1One ERU = 20 fixture units per the schedule of fixture units.	

The non-residential customers are charged based on an equivalent residential unit (ERU) that is determined by the number of fixture units. One ERU is equal to 20 fixture units per the schedule of fixture units that is on file at the City.

New customers connecting in the south island sewer area are also subject to a connection charge that is determined at the time of connection.

10.4.3 Affordability

The Environmental Protection Agency (EPA) defines affordable sewer rates as two percent of median household income (MHI). Another way of looking at affordability is to ask about the definition of hardship for primary sewer grant and loan programs. The Clean Water State Revolving Fund loan program, managed by the Department of Ecology (Ecology), uses the EPA definition of two percent of MHI. With a sewer cost greater than two percent of MHI, a community may be eligible for higher grants, subsidies or lower interest rates. These programs are typically targeted toward residential customers.

The Ecology application guidelines provide the MHI and hardship rate for communities around the State. The current funding guidelines for State Fiscal Year 2016 estimate the MHI for the City to be \$92,558 from the American Community Survey with the current census. To qualify for hardship, two percent of the MHI would be \$1,851, or \$154.00 per month. By this measure, the current average residential rate of \$115.49 is affordable for sewer service.

Another measure of affordability is what residents in other jurisdictions are paying. Table 10.5 compares current 2014 single-family monthly rates for similar jurisdictions in Western Washington. The 2014 Association of Washington Cities (AWC) 2014 Utility Rate Survey was used to identify cities with sewer connections between 1,700 and 3,000. Some jurisdictions have a flat sewer rate and others have a base + volume rate like Bainbridge. In order to compare apples to apples, the table calculates the amount for a typical single family residence using 1,000 cubic feet of water in a month.

Table 10.5 Single-Family Monthly Sewer Rates General Sewer Plan City of Bainbridge Island	
Service Provider	Sewer
Bainbridge	\$115.49
Chehalis	\$111.10
Enumclaw	\$106.33
Sumner	\$83.14
Snohomish	\$69.50

Table 10.5 Single-Family Monthly Sewer Rates General Sewer Plan City of Bainbridge Island	
Service Provider	Sewer
Duvall	\$67.02
Brier	\$60.72
Stanwood	\$57.91
Sequim	\$57.55
Fircrest	\$57.00
College Place	\$55.75
Burlington	\$52.36
Port Orchard	\$49.00
Fife	\$42.01

Figure 10.2 displays the same single family comparison. Bainbridge Island has approximately 2,200 sewer customers.

10.5 CAPITAL IMPROVEMENT FUNDING SOURCES

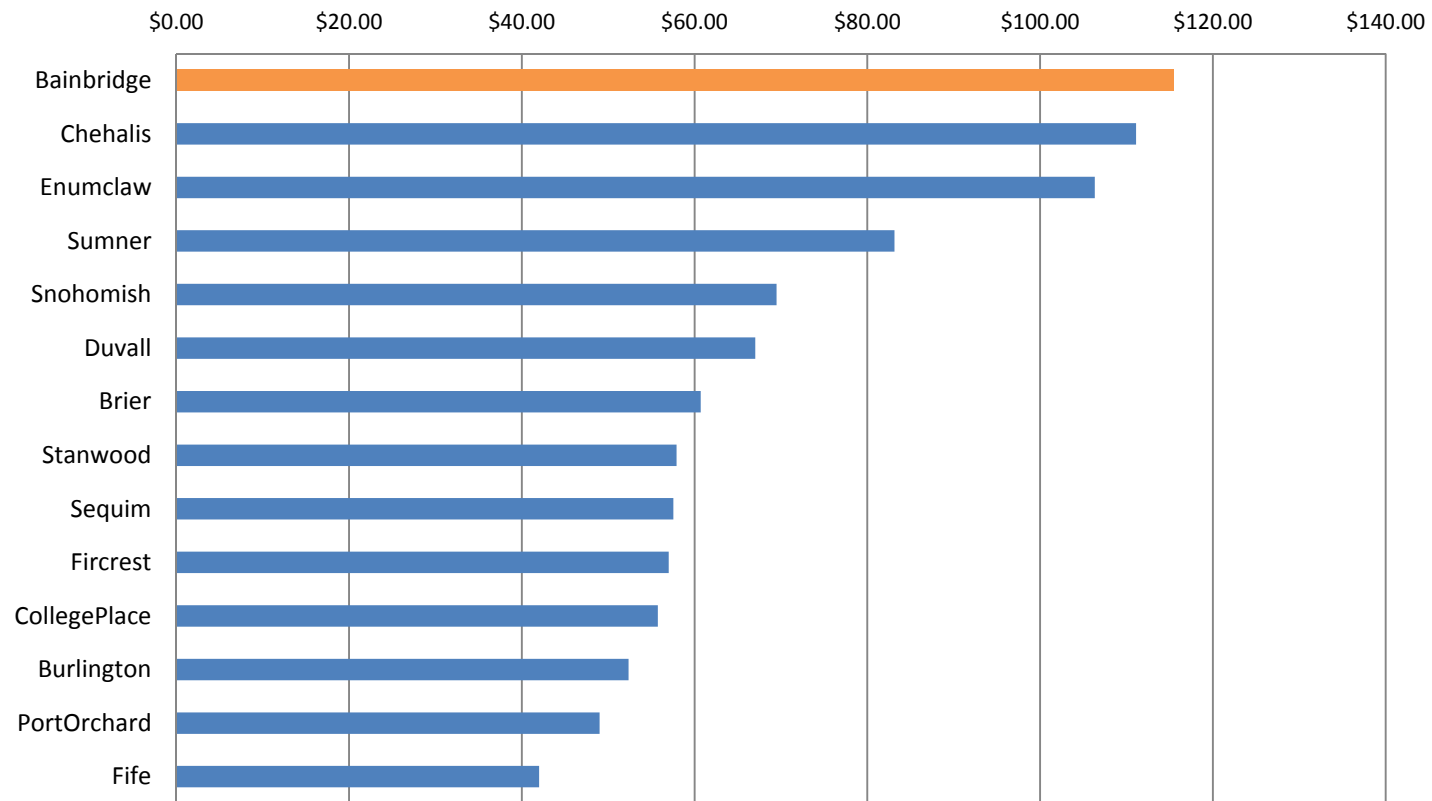
The City has been successful at using a variety of capital funding sources, including grants from various sources, general obligation or revenue bonds, PWTF loans, local improvement districts, sewer reserves and repaying debt with monthly sewer rates.

The recommended CIP includes a combination of improvements to existing facilities, replacement of existing facilities and additional capacity. The use of debt to finance should be carefully considered as there is a cost to securing financing. For large cost projects that provide years of service, a low-interest loan or bond sale can provide construction funding sooner and spread the repayment over a series of year to reduce the impact on ratepayers.

Typical funding sources for capital improvements can be described in several categories:

1. Grant or low-interest loan programs are offered by state, federal and local agencies to assist in funding infrastructure projects. Each program will have its own requirements, eligibility, application cycle and method of doing business. In tough economic times, program changes are common and should be reviewed before seeking funding.

Monthly Sewer - Typical Residence @ 1000cf
AWC 2014 Rate Survey (1,700-3,000 connections)



**SINGLE-FAMILY MONTHLY
SEWER RATES COMPARISON**

FIGURE 10.2

CITY OF BAINBRIDGE ISLAND
 GENERAL SEWER PLAN

2. Bond sales are a common funding method where the City has the authority to sell bonds to fund the improvements and will be repaid over a number of years. This helps the utility lock in current interest rates to complete projects over a maximum three-year period. Revenue bonds are most common for sewer utilities, where the repayment is promised from the reliable stream of service charge revenue. General obligation bonds can also be used where the City pledges the overall revenue of the City, resulting in lower interest costs for ratepayers.
3. Contributions from joint partners, developer extensions and local improvement districts are another category where specific owners, developers or partners pay for the improvements. This category also includes city projects that involve more than one utility or city function, such as street overlay, stormwater and water projects.
4. Other sources include state or federal appropriations, such as an earmark outside of funding assistance programs, one-time legislative programs or local regional programs.
5. Users include system development fees paid by new connections, monthly sewer rates to pay for projects or debt resulting from projects, and sewer reserves saved for future capital improvements.

The primary grant and loan programs for sewer collection projects are described below.

10.5.1.1 State Of Washington Department Of Commerce

The State of Washington Department of Commerce manages several programs targeted toward infrastructure along with community, economic and job development. These include the Community Economic Revitalization Board (CERB) programs to assist in attracting and retaining private investment and resulting in jobs and increased tax revenue to the community. These programs may provide a grant combined with a loan. A fairly new program has been added, Energy Efficiency Grants for Higher Education and Local Governments. The maximum grant under this program has been \$500,000 for local governments and would be available for rehabilitating existing pump stations.

The Public Works Trust Fund (PWTF): The PWTF has had several programs, including construction, pre-construction, emergency and planning. Due to recent State budget issues and legislative priorities, this program is not as reliable as it had once been. The construction program and the emergency program are currently the two active programs. The construction program offers low-interest loans up to \$10 million with an average loan over 20-years at 60% of the bond rate for interest. The City has successfully used this program in the past. The emergency program carries a higher interest rate but can be instrumental when unforeseen emergent needs arise that require substantial investment.

The PWTF construction program requires projects to be ready to proceed and thus the loans must be drawn within 36 months of approval. This is a competitive program with an annual application cycle in January to May of each year, with funds available the following

year. It is anticipated that the Public Works Board will open an application cycle in May or June 2015 depending on the outcome of the current legislative session.

It is possible that the PWTF pre-construction loan program may return. This loan program assisted jurisdictions with funding for engineering design, environmental, archeological, etc. requirements prior to construction.

Community Development Block Grant (CDBG) Program is also housed within the Department of Commerce. A city such as Tukwila would need to go through King County to apply for CDBG funds to assist in a low-income neighborhood.

10.5.1.2 State Of Washington Department Of Ecology

Ecology attempts to have one combined process for the Integrated Water Quality Programs (Centennial Clean Water Program, Clean Water State Revolving Fund, and Section 319) for grants and loans for wastewater systems. The annual applications are due around October of each year. The key to a high rating for Ecology is to identify which water quality problems exist and are being addressed by the project. Low-interest loans are offered at 60 percent of the bond market rate, currently 2.4 percent interest, and limited grants are available for hardship communities. The standard loan is for 20 years and lower interest rates are available for five- and ten-year loan terms.

The draft offer list is published at the end of February and the final offer list comes in June. Agreements must be signed within a year of the offer. Actual work must begin within 16 months of the final offer list and be completed within five years. Ecology defines hardship where the sewer rate is greater than 2 percent of MHI. In hardship cases, limited grants are available to help make sewer more affordable for residential customers. Grants could include principal forgiveness or interest rate subsidy and would be matched with a companion loan. The maximum grant has been up to \$5 million.

The program has also been offering principal forgiveness for eligible “green” projects. The current eligibility parameters should be considered to determine whether the project may qualify.

Another source of potential capital funding is through the economic development path. There are county, state and federal programs available to assist local governments in providing the necessary infrastructure to attract and retain private sector investment and jobs. These programs may or may not have funding available on a regular basis, so it is important to check websites and speak with program administrators before pursuing a particular program. With the current economy, there are new programs being established, either as a one-time offer or ongoing program.

10.5.1.3 US Economic Development Administration (USEDA)

The United States Department of Commerce Economic Development Administration has a Public Works and Economic Development Program to help support public infrastructure that is necessary to generate or retain private sector jobs and investments, attract private sector capital and promote regional competitiveness. The typical maximum is \$1 million and all federal regulations would apply.

10.5.1.4 Other

Congressional or State Appropriations can be acquired by working with federal or state elected representatives to gain their support and request an appropriation specific to your project. In this budget climate, it is extremely difficult to obtain federal appropriations. State appropriations are also difficult to obtain.

The State of Washington has had several pilot or ongoing Local Infrastructure Financing Tool Programs. The successful applicant is approved to retain a portion of the increased taxes from an area resulting from the targeted investment in infrastructure. Given the State budget issues, these programs may or may not be available and are typically subject to legislative approval.

There is an infrastructure funding program database that is provided by the Infrastructure Assistance Coordinating Council (IACC). This can be accessed on the web directly at www.infracfunding.wa.gov. This database is very helpful in determining which funding assistance programs may be available at the time the City is considering each project.

10.6 SEWER CAPITAL IMPROVEMENTS

The recommended sewer capital improvements were presented earlier in Chapter 9. The projects were identified as either short-term, 2015-2025, or long-term, 2026-2035. The cost estimates were prepared using the June 2014 Engineering News Record costs. It is reasonable to assume that the project costs will change by year based on the construction schedule. The recommended projects are estimated to cost \$15,894,000 in 2014 dollars, with \$10,220,000 in the short-term and \$5,674,000 in the long-term,

10.6.1 Six-Year Sewer Capital Improvements

The Short-Term Capital Improvement Plan (CIP) of \$10,220,000 in 2014 dollars and is planned for an eleven-year period 2015 to 2025 as shown in Table 10.6. The average annual cost for planning the six-year capital improvements is \$929,000 and will provide a six-year CIP of \$5,574,000.

In order to allow the most flexibility for the City to complete the projects, the average annual amount is used in the six-year financial plan. The 2014 average annual costs are escalated

each year by 3.5% to reflect the anticipated increase in construction costs. This is important to keep the level of funding in balance with the project costs.

There are two recurring annual programs totaling \$381,000 including: 1) the annual pipeline preservation program is \$120,000 per year and 2) the pump station repair and improvement program is \$261,000 per year. The remaining \$512,000 per year will be used to fund completion of the other projects.

Table 10.6 Short-term Sewer CIP General Sewer Plan City of Bainbridge Island			
No.	Project	Short Term (2015-25)	Annual Program
P-1	Annual Pipeline Preservation Program	\$1,317,000	\$120,000
P-2	Lower Lovell Beach Mains Replacement	\$595,000	
PS-1	Pump Station Repair & Improvement Program	\$2,870,000	\$261,000
PS-2	Village Pump Station Upgrade	\$488,000	
PS-3	North Town Woods Pump Station Upgrade	\$400,000	
PS-5	New Brooklyn Force Main & Woodward P.S. Modifications	\$200,000	
TP-1	Short-Term Capacity & Improvements Evaluation	\$150,000	
TP-2	Outfall Extension	\$2,600,000	
TP-3	Short-Term WWTP Improvements	\$1,000,000	
TP-4	WWTP Influent Pipe Improvements	\$400,000	
G-1	General Sewer Plan Updates	\$150,000	
G-2	South Island Study Area Flow Evaluation	\$50,000	
Total Short-Term Cost (\$2014)		\$10,220,000	
Annual Cost		\$929,000	\$381,000
Total Six-Year CIP (\$2014)		\$5,574,000	

10.6.2 Six-Year Sewer CIP Funding Plan

The 2014 average annual cost for the recommended six-year CIP is \$929,000 per year and reflects a “pay-as-you-go” CIP with no additional borrowing. With the Eagle Harbor Beach Main Replacement project nearing completion for less than the PWTF loan offer, the City requested and recently received PWTF approval to include the Lower Lovell Beach Main Replacement project in the existing loan. After removing the \$595,000 for Lower Lovell, the annual pay-as-you-go amount is \$875,000 as shown in Table 10.7. With the

additional debt repayment, estimated to be \$43,000, the annual cost of this scenario would be \$918,000 for an annual savings of \$11,000.

Table 10.7 Six-Year Annual CIP Cost General Sewer Plan City of Bainbridge Island	
	Cost
Total Short-Term Cost (\$2014)	\$10,220,000
Include Lower Lovell in Existing PWTF	\$595,000
Remainder Pay-As-You-Go (\$2014)	\$9,625,000
Annual Cost Pay-As-You-Go	\$875,000
Annual Cost Additional Debt for CIP	\$43,000
Total Annual Cost this Scenario	\$918,000

The annual cost is brought into the six-year financial outlook and escalated by 3.5% per year. The additional debt payment is also reflected in the six-year outlook.

An alternate scenario was developed and is shown in Table 10.8. The CIP was reviewed to determine whether any projects may be potential candidates for future borrowing. The Outfall Extension project is a possible candidate for borrowing from a low-interest program (either PWTF or Ecology). If a 20-year loan at 3.0% interest is assumed, with the project occurring in 2016 (application in 2015), the debt repayment would begin in 2017. The annual pay-as-you-go amount would be reduced to \$639,000. The new debt repayment would be \$230,000 per year (including Lower Lovell and the outfall extension). The annual cost of this scenario would be \$869,000 and would include debt payments through 2036.

Table 10.8 Potential New Debt for Outfall Extension General Sewer Plan City of Bainbridge Island	
	Cost
Pay-As-You-Go CIP	\$9,625,000
Outfall Extension - Potential New Debt ¹	\$2,600,000
Remainder Pay-As-You-Go (\$2014)	\$7,025,000
Annual Cost Pay-As-You-Go	\$639,000
Annual Cost Additional/New Debt for CIP	\$230,000
Total Annual Cost this Scenario	\$869,000

10.6.3 Six-Year Sewer CIP Funding Impact on Rates

The CIP funding scenarios were run through the sewer financial model developed for this plan to test and compare the estimated impact on monthly sewer rates. The model estimates the percentage impact to balance the revenue and expenditures and applies it to the monthly rates. The results are shown in Table 10.9. In all cases, the rate estimates assume that annual rate revenue should fully cover estimated operating, debt repayment and capital costs.

Under Scenario A: Pay-As-You-Go (including Lower Lovell in the existing PWTF loan), the current base rate of \$42.69 would need to increase approximately 13% or \$5.65 in 2015 to fund the recommended CIP and another three percent or \$1-\$2 per year thereafter. The model estimates the rate would need to be \$55.96 by 2020.

Scenario B includes borrowing for the outfall extension and would spread the impact on rates over three years. The current base rate of \$42.69 would need to increase approximately 15% or \$6.75 by 2017 to fund the recommended CIP and another two percent or \$1.00 per year thereafter. The model estimates the rate would need to be \$52.69 by 2020.

Table 10.9 CIP Funding Scenarios – Impact on Monthly Sewer Rate General Sewer Plan City of Bainbridge Island							
SEWER CIP FUNDING	2014	2015	2016	2017	2018	2019	2020
SCENARIO A: PAY-AS-YOU-GO (Eagle Harbor Beach Mains & Lower Lovell PWTF Loan = \$3.8M)							
This scenario requires a 13% rate increase in 2015 and then about 3% per year thereafter.							
<i>Cumulative Impact on Sewer Rates</i>		13.2%	16.1%	19.0%	22.1%	25.1%	28.1%
<i>Annual Impact on Sewer Rates</i>		13.2%	2.9%	2.9%	3.1%	3.1%	3.0%
Sewer Base Rate per mo	\$42.69	\$48.34	\$49.72	\$51.16	\$52.74	\$54.35	\$55.96
Sewer Volume Rate per 100cf	\$7.28	\$8.24	\$8.48	\$8.72	\$8.99	\$9.27	\$9.54
Single Family @ 1,000 cf/mo	\$115.49	\$130.78	\$134.51	\$138.41	\$142.67	\$147.03	\$151.38
Annual Impact on Base Rate		\$5.65	\$1.38	\$1.44	\$1.57	\$1.61	\$1.61
SCENARIO B: BORROW FOR OUTFALL EXTENSION PROJECT in 2016, PAYMENT BEGINS 2017							
This scenario allows the utility to spread a 15% increase over 3 years 2015-17 and then about 2% per year.							
<i>Cumulative Impact on Sewer Rates</i>		5.7%	7.8%	15.1%	17.3%	19.5%	21.6%
<i>Annual Impact on Sewer Rates</i>		5.7%	2.1%	7.3%	2.2%	2.2%	2.1%
Sewer Base Rate per mo	\$42.69	\$45.14	\$46.08	\$49.44	\$50.54	\$51.63	\$52.69
Sewer Volume Rate per 100cf	\$7.28	\$7.70	\$7.86	\$8.43	\$8.62	\$8.81	\$8.99
Single Family @ 1,000 cf/mo	\$115.49	\$122.13	\$124.67	\$133.76	\$136.72	\$139.68	\$142.55
Annual Impact on Base Rate		\$2.45	\$0.94	\$3.36	\$1.09	\$1.10	\$1.06

10.6.4 Six-Year Sewer CIP Funding Sources

Development of the funding plan includes reviewing the CIP projects and matching appropriate funding sources. System replacement projects should be funded by sewer rates on an ongoing basis. Projects that are necessary to expand capacity or extend the system should be funded by growth through system participation fees.

After reviewing the recommended CIP projects, the majority are system replacement projects that should be funded by ongoing monthly sewer rates. The pump station upgrade projects are necessary to provide additional future capacity. Each upgrade will also likely have some elements of replacement. When these projects are scheduled, the utility should determine the appropriate amount of system participation that should be used.

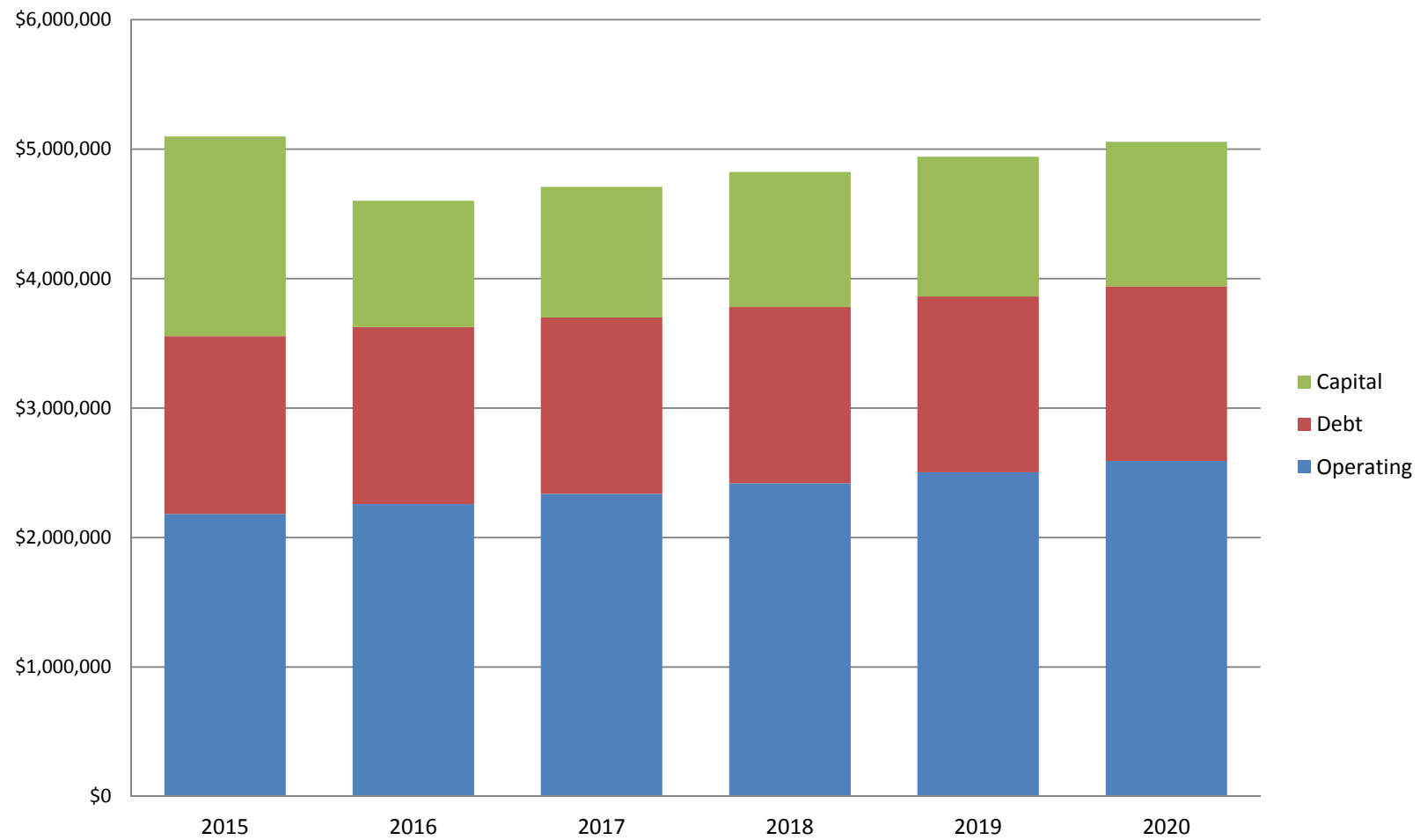
Borrowing is appropriate for costly projects that will provide long-term benefit to the sewer system. Borrowing allows the utility to invest and construct now and spread the repayment over a number of years. This can be a powerful tool in reducing the impact on ratepayers – the rates can be held lower and projects completed sooner than waiting to collect the funding before proceeding with a project. Low-interest loan programs (PWTF and Ecology) usually have 20-year payback periods. Thus if a project does not provide 20-years of benefit, then such a loan would not be recommended.

10.7 SIX-YEAR SEWER FINANCIAL PLAN

The six-year sewer financial plan includes estimated revenue and expenditures for operations, debt service and CIP. Conservative assumptions were used to make future projections from the 2014 budget and necessary adjustments. Customer growth is assumed to be 0.5% per year. Costs are escalated at 3.5% per year to reflect anticipated inflation. Debt service is based on current debt schedules and estimated for the open PWTF loan and potential future loan.

The financial model shows that the utility will either be increasing reserves or using reserves on an annual basis to balance. Table 10.10 shows the six-year sewer financial plan and indicates that rate increases will be necessary to fund the recommended CIP.

Figure 10.3 provides a graphical summary of six-year operations, debt and capital.



SIX-YEAR SEWER EXPENSE OUTLOOK

FIGURE 10.3

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN

Table 10.10 Six-Year Sewer Financial Plan
General Sewer Plan
City of Bainbridge Island

City of Bainbridge Island							
General Sewer Plan		CIP FUNDING SCENARIO A: PAY-AS-YOU-GO (EHBM & LL PWTF \$3.8M))					
Prepared by KI&A based on budget reports provided by City							
Summary	Budget/Base	Projected	Projected	Projected	Projected	Projected	Projected
SEWER OPERATING FUND 402	2014	2015	2016	2017	2018	2019	2020
Revenues							
Sewer Sales (current rates)	3,500,000	3,517,500	3,535,088	3,552,763	3,570,527	3,588,379	3,606,321
Investment Interest	16,000	16,000	16,000	16,000	16,000	16,000	16,000
Special Capital Assessments	316,918	298,694	281,517	265,328	250,071	235,690	222,137
Capital Contrib-Prop Funds on	200,000	200,000	200,000	200,000	200,000	200,000	200,000
State PWTF-Loan Proceeds	3,200,000	600,000					
Total Revenue	7,232,918	4,632,194	4,032,605	4,034,091	4,036,597	4,040,070	4,044,458
Expenses							
Operating Expense							
Salaries & Benefits	863,964	894,203	925,500	957,892	991,419	1,026,118	1,062,032
Salaries - Overtime	39,671	41,059	42,497	43,984	45,523	47,117	48,766
Sal & Benes - Staff Separation	10,600	10,971	11,355	11,752	12,164	12,589	13,030
Supplies	68,914	71,326	73,822	76,406	79,080	81,848	84,713
Professional Services	228,860	236,870	245,161	253,741	262,622	271,814	281,327
Other Services & Charges	180,158	186,464	192,990	199,744	206,735	213,971	221,460
Utilities	131,580	136,185	140,952	145,885	150,991	156,276	161,745
Biosolids Waste Disposal	81,124	83,963	86,902	89,944	93,092	96,350	99,722
Repairs	76,715	79,400	82,179	85,055	88,032	91,113	94,302
Intergovernmental Services	151,100	156,389	161,862	167,527	173,391	179,459	185,740
State Excise Tax	65,926	68,233	70,622	73,093	75,652	78,299	81,040
City Utility Tax	210,000	217,350	224,957	232,831	240,980	249,414	258,144
Subtotal Operating Expense	2,108,612	2,182,413	2,258,798	2,337,856	2,419,681	2,504,370	2,592,023
Debt Expense							
Existing Debt Repayment (P+I)	1,391,553	1,373,447	1,367,699	1,361,801	1,360,753	1,357,204	1,348,256
New Debt for CIP							
Total Debt Expense	1,391,553	1,373,447	1,367,699	1,361,801	1,360,753	1,357,204	1,348,256
Capital expense							
Capital Sal, Bene, Supp, Services	516,045						
Construction & Improvements	3,531,000	600,000					
Capital Equipment	35,000	36,000	37,000	38,000	39,000	40,000	41,000
Capital Improvement Plan (CIP)		906,000	938,000	971,000	1,005,000	1,040,000	1,076,000
Subtotal Capital Expense	4,082,045	1,542,000	975,000	1,009,000	1,044,000	1,080,000	1,117,000
Total Expense	7,582,210	5,097,861	4,601,497	4,708,657	4,824,433	4,941,574	5,057,279
Annual Increase/(Use) of Reserves	(349,292)	(465,667)	(568,892)	(674,565)	(787,836)	(901,504)	(1,012,820)
Percent of Sales-Cumulative		13.2%	16.1%	19.0%	22.1%	25.1%	28.1%
Percent of Sales-Annual		13.2%	2.9%	2.9%	3.1%	3.1%	3.0%
Sewer Base Rate per mo	\$42.69	\$48.34	\$49.72	\$51.16	\$52.74	\$54.35	\$55.96
Sewer Volume Rate per 100cf	\$7.28	\$8.24	\$8.48	\$8.72	\$8.99	\$9.27	\$9.54
Single Family @ 1,000 cf/mo	\$115.49	\$130.78	\$134.51	\$138.41	\$142.67	\$147.03	\$151.38